



University of Sultan Moulay Slimane

Faculty of Sciences and Technics, Beni Mellal

Laboratory of Biotechnology and Valorization of Plant Genetic Resources

Co-Organize with the Association of ADAR Beni Mellal-Khenifra, Morocco



1st International Congress



Under the theme:

SUSTAINABLE AGRICULTURE:

TOOLS AND INNOVATIONS «AgriNov2021»



27-30th October 2021

Conference amphitheater of the Faculty of Sciences and Technics



Faculty of Sciences and Techniques, USMS, Beni Mellal – Morocco, 27- 30th October 2021

Abstracts Book

1st International Congress
**SUSTAINABLE AGRICULTURE:
TOOLS AND INNOVATIONS**
«AgriNov2021»



Abstracts Book

October, 27-30th 2021

Faculty of Sciences and Technics
University of Sultan Moulay Slimane

FOREWORD

Currently, the agricultural world is experiencing a remarkable boom and at the same time a pivotal period marked by multifaceted and increasing threats in several sectors. The negative effects on agricultural production and people's livelihoods are being felt in many parts of the world and will certainly only worsen over time. Thus, agricultural stakeholders, policy makers and citizens are forced to position themselves for a real paradigm shift in attitudes, practices and consumption patterns. Indeed, our modern societies must make a major paradigm shift to build a sustainable agriculture that takes into account the ecosystem services to which it contributes and which our societies accept to assume the economic counterpart. This agriculture must necessarily be part of its territory, and change past practice that emphasizes the export of non-renewable resources such as water, with catastrophic carbon footprint assessments at the expense of know-how and expertise exports.

In Morocco, the agriculture is an important sector, counting for 14% of the gross national product and employing 40% of the workforce. A new development strategy "Green Generation 2020-2030" has recently been launched by the Moroccan Ministry of Agriculture, Fishery, Rural development, Water and Forest with the aim of reinforcing the achievements of the previous development strategy "Green Morocco" and filling the gaps that have been recorded, particularly in terms of environmental conservation, social inclusion and sustainability of food systems.... In this context, support must be given to this transition by rethinking the methods used to strengthen and support systemic agricultural development. This can only be evident if R&D efforts are sufficiently developed and innovative measures are taken.

Sustainable agriculture, using the ecology principles and concepts, allows designing innovative agricultural models, combining the tripartite principle of economic, social and environmental improvement. Look at what is being done and succeeds elsewhere has become crucial to provide benchmarks that are original, powerful and inspiring.

With the emergence of the Covid-19 pandemic, several sectors have been bloated. Even scientific researchers with their partners in agriculture and environmental preservation have struggled to highlight innovative and sustainable advances in agricultural R&D. It is in this perspective that the first International Congress on Sustainable Agriculture: Tools and Innovations (AgriNov2021) will be held in Beni Mellal from 27 to 30 October. The event will bring together leading researchers and development practitioners in the fields of agriculture and environmental conservation. It will be an ideal platform to exchange and discuss experiences and/ or innovations in sustainable agriculture. It is also an opportunity to set up collaborations between researchers at the national and international levels.

We would like to thank all our partners who have contributed to the success of this event, as well as all those who ensured the production of this collection. We also thank the members of the scientific and the organizing committees for their expertise and the time devoted to success this edition.

Organizing Committee



Conference ID

CONFERENCE TITLE

1st International Congress Sustainable Agriculture: Tools and Innovations «AgriNov2021»



DATE AND PLACE

October, 27-30th 2021/ Faculty of Sciences and Technics, University of Sultan Moulay Slimane, Beni Mellal, Morocco

Participations

Speaker presentations: 25

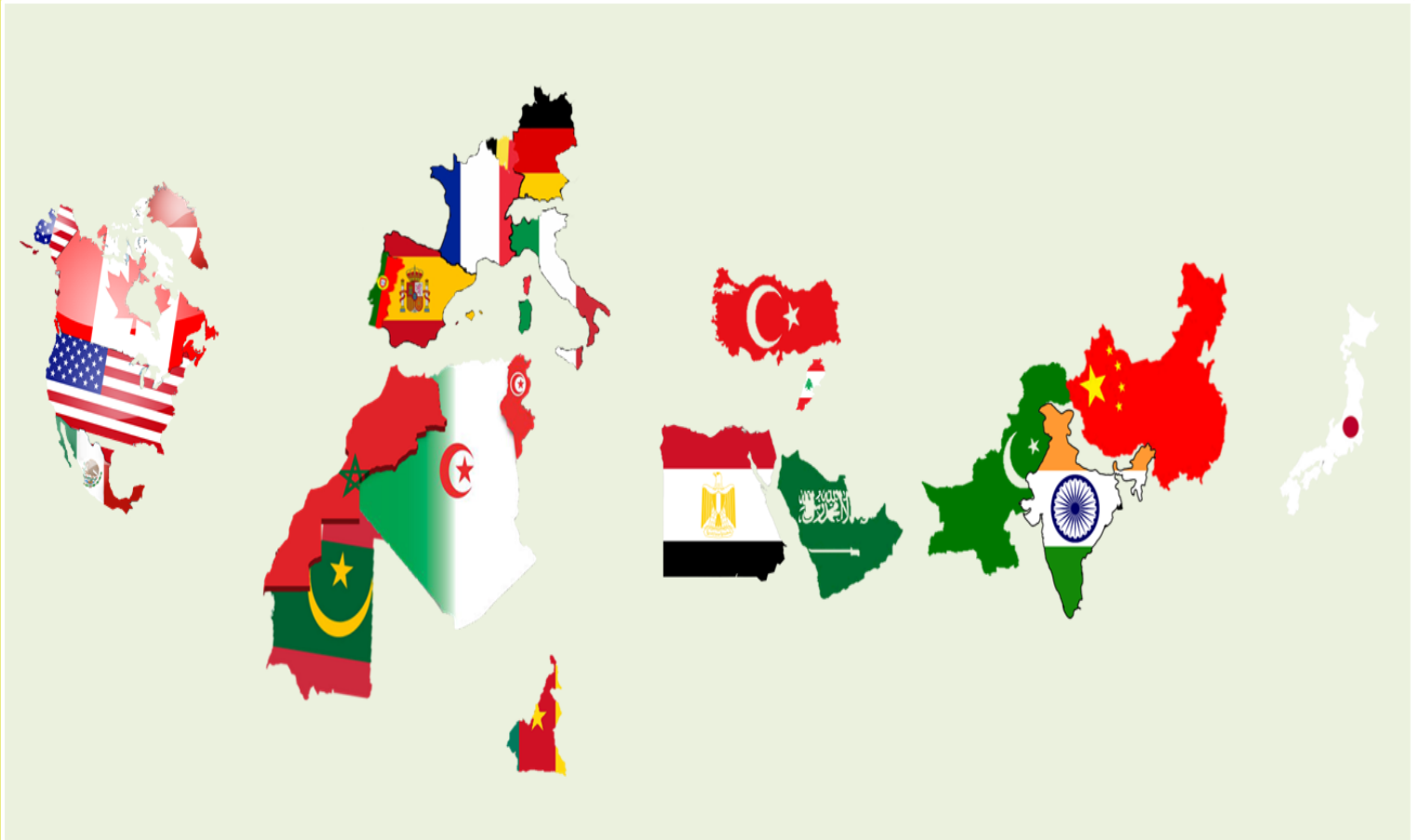
Oral presentations: 213

Poster presentations: 105

Sponsored by



PARTICIPANTS COUNTRY



Morocco, Algeria, Mauritania, Tunisia, Egypt, Cameroon,

USA, Canada, Mexico,

Portugal, Spain, France, Italy, Belgium, Germany, Turkey,

Saudi Arabia, Lebanon,

China, Japan, India, Pakistan

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SCIENTIFIC PROGRAM

MERCREDI 27 OCTOBRE 2021/ WEDNESDAY,
OCTOBER 27th 2021

Amphi de conférences	08H00 – 10H00	Accueil et inscription / welcome and registration
	10H00 – 11H00	Cérémonie d'ouverture et allocutions officielles/ official opening ceremony
CONFÉRENCES INAUGURALES / OPENING CONFERENCES		
<i>MODERATION : FILALI-MALTOUF A. & BOUKCIM H.</i>		
Amphi de conférences	11H00 – 11H30	Conference 1: Rôle du conseil agricole dans la mise en oeuvre de la stratégie Génération Green au Maroc. Dr. <u>Salah Eddine BAKKALI YAKHLEF</u> , Directeur d'ingénierie du conseil agricole, Office National du Conseil Agricole, Rabat-Morocco.
	11H30 – 12H00	Cocktail de bienvenue & Posters session / Welcome reception
	12H00 – 12H20	Conference 2: Toward a new approach for addressing water shortages in semi-arid regions. Prof. <u>Abdelghani CHEHBOUNJ</u> , Mohammed VI Polytechnic University, Morocco
	12H20 – 12H40	Conference 3: Soil security under conservation agriculture in drylands: benefits, opportunities and challenges. Dr. <u>Rachid MRABET</u> , INRA, Morocco
	12H40 – 13H00	DISCUSSION
13H00 – 14H30		DÉJEUNER / LUNCH
PHOTO SOUVENIR OFFICIELLE DES PARTICIPANTS (JUSTE APRÈS LE DÉJEUNER)/ OFFICIAL PHOTO OF THE PARTICIPANTS (JUST AFTER LUNCH)		

14H30 – 19H30

SESSIONS PARALLELES 1/ PARALLEL SESSIONS 1

THÈME I : BIOTECHNOLOGIE ET AMÉLIORATION DES PLANTES / CONSERVATION ET VALORISATION DES PRODUITS LOCAUX / TOPIC I : BIOTECHNOLOGY AND PLANT BREEDING / CONSERVATION AND VALORIZATION OF LOCAL PRODUCTS.
MODERATION: DHIBA D. & BAAZIZ M.
Amphi de conférences

14H30 – 14H50

Conference 4 : Chlorophyll a fluorescence and absorbance at 820 nm as tools to prob physiological status of plants under abiotic stress conditions

Prof. Abdellah OUKARROUM, Mohammed VI Polytechnic University, Morocco

14H50 – 15H10

Conference 5 : Valorization of Moroccan saffron '*Crocus sativus* L. by plant biotechnologies.

Prof. Mohammed Amine SERGHINI (Ibn Zohr University, Agadir, Morocco.

15H10 – 15H30

Conference 6 : From Plants in the Morocco to Medicines: Bio prospecting, Benefit Sharing, Valorisation, Conservation, and Legislation.

Prof. Mohammed HMAMOUCHE (Faculty of Medicine, University of Montreal, Canada).

15H30 – 15H50

Conference 7: Molecular and cellular mechanisms driving somatic variation in grapevine.

Prof. José Miguel MARTÍNEZ-ZAPATER (Instituto de Ciencias de la Vid y del Vino, Spain)

15H50 – 16H20

DISCUSSION
MODERATION: BARGAZ A. & ELMOUSSADIK A.
Amphi de conférences

16H20 – 17H40

Communications orales (Thème I / Topic I).

17H40– 18H00

**Pause-café / Coffee Break
Session de Poster (Thèmes I / Topics I)**

Amphi de conférences

18H00– 19H30

Communications orales (Thème I / Topic I).

THÈME II : RESSOURCES GENOMIQUES ET BIO-INFORMATIQUE/ AGRICULTURE INTELLIGENTE / TOPIC II: GENOMIC RESOURCES AND BIOINFORMATICS/ SMART AGRICULTURE.
MODERATION : ELFAHIME E. & YASRI A.
Salle 1 bloc C

14H30 – 14H50

Conference 8: Towards a sustainable management of farm animal genetic diversity in the context of climate change: The case of sheep and goats.

Dr. Badr BENJELLOUN, Head of, INRA Regional Research Centre of Tadla-Beni Mellal, Morocco.

14H50 – 15H10

Conference 9: Efficient use and management of conventional and non-conventional water resources through smart technologies applied to improve the quality and safety of Mediterranean agriculture in semi-arid area

Dr. Antonio SKARMETA & Ludovic Ferrer, University of Murcia-Arvm Agriculture Moroccan society

15H10 – 15H30

Conference 10: Sunflower Wild Resources: The Essential Genetic Abundance for Sustainable Production.

Prof. Yalcin KAYA, Head of Department of Genetic and Bioengineering, Trakya University, Turkey.

15H30 – 15H50

Conference 11: Place du Sséquenceg haut débit et autres techniques moléculaires dans le domaine de l'agriculture.

Prof. Sanaâ LEMRISS, Head of Biosafety Department 3 - PCL3, Rabat, Morocco

15H50 – 16H20

DISCUSSION
MODERATION: SAÏDI N. & ZEHDİ S.
Salle 1 Bloc C

16H20 – 18H10

Communications orales (Thème II / Topic II)

18H10– 18H25

**Pause-café / Coffee Break
Session de Poster (Thèmes II / Topics II)**

Salle 1 Bloc C

18H25– 19H30

Communications orales (Thème II / Topic II).

JEUDI 28 OCTOBRE 2021/ THURSDAY, OCTOBER 28th 2021

08H30 – 12H45 SESSIONS PARALLELES 2/ PARALLEL SESSIONS 2

THÈME III : INTERACTIONS PLANTES - MICROORGANISMES : BIOFERTILISATION ET BIOCONTRÔLE / TOPIC III: PANT – MICROORGANISMS INTERACTIONS : BIOFERTILIZATION AND BIOCONTROL.

MODERATION: HIJRI M. & OUFDOU K. & OUKARROUM A.

Amphi de conférences	08H30 – 08H50	Conference 12: Optimization of rhizosphere-microbial interactions to improve P use efficiency. Prof. <u>Adnane BARGAZ</u> , Mohammed VI Polytechnic University, Morocco.
	08H50 – 09H10	Conference 13: Correlation between holobiont metabolomics and the pearl millet root-associated-microbiota. Dr. <u>Wafa ACHOUAK</u> , CNRS-CEA-Aix-Marseille University, France.
	09H10 – 09H30	Conference 14: From metagenomics to bioformulation of plant growth promoting bacteria Prof. <u>Issam Meftah KADMIRI</u> , MacsiR- Rabat & Mohammed VI Polytechnic University, Morocco.
	09H30 – 09H50	Conference 15: <i>Relative effects of the plant, the soil and the environment on rhizosphere bacterial community composition and function.</i> Dr. <u>Mika TARKKA</u> (Department of Soil Ecology Helmholtz Centre for Environmental Research, Germany).
	09H50 – 10H20	DISCUSSION

MODERATION: AMIR S. & HAMDALI H.

Amphi de conférences 10H20 - 11H30 Communications orales (Thème III / Topic III)

11H30 - 11H45 Pause-café / Coffee Break
Session de Poster (Thèmes III / Topics III)

Amphi de conférences 11H45 - 12H45 Communications orales (Thème III)

THÈME IV : SOL- SYSTÈMES DE CONTRÔLE DE LA POLLUTION ET DE LA RÉHABILITATION / TOPIC IV: SOIL- POLLUTION CONTROL AND RHABILITATION SYSTEMS.

MODERATION : TRIFI N. & HEULIN T.

Salle 1 bloc C	08H30 – 08H50	Conference 16: Date palm, study of the history and Genetic Diversity, for better conservation Prof. <u>Salwa ZEHDJ</u> , University of Tunis El Manar, Tunisia
	08H50 – 09H10	Conference 17: Current status of Mediterranean agricultural soils pollution: Diagnostic and monitoring. Prof. <u>Noureddine BOUSSERRHINE</u> , Est Creteil Paris University, France.
	09H10 - 09H30	Conderence 18: Cadmium minimization in rice cultivation. Prof. <u>Majeti Narasimha Vara PRASAD</u> ., University of Hyderabad, Telangana, India.
09H30 – 10H00	DISCUSSION	

MODERATION : MEZRIOUI N. & ELFALLEH W.

Salle 1 Bloc C 10H00- 11H30 Communications orales (Thème IV / Topic IV).

11H30 - 11H45 Pause-café / Coffee Break
Session de Poster (Thèmes IV / Thèmes IV)

Salle 1 Bloc C 11H45 - 12H45 Communications orales (Thème IV / Topic IV)

12H45 - 14H15 DÉJEUNER / LUNCH

14H15 – 18H45		SESSIONS PARALLELES 3/ PARALLEL SESSIONS 3
THÈME V : SCIENCE ALIMENTAIRE ET NUTRITION / TOPIC V: FOOD SCIENCE AND NUTRITION.		
MODERATION: HADDIOUI A. & BOUKSAIM M.		
Amphi de conférences	14H15 – 14H35	Conference 19: Application of DNA techniques in the analysis of food fraud: the case of meats. Prof. <u>Hicham EL OSSMANI</u> , Head of Environment Department in Forensic Institute of Royale Gendarmerie, Morocco.
	14H35 – 14H55	Conference 20: Evolution of sequencing technologies and their impact on agri-food research. Prof. <u>Mostafa EL FAHIME</u> , CNSRT Rabat, Morocco.
	14H55 – 15H15	Conference 21: Pomegranate by products: potential industrial uses. Prof. <u>Valid ELFALLEH</u> , University of Gabes, Tunisia.
	15H15 – 15H45	DISCUSSION
MODERATION: MEDDICH A. & BOUDA S.		
Amphi de conférences	15H45- 17H30	Communications orales (Thème V / Topic V)
	17H30 - 17H45	Pause-café / Coffee Break Session de Poster (Thèmes V / Topics V).
Amphi de conférences	17H45 – 18H45	Communications orales (Thème V / Topic V).
THEME VI : AGROÉCOLOGIE ET CHANGEMENT CLIMATIQUE/ TOPIC VI: AGROECOLOGY AND CLIMATE CHANGE.		
MODERATION: ABBAS Y. & BOUSSERRHINE N. & MRABET R.		
Salle 1 Bloc C	14H15 – 14H35	Conference 22: Rhizobium alamii improves water stress tolerance in rapeseed. Dr. <u>Thierry HEULIN</u> , CNRS-CEA-Aix-Marseille University, France.
	14H35 – 15H55	Conference 23: Microbiome of field grown hemp reveals potential microbial interactions with root and rhizosphere soil. Prof. <u>Mohammed HIJRI</u> , University of Montreal, Canada.
	15H55– 16H15	Conference 24: Forests, and trees and shrubs on and near farms for sustainable diets. Prof. <u>Patrick VAN DAMME</u> , Ghent University, Belgium.
	16H15– 16H45	DISCUSSION
MODERATION: WAHID N. & ZINELABIDINE H.		
Salle 1 Bloc C	16H45- 17H30	Communications orales (Thème VI / Topic VI).
	17H30 - 17H45	Pause-café / Coffee Break Session de Poster (Thèmes VI / Topics VI)
Salle 1 Bloc C	17H45 – 18H45	Communications orales (Thème VI / Topic VI).

VENDREDI 29 OCTOBRE 2021/ FRIDAY, OCTOBER 29th 2021

09H00 – 12H30

SESSIONS PARALLELES 4/ PARALLEL SESSIONS 4

THÈME VII : AGRICULTURE DE PRÉCISION MODÉLISATION ET TÉLÉDETECTION DES SCIENCES DE LA TERRE / TOPIC VII PRECISION AGRICULTURE MODELING & EARTH SCINECES REMOTE SENSING.

THÈME VIII : ÉCONOMIE AGRICOLE / TOPIC VIII: AGRICULTURAL ECONOMY.

MODERATION **THÈME VII** : ACHOUAK W. & CHEHBOUNI A.

09H00 – 09H20

Conference 25: Irrigation Requirement Estimation from Satellite to the Farm.
Dr. Lahouari BOUNOUA, NASA Goddard Space Flight Center Greenbelt, Maryland, USA.

09H20 – 09H30

DISCUSSION

09H30 - 10H20

Communications orales (Thème VII / Topic VII).

Amphi de conférences

MODERATION **THÈME VIII** : HACHIMI H. & MARGHALI S.

10H20 – 11H00

Communications orales (Thème VIII / Topic VIII).

11H00 – 11H20

DISCUSSION

11H20 - 11H35

Pause-café / Coffee Break
Session de Poster (Thèmes VII + VIII / Topics VII + VIII).

11H20 - 12H30

Communications orales (Thème VIII / Topic VIII).

THÈME I BIS: BIOTECHNOLOGIE ET AMÉLIORATION DES PLANTES / CONSERVATION ET VALORISATION DES PRODUITS LOCAUX / TOPIC I : BIOTECHNOLOGY AND PLANT BREEDING / CONSERVATION AND VALORIZATION OF LOCAL PRODUCTS

MODERATION : SERGHINI M.A. & ENNAJI M. & SAÏDI N.

Salle 1 Bloc C

09H00 – 11H20

Communications orales BIS (Thème I / Topic I).

11H20 - 11H35

Pause-café / Coffee Break
Session de Poster (Thèmes I / Topics I)

11H35 - 12H30

Communications orales BIS (Thème I / Topic I).

12H30 - 14H30

DÉJEUNER / LUNCH

14H30 - 16H00

Tables rondes (Roundtables)

Amphi de conférences

Salle 1 Bloc C

Salle 2 Bloc C

Table ronde 1 (Roundtable 1): Green Generation *MODERATION: BOUKCIM H. & ABBAS Y.*
Table ronde 2 (Roundtable 2): Climate change and smart Agriculture
MODERATION: BOUSSERRHINNE N. & MRABET R.
Table ronde 3 (Roundtable 3): Food safety.
MODERATION: BOUKSAIM M. & SAÏDI N.

16H00 – 16H15

Pause-café / Coffee Break

16H15 - 19H00

Synthèse et recommandations sur la 1^{ère} édition d'AgriNov2021
(Congress synthesis and recommandations)
Programmation de la 2^{ème} édition d'AgriNov2021 (2nd Edition
scheduling of AgriNov)
- Cérémonie de clôture / closing ceremony

20H00

Diner Gala / Gala dinner

SAMEDI 30 OCTOBRE 2021/ SATURDAY,
OCTOBER 30th 2021

08H00 – 22H00

Excursion aux cascades d'Ouzoud et au lac de Bin El Ouidane
(Excursion to Ouzoud waterfalls and test the waters at Bin El-
Ouidane lake).

Speakers' biography & abstracts

Dr. Salah Eddine BAKKALI YAKHLEF



Directeur de l'Ingénierie du Conseil Agricole
Office National du Conseil Agricole

Titulaire d'un Doctorat National en Microbiologie, Université Mohamed 1er Oujda et IAV Hassan II (2000) ; **03** Masters (i) en Biologie Moléculaire et Biotechnologie, Université libre de Bruxelles (1994), (ii) Master en Management Public, ISCAE de Rabat (2018) et (iii) Master en BIG DATA et Intelligence Artificielle, UIR de Rabat (2021)

- Chercheur et responsable de laboratoire de biologie moléculaire et biotechnologie au Centre de Recherche Forestière CRF/HCEFLCD/ Rabat (2002-2011) : Coordination de (04) Projets de Recherche (PRAD, CNRST, FAO), Encadrement de Thèses de Doctorat (03), Master (05) et Projets de Fin d'études (05), (20) Publications dans des journaux à Comité de lecture, Auteur (1) Ouvrage « Antibiorésistance d'Escherichia coli aviaire au Maroc » et (03) Chapitres dans les ouvrages scientifiques

- Chef de Service de la Recherche Développement, Chef de division de l'Enseignement supérieur et de RD et Directeur centrale par intérim à la Direction de l'Enseignement, de la Formation et de la Recherche (DEFR) au Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts (2011-2017)

- Directeur de l'Ingénierie du Conseil Agricole à l'Office National du Conseil Agricole (ONCA) (2018 à aujourd'hui)

Administrateur de la Plateforme Digitale du Conseil Agricole « PDCA »

Coordinateur National du Réseau Virtuel de communication et d'appui conseil « ARDNA »

Rôle du conseil agricole dans la mise en œuvre de la stratégie Génération Green au Maroc.

La stratégie Génération Green 2020-2030 (GG), présentée devant sa Majesté le Roi Mohamed VI, est le fruit de l'évaluation des résultats du Plan Maroc Vert (PMV) avec tous les acteurs du secteur agricole qui se veut comme un nouveau départ pour le développement agricole au Maroc. Cette nouvelle stratégie se base sur deux principaux fondements, à savoir, la valorisation de l'élément humain et la pérennisation du développement agricole.

Le conseil agricole, à travers l'Office National de Conseil Agricole (ONCA), est désormais plus sollicité dans le cadre de la Génération Green pour asseoir et renforcer ces deux fondements à travers la consolidation des acquis du Plan Maroc Vert; tout en contribuant à l'instauration d'une nouvelle génération de classe moyenne, de jeunes entrepreneurs agricoles, d'organisations agricoles et de mécanismes d'accompagnement.

Conformément aux objectifs stratégiques de la stratégie nationale du conseil agricole en matière gouvernance, d'encadrement et de conseil des agriculteurs et professionnels, l'ONCA a apporté, depuis sa création en 2013 à nos jours, une précieuse contribution quant à l'opérationnalisation des projets structurants du Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts, entre autres les projets de l'agriculture solidaire, les filières de production, l'organisation des acteurs, et le Programme National de l'Economie d'Eau d'Irrigation (PNEEI/PEI).

En effet, et pour une mise en œuvre réussie de ces chantiers, l'ONCA veille à mettre à jour ses missions, approche et outils afin de se conformer aux orientations de cette nouvelle stratégie tant ambitieuse que réalisable.

Par ailleurs, et pour raisonner l'organisation de son déploiement régional et territorial de manière optimale, l'ONCA a conçu la cartographie digitale nationale du conseil agricole ayant pour objectifs :

- Ressortir le besoin qualitatif et quantitatif en conseil agricole ;
- Quantifier les moyens humains et financiers à mettre en œuvre pour répondre à ce besoin en conseil agricole pour un développement durable du secteur de l'agriculture.

Conference 1

Prof. CHEHBOUNI Abdelghani

Mohammed VI Polytechnic University of Benguerir, **Morocco**
International Water Research Institute (IWRI)
Lead Program «Water & Climat »

abdelghani.chehbouni@um6p.ma



Dr. Abdelghani Chehbouni from Mohammed VI Polytechnic University, Morocco, is a doctor in hydrology and remote sensing. His main research interests include the application of remotely sensed data in land-surface-atmosphere models especially in arid and semi-arid regions. He is co-investigator of several Remote Sensing Programs (VEGETATION, ERS2/ATSR2, EOS), and participates in several international investigations (MONSOON'90, Hapex Sahel). In 2000, he joined CESBIO as the leader of hydrology group.

Toward a new approach for addressing water shortages in semi-arid regions

Abdelghani CHEHBOUNI^{1,2}, Youssef Brouziyne¹, Abdelghani Boudhar^{3,4} & Driss Dhiba¹

¹ Mohammed VI Polytechnic University, International Water Research Institute, Ben Guerir, Morocco.

² Institut de recherche & développement, Unité mixte de recherche, Centre d'études spatiales de la biosphère (Cesbio), Toulouse, France

³ Sultan Moulay Slimane University, Beni Mellal, Morocco

⁴ Mohammed VI Polytechnic University, Center for Remote sensing Application, Ben Guerir, Morocco

In the recent years, international organizations as well as research communities have pointed out that water shortage is a limiting factor for the economic and social development in Africa. The increasing needs of water for agriculture and other uses combined with the expected changes in hydrometeorological regimes will certainly jeopardize the fragile secular balance between resources and uses in the continent. It is thus crucial to develop an appropriate management strategy to cope and to adapt to this new and challenging situation.

Such strategy should be co-constructed among scientist, resources managers, policy makers and stakeholders. In fact, several factors other than technical should be taken into account such as social acceptance, economic viability, institutional readiness and political willingness to ensure their effectiveness. In fact, knowledge is no longer seen as a component of power that allows the "knowers" to impose their reference system on others, but, on the contrary, scientific work reveals the need for cooperation and recognition of ordinary knowledge in order to allow the innovations necessary for sustainable development as it relates to issues such as climate change and water resources. The objective of this presentation is to provide a new approach/paradigm based on the concept of sustainability science for addressing the issue of water shortages in semi-arid regions in Morocco and Africa. This new emerging approach is based on the combination of digital technology/remote sensing, creativity, innovation and collective intelligence.

Key words: Water shortage, new paradigm, sustainability science, remote sensing, collective intelligence.

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Dr Rachid Mrabet is a research Director and Senior Cropping Systems Agronomist in The National Institut of Agronomic Research (INRA Rabat, Morocco). His research is focused on Agrophysics, Agronomy and Soil Science. He is senior researcher with expertise on conservation agriculture, on climate change mitigation and adaptation. He is Deputy President of WASWAC. Panelist at the International Conservation Agriculture Advisory Panel for Africa. Equally, interested in hydrologic modeling.

Soil security under conservation agriculture in drylands: benefits, opportunities and challenges

Drylands, home of one-third of global population, span over 40% of the Earth's continental area and are expanding due climate change. Dryland agriculture is confronting immense challenges while pushing the boundaries of sustainability. Land degradation such as erosion, fertility loss and mining, compaction, salinity, acidification, soil carbon decline, and biodiversity loss have long been reported and are recognized as major threats to ensuring food security for growing population. As food, water and energy security are essential global challenges, secure soils are critical for providing food, fiber and a web of ecological and regulating services while mitigating climate change and providing resilient farming systems. Through intensification, conventional agriculture is failing to ensure food security, protect environment and maintain key soil functions. In this paper, soil security in its diverse dimensions and characteristics will be discussed while implementing, applying and upscaling the three principles of conservation agriculture in dryland farming systems. The paper assesses and discusses conservation agriculture as means to enhance productivity and efficiency of food systems, minimizing or restoring degradation processes, abating and mitigating climate change and providing knowledge, skill development, capacity building, ecological and social services to society. This work gathers lessons from various experiences in drylands in order to provide opportunities from conservation agriculture in ensuring soil security which guaranty environment sustainability at large. Challenges reported whileredesigning conservation agriculture landscapes in drylands are also reviewed and debated mainly for resource-poor farmers. Goals and benefits from soil security under conservation agriculture need to be developed within broad and cross-sector policy context.

Keywords: Dryland, Conservation agriculture, Soil security, Sustainability.

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Chlorophyll a fluorescence and absorbance at 820 nm as tools to prob physiological status of plants under abiotic stress conditions

Chlorophyll *a* fluorescence (ChlF) emitted by photosynthetic organisms on a dark-to-light transition is characterised by a polyphasic chlorophyll OJIP. The fluorescence intensity increases quickly from a minimum fluorescence intensity (F_0) to a maximum fluorescence intensity (F_M) and with two intermediate steps labelled as J (F_J) and I (F_I). The OJIP transient can also be divided to two rise phases: the photochemical phase O-J and the thermal phase J-I-P. Recently, a new technique was developed for studying the energetic behaviour of the stress-induced damage to the photosynthetic apparatus based on simultaneous measurements of the kinetics of ChlF and the modulated 820 nm signal (measured in reflection mode, MR). Kinetic changes at 820 nm reflect changes in the redox states of the primary electron donors of photosystem I (P700) and plastocyanin (PC) with a small contribution of ferredoxin. The shapes of the ChlF and MR transients depend on the photosynthetic sample and its physiological state. The ChlF transient (OJIP) depends on the redox state of the PSII reaction centres (RC) and reflects the subsequent reduction of the acceptor side of PSII, the PQ pool and the electron acceptors around PSI.

Keywords: Chlorophyll a, fluorescence intensity, abiotic stress.

Prof. Mohammed Amine SERGHINI

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Mohammed Amine SERGHINI, born in 1964, holds a thesis from the Louis Pasteur University of Strasbourg, France and a PhD from IbnZohrUniversity of Agadir, Morocco in molecular plant virology. He did post doctoral work at the John Innes Institute, Norwich, GB. Currently, he is a professor of higher education and director of biotechnology and genetic resources team in the faculty of sciences – IbnZohr University, Agadir. Prof. M. A. SERGHINI was an interim dean of the faculty of sciences of Agadir, vice dean of the polydisciplinary faculty of Taroudant and head of the biological department of sciences faculty of Agadir. He was also a founder and manager of different branches of plant biotechnologies (DESA, Master).

Prof. M.A. SERGHINI is a member of several learned associations and national and international scientific networks. He is a reviewer for several international journals and sits on several scientific committees and organizes international scientific congresses. He has to his credit the supervision of several theses and the participation in thirty thesis defenses and PhD theses including thirteen as president of the jury and eight as rapporteur.

In terms of research activities, Prof. M.A. SERGHINI carries out several national and international research programs in the field of plant biotechnologies. He has supervised more than twelve doctoral theses and has published around forty publications in national and international journals and more than a hundred oral communications and more than seventy poster communications at national and international conferences.

Valorization of Moroccan saffron '*Crocus sativus* L. by plant biotechnologies

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Saffron, the most expensive spice in the world, is called 'red gold'. It is constituted by the dried stigmas of the flower of *Crocus sativus* L., an iridacea which bloom the month of October. *C. sativus* is a corm plant undemanding at the edaphic level and which supports harsh winters (up to -10 °C) and hot summers (over 40 °C) with a biological cycle where its corms are at state of dormancy in the soil half the year. Saffron has aromatic and medicinal properties at low doses. Recently, a growing interest focuses on its components which may have an anti-carcinogenic effect

World saffron production amounts to some 400 tonnes/year. The main producing countries are: Iran (94%), Greece (2.2%), Morocco (1.5%), India (1%), Spain (0.5%) and other countries (0.7%). Morocco is the largest African producer of saffron that constitutes a flagship local product and which strongly contributes to the income of local people.

If aspects related to saffron, such as the structuring of producers, the cultural management, the packaging, and the marketing have marked a significant progression, the in-depth knowledge of the biology of the plant, the chemical component of its spice, and the molecular identity of accessions represent a continuous challenge to scientific research and plant biotechnologies are currently being used intensively in order to improve the production of saffron and protect its authenticity.

The conference will focus on the contributions of scientific research to saffron starting with the agromorpho-physiological aspects of *C. sativus* different accessions by the study and comparison of various parameters related to the underground part and the aerial part in order to achieve a clonal selection. The chemical part will focus on the main metabolites of saffron in the context of the ISO standard. These metabolites are crocins, picrocrocins and safranal which are respectively responsible for its colour, taste and aroma. The chemical study of saffron is able to evaluate the content of its three main metabolites, to control the authenticity and to distinguish different geographical origins of this spice using UV-Vis, HPLC, GC, IR and colorimetric techniques.

The molecular aspect will deal with the use of molecular markers such as microsatellites (SSR), inter-microsatellites (ISSR) and barcoding to characterize different accessions of saffron, assigning their molecular identities able to counter fraud attempts linked to the high cost of this spice. The application of plant biotechnologies to saffron, such as plant tissue culture is undertaken with the aim of accelerating seed production of elite accessions and producing the secondary metabolites of this plant. Finally, the research conducted on the recovery of saffron flower waste will be described in the context of production of bio-dyes.

Key words: Saffron, *Crocus sativus* L., metabolites, plant tissue culture, molecular markers, bio-dyes.

Prof. Dr. Mohammed HMAMOUCHI

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Mohammed Hmamouchi has obtained a Ph.D. in Phytochemistry (1987, Laval University, Canada), 35 years experience of research. After his graduation, he gets research and teaching positions in the Rabat Medical & Pharmacy School, Mohammed V University. In 2004 he was appointed by Moroccan government to develop and implement national policies on Medicinal and Aromatic Plants. He oversaw build and equipment, as a Director, a National Institute on Medicinal and Aromatic Plants (<http://www.anpma.ma/>). In 2011 he became President of the Arab Federation of Medicinal and Aromatic Plants. He managed several research projects, contracts and cooperation agreement. He has worked with many international institutions and companies in over 30 countries (France, Spain, USA, Canada, England, Belgium, Bulgaria, Cyprus, Corsica, Greece, Holland, Italy, Poland, Portugal, Romania, Senegal, Switzerland, Turkey, Algeria, Saudi Arabia, Egypt, Jordan, Kuwait, Lebanon, Libya, Morocco, Mauritania, Palestine, Sudan, Syria, Tunisia, Yemen, the various international organizations and donors: European Union, FAO, FEM-PNUD, AUF, ISESCO, UNESCO, OMS/ EMRO, FIDA, ICARDA, IPIGRI-WAN). He was also the focal point of different international conventions and agreements, and coordinator of national and international MAP networks (Ex.Tempus: European Union Projects). In 2013 he became Advisor to the Minister of Higher Teacher Education, Scientific Research. Dr. Hmamouchi continuing to do research, to be invited to give plenary lectures at the Congress (Guest Speakers). He is a member of several professional bodies and has received many grants and awards.

Since 2016, he is visiting professor at the University of Montreal (Canada), teaching Phytochemistry and Medicinal Plant activities at the MSc in Pharmacology and D.E.S.S. in clinical pharmacology. He has been an expert since 2017 with the Canadian Consortium for Research and Innovation in Industrial Bioprocessing. It appraises and evaluates the projects submitted for financing in the sectors of bio-industrial products (bioenergy, biomaterials chemistry), health, nutraceuticals, environment and agriculture / agrifood). He has also gained industry expertise as a Technical Director of company in Canada.

From plants in the Morocco to medicines: bio prospecting, benefit sharing, valorisation, conservation, and legislation

The ownership, control and distribution of the benefits of the use of biodiversity have been vigorously contested - across economic, political and legal aspects. In recent years, especially since the entry into force of the CB, pharmaceutical companies have formed an important group of bioprospecting-oriented players towards the search for new natural products from plants.

The scope of our research activities is to contribute to a scientifically based image of bioprospecting by focusing on a few case studies using an interdisciplinary approach. In this presentation, we examine the effects of bioprospecting, scientific research, valuation, on conservation and development: i.e., the conservation of biodiversity; the sustainability of the collection; and economic and social development in the countries of origin. Our activities include the collection of plants taxonomically identified and / or selected for medically active components in order to generate substantial income for source countries for purposes such as biodiversity conservation, health care, and social and economic development.

The conclusions of the case studies of our research presented here are first of all those certain economic gains are possible from bioprospecting using an interdisciplinary approach. However, a fundamental need for source countries is to establish an institutional framework to facilitate sustainable bioprospecting with benefit sharing. Second, the activity can represent a sustainable use of biodiversity, but this requires the actors to develop an adequate methodology.

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Prof. José Miguel Martínez-Zapater was director of the Instituto de Ciencias de la Vid y del Vino (Vine and WineScienceInstitute) Logroño, Spain, since 2008. His research mainly focuses on mitigating the effects of climate change, generating knowledge about the basic processes involved in viticulture, grape development and maturation, winemaking, technological development of processes and products that making wine industry more competitive. His research also focuses on the development of more sustainable wine approaches and the control of new vine pests.

From plants in the Morocco to medicines: bio prospecting, benefit sharing, valorisation, conservation, and legislation

Somatic variation contributes to cultivar evolution in woody crops, being a source of novel traits and the base for adaptation to changing environmental and cultivation conditions in species like grapes or citrus. Understanding the molecular and cellular causes of this variation provides tools for genetics-assisted selection and breeding as well as to direct genome editing approaches to improve traditional elite cultivars. In addition, the molecular characterization of somatic variants can also generate information on gene biological function and genome evolution. We review the available genetic and molecular information on somatic variation or several relevant traits in grapes and describe strategies for its study, which result from the combination of classical phenotyping and genetic approaches with new nucleic acids high-throughput sequencing technologies. Finally, we address preliminary conclusions that could be established from the results and that help driving future studies.

Keywords: Grapevine, Somatic variation, Genome sequence variation, Somatic mutations, Chimerism, Forward genomics.

Dr. Badr Benjelloun

Head of the INRA Regional Research Centre of Tadla- Beni Mellal, Morocco



Dr Badr Benjelloun has 15 years of research experience in livestock genetics. He is a researcher in livestock genomics at INRA and a visiting scientist at Laboratoire d'Ecologie Alpine, CNRS/UGA in France since 2015. He is the Head of the INRA Regional Research Centre of Tadla. After his postgraduate education as an Engineer in Livestock Production, he completed his PhD education in Biodiversity, Ecology and Environment at the University of Grenoble Alpes in France. He has been involved in many national and international collaboration initiatives, e.g. the EU funded projects Scala-Medi, NextGen, IMAGE and the VarGoats initiative of the International Goat Genome Consortium. He worked on studying genome diversity and the bases of local adaptation using WGS data in small ruminants and published several scientific papers. His ongoing work is focusing on the use of various Omics technologies for implementing sustainable breeding schemes of terrestrial livestock.

Towards a sustainable management of farm animal genetic diversity in the context of climate change: The case of sheep and goats

The sustainability of breeding systems relies first and foremost on the ability of farm animals to remain productive in the context of climate changes. This ability primarily depends on adaptive traits and standing genetic variation in the raised breeds. The understanding of genetic bases of local adaptation and the accurate assessment of genetic diversity are thus key elements when conceiving management programs aiming at developing sustainably farm animals in a country. Otherwise, sequencing technologies allow now for an unprecedented access to genotyping animals by sequencing. The future programs of farm animal management have to exploit these technological advances to improve their effectiveness and efficiency. By using a wide framework based on whole genome analyses of Moroccan small ruminants, this talk will present outcomes from research by our team aiming at depicting genetic traceability of local breeds as well as genetic bases of local adaptation to specific and extreme environments encountered in the country. Based on the results we obtained, we will present: (i) Genomic bases of local adaptation to eco-climatic constraints in Moroccan sheep and goats; (ii) Whole genome traceability of the main local breeds raised in Morocco; (iii) The global genomic diversity in local sheep and goats compared to their wild relatives and a panel of worldwide 'Cosmopolitan' breeds; (iv) The evaluation of whole genome genotyping strategies to assess adaptive and neutral genome diversity; (v) The possible uses of the obtained results combined with recent advances in sequencing (e.g. nanopore sequencing technologies) for implementing wide-scale programs for a sustainable management of farm animals.

Dr. Antonio SKARMETA

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Efficient use and management of conventional and non-conventional water resources through smart technologies applied to improve the quality and safety of Mediterranean agriculture in semi-arid area

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WATERMED 4.0 main vision is to develop and to apply an integrated decision support system based on the Internet of Things, for managing the whole water cycle in agriculture, monitoring water resources (conventional and non-conventional) and water demands including the measure of economic, energy, social and governance factors that influence the water use efficiency in Mediterranean agricultural production areas.

WATERMED will design and develop an IoT-based platform based on a layered architecture that considers several types of **services** to ensure its replication and adaptability to different crops and locations. Entirely replicable services deal with IoT services, virtual entities and storage services, and data analytics and machine learning, respectively. Fully customizable services deal with water data management issues that specialize generic analytic services into particular techniques for different types of irrigation and water distribution. Those services may require being customized whenever a new pilot is designed, developed and deployed. Finally, application specific services require higher development effort since they serve particular farms. The architecture may be implemented in a range of deployment configurations involving the use of smart algorithms and analytics in the cloud, fog-based smart decisions located on the farm premises and possibly mobile fog.

The overall approach of this proposal is increasing the efficiency in the management of conventional and non-conventional water resources applied to agriculture from an integral perspective. The new perspective comes from the assumption that technology development, societal engagement, governance and transferring knowledge will be enhanced by the new possibilities of digitalisation through an open platform, in a form that best fits the needs of end-users and the associated supply chain, from high waters (water management authorities, water planning organisations, wastewater treatment plants, technology SME's) to the plot (irrigation communities, farmers and technology SME's). The expected impacts will be easily monitored all along the water cycle for agriculture, real-time controlled by the Internet of Things and Services, helping to increase quantity and quality of water available for agriculture and to save water and nutrients.

In this presentation we will navigate over the WATERMED4.0 platform and describe the main features and water services developed by means of the integration of IoT, GIS and satellite information in order to provide recommendation at different levels.

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Yalcin Kaya is a professor from Trakya University, Edirne, Turkey. He has longer carrier and experience on plant breeding and genetics and developed many sunflower hybrids and lines. He has worked in Trakya Agricultural Research Institute, Turkey as National Sunflower Coordinator and as Project leader for over 20 years and institute deputy director. Now, he is a Director of the Plant Breeding Research Center and Head of the Genetic Engineering Department in Trakya University. He is currently FAO Sunflower Research Coordinator. He is also former President of Turkish Plant Breeders Union and International Sunflower Association.

Sunflower wild resources : The essential genetic abundance for sustainable production

Due to global warming in recent years, sunflower (*Helianthus annuus* L.) growing in summer encounters frequently commonly severe droughts during the vegetation period. Due to lower income per area, sunflower could not compete successfully with other crops in the rotation system. Then sunflower push into poor soils so it suffers more year by year from these hard conditions in the future as well. These drought or higher temperatures reduce seed and oil yield seriously then sunflower breeders focus on mostly developing drought tolerant genotypes in their sunflower breeding programs frequently to develop drought tolerant hybrids as well as having higher adaption capacity ones in the dry conditions. However, breeder need stress tolerant genes to develop these kinds of varieties and these genes mostly are found in wild sunflower species. Wild sunflower *Helianthus* genus has wide growing areas which are in different and severe climatic zones and very poor soils. Therefore, the genus has higher adaptation capability for these harder conditions. Wild sunflower resources have plenty of genes which are tolerant to biotic and abiotic stress conditions as well as different seed quality and other yield traits. The sunflower scientists have developed different high quality and yielding cultivars utilizing genes from wild sunflowers. However, there are different chromosome barriers and seed sterilities during the breeding process for gene transfers in both direct crossing and also interspecific hybridizations. Furthermore, there are some problems for testing and screening then determining of these useful genes for breeders. However, new molecular techniques and biotech methods help breeders efficiently in recent years for screening of these large wild sunflower genetic resources utilizing from molecular markers. Moreover, after determining these genes, molecular techniques assist to breeders to transfer these genes easily esp. new ones such as CRISPR, NGS gene sequencing, gene silencing, etc.

Keywords: Drought tolerance, Sunflower, Inbred Lines, Seed Yield, Yield traits, Molecular methods

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Dr Sanaâ LEMRISS has a assistant professor and headed the Biosafety Department PLC3 of Research and Medical Analysis Laboratory of Gendarmerie Royale (Rabat, Morocco), since 2006. His interdisciplinary research is focused on molecular microbiology and microbial pathogenesis for human and environment using novel technologies (NGS, MALDI-TOF, PCR...). She is senior researcher with national expertise on infection prevention and control and molecular pathogen diagnostics.

Place du séquençage haut débit et autres techniques moléculaires dans le domaine de l'agriculture

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Les maladies infectieuses chez les animaux domestiques ou sauvages ont un impact sévère sur l'économie d'un pays voire sur la santé publique.

Le développement des outils moléculaires, des technologies de séquençage et l'accès à l'information génétique de données de séquençage *in silico* (l'information de séquençage numérique) contribuent de façon déterminante à la détection et à la maîtrise des flambées de maladies infectieuses, en facilitant la mise au point de produits de diagnostic, de médicaments et de vaccins et en guidant les activités de riposte aux flambées des pandémies.

Au cours de ces dernières années, l'émergence de nouveaux virus de la grippe (H5N1 et H1N1) et de coronavirus (SARS-CoV-2), a encore accentué l'importance d'avoir accès à l'«information de séquençage numérique» génomiques du monde entier y compris le Maroc, permettant en particulier de détecter les mutations associées à une modification de la transmissibilité et/ou de la pathogénicité du virus, ainsi que les mutations susceptibles de réduire l'utilité des contre-mesures médicales (diagnostic, vaccins et traitements).

La plus grande plateforme mondiale à accès ouvert de l'initiative mondiale sur le partage des données sur la grippe aviaire (Global Initiative on Sharing Avian Influenza Data , GISAID) a permis la création de 3 types de bases de données de l'«information de séquençage numérique», EpiFlu™, EpiRSV™ et Epi-CoV™, utilisées dans le cadre d'un accord multilatéral sur l'accès et le partage des avantages, notamment avec le cadre des préparations pandémiques de l'OMS.

Des études des mutations virales (H1N1 et SARS-CoV-2) dans le temps et dans l'espace ont aidé à suivre la propagation de ces agents pathogènes et à mieux comprendre les voies de transmission potentielles et la dynamique de la transmission. Des analyses phylogénétiques ont permis de reconstituer la chronologie de l'évolution de ces agents pathogènes. Les analyses phylogénétiques et phylodynamiques ont fournis des informations exhaustives qui peuvent être précieuses dans la riposte aux flambées.

Des inquiétudes liées à l'utilisation de l'information de séquençage numérique ont émergé et en particulier le partage juste et équitable des avantages découlant de cette utilisation par les différents pays.

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Dr Adnane Bargaz main research interests are in the general field of plant-microbiome interactions. He is conducting interdisciplinary research including investigations on i) crop physiology, mineral nutrient use efficiency and dynamics from the rhizosphere interface to the plant on surface ii) beneficial plant-microbe interactions with focus on P and N nutrition and iii) the evaluation of the microorganisms potential use as candidate bio-inoculants particularly in plant stress situations.

Optimization of rhizosphere-microbial interactions to improve P use efficiency

Phosphorus (P) is an important nutrient, which is highly needed for a better crop growth and yield production. However, the availability of P is often low in most soils and that cropping systems in low-P agro-systems require, among others, additional P to maximize growth and yield. Biological strategies based on plant- and microbe-potentialities have been increasingly adopted to improve P use efficiency (PUE). It is now believed that a rational use of mineral P fertilizers alongside agriculturally profitable biosystems (e.g., cropping systems, beneficial microbes, etc.) have the potential to contribute a productive and sustainable agriculture. In this context, greenhouse- and field-based research investigations have mainly focused on studying PUE in several major crops including cereals (e.g., wheat, corn, barley) and legumes (e.g., common bean, faba bean, soybean). Findings on these crops under different P regimes reported several strategies that plants used for a better use of P either by improving its availability in soil or their uptake as well as internal P remobilization. For instance, rhizosphere modifications including variations in root architectural traits, nodulation, root and nodule stratification across soil layers, rhizosphere acidification, induction of specific genes (e.g., P-hydrolyzing phosphatases, etc.) are all involved in PUE. Research on N₂-fixing legumes has reported various rhizosphere biochemical and architectural modifications associated to a higher PUE. Stimulation of rooting system, nodulation, nodule respiration, as well as enzyme activities and gene expression of several phosphatases were found to be involved in PUE and plant growth. Belowground interactions in legume-based cropping systems such as the grain legume-cereal intercrop were also reported to improve plant P acquisition. Increased biomass, length, and surface area of roots, efficient rhizobial symbiosis, increased P hydrolyzing acid phosphatases; higher root microbial diversity and grain yield were found to be associated with higher PUE in different cereal-legume intercrops. In addition, importance of P-solubilizing and N₂-fixing bacteria was highlighted through a series of inoculation experiments under different P regimes (soluble vs insoluble). As per current knowledge, it is highly important to continue understanding how crops and microbes may achieve an efficient use “both internally and externally” of P. Such a biological approach needs to be further optimized for a better use of mineral resources such as P, crop productivity and stress tolerance.

Key Words: Phosphate, solubilization, nutrients, legumes, nodulation, crops, rhizosphere, roots, bacteria

Dr. ACHOUAK Wafa

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She is research director at CNRS and directs the Laboratory of Microbial Ecology of the Rhizosphere and the Extreme Environment (LEMIRE) at CEA Cadarache since 2004. Her current research focuses on the adaptive response of bacteria to fluctuations in their environment, the role of regulatory non-coding RNAs in plant-bacterial molecular interactions, the regulation and expression of phyto-beneficial traits of bacteria associated with plant roots and their exploitation for environmentally friendly agricultural applications. She has been member of the scientific committee of the national programme "Coastal and Continental Ecosphere (EC2CO)": ECOTOxicology, ecoDYNamics of Con-taminants (ECODYN); member of the Steering Committee and Scientific Committee of the "Research Federation" ECCOREV; member of Labex SERENADE and GDR-i F-USA i-Ceint, and member of the CSS INRA BIHASC.

Correlation between holobiont metabolomics and the pearl millet root-associated-microbiota

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Plants and their associated microbiota have long interacted, forming an assemblage of species often referred to as a holobiont. Microbiomes can greatly expand the genomic and metabolic capabilities of their plant hosts, providing or facilitating a range of essential life-supporting functions, including nutrient acquisition, immune modulation, growth promotion, biocontrol, and abiotic stress tolerance. These interactions are mainly driven by root exudates, whose composition reflects contradictory attractive and repulsive behaviors, as they are highly diverse and contain nutritional, antimicrobial and signaling molecules.

We characterized the assemblages and ecological network microbial populations most influenced by changes in root exudation of four pearl millet inbred lines with contrasting rhizosphere aggregation patterns and the correlation of these populations with specific metabolic pathways and compounds from roots, shoots, and root exudates.

We provide plausible evidence for the importance of heritable plant traits carried by the inbred lines in modulating plant-associated microbiomes by establishing diverse metabolic profiles in their tissue and root exudates and the strong correlation of these two interconnected aspects manifested by co-inertia analysis.

Root exudates composition is revealed to be a major component of root-associated microbiome modulation of the pearl millet lines in correlation with their soil aggregation capacities.

Keywords: Pearl millet, root exudates, microbial population and networks, metabolic profiles, soil aggregation.

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Prof. Issam MEFTAH KADMIRI



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The research done by Dr. Kadmiri is focused on the microbiome inhabiting soil and plant parts and how the microbiome is related to plant growth and fitness. Using culture dependent and independent approaches, this research is targeting the knowledge of main microbiome attributes that can be manipulated to develop microbial based product for sustainable agriculture. With more than 20 publications in indexed journals and 7 patents, Dr. Kadmiri contributes to this field at the national and international levels through different research projects.

From metagenomics to bioformulation of plant growth promoting bacteria

The term microbiome can be defined as the theatre of activities of microorganisms living in a given ecosystem. The plant associated microbiomes can interact with host development, physiology and systematic defense, confer fitness advantages to plant host and increase plant tolerance to stress and drought. In fact, plant Microbiome was identified as a key for the next green revolution, and numerous products and microbiome management strategies were developed in agriculture including (i) microbiome transplants, (ii) microbial inoculants, (iii) microbial and plant extracts, (iv) methods to change environmental conditions and (V) microbiome engineering.

Both traditional and the newly developed next-generation sequencing approaches are required to profile microbial communities and their dynamic in different plants and plant compartments and to develop microbial based products.

In this communication, examples of sequencing and cultivation-based studies will be developed. These studies demonstrated the need to profile microbiome is some native and wild species, mainly in Morocco, that could harbor some interesting functionalities for plant growth and development and stress tolerance. Using molecular approaches, a whole picture of bacterial diversity and functionalities could be obtained and then the identified taxa could be targeted using cultivation-based approach. Interesting strains need to be formulated and tested under controlled and field conditions to evaluate their agronomic performance in a ready and easy to use format. Different approaches of bacterial formulation including spray drying and encapsulation technologies will be presented.

Keywords: Plant Microbiome, 16S metagenomics, Isolates, Formulation, plant growth promoting bacteria.

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Dr Mika Tarkka is a Senior Scientist in Molecular Plant-Microbe Interactions, Department of Soil Ecology, Helmholtz Centre for Environmental Research – UFZ, Germany. His current work on ectomycorrhizal symbiosis is to assess the physiological and molecular interactions from both the host plants and the symbiotic fungus' point of view. While much of the current work focusses on genome regulation. Dr Tarkka main motivation in this research field is to contribute to the assessment of the overall impact of microorganisms on plant health, and to assess the existing uses of microbes for improved plant production.

Relative effects of the plant, the soil and the environment on rhizosphere bacterial community composition and function

Research on plant microbe interactions has developed into separate disciplines addressing different organizational levels, broadly speaking the ecology and the functional properties. Integration of mycorrhizosphere, rhizosphere microbiome, soil, and plant research at different scales is necessary to understand the feedback processes occurring in the plant soil system. This lecture highlights our recent contributions in the area of rhizosphere research, depicting the impacts of soil type, agricultural management and climate change on rhizosphere processes. An overview of an on-going approach that overcomes disciplinary boundaries is represented, investigation of spatiotemporal organization of maize rhizosphere [1]. In this context, a particular emphasis has been maize response to, and effect on, rhizosphere microbiome, reaching from in vitro cultures to the field scale. The second example concerns the interacting effects of agricultural management, climate change and plant development on the community composition and function of rhizosphere microorganisms and uses a large-scale climate change experiment, Global Change Experimental Facility [2], as the experimental platform. Finally, we report on the impact of plant community composition to the adaptation of grassland soil pseudomonads to water scarcity. We conclude that the establishment and the perspective of rhizosphere research should rely on combining different organizational levels and methods to investigate the same research question.

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Since the 2000s, her research activities have focused primarily on genetic diversity of date palm; cultivar and sexe identification of cultivars and pollinators.

She has published more than 30 papers in reputed journals and delivered over 50 presentations at national and international conferences. She has been serving as a reviewer for many articles in her specialization. She is also coordinator of several Tunisian research projects and she participates in several national and international projects. She has developed collaborations with several national and international teams.

Le palmier dattier : Etude de l'histoire et de la diversité génétique, pour une meilleure conservation

Salwa ZEHDI-AZOUZI, Emira Cherif, Afifa Hachef, Souhila Moussouni, Summar Abbas Naqvi, Nathalie Chabrilange, Sabira Abdoukader, Abdourahman Daher, Jean-Frederic Terral, Sylvain Santoni, Marco Ballardini, Antonio Mercuri, Claudio Littardi, Frédérique Aberlenc-Bertossi

Université de Tunis El Manar, Faculté des Sciences de Tunis, Laboratoire de Génétique Moléculaire, Immunologie et Biotechnologie, Tunisie

Le palmier dattier occupe une place importante dans l'édification du système oasien où cette espèce est maintenue depuis des siècles grâce au savoir-faire des agriculteurs. Ces derniers ont sélectionné plusieurs écotypes capables de se développer dans des conditions très diversifiées et ce afin de répondre aux exigences locales. L'élaboration d'un programme de recherche, visant la préservation de ce patrimoine phytogénétique a constitué l'un des impératifs de plusieurs acteurs (agronomes, chercheurs, phoeniciculteurs etc). Dans cette optique, nous avons mis à profit les techniques d'analyse de la diversité génomique des végétaux supérieurs pour explorer le polymorphisme moléculaire, établir les empreintes génétiques du patrimoine phoenicicole tunisien et étudier la diversité et la structuration génétique de cette espèce dans son aire de répartition géographique historique allant de la Mauritanie au Pakistan. Les résultats obtenus montrent que le palmier dattier affiche une grande diversité génétique et que la variation génétique est géographiquement structurée. En effet, nous avons montré l'existence de deux pools nommés pool Est et pool Ouest. Les accessions de l'Est sont considérablement différentes de celles de l'ouest suggérant qu'elles ont chacune leur propre origine autochtone. Par conséquent, cette forte différenciation pourrait être le résultat de deux événements de domestication.

L'Afrique du Nord est également soit un centre de domestication primaire ou un centre de domestication secondaire. Par ailleurs et dans le but d'initier une stratégie de recherche visant l'amélioration de cette espèce l'identification des cultivars et l'identification du sexe des jeunes plantules issues de germination ont été largement abordés dans notre programme de recherche palmier dattier.

A la lumière des résultats de génotypage nous avons procédé à la mise en place d'un outil moléculaire permettant l'identification efficace de tous les génotypes de palmier dattier à l'échelle mondiale, il s'agit ici d'empreintes génétiques universelles pour le dattier.

Ce travail nous a également permis d'identifier des allèles mâles spécifiques qui représentent les premiers marqueurs moléculaires fiables et validés permettant de discriminer le sexe chez le palmier dattier. Ils permettront par conséquent, de raccourcir considérablement le temps requis pour l'identification du sexe de jeunes plantules.

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Professor at the University Paris Est-Créteil. The objective of his research is to study, in an integrative manner and under differentiated conditions (soils, sediments and water column) the interconnections between: the environmental and physico-chemical characteristics of the environment, the microbial composition and its activity and finally, the impact of contaminants on higher aquatic and terrestrial microorganisms and organisms in food chains.

Current status of Mediterranean agricultural soils pollution : Diagnostic and monitoring

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In the last decades, soil pollution has drawn worldwide attention. Numerous pollutants such as heavy metal and microplastic can penetrate in soil and cause consequently several damages to soil biota leading to a decrease on biofertility and crop yield. Pollutants can reach soil via direct atmospheric aerial deposit, mining activities, use of plastic mulching, agriculture practices such as application of sewage sludge, fertilizers and irrigation with treated wastewater.

While Geochemical conditions and erosion are a well recognized means of remobilizing pollutants, recently studies underline that soil microbial communities play an important role in metal pollutants distribution and speciation. Indeed, in natural environments, and in particular in agricultural soils, heterotrophic bacteria and specially ferri-reducing ones are a major actor driving organic matter degradation, iron oxide solubilization releasing their associated pollutants.

For assessment of pollutants impact on soil, chemical tools such as chemical extraction are used. However biological biomarkers are of relevant importance. Earthworms are actually considered as bioindicators often used to evaluate the impact of pollutants on soils. Thus, studying their responses using biochemical and transcriptional approaches could be considered as a relevant tool to understand ecosystem dysfunctions. Also, the activity of soil microbiota is an important indicator. Indeed, due to their importance for the soil and their rapid response to soil perturbations, soil enzymes are considered as indicators of soil quality. Also, Community Level Physiological Profiles (CLPP) is frequently employed to determine the effects of various environmental factors on biological activity at soil by following catabolic traits. Therefore, it is important to determine the potential ecological risks imposed by pollutants on agricultural soil.

Keywords: Agricultural soils, pollutants, microorganisms, toxicity, Biomarkers, Earthworms.

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He is currently Emeritus Professor, School of Life Sciences, University of Hyderabad, Hyderabad, India. Formerly Dean, School of Life Sciences, Formerly Head, Dept of Plant Sciences, Formerly Co-ordinator, Biotechnology Program Formerly Co-ordinator of PG Diploma in Environmental education and management.

Did M.Sc (Botany) from Andhra University, Waltair 1973-75; Ph.D (Botany) Lucknow University, Lucknow 1975-79. (Research conducted at Birbal Sahni Institute of Palaeosciences, An autonomous Inst. Under the Dept. of Sci & Tech, Govt. of India). He made significant contributions to the field of plant-metal interactions, bioremediation, and bioeconomy. Published 221 research articles in peer-reviewed Journals, 153 book chapters; Edited 34 books.

h-index Scopus: 48; Citations: 10595

Academic honors: 1. XIX Int. Bot. Congress Excellent Scholar Awardee, July 23-29, 2017, Shenzhen, China ; 2. Pitamber Pant National Environment Fellow 2007 awarded by the Ministry of Environment, Forests and Climate Change, Government of India ; 3. Recipient of Prof. KS Bilgrami award—2015 by the Soc for Plant Research, India ; 4. Served as COST action 859 (Phytotechnology) working group member, ESF; 5. Elected Fellow—Linnean Society of London, UK; 6. Elected Fellow—National Institute of Ecology, New Delhi

Cadmium minimization in rice cultivation

Cadmium (Cd) is a toxic trace element belongs to group II B of periodic table of elements. Cd accumulation pose serious health implications in human such as anemia, hypertension, cancer, cardiac failure, cerebro vascular infarction, emphysema, proteinuria, serious damage in lungs, renal dysfunction, cataract formation in eyes, and osteoporosis. Major route of Cd uptake in human is through daily intake of food stuffs that contain Cd. Average daily intake of Cd is considered as 30 µg that varies between populations. Usage of Cd in industrial applications such as anticorrosive agents for aircraft, stabilizer in polyvinylchloride (PVC) products, color pigments, neutron-absorber in nuclear power plants, and fabrication of nickel-cadmium batteries has resulted in the increase in demand of Cd.

Cadmium (Cd) contamination of rice is found in areas irrigated by waste water from mines. Cd contamination of rice fields can also result from the application of Cd-rich phosphate fertilizers. Consequently, millions of tons of rice are discarded. In Asia, irrigated paddy-based cropping systems provide rice grains as food for about 2 billion people. A daily intake of 20–40 µg Cd from rice is reported in regions where rice is used as a food. Daily rice Cd intake leads to disease such as bone mineralization. Hence, Cd minimization in rice is needed. This article reviews sustainable agriculture and molecular techniques that prevent Cd uptake in rice. Cadmium minimization can be done either by field remediation or change in plant functions. Organic farming decreases Cd uptake and remediates crop fields. Cd hyper accumulator plants and Cd immobilizing microbes can be used for field remediation. Cd amount in rice can be controlled by gene families that code for putative transition metal transporters or metal chaperones and quantitative trait loci (QTL). Generation of Cd exclusion rice is possible by transgenics.

Keywords: Azolla, Biogeochemistry, Biosorption, Cadmium exclusion rice, Cadmium responsive genes, Cadmium transporters, Ecophysiology, Metal chelators, Phytotechnology.

Prof. EL OSSMANI Hicham

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2000-2009: Chouaïb Doukkali University (El Jadida- Morocco)

Masters project entitled "The anthropogenic characterization of the Arabic-speaking population of Beni Mellal, Comparative Study at the Mediterranean Basin" using blood groups and dermatoglyphs as genetic markers (Survey, identification of isolates, interview, questionnaire, collection of fingerprints and human blood).

PhD thesis project entitled "Exploitation of STR microsatellites in the characterization of the genetic and phylogenetic structure of a sample of Arabic speakers in the Rabat-Salé-Zemmour-Zaër region". In this work we used 15 STRs markers used in forensic science to study the genetic and phylogenetic structure of a sample of Arabic speakers from Rabat-Salé-Zemmour-Zaër. A sample of 204 individuals was used in this study.

2002-2021: Member of the Group of Anthropologists in French Language GALF

2007-2021: Member of the Traces and Micro traces Working Group of the Moroccan SMSF Forensic Society. Member of the International Group of Genetic Forensic Sciences ISFG

2003-2018: Expert on Genetic Fingerprinting at the Genetics Laboratory of the Royal Gendarmerie in Rabat.

2018-present: Head of Environment Department in Forensic Institute of Gendarmerie Royale in Morocco.

Application of DNA techniques in the analysis of food fraud: the case of meats

Before using a procedure for forensic analysis applications, the laboratory should conduct internal validation studies in accordance with the requirements of ISO / IEC 17025: 2017 (clauses 7.2.2 and 7.8.1.2) and in accordance with DNA Analysis Methods Scientific Working Group (SWGDM), internal validation is an accumulation of test data within the laboratory to demonstrate that established methods and procedures are working as intended, we will performed the validation of Chipron Meat version 5.0 (which can detect 24 animal species) for species specificity and limit of detection (LoD), using meat mixes for beef and carabeef. The species origin identity of the meat samples used was pre-confirmed using nucleotide sequencing of mitochondrial 12S rRNA amplicons and mitochondrial D-loop species-specific PCR. To check the LO for beef and carabeef, different meat mixes were prepared up to a final weight of 50 g, adding a specified weight, i.e., 0.5 g and 1 g of adulterating species to a matrix species to achieve a mixture concentration of 1% and 2% (w / w), respectively. For the specificity of the method, meat from both adulterating and matrix species was prepared to a final weight of 200 mg. From all triplicate samples, DNA was extracted by spin column method and PCR test (target gene, 16S rRNA) and hybridization was performed according to the manufacturer's kit. An LDD as low as 1% for beef in beef carabeef has been observed. The specificity study using 100% beef and carabeef showed that the species-specific probes in the chip were robust and any possibility of cross-reactivity was excluded. Repeatability was analyzed in triplicate and concluded that the technique provides a foolproof tool for forensic analysis of meat at MSIL, ICAR-NRC on meat. In addition, the Chipron test kit can be validated with other meat mixes such as mutton / goat / chicken / turkey / pork / camel / horse according to stakeholder requirements.

Keywords: 16S rRNA, Chipron, Sequencing, DNA chip.

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Dr EL FAHIME joined the CNRST in 2006, where he set-up the first national platform for functional genomics, which provides services to Moroccan scientific community working in the field of life and medical sciences. In parallel he is involved in several national projects, including those requiring expertise in fields of molecular biology and functional genomics. He is a member of the national Neurogenetics network; his work is focused on developing molecular tools for rapid diagnostic, developing animal and cellular models for identified genetic diseases, performing functional genomics investigation on identified genetic diseases. Dr El Fahime is also involved in the molecular detection and genotyping of human papillomavirus in cervical carcinoma among Moroccan women.

Evolution of sequencing technologies and their impact on agri-food research

Genetic resources (GR) are an essential component of biodiversity and represent a major challenge for research and development. Indeed, these genetic resources, whether they come from plants, animals or micro-organisms, can be used for various purposes (for example for fundamental research or the marketing of products). This use always involves a research phase prior to any development.

The emergence of high-throughput sequencing tools has favored an unprecedented accumulation of knowledge on genetic resources, leading to important applications, including diagnostics, therapeutics, agri-food and environmental improvement based on the direct or indirect use of genes and their wild or modified products. Many companies have invested in these technologies to prepare themselves not only for the expected consequences of the advancement of knowledge on genomes, but also for the possible applications.

In this talk we will review the technological revolution in the field of DNA sequencing and focus on potential applications of sequencing in Agri-food research.

Prof. EL FALLEH Walid

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Dr EL FAHIME joined the CNRST in 2006, where he set-up the first national platform for functional genomics, which provides services to Moroccan scientific community working in the field of life and medical sciences. In parallel he is involved in several national projects, including those requiring expertise in fields of molecular biology and functional genomics. He is a member of the national Neurogenetics network; his work is focused on developing molecular tools for rapid diagnostic, developing animal and cellular models for identified genetic diseases, performing functional genomics investigation on identified genetic diseases. Dr El Fahime is also involved in the molecular detection and genotyping of human papillomavirus in cervical carcinoma among Moroccan women.

Pomegranate by products: potential industrial uses

Recently there have been interests in agro-wastes application in order to replace synthetic chemicals which are expensive and very hazardous to the environment. In this context pomegranate byproducts (peel, leaves seeds... etc.) were used and exploited for potential industrial applications.

Our group is working on several schemes of pomegranate byproducts valorization. This including medicinal and pharmaceutical uses based on a phytochemical screening of the main bioactive compounds. In addition, our group studied the applications of pomegranate peel as food supplements to enhance the shelf life and antioxidant potential of processed food and bioproducts. In a different context, the pomegranate peel was successfully used in the photocatalytic system as a bio-adsorbent for the removal of textile dye herbicide in the presence of heavy metals. Our recent study on pomegranate peel showed a promising result as a green eco-friendly corrosion inhibitor for steel rebar's embedded in cement paste. Therefore, these results confirm, once again, that natural plants are a good substitute for synthetic one and would be very advantageous for industrial applications.

Keywords: Pomegranate; byproducts; antioxidant; functional food; water treatment; corrosion inhibitor.

Dr. HEULIN Thierry

CNRS-CEA-Aix-Marseille University, France



Thierry Heulin is a research director at the CNRS. He was Director of the UMR 7265 BVME "Plant Biology and Environmental Microbiology" (CEA/CNRS/Aix-Marseille II) from 2003 to 2011. He was Director of the Institute of Environmental Biology and Biotechnology (iBEB-CEA-DSV, Cadarache) from 2007 to 2016, President of the CS de France Génomique (2012-2017).

Dr. Heulin has been interested in the ecology of nitrogen-fixing bacteria and is currently working on exopolysaccharide-producing bacteria in the rhizosphere of cultivated plants (diversity, taxonomy, physiology)

Rhizobium alamii improves water stress tolerance in rapeseed

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The classical properties sought in PGPR are based on the production of phytohormones and other growth-promoting molecules. However, few studies have been done on the production of exopolysaccharides (EPS), despite their crucial role in the plant-soil interactions.

We have compared the effect of two strains of EPS-producing *Rhizobium alamii* on rapeseed grown in a calcareous silty-clay soil under water stress conditions or not. Water stress resulted in a significant decrease in leaf area, shoot biomass and RAS/RT ratio, as well as overall beta-diversity. Inoculation with *R. alamii* YAS34 and GBV030 under water stress conditions produced the same shoot dry biomass compared to uninoculated treatment in absence of water stress. Only *R. alamii* GBV030 had a significant effect on shoot biomass under both water conditions. LE fSe analysis identified characteristic bacterial families, *Flavobacteriaceae* and *Comamonadaceae*, in the RT and RAS compartments for the treatment inoculated by *R. alamii* GBV030 under unstressed conditions, as well as *Halomonadaceae* (RT) and several species belonging to *Actinomycetales* (RAS). We have demonstrated that *R. alamii* GBV030 had a PGPR effect on rapeseed growth, increasing its tolerance to water stress. Suggested mechanisms probably comprise the production of EPS contributing to the expression of a cascade of other PGP traits.

Dr. Prof. HIJRI Mohammed

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Prof. Hijri obtained his BSc in 1994 in Cell Biology and his MSc and PhD in Biochemistry, Molecular and Cell Biology at the University of Bourgogne (Dijon, France) in 1995 and 1999, respectively. His projects aimed to study the organization of the genetic polymorphism of the arbuscular mycorrhizal fungus *Scutellospora* and the molecular genetics and the evolution of arbuscular mycorrhizal fungi. In September 2005, he joined the IRBV and the department of Biological Sciences of the University of Montréal (Canada).

Microbiome of field grown hemp reveals potential microbial interactions with root and rhizosphere soil

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Hemp (*Cannabis sativa* L.) is a crop bred and grown for the production of fiber, grain, and floral extracts that contribute to health and wellness. Hemp plants interact with a myriad of microbiota inhabiting the phyllosphere, endosphere, rhizoplane and rhizosphere. These microbes offer many ecological services particularly those of belowground biotopes which are involved in nutrient cycling, uptake and alleviating biotic and abiotic stress. The microbiota communities of the hemp rhizosphere in the field are not well documented. To discover core microbiota associated with field grown hemp, we cultivated single *C. sativa* cultivar, 'TJ's CBD' in six different fields in New York and sampled hemp roots and their rhizospheric soil. We used Illumina MiSeq amplicon sequencing targeting 16S rRNA of bacteria and ITS of fungi to study microbial community structure of hemp roots and rhizospheres. We found that Planctobacteria and Ascomycota dominated the taxonomic composition of hemp associated microbial community. We identified potential core microbiota in each community (bacteria: eight bacterial amplicon sequence variant - ASV, identified as *Gimesia maris*, *Pirellulasp. Lacipirellulalimnantheis*, *Gemmatasp.* And unclassified Planctobacteria; fungi: three ASVs identified as *Fusarium oxysporum*, *Gibellulopsis piscis*, and *Mortierella minutissima*). We found 14 ASVs as hub taxa (eight bacterial ASVs in the root, and four bacterial and two fungal ASVs in the rhizosphere soil), and 10 bacterial ASVs connected the root and rhizosphere soil microbiota to form an extended microbial communication in hemp. The only hub taxa detected in both the root and rhizospheres oil microbiota was ASV37 (*Caulifigura coniformis*), a bacterial taxon. The core microbiota and global hub taxa can be studied further for biocontrol activities and functional investigations in the formulation of hemp bioinoculants. This study documented the microbial diversity and community structure of hemp grown in six fields, which could contribute towards the development of bioinoculants for hemp that could be used in organic farming.

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Prof. VAN DAMME Patrick

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Patrick Van Damme has extensive experience with teaching and R&D in (sub)tropical agriculture and ethnobotany in the (sub)tropics. He is chair of the Centre for Sustainable Development, and of the Ghent University Association Africa Platform. He is member of several professional societies (Economic Botany, ...). Dr Patrick is a vice-chair of the International Foundation for Science, chair of the European Forum for Agricultural Research for Development (www.efard.eu), and executive committee member of the Global Forum for Agricultural Research (www.gfar.net). He is expert committee member for the CITES (plants) and Cartagena protocols (Belgium), and also advises on CBD/ABS-related matters.

He published more than 600 scientific articles, books and book chapters, with nearly 210 in peer-reviewed journals with impact factor (WoS).

Forests, and trees and shrubs on and near farms for sustainable diets

Characterizing and preserving agrobiodiversity and sustainably integrating it into production systems, is key to complementing food from formal agricultural production, and helps provide viable diets to often resource-poor farmers. For decades, we have been collecting ethnobotanical information on traditionally known and used plant species. Based on this info, and in combination with formal, biochemical but also ecological characterization, we have been developing new crops need inglow to no inputs that can be grown in traditional production environments.

Our presentation will illustrate our approach through different examples from the field and conclude that there still is a great need to further explore the potential of thousands of interesting plant species for food.

Dr. BOUNOUA Lahouari

NASA · Biospheric Sciences Laboratory, Dr. Atmospheric Sciences, PhD, USA



Dr. Lahouari Bounoua joined NASA Goddard Space Flight Center Biospheric Sciences Branch in 1993 as a junior member of one of the finest and largest (1991-2000) Earth Observing Science (EOS) Interdisciplinary Science (IDS) group specialized in the use of satellite observations and models to study the biosphere-atmosphere interactions, including the exchanges of carbon, water and energy. He continued to work on many aspects of the interactions between vegetation and climate and published several papers on the subject between 1996 and 2002, some of them have been the focus of much public interest.

Irrigation requirement estimation from satellite to the farm

I explore an inverse biophysical modeling process forced by satellite and climatological data to quantify irrigation requirements in semi-arid agricultural areas. I constrain the carbon and water budgets modeled under both equilibrium, balance between vegetation and climate, and non-equilibrium, water added through irrigation, and postulate that the degree to which irrigated lands vary from equilibrium climate conditions is related to the amount of irrigation.

The amount of water required over and above precipitation is considered as an irrigation requirement. The modeled estimates account for 87% of the total reported irrigation water use, when soil salinity is not important and 66% in saline lands.

Oral communications



**Biotechnologie et amélioration des plantes /
conservation et valorisation des produits
locaux**

**Biotechnology and plant breeding /
conservation and valorization of local
products**

Thème/Topic



Characterisation of volatile compounds of Moroccan strawberry tree (*Arbutus unedo* L.) fruit using head space solid phase microextraction coupled with GC-MS

CO-1

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Wild edible fruits have been used centuries by local people mainly for nutrition purposes. Among wild edible fruits, the strawberry tree (*Arbutus unedo* L.) is widely distributed mainly in Mediterranean countries. However, the lack of information about strawberry tree genetic resources in Mediterranean countries is a major cause of its slow exploitation by breeders. In this study, the volatile compounds of strawberry tree fruits were identified using Head spaces solid phase microextraction coupled with gas chromatography - mass spectrometry analysis. The results revealed important variations among strawberry tree samples according to their volatile composition. Thus, 25 volatile

compounds in strawberry tree fruits were identified. Hexadecanoic acid was the most abundant in all strawberry tree samples, ranging from 27.68% to 52.18%. For discrimination of strawberry tree genotypes, a clustering was based on the first three principal components of PCA model of volatile constituents was built. Total variance of 61.63% was explained by the first three components. The PCA revealed seven homogeneous groups of strawberry tree genotypes according to their composition in volatile compounds. **Keywords:** *Arbutus unedo* L; strawberry tree; volatile compounds; HSPME/GC-MS ; Morocco

Antifungal activity of *Artemisia absinthium* and *Mentha pulegium* plant extracts and essential oils against *Fusarium oxysporum* f. sp. *albedinis*: the causal agent of Bayoud disease on date palm in Morocco

CO-2

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Fusarium oxysporum f.sp. *albedinis* (Foa) is the causal agent of the vascular wilt of date palm, also known as Bayoud disease. It is the most serious soilborne disease that causes the disappearance of millions of palm trees in Moroccan oases. Attempts to control the disease have focused on the selection of genetically resistant cultivars. However, some of the elite-but-sensitive industrial cultivars, notably "Medjool", are highly sensitive to Foa and their cultivation requires an integrated management. The objective of this study was to examine the effect of ethanolic and aqueous leaf extracts and essential oils of the plants *Artemisia absinthium* and *Mentha pulegium* on Foa under laboratory conditions. Four concentrations of plant extracts (0.625 mg/ml to 5 mg/ml) and essential oils (1 ul/ml to 7 ul/ml) were tested for their ability to inhibit Foa spore germination, sporulation, and mycelial growth. The most significant results were obtained using the

ethanolic extract of *A. absinthium* and the essential oil of *M. pulegium*. When applied at 5 mg/ml, the ethanolic extract of *A. absinthium* induced 100% inhibition of Foa spore germination as well as sporulation, and 35% inhibition of the pathogen mycelial growth. All other extracts showed weaker effects on Foa. In addition, the essential oil of *M. pulegium* was more effective against Foa compared to the essential oils of *A. absinthium*. The former completely inhibited Foa mycelial growth and sporulation even at a low concentration of 4 ul/ml. These results provide significant insight into the potential of using bioactive compounds from *A. absinthium* and *M. pulegium* in future management strategies of date palm Bayoud disease in Morocco.

Keywords: *Fusarium oxysporum* f.sp. *albedinis*, vascular wilt, date palm, *Artemisia absinthium*, *Mentha pulegium*, plant extracts, essential oils

Chemical characterization of Ferraduel and Ferragnes almond oil and meal as mechanical extraction products

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CO-3

Ferraduel and Ferragnes, which native of France, are the most cultivated varieties of almond in eastern Morocco by Moroccan Agricultural ministry. In this study, the two varieties were studied in order to evaluate oil yield, fatty acid (FA) profile, and physicochemical properties of kernel oil and in addition of the composition and the nutritional value of almond meal. For this purpose, extraction of almond oil, from the two varieties, was carried out by mechanical press. Ferraduel and Ferragnes, oil yield was 50.20 and 49.53 %, oleic, linoleic and palmitic acids are the major fatty acids and were 73- 67 %, 15- 21.50 % and 7.3- 7.5 % respectively. Acidity index and peroxide value were 0.34- 0.33 % and 4.50- 4.00 mequi O₂. Total phenols, oxidative stability and α -, β -, γ -tocopherol isomers were 85.52- 327.15 mg/kg; 26.23- 33.04 h; 316.40- 266.52 mg/kg; 1.74- 1.30 mg/kg; 3.10- 1.30 mg/kg for the two varieties respectively. δ - tocopherol was not detected. In the other hand, Ferraduel and Ferragnes moisture, proteins, fibers, total sugars, oil recovery and ash were 91- 90.30; 49 -

46.54%; 33.80 -19.24 %; 16.80 -17.85%; 12.6 - 9.80 %; 5.65 - 6.12% respectively. Potassium was the major mineral 4156.9-4316.2 mg/Kg followed by Phosphor 4013.2-4061.2 mg/kg; Calcium 1282.64-1488.65 mg/kg; Magnesium 895.4- 1019.7 mg/kg; Iron 109.95 - 79.93 mg/kg and Copper 25.86 -22.35 mg/kg. Sodium was not detected in almond meal. The amino acid profile presents eight essential amino acids (Cysteine, Methionine, Isoleucine, Leucine, Phenylalanine, Tyrosine, and Lysine Valine) and the Protein Digestibility Corrected Amino Acid Score (PDCAAS) was 68.02 % and 41.81% for Ferraduel and Ferragnes respectively. Significant difference was detected in oleic acid content, total phenols, oxidative stability and tocopherols, and in proteins, PDCAAS, fiber and ash. We conclude the analyzed almond oils and meals present an interesting cosmetic and nutritional value for healthy foodstuffs.

Key words: Almond oil, Almond meal, Amino acid, Fatty acid, Nutritional quality, Tocopherols

Chemical composition and in vitro digestibility of local *Sulla flexuosa* (*Hedysarum flexuosum* L.) ecotypes in Northern Morocco

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CO-4

The present work is part of the assessment of wild genetic plant resources of forage interest in Northern Morocco and consisted of studying the agro-morphology, phenology and bromatology of *Sulla flexuosa* (*Hedysarum flexuosum* L.) ecotypes. Twenty-one wild *S. flexuosa* ecotypes were collected from 21 sites distant at least 30 km. The edaphic and climatic characteristics of the collection sites were studied and showed a great variability from one site to another, testifying to the remarkable adaptability of *S. flexuosa*. During two consecutive years (2018/2019 and 2019/2020), these 21 ecotypes were cultivated on experimental plots at INRA Tangier. The experimental design was in three complete randomized blocks. Plants were cut at three different stages of

growth (budding, start of flowering and full flowering). They were taken to laboratory for chemical composition and digestibility assessment.

Results showed a wide variability between ecotypes for fiber content (NDF, ADF, ADL, Crude fibers), Ether extract (EE), Crude proteins (CP), Mineral matter (MM) and digestibility over the three cutting stages during two years. Full flowering showed the highest protein content and dry matter yield compared to other stages but the lowest digestibility. Start of flowering is the best compromise between yield, protein content and digestibility.

Keywords: *Hedysarum flexuosum*; forage; chemical composition, digestibility, Northern Morocco.

Impact of landscape on pollinator diversity in four different agro-ecosystems of Morocco

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CO-5

The pollination services provided by pollinators, mostly insects, are essential to sustain food security and ensure successful reproduction of most flowering plants. However, wild pollinators are threatened by several factors such as degradation and loss of their habitats (floral and nesting resources) which are generally linked to intensive agriculture, urbanization, and other human activities. The FAP approach "Farming with Alternative Pollinators" has been developed as a new strategy in middle income country to conserve pollinator in agro-ecosystem. It consists of sowing strips of marketable habitat enhancement plants (MHEP) around the main crop. As previous studies showed that landscape can have an impact on the efficiency of conservation strategies for pollinators, we conducted a study on the interaction between landscape and FAP approach in 20 fields in four different agro-ecosystem across Morocco. We

aim to 1) Evaluate how landscape influence bee communities inside and outside crops; 2) Characterize how landscape impact the efficiency of FAP approach mitigating abundance and species richness of pollinators. Pollinator communities were sampled within main crop and within the surrounding landscape. We show that the landscape has a significant impact on the abundance and the species richness of bees found outside the crop but does not affect these parameters inside the main crop. We found that FAP fields surrounded by more than 75% of the agricultural landscape are more attractive than the FAP fields surrounded by less than 50% of the agricultural landscape. These findings indicate that FAP approach, as a strategy of conservation of wild pollinators, is more efficient in agro-ecosystem with a high percentage of agricultural elements in the landscape.

Keywords: Agriculture, Landscape composition, Morocco, Wild Pollinators, Diversity.

Sargassum flavifolium and *Centroceras clavulatum*: Moroccan seaweeds from Mediterranean coast for biostimulation of *Medicago sativa* development

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CO-6

Choosing a sustainable agricultural model has become a challenge for agriculture and food security in order to reduce the use of chemical fertilizers and pesticides. To limit the negative effects associated with the use of these chemicals and preserve the environment, organic farming has experienced a great development. Hence the interest on natural products of natural origin such as plants and algae.

The main objective of this study was the evaluation of the biostimulant effect of both *Sargassum flavifolium* and *Centroceras clavulatum* extracts on the germination and growth of *Medicago sativa* crop. For this purpose, alfalfa seeds and seedlings were exposed to four treatments based on macroalgae extracts (25%, 50%, 75% and 100%). Then the determination of the germination rate, plant growth and the mineral elements contents (Na⁺, K⁺ and Ca²⁺), were carried out on the obtained

plant biomasses.

The obtained results revealed that the exposure of plants to the aqueous extracts of *S. flavifolium* and *C. clavulatum* induced a significant increase in several growth parameters, namely germination rate, plants development and biomasses (dry weight). In addition, the application of the studied algal extracts resulted in an enhancement on the mineral elements contents. Seaweeds extracts induced also a net increase on chlorophylls and carotenoids contents. In the light of the obtained results, the studied macroalgae extracts could be suitable for improving plant development. Besides, they could constitute a promising path for the development of sustainable agricultural practices that are more environmentally eco-friendly.

Keywords: *Sargassum flavifolium*, *Centroceras clavulatum*, Seaweeds, Biofertilization, Biostimulation, *Medicago sativa*, Growth, Mineral elements, pigment contents.

Exogenous silicon as inorganic biostimulant to improve salt tolerance in fenugreek (*Trigonella foenum-graecum* L.)

CO-7

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In the present study, we investigate the beneficial effects of exogenous silicon (Si) as inorganic biostimulant on fenugreek (*Trigonella foenum-graecum* L.) growth under saline conditions. The experiment was carried out in a growth chamber at 25 ± 1 °C, 60% - 80% relative humidity and a photoperiod of 16h at the Polydisciplinary Faculty of Beni-Mellal, Morocco. After germination, the fenugreek seedlings were treated with 3 mM Si and submitted to 200 mM NaCl. After one month of stress, the plants were harvested and subjected to some agrophysiological and biochemical analyses associated with salt tolerance. Results showed that 200 mM NaCl significantly reduced plant biomass, plant height, number of seed per pod, leaf area, relative water content, stomatal conductance, photosystem II efficiency (fv/fm) and total chlorophyll and carotenoids contents. However, exogenous Si supplementation contracted these negative impacts of salt and significantly improved all of

the previous parameters studied. Furthermore, salinity also induced an oxidative stress reflected by high malonyldialdehyde and hydrogen peroxide contents, and electrolyte leakage percentage. Though, salt-mediated oxidative stress was alleviated by Si through an increase in the activity of non-enzymatic and enzymatic antioxidant systems such as SOD and PPO activities and the content of total polyphenol and flavonoids. In addition, salt-reduced key compatible solute accumulation was also improved by exogenous Si through an increase in the content of proline, glycine betaine, and soluble sugars, suggesting that 3 mM Si application was directly involved in the central defensive mechanisms to enhance salt tolerance of fenugreek, which is an important aromatic and medicinal plant in Morocco.

Keywords: Fenugreek, Growth, Silicon, Salt stress, Compatible solute, Antioxidant activity, Tolerance.

Characterization of variability in virulence of a Moroccan population of *Botrytis* spp. to *Faba bean*.

CO-8

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Chocolate spot is an important disease of faba bean (*Vicia faba*) in Morocco, causing more than 60% of yield losses on susceptible cultivars. Two species *Botrytis cinerea* and *B. fabae* represent the causal agents of disease in Morocco. Information on pathogen virulence diversity will be useful in breeding strategies of the new faba bean cultivars. A pathogenicity test of a population of 54 isolates of *Botrytis* spp. originated from seven geographic regions was conducted using a simple technique of detached leaves on differential genotypes. Four faba bean genotypes were selected as a differential set according to a preliminary test using 10 isolates. The reaction of these differentials tested separately with 54 isolates of *Botrytis* spp. showed significant variability in

the degree of virulence of the fungus. The cluster analysis showed three level of virulence of *Botrytis* spp. The highly and moderately virulent isolates were the most frequent and represented 54 % of the population. The majority of these isolates were identified as *B. cinerea* and only 20% were *B. fabae*. The distribution of these groups had no geographic preferences and they were present in all regions. The high percentage of virulent isolates and their large distribution showed the need for more durable sources of resistance than those available in Moroccan faba bean cultivars.

The anti-venom potential of methanolic and ethyl acetate extracts from *Thapsia garganica* roots used in traditional medicine against scorpionic envenomation

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The present study describes the antivenom efficacy of ethyl acetate extract (EaE) and methanol extracts (MeE) of *Thapsia garganica* (TG) plant roots on Swiss mice model poisoned by the scorpion *Buthus occitanus* (BO) venom using histological and biochemical studies. This study follows on from previous work [1] already published on the leaves of TG. Given the use of the root of this plant in the scorpion pharmacopia we want to check this traditional use in case of envenomation with scientific evidence. The EaE and MeE TG root were obtained by the Soxhlet apparatus. Swiss albino mice weighing 24-30 g were manipulated. Phytochemical screening and HPLC analysis were used to determine the major phenolic components present in the root of the plant. we used various doses to evaluate the protective capacity of MeE (100 mg/kg; 500 mg/kg) and EaE (100 mg/kg; 500 mg/kg) of the root of the plant against the venom of the scorpion BO, the average survival time of the animals

during a period of 24 h is the parameter used to determine the anti-venom potential of the plant. Histological and biochemical modifications in vital organs of animals were also monitored. Phytochemical screening performed to evaluate the main component while the quantification and qualification of phenolic compounds present in the root were estimated using high performance liquid chromatography (HPLC) method. The results indicate that the LD₅₀ of the venom of BO by the subcutaneous route is 0.52 mg/kg. Phytochemical analysis revealed a high content of phenolic compounds of (28,941 mg/g of extract) in the extracts. HPLC analysis showed that Thapsigargine, Gallic acid, Coffee acid, Rutin, Catechin, Ferric acid, P-coumaric, Sorbic acid, Chlorogenic acid and Quercetin are the main components of our extracts. This study supports the traditional use of TG root extract against scorpion venom.

Keywords: *Thapsia garganica* root; Antivenom activity; Antioxidant; Histology; HPLC.

Estimation of heritability and genetic gain for biochemical and agro-morphological traits in doubled haploid barley lines under salt stress conditions

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Salinity is one of the most important abiotic stresses affecting crops in arid and semi-arid regions. The genetic improvement for salinity tolerance using in vitro another culture method is one of the most important priorities of our investigation. The present study was conducted to estimate heritability (H^2) and genetic gain (GG) among ten traits studied in doubled haploid (DH) barley lines and their parents exposed in salt stress. The studied traits were the proline, Na^+ , K^+ , and K^+/Na^+ ratio, stomatal conductance, chlorophyll content, flag leaf area, plant height, number of fertile spikes per plant, number of grains per spike, number of spikelets per spike, hundred-seed weight, and grain yield. Analysis of

variance (ANOVA) revealed a significant difference among the DH genotypes and their parents for the major studied traits. Salinity significantly affected the parent more than the DH lines. High heritability was found in hundred-seed weight and plant height. The traits showing high and moderate heritability coupled with high expected genetic gain were plant height, K^+/Na^+ ratio, proline and number of fertile spikes per plant. These traits are recommended as selection criteria for salinity tolerance.

Keywords: Barley, doubled haploid lines, salt stress, broad sense heritability, genetic gain

Valorization of squash (*Cucurbita maxima* Duch) biodiversity: approaches and main results

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CC-11

Tunisia is one of the most important diversity centers for cultivated Cucurbits accessions characterized by their adaptation to climatic changes. The majority of the production of squash (*Cucurbita maxima*) is based on landraces maintained for the years by the local farmers. The genetic diversity among 31 local *Cucurbita maxima* accessions was investigated by agro-morphological, biochemical traits. The best ones (15) were characterized by molecular markers; 60 RAPD markers, 17 ISSR markers and 25 different combinations of SRAP markers, were used to characterize these squash accessions. The morphological characterization has revealed a great diversity in cotyledon, leaf, fruit and seed parameters within the Tunisian accessions. All markers used were highly polymorphic; with a percentage of polymorphic bands higher than 90% for all markers. The PIC values for the three types of markers, ranged between 1.04 and 0.38 for our collection for which the RAPDs marker resulted the most informative. The

molecular analysis grouped the accession on the basis of the area of cultivation. The total phenolic contents and the antioxidant effects on seeds of these accessions were also analyzed to determine their potential utilization as a raw material for food, chemical and pharmaceutical industries. The high level of seed chemicals content in all the accessions confirmed the high nutritional value of *Cucurbita maxima* and in particular, the high antioxidant activity of oil seed extracts highlighted the added value of these accessions, traditionally used exclusively for animals feed, that could be used also for human consumption. Also, these local accessions will be useful for *Cucurbita maxima* plant breeding and need more research related to their abiotic stress tolerance/resistance (salinity, drought, temperature).

Key words: *Cucurbita maxima*, molecular characterization, genetic diversity, chemical analysis

Effects of drought stress on leaf chlorophyll a fluorescence of different genotypes of eggplants grown under Mediterranean climate conditions of the Northeast of Morocco

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CC-12

In recent decades, global warming has a direct impact on agriculture, especially in arid regions like Africa and the Mediterranean region. Morocco, with an arid climate, gives importance for food security and the agricultural sector. Local vegetable production presents an agricultural sector with great economic value. Recently, the areas of vegetable production have been reduced due to the lack of rainfall. Drought is the most important limiting factor affecting plant growth and seed yields, preventing the full genetic potential of crops and reducing local agricultural production. The choice of drought tolerant cultivars presents one of the good agricultural practices and an important topic of research. Moreover, eggplant cultivation presents production with added economic value. Few droughts tolerant eggplant cultivars and genotypes exist on the Moroccan market. This present research work is part of the international project entitled C4C or "Crops For Change; Tackling the global warming effects in crops", selected by FOS-ERANET in 2021. The aim of this work is to study the effects of two regimes of irrigation on chlorophyll a fluorescence and stress status of different genotypes of egg-

plants selected by Italian and Turkish laboratories for drought and high temperature tolerances. Thirteen selected genotypes were used and compared to two commercial cultivars used by local growers. Two regimes of drip irrigations were used (100% water (which is considered as the control strategy adopted by the grower) and 50% water, as drought stress treatment). Trials were conducted under the Mediterranean climate conditions of the Northeast of Morocco, in the Nador area. Fifty physiological stress indexes based on chlorophyll fluorescence parameters (including F0, Fv, Fm, Vi, Vj, Sm, N, ABS, ETR, DI, RE, PI, etc.) were measured under clear sky conditions. These parameters are related to the light phase of photosynthesis and to the transfer and interception of photons and electrons by PSI and PSII (PSI = photosystem) as well as by chlorophyll antennas and reaction centers. These parameters are related to plant stress status as reported by Starsser, 2001. The obtained results will be discussed.

Keywords: climate change, genetic, irrigation, photosystem, temperature, tolerance.

Nouveau procédé de production de compost à partir du lixiviat des décharges en utilisant les écumes des sucreries et les déchets verts

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CO-13

Du fait de la forte teneur en eau et de l'option d'enfouissement choisie au Maroc sans tri en amont, les déchets ménagers génèrent au niveau des décharges de grandes quantités de lixiviat qui pose de grands problèmes. Plusieurs techniques sont aujourd'hui considérées comme potentiellement efficaces pour la dépollution et le traitement des lixiviats mais toutes ces techniques se sont avérées malheureusement insuffisantes et parfois inadéquates en raison du coût que doit supporter le gestionnaire de la décharge. La transformation du lixiviat en compost en utilisant les écumes des sucreries et les déchets verts existant dans la décharge même constitue une nouvelle solution qui vient d'être testée à la décharge contrôlée d'Oujda. Cette solution a pour avantage d'être très peu coûteuse, biologique et générant un produit à valeur ajoutée qui est le compost. Deux barils ont été remplis par environ 100 l de lixiviat : les écumes ont été rajoutées dans le baril 2 alors que le baril 1, constituant le témoin, n'a pas reçu d'écumes. Le temps de contact est de 24 au bout desquelles les déchets verts sont ajoutés dans les 2 barils jusqu'à absorption totale du lixiviat. Les contenus des deux barils sont mélangés soigneusement par retournement pour assurer une bonne homogénéisation avant qu'ils soient déversés sur des bâches en plastique pour constituer 2 andains ; ceux-ci sont couverts par du plastique afin d'éviter l'évaporation. Le compostage des deux andains est suivi pendant 90 jours avec des prélèvements à temps déterminés pour les analyses physico-chimiques. En relation avec la composition des écumes, le temps de contact de 24 h a été suffisant pour

réduire la charge du lixiviat en flore pathogène de streptocoques fécaux, de 90,6 %. Par ce même traitement, les odeurs nauséabondes connues du lixiviat disparaissent dès les 3 premiers jours. Le suivi physico chimique lors du compostage montre que la température des deux andains a suivi une évolution caractéristique avec notamment une augmentation de la température dès la première semaine pour atteindre 58,5 °C pour l'andain avec écumes et 56,6 °C pour le témoin ; l'humidité a été maintenue dans l'intervalle 50-60 % par un arrosage régulier pour une bonne activité bactérienne. La dégradation de la matière organique est meilleure en présence des écumes (31 % contre 28 % pour le témoin). Malgré le caractère alcalin des écumes, le pH du compost final, légèrement alcalin, reste acceptable pour les espaces verts et pour beaucoup de plantes. Avec notamment 38 % MS de matière organique la qualité finale du compost est conforme à la norme NFU 44- 051 ; aucune toxicité n'est observée avec le test de phytotoxicité ; le compost final pourrait donc bien être utilisé comme amendement organique pour les sols Marocains ainsi que pour la réhabilitation des sites dégradés. Le co-compostage des déchets de l'industrie sucrière et du lixiviat est une solution durable au problème posé à la fois par le lixiviat des décharges et par les écumes des sucreries.

Mots clés : lixiviat, déchets verts, écumes de sucrerie, compost.

Extraction and enzymatic assay of soluble and ionically wall-bound guaiacol peroxidases in *Argania spinosa* (L.) Skeels leaves

CC-14

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Peroxidases (POX) are involved in a broad range of physiological processes throughout the plant life cycle due to the high number of enzymatic isoforms (isoenzymes) and the versatility of their enzyme-catalysed reactions. In this study, extraction and enzymatic assay of soluble and ionically wall-bound peroxidases were performed in *Argania spinosa* (L.) Skeels leaves. Two enzyme fractions of peroxidases were obtained from *A. spinosa* by a progressive solubility method leading to the soluble peroxidases (S) and the ionically wall-bound peroxidases (I) fractions. The enzymes were characterized for thermal stability and optimal pH and their behaviour in the presence of bivalent ions was analysed, using guaiacol as substrate. For both soluble and ionically wall-bound peroxidases, activity was revealed after the addition of the phenols-complexing agents PVP or PVPP, to the extraction protocol. Phenol's inhibition power on guaiacol peroxidases

in argan extract was demonstrated. In fact, enzymes activities were totally abated after 10 µL/mL phenols extract addition. For the (S) fraction, optimum activity was obtained between pH 3.6–7, with a highest activity at pH 5.6. For the (I) fraction, high activities were recorded over pH 3.4–9 with a peak activity at pH 5.0. The (I) fraction of the enzymes showed maximum activity at 55 °C and kept fairly active at 90 °C, while the (S) fraction started to lose activity at 55 °C and became inactive at 75 °C. Activities were enhanced in the presence of Fe²⁺, Ca²⁺ and Mg²⁺ ions, however, a lag time of 60 seconds was observed for both Ca²⁺ and Mg²⁺ ions. Fe²⁺ ion completely abolished the lag time at all studied concentrations (0.2 mM, 0.5 mM, 1 mM and 2 mM) while Cu²⁺ ions suppressed the lag time at 2 mM concentration.

Key words: *Argania spinosa* L., peroxidases, PVP, bivalent ion, lag time, phenolics.

0

Do Fruit morphological variations could constitute a good marker for characterization of Argan tree varieties?

CC-15

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The objective of this work is the molecular characterization of most common identified morphotypes of critically endangered rare Moroccan species *Argania spinosa*. In this respect, 18 RAPD markers and 20 SSR markers have been assayed in 38 argan tree accessions from the three most commonly identified morphotypes: oval, spherical and spindle fruit types. The obtained results showed that a total of 140 polymorphic RAPD bands were detected out of 146 bands. The number of presumed alleles revealed by the SSR analysis ranged from 1 to 5 alleles per locus with a total number of 32 alleles identified. Also, results demonstrated an extensive genetic variability within the tested argan accessions. Furthermore, RAPDs presented a high level of polymorphism and greater information content than

SSRs.

Our results could indicate that *Vitellaria paradoxa* is genetically closer to argan than *Manilkara huberi*. In addition, the correlation between the clustering based on RAPD and SSR markers were in general low. The observed clustering could be better explained according to geographic proximity than morphotype. For this reason, the traditional morphological characterization of the argan accessions in morphotypes (according to fruit phenotype) seems not to be in correlation to the real genetic background (genotype) of this species. The implications of these results in the creation of effective germplasm core collection in argan have been also discussed.

The chemical composition of the essential oil of *Rosmarinus officinalis* from the Oriental region

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CC-16

The eastern region of Morocco covers the largest area of Rosemary on a national scale, with production, in dry leaves, and essential oils (EO). Rosemary (*Rosmarinus officinalis*) is a very abundant species in the province of Jerada in eastern Morocco, it is used in popular medicine, cosmetics and phytopharmacy. The purpose of this study was to identify the bioactive molecules found in the essential oil of *Rosmarinus officinalis*. The extraction process of rosemary EO was performed by Clevenger hydrodistillation. The chemical composition was determined using the Gas Chromatography coupled

to Mass Spectrometry (GC-MS) analysis. The chemical study of this essential oil by GC-MS revealed its richness in 1,8 cineol compared to other compounds found in this oil. In conclusion, Eucalyptol or 1,8-Cineol remains one of the main constituents of the EO of *R. officinalis*, which is thus used in perfumery, in Pharmaceuticals and other cosmetics.

Keywords: *Rosmarinus officinalis*, extraction, essential oil, 1,8 cineol, Jerada-Morocco.

Effect of chemical pre-storage treatments on enzymatic browning kinetics and major bioactive compounds of dried figs (*Ficus carica* L.): Combined biochemical analyses and FTIR-ATR fingerprinting

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CC-17

Enzymatic browning is a limitative factor of several agri-product quality and marketability and is behind more than 50% of fruit industry losses. Sulfites are widely used to prevent enzymatic browning; however, their use was restricted due to their negative effect on consumer health. In this study, the results of the impact of ascorbic (AA) and salicylic (AS) acids, calcium chloride (CC), compared to potassium bisulfite (KBS) on enzymatic browning (BE), showed with the monitoring of the evolution of the kinetics of the total soluble sugars contents (SST), flavonoids (FT), anthocyanins (AT), quantification of polyphenols (CPT), antioxidant activity (by measuring the inhibition rates of DPPH and ABTS), the polyphenoloxidase enzymatic activity (PPO), the kinetics of water activity and the evolution of the browning index (BI) with a combination of the classical UV-Visible spectrophotometric method and the FTIR-ATR spectroscopy, throughout the experimental period of 75 days of storage, at a rate of once every 15 days, that all the interactions between the factors considered (treatment, concentration, duration and mode of conditioning) were significant ($p < 0.05$). However, the combined effect of treatment,

concentration, and conditioning time seems to contribute the most to explaining the kinetics of the physico-biochemical biomarkers evaluated. AA (2 %) thus made it possible to obtain the highest CPT contents (142.88 mg/100 mg), the highest DPPH inhibition rates (81.96 %) and ABTS (29.19 %), in addition to the low values for PPO activity (1 U/mg), as well as in SST (7701 µg/ml). The results of FTIR-ATR spectroscopy which applied for the ethanolic extracts of dried figs revealed several major regions of vibration corresponding to carbohydrates, carboxylic acids, free amino acids, polyphenols, organic acids and achenes. The fingerprints and their calculated areas were able to confirm the appearance of the polyphenols obtained with those evaluated by UV-Visible spectrophotometry. As many areas of figs enzymatic browning are still needed to be investigated further, information from this research could be applied further in the dried figs industry to improve quality and storage stability and as a potential alternative to the use of sulphites.

Keywords: enzymatic browning, polyphenoloxidase, FTIR-ATR spectroscopy, dried figs, *Ficus carica* L.

Potential of saffron '*Crocus sativus* L' flower waste as antioxidant and natural dye

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CC-18

Medicinal plants constitute an inexhaustible natural source of molecules with very varied biological and pharmacological activities. Morocco places great importance and is committed in the framework of the Green Morocco Plan to the valorization of its natural resources, of which saffron (*Crocus sativus* L.) is considered among the main flagship local products. It is the most expensive spice in the world, but is considered one of the least exploited species in the level of their by-products. One kg of saffron spice generates about 350 kg of petals that are currently unused and discarded. The valorization of these by-products requires a search of new uses for optimal and more sustainable management of the crop.

The main idea of this study is to convert the waste of

saffron flower to an eco-friendly natural colorant with antioxidant proprieties for sustainable textile coloration of wool and cotton fabrics. This work studies the stability of saffron flower extract by UV-Vis spectroscopic analysis, thermo-gravimetric analysis, and differential scanning calorimetry. Also, by using of some mordants, the range of hue that wool and cotton fabrics can get is studied. Color depth and fastness properties (light and wash fastness) as key properties for technical and commercial success were measured. The antioxidant activity was evaluated using in vitro assays such as DPPH free radical, FRAP and β -carotene bleaching assay.

Keywords: *Crocus sativus* L - Dyeing - Saffron waste - Antioxidant activity – Wool - Cotton.

Effect of five biostimulants on yield and quality of peaches under the conditions of Sais plain (Morocco)

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CC-19

The increase in demand for food over the world seems to be the biggest challenge for farmers, and the main reason for the food industry competition. Moreover, climate change may induce many abiotic stresses such as water shortage and irregular temperature fluctuation and impaired tree fructification. Several biostimulants or biostimulant like products has been tested and/or used in order to alleviate the negative effect of this climate change. Little information is available on the use of biostimulants to reduce the adverse effect of climate change on peaches under the conditions of Sais plain (Morocco) characterized by calcareous soils and very hot and dry summers. This study aims to evaluate the improvement of production and quality challenges of peaches in Sais plain (Morocco). The experiment was carried out during 2018 season in a conventional peach

orchard (Zee Lady grafted onto almond rootstock) in order to evaluate biostimulant effects of five products namely Vitazyme (T1), Protifert LMW10 (T2), Protifert LMW6.3 (T3), Protifert Zinc (T4) and Naturfer (T5) on fruit yield and quality. Control plots of unsprayed trees (T0) were also considered. The six variants were compared according to a latin square design with 3 repetitions. Data collected indicated all the five biostimulants improved harvest size and fruit number per tree. In addition, most of the fruit pomological and chemical parameters considered namely fruit weight, fruit diameter, fruit length, fruit flesh weight, fruit core weight and total soluble sugars were affected by the biostimulant application.

Keywords: Biostimulants, Fruit drop, Fruit quality, Parameters, Peach.

Extraction and characterization of the essential oil of geranium Morocco: comparison with essential oil of Bourbon and Egypt geranium for its development in Morocco

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CC-20

The objective of our study is part of the scientific research for the development of the essential oil of Geranium cultivated in Morocco and to compare its quality with that of Geranium type Egypt (*Pelargonium asperum*) and type Bourbon (*Pelargonium graveolens*). Indeed, Geranium has always been known but poorly exploited in Morocco despite the success of its culture. Geranium essential oil represents an economic interest and a significant financial windfall.

Geranium asperum and *graveolens* are aromatic and medicinal plants belonging to the Geraniaceae family. Knowing that the chemical composition of essential oil of geranium changes in quantity and quality from one origin to another. Our work is based on a comparison

between the chemical composition of essential oils of Geranium (*Pelargonium graveolens*) originating from the Errachidia region specially harvested in Tinjdad, with the chemical composition of essential oils of Geranium Egypt (*Pelargonium asperum*) and Bourbon (*Pelargonium graveolens*). These analyzes were carried out by gas chromatography coupled to MS, GC-FIS / MS. We also tried to search for flavonoids and polyphenols that exist in our factory using High Performance Liquid Chromatography coupled with UV, HPLC / UV, and comparing the spectra we had with the aglycon spectra using the same method. .

Key words: *Geranium asperum*, *Geranium graveolens*, Essential oil, Chemical analysis, Pharmaceutical industry, Fragrance industry.

Optimization of an eco-friendly process for the extraction of hempseed oil using enzymes

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CC-21

Aqueous enzymatic extraction has emerged as an alternative and eco-friendly technology for seeds' oil extraction in response to consumer expectations for highly nutritious and safety products, as well as industrial requirements to reduce the environmental impact of solvent oil extraction from oilseeds. The aim of this study is to optimize an aqueous enzymatic extraction (AEE) method for oil extraction from hempseeds from northern Morocco. A mixture of three enzymes, hemicellulose, protease and pectinase, was used to extract the oil from the cannabis seeds. The effects of four factors were investigated, including enzyme concentration, pH incubation time and hydrolysis temperature, on the extraction yield of hemp seed oil. The optimized hydroly-

sis conditions are 4.5% (w/w) enzyme concentration, pH 6.5 and an incubation time of 4 hours at 60 ° C. Under these optimal conditions, the results show that AEE reach a maximum of 30.65% oil recovery. In addition, the analyzed quality parameters (Peroxide and oxidative stability indices) of the hempseed oil obtained by this eco-friendly process show better values compared to those of the oil obtained by Soxhlet extraction.

Keywords: Hempseed oil, Aqueous enzymatic extraction, Oil recovery

Initiation and multiplication of saffron (*Crocus sativus* L.) through in-vitro culture

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CO-22

Saffron (*Crocus sativus* L.), the most expensive spice in the world obtained from the stigmas, is an autumn-flowering and sterile triploid ($2n=3x=24$) geophyte species that belong to the Iridaceae family. It is propagated mainly by vegetative reproduction through the development of daughter corms from the mother corm. Low multiplication rates of daughter corms under natural conditions and many biotic and abiotic stresses reduce productivity, thereby restraining the availability of planting material (corms). Any effort to accelerate their multiplication will be desired.

Thus, the main objective of this work is to improve the vegetative propagation of saffron through tissue culture. Preliminary results result of the in vitro trials show that for the initiation phase, MS medium supplemented with ANA in combination with BAP was more effective since it allows a sprouting rate of 90%. As for the multiplication phase, the highest number of shoots was observed on MS medium supplemented with a high concentration of BAP.

Keywords: *Crocus sativus* L., corm, growth regulators, in vitro culture.

Impact of treating bitter almond seeds with dormancy-breaking applications on germination percentage and growth of the produced seedlings

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CO-23

This research was conducted in the National Research Centre (NRC), Dokki, Cairo, Egypt during the period 2017/2018 and 2018/2019, in order to study the effects of cold stratification (CS) periods and gibberellic acid (GA_3) concentrations on seeds germination percentage, mean germination time, and growth of produced seedling of bitter almond which used as rootstock for almond cultivars. Seeds were stratified at $5 \pm 1^\circ C$ for 0 (control), 2, 4, 6 weeks. At the end of every cold stratification period, seeds were soaked in GA_3 solutions at 0, 500, 1000 and 1500 ppm concentrations. Treated seeds were sown in polyethylene bags containing sandy loam soil and placed in the greenhouse to determine the germination percentage and

following up the vegetative growth of the produced seedlings. The highest germination percentage and lowest mean germination time were obtained from the combination of CS periods for 6 weeks with GA_3 at 1500 ppm. The best growth of seedlings was obtained from CS for 4 and 6 weeks at the same concentrate without significant differences between them. As a result, it can be concluded that CS for 4 weeks and applications GA_3 at 1500 ppm is effective in breaking dormancy of bitter almond seeds and increasing germination percentage and growth of the produced seedlings.

Keywords: - Bitter almond, cold stratification, GA_3 , seed dormancy, seed germination, seedling growth.

Are 'Picholine Marocaine' olive leaves a valuable source of bioactive compounds? A metabolomic approach

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CO-24

Morocco, the recovery of olive agroindustry by products as potential sources of high-added value substances has been underestimated until now despite the great advances in this filed worldwide. This work aims to fill the knowledge gaps in the particular field of olive leaves bioactive compounds composition and to contribute to the ongoing discussion with regards to intensifying efforts towards their valorization for recovery purposes in this country. To do so, the phenolic fraction of olive leaves of 'Picholine Marocaine' variety cultivated in the Moroccan Beni Mellal region was investigated. A total of 50 samples were collected during the 2018/2019 crop season and analyzed for their phenolic richness by using ultrasonic-assisted extraction followed by liquid chromatography coupled to negative electrospray ionization mass spectrometry (LC-ESI MS) analysis. The

obtained results show that the phenolic fraction of analyzed samples contains 38 phenolic including 16 secoiridoids, 9 flavonoids in aglycon form, 7 flavonoids in glycosylated form, 4 simple phenols, 1 phenolic acid and 1 lignan. The olive leaves of 'Picholine Marocaine' variety exhibited a total phenolic content of 43995,43 mg/kg dry weight (DW) been the secoiridoids compounds the most abundant one (34094,53 mg/kg DW), followed by flavonoids in glycosylated form (7582,82 mg/kg DW), simple phenols (2124.13 mg/kg DW) and flavonoids in aglycon form (16,61 mg/kg DW). Furthermore, lower contents of lignans (10,13 mg/kg DW) and phenolic acids (7,22 mg/kg DW) were recorded in the investigated samples.

Keywords: Olive leaves, 'Picholine Marocaine', phenolic compounds, liquid chromatography-mass spectrometry.

Viability assessment of some Moroccan selections of Date Palm (*Phoenix dactylifera* L.) pollen

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CC-25

Information regarding pollen viability for internationally important date palm cultivars is limited. No such information has been reported on Moroccan male selections. The present study aims to compare the results of two pollen viability tests (in vitro germination and acetocarmine test, using 38 selected pollen types from different geographical origins in Southeastern Morocco. The in vitro pollen germination of this Moroccan male selection was estimated using a modified Brewbaker and Kwack (BK) medium. The results showed significant variability among all pollen grains in staining and germination percentages. The pollen grains Dk-13 and Dk-30 were the most interesting, having the

highest staining (98.74 and 98.37 %, respectively) and germination percentages (94.21 and 93.66 %, respectively). The difference between them was not statistically significant. A highly positive correlation between in vitro germination and the acetocarmine viability test was observed ($r = 0.717$; $P < 0.01$). This is the first report emphasizing the pollen viability testing methods of date palm pollen in Morocco. Dk-13 and Dk-30 were proposed for the date palm males National Breeding Program, as they showed highest staining and germination percentages.

Key words: Acetocarmine, Date palm pollen, In vitro germination, Pollen viability

Impact of the harvest period on the composition of oils of *Opuntia Ficus Indica* in fatty acids

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CC-26

Human and territorial development efforts aim at enhancing and exploiting natural resources. In this vein, this paper would offer all the units exploiting the oils from the seeds of *Opuntia ficus indica* in their artisanal or industrial preparation as well as new ways of valuing this soil by determining the optimal harvest period. Optimizing the quality of the oil necessarily requires careful determination of the harvest period. The impact of the ripening process of the fruit, on the quality of the oils of the two varieties (Aïssa and Moussa) in fatty acids, was monitored. The yield is optimal at the end of July for Aïssa and at the end of October for Moussa. Following chromatographic analysis, CPG, *Opuntia* seed of *Opuntia ficus-indica* is rich in unsaturated fatty acids (89.86%). At the start of maturation, the level of linoleic acid is 63.62% in contrast to oleic acid

which is only 15.14%. At the end of ripening, there is a decrease in the percentage of linoleic acid (57.03%) and an increase in that of oleic acid (20.32%) (Cultivar Aïssa). At the same time, palmitic acid experienced a slight decrease during the ripening period.

One of the peculiarities of the samples selected in this work on oil from prickly pear is the presence of traces of myristic acid in all oils analyzed. This could constitute a biochemical originality of the oil of the prickly pear of Morocco. The result ensures that the phenomenon of lipid accumulation during the ripening of prickly-pear fruits is accompanied by an increase in the degree of unsaturation following a drop at the levels of saturated fatty acids in favor of mono fatty acids and polyunsaturated.

Keywords: Exploitation of natural resources, maturation period, fatty acids, CPG chromatography, *Opuntia ficus indica*

Regarding genetic diversity as a tool for sustainable development!

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CC-27

Plant genetic resources and the genetic diversity they contain play a vital role in economic, social and ecological development. Genetic diversity remains the most important raw material for participatory conservation and for the breeder. The conservation of the diversity of natural resources, the sustainable use of the constituents of this diversity, and the fair and equitable sharing of the benefits arising from the exploitation of genetic resources, is important for socio-economic balance (improvement of genetic resources) and ecological (conservation of genetic diversity). However, the too rapid demographic growth of

the populations of the planet accompanied by climate change has upset the harmonious balance between man and his environment.

However, participatory breeding is a response to the green revolution of ecological and socio-economic interest. It consists in associating genetic diversity more closely with the creation of improved genetic material, e.g. in terms of phytomass, required agronomic traits, resistance to biotic and abiotic stress, chemical nature, etc. Case studies of certain species will be exhibited.

Keywords: Genetic diversity; genetic variability; heritability; genetic improvement.

Composition chimique et activité antimicrobienne d'huile essentielle de *Cuminum cyminum* d'Alnif Maroc.

CC-28

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La résistance des bactéries aux antibiotiques augmente avec les années, cela pose un problème mondial sérieux ce qui conduit la recherche à identifier de nouvelles biomolécules avec une activité antibactérienne, extraites de plantes et leurs dérivés, tels que les huiles essentielles.

Le cumin (*Cuminum cyminum* L) plante herbacée de la famille des ombellifères, ses graines sont des épices anciennes à forte odeur aromatique et goût amer qui sont largement utilisés depuis l'antiquité comme médicament ; ils sont cultivés au Maroc dans la région d'Alnif (région d'Errachidia). L'extraction de l'huile essentielle la plante

est faite par hydrodistillation à partir des grains du cumin suivi d'une analyse chromatographique en phase gazeuse couplé à la masse pour évaluer l'effet antibactérien qu'était réalisé par la méthode de diffusion sur disque vis-à-vis plusieurs souches tels que *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli* et *Salmonella* sp. À partir de ces études, on dit que l'huile essentielle de cumin possède une forte activité contre les agents pathogènes d'où son utilisation comme antibiotique est recommandée.

Mots clé : *Cuminum cyminum* L., hydrodistillation, analyses chromatographiques, effet antibactérien

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Essential oil composition of *Cladanthus eriolepis* (Coss. ex Maire) Oberpr. & Vogt, an endemic species to Morocco

CC-29

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Cladanthus eriolepis (Coss. ex Maire) Oberpr. & Vogt. is endemic to High Atlas (Dades Gorge and Todgha Gorge), the Anti Atlas and Saharan Morocco. It is known under the vernacular names 'Alougjim, gtaa-eddib, laatetecha' and 'Lamghizal'. Two essential oil samples have been isolated from aerial parts and analyzed by combination of chromatographic and spectroscopic techniques [gas chromatography (GC) in combination with retention indices (RI), gas chromatography-mass spectrometry (GC/MS) and ¹³C-NMR spectroscopy]. The compositions of both oil samples were dominated by hemiterpene esters such as isobutyl isobutyrate (21.2% and 20.8% respectively) and isobutyl angelate (22.0% and 22.4% respectively). Other esters

present at appreciable contents were 2-methylallyl isobutyrate (5.3% and 5.5%), 2-methylbutyl isobutyrate (5.7% and 5.8%), 2-methylallyl angelate (4.6% and 4.9%) and 2-methylbutyl angelate (7.7% and 7.2%) beside α -pinene (9.5% and 5.8%) and β -bisabolene (2.8% and 4.0%). The compositions of the investigated oil samples from *C. eriolepis* differed substantially with literature data and with those of other *Cladanthus species* growing wild in Morocco.

Keywords: *Cladanthus eriolepis*; endemic; essential oil; hemiterpene esters; ¹³C-NMR

Development of thermal insulation materials reinforced with agricultural by-products

CC-30

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This work is part of the valorization of plants available in abundance in the region of Drâa-Tafilalet as the fibers extracted from Alfa plant, respecting the conditions of harvesting to ensure its good regeneration. These fibers present an interesting cellular porous structure, allowing to obtain good thermal insulation properties. The elaboration and experimental characterization of these composite materials based on different weight contents of Alfa fibers (80, 70, 60, 50 and 40%) have been carried out. The thermo-physical properties of five cardboard composites rein-

forced with the fibers of the Alfa plant were experimentally evaluated using the high insulation house method. In addition, a life cycle cost analysis has been performed to determine the optimal insulation thickness and energy savings. The results of this study show that these insulation materials-based Alfa fibers have good thermal properties for the insulation and present several environmental and economic advantages.

Keywords: Thermal insulation; Alfa; Life Cycle Cost; Optimum insulation thickness.

Valorization of agricultural waste for the development of thermal insulation materials for buildings

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CC-31

The aim of this work is to design and characterize new thermal insulation biosourced based on the date palm waste available in abundance in Drâa Tafilalet region, these insulation materials are destined for housing thermal insulation. Indeed, the date palm represents the main agricultural activity of the Drâa Tafilalet region, but unfortunately its waste often not recycled. The latter can present a good source for formulating insulation materials which are efficient and safe compared to other conventional materials. At this stage, several insulation materials have been designed from five mass fractions of date palm fiber (DPF) (40%, 50%, 60%, 70% and 80%) mixed with cardboard as a binder between the fibers. Then, the thermal characterization of these composites

was performed using a high insulation house to determine the thermophysical properties. Based on life cycle cost analysis, optimal insulation thicknesses, energy savings and payback periods have been determined. The results showed that our developed insulation materials are competitive with conventional insulation materials. In addition, they offer several environmental and economic advantages.

Keywords: Thermal insulation material; Date palm fiber wastes; Thermal conductivity; Life Cycle Cost analysis; Optimum insulation thickness; Energy saving.

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Chemical composition of essential oils in *Mentha Spicata* L. from several Tunisian bioclimatic regions

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CC-32

Considering the importance of bioclimatic conditions in shaping the production and accumulation of secondary metabolites in medical and aromatic plants, we proposed herein to analyze the essential oil compositions of 12 mintaccessions, cultivated in several bioclimatic regions, and investigate the relationship between meteorological conditions and most significant essential oil compound levels. Plant material was identified as *M. spicata* L. and *M. spicata* "Moroccan". Essential oils from aerial parts were obtained by hydro-distillation and their components were identified by gas chromatography/mass spectrometry. The major components of these oils were carvone (50-75%), limonene (10-23%) and 1,8-cineole (0-8%). In average, carvone concentration was higher in *M. spicata* "Moroccan" (61-76%)

than in *M. spicata* L. (50-63%). It increased significantly with the increase of temperature ($P < 0.05$) but it was negatively affected by precipitation. Limonene and 1,8-cineole concentrations in *M. spicata* "Moroccan" were less affected by bioclimatic regions than *M. spicata* L. This study may guide a better choice of the bioclimatic conditions to promote a better quality of aromatic and medicinal plants with their researched compounds.

Key words: *M. spicata*, Essential oil, bioclimatic, Tunisia

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Contribution to the valorization of pomegranate in Morocco by characterizing morphological and biochemical indices of qualitative and nutritional interest

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CC-33

In this work, an approach combining a morpho-pomological study of pomegranate fresh fruits and a metabolomic characterization of their juices was applied on samples of "Sefri" variety cultivated in the Protected Geographical Indication (PGI) 'Oulad Abdellah', Morocco. To do so, 38 fruits samples were collected at commercial ripening stage over the crop season 2018/2019. The morpho-pomological characterization focused particularly on traits relating to the size and weight of fruit, arils and seeds as well as maturity indices of fruits. Juices were, firstly analyzed for their total sugar content, titratable acidity, and pH, then their metabolomic profile was investigated by applying a reliable and sensitive High Performance Liquid Chromatography Electrospray Mass Spectrometry analytical approach.

The obtained results showed that "Sefri" variety fruits are characterized by a large size (its weight and diameter are, in terms of average, greater than 501.00 g and 110.61 mm, respectively), a high yield in arils correlated with a low weight

of seeds, a juice content ranging from 27.39 to 54.97 ml/100 g of fruit and a high-quality taste sensation of the juice thanks to its sweet and sour taste. Moreover, the preliminary characterization of the bioactive fraction of pomegranate revealed the occurrence of numerous chemically and functionally distinct metabolites that vary considerably in terms of concentration. Particularly, it was revealed the abundant presence of tannins (among the 27 phenolic compounds identified in the juices used in this study, 10 are ellagitannins and gallotannins), phenolic acids come second with 7 compounds, followed by anthocyanins (6 compounds) and flavonoids with 4 compounds. In addition to these phenolic compounds, two amino acids (phenylalanine and tryptophan) and one vitamin (B5 or pantothenic acid) were identified.

Keywords: Pomegranate, "Sefri" cultivar, morpho-pomological indices, metabolomic, phenolics, liquid chromatography-mass spectrometry.

Profil phénolique et activité antioxydante de six variétés communes de palmier dattier (*Phoenix dactylifera* L.)

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CC-34

Le palmier dattier (*Phoenix dactylifera* L.) est l'une des plus anciennes espèces oasiennes cultivées dans les régions de sud de la méditerranée, souvent connu par la variété Deglet Nour la plus appréciée et commercialisée. En Tunisie, les autres variétés, qui présentent 35% du nombre total des palmiers, n'ont pas un intérêt économique et sont considérées comme des variétés communes et délaissées.

Notre choix s'est porté sur six variétés communes collectées dans trois régions oasiennes de sud Tunisien (Ftimi, Fazzeni, Ghars, Hessa, Kenta et Bouhattam) et d'une variété référence « Deglet Nour ». Notre travail repose sur l'étude de la phytochimie, les dosages des composés phénoliques, flavonoïdes et tanins, et l'évaluation de l'activité antioxydante des extraits des fruits de ces variétés. En effet, les résultats ont mis en évidence une grande variabilité des paramètres phytochimiques étudiés. La teneur en sucre totaux varie entre 36.32g/l et 45.01 g/l. La teneur la plus élevée en cendre a été enregistrée par les cultivars Ftimi et Hessa. Les polyphénols, les flavonoïdes totaux et les tannins condensés ont été présent en quantité importante dans les sept variétés, avec prédominance de cultivar Ftimi (204,044 mg EAG/100 g MF, 117,352 mg

ER/100g MF, 147,926 mg ECT/100g MF respectivement). De même, ce cultivar possède le meilleur potentiel antioxydant avec 131,593 mg CAET/100g MF et 106,579 mg CAET/100g MF respectivement pour les tests DPPH et ABTS+. L'examen des composés phénoliques identifiés dans l'extrait éthanolique de chaque cultivar a révélé que « Kenta » présente le nombre le plus élevé (20 composés) suivie par le cultivar « Ftimi » qui présente 19 composés comparés avec ceux identifiés pour « Deglet Nour » présentant le moindre nombre des composés (16 composés). Cinq composés (acide quinique, Epicathéchine, Rutine, Hyperoside et Kampherol) sont prédominants. Sur la base de toutes les données visualisées dans la carte thermique, les plantes ont été regroupées en deux groupes. Les cultivars Kenta, Ftimi et Deglet Nour ont été sélectionnées pour leur potentiel antioxydant et leurs teneurs en composés phénoliques les plus élevés ce qui pourrait être un produit intéressant à des fins industrielles.

by hemiterpene esters such as esters; 13C-NMR

Mots clés : *Phoenix dactylifera* ; variétés communes ; Activité antioxydante ; composition phénolique

Ammodaucus leucotrichus Coss. & Durieu: Antihyperglycemic activity via the inhibition of α -glucosidase, and intestinal glucose absorption activities

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CC-35

Ammodaucus leucotrichus commonly known as a 'Kamune es sufi or akâman' in Morocco, is used to treat many diseases including diabetes. This work aims to investigate the effect of the aqueous extract of *Ammodaucus leucotrichus* fruits (AEAL) on α -glucosidase and intestinal glucose absorption activities.

The antihyperglycemic effect of the AEAL was tested against the intestinal α -glucosidase activity, in vitro, at the concentrations (41-328 μ g/mL). In addition, the inhibitory effect of the AEAL (150 mg/kg) against this enzyme was confirmed, in vivo in normal and alloxan diabetic rats using sucrose as a substrate. The antihyperglycemic effect of the AEAL was also tested against intestinal D-glucose absorption activity at the dose of

150 mg/kg using the jejunum segment perfusion technique, in situ.

The results of this study showed that the AEAL was significantly ($p < 0.001$) inhibited the intestinal α -glucosidase, in vitro ($IC_{50} = 0.254$ mg/mL). In vivo, the oral intake of the AEAL at a dose of 150 mg/kg has significantly attenuated the hyperglycemia induced by the sucrose in the normal and alloxan diabetic rats. AEAL, also, significantly ($p < 0.01$) decreased intestinal glucose absorption, in situ. *A. leucotrichus* showed a significant antihyperglycemic activity. This effect can be explained by the inhibition of α -glucosidase activity, and the intestinal absorption of D-glucose.

Keywords: alloxan; α -glucosidase; *Ammodaucus leucotrichus*; anti-hyperglycemic; intestinal glucose absorption.

Criblage phytochimique et activité antioxydante de *Scorzonera undulata*

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CC-36

Le présent travail contribue à la valorisation de *Scorzonera undulata* une plante sauvage au Sud-Ouest de la Tunisie. Cette étude s'intéresse aux critères botaniques, physicochimiques, et phytochimiques de trois organes (fleur, feuille et racine). La première partie de ce travail concerne l'étude botanique de la plante. Elle s'agit d'une plante herbacée vivace qui possède les caractéristiques d'Eudicotylidones avec la présence d'une racine tubéreuse qui joue le rôle d'un organe de réserve. La deuxième partie concerne la caractérisation physicochimique (spectre FTIR, teneur en eau (%), teneur en cendre (%)) de trois organes ainsi que le dosage de sucre réducteur par la méthode DNS, l'identification des sucres solubles (glucose, fructose et saccharose) par HPLC et le dosage des protéines par la méthode de Kjeldahl de la partie racinaire. Les résultats montrent la différence entre les trois organes en termes de composition biochimique ainsi la racine présente une source naturelle de sucres et de protéines. La troisième partie est consacrée à l'extraction et la quantification des phénols totaux, flavonoïdes, anthocyanine par des dosages spec-

trophotométrique et par HPLC. L'extraction des composés phénoliques est réalisée par trois méthodes macération (MC), décoction (DC) et ultrason (US). Deux solvants (eau et éthanol) sont utilisés pour optimiser l'extraction des composés phénoliques. La variation des méthodes d'extractions et de solvants a porté une variation sur la potentialité de Trois organes (FLR, FL et RC) en termes de molécules bioactives. En effet les résultats montrent que les deux organes FLR et FL sont les plus riches en composés phénoliques, la décoction est la meilleure méthode d'extraction. L'eau est préférable dans l'extraction des polyphénols à partir des organes de *Scorzonera undulata*. Dans la dernière partie de cette étude on s'intéresse à l'évaluation de l'activité antioxydante des extraits de trois organes (FLR, FL, RC) en utilisant deux différentes techniques : test DPPH et ABTS. Le résultat confirme la capacité de la décoction pour l'extraction des composés bioactifs et la richesse des deux organes FLR et FL en composés phénoliques plus précisément en antioxydants.

Mots clés : *Scorzonera undulata*, description, physicochimiques, polyphénols, antioxydant, HPLC.

Évaluation de la diversité génétique d'une collection ex-situ de cerisier (*Prunus avium*) par l'intégration des caractères morphologiques, physico-chimiques et biochimiques.

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Introduit au Maroc au début du siècle dernier, le cerisier s'accommode bien des conditions écogéographiques du pays, notamment les hautes altitudes qui permettent de satisfaire ses besoins en froid hivernal. Le profil variétal en culture est relativement restreint et se repose principalement sur les groupes des bigarreaux (Burlat, Moreau, Van, Hedelfingen, Napoléon...).

Le présent travail est une étude de caractérisation des ressources génétiques de cerisier (*Prunus avium*) en collection à l'INRA (Domaine Expérimental Lanouceur) à l'aide des caractères pomologiques, physicochimiques et biochimiques. La caractérisation de 10 génotypes ont permis de mettre en évidence une diversité importante pour tous les descripteurs utilisés. L'analyse biochimique des fruits a montré une variation hautement significative pour tous les paramètres étudiés. La teneur en polyphénols totaux a varié en fonction des génotypes de 14,33 à 43,12 mg d'GAE /gMS avec une moyenne de 29,15mg d'GAE /gMS. La teneur en flavonoïdes totaux a varié de 5,79 mgd'EC/gMS à 14,38 mg d'EC/gMS avec une moyenne de 29,28mg d'EC/gMS. La teneur en anthocyanine

totaux varie entre 0,083 et 0,208 mg d'équivalent de cyanidine-3-glucoside par g deMS avec une moyenne de 0,138mg d'équivalent de cyanidine-3-glucoside par g deMS. La teneur en proanthocyanidines oscille entre 0,07mg/gMS et 0,20 mg/gMS avec une moyenne de 0,135mg/gMS. De mêmes, l'activité antioxydante varie significativement entre 62,90 et 81,9% avec une moyenne de 74,8%. La teneur en sucres solubles totaux varie de 119,66mgEG /g MS, au 103,8 mgEG /g avec une moyenne de 112mgEG /gMS. Pour l'ensemble des descripteurs pomologique la variance est hautement significative pour le diamètre de pédoncule et de noyaux et la longueur de noyaux. Tous les cultivars ont donné des cerises d'un poids moyen supérieur à 2 g et des noyaux d'un poids moyen supérieur légèrement à 0,1g. Le poids du fruit moyen varie de 2,63g à 5,18 g avec une moyenne de 3,69g. Ainsi, le poids des noyaux varie de 0,12 g à 0,29g avec une moyenne de 0,20g. La variabilité importante élucidée entre les génotypes et variétés de cerisier constitue une base de sélection et traçage d'un programme d'amélioration de l'espèce au Maroc.

Mots clés : Cerisier, *Prunus Avium*, collection ex-situ, diversité, biochimie, pomologie.

Evaluation de la tolérance au stress hydrique et au déficit en azote des populations Algériennes de maïs (*Zea mays* L.) du désert du Sahara

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CC-38

La sécheresse et la déficience en azote sont des stress majeurs pour le maïs (*Zea mays* L.), et les populations de maïs du Sahara sont des sources potentielles de tolérance au stress. Les objectifs étaient d'évaluer la tolérance, les effets variétaux et l'hétérosis des populations algériennes sous une fertilisation sans azote et un stress hydrique. Un diallele de six populations Algériennes de maïs a été évalué sous sécheresse (300 ml d'irrigation) par rapport au contrôle (600 mm) et sous fertilisation sans azote par rapport à une fertilisation azotée de 120 kg/ha-1. Les génotypes ont montré des différences significatives et des effets génétiques pour la tolérance au stress hydrique et azoté.

Les effets variétaux et l'hétérosis n'étaient significatifs que sous stress hydrique pour l'ASI, ce qui suggère que l'action génétique additive et non additive était importante pour transmettre ce caractère sous stress. L'effet variétal pour le rendement était significatif sous apport azoté, dans le cas d'un environnement bien irrigué et dans le cas d'un stress hydrique, ce qui indique qu'il existe une diversité génétique pour le rendement et, en particulier, dans le cas d'un stress dû à la sécheresse. Cependant, l'effet d'hétérosis était significatif sous tous les traitements. Sous un régime bien irrigué avec apport

d'azote, la hauteur des plantes est principalement contrôlée par des effets additifs.

Pour l'ASI, les populations les plus prometteuses étaient AOR et BAH en cas de sécheresse, MST en cas de stress hydrique et azoté et également en conditions de contrôle, et SHH dans toutes les conditions de stress. Pour la hauteur des plantes, les populations les plus prometteuses étaient BAH sous stress hydrique et azoté, IGS en conditions bien irriguées avec ou sans apport d'azote, et IZM en conditions de contrôle. En ce qui concerne le rendement, nous proposons une sélection récurrente réciproque pour tirer profit des effets additifs et non additifs, en utilisant AOR et IGS, puisqu'ils ont montré une bonne performance dans des conditions optimales et de stress, pour améliorer l'hétérosis du rendement pour AOR×IGS. Ces populations et BAH pourraient être des sources de lignées consanguines « inbred » tolérantes à la sécheresse et à la fertilisation sans azote. Ces populations et ces croisements pourraient être utilisés comme matériel de base parmi les populations algériennes pour les programmes de sélection axés sur la tolérance au stress hydrique ou azoté.

Mots-clés : stress hydrique ; maïs ; hétérosis ; stress azoté ; populations Algériennes ; tolérance

Field and in vitro evaluation of mandarin cultivars resistance to *Alternaria alternata*

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Alternaria brown spot of tangerines (ABS) caused by the necrotrophic fungus *Alternaria alternata* (Fr.) Keissl, is one of the most destructive diseases affecting worldwide mandarins, especially under the Mediterranean climate. The present study aims to assess the susceptibility to the *A. alternata*, through in vivo and in vitro inoculation for 10 mandarins varieties from a Moroccan collection at INRA-Kénitra, including, Ananas, Bergamota, Dancy, Murcott Honey, Carvhalal, Satsuma Wase, Vohanisahy Ifranica, Temple, Nadorcott, Lée. Field inoculation trials were performed, in parallel, with the laboratory experiments by inoculation of fungal spores in fruits and young detached leaves. Therefore,

in vitro leaves inoculations were conducted in both successive years to confirm results and selected the ABS-resistant hybrids. The severity of disease in fruits and leaves was determined by following a specific diagrammatic scale of ABS and calculating the disease progress curve (AUDPC). The results indicate that all the cultivars showed diseases symptoms on fruits and leaves either, in the field or in the laboratory. Temple, Nadorcott, Lée and Vohanisahy Ifranica had low ADPC values and seem to be resistant to the disease, whereas, others as Dancy, Carvhalal, Ananas, Murcott Honey, Satsuma Wase have exhibited a greater disease severity.

Keywords: Mandarin, resistance, *Alternaria alternata*

Morphological and physicochemical characterization of diverse strawberry tree (*Arbutus unedo L.*) genotypes from Morocco

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CC-40

The strawberry tree (*Arbutus unedo L.*) is a fruit species that belongs to the Ericaceae family and is distributed largely in the Mediterranean region. The phenotypic diversity of the strawberry tree has largely gone unheeded for many reasons, some of which have to do with its wild aspect, since it still naturally grows in the mountains and remain spoorly exploited. In this regard, this study aims to investigate the phenotypic diversity within strawberry tree genotypes widely grown in Morocco, based on their physico-morphological properties. Significant variability was observed among investigated genotypes for all traits except for the peduncle weight. Chemometric evaluation using the principal component analysis model was used to determine the most discriminant traits among the data set. Principal component

analysis showed that morphological parameters such as fruit length, width, and weight, blade length, leaf length, chromatic coordinates (L^* and b^*), and physicochemical attributes (total soluble solids, titratable acidity, glucose, and fructose) were the most discriminative variables in strawberry tree genotype assessment. These descriptors captured a high level of a total variance within the data set. Principal component analysis based on the first three principal components revealed five mean homogeneous groups of strawberry trees genotypes according to their physico-morphological properties.

Keywords: *Arbutus unedo L.*; Strawberry tree; Physicochemical properties; Morphology; Morocco

Effet de provenance sur la variabilité morphologique des populations naturelles de myrte commun (*Myrtus communis* L.) du Maroc

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CC-41

Le myrte commun est un arbuste méditerranéen à feuillage persistant, appartenant à la famille des myrtacées. Cette espèce a une grande importance à l'échelle alimentaire, industrielle et thérapeutique. La demande en marché nationale et internationale en huiles essentiels du myrte est de plus en plus croissante. Toutefois au Maroc, cette espèce reste moins valorisée et en état naturel dégradé. Un plan d'amélioration et de conservation génétique est bien nécessaire pour le développement durable de cette espèce. Dans ce cadre, cette étude a pour objectif de déterminer la variation intra et inter-populations naturelles du myrte au Maroc. Le matériel végétal est collecté systématiquement en décembre 2017 et janvier 2018 à partir de douze populations naturelles de cette espèce réparties dans différentes régions biogéographiques : le pré-rif, le rif occidental et le plateau central. L'analyse de la variance (ANOVA) à un seul facteur montre une variation significative intra et inter-population pour la majorité des traits morphologiques étudiés, notamment la largeur et la longueur des feuilles et le fruit, le nombre de graines par fruit, le poids de fruits et le poids de graines par fruits. Ceci suggère un effet de provenance. Certains des traits morphologiques ont montré

une forte corrélation positive, c'est le cas entre la largeur de fruit (LRF) et sa longueur (LGF), Le poids total des graines par fruit (PTG/F) et le poids de fruits (PF), Le poids moyen des graines (PG) avec le nombre total de graines par fruit (NTG/F) et La longueur de la feuille (LGF_e) avec le poids total de graines par fruit (PTG/F). Ces corrélations pourraient être exploitées comme bio-indicateurs pour des tests de plantation ex-situ en faveur des programmes de sélection du myrte au Maroc. L'analyse en composantes principales (ACP) et la classification hiérarchique ont permis de regrouper les populations en relation avec les conditions géographiques. Ainsi, Deux principaux groupes ont été bien identifiés dans cette étude : Le premier sous-groupe (A) est constitué de six accessions, quatre provenant du Rif (DAR, IZA, BT, BOUH) et deux du Plateau Central (BRA et BS) avec une légère différenciation de la population BT. Le deuxième groupe (B) est composé de cinq populations, quatre populations du pré-Rif (SAH, IKA, AGH et GHA) et une population du plateau central (RAB).

Mots clés : *Myrtus communis* L., variabilité génétique, traits morphologique, provenance, Maroc

Fruit quality of various pomegranate cultivars: phenotypic variation of physico-chemical traits and their inter-annual stability

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Ce travail a consisté en un screening physico-chimique des fruits d'une collection ex-situ de 16 cultivars de grenadiers (*Punica granatum* L.), sur trois années 2009, 2017 et 2018. Les résultats ont montré que l'année de récolte avait une influence sur les attributs physico-chimiques des fruits. Globalement, ils ont montré que les fruits récoltés en 2017 présentaient une meilleure qualité que ceux récoltés en 2009 et 2018. En effet, le poids, le diamètre et la hauteur des fruits étaient relativement plus élevés en 2017, dépassant les valeurs enregistrées en 2018 de 22,8%, 13,5% et 4% respectivement. En outre, le poids et la longueur de l'arille et certaines propriétés chimiques, le pH, les degrés brix et l'indice de maturité, ont présenté des valeurs plus élevées en 2017, dépassant celles enregistrées en 2018 par des taux de 3%, 7% et 3%, 14% et 80%, respectivement. L'analyse en composantes principales (ACP) basée sur l'ensemble des paramètres mesurés a montré une forte variabilité en fonction du génotype et de l'année de récolte. Cependant, un niveau de variance plus faible a été estimé entre les fruits récoltés en 2009 et 2017, probablement en raison de la similarité du climat entre ces deux années. L'analyse de regroupement a mis en évidence une grande diversité au sein de la collection étudiée, en dis-

tinguant cinq principaux groupes de cultivars. Le génotype local 'OunkHmam' et le génotype étranger 'Gordo de Jativa' ont été classés comme un groupe distinct, avec des profils typiques, ayant des fruits avec des caractères différentiels. Pour 'OunkHmam', la hauteur du calice (22,04 mm) et le nombre de sépales (7,11) sont les plus élevés parmi les accessions étudiées. Cependant, elle a enregistré le plus faible poids d'arille (266,98 mg) avec une valeur de pH acide (2,79). La deuxième variété 'Gordo de Jativa' a le rendement et le poids de l'arille et le rendement en arilles les plus élevés (73,34%, 51,02g, 16,08% respectivement). Elle se distingue également par un plus petit diamètre du calice (18,97 mm). Les paramètres qui ont le plus d'impact sur la discrimination entre les cultivars sont le poids du fruit, le poids des graines, le diamètre du calice et le rendement en arilles. Les résultats de ce travail sont d'un grand intérêt pour le développement de la filière grenade au Maroc, qui prévoit certains potentiels qualitatifs des cultivars locaux et leur stabilité en fonction de l'année de récolte, par rapport à certaines variétés étrangères.

Mots clés : *Punica granatum* L.; effet année de récolte; qualité des fruits; paramètres physico-chimiques des fruits; diversité des grenadiers.

Influence of native and alkali treatments on agar polymers extracted from the introduced seaweed

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Seaweed's cell wall and other components in the cellular matrix are made up of mostly structural polysaccharides existing as a hetero-polysaccharide complex. A large amount of these polymers is sulfated, which includes agar (with two polysaccharides mixtures, namely agarose and agaropectin) from red seaweeds mainly *Gelidium* and *Gracilaria*. This phycocolloid is in high demand as stabilizing and gelling agents in agri-food, cosmetic, pharmaceutical, biomedical and biotechnology industries. The yield and quality of agar varies with the species and related to extraction techniques, life cycle and environmental factors. This study aims to evaluate the variation of the yield and the quality of native and alkaline treated agar from the invader agarophyte *Agarophyton vermiculophyllum* harvested from the Oualidia lagoon (Morocco). The agars from thalli collected during winter were extracted according to two methods, one based on native extraction and the other with alkaline pretreatment. The extracted agars were characterized by ¹³C NMR and FTIR spectroscopy. The ob-

tained results indicated that agar from *A. vermiculophyllum* is mainly composed of alternating 3-linked D-galactose and 4-linked 3,6-anhydro-L-galactose, with methyl substitution. Native agarocolloid yield (20.80± 0.9%) was higher than that of the alkaline pretreated samples (18.44±0.8%). Higher gel strength was obtained for alkaline pretreated agar (418.33 ± 7.63g cm⁻²) and lower gel strength from the native extraction (217.23 ± 6.42g cm⁻²). The maximum values of gelling temperature (37.23 ± 0.49 °C) and melting temperature (83.23 ± 0.25 °C) were obtained during alkaline pretreatment. However, the minimum values of gelling temperature (21.9 ± 0.43 °C) and melting temperature (70.133 ± 0.37 °C) were achieved for the native extracted agar. Considering the yield, chemical and gel properties of the extracted polymer, the invasive alien seaweed *Agarophyton vermiculophyllum* could be considered as a potential source of agar industry in Morocco.

Keywords: *Agarophyton vermiculophyllum*, agar yield, gel properties, ¹³C NMR, FTIR, Oualidia lagoon, Morocco.

Study of the chemical composition, anticandida and antioxidant activities of wild and cultivated *Origanum compactum* essential oil from the municipality of chaoun in Morocco

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Origanum Compactum is one of the endemic Moroccan medicinal species that are intensively exploited in nature due to its many therapeutic properties. In order to highlight the importance of this plant species, the chemical composition of their essential oils and their biological activities are studied. The chemical composition was identified by gas chromatography coupled with mass spectrometry. The yield of essential oils was 3.5% for the wild plant and 3.36% for the cultivated plant. 12 compounds have been identified in the essential oil of the wild plant. Carvacrol was the predominant compound 58.95%, followed by p-cymene 18.38 (%) and gamma-terpinene 8.36%. For the cultivated plant 27 compounds were identified Carvacrol was the predominant compound 45.33% followed by p-cymene 22.19% and gamma-Terpinene 10.06%. The essential oil of both plants was studied for its antimicrobial activity in vitro against four fungal strains using aromatogram method the minimum inhibitory concentration (MIC) and the minimum fungicidal concentration (MBC). In

solid medium, it was found that the essential oil was active against the strains tested. In liquid medium, MIC and MBC ranged from 216 to 288 µg/ml. Antioxidant activity was investigated by 1,1-diphenyl-2-picrylhydrazyl radical scanning assay (DPPH). The results of this study revealed that the essential oil of both plants has a good antioxidant effect. In conclusion, the antimicrobial effect and the antioxidant property of the essential oil of *Origanum Compactum* can present a promising and less risky alternative than the synthetic antimicrobial and antioxidant used in conservation. Applications in the pharmaceutical and food industry are now possible; furthermore, culture could be a promising solution to ensure sustainable use of this medicinal species endemic and endangered.

Keywords: Essential oil, *Origanum Compactum*, chemical analysis, antimicrobial activity, antioxidant activity, spontaneous, cultivated plant

Screening of a pomegranate (*Punica granatum* L.) collection for drought tolerance

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The aim of this study was to assess eleven Mediterranean pomegranate cultivars for drought tolerance based on their responses to severe water stress. The experiment was performed under field conditions in Sais Plain (NW Morocco) on twelve-year-old pomegranate trees (*Punica granatum* L.), under drip irrigation. For each cultivar, two treatments were applied from fruit set to harvest: a control treatment irrigated at 100 % of seasonal ETc (FI), and a continuous deficit treatment irrigated at 50 % of Etc (CDI). The measurements concerned fruit yield, fruitweight, aril content, arilweight, seedweight, juice content, shoot length, leaf area, foliage density, wood density and concentration of chlorophyll-a and chlorophyll-b. Results showed clear differences among pomegranate cultivars in response to water stress. The most frequent effects of water stress were recorded on yield, fruit weight and chlorophyll pigment contents. Fruit yield was not affected in Zheri Automne cultivar, while it was significantly decreased under CDI

in all other cultivars by 14 % in Bzou to 51% in Ounk Hmam. A significant decrease of fruit weight was observed in six cultivars, with a rate of 13 % in Gordo de Jativa cultivar to 24 % in average for Grenade Jaune, Grenade Rouge and Ounk Hmam. These last cultivars were the only one affected in juice content by 9–11%. Regarding CDI effect on vegetative growth, it was recorded a high decrease of shoot length in the cultivars Gjeibi (78 %), Sefri (64 %) and Mollar Osin Hueso (38 %). The cultivars ranking for drought tolerance based on mean ratios of all traits between CDI and FI treatments was drawn according to cluster analysis, combined to a scoring method. It was thus retained that the most drought tolerant cultivar was Zheri Automne, followed by Djebali and Bzou, while Grenade Rouge cultivar was the most sensitive.

Keywords: Climate change, *Punica agranatum* L., Drought stress tolerance, Productive potential, Vegetative growth.

Acute and sub-chronic treatment of roasted and unroasted Argan oil on postprandial glycaemia and its effect on glucose uptake by isolated rat hemidiaphragm

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Diabetes mellitus is a serious metabolic disease, which affects a large number of populations in the world. It may be treated by the medicinal plant, which is considered as the most method used by Moroccan people. Argan oil is one of the products used in Morocco for anti-diabetic purposes. This work aims to study the effect of acute and subchronic treatment of the roasted (Roil) and unroasted (UnRoil) *Argania spinosa* L. seeds oils on oral glucose tolerance test (OGTT) and evaluate the effect of these oils on the glucose absorption by the diaphragm. The investigation of the anti-hyperglycemic effect of Roil and UnRoil was carried out on normal and alloxan diabetic rats, by treating the animals with 2 ml/Kg/day of Roil or UnRoil for 1 day (Acute treatment) and 4 weeks (Subchronic treatment). Then, OGTT was carried out at the end of each treatment period and the body weight was checked for each week. Besides, these oils (1 g/l) was tested also on glu-

cose absorption by the diaphragm isolated from Wistar rats, in vitro. The results of this work showed that the Roil and the UnRoil decreased significantly the postprandial blood glucose level in acute and sub-chronic treatments in normal and diabetic rats. Besides, the oral intake of these oils at 2 mg/Kg/day for 4 weeks in diabetic rats, was attenuated significantly the postprandial glycaemia as compared to the group treated with these oils at short-term. Furthermore, in vitro glucose uptake by the hemidiaphragm study showed that Argan oil promote glucose consumption by the muscles. UnRoil showed a potent effect than Roil and insulin towards this consumption.

Keywords: Antihyperglycemic, *Argania spinosa* oil, Sapotaceae, peripheral glucose uptake, diaphragm, roasting process

Optimisation du processus d'extraction du sirop de dattes (Tahlaoute) et caractérisation de sa qualité physicochimique et microbiologique : valorisation des écarts de tri de la variété marocaine « Majhoul »

CC-47

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D'après une enquête menée dans une coopérative de transformation des dattes, située à la région Drâa-Tafilalet, nous avons conclu que le brunissement est le problème majeur rencontré lors de l'extraction du sirop de dattes « Tahlaoute », ce qui détériore sa qualité organoleptique. Nous avons alors prélevé un échantillon de sirop fabriqué au sein de cette coopérative, que l'on a caractérisé au laboratoire et qui servira comme standard. Les résultats obtenus relatifs aux propriétés physicochimiques ont montré que ce sirop est défini par un pH de 3,84, une acidité de 1,344g/100g ± 0,01, une teneur en eau de 25,68% ± 1,28, une activité d'eau Aw de 0,72 ± 0,01, un degré Brix de 74%, un taux de cendres de 1,98% ± 0,13 et un indice de brun de 99,45 ± 0,03. Concernant l'analyse microbiologique, ce sirop a montré une bonne qualité due, d'une part, à sa faible teneur en eau, son Aw réduite, son pH acide et, d'autre part, à la température élevée de la cuisson et à la présence de composés phénoliques antimicrobiens. Ensuite, nous avons élaboré un sirop de dattes à partir des écarts de tri

de la variété marocaine « Majhoul », en faisant varier les facteurs influençant : température d'extraction et de concentration (60, 70, 80, 90 et 100 °C), temps d'extraction (30, 60, 120 et 180 min) et rapport eau/datte (1 :1, 2 :1 et 3 :1), selon une approche d'optimisation classique (one variable at time). En se basant sur la caractérisation physicochimique des différents sirops obtenus, nous avons sélectionné 70°C comme température optimale d'extraction et de concentration, un temps d'extraction de 2h et un rapport Eau/Pulpe = 2. En effet, la préparation du sirop selon ce barème optimisé a abouti à un produit de bonne qualité microbiologique, caractérisé par un pH de 4,72, une acidité de 0,77g / 100g ± 0,05, une Aw de 0,554 ± 0,15, un degré Brix de 76 ± 0,5, un taux de cendres de 1,62% ± 0,15 et un indice de Brun de 97,2 ± 0,23, plus faible que celui du sirop standard.

Mots clés : Sirop de datte, Brunissement, Extraction, Physicochimique, Microbiologique, Optimisation.

Caractérisation chimique et biologique des composés phénoliques de *Thymus satureioides* et *Juniperus phoenicea* et de leur association

CC-48

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Les extraits phénoliques et leurs composants sont de plus en plus populaires en tant qu'agents antioxydants et antimicrobiens naturels. Dans ce travail, la composition chimique et les propriétés biologiques des extraits phénoliques de *Thymus satureioides* et *Juniperus phoenicea* seuls ou mélangés ont été déterminées. Le contenu phénolique a été déterminé par la méthode de Folin Ciocalteu et les flavonoïdes par le chlorure d'aluminium AlCl₃ en présence du nitrite de sodium NaNO₂. Les teneurs en composés phénoliques totaux et en flavonoïdes suivent le même ordre. L'extrait issu de l'association des plantes de thym et de genévrier a présenté les plus fortes teneurs, suivi des extraits phénoliques en association et de l'extrait de *J. phoenicea*. Les teneurs les plus faibles ont été enregistrées pour l'extrait de *T. satureioides*. L'activité antioxydante a été évaluée par deux méthodes : par inhibition du radical libre du 2, 2-diphényl-1-picrylhydrazyle (DPPH) et par le pouvoir réducteur du fer (FRAP). Le mélange des extraits

phénoliques de *T. satureioides* et *J. phoenicea* a montré un pouvoir antioxydant supérieur avec une IC₅₀ de l'ordre de 0,13 ± 0,02 mg/ml. Par ailleurs, l'activité antibactérienne des extraits phénoliques a été déterminée sur quatre souches bactériennes, en utilisant la méthode de diffusion sur disque. Les résultats ont montré que l'extrait phénolique issu de la poudre de *T. satureioides* et *J. Phoenicea* mélangée ont en général une activité antibactérienne importante comparée à celle observée pour les autres extraits. L'utilisation des extraits phénoliques en association pourrait constituer un autre mode d'emploi en phytothérapie.

Mots clés : *T. satureioides*, *J. phoenicea*, Composés phénoliques, Composition chimique, Activité antibactérienne, Activité antioxydante

Approches pour la valorisation de *Balanites aegyptiaca* en Mauritanie : Analyse de la diversité morphologique, physico-chimique et moléculaire de populations naturelles.

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L'objectif de ce travail a été d'estimer et de comparer la diversité génétique intra et inter-population de *Balanites aegyptiaca* dans les régions sahélo-sahariennes en Mauritanie et d'analyser et comparer la composition physico-chimique des fruits. Une enquête ethnobotanique, réalisée auprès de 70 personnes à Nouakchott, a montré que toutes les parties de la plante sont utilisées par la population mauritanienne à des fins alimentaires, médicinales et fourragères. Les fruits et les feuilles restent les parties les plus utilisées. L'analyse physico-chimique a révélé que la pulpe de fruit de *B. aegyptiaca* est une importante source de sucres (33 g/100 g MS), de composés bioactifs (polyphénols, flavonoïdes, tannins), avec une activité antioxydante relativement importante. Les graines sont riches en lipides (46,2 g/100 g MS) et en protéines (29,5 g/100 g MS). D'autre part, 16 amorces SSR, ont été utilisées pour évaluer la diversité génétique de *B. aegyptiaca*. À partir de ces amorces, 505 bandes polymorphes ont été générées avec une moyenne de

31,5 fragments par amorce. Les principaux paramètres (PIC, MI, et RP) ont montré que les marqueurs utilisés présentent une informativité moyenne. Le coefficient de différenciation génétique (GST) est de 0,2 ; il a été confirmé par l'Analyse de Variance Moléculaire (AMOVA). Cette dernière a révélé que 80% de variations génétiques sont intra-populations et 20% entre les populations. Cette répartition de la variabilité est justifiée par un flux de gènes élevé ($Nm = 1,91$). Le dendrogramme (UPGMA) basé sur le coefficient de similarité de Jaccard, PCoA et l'analyse de la structure génétique ont divisé les sept populations en deux principaux groupes. Un des groupes contient seulement les deux populations de la zone saharienne (Chami et Tazyzet). Ces résultats constituent des données de base pour les programmes de conservation de cette ressource génétique négligée.

Mots-clés : *Balanites aegyptiaca* L., activité antioxydante, diversité génétique

Tunisian Olive genetic resources diversity in the Mediterranean region

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CC-50

Olea europaea L. is one of the oldest species in the Mediterranean Basin. Olive cultivation in Tunisia is very old from the Phoenicians colonization followed by Greek, Roman and Arab civilizations. Moreover, gene flow occurs from different countries all over the Mediterranean basin contributing to the enrichment of the Tunisian olive germplasm. The main cultivated olive cultivars of Tunisia and new identified cultivars were genotyped using of 10 microsatellites markers. A large genetic diversity of Tunisian germplasm was evidenced. Genotyping allowed the establishment of reference collection-maintained ex situ at the national olive collection at Boughrara. Results highlighted the presence of a hot spot of diversity of olive in the oasis of Degache and potential new minor cultivars originated from the North Est of Tunisia. Using genetic distances,

principal coordinate analysis (PCoA) and the genetic structure, we underlined the large genetic variability of Degache genotypes and a clear differentiation from modern varieties. This result suggests that this germplasm might present traits of adaptation useful for breeding to improve resilience to biotic stresses. This work highlights the use of SSR markers for the management of genetic diversity and conservation of national olive germplasm in situ and on farm.

Key words: *Olea europaea*, genetic diversity, SSR, Tunisia.

Moroccan Olive mill by-products: Towards a better understanding of their richness in highly valuable bioactive compounds – A preliminary study

CC-51

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Annually, virgin olive oil production in Morocco generates huge amounts of residues (mainly olive mill wastewater (OMWW) and olive pomace (OP)), which represent a waste management issue both ecologically and economically. Considering the current pro-ecological and environmentally friendly trends in this country, marked especially by strengthening and reinforcing environmental regulations, olive oil by-products disposal management constitutes, nowadays, a challenging issue. Finding creative ways to manage these by-products or even more important valorizing them, should be the cornerstone of the sustainable development strategy of this sector. Unfortunately, as compared to other olive oil producing countries where olive oil by-products have been transformed into valuable products to foster a transition towards a sustainable and circular bioeconomy, in Morocco little has been done and achieved so far. For this reason, this work was conducted as a first step toward exploring the potential of valorizing olive oil by-products in Morocco for the recovery of value-added compounds for food and cosmetic applica-

tions. Thus, this research aimed to characterize the richness of "Picholine marocaine" olive mill by products in two powerful antioxidants: hydroxytyrosol and tyrosol. A total of 57 samples (35 OP and 22 OMWW samples) were collected from olive oil mills located in Meknès region and analyzed for their content on hydroxytyrosol and tyrosol by applying an ultrasound assisted extraction method followed by a liquid chromatography separation and quantification analytical approach. The results showed that the amount of hydroxytyrosol in studied samples ranged from 2.17 to 127.31 mg /100 ml of OMWW and from 0.46 and 7.66 mg/100 g of OP, whereas tyrosol content was found in the range of 2.13 mg to 56.81 mg/ 100 ml of OMWW. Bearing in mind these results, and if considering the huge amounts of OP and OMWW produced annually in Meknès region, it can be concluded that there is a high potential to valorize olive mill by-products in this region through the extraction of hydroxytyrosol and tyrosol and their application as food and/or cosmetic ingredients.

Keywords: Olive mill wastewater; olive pomace; "Picholine Marocaine"; bioactive compounds; hydroxytyrosol; tyrosol.

Phenolic fraction concentrates of *Phoenix dactylifera* L. seeds: A promising antioxidant and glucose regulator

CC-52

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The beneficial effects of natural polyphenolic compounds are increasingly emerging as powerful antioxidants and digestive boosters. *Phoenix dactylifera* seeds are recently identified as a health functional food with rich amounts of phenolic compounds. The current study aims at; first, analyzing the phenolic profile obtained from Moroccan variety of date seeds. Second, evaluating the antioxidant and digestive enzymes inhibitory capacity of phenolic fractions concentrates (PFC) of date seeds as potential antihyperglycemic agent. Lineweaver-Burk plot analysis was performed to evaluate PFC inhibitory effect against digestive enzyme activity in presence of different doses of substrate. Wistar rats were recruited to determine the acute and subacute oral toxicity of PFC. Finally, the optimal dose of PFC was selected and its effects on metabolic, hematological and biochemical parameters were determined. HPLC analysis revealed that PFC contains abundant amounts of phenolic acid: Caffeic acid, Chlorogenic acid, 3,4-dihydroxybenzoic acid, p-Hydroxybenzoic acid, and 3-Hydroxybenzoic acid. PFC showed powerful antioxidant activity as determined by scavenging and reducing assays.

PFC significantly inhibited alpha-amylase and alpha-glucosidase enzymes by 87.3% and 78.7% respectively via mixed manipulation of Km and Vmax. Acute toxicity examinations revealed PFC to be practically non-toxic with LD50 > 5000mg PFC/kg for both sexes of rat. The NOAEL and LOAEL for oral administration of PFC were respectively 1000mg/kg and 2500mg/kg for both sexes. Finally, the subacute study showed that the dose 50mg PFC/kg did not cause any changes in metabolic, biochemical and hematological parameters and considered to be the optimal healthy dose for rats, and consequently, induces an improvement in glucose concentration in rats. In conclusion, the rational use of phenolic date seeds fractions presents powerful antioxidant and blood glucose regulating agents that can aid in management of diabetes mellitus.

Keywords: Acute and sub-acute toxicity; Antioxidant activity; digestive enzyme; Moroccan Date seeds; Phenolic fraction concentrates; Wistar rats.

Optimization and determination of polyphenol oxidase activities in apricots vr, canino (*Prunus armeniaca* L.) from Morocco

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Polyphenol oxidases is a copper-containing enzyme, catalyzes two reactions involving molecular oxygen. The first reaction is the o-hydroxylation of monophenols into o-diphenols followed by oxidation of o-diphenols to o-quinones as the second reaction. These o-quinones have a high tendency to polymerize, leading to the formation of pigments. The consequences of this reaction are mainly the decrease in shelf life and loss of organoleptic qualities of fruit by oxidation of its endogenous phenolic compounds. The objective of this study was to characterize the optimum condition to have a high enzyme velocity and use this condition as a start point to find a potential inhibitor of browning phenomena caused by PPO. To achieve this objective, the activity of polyphenol oxidase (PPO) of the Canino variety from different regions (*Prunus armeniaca* L. VR, Canino) was evaluated by the spectrophotometric method. The enzymes were extracted from the Apricots 4 g with 20 ml

of McIlvaine buffer. PPO activity was determined using catechol (C₆H₆O₂) as a substrate. The effects of the amounts of enzyme extract (250 µl to 750 µl), substrate concentration (25mM to 200 mM), pH (5.2-6.8). Temperature stability (20 – 90°C), and origin were investigated. The PPO activity was linearly increased with an increasing amount of the enzymatic crude also an increase with the concentration of catechol until a concentration of 75 mM above this concentration velocity wasn't affected significantly. The highest activity of PPO = 23.92 UIA/g.min was obtained at ambient temperature when using a catechol concentration of 75 mM in medium with pH=6,4 (Canino apricot from Marrakech).

Keywords: Polyphenol oxidase; enzyme activity, *Prunus armeniaca* L.; Optimization.

Évaluation de la diversité génétique des cultivars marocains du prunier à l'aide des marqueurs morphologiques et moléculaires

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CC-54

Le prunier revêt une importance économique primordiale tant au niveau mondial que national. Au Maroc, il est largement reparti dans plusieurs régions sous forme des cultivars locaux et des variétés introduites. Toutefois, Cet arbre reste encore très peu étudié à l'échelle nationale. Ainsi, nous avons étudié la variabilité génétique de quelques cultivars du prunier via des marqueurs morphologiques et moléculaires. L'évaluation de la variabilité morpho-pomologique à l'aide de 30 traits liés aux feuilles, aux fruits et aux noyaux a révélé une grande diversité pour la majorité des caractères analysés. Les résultats obtenus ont montré que se sont le poids, la taille, la longueur, le diamètre du fruit, la largeur du noyau et la longueur des feuilles qui sont les plus discriminants des cultivars étudiés. D'autre part, l'utilisation de 14 amorces ISSR a engendré un poly-

morphe très élevé entre les cultivars étudiés. Les valeurs élevées obtenues pour les paramètres PIC (0,45) et Rp (3,03) ont prouvé l'efficacité de ces marqueurs pour étudier la variabilité et la différenciation génétique des cultivars du prunier. Les distances génétiques de Nei obtenues entre les différents cultivars étudiés ont varié de 0,06 à 0,67, alors que les indices de la diversité génétique de Nei (Ht) et (Hs) sont 0,27 et 0,21 ; respectivement. L'analyse hiérarchique des cultivars du prunier, conduite sur la base des caractères phénotypiques et des marqueurs ISSRs, a abouti à l'identification de deux groupes principaux indépendamment de leurs origines géographiques et leurs dénominations.

Mots clés : Prunier ; Cultivars ; diversité ; Marqueurs ISSR ; Variabilité phénotypique.

Bioplastic based on parthenocarpic Date fibers: Characterization and microorganisms involved in degrading

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The aim of this study was to develop biodegradable films by incorporating fibers concentrate of parthenocarpic date (FCPD) as easily available ingredients. The FCPD based film showed enhanced thickness, water solubility, phenol content and antioxidant capacity. However, the transparency was reduced which enhance the film opacity by the addition of FCPD. Scanning electronic microscopy (SEM) showed homogeneity between fibers and the constituents of the film. In addition, the FCPDs have enhanced the microbial biodegradation of the developed films as showed by SEM.

Quantitative PCR using specific primers for nine target microbial groups showed that fungi were the predominant agent of the biodegradation. Among bacteria, real-time PCR have found that β -Proteobacteria, Acidobacteria, Bacteroidetes and α -Proteobacteriagroups were involved in film biodegradation.

Keywords: Parthenocarpic Date; Fibers; Bioplastic; Biodegradation; SEM; qPCR

Evaluation and optimization of bioethanol production from argane pulp as a new biomass for second generation biofuel

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CC-56

Bioethanol production from low-cost lignocellulosic materials as crop and horticulture residues has substantial promise for future source of biofuel. In this work, argane pulp was collected from several locations of southern morocco, characterized and used for bioethanol production. This work is the first that describes this application, with a purpose of valorization of the argane oil production process by-products and its evaluation as a new source for industrial production of bioethanol. Physico-chemical characteristics of argane pulp were determined. The values observed for fermentable sugars and cellulose were sufficient to warrant use as an ethanol feedstock. The effect of geoclimatic conditions on argane pulp composition was investigated. The saccharification step of this biomass was carried out using dilute sulfuric acid followed by a second stage of sulfuric acid hydrolysis to extract the maximum of fermentable sugars, generating a maximum of total (TS) and reducing (RS) sugars of TS: 229.74 mg/mL, RS: 91.11 mg/mL for pretreated and hydrolysed argane pulp. The obtained hydrolysate was subjected to a comparative fermentation study using commercial and laboratory

scale isolated *S. cerevisiae* yeast. All these steps were optimized using response surface methodology with Nemrodw software. The final step was the dehydration of the produced bioethanol using pervaporation process. The results showed that the isolated *S. cerevisiae* (Saxapahaw-DS1693) yeast was more efficient than the commercial *S. cerevisiae* with highest yield of 5.91 mg/mL and productivity of 0.098 g/L.h in 60 h, providing the possible use of this argane by-product as new biomass to improve its valorization.

Moreover, the fermentation broth was subjected to double distillation to extract bioethanol from the mixture, with a concentration of 10 % of water content. The pervaporation process was used finally to dehydrate or concentrate the produced bioethanol, which improved its purity from 90% to 97%.

Keywords: Biofuels, Bioethanol, Lignocellulosic biomass, Valorization, *Argania spinosa* pulp.

Valorization of bioactive molecules in vegetable oils

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CC-57

Vegetable oils are produced for different uses: food, therapeutic or cosmetic. The importance of these uses has imposed a global control of these fatty substances by physico-chemical and biological analyzes.

The present work constitutes a contribution to the valuation of the bio-activity of 4 Moroccan vegetable oils by extraction and quantification of their phenolic fractions according to different modes of extraction and evaluation of their antibacterial potential according to diffusion on disk method. This biological test is tested on 3 strains of bacteria, namely the bacteria *Escherichia coli*, *Klebsiella pneumonia*.

The results obtained allow several conclusions to be drawn and show that the oils studied have a variable activity depending on the different concentrations and method of extraction and also demonstrate that these

oils have considerable biological activities which can be valued as a formulation ingredient in the agro-food and pharmaceutical sector.

Keywords: Vegetable oil; phenolic fraction; antibacterial activity.

Improving water productivity of peach cv. Flordastar by partial root zone drying and deficit irrigation strategies

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CC-58

Peach is an important fruit tree in the irrigated areas of southern Tunisia with a progressive increase in the last years. A three-year field experiment (2013-2015) on peach was conducted in a commercial orchard. Trees were thinned and trained on a usual practice of the farmer. The soil type was sandy textured with a low organic matter content. The peach cultivar was Flordastar on Garnem rootstock at 5*5 m planted in 2009. The partial root zone drying (PRD50) irrigation treatment and a deficit irrigation treatment (DI) with 50% of full crop requirement ETC were compared to full irrigation (FI). The results showed that DI and PRD produced water savings. Fruit yield decreased significantly by the restriction of 50% of ETC and at the same

level for both DI and PRD. Compared to FI, DI and PRD treatments water productivity was significantly increased.

Key words: Peach tree, deficit irrigation, partial root zone drying, yield, water productivity

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CC-59

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One of the most harmful impacts of salt stress on N₂-fixing legumes is the generation of oxidative stress. Silicon (Si) has been reported to have the ability to modulate oxidative stress metabolism in both shoots and roots. Here, for the first time, we investigated the protective effects of exogenous Si on oxidative stress alleviation in nodule of two Moroccan *Medicago sativa* L. varieties, Oued Lmalah (OL) and Demnate 201 (Dm), and a European variety from Serbia, NS Mediana ZMS V (NS Med) under salt stress. The experiment was conducted in a growth chamber at 25 ± 2 °C day/night and a 16 h photoperiod at B2DRN Lab. Nodulated plants were grown under 200mM NaCl with or without 3 mM Si for one month and analyzed for their oxidative stress. Results indicated that salt stress decreased shoots and roots dry biomass, nodules num-

ber and nitrogen content, with NS Med exhibiting the highest decrease of all of the mentioned parameters. This constraint increased malonyldialdehyde (MDA) of nodules especially for NS Med variety where the highest increment rate was noted. Moreover, higher hydrogen peroxide (H₂O₂) content and electrolyte leakage (EL) were noticed in salt stressed-nodules of the three alfalfa varieties particularly those of NS Med. However, addition of Si to salt-stressed plants substantially alleviated the adverse effect of NaCl on growth and nodulation of alfalfa plants as reflected by an improved plant biomass nodulation and nitrogen content. In addition, Si application resulted in a decrease of H₂O₂, MDA and EL and this was mediated by an increase in the enzymatic and non-enzymatic antioxidant activities. Our findings showed that exogenous Si application could be a promising way to improve alfalfa root-nodule efficiency under salinity.

Keywords: *Medicago sativa* L.; Salt stress; Silicon; Nodulation; Oxidative stress; antioxidant activities.

Canopy management and cluster thinning to enhance bioactive compounds of flavonoids and non-flavonoids in berries to improve fruit quality of "Crimson Seedless" grapevines

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CC-60

Flavonoids and non-flavonoids compounds belong to plant secondary metabolites synthesized through the shikimic acid and phenylpropanoid pathways, are found in grape berries and having antioxidant properties, therefore namely bioactive compounds. Flavonoids play a key role to provide pigments to fruits. In this regard, the aim of this trial was to study the effect of canopy management and fruit thinning on flavonoids (6 major subclasses: flavonols, flavan-3-ols, anthocyanidins, flavanones, flavones, isoflavones) and non-flavonoids (phenolic acids and stilbenes) in berries to improve fruit quality particularly the antioxidant attributes and fruit pigments of 'Crimson Seedless' grapevines which may fail to develop adequate red colour. Thus, six treatments were applied during two consecutive seasons, as follows; T1: leaf basal removal (LBR), T2: leaf basal removal + hedging (LBR+H), T3: leaf basal removal + sterile shoot removal (SSR+LBR), T4: T2 + T3 (LBR+SSR+H), T5: leaf basal removal + fruit thinning (LBR+FTH), T6: control (untreated vines). The result showed that the bioactive compounds of non-flavonoids that detected in 'Crimson Seedless' grapes were affected by all treatments compared to the control which were phenolic acids via caffeoyltartaric acid, and two hydroxycinnamic acids as well as all stilbene derivatives i.e., cis-piceid and trans-piceid, resveratrol. Also, all treatments compared to the untreated vines increased the bioactive compounds of flavonoids such as flavonols i.e. quercetin 3- glucoside, kaempferol 3-glucoside, 5

flavonols compounds and total flavonols. Also, the 2nd subclass of flavonoids; Flavan 3-ols raised by all treatments via flavanone compounds of procyanidin and total flavan 3-ols, while LBR + FTH increased procyanidin B2, however, epicatechin was not affected by all treatments including the control. Concerning the anthocyanins (3rd subclass of flavonoids); paeonidin 3-glucoside and other seven anthocyanins compounds influenced by all treatments, however, cyanidin 3-glucoside was affected by LBR + FTH treatment only, where as malvidin 3-glucose enhanced by two treatments LBR + FTH and LBR + H + SSR. All treatments raised total anthocyanins in grape berry and skin compared to the control. In addition, all treatments increased 16 phenolic compounds and total phenolic compounds. Regarding the other chemical attributes of fruit quality, the sugar fractions in grape berries i.e. glucose, fructose, sorbitol and (T.S.S%), T.S.S/acid ratio increased by all treatments in compared to the control. However, the acidity concentration decreased in berries by all treatments in comparing with the untreated vines. As for the physical properties of fruit quality, all treatments improved cluster weight and dimensions of berries per cluster, berry dimensions, weight and volume of berry, juice weight, volume and berry juice %. In contrast, all treatments decreased berry firmness and adherence as well as cluster compactness.

Key words: grape- canopy management – fruit thinning – fruit quality – flavonoids – non-flavonoids.

In vitro propagation of *Spathiphyllum wallisii* by direct organogenesis

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CC-61

Spathiphyllum is an important ornamental plant because of its attractive foliage and long-lasting white flowers. Many nurseries in Morocco import this plant from other countries because its propagation using conventional methods is not commercially viable to meet the increasing demands. Micropropagation of *Spathiphyllum wallisii* is described as an efficacious vegetative multiplication method for mass propagation of healthy and homogeneous plant material. This study, which aims to develop a protocol for *in vitro* propagation of *Spathiphyllum* by direct organogenesis, was performed on apical buds, using MS medium with different growth regulators. The medium which contains 1 mg/l of BAP gave longer vitroplants with an average size of 5.67 cm and a maximum number of leaves (4 leaves/explant) after 8 weeks of culture. In this initiation phase, the medium

supplemented with 2mg BAP / 0.5mg AIA, gave the maximum number of shoots. The *high rate* of shoot multiplication has been achieved in this protocol with an average number of 5.5 shoots/explants in the multiplication phase using the same medium.

Key words: Ornamental plant, *Spathiphyllum*, *In vitro* culture, Propagation, Direct organogenesis.

Influence of continuous deficit irrigation on the yield and fruit quality in Wonderful and Sefri pomegranates

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CC-62

This work investigated the effects of continuous deficit irrigation (CDI) on yield and fruit physico-biochemical properties of two pomegranate cultivars (cv. Sefri and Wonderful) in the Sais Plain in northern Morocco over two consecutive seasons (2018-2019). Irrigation treatments consisted of a control, irrigation applied to fully satisfy crop water requirements (100% ET_C), and two CDI treatments, 70% ET_C (CDI₇₀) and 50% ET_C (CDI₅₀), applied from fruit set to harvest. The effects of the CDI treatments differed between cultivars and years. In Sefri, yield and fruit weight were significantly reduced from the first year under CDI₅₀, and in the second year, they even decreased under CDI₇₀. In Wonderful, a significant reduction in yield occurred in the second year under both CDI treatments. Fruit juice content was reduced in both cultivars, particularly under CDI₅₀, with no significant effect on fruit aril content

and aril weight. As for juice chemical properties, it was observed a decrease in total soluble solids content, especially under CDI₅₀. Biochemically, a significant decrease in total soluble sugars content was observed from the first year in juice of both cultivars. In the second year, reductions in total polyphenols content became significant, and particularly in Wonderful, it was also recorded a decrease in total anthocyanins content. These results indicate that CDI decreases yields and affects negatively fruit quality in pomegranate, even under moderate regime of 70% ET_C. These negative effects of CDI may be dramatic depending on pomegranate genotypes, as observed in Sefri, compared to wonderful cultivar.

Keywords: *Punica granatum* L., water stress, fruit yield, fruit physical traits, juice quality

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CO-63

The characterization of the local genetic resources of Moroccan lentisque aims to participate in the dynamics of management and conservation of a very rich heritage. Our study has focused on the evaluation of the morphological parameters and ISSRs markers of lentisque populations collected in different regions in Morocco. The results of analysis of variance and comparison of the means of the 24 morpho-pomological traits studied revealed a significant diversity within and between the different origins corresponding to different bioclimates ($P < 0.001$). The M'riat population shows a leaf length (7.80 cm) higher than other populations and the smallest is recorded in the Lkbab population (5.46 cm), while, this character has a significantly positive correlation with the languor of the almond ($r = 0.46^{***}$). For the molecular identification of the studied populations based on ISSRs molecular markers, the results showed that the thirteen ISSR primers produced 121 markers, of which 110 are polymorphic, corresponding to a polymorphic percentage of 91.21%. The number of polymorphic markers ranges from five (UBC807) to twelve (UBC868) with an average of eight markers per primer. The mean values of the PIC, RP, I and Ht were 0.79; 4.89; 0.47 and 0.31, respectively. This indicates, on the

one hand, that the ISSRs markers used represent an effective and important tool for the genetic analysis of the Pistachio Lentisk and, on the other hand, the existence of a great genetic variability in this species. Also, molecular variance analysis (AMOVA) showed that the majority of genetic variability occurs at the intra-population level (57.24%) and the populations studied were highly differentiated ($F_{ST} = 0.42$) in accordance with a very restricted gene flow between them ($N_{em} = 0.42$). On the other hand, the hierarchical AMOVA showed a small percentage between the geographical (3.76%) and bioclimatic (-0.94%) groups formed by 11 populations. The genetic distance between populations revealed that the populations of Issekssi and Tifirdine are the closest genetically (0.079), while those of Ait Yahya Oussed and Bin El Ouidane are the most divergent (0.380). Moreover, the geographic distances between populations did not explain their corresponding genetic distances according to the Mantel test ($r = 0.074$; $t = 0.328$; $P = 0.628$).

Keywords: Lentisque, genetic diversity, morphological parameters, ISSR markers.

Nitrogen and potassium fertilization to promote bioactive compounds of flavonoids and non-flavonoids for improving fruit quality of "Crimson Seedless" grapevines

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CO-64

Flavonoids occur widely in plants and are a biologically major and chemically diverse group of secondary metabolites that can be divided into subgroups including anthocyanidins, flavan-3-ols, flavones, flavanols, flavanones and isoflavones. Whereas, non-flavonoids are diverse of phenolic acids and stilbene derivatives. Flavonoids and non-flavonoids compound are bioactive compounds having antioxidant properties and their present in fruit improves its antioxidant attributes. Moreover, flavonoids play a key role to provide fruit pigments. Therefore, the aim of this experiment was to study the effect of nitrogen and potassium fertilization on flavonoids and non-flavonoids and other chemical attribute in fruits to improve fruit quality by raising its antioxidant attributes especially fruit pigments of 'Crimson Seedless' grapevines which may fail to develop adequate red colour. thus, 9 treatments of combination between N (24,36 and 48 kg/h.) and K (240, 285 and 330 kg/h) were applied during two consecutive seasons as follows: (T1) N 24 K 240, (T2) N 24 K 285, (T3) N 24 K 330, (T4) N 36 K 240, (T5) N 36 K 285, (T6) N36 K 330, (T7) N 48 K 240, (T8) N 48 K 285, (T9) N 48 K 330. The result showed that three phenolic acids were detected in this study: caffeoyltartaric acid and two unknown hydroxycinnamic acid derivatives. T3 (low nitrogen rate 24 kg/ha combined with high K level 330 K₂O/ha) gave highest concentration of caffeoyltartaric acid. 3 Stilbene derivatives were detected and identified: *cis* and *trans*-piceid, and resveratrol. *cis* -Piceid was highest by T2 (low nitrogen rate 24 kg/ha combined with medium potassium level 285 K₂O/ha) and lowest by T7. A similar tendency was found for *Trans*-piceid. The aglycone resveratrol was rarely detected. Flavonols were detected: quercetin 3-glucoside, kaempferol 3-glucoside and five unknown flavonols. Medium K fertilization resulted in higher concentration of flavonols compounds in the skin. Flavan 3-ols that were detected are: procyanidin B2, epicatechin and nine unknown proanthocyanidins. T3 and T7 had highest value of procyanidin B2 and T9 had the lowest one in

the second season. Epicatechin was not affected by the N and K fertilization treatments. Total anthocyanins content in the berry generally show a high variability in the experiment. Therefore, the color of berries might have been more influenced by the ripening process than by the fertilizer treatments. 10 anthocyanins were detected in the skin berry: cyanidin 3-glucoside, paeonidin 3-glucoside, malvidin 3-glucoside and seven unknown anthocyanins. Cyanidin 3-glucoside was produced with a larger content by T2 and T3 than T9 in the second year. Paeonidin 3-glucoside was the most abundant anthocyanin in 'Crimson Seedless' skin berry. T3 had a high amount compared with all other N and K fertilization treatments. Malvidin 3-glucoside was increased by T3 than T1, T2, T4 and T9. While, no significant value has found between T3 and the other N and K fertilization treatments. Total anthocyanin content in the berry skin was improved by T3 (low nitrogen rate 24 kg/ha combined with high K level 330 K₂O/ha) compared to the other N and K fertilization. The study detected also 16 unknown phenolic compounds. All of them were differently affected by N and K fertilization. Total phenolic compounds were impacted by N and K fertilization treatments, T2 had the biggest amount compared to T4 and T9. No significant difference was found between T2 and the other N and K fertilization. Concerning the other chemical component of fruit quality, sugars fraction varied between N and K treatments. Glucose was enhanced by T9 compared to T2 in the first year. Fructose enhanced by T7 than T2 in the first year. Whereas, sorbitol remained constant. The acidity decreased as well as T.S.S. and T.S.S/acid ratio was optimized with high K fertilization (330 kg K₂O/ha) combined with medium N-level (36 kg/ha). Regarding the physical properties of fruit quality, the amount of juice per berry increased and fruit firmness and adherence decreased in the high N-variant (48 kg/ha).

Key words: grape – N fertilization – K fertilization –fruit quality – flavonoids – non-flavonoids.

Ressources génomiques et bio-
informatique/ agriculture intelligente

Genomic resources and bioinformatics/
smart agriculture

Thème/Topic



Genetic diversity and structure analysis of natural populations of *Euphorbia resinifera* using ISSR markers

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CC-01

To evaluate the genetic diversity of *Euphorbia resinifera* Berg, eight natural populations were collected from its geographical area (High and Middle Atlas) and analyzed with ISSR markers. Seven ISSR primers generated 70 bands of which 64 are polymorphic corresponding to a percentage of polymorphism of 91%. This high percentage of polymorphism suggests that there is an important genetic diversity in this endemic species in Morocco. The total number of bands per primer ranged from 6 to 12 with an average of 9.28 bands per primer. The Rp registered values ranging from 0.95 to 4, while the mean of I and Ht were respectively 0.18 and 0.31 indicating high genetic diversity in this species. Thus, the high values of PIC and Rp parameters show that the ISSR primers are very informative and effective for analyzing the genetic diversity and structure of *E. resinifera*. The results of the molecular analysis of variance showed that 66.57% of the total variability is present within-population and that 33.43% exists inter-

population. The studied populations are highly differentiated (FST=0.33) in agreement with very limited gene flow between populations (Nm=0.49). Genetic distances between populations showed that the populations of Ouzoud and Fom Jamaa from High Atlas are the most genetically distant (0.53). Moreover, the geographical distances between populations are correlated with their corresponding genetic distances according to the Mantel test ($r=0.460$; $P=0.01$). These results suggest that the population structuring follows a model of isolation by distance. The genetic structuring of populations into five groups obtained from Neighbour-joining and Structure analysis revealed a dependence on the geographical origin of the populations. This information will be useful to define conservation strategies and improvement programs of this species.

Keywords: *Euphorbia resinifera*, genetic diversity, AMOVA, ISSR, polymorphism, Atlas Mountain

miRNAs: new actors to improve tomato tolerance to abiotic stress

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CC-02

To overcome changes in their environment, plants undergo a transcriptional reprogramming to activate stress-response pathways. Conserved DNA-derived Polymorphism (CDDP) approach and visual phenotypic assortment permits to select two contrasting heat-tolerant and heat-sensitive tomato cultivars. Based on discriminating CDDP-markers, a protein functional network was built allowing prediction of candidate genes and their regulat-

ing miRNA. Expression patterns analysis revealed that miRNA-targets modules expression seems to be modulated through a complex heat-stress regulatory network. Integrating biological and genetic resources data is required to select valuable tomato genotype that can be considered in marker-assisted breeding programs to improve heat tolerance.

Key words: miRNA-targets, CDDPs; Heat stress.

SRAP markers for genetic diversity assessment of Tunisian *Festuca arundinacea* populations

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CC-03

Tall fescue (*Festuca arundinacea* Schreb.) is a perennial grass of high importance in northern Tunisia. This species is widely used in pasture, lawns, and hays. The estimation of genetic levels' variation will be of great interest to insure the potentialities of indigenous populations for future adaptation and evolutionary responses to environmental changes. The aim of this study was to analyze the genetic diversity sequence-related amplified polymorphism (SRAP) markers to estimate the genetic diversity within and between spontaneous and cultivated populations of Tunisian tall fescue. The results showed the efficiency of the SRAP technique on the detection of polymorphism, justified by a high percentage of polymorphism (93.33%) associated with a high informational content

of polymorphism (0.78). Analysis of molecular variance revealed significant variability within populations with a percentage variation of 75.94%, significantly higher than the variance between populations (24.06%). This result is confirmed by a low coefficient of genetic differentiation ($Gst=0.221$). The use of three statistical structuring methods (factor analyzes, hierarchical classifications and Bayesian analysis) revealed that the population structure was independent of the geographic origin and was not affected by environmental factors.

Key words: Forage grasses, *Festuca arundinacea*, Genetic diversity, molecular markers SRAP, spontaneous populations, cultivars.

Conservation and genetic diversity of squash (*Cucurbita maxima* Duch.) in Tunisia

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CO-04

The Cucurbitaceae, commonly known as cucurbits, is an important family comprising one of the most genetically diverse groups of food plants in the world. Because of its strategic position and the diversity of ecosystems and climatic conditions, Tunisia is considered one of the most important biodiversity hotspot in the Mediterranean basin notably for cucurbits with Squash (*Cucurbita maxima* Duch) and zucchini (*Cucurbita pepo* L.) being ones of the most cultivated species. Squash production is mainly based on landraces maintained for several years by the local farmers. Taking into consideration the genetic diversity and the nutritional value of squash germplasm resources, several collecting missions around the country was undertaken since 2012 by the National Gene Bank of Tunisia in collaboration with the

Laboratory of Vegetable Crops, High Agronomic Institute of Chott Mariem-Tunisia (UR 13AGR03). In total, 54 accessions have been collected and placed into medium and long-term storage. The collection was agromorphologically characterized, using international descriptors related to the full range of plant parts. Univariate (ANOVA) and multivariate (PCA, FCA and HCA) analyses were carried out in order to elucidate the morphological diversity in the collection. Significant differences were observed among accessions for almost all quantitative and qualitative characters. Globally, four typologies traditionally known as Bejaoui, Gaaloui, Karkoubi and Batati and having specific fruit characteristics were identified.

Key words: genetic diversity, landraces, squash.

Polymorphisms of casein and α -lactalbumin genes in local Moroccan goat

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CO-05

This work aims to study population genomics parameters in the main Moroccan goat populations (Black, North and Draa) and to identify alleles of five milk genes in these goat populations. We had worked on the coding parts of the casein genes (Casein α 1, Casein α 2, β -casein, κ -casein) and the α -lactalbumin gene which are found in the whey. The analyzed genomic regions (of targeted genes) were extracted from whole genome data of 66 individuals, belonging to three populations, representative of the eco-climatic and racial diversity of Morocco. We studied intra-population genetic diversity via observed (H_o) and expected (H_e) heterozygosity as well as nucleotide diversity (π). We found a high diversity which is close to the results when considering the whole genomic variants of these studied individuals, with a slight difference between Black population in comparison with the two other populations. These results suggest that these two populations North and Draa undergo more selection on some casein genes and on α -lactalbumin than the Black population. For the

indices of intra-population differentiation (H_o , H_e and π) and inter-population (pairwise F_{ST}); the casein α 2, κ -casein and α -lactalbumin genes show a distance between the studied populations. Based on the genomic data of the five studied genes, a population structure analysis (using sNMF software) and phylogenetic trees were constructed. The results suggest that there is a weak structuring between these breeds and that the breed effect is too weak on these studied genes. However, this does not exclude that there may be some individuals that are selected for milk even if this is not observed in the entire breed. For the casein α 1 gene, the B2 allele doesn't exist in these breeds and the A, F, and N alleles are present in individuals belonging to the three populations but not in an entire population. These results can be used to improve goat milk production and quality, by integrating the individuals with best alleles in selection schemes.

Keywords: Moroccan goats, milk genes, genomic diversity, phylogeny, population structure.

Flowering phenological trends under climate change of the arid Mediterranean region: The model of date palm

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CO-06

In the last Century, the timing of flowering, which is the major component of reproductive success, has been altered by climate changes, especially in the arid Mediterranean regions. Monitoring these phenological behaviors is interesting because it allows us to quantify the magnitude of the ecological perturbation caused by global climate change in this area. We, therefore, investigated the flowering response of a collection of male date palms (*Phoenix dactylifera* L.) to climatic variation for a period of three years in order to draw a flowering calendar and to address the flowering asynchronism. The flowering phenological data were collected for the emergence and the opening of the first spathe events of a male genotypes collection from January to April for

each study year. Meteorological data were analyzed at the temporal scale of observations. In our study, a variability of the reproductive phase within this collection is observed between years. The recording flowering events revealed a striking trend of precocity for the first spathe emergence and strong stability in the spathe opening stage. Our findings demonstrated a flowering onset advancing and extended emergence-opening duration. Of the examined collection, a set of male genitors have been selected for their interesting flowering behaviors. This investigation represents an essential phenotypic basis for upcoming flowering-linked genetic research in date palm.

Keywords: Flowering asynchronism, Global Climate change, Great variability, *Phoenix dactylifera* L., Striking trend.

Séquençage du génome de la variété marocaine Boufeggous : les premières étapes

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CO-07

Le palmier dattier est un arbre de grandeur, il est un arbre qui survit aux conditions extrêmes des oasis, un arbre qui a une grande longévité, et un arbre qui donne un fruit exceptionnel avec une grande valeur nutritive. De ce fait, et vu que les surfaces peuplées par cette espèce sont en étroite réduction, il a fallu procéder à des sélections pour identifier des génotypes capables de résister aux différents stress biotiques et abiotiques à cause de cette réduction. Ces travaux se sont heurtés aux problèmes tels que : le long cycle de vie de cet arbre (7 à 10 années), la charge financière élevée nécessaire à sa plantation et son entretien durant ces années. Ainsi, le séquençage de son génome et sa dessiccation est une étape primordiale pour mieux comprendre son métabolisme et identifier les gènes intervenant dans les

différents processus vitaux. Dans ce papier, on vous présente les résultats préliminaires du séquençage du génome complet de la variété Marocaine Boufeggous, tout en comparant les différentes technologies de séquençage et les différents logiciels d'analyses bioinformatiques testés ainsi qu'un aperçu des principales difficultés et limitations rencontrées.

Mots clés : séquençage haut débit, NGS, analyses bioinformatiques, palmier dattier, génome

A new agronomic potential: *Medicago minima* from an unknown plant to a breeding program

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CC-08

Medicago minima (L.) Bart, commonly known as "little bur medic" is a pasture legume native of the Mediterranean Basin and adjacent temperate zones. This species tolerates the most varied climates and has significant biochemical and agronomic potential for humans and their environment, but it remains very little known and unexploited. In our study, twelve populations selected from various Tunisian areas were tested for six agro-morphological parameters related to the plant vegetative developments (H, MFr), to blooming (NF, DAF), and to seeds (NGr, LGr), then for three biochemical characteristics (total phenolic contents, total flavonoid content, and antioxidant activities) and 21 molecular markers SRAP. Statistical analysis of the dataset showed a strong agro-morphological and biochemical heterogene-

ity between the studied populations. Likewise, the molecular analysis revealed a wide range of genetic diversity among the studied populations. In addition, the correlation analysis of all studied parameters highlights a positive association of the molecular markers to the agro-morphological and biochemical traits. These associations can be used in the selection program (marker-assisted selection). The findings of this study will be useful in identifying high yielding *Medicago minima* lines exhibiting traits of interest. These selected breeding lines will be used for the genetic improvement of *Medicago minima* in the future.

Key words: *Medicago minima* – Agro-morphological traits – Molecular markers – Biochemical interest – Association analysis – Select

SSR markers-based genotyping of *Brassica oleracea* complex species

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CC-09

The species *Brassica oleracea* encompasses an extraordinary variability, making it a perfect platform for crop improvement practices, thus it contains potential molecules. The glucosinolates (GLS) content constitutes a complex quantitative trait, and it's considered as the major secondary metabolites in Brassica. However, genes likely to be involved in the biochemical pathways. In this context, the aim is to study the diversity expressed by a set of *Brassica oleracea* complex species (n=9), including *B. oleracea* landraces and wild species using SSR markers linked to GLS genes. Statistical analyses were carried out with R software. Genotyping by simple sequence repeat (SSR) DNA markers led to the identification of highly informative primer combinations. Moreover, AMOVA analyses highlighted a significant level of molecular variation among accessions. The use of molecular approaches has greatly facilitated the improvement of agronomic traits and the selection process.

Key words: *Brassica oleracea* – Glucosinolate – SSR markers

Crop water stress retrieval using thermal Landsat observations and an energy balance model

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CO-10

Optimizing water management in agriculture is essential over semi-arid areas in order to preserve water resources that are already low and erratic due to human actions and climate change. Information on the crop water stress at a high spatio-temporal scale is relevant to irrigation management. The objective of this study is to retrieve the crop water stress using thermal infrared data derived from Landsat-7 and Landsat-8 satellites over irrigated district in the Haouz plain, Morocco. The crop water stress index is estimated from Landsat-derived land surface temperature (LST) combined with the LST endmembers (in wet and dry conditions). The LST endmembers are simulated by a surface energy balance model driven by meteorological forcing and Landsat-

derived fractional vegetation cover. The investigated method is calibrated and validated over two wheat parcels located in the same area near Marrakech city central Morocco.

Keywords: Water stress index; Surface temperature; Landsat; Energy balance.

Genetic diversity of Moroccan Apple cultivars revealed with SSR Markers

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CO-11

Genetic diversity of 27 apple genotypes cultivated in four geographical regions of Morocco was screened using 26 simple sequence repeat (SSR) primers. These SSR loci yielded a total of 195 polymorphic SSR alleles in ranging size of 78 to 209 bp. The obtained values for the average number of alleles per locus (7.5), effective numbers of alleles (4.62), Shannon's information index (1.66), expected heterozygosity (0.76), observed heterozygosity (0.74) and polymorphism information content (0.76), showed a high level of polymorphism and suggest that Moroccan apple cultivars have significant genetic diversity. The principal coordinate analysis and UPGMA dendrogram suggested the presence of four well-defined groups, which was confirmed later by model-based population structure. Furthermore, strong genetic differentiation between these four groups was also detected compared with other studies ($F_{ST}=0.28$). Most of the individuals segregated into the four groups showed a membership coefficient greater than 0.80,

which indicate their better genetic integrity. After comparing SSR profiles and genotypes names, we conclude that the problem of homonyms and/or labeling errors appear in the studied genotypes. However, based on genetic profiles, two individuals (Naour 1/Naour 2 and Laakri 5/Laakri 6) found to be duplicated. Also, the results show that some cultivars with the same name are grouped in different clusters suggesting the existence of possible homonymy. Lastly, the present work confirms the usefulness of SSR markers for the elimination of duplications and characterization of diversity and hybrid characters of cultivars within the species *Malus*. However, we suggest that this work could serve as basic information to assess the apple germplasm in Morocco.

Keywords: *Malus × domestica*, SSR markers, genetic diversity, Apple, Morocco.

Interactions Plantes - Microorganismes :
Biofertilisation et Biocontrôle

Pant - Microorganisms Interactions :
Biofertilization and Biocontrol.

Thème/Topic



Influence du type de travail du sol sur le taux de colonisation des racines de la lentille (*Lens culinaris* L.) par les mycorhizes arbusculaires dans la région semi-aride d'Algérie

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CO-01

La relation symbiotique entre les plantes et les champignons mycorhizes à arbuscule (CMA), qui concerne la majorité des espèces végétales, est fortement impliquée dans la nutrition minérale de la plante, la tolérance au stress abiotique et biotique (la sécheresse, les températures extrêmes et les pathogènes). L'objectif de cette étude a été d'examiner l'effet de quatre techniques de travail du sol à savoir : le semis direct à dent (SDT), le semis direct à disque (SDD), la technique culturale simplifiée (TCS) communément appelé travail minimum (TM) et le travail conventionnel (TC), sur le taux de colonisation racinaire par les CMA chez la culture de lentille (*Lens culinaris* L.). Les essais ont été menés à la ferme expérimentale de l'institut technique des grandes cultures (ITGC –Sétif-), durant la campagne agricole 2018/ 2019. L'ANOVA a montré que les techniques culturales n'affectent pas le taux de colonisation totale (TCT), le taux d'arbuscules (TCA) et le taux des vési-

cules (TCV). De plus, ces résultats montrent que le TCT varie de 44,44 % pour le TM à 26,91 % pour le SDT. Aussi le TCA se montre élevé en TM avec 37,04 % suivi par le SDD avec un taux de 22,22 %. Le SDD a enregistré un TCV plus élevé avec un taux de 28,31 %. En conclusion le TM et le SDD favorisent la relation plante-champignons mycorhizes dans la région semi-aride d'Algérie où le stress hydrique persiste.

Mots clés : Symbiose mycorhizienne, lentille, colonisation, semi-aride, Algérie.

Effet de *Trichoderma harzianum* sur l'induction de la résistance systémique chez *Arabidopsis thaliana*

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CO-02

Les espèces de *Trichoderma* ont été décrites comme des inducteurs de la résistance systémique des plantes en relation avec leur activité antagoniste. L'objectif de cette étude était d'évaluer l'effet des souches sélectionnées de *Trichoderma harzianum* sur l'induction de la résistance systémique chez *Arabidopsis thaliana* comme modèle de génétique moléculaire des plantes. La souche A de *Trichoderma harzianum* a été identifiée et confirmée pour son potentiel antagoniste in vitro et in vivo dans des études précédentes. Afin d'explorer ce mécanisme, deux mutants d'*A. thaliana* portant un promoteur PR1 (un marqueur conventionnel de la voie de l'acide salicylique (AS)) et un promoteur LOX2 (un marqueur déclenchant l'activation de la voie de l'acide jasmonique (AJ)) ont été analysés après inoculation des antagonistes. L'analyse des lignées transgéniques rapporteuses a démontré que *T. harzianum* a induit les voies de défense d'*A. thaliana* en activant AS et AJ à un niveau

élevé par rapport aux lignées traitées avec des éliciteurs chimiques de référence (acibenzolar-S-méthyl (Bion 50 WG), AS, et méthyl jasmonate). L'efficacité de *T. harzianum* A dans l'induction du mécanisme de défense chez *A. thaliana* a été démontrée dans cette étude.

Mots-clés : *Trichoderma harzianum* ; acide salicylique ; acide jasmonique ; *Arabidopsis thaliana*.

Impact of biochar mixed with compost application on olive, some soil properties and water productivity

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CO-03

This study was conducted at Ismailia Desert in Egypt during two seasons 2019 and 2020 to investigate the effect of biochar or/ and compost on soil properties of new reclaimed sandy soil and yield of Picual olive trees. Measured and simulated olive water productivities were calculated using by Aquacrop model. The results showed that soil organic carbon and organic matter were markedly affected by biochar and compost additions. Moreover, the incorporation of biochar and compost led to enhancement in hydro-physical properties through decreasing bulk density and hydraulic conductivity of soil and increasing soil total porosity, water-holding capacity, and thus olive water productivity. Both biochar or/ and compost had valuable influences on growth, nutrients content, yield, fruit quality, and oil percentage in olive fruits, especially application with

biochar at 75% plus compost at 25%. In conclusion, it can be recommended to mix biochar with compost in the agricultural management of sandy soil for enhancing its productivity.

Keywords: Olive yield, Biochar, compost, organic carbon, soil properties, water productivity.

Bio-fertilizers issued from anaerobic digestion of olive mill wastewater with phosphate residues and applied on tomatoes: targeting circular economy concept

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CO-04

Tomato *Solanum lycopersicum* plants were grown under greenhouse located on a research platform in Murcia (Spain). Tomatoes plant were fed with bio-fertilizers issued from anaerobic digestion of olive mill wastewater (OMW) without and with 1%, 5% of phosphate residues (PR) in mesophilic conditions for 25 days in batch reactors. 1% of Substrates (OMW initial, OMW+1%PR initial, OMW+5%PR initial and PR) and digestates (OMW final, OMW+1%PR final and OMW+5%PR final) was provided fortnightly to the plants. Reclaimed water from the same wastewater treatment plant was used for automatic controlled irrigation. It contained low level of chemical fertilizers in order to compare tomato plant growth, leaf analysis, steam water potential, production yield and fruit quality results to plants fed with bio-fertilizers. Generally, pa-

rameters and results were positively increased during growing and harvesting stage, which refer to the presence of essential elements that cover plants need. Plants fed with biofertilizers showed the highest plant height (OMW+5% PR initial), and better accumulation of essential elements in leaves (OMW+1%PR final and OMW+5%PR final). The maximum average fruit weight per treatment was obtained when applying (OMW+5% PR final) and the maximum yield production per plant was obtained when applying phosphates residues. Biofertilizers (digestates) showed good performances, high fruit quality and perfect tomato yield production.

Keywords: Anaerobic digestion, biofertilizers, Olive mill wastewater, Phosphate residues, Reclaimed water.

Arbuscular mycorrhizal fungi and compost to Improve Photosynthetic Apparatus, Growth, and drought stress tolerance of *Chenopodium quinoa* in field conditions

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Drought and water stress induced by climate change are among the main factors limiting agricultural production by decreasing crop yields, especially in arid and semi-arid regions of the world. Quinoa (*Chenopodium quinoa*), thanks to its high nutritional value and its ability to adapt to unfavorable conditions such as water deficit, is considered one of the solutions to ensure food security under drought conditions that the world is currently experiencing. In addition to the introduction of quinoa as a new resistant crop, the application of organic and microbial biostimulants is also a promising new strategy to reduce the damage caused by this water stress and to increase yields of this crop. However, the impact of these biostimulants on the plant at the physiological and biochemical level has not yet been evaluated. We studied the impact of two doses of organic fertilizers based on vermicompost (VC) (VC5: 5 t/ha and VC10: 10 t/ha) and arbuscular mycorrhizal fungi (AMF) applied individually or in combination under two water regimes (WW: well watered and DS: drought stress) in

the field. Indeed, lack of water negatively affected physiological and biochemical parameters of quinoa plants. Biomass, leaf water potential and stomatal conductance decreased under water stress, as well as total soluble sugars and protein contents in leaves and roots. However, malondialdehyde and hydrogen peroxidase levels increased under stress conditions. The VC10+AMF combination showed the best results in both regimes by increasing growth, sugar and protein contents and decreasing antioxidants in leaves and roots of quinoa plants in the field. Under severe water regime, VC10+AMF increased 1000 grain weight by 6.16% compared to the control. These results show that the combination of AMF and vermicompost significantly improves the physiological and biochemical characteristics of quinoa to cope with water stress, which can increase crop yields, especially in arid and semi-arid regions.

Keywords: Biostimulants, crop sustainability, agrophysiological responses, water scarcity, compost, mycorrhizae.

Characterization of the genetic resistance to aggressive strains of Cucumber mosaic virus in melon

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Cucumber mosaic virus (CMV) is one of the most common, widespread and destructive cucurbit viruses. It belongs to the *Cucumovirus* genus in the Bromoviridae family and has several strains assigned to two subgroups (SGI and SGII).

In melon (*Cucumis melo* L.), resistance to CMV is recessive and involves at least three QTLs: *cmv1* in linkage group XII (LGXII), *cmvqw3.1* in LGIII and *cmvqw10.1* in LGX. The major QTL *cmv1* has been well studied. It provides full resistance against CMV strains of SGII only, by restricting the virus in the bundle sheath cells in a manner dependent on the viral movement protein. The two additional QTLs (*cmvqw3.1* and *cmvqw10.1*) are also necessary and cooperate with *cmv1* to confer resistance to SGI strains. Nevertheless, the mechanisms of melon resistance conferred by these two QTLs are not fully understood and need to be more dissected and characterized.

The aim of this study was to characterize the resistance conferred by the QTL *cmvqw10.1* and to determine at which step

of the viral infection, the virus is restricted in resistant lines. The first true leaves of introgression lines harboring different combinations of CMV resistance QTLs, were inoculated with the pseudo-recombinant virus CMV-F1F2F3, composed by three molecular clones corresponding to the three genomic RNAs of the strain CMV-FNY. Results of viral accumulation in the petioles of inoculated leaves using the qPCR technique showed that the QTL *cmvqw10.1* cooperates with *cmv1* to block the virus in the inoculated leaf and limit its passage to the phloem thus preventing systemic infection. This result provides a better understanding of the melon's resistance mechanisms to CMV.

Keywords: Melon, *Cucumber mosaic virus*, genetic resistance, introgression lines, infection experiments, viral accumulation.

Characterization of *Fusarium* species associated with root rot of sugar beet in Morocco

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CC-07

Sugar beet (*Beta vulgaris* ssp.) is a widely cultivated plant in the world and is the second-largest crop used as a source of sugar. In Morocco, the cultivation of sugar beet annually occupies an area of approximately 65,000 hectares and allows the production of more than 3 million tons of roots. However, root rot in sugar beet caused by *Fusarium* dramatically reduces yield, juice purity, and sugar concentration. Therefore, this study aimed to identify and characterize *Fusarium* species associated with root rot of sugar beet grown in the region of Beni Mellal (center of the country). In this study, one hundred and nine isolates of *Fusarium* were collected from sugar beet roots showing typical symptoms of root rot from 2018 to 2021. After screening based on the pathogenicity test, twenty-nine isolates of *Fusarium* were identified on based on morphological characteristics and sequence analyzes of the internal transcribed spacer (ITS) region of ribosomal DNA (rDNA) and translational extension factor 1 α (EF-1 α), eight species of

Fusarium have been identified. *Fusarium oxysporum* was the most frequently identified, followed by *F. nygmai*, *F. equiseti*, *F. falciforme*, *F. tricinctum*, *F. proliferatum*, *F. culmorum* and *neocosmospora falciformis*. After 6 weeks of inoculations under greenhouse conditions, the isolates studied caused tip rot and vascular discoloration of sugar beet roots, with a disease incidence ranging from 70.2 to 100.0% and a disease index ranging from 30.1 to 79.50%. *F. oxysporum* and *F. nygmai* were the most aggressive. Many tested isolates resulted in a significant reduction in the growth traits evaluated. This is the first detailed report of *Fusarium* species causing root rot in sugar beet in Morocco.

Keywords : Sugar beet, *Fusarium* species, rDNA-ITS, EF-1 α , Root rot, Pathogenicity.

Diversity of arbuscular mycorrhizal fungi in the rhizosphere of date palm tree (*Phoenix dactylifera* L.) in the oasis of Figuig (Eastern high atlas, Morocco)

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CC-08

Dans les écosystèmes arides, les champignons mycorhiziens à arbuscules (CMA) jouent un rôle important dans l'amélioration de l'absorption des nutriments par les plantes et la protection contre divers stress biotiques et abiotiques. L'oasis de Figuig qui fait partie de la région de l'oriental marocain est attaquée par la maladie du Bayoud causée par le *Fusarium oxysporum* f. sp. *albedinis* (Foa), qui présente un facteur limitant de la culture du palmier dattier, de plus la palmeraie est menacée par la sécheresse qui agit négativement sur le développement de l'agriculture locale et en particulier sur la phoéniculture. Cette présente étude consiste à étudier la biodiversité et le taux de colonisation racinaires des CMA sur le palmier-dattier (*Phoenix dactylifera* L.) en se basant sur les caractéristiques morphologiques (morphotypage) des spores. L'identification des champignons mycorhiziens arbusculaires et l'évaluation du taux de mycorhization des racines ont été

réalisées respectivement à partir des spores recueillies dans des échantillons de sol et des racines prélevées dans différents points de la rhizosphère de la palmeraie de Figuig. Les analyses des résultats ont montré la présence de différentes structures mycorhiziennes (vésicules/spores/arbuscules / hyphes uniquement) caractérisant les endomycorhizes sur les 15 sites échantillonnés. Le taux de colonisation des racines par les CMA varie d'une manière significative allant de 47% à 79% dans la rhizosphère de la palmeraie. Les analyses morphologiques révèlent la présence de souches appartenant à la famille des Glomeraceae avec un potentiel pour la découverte de nouveaux genres et espèces.

Mots clés : Champignons mycorhiziens à arbuscules (CMA), Diversité, Figuig, *Phoenix dactylifera*., Bayoud

Status report on the storage conditions of apples at conservation stations in Morocco

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CO-09

After the harvest, a large part of the Moroccan apple production is stored in cold rooms in order to ensure, on the one hand, a regular supply of the Moroccan market and on the other hand to preserve the organoleptic qualities of this climacteric fruit at an optimum level for as long as possible. However, apples in storage are subject to various physiological and fungal diseases that harm their quality. The objective of this study is to inquire into the storage conditions of apples, to identify the fungal diseases which affect apples in post-harvest, to determine their incidence and to evaluate the density of the spores of pathogenic fungi in the chambers of storage. The study concerned cold stores located in 4 apple-growing areas in Morocco, namely: Meknes-Elhajib, Fes-Sefrou, Ifrane-Azrou and Zayda-Midelt. To do this, surveys were carried out in 32 refrigeration stations and samples of rotten apples were collected in 40 storage warehouses for analysis. Within the sampled stations, Petri dishes containing PDA medium were exposed to estimate the microbial spore load in the atmosphere of each station. According to the results obtained,

94% of storage units adopt normal cold rooms while only 6% opt for controlled atmosphere storage rooms. It also turns out that the losses of apples due to fungal diseases during storage vary between 5% and 20%. The pre-harvest treatments carried out are chemical treatments based on methyl thiophanate and rarely carbendazim or difenoconazole. The storage period of apples varies between 6 months and 10 months. Regarding the spore density of pathogenic fungi in the air of the storage chambers, the conservation stations in the Zayda-Midelt area showed a high density compared to the other study areas. Microbiological isolations, on culture medium, showed that the genus *Penicillium* spp. was the most dominant over other pathogenic fungi affecting apples in postharvest.

Keywords: apples, refrigeration stations, fungal diseases, storage conditions.

Isolation and characterization of endophytic actinomycetes associated with two medicinal plants in Beni-Mellal region, Morocco

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CO-10

This study aimed the isolation and screening of endophytic actinobacteria associated with two medicinal plants *Thymus saturoides* and *Lavandula multifida* collected in Beni-Mellal region, Morocco. A total of eleven endophytic actinomycetes strains were isolated and purified using Starch Casein Agar (SCA). These isolates were identified on the basis of their macromorphological characters on International Streptomyces Project (ISP₂, ISP₃, ISP₄ and ISP₅) and micromorphological characters by the Gram staining reaction. All these isolates were screened for their potential in tolerance to pH variation, salinity, low phosphorus availability and for their biocontrol potential against *Fusarium oxysporum* f.sp. *albedinis*. The obtained results indicated that the majority of isolates were able to grow in a pH range of 4 to 8 and tolerated the salt stress upto 8% NaCl. The solubilization efficiency of inorganic phosphate on PVK agar medium ranged from 25% to 458%. On PVK liquid medium, the amount of soluble phosphate varied from 163.81 µg/mL to 730 µg/mL. For Indole-3-Acetic acid

(IAA) production, the amount produced varied from 1.70 µgIAA /mL and 14.13 µgIAA /mL. Moreover, the majority of tested strains were able to grow on Nitrogen-free medium. Endophytic actinomycetes isolates showed also a remarkable capacity to degrade some compounds such as cellulose and starch. In addition, some showed a strong inhibitory activity against the fungus *Fusarium oxysporum* f.sp. *albedinis* with a percentage of inhibition ranged from 69.13% to 86.6%. The molecular characterization of isolates based on the housekeeping genes are in progress.

Keywords: endophytic actinomycetes, *Thymus saturoides*, *Lavandula multifida*, *Fusarium oxysporum*, salinity, Phosphorus, Biocontrol.

Effectiveness of mating disruption with TUTATEC® diffusers to fight against *Tuta absoluta* (Lepidoptera: Gelechiidae) in heated greenhouses in southern Tunisia

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CO-11

The production in geothermal greenhouses in Tunisia has experienced remarkable growth since its inception. Despite the importance of this sector, there are pest problems that bear damage to crops in greenhouses heated; especially the tomato leaf miner *Tuta absoluta* considered one of the most devastating pests of tomato crops. The object of this study was to evaluate the effectiveness of manual stripping and sexual confusion in greenhouses heated by geothermal waters in southern Tunisia to fight against *T. absoluta*. For this purpose, sex pheromone dispensers TUTATEC® were applied at two doses of 300 dispensers/ha and 600 dispensers/ha. The catches of males in the pheromone traps as well as the percentages of infested leaves and fruits were monitored weekly and compared with mechanical leaf removal and insecticide treated greenhouses. In green-

houses treated with mating disruption at the rate of 600 sprays/ha, a 92% reduction in male trap catches was observed compared to greenhouses with mechanical control. Damage on leaves and fruits was significantly lower with mating disruption with a reduction of leaf infestation by 31% and fruit infestation by 53%. However, the dose of 300 sprays/ha applied in geothermal greenhouses was not able to reduce the damage caused by *T. absoluta* on leaves and fruits compared to greenhouses conducted with mechanical control. These results suggest that the disruption of mating is effective in the management of *T. absoluta* and could be a primary compass for IPM to control this pest.

Key words: *Tuta absoluta*, mechanical control, mating disruption, TUTATEC®, IPM, heated greenhouse

Effect of endemic rock phosphate solubilizing Actinobacteria on sugar beet (*Beta vulgaris* L.) growth under field experiments

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CO-12

Phosphorus (P) is one of the most important elements for sugar beet growth and development. In order to improve P nutrition of sugar beet plants and preserve the environment, two endemic P solubilizing *Streptomyces* spp.: *S. bellus* (SB) and *S. saprophyticus* (SS), previously isolated from sugar beet soils of Beni Mellal region and selected for their multiple plant growth promoting activities were evaluated in field conditions. The results showed that inoculation with SB or SS strains increase the growth and yield of sugar beet when mixed with natural rock phosphate (RP). The highest root and shoot yield were recorded with SS+RP and the highest root and shoot length were registered with SB+RP compared to unfertilized plants. The two strains increase nitrogen (N), P and potassium (K) content in shoots and

roots. The highest level of P and K in shoots was recorded in plants inoculated with SB. In addition, inoculation by SS affect significantly the root yield (140.41 t/ha) compared to the negative control. Moreover, soil available nutrients (NPK) were increased after inoculation of both SB and SS strains with the highest values are recorded with SB. After 6 months of growth, the combination with SB and RP showed an interesting ability to be used as bio-fertilizer for ecological and sustainable sugar beet agriculture.

Keywords: *Streptomyces* spp, rock phosphate, phosphorus, bio-fertilizer, sugar beet, field experiments.

Bio solubilization of mineral compounds by *Streptomyces bellus* isolated from sugar beet soil of Beni Mellal region in Morocco

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CC-13

Solubilization of mineral compounds by *Streptomyces* has been not well studied. The solubilization mechanisms by those strains often involve the excretion of chelating substances such as siderophores. In this issue, we describe the characterization of a novel solubilizing mechanism used by a *Streptomyces* strain related to *Streptomyces bellus* (SB) isolated from a Moroccan sugar beet soil which was the most efficient on minerals solubilization and sugar beet growth promotion under pot experiments and in field trial. The main objective of this study is the identification of organic acids secreted by SB strain in order to better understanding its solubilization mechanism. Thus, standard solutions of some organic acids as well as samples taken from aqueous culture media are filtered before being analyzed using high performance liquid chromatography coupled with

mass spectrometry (HPLC-MS). Results of HPLC-analysis, interpreted by Single Ion Recording mode SIR to prevent interference, revealed the presence of three organic acids, namely succinic acid (RT= 2.536 min), citric acid (RT = 3.517 min) and L-malic acid (RT = 3.531 min), with citric acid being less abundant. These preliminary studies are yet to be completed by other chemical studies to illustrate the chemical structure of the active(s) molecule(s) responsible(s) for the solubilization process. In addition, the revelation of organic acids produced by SB strain remains an interesting way for a potential application as a novel type of bio-fertilizer combined to natural minerals.

Keywords: *Streptomyces bellus*, mineral compounds, bio-fertilizer, organic acids, mechanism.

Diversity and relative abundance of insect visitors of the main entomophilous crops in Morocco

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CC-14

Farmers worked continuously to find ways to increase their yields and improve the quality of their harvest. In addition to external agricultural inputs (fertilizers, pesticides), crops benefit freely from pollination service which influence widely crop production. We investigate in this study the potential of agroecosystems and crops to host high diversity of wild bees in Morocco. We collected insects present in nine agricultural systems and visiting a total of 22 crops across four eco-climatic regions in this country for two years (2018-2019).

We recorded a total of 53,362 insects in all agroecosystems during 2018 and 2019. 37,440 individuals were detected as crop visitors. Bees were by far the most abundant group visiting crops. Honeybees represented 66% of crop visitors followed by wild bees with 22% of specimens in abundance. We identified a total of six families, 39 genera and 220 species of wild bee visiting

crops representing 23% of national species richness. Three genera (i.e. *Lasioglossum*, *Andrena* and *Xylocopa*) represented 53% of the total abundance of wild bees visiting crops while *Melecta*, *Pseudoanthidium*, *Lithurgus*, *Dioxys* and *Ammobates* are found as rare. Comparison of abundance and species richness of wild bees visiting crops using GLMM analysis showed significant differences between regions for zucchini, *faba bean* and eggplant while pumpkin and apple were visited by similar diversity.

This study highlights the high diversity of pollinators in agroecosystems in Morocco. It is considered as the first step to explore the pollinator fauna in this country and gives basic information for future studies on pollinator conservation and pollination service.

Key words: Honeybee, wild bees; *Lasioglossum*; *Andrena*; *Xylocopa*; pollination service, agroecosystem.

Growth promotion and protection against root rot of sugar beet (*Beta vulgaris L.*) by two rock phosphate and potassium solubilizing *Streptomyces* spp. under greenhouse conditions

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Phosphorus (P) and potassium (K) shortages inhibit crop production, and soil borne plant diseases such as root rot by *Fusarium* spp. can cause extensive damage to crops. *Streptomyces bellus* (SB) and *S. saprophyticus* (SS) solubilize P and K and inhibit sugar beet (*Beta vulgaris L.*) associated *Fusarium* strains in laboratory conditions. To address their performance *in vivo*, we tested their effects on sugar beet growth and root rot development. The tested strains showed a significant beneficial effect on growth and yield parameters of sugar beet when mixed in the soil with insoluble natural rock phosphate (RP) and/or K mineral orthoclase (OT). Compared to the non-inoculated treatment, the highest shoot and root dry biomass were recorded with

RP+OT+SB. Highest P and K levels in leaves were with OT+SB and RP+SB, and the treatment RP+OT+SB increased both soil P and K. Interestingly, these SS and SB strains exhibited higher protection effects with 100% and 75%, respectively, when the soil was infested by *Fusarium equiseti* and *F. fujikuroi*, causal agents of root rot disease of sugar beet in Beni Mellal region. These results can be exploited to mitigate the detrimental impacts of nutrient limitation for and disease susceptibility of sugar beet.

Keywords: Rock phosphate and orthoclase solubilizing *Streptomyces*, sugar beet growth, biocontrol, root rot, greenhouse conditions.

Evaluation of the phytochemical profile to the mycorrhizal potential of rhizospheric soils of some endemic Moroccan PAMs

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CO-16

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People have widely used aromatic and medicinal plants (PAM) since ancient times. They are the basis of many medical treatments worldwide. However, the increased use of these resources, the harsh environmental conditions, and the traditional cultivation techniques hamper the development of this sector. The long-term objective of our work is to improve the AMP performances using efficient arbuscular mycorrhizal fungi (AMF) inocula. We carried out the present study to assess the correlation between the chemical profiles and biological activities of *Lavanduladentata* and *Thymus satureioides* essential oils and the mycorrhizal potential rhizospheric soils in Asni Oukaimden and Had Draa Essaouira regions. The results of the analysis of essential oils obtained by hydro-distillation of the aerial parts of *T. satureioides* and *L. dentata* by GC / MS revealed the abundance of hydrocarbon monoterpenes with (31.82% - 36.84%), and oxygenated monoterpenes with (30.00% - 31.82%) in *T. satureioides*, and hydrocarbon monoterpenes (20.69% - 42.86%) in *L. dentata* in the region of Had Draa Essaouira, on the other hand, *L. dentata* from

the region of Asni shows an important content of oxygenated monoterpene (41.38%). The antioxidant activity of essential oils, evaluated by the Inhibition of the free radical of DPPH, showed an IC50 ranging from 0.29±0.01 mg/ml to 0.47±0.02 mg/ml for *T. satureioides* respectively at sites 1 and 2 of the Asni Oukaimden region while *L. dentata* revealed less antioxidant activity (3.94 to 6.46 mg / ml). These results are strongly linked to the mycorrhizal potential of the rhizospheric soil of the two species. The mycorrhizal frequency (F%) varied between 63.16 and 94.74%, and the intensity of root colonization (M%) was between 15, 42, and 46.89%. The most probable number of propagules (NPP) varied between 197 and 1373 propagules / cm³ of soil. Moreover, the soils have an alkaline pH (8.61 to 8.17), with low phosphorus (6.94 to 16.36 mg / g), sodium (1.670 to 2.53 mg / g), potassium (1.38 to 8.61 mg / g), and calcium (16.58 to 73.45 mg / g) contents.

Key words: *T. satureioides*, *L. dentata*, AMF, Essential oils, antioxidant activity.

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Actinomycetes isolated from Moroccan oat soils: Diversity and screening for phosphate bio-solubilization

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CC-17

Soil Actinomycete explorations appear to be a solution to optimize the use of phosphate (P) resource and to enhance the plant growth. The current study was aimed to explore the distribution of Actinomycetes from four different rhizospheric oat soils in Morocco and to investigate their potential of phosphates solubilization abilities. The distribution of Actinomycetes was significantly more abundant in Settât (9.6%), Tanger (7.5%) and Beni Mellal (6.9%) than in Merchouch (4.8%) regions. Significant correlations ($p < 0.01$) was observed between the % of Actinomycetes, the granulometry parameters, the pH values ($r = 0.854$) and the P contents ($r = 0.781$). A total of 235 Actinomycete strains were isolated from these four sites and tested for their ability to grow on a synthetic minimum medium (SMM) containing insoluble natural rock phosphate (RP) as unique P source. 143 isolates (60.8%) were able to grow in SMM medium with RP, suggesting that they were able to use the P trapped in the RP for their own growth. 25 isolates

(17%) were the most active growth using the SMM containing a synthetic tricalcium phosphate (TCP) as sole P source. Nine of these isolates were selected for their P solubilization abilities in liquid SMM cultures. The highest amount of P solubilized was 163.8 $\mu\text{g/mL}$ for RP and 110.27 $\mu\text{g/mL}$ for TCP with no pH acidification. The primarily P solubilization mechanisms involved the implication of siderophores production by the selected strains. Eight of these strains were shown to belong to the genus *Streptomyces* and one, to the genus *Promicromonospora*. These results strengthen the ability of Actinomycetes to solubilize insoluble P forms essential mineral which can satisfy plant and nutrition needs. The selection of the most effective Actinomycetes could be an advantageous biofertilization method for a marketable product.

Keywords: Actinomycetes, isolation, screening, phosphate solubilization, Moroccan oat soils, Biofertilizers

Etude de la revalorisation de sols appauvris via biofertilisation et réutilisation des eaux usées épurées

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CC-18

L'appauvrissement du sol des terres agricoles irriguées suite à l'augmentation de la salinité qui est due principalement à l'utilisation excessive des engrais et à la surexploitation des réserves en eaux souterraines se pose de nos jours avec acuité dans plusieurs régions du royaume.

Garantir la rentabilité et la qualité de la production doit s'appuyer sur la base d'un développement durable en tenant compte le changement climatique et l'impact sur l'environnement. C'est dans cette optique que s'inscrit l'objectif de notre étude et qui se focalise sur la biofertilisation du sol.

L'étude traite conjointement trois aspects principaux. Le premier étant une prospection de terrains dans la zone du Grand Agadir et un échantillonnage de sols appuyés par des analyses détaillées concernant les caractéristiques structurales et physico-chimiques ainsi que la fraction organique et biologique dont principalement les bactéries fixatrices d'azote. Les données recueillis *in situ* indiquent une légèreté marquante du sol, la profondeur ne présente pas de grande variation et des formations calcaire du jurassique. Les résultats au niveau laboratoire indiquent une texture généralement sableuse, le pH s'affiche entre 7,5 et 8,1 et la fraction minérale présente quelques variations. La teneur en matière organique est généralement faible et l'étude de la fraction biologique est en cours.

Le deuxième volet couvre la possibilité d'introduire une variété végétale fourragère autochtone en vue d'une part sa valori-

sation, et d'autre part pour un remplacement de la luzerne dont les exigences hydriques sont très importantes.

Trois plantes annuelles à graines ont été choisies : *Medicago polymorpha* prise comme témoin, *Lupinus cosentinii* et *Lupinus luteus*. Le test de germination a été mené en premier lieu en sol en semi-direct dans une station expérimentale. Aucun résultat n'a été obtenu pour la deuxième espèce. Afin d'écarter toute hypothèse, le test a été repris pour évaluer la capacité de germination des graines en laboratoire. Le test a été menée sans scarification en incubation sur boîtes de pétri contenant de l'eau gélosée. Les résultats ont montré un bon pourcentage de germination pour *Medicago polymorpha* et 100 % de germination pour *Lupinus luteus*. Alors que pour *Lupinus cosentinii*, le pourcentage de germination était très faible. Le test a été encore reconduit pour les semences de l'année suivante, les résultats n'ont pas aboutit à une amélioration. Le choix s'est finalement porté sur *Lupinus luteus*.

Le dernier aspect et qui est en cours de réalisation s'inscrit dans un cadre de développement durable et couvre la réutilisation des eaux usées épurées pour l'arrosage selon les exigences de l'espèce végétale utilisée et en respect des normes nationales établies pour l'irrigation.

Mots-clés : Biofertilisation – Réhabilitation – Sols marginaux – Symbiose – Eaux usées épurées

Combined use of mycorrhizae and green compost for reducing the deleterious effects of salt stress in two genotypes of quinoa (*Chenopodium quinoa*)

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CC-19

Quinoa (*Chenopodium quinoa* Wild) is a nutritious seed crop with a great potential to grow in saline soils. Although it is highly resistant to salinity, the repeated and excessive use of chemical fertilizers has harmful effects on soil microorganisms, which affects soil fertility and limits the production of this crop. In this context, the present work aims at assessing the effect of two different organic fertilizers arbuscular mycorrhizal fungi (AMF), and/or compost. To meet this objective, we carried out a greenhouse experiment to study the impacts of these biofertilizers on growth, physiological and biochemical parameters of two varieties of quinoa grown under salt stress (0, 150, and 300 mM). The results showed that salt stress had a negative effect on growth, physiological and biochemical parameters.

However, biofertilizers, used alone or in combination, increased these traits in the presence or absence of stress. The bipartite combination AMF+Comp efficiently increased yield, growth, stomatal conductance, photosystem II efficiency, photosynthetic pigments (chlorophyll and carotenoids), protein and sugar of both quinoa varieties compared to the other treatments and to the control. Therefore, the results of this study suggest that the use of AMF and compost and especially their combination could be a good strategy to improve the productivity of plants under these unfavorable conditions.

Keywords: Compost, Arbuscular mycorrhizal fungi, salt stress, tolerance, *Chenopodium quinoa*.

Beneficial effect of organic liquid fertilizer on growth and mineral status of some olive seedling cultivars

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CC-20

This study was carried out in shade house of National Research Center, Dokki, Giza government, Egypt on the olive seedlings of Picual, Manzanillo, Koratina, Koroneiki and Meraki cultivars to study the influence of three time of application of pigeon manure tea (15, 30 and 45 days) as liquid organic fertilizer. In general, the application of pigeon manure tea as soil application every 45 days gave the best results for increasing most studied vegetative growth parameters such as plant height, shoots number, trunk diameter, Shoot fresh and dry weight, root numbers, length, root fresh and dry weight. From the other hand, the application of pigeon manure tea as soil application every 30 days gave the maximum nitrogen, potassium and phospho-

rus contents in leaf seedlings comparing with untreated olive seedling cultivars.

Key words: olive, seedling, "Picual", "Manzanillo", "Koratina", "Koroneiki" and "Meraki", pigeon manure tea, liquid organic fertilizer, growth parameters, root parameters, leave mineral content.

Physicochemical and nutritional quality analysis of Chickpea (*Cicer Arietinum L.*) varieties Grown in Morocco

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CO-21

Chickpea (*Cicer arietinum L.*) is an important legume food crop in many developing countries, and there are substantial research programmes to improve its disease resistance, its agronomic, physicochemical and nutritional quality. It provides quality protein, basic mineral elements such as iron and zinc and interesting dietary fiber with low fat and glycemic index (Williams and U. Singh, 1987). In Morocco, chickpea is the second major food legume after faba bean.

Seven varieties of chickpeas grown in Morocco (Arifi, Douyet, Farihane, Moubarak, Rizki, Zahor and Garbonzo) were the subject of this study. For physicochemical characterization, the size and the color of the grains were determined by a GrainScan software method. Hydration capacity of seed was deduced from the equations of Williams et al. (1983). For the determination of minerals, we proceeded to an acid digestion followed by an analysis by inductively coupled plasma-optical emission spectroscopy (ICP-OES). The protein content was measured by a modified Kjeldahl method.

The physicochemical characterization of the seeds revealed

highly significant variations within the collection concerning seed size and color. The hydration capacity of the seeds varied considerably (0.347-0.693 g seed⁻¹), with an average value of 0,408 g seed⁻¹. With regard to Concentration of protein, it varied from 23.27% (Rizki) to 28.60% (Garbonzo) among chickpea varieties. For iron and zinc, the contents varied respectively between minima 48.22mg/Kg and 36.97mg/Kg; and maxima 66.06mg/Kg and 70.90mg/Kg. Nine other minerals (Se, P, Mn, K, Ni, Cu, Ca, Ba, Mg) were also measured. Note that the highest iron content was recorded in the Moubarak variety. However, the Garbonzo variety had the highest levels of zinc, potassium and phosphorus. Correlations between the different parameters studied were also made to show out the different associations.

These results can be useful to select varieties with good physicochemical characteristics and higher protein and micronutrients content for their use in the food industry for better feeding.

Keywords: Chickpea; size; color; mineral; nutritional quality; protein.

The potential use of bacteria isolated from the earthworms *Apporectodea molleri* to promote spinach (*Spinacia oleracia*) growth under heavy metals stress

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CO-22

Heavy metals soil contamination became a serious environmental problem that occurred mainly through the high metal wastes disposal and excessive application of fertilizers in agriculture. Phytoremediation is one of the promising methods used in decontamination since it is cost-effective and environmentally friendly. when assisted by bioaugmentation – using plant growth promoting (PGP) bacteria – propitious results are observed since it alleviates heavy metal stress while promoting plant growth. In the present study, we investigate plant growth promotion traits of five bacterial isolates from the earthworm *Apporectodea molleri* and their resistance to heavy metals (Mn, Zn, Cu, Cd and Ni). Further, we studied their potential use in the presence of spinach plant as bioremediation agents in soil artificially contaminated with heavy metals mixture (100 mg/kg Ni, 150 mg/kg Cd, 150 mg/kg Cu, 300 mg/kg Zn and 600 mg/Kg Mn). The five strains (*Bacillus circulans* TC7, *B. subtilis* TC34, *Bacillus* sp. TC4, *Terribacillus* sp. TC45 and *Pseudomonas* sp. TC33) were isolated from the chloragogenous tissue of *Apporectodea molleri*. They were all siderophores producers, phosphate and potassium solubilizers and had the ability to fix atmospheric nitrogen in liquid media,

furthermore, two strains were able to produce IAA in the range of 30 µg.mL⁻¹. The selected isolates tolerated the tested heavy metals at different ranges. Maximum Inhibitory Concentration MIC for manganese varied between 70 and 90 mM and for Zinc between 2.5 and 5.5 mM. For Copper and Cadmium, strains tolerated them in the range of 0.5 to 1.3 mM while for Nickel in the range of 0.5 and 0.6 mM. Their application as bioaugmentation agents to assist the phytoremediation of heavy metals contaminated soil using spinach plant promotes the plant growth by 10-folds compared to the control. In addition, the bacterial isolates had beneficial effect in enhancing chlorophyll content, soil phosphatase and urease, total carbon, bacterial community as well as soil chemical properties and heavy metals mobility compared to the control with spinach in the absence of bacteria. The obtained results illustrate the high potential of the isolates which make them interesting bioaugmentation candidates for future field applications.

Keywords: Earthworms – PGP bacteria – bioaugmentation – phytoremediation – heavy metals – soil contamination.

Effect of rock phosphate soil application and nutrients solubilizing bacteria on yield and fruit quality of olive trees cv. "Picual" under the arid zone

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CO-23

Natural rocks are safe and favour instates to mineral fertilizers and is considered as important source of slowly release fertilization to the plant throughout the growing season. The speed facilitating of the elements from these rocks increases by applying the appropriate solubilizing bacteria that percolates these rocks to provide the elements gradually to the plants. The objective of this study was to use different amounts of rock phosphate (1, 2 or 3 kg/tree) with different time of additions (2 or 3 times) for phosphorous and sulfur release bacteria to form 6 treatments beside the control (untreated trees) on vegetative growth, leaf mineral contents, yield and fruit quality of Picual olive trees grown in sandy soil, under drip irrigation system during two seasons.

The results showed that application of 2 or 3 kg of rock phosphate per tree with phosphorous and sulfur release bacteria for three times increased no. leaves/shoot and shoot length. In addition, the soil application of 2 or 3 kg rock phosphate per tree for three times of P and S release bacteria gave the highest yield (kg/tree) and improves fruit quality. Generally, the treatment of 2 kg rock phosphate per tree for three times of P and S release bacteria is recommended due to its clear effect among all treatments on the abovementioned parameters.

Key words: Rock phosphate - P release bacteria – S release bacteria – Olive –Yield – Fruit quality

"Bayoud" disease caused by *Fusarium oxysporum* f. sp. albedinis, a serious constraint for date palm (*Phoenix dactylifera*) industry development in Morocco

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CO-24

Date palm (*Phoenix dactylifera*) is an important food and commercial perennial crop in the Sahara and North Africa. A vascular wilt disease, popularly known as "Bayoud", incited by the soilborne fungus *Fusarium oxysporum* f. sp. albedinis has been taking its toll in date palm-growing regions in Morocco and Algeria. Since it first appeared in Morocco in the late 19th century, the disease has spread to the entire Morocco and extended to the western half of Algerian Sahara. The first attempts to control the disease consisted of using systemic fungicides which did not give satisfactory results. In Morocco, date palm groves harbor a tremendous genetic variability that has served for mass selection of many cultivars allying resistance and good fruit quality cultivars. However, some of the elite-but-sensitive industrial cultivars, notably "Medjool", are highly appreciated by growers and their cultivation requires an integrated management. The discovery of soils that are suppressive to the disease and the isolation of

many antagonists has opened new perspectives for the use of these antagonists as biocontrol agents, combined with soil solarization and fumigation, and soil amendment. Preliminary results indicate that soil solarization and fumigation in combination have the potential to disinfest soils and create an empty niche likely to be filled with biocontrol agents supported by soil amendments to protect date palm from the pathogen. New high throughput sequencing technologies have allowed genome characterization of the causal agent and offer great opportunities for the understanding of molecular underpinnings that govern host-pathogen interactions. This opens novel research paths for rapid selection of new genetically resistant cultivars.

Key words: Date palm, Bayoud disease, Mass selection, Biocontrol

Combination of native arbuscular mycorrhizal fungi, and/or green compost enhance salinity tolerance in alfalfa (*Medicago sativa*)

CO-25

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Salinity is one of the devastating abiotic stresses that cause reductions in crop production. Increased salinization negatively affects alfalfa growth and metabolism. This study was undertaken to examine the efficacy of green compost (C; made from green waste) and arbuscular mycorrhizal fungi (M; native consortium from the field) individually or in combination as an effective strategy to improve alfalfa productivity under non-saline and high-saline (120 mM NaCl) conditions. In addition, we sought to understand the agro-physiological and metabolic basis and soil glomalin content of biofertilizer-induced salt tolerance in alfalfa. Here, we show that mycorrhizal infection was enhanced after M inoculation, while C application significantly reduced it.

Salinity reduced growth, physiological functioning and protein concentration, but the antioxidant system was activated. Application of selected biofertilizers, especially C alone or combined with M improved alfalfa tolerance. CM bi-combination mitigated the negative effects of high salinity by stimulating plant growth, root and nodule dry matter, mineral (P, N, and K) uptake, antioxidant system, compatible solute synthesis, and soil glomalin content, photosynthesis and decreasing Na⁺ and Cl accumulation, lipid peroxidation, H₂O₂ content, and electrolyte leakage.

Keywords: Antioxidant status; autochthonous biofertilizers; by-product; microbiome; nutrient uptake; salt-tolerance mechanisms

Investigation in silico de l'activité bioinsecticide des métabolites secondaires d'actinomycètes contre l'insecte ravageur des légumineuses *Acyrtosiphon pisum*

CO-26

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Acyrtosiphon pisum ou puceron du pois est un insecte ravageur de la famille des aphididés, qui s'attaque à différentes espèces de légumineuses comme le haricot et le pois. En parasitant ces plantes, il transmet un virus responsable de la maladie de la mosaïque du pois. Ce ravageur provoque des pertes de récolte économiquement lourdes dans le monde entier. L'utilisation d'insecticides conventionnels chimiques est le seul moyen pour contrôler le développement de ce ravageur. Cependant, les conséquences néfastes de ces produits chimiques sont bien connues, où ils polluent les différents compartiments de l'environnement, constituant ainsi un risque majeur pour la santé humaine et environnementale. La recherche d'une alternative plus écologique, respectueuse de l'environnement est donc une nécessité. Les actinomycètes représentent une source de métabolites secondaires biologiquement actifs comme les antibiotiques et les agents biopesticides. Dans cette étude 100 métabolites secondaires d'actinomycètes ont fait l'objet d'une recherche in-silico par docking moléculaire, en criblant leurs potentiels inhibiteurs contre l'enzyme acétylcholinestérase (AceE) de *A. pisum*. La structure 3D de l'enzyme AceE indisponible dans la base de données

PDB a d'abord été modélisée en utilisant le programme Modeller, puis la qualité stéréochimique du modèle a été validée. L'amarrage moléculaire réalisé par l'algorithme d'Autodock Vina a permis la sélection de cinq métabolites donnant une énergie de liaison proche ou inférieure à celle de l'inhibiteur co-cristallisé du meilleur template homologue trouvé par BLASTp. Les top cinq métabolites sont : la Diazepinomicine (-10,9Kcal/mol), Hygromycine (-10,3Kcal/mol), Lomofungine (-9,5Kcal/mol), Anthraquinone (-9,4Kcal/mol) et la Resistomycine (9,4Kcal/mol). Ces composants ont montré de nombreuses interactions avec les résidus clés du site catalytique de l'enzyme AceE, indiquant leur potentiel inhibiteur de son activité biologique. La sécurité environnementale et sanitaire de ces composants ainsi que leur biodisponibilité ont également été étudiés par la vérification de plusieurs critères pharmacocinétiques et ADMET, suggérant l'intérêt de ces composants comme de potentiels agents bioinsecticides contre le ravageur *A. pisum*.

Mots clés : biocontrôle, bioinsecticide, *Acyrtosiphon pisum*, Actinomycètes, docking moléculaire.

Efficacité des huiles essentielles de *Citrus aurantium* pour lutter contre *Callosobruchus maculatus* (f.) (Coleoptera, bruchidae)

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CO-27

Pendant leur stockage, les graines des légumineuses subissent des pertes considérables par plusieurs ravageurs, principalement *Callosobruchus maculatus*. Au Maroc, les pesticides de synthèse restent le moyen le plus utilisé pour la protection des denrées stockées. Ils engendrent des effets néfastes sur l'Homme et l'environnement, en plus des phénomènes de résistance chez les ravageurs.

Dans la perspective d'élaborer une nouvelle approche de protection des légumineuses contre *C. maculatus*, les huiles essentielles de *Citrus aurantium* appliquées au laboratoire sous des conditions contrôlées (27°C, 70 ±5% d'humidité relative et 12h de lumière) ont été testées contre *C. maculatus* élevé aux dépens des graines du pois chiche à raison de 100 ; 150 ; 250 et 300 µl. Pour chaque concentration, 10 couples de la bruche ont été libérés sur 50 graines traitées. Dans les mêmes conditions, des lots de graines non traitées ont été utilisés comme témoins. Ces huiles ont été analysées par la CPG-SM, le composé majoritaire est le limonène (86,18%). La

mortalité journalière des bruches, les œufs pondus, éclos et non éclos émis sur les graines, les adultes émergés ont été recensés. Les huiles essentielles de *C. aurantium* exercent des effets négatifs sur la bruche, ils affectent la longévité, (lots traités = 2-7j < témoin = 2-13j), la fécondité (lots traités = 241 à 143 œufs/10 femelles < Témoin = 437-491 œufs/10femelles), la fertilité (lots traités = 40,69-76.24% < Témoin = 93,75- 95,44%) et le taux du succès de la bruche (lots traités = 17,48-58.42% < Témoin = 86,35- 92,33%). Les CL50 et CL99 (1 à 5jours) vont respectivement de 220,99 à 50,87 µl/l d'air et 548,91 à 103,43 µl/l d'air pour les femelles et 257,38 µl/l à 54,21 et 605,98 à 109,76µl/l d'air pour les mâles. Les huiles essentielles du bigaradier peuvent être utilisées en gestion intégrée des ravageurs des denrées entreposées sans risques sanitaires ni environnementaux.

Mots clés : Légumineuses stockées ; *Callosobruchus maculatus* ; Huiles essentielles ; fumigation ; *Citrus aurantium*.

Use of Oyster shell ash of *Crassostrea* spp. in mass production of sanitized seedlings of *Colocasia esculenta* L. Schott by the PIF method and influence of some fertilizers during their growth in acclimation

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CO-28

The scarcity of *Colocasia esculenta* L. Schott seeds available to cover the needs of farmers is attributed to the attacks of *Phytophthora colocasiae* Racib., a causal agent of taro blight. The direct impact of this pathogen is the lack of tubers for consumption and the near disappearance of monoculture taro plantations. To solve this problem, the objective of this work was to mass produce sanitized seedlings of two cultivars of *C. esculenta* by the PIF method and to evaluate the influence of some fertilizers on the growth of these PIF plants during acclimatization. For this purpose, two cultivars (Makoumba and Ehkwan'frè) of *C. esculenta* were used. For each cultivar, 60 corm fragments with a mass of 500g were grown in propagators (in the absence and presence oyster shell ash of *Crassostrea* spp.). Analysis of agronomic parameters was done during the two months of culture in the propagators. Weaning's of PIF plants were performed at the end of each month. During acclimation, five treatments were applied (Control, arbuscular mycorrhizal fungi, Tithonia diversifolia leaf powder, Oyster shell ash, and dried cow dung). Their influence was evaluated on the growth during three months

and significant differences were identified by ANOVA via the Student Newman and Keuls test at 5%. The results obtained showed that the average number of buds emitted/corm was more significant in the presence of oyster shell ash. From the 120 corm fragments used, a total of 599 PIF plants were produced, 246 and 353 PIF plants for the cultivars of Makoumba and Ehkwan'frè respectively. The maximum number of weaned PIF plants was recorded in the presence of oyster shell ash. The average size of these plants varied significantly in the propagators depending on the growth substrates. In acclimation, principal component analyses performed showed a positive correlation between mean leaf number and mean leaf area in plants inoculated with AMFs at the third month of culture. Oyster shell ash propagator amendment stimulated the production of PIF Plants. The PIF technique used boosted seed production 4.99 times from the 120 corm fragments used.

Keywords: *Colocasia esculenta* L. Schott, Oyster shell ash, PIF methods, Seed plants, acclimation, fertilization.

Application of arbuscular mycorrhizal fungi in the production of minitubers: a new approach to produce sanitized seeds of *Xanthosomasagittifolium* L. Schott

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CO-29

The general objective of this work is to evaluate the effect of mycorrhizal biofertilizers on the development and production of minitubers in *X. sagittifolium* to be used as sanitized seeds. Vitroplants of *X. sagittifolium* aged of 45 days were acclimated for one month and then mycorrhized. Four species of arbuscular mycorrhizal fungi (AMF) (*Glomus intraradices*, *Acaulospora tuberculata*, *Gigaspora margarita* and *Glomus* sp.) from the IRAD collection were used. Their effects were monitored for 180 days and data collected every 60 days. The results obtained showed that the presence of AMF stimulates the growth of the plant and the production of minitubers. Agronomically, the treatment of plants leads to an increase in the number of roots in treated plants compared to controls. A peak of growth is observed at 120 days. It's about 12 and 15 respectively in the control and in the treated plants. The leaf area also increases from 34 to 43.16 cm², the average plant size from 25 to 43 cm, respectively in controls and inoculated plants. Cytological analyzes show endophytic structures characteristic of endomycorrhizae such as arbuscular and branched

pedicels (specific structure of Acaulosporaceae). In all treatments, mycorrhizal intensity, arbuscular content and mycorrhizal dependence were low and less than 50%. This indicates that the minituberization in *X. sagittifolium* does not depend only on the presence of the AMFs, but rather is stimulated by them. The results show that in the presence of AMF, the number of minitubers produced is three times higher compared to controls. The best percentage of tuberization (80%) is obtained with a mixture of the four strains of AMF. These minitubers keep 50% of their germinative supply after two months of storage at a temperature of 7 ~ 10 ° C. In general, this work indicated, that the mixture of the four AMF strains has a higher effect and therefore may constitute a potential biofertilizers in the production of sanitized seeds of *X. sagittifolium*.

Key words: *Xanthosoma sagittifolium* L. Schott, arbuscular mycorrhizal fungi, minituberization, metabolites and germination test.

Microbial diversity in soils enriched in rock phosphate ores

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CO-30

Among the large diversity of phosphate fertilizers, rock phosphate (RP) is recognized as an efficient eco-friendly product for a more sustainable agriculture. Concomitantly, the root microbiome is identified as a key compound for plant growth by assisting notably nutrient uptake, and as a critical driver of soil processes, notably P-cycling. However, the interactions between RP and the overall plant-associated microbial communities is poorly known, despite a deeper understanding of these could be relevant for designing microbial inoculum, providing agronomic recommendations about P fertilization and managing P dynamics in soils. In this context, we investigated native bacterial and fungal communities across different sites, formerly disturbed by mining inputs of excavated raw RP ores, then abandoned and subjected to gradual natural whole-ecosystem restoration for over a century, without anthropogenic disturbance until today. Analysis of the soil physicochemical properties was performed and microbial communities were profiled after MiSeq sequencing of 16S rRNA gene and internal transcribed spacer sequences. Clear differences in soil properties were noticed, especially in total and available P, reaching up to 13 927.9 and 339.46 mg/kg soil, respectively. In such P-rich soils, root colonization by arbus-

cular mycorrhizal fungi (vesicular and arbuscular forms) was quantified and percentages of colonization ranged from more 40% to 70% depending on the site, with a mean percentage of 59%. In addition, analysis of the amplicon sequence variants (ASV) dataset showed that, for the highest microbial taxon ranks, comparable patterns in terms of prevailing taxon identity were displayed by the microbial communities, regardless of whether the soils were affected by the past RP input event and regardless of soil P concentration. Thus, *Ascomycota* and *Actinobacteriota* were prevalent phyla in all sampled soils, as well as *Proteobacteria* and *Basidiomycota* to a lesser extent. Besides, distinct microbial taxonomic distributions were observed between root and rhizospheric compartments; notably Actinobacteriota, Acidobacteriota, alpha-Proteobacteria, Basidiomycota and Ascomycota were increased in soils compared to roots, while Bacteroidota are increased in root-compartment. In opposite, inputs of RP did not result in discernible differences in taxa abundance, at the highest microbial taxa ranks. But occurrence of indicator species of soils with RP inputs was highlighted for the both microbial kingdoms.

Keywords: Rock phosphate, mining inputs, metagenomics, microbial communities, taxonomic diversity.

Étude de la toxicité des extraits de quelques plantes spontanées contre la cochenille du figuier de Barbarie *Dactylopius opuntiae* (Cockerell) (Hemiptera : Dactylopiidae) en conditions semi-naturelles

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CC-31

Le figuier de barbarie est une culture particulièrement sujette aux fortes attaques de *Dactylopius opuntiae* qui est considérée comme l'un des défis majeurs de cette culture, son impact et ses dégâts directs et indirects augmentent d'une année à l'autre à cause de sa capacité de reproduire rapidement. La lutte par des biopesticides attire l'attention des chercheurs à l'heure actuelle, surtout par l'utilisation des plantes à fort pouvoir insecticide et qui existe d'une manière abondante dans notre pays. Cette étude vise à trouver une méthode de lutte biologique en utilisant de extraits de quelques plantes : le latex d'*Euphorbia officinarum*, les extraits éthalonique des plantes : *Nerium oleander*, *Thymus vulgaris*, et *Nicotiana glauca*, et le temoine d-Limonène. Pour chaque extrait, les concentrations de 16%, 8%, 4%, 2% et 1% et 0% ont été préparées pour les tests biologiques en conditions semi-naturelles qu'on a effectué au niveau de la serre experimental en filet anti-thrips pour empêcher la réinfectataion. L'essai a révélé des résultats très importants. En effet, l'ensemble des extraits des plantes utilisés ont eu un effet insecticide qui est en rapport

avec la concentration et le temps d'observation. La mortalité la plus forte a été notée pour le témoin d-limonène 100% après 72h de l'application en réponse à une concentration de 80000ppm. Les extraits de *Nicotiana glauca* et *Euphorbia officinarum* ont aussi montré une activité insecticide considérable de 89% et 80% respectivement en réponse à une concentration de (160 000 ppm). Les deux autres extraits de plantes ont également provoqué un effet insecticide. En effet, des taux mortalités de l'ordre de 59% et 55% ont été, respectivement, observées pour la concentration la plus élevée 16% (160 000ppm) 120 heures après l'application du traitement par l'extrait de *Nerium oleander* et l'extrait de *Thymus vulgaris*. Ce travail propose une alternative à l'utilisation des pesticides conventionnels et par conséquent, éviter le problème de résistance, et limiter les effets néfastes des pesticides sur l'environnement et la santé humaine ainsi que la faune auxiliaire.

Mots clés : Figuier de barbarie, *Dactylopius opuntiae*, Biopesticide, Lutte biologique, Plante spontanée.

Combination vermicompost and nano-fertilizer applications and its impact on growth performance of strawberry

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CC-32

Strawberry is one the economic crops for Egypt. There is potentially to improve growth and quality of this crop by applying vermicompost combined with nano-fertilizer.

Current work carried out in National research Centers Farm, Northern Egypt, under greenhouse condition to estimate the impact of two types of vermicompost at different doses combined with nano-fertilizers on strawberry plants (2019/2020), as well as soil health. Strawberry seedlings were divided into 9 groups according to treatments. At the end of each growth season, different parameters were measured in this context concern plant growth performance, nutrient content, fruit quality and soil health.

Obtained results show that their positive impact of combining vermicompost and nano-fertilizer on fresh and dry weight of leaves; nutrient contents, fruit quality, soil health and (T₈) surpassed all studied treatments in its impact on

the most of studied parameters. T₄ resulted in the highest leaf N content. T₆ was recorded the highest value of fruit acidity and T₁ produced the highest value sugar content and VC. T₄ led to increasing anthocyanin in fruit comparing with other treatments. Also, T₅ produced the highest value of P content in soil and T₂ resulted in increasing Ca in soil than other treatments. Meanwhile, T₁ surpassed all treatments in its impact on microbial activity.

Keywords: strawberry, vermicompost, nano-fertilizer, soil heath, fruit quality.

Role of nitrogen fixing bacteria nodulating lentil based on their Plant Growth Promoting Activities and abiotic stress tolerance

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CO-33

The role of Rhizobia in agriculture has been widely studied. This particular interest is due to their capacity to fix atmospheric nitrogen when they are in symbiotic association with legumes. However, their activities stimulating the growth of non-leguminous plants are less studied.

The present work consists of evaluating the plant growth promotion activity in eighteen Rhizobium strains nodulating lentil.

The activities sought are the solubilization of inorganic phosphate, the production of indole acetic acid (AIA), as phytohormone on YMA medium supplemented with L-Tryptophan as well as testing the strains ability to grow under some abiotic stress specifically drought and salt stress.

According to the obtained results, six strains expressed

their capacities to dissolve inorganic phosphate. The highest solubilization index (2.29) was recorded by the strain AN32.

Furthermore, the production of indole acetic acid (IAA) was observed in the majority of the studied strains. According to the quantitative evaluation, the strain N5 showed the best production of IAA with a maximum value of 56.42µg / ml. In addition, under different PEG concentration, it was observed that the strain CIAT is the most drought tolerant, however, the strains were clearly affected by NaCl concentrations added to the medium.

Key words: Rhizobium-Lentil; PGPR; Phosphate Solubilisation; Indole acetic acid, abiotic stress.

Diversity and community analysis of plant parasitic nematodes associated with citrus in Marrakech-safi region of Morocco

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CO-34

Backed by real assets including its Mediterranean climate, fertile soils, effective agricultural reform programs, and its geographic location, Morocco ranks among the top ten citrus producer countries worldwide. These strong assets offer several advantages, such as early fruiting and long harvest season, good quality and low-cost production, and closeness of export markets. However, the citrus sector is facing several constraints which hump its development. Indeed, the spread of phytoparasitic nematodes has had negatively impacted on the citrus quality and yield. The main objective of this paper is to identify the key harmful nematodes to the Moroccan citrus crops and to highlight the appropriate methods to manage them. A survey was carried out during the year 2020 to assess the diversity and community structure of phytoparasitic nematodes in the citrus regions of Marrakech-Safi. Fifteen nematode genera and species were identified from soil and root samples. The most common plant-parasitic nematodes (PPN) species

were *Tylenchulus semipenetrans*, *Pratylenchus* spp., *Helicotylenchus* spp., *Tylenchus* spp. and *Xiphinema* spp. in terms of abundance and frequency, the nematode *Tylenchulus semipenetrans* associated with die-back of citrus was highly abundant (61,6%) followed by the spiral nematode *Helicotylenchus* spp. (60%), *Tylenchus* spp. (51,6), *Xiphinema* spp. (30%) and the root-knot nematodes *Meloidogyne* spp. (23,33%). Other nematodes were also identified including: *Hoplolaimus indicus*, *Longidorus* spp., *Xiphinema americanum*, *Trichodorus* spp., *Criconemoides*, *Hemicycliophora* spp. This description of plant-parasitic nematodes associated with citrus fields in Marrakech-Safi region provided a starting point from which further studies have been implemented in the other citrus regions of Morocco with the overall aim of developing effective management strategies.

Keywords: Citrus, nematodes, diversity, community analysis.

Legume nodules in soils with low phosphorus availability: Mechanisms and adaptation strategies

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CO-35

Common bean (*Phaseolus vulgaris* L.) is an excellent protein and mineral source for human consumption. Likewise, this legume, through symbiosis with rhizobia, incorporates atmospheric dinitrogen (N₂) into the food chain. Unfortunately, these properties are seriously affected when common bean plants grow on soils with low phosphate levels. Hence, in order to design strategies to develop elite cultivars able to produce high quality seeds and efficiently fix N₂ under phosphorus (P) deficiency, it is important to understand how common bean copes with this nutritional constraint. Over the two past decades, significant progress has been made in understanding the genetic

and metabolic responses of common bean. In this study, we summarize and discuss recent advances in the understanding of the strategies that nodulating common bean use to cope with P-deficiency. We also discuss future directions and research priorities that may lead to a better understanding of the physiological and molecular adaptations that allow common bean to thrive under conditions of P-deficiency.

Keywords: Legumes, N₂ fixation, common bean, phosphorus deficiency, abiotic constraints.

Date seeds (*Phoenix dactylifera* L.) an excellent source of antibacterial and antifungal molecules

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CO-36

Date seeds (*Phoenix dactylifera* L.) are a valuable lignocellulosic source for functional and bioactive molecules; they are traditionally used in folk Moroccan remedies. The aim of our work is to study the microbial effects of date seeds crude extracts (aqueous and alcoholic) against pathogenic bacteria (*Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*) and fungus (*Botrytis cinerea* and *Fusarium oxysporum*). Alcoholic extracts (Acetone, methanol and ethanol) presented the remarkable sensitivity of tested bacteria while aqueous extracts did not indicate inhibition of the microbial growth. In contrast, Acetonic extract exerted significant effect recorded a highest inhibition zone (11.75±0.12 – 21.68±0.45 mm) and the lowest MIC (0.78 - 3.13 mg/mL) followed by methanolic extract which MIC value varied between 0.78 - 6.25 mg/mL and ethanolic extract that recorded MIC value changed between 1.56 to 6.25 mg/mL. Moreover, the antifungal activity results have shown that

acetonic extracts exercised a high growth inhibition against *Botrytis cinerea* and *Fusarium oxysporum* with an inhibition of 87.73% ± 2.23 and 63.35±3.16. HPLC analysis revealed that tested date seeds powder contains several phenolic compounds (Caffeic acid, Chlorogenic acid, Vanillic acid and Protocatechuic acid) those last was exerted an antibacterial effect against the tested bacteria except Chlorogenic acid. Nevertheless, Vanillic acid was found to have an effective effect to inhibit the microbial growth a highest inhibition zone (10.08±0.12 - 18.97±0.19 mm) followed by Caffeic acid (8.10±0.05 - 13.40±0.61 mm) and Protocatechuic acid (7.92±0.16 - 13.05±0.02 mm). Date seeds possess antimicrobial activity, and therefore Date seeds could be effectively used as a natural source to make bioproducts with high significant value for human health.

Keywords: Date seeds (*Phoenix dactylifera* L.), antimicrobial activity, date seeds extracts, MIC, phenolic compounds.

Recherche des bactéries rhizosphériques à fort potentiel pesticide contre les principaux champignons pathogènes de la culture de Tomate

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CC-37

L'objectif de cette étude est l'isolement des bactéries à partir de la rhizosphère de la culture de tomate dans la région Souss pour les utiliser dans la lutte biologique contre les maladies cryptogamiques les plus importantes dans la région ; à savoir Botrytis, Alternariose, Oïdium et Mildiou. Des souches bactériennes d'un nombre de 93 ont été isolées par la méthode de la suspension-dilution sur le milieu de culture gélose nutritive (GN) ; dont 52 souches sont rhizosphériques (RS), 10 souches sont endorhizosphériques (ES) et 31 souches sont isolées du rhizoplan (RP). Les agents pathogènes *Botrytis cinerea* et *Alternaria alternata* ont été isolés à partir des plantes de tomate infectées, de la même région, selon la méthode standard sur le milieu de culture gélose dextrose de pomme de terre (PDA) alors que les champignons *Oïdium lycopersici* et *Phytophthora infestans*, en tant que parasites obligatoires, ont été isolés selon deux méthodes ; une sur les tranches de pomme de terre et l'autre sur les cotylédons. L'étude de l'effet antagoniste des isolats bactériens vis-à-vis du *Botrytis cinerea* (B.c) par la technique de la double culture, a permis la sélection de 46 souches bactériennes dont la zone d'inhibition

est supérieure à 10%. Ces dernières ont été testées aussi par la même technique sur les trois autres champignons : *Alternaria alternata* (A.a), *Oïdium lycopersici* (O.l) et *Phytophthora infestans* (P.i). Cependant, uniquement 12 isolats ont présenté une zone d'inhibition supérieure à 10% pour les trois champignons en question. Parmi ces 12 isolats, cinq ont eu un potentiel pesticide contre les quatre champignons et qui sont RS45, RS61, RS65, RP6 et RS60. Un effet de l'ordre de 80% a été observé chez la souche RS60 sur B.c et la souche RS65 sur P.i. L'identification génétique des 5 souches a révélé qu'il s'agit de *Paenibacillus polymyxa* DSM740DSM et *Bacillus cereus* 994000168LBK isolées de la rhizosphère ; *Bacillus subtilis* DSM5552DSM isolée du rhizoplan et *Bacillus amyloliquefaciens*-ssp-*plantarum* CICC23985-bCICC isolée des deux zones rhizosphère et rhizoplan. Les souches RS60 et RS65 sont en cours d'identification génétique (séquençage par PCR). Les autres isolats, qui ont montré un fort potentiel contre un seul ou deux champignons sont aussi identifiés.

Mots-clés : Tomate, maladies cryptogamiques, lutte biologique, Bactéries.

Isolation and characterization of phosphate solubilizing bacteria from the rhizosphere of barley and alfalfa in the region Marrakech-Safi

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CC-38

Plant growth promoting rhizobacteria (PGPR) have the ability to solubilize insoluble phosphorus to make it available for plant roots to be absorbed, is considered as an eco-friendly and cost-effective strategy to improve crop production under adverse environmental conditions. In the present study, 16 phosphate solubilizing bacteria (PSB) were isolated from barley and alfalfa rhizosphere grown in mono-culture and in association from two agricultural sites located in the Marrakech-Safi region, Morocco. Selected isolates were also evaluated for other plant growth promoting (PGP) functions including indole acetic acid production, siderophore, ammonia, hydrogen cyanide production and potassium and zinc solubilization. Out of 16 strains, 7 isolates were shown salt tolerance capacity up to 1 M and 5 isolates were shown

maximum tolerance for polyethylene glycol concentration (40 g/100 ml). Looking at the various traits of all the rhizobacterial isolates E1, E5, LM3, and LL1 can be considered as good candidates to test as potential biofertilizer to support the growth and production of barley and alfalfa under drought and salt conditions.

Key words: PGPR, PSB, PGP, environmental conditions, biofertilizer, barley and alfalfa.

Seaweeds Essential Oils as a new source of bioactive compounds for *Microcystis aeruginosa* growth control

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The application of natural compounds extracted from seaweeds is a promising eco-friendly alternative solution for harmful algae control in aquatic ecosystems. In the present study, the anti-cyanobacterial activity of three Moroccan marine macroalgae essential oils (EOs) was tested and evaluated on unicellular *Microcystis aeruginosa cyanobacterium*. Also, the possible anti-cyanobacterial response mechanisms were investigated by analyzing the antioxidant enzyme activities of *M. aeruginosa* cells. The results of EOs GC-MS analyses revealed a complex chemical composition, allowing the identification of 91 constituents. Palmitic acid, palmitoleic acid and eicosapentaenoic acid were the most predominant compounds in *Cystoseira tamariscifolia*, *Sargassum muticum* and *Ulva lactuca* EOs, respectively. The highest anti-cyanobacterial activity was recorded for *Cystoseira tamariscifolia* EO (ZI = 46.33 mm, MIC = 7.81

µg/mL and MBC = 15.62 µg/mL). The growth, chlorophyll-a and protein content of the tested cyanobacteria were significantly reduced by *C. tamariscifolia* EO at both used concentrations (inhibition rate > 67% during the 6 days test period in liquid media). Furthermore, oxidative stress caused by *C. tamariscifolia* EO on cyanobacterium cells, showed an increase of the activities of superoxide dismutase (SOD), catalase (CAT) and malondialdehyde (MDA) concentration was significantly elevated after two days of exposure. Overall, these experimental findings can open a promising new natural pathway based on the use of seaweeds essential oils to the fight against potent toxic cyanobacteria harmful algal blooms (CyanoHAB).

Keywords: Anti-cyanobacterial activity, Bio-control, Seaweeds Essential oils, *Microcystis aeruginosa*.

CO-39

Characterization of plant growth promoting rhizobacteria and evaluation of their benefits on

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The objective of this work focuses on the use of plant growth promoting rhizobacteria (PGPR) as biofertilizers-biostimulants to promote crop growth in low soil phosphorus availability. Hence, in the first part of this work, a total number of 40 isolates were isolated from the nodules of chickpea (*Cicerarietinum* L.) and rhizospheric soil of wheat (*Triticum durum* Desf.). The characterization of the isolates showed that the C3 and P5 isolates obtained respectively from chickpea-nodules and from the rhizospheric soil of wheat showed a high solubilizing potential of the complexed phosphorus, in the form of Tricalcium Phosphate (TCP). Solubilization indexes of 1.59 and 3.60 in PVK agar medium and soluble P concentrations of 663 and 1043 µg P/mL in PVK liquid medium were respectively noted. These two isolates also showed their abil-

ity to fix atmospheric nitrogen in vitro and a high tolerance to abiotic stresses, in particular the salinity (4% NaCl) and the variation of the medium pH (4.5 and 8.5). Likewise, these two isolates showed considerable concentrations of Indol 3-acetic acid (IAA) with a production of 10.04 µg IAA/mL for P5 and 6.43 µg IAA/ mL for C3. The isolate C3 was detected as exopolysaccharides producer with a concentration of 236.11 µg glucose/mL. Furthermore, the second part of this work aims at evaluating the co-inoculation effect with two isolates on the growth of chickpea and wheat plants under low phosphorus availability. The obtained results showed that the inoculation of alfalfa plants with two strains, alone or combined, increased the plant biomass, the number of leaves and the plant height compared to the corresponding controls. Also, the separate inoculation and co-inoculation with these two isolates showed a significant (p<0.001) increase in the P plant contents. Our results suggest that these two isolates can be recommended for their plant growth promoting effects to improve chickpea and wheat tolerance to low soil phosphorus availability.

CO-40

Microorganisms crop protection against *Botrytis cinerea* by Rhizosphere biological control agents *Bacillus velezensis* S3 and *Enterobacter cloacae* S6

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CC-41

The gray mold caused by *Botrytis cinerea* has a devastating impact on various economically important crops, including grape vine (*Vitis vinifera* L.), with annual economic losses exceeding \$10 to 100 billion worldwide. Currently, the pesticides remain the main method used to reduce the incidence of this phytopathogenic fungus. However, in addition to emergence of multidrug resistance, chemicals must be increasingly restricted in order to limit their impact on the environment and human health. Thus, in recent years, biological protection is gaining renewed interest. Therefore, the aim of our project is the development of new biotechnologies allowing the grapevine to better resist pathogenic pressures, through the use of beneficial micro-organisms. A

total of 42 micro-organisms have been isolated. Only the most efficient bacteria with antifungal activities against *Botrytis cinerea* were selected for further characterization. When the grapevine plantlets were infected with *B. cinerea*, all plants associated with isolated strains showed a protection against the pathogen compared to non-inoculated plantlets. The study concludes that those bacteria could be potentially useful as a suitable bio-control agent in harvested grapevine.

Keywords: Grapevine; Gray mold; Rhizobacteria, Root-inoculation, Biocontrol.

Primary screening of Moroccan Actinobacteria isolates for their biocontrol potential against root-knot nematodes *Meloidogyne* spp.

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CC-42

Root-knot nematodes *Meloidogyne* spp. are the most destructive plant parasitic nematodes that are responsible mainly for considerable agricultural and economical yield losses. To control this pest, the producers massively use chemical methods. However, their massive use has a negative impact on the environment and human health. Recently, more attention is given to the biological control using microbial bio-based formulations as a sustainable efficient alternative and eco-friendly solution for the environment. Among these, Actinobacteria are increasingly used as candidates for biocontrol and showed potential to control a wide range of plant diseases.

Therefore, the present work reports a primary biological screening of Actinobacteria and their nematocidal activities against *Meloidogyne* spp. In this experiment, the bacteria used were isolated from different Moroccan ecosystems and then purified in order to be used in bioassays. Nine isolates -previously selected based on their

ability to produce bio-insecticide compounds- were screened *in vitro* for their potential nematocidal effect on eggs and second stage juveniles (J2) of *Meloidogyne* spp. using 96 well plates. Obtained results showed that, compared to the control, many isolates have a nematocidal activity after 10 days of treatment with highest and significant percentages of egg hatch inhibition and J2 mortality (78% and 40% respectively) of the endophytic actinobacteria isolate AI8.

This finding proves that Moroccan Actinobacteria isolates has an interesting direct nematocidal effect and could be a promising effective tool for a sustainable control of Root-Knot Nematode.

Keywords: Moroccan Actinobacteria, *Meloidogyne* spp., *in vitro* screening, nematocidal activity, egg hatch.

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CO-43

Melon is a crop with strong growth potential and of undeniable socio-economic importance. Morocco ranks 13th worldwide with an annual production of 518,000 T and a cultivated area of 17,000 ha. However, this sector faces several biotic and abiotic constraints, which hinder its development and productivity. Several studies have shown that maintaining substantial productivity in harsh environments is due, in large part, to the beneficial association of the plant roots with the soil mycorrhizal fungi to form mycorrhizae. The main objective of this work is to evaluate the mycorrhizal potential of the rhizospheric soil of melon (*Cucumis melo*. L) in relation to the soil properties and farming practices in different farms of the Marrakech region: El-ouidane, Loudaya, Tamellalt, Ouladdlim and the agricultural domain Graoua.

Microscopic analysis showed the presence of mycorrhizal structures (hyphae, arbuscules and vesicles) and high mycorrhizal frequency (% F) and colonization intensity (% M) in the root samples collected from the different farms, highlighting the natural mycotrophy of the studied melon varieties (pineapple, silvio, chewbaka, salomon and funchal). The mycorrhizal frequency was higher in Ouladdlim (52.3%), Graoua domain (45.2%) and El-Ouidane (40%) than in Tamellalt (38 %) and Loudaya (29.8%). However, the mycorrhizal colo-

nization intensity was highest in El-Ouidane (50.1%) and lowest in Loudaya (18%). Likewise, El-Ouidane exhibited the highest number of propagules (1567 propagules / 100 g of soil) and the highest number of spores (758.33 spores / 100 g of soil), while Loudaya recorded the lowest values (243 propagules / 100 g of soil; 189 spores / 100 g of soil).

The results of the physicochemical analysis showed that the various soil samples have a slightly alkaline pH and a low conductivity, justifying their low salinity. All the studied soils were poor in limestone with the exception of the Loudaya region (6.23%). The organic matter content is moderately low, varying between 3.40% in El-ouidane and 1.15% Loudaya. The available phosphorus content was highest in El-Ouidane (0.064% mg / g of soil) and lowest in OuladDlim (0.049% mg / g of soil), which was somehow positively correlated to the mycorrhizal potential. The mineral nutrient contents were low and quite variable between the different soil and not correlated to the mycorrhizal potential.

Keyword : Melon (*Cucumis melo*. L), Mycorrhizal potential, ArbuscularMycorrhizal Fungi.

**Sol- Systèmes de Contrôle de la Pollution
et de la Réhabilitation.**

**Soil- Pollution Control and Rhabilitation
Systems.**

Thème/Topic



Optimization of composting process based on bioprocess parameters

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CC-01

Waste generation has increased massively around the world in the last decades. This comes down to the populations' increase across the world. Most of this waste is biodegradable, mainly green waste, food industries waste such as restaurants, and olive oil mill industries. This type of waste is one of the polluting materials that disrupt various fields of human and natural activities such as water resources degradation and landfills over-saturation. In order to solve this problem, another alternative exists to reuse this waste instead of throwing it away or burning it, it may be composted through a biotechnological process which transforms the waste into a new useful product "the compost" used as a bio fertilizer in agriculture. It is not easy to produce a compost which respects the French Standard (NF 44-51), because of the non-linear interaction between biological and physico-chemical parameters throughout the process. The classic composting process presents several problems, the major difficulty is to find the best proportions of feedstock leading to a final C/N ratio between 12 and 15, the main indicator of compost maturity, a neutral

pH around 7, a humidity (H%) between 40% and 60% and organic matter of 20 to 60%, at ambient temperature (T). That's why an accurate optimization of the composting process is necessary for predicting the process parameters such as pH, C/N ratio, H%, OM% and T, to ensure the efficiency of the composting process, dealing with a compost of a good quality. In order to optimize the initial proportions of raw waste materials, a data matrix of composts already published by Moroccan and Tunisian researchers], and the multilinear regression method were used to determine the compost final parameters values, from the initial mixture of the different ingredients.

The best mixture established satisfying the response constraints previously cited was 13.9% of green waste, 51.9% of olive mill wastewater, 7.81% of olive mill solid waste, 14.7% of poultry manure, 3.56% of exhausted olive cake, 3.41% of sesame bark, and 4.65% grape marcs.

Keywords: Composting process, Optimization Stepwise regression, pH, C/N ratio, Organic matter content.

Effect of solid phosphate sludges amendments on the growth of fruit and forest trees in the nursery

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CC-02

The use of solid phosphate sludges, generated from phosphate treatment processes at mining sites in agriculture, is an alternative recovery technique possible loss of phosphates. Our objective in this study is to see the possibility of using this sludge in the nurseries for the production of plant of fruit and forest trees. Two experiments were carried out. In the first one, we tested several mixtures of sludge with sandy soil of Maamora forest (control mixture S1) which is the substrate most used by nurserymen in the region of Rabat-Salé-Kenitra: S2 (10 %), S3 (20 %), S4 (30 %), S5 (40 %) and S6 (50 %) (v/v) on many plant species: apple (*Malus halliana*), olive (*Olea europaea* L. cv. *Picholine*), pomegranate (*Punica granatum*), citrus rootstocks (*Citrus volkameriana*, *Citrus macrophylla*, *Carrizo citrange* and Sour orange (*Citrus aurantium*)), carob (*Ceratonia siliqua*), argan (*Argania spinosa*) and acacia (*Acacia Senegal*). In the second experiment, we tested the same mixtures, but with sand. Four mixtures with 10% (v/v) concentration of 4 composts based on phosphate sludge (B1, B2, B3 and B7) were added. The plants used in this experiment are: Two citrus rootstocks (*Citrus volkameria-*

na, *Carrizo citrange*) and carob. The measured growth parameters are Plant height, Trunk diameter and leaf chlorophyll content index (SPAD). The results of the first experiment showed that there was a slightly higher growth in the control mixture (S1) for pomegranate, acacia and *C. volkameriana* plants. Furthermore, the relative growth was higher at phosphate sludge concentrations of 20 to 30% for the other plants species, although there was no significant difference between treatments. The estimations of AUGPC (area under the growth progress curve) showed there was also no significant difference in the most species except for *C. volkameriana* and S3 mixture of acacia plants compared to control mixture. In the second experiment the relative growth in M4 mixture was higher and the AUGCP showed a significant difference compared to M1 control mixture. For this purpose, the phosphate sludge has a great potential to be used in the nurseries and create a favorable soil condition as a cultivation substrate.

Keywords: Solid Phosphate sludge; Substrate; Nursery; Plants; Growth.

Assessment of metallic pollution using the GIS approach and pollution indices in agricultural soils irrigated with wastewater from Day River in Beni Mellal, Morocco

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CO-03

Among the most widespread problems in the world, we mention the problem of wastewater irrigation. This use seems to be the solution to compensate for the need in water. However, wastewater contains undesirable chemical elements that can accumulate in the soil. The purpose of this study was to assess the pollution of agricultural soils watered by wastewater from Day River in Beni Mellal. To achieve our objective, 35 samples of agricultural soils with a depth of 0-30 cm were analyzed to determine some physicochemical characteristics of the soil (OM, CaCO₃, pH, EC, texture) and a set of heavy metals (As, Cr, Cu, Cd, Ni, Pb, Zn and Fe). The level of pollution was assessed using Geographic Information Systems (GIS), and some pollution indices such as: Geo-accumulation indices (IGEO), Enrichment Factor (EF), Contamination Factors (CF), Pollution Load Index (PLI) and Potential Ecological Risk Assessment (RI). The results of the analysis showed that the agricultural soils had a clayey to silty-clay texture, alkaline pH,

rich in organic Matter (OM) and calcium carbonate (CaCO₃) with high concentrations of metallic elements (As: 8.24 mg/kg, Cr: 77.77 mg/kg, Cu: 87.40 mg/kg, Cd: 4.89 mg/kg, Ni : 42.33 mg/kg, Pb: 109.66 mg/kg, Zn : 75.98 mg/kg and Fe: 26248.18 mg/kg) showing that Cd and Pb concentration exceeded the WHO and FAO limits. We take note that the highest concentration levels of heavy metals were found around areas located near Day River source, and the points where it crossed villages in Beni Mellal suburb. The Igeo, EF, CF, PLI and RI indices and the spatial distribution of the heavy metals revealed medium to high contamination of the soil by heavy metals and this contamination came from anthropogenic origin related to irrigation by wastewater and the intensive land use in agriculture as well as to the influence of the soil properties such as organic matter, pH and clay mineralogy.

Keywords: Day River, wastewater, metallic pollution, pollution indices.

GIS and AHP multi-criteria analysis methods in the assessment of the quality in agricultural soil irrigated with Wastewater: Case of the Day River, Beni Mellal (Morocco)

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CO-04

The quality analysis is of crucial importance in the management of land use as well as the fertility and production of agricultural soils. The objective of this study is to determine the quality of agricultural soils irrigated by wastewater from the Day River, which has been receiving domestic and industrial untreated wastewater from Beni Mellal city and surrounding villages for several decades, using geographic information systems (GIS) techniques and the multicriteria analytical hierarchy process (AHP) method, in addition to geographic information systems (GIS) techniques that we applied previously, together with pollution indices. To this end, we collected 35 agricultural soil samples over a total area of 26563.54 ha and depth from 0-30 cm. First, all the samples were analyzed to characterize the soil quality assessment criteria, by determining Organic matter (OM), Organic carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Cation exchange capacity (CEC), Humidity, Hydrogen potential (pH), Carbonates (CaCO₃),

Texture, Salinity, Electrical conductivity (EC), Depth and Slope. The AHP method was used to determine the weight of each criterion and sub-criteria from the pairwise comparison matrix via the overlay of the weights. The GIS was used to generate the maps of the spatial distribution of each criterion and the map of soil quality using the determined weights. The obtained result shows that 10.39% (2760.49 ha) of the study area is classified as "excellent quality", 18.81% (4996.48 ha) as "good quality", 39.13% (10393.62 ha) as "medium quality", and 31.67% (8412.95 ha) as "poor quality" for sustainable intensive agriculture. The findings reveal that contamination and intensive agriculture is responsible for the poor soil quality in the study area. These results provide land-use managers, policymakers, and environmental organizations with valuable data to help in preserving and protecting soil.

Keywords: Soil quality, Analytic hierarchy process, GIS, Land suitability

Impact of the pesticide imidacloprid on morphology and physiology of the *Phaseolus vulgaris* L. plant, its bioaccumulation and translocation behavior

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CO-05

Arbitrary use of insecticides in agricultural practices cause severe environmental hazard that adversely affects the growth and productivity of edible crops. The aim of the present study is to evaluate the toxicological potential effect of imidacloprid (IMD) insecticide using common bean plant *Phaseolus vulgaris* L. Application of IMD at different concentrations (0.0005-0.05 mol L⁻¹) resulted a progressive reduction in biological response of plant. Germination rate and seed vigor index reduced significantly ($p \leq 0.05$) compared to the control. The higher applied dose (5.0×10^{-2} mol L⁻¹) maximally and significantly ($p \leq 0.0001$) inhibited germination rate and vigor index. A similar effect of IMD was observed on seedling development in term of roots length, plant length, number of leaves and number of nods over control. Concerning pigments content, chlorophyll a, b and

total chlorophyll maximally decreased by 95,26%, 80.44% and 82,15 % respectively at higher applied dose. The bioaccumulation and translocation behavior of IMD in bean plant was investigated. The result revealed that the tested insecticide can be bioaccumulate in roots and translocated into stems and leaves. Conclusively, the present study indicated that chemical IMD is dangerous for vegetable production. Hence, its bioaccumulation in edible plant tissues poses a potential environmental and sanitary risk.

Keywords: imidacloprid, germination, photosynthetic pigments, bioaccumulation, translocation.

Screening of multiple plant growth promoting traits of heavy metal resistant rhizobacteria isolated from the rhizosphere of *Astragalus armatus* to contribute to the rehabilitation of contaminated soils

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CO-06

Heavy metal contamination is a serious environmental hazard for agricultural soils, plants, animals and human beings. Phytoremediation plays a beneficial role in the remediation of heavy metals contamination from soil, but using plants alone for remediation faces many limitations and becomes less effective with increasing toxicity. Growth promoting rhizobacteria (PGPR), inhabitants of the plant rhizosphere, play a supporting role and promote bioremediation of soil by improving plant growth and facilitating sequestration of toxic heavy metals.

In this context, the aim of this work is the isolation and screening of plant growth promoting (PGP) traits of lead-resistant rhizobacteria in order to be used in remediation of lead-contaminated soils. In the first place, we isolated 86 strains from the rhizospheric soil of *Astragalus armatus* grown in a mining site in Morocco, 47% had the ability to tolerate lead at 1700ppm. The isolates with solubilization diameter of tricalcium phosphate higher

than 0.5 cm on PVK solid mediums were maintained for the rest of tests. The concentrations of solubilized P on PVK liquid medium were between 186,43 and 109,03 mg/L; this solubilization was accompanied by a pH decrease from 6.8 to 3.2. All the selected strains were positive for the production of ammonia, amylase and cellulase, 30% were able to produce indoleacetic acid and 40% produced hydrogen cyanide. The percentages of produced siderophores ranged from 6,77 to 66,42. The rhizobacterial strains selected in this study had the potential to be used as efficient bioinoculants in phytoremediation of soils contaminated with lead.

Keywords: PGPR, Lead, Heavy metals, Rhizobacteria, PGP, phytoremediation

Les bonnes pratiques pour maîtriser les risques dues aux effluents liquides de la tannerie : Étude de cas

CO-07

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L'industrie de transformation et traitement de peaux brutes appelée autrement la tannerie, se trouve parmi les industries qui se caractérise par des effluents liquides pouvant nuire à l'environnement et à la santé des opérateurs (e.g. H₂S). D'où l'intérêt est de définir et caractériser ses effluents en vue de trouver des solutions permettant la réduction de la charge polluante et réduire la toxicité par le biais des techniques de ségrégation, de valorisation et de traitement.

Dans ce travail, des bonnes pratiques pour la maîtrise des risques dues aux effluents de la tannerie ont été détaillées, à travers une ségrégation des flux des rejets liquides, notamment ceux des opérations d'épilage / pelanage et du tannage. En vue de diminuer les risques liés au mélange des rejets d'épilage/pelanage (basique) d'un côté et ceux du tannage (acide) d'un autre, ce qui pourra conduire à la formation du sulfure d'hydrogène H₂S (gaz très toxique), une station de traitement consa-

crée au traitement du sulfure par oxydation catalytique afin de diminuer la quantité du soufre active dans la phase liquide est proposée, ainsi qu'une unité de récupération du chrome III à partir des rejets de tannage par précipitation, afin de permettre le recyclage de cet agent vers la Tannerie. Par la suite nous allons mettre en œuvre une conception globale de traitement des effluents liquides de la tannerie.

Un diagnostic sur terrain lors de la visite d'une tannerie industrielle nous a permis de déceler et analyser les risques liés à la formation de H₂S au cours du processus de fabrication du cuir et d'établir une liste de recommandations à suivre pour diminuer au maximum le risque de formation du sulfure d'hydrogène H₂S dans les différents ateliers de traitement du cuir.

Mots-clés : Tannerie, effluent, chrome, traitement, environnement, H₂S

Nematodes of the Sous- Massa National Park: Diversity and application as bioindicators for soil health

CO-08

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The national park of Sous-Massa is classified among the natural reserves of great ecological importance in Morocco and plays an important role in the economic and social development of locale population. However, the soil of this ecosystem is under several anthropic and environmental constraints that restrict the sustainable of provided ecosystemic service. In order to assess the quality and functioning of the soil in Sous-Massa National Park, nematodes were used, as a relevant bioindicators to assess soil health and functioning as these organisms can integrate a large amount of information on soil food web and nutrients cycling process. This study was carried out to (i) describe the diversity of nematode communities in the Park's soil, (ii) characterize different communities' assemblage and distribution pattern (iii) assess the soil quality in the Park. In order to meet these goals forty-six sites were surveyed. A total of 50 genera

of nematodes, belonging to 31 families have been detected and identified at the different sites. These nematodes are distributed within five trophic groups, namely bacterivores, herbivores, fungivores, carnivores and omnivores with the predominance of the first two groups. The population of bacterivorous nematodes is mainly represented by the family of *Cephalobidae*, while that of herbivores is dominated by the families of *Belonolaimidae*, *Hoplolaimidae* and *Longidoridae*. The calculation of nematofauna indices revealed that soils from cultivated areas are degraded, depleted in nitrogen and characterized by a high C / N ratio. On the other hand, the soils of protected areas (less anthropized) are mature, fertile, structured with a moderate C / N ratio.

Keywords: Nematodes; Communities; Diversity; Ecology; Soil quality.

Unintentional spread of three exotic ornamental plants in Chott-Mariem (Tunisia)

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CO-09

Ornamental horticulture is the main pathway of worldwide deliberate introduction of invasive alien plants. Ornamental plants may become invasive since they escape cultivation in landscape. The main objective of this paper is to increase the awareness of the national ornamental industry about the invasive risk of some exotic ornamental species. The presence of three exotic ornamental plants (*Lantana camara* L., *Agave Americana* L., and *Carpobrotus edulis* (L.) N.E.Br.) was monitored in natural and disturbed areas from June to July 2020. This monitoring was carried out in Chott Mariem, within 600 ha, using the full covering method. The occurrences of these species were recorded with GPS/GIS technology. The abundance of each infestation spot was described according to the Braun-Blanquet dominance-abundance scale. *L. camara* was recorded in 23 positions in the margins of fields and roadsides (35%) and in crop fields and olive orchards (52%). The species

abundance in these infestations ranges from 50-75% (margins) to < 5% (olive orchards). *C. edulis* was recorded in 21 positions, mainly in coastal areas. These infestations were linear and 60% of them were in the length category of 50-100 m and the abundance category of 50-75%. *A. americana* was recorded in seven positions, mainly in field borders with an abundance ranging from <5 % to 50-75%. The present study highlights the risk of exotic ornamental plant species in the absence of a code of conduct for the ornamental horticulture industry. Further studies should consider more exotic ornamental plants in a larger scale to rank them according to their potential invasive risks.

Key words: *Lantana camara*, *Agave americana*, *Carpobrotus edulis*, Tunisia.

Evaluation de la pollution métallique des sols : cas des sites miniers de la région de Béni Mellal (Maroc)

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CO-10

La pollution des sols devient aujourd'hui un problème préoccupant. En effet, la contamination des sols par les éléments traces métalliques (ETM) constitue un risque pour la santé humaine et une menace pour la protection de l'environnement. Elle doit donc faire l'objet d'une réhabilitation pour réduire leurs impacts. Dans ce contexte, une étude approfondie des sols a donc été menée dans les sites miniers de la région de Béni Mellal, afin d'évaluer l'état actuel de la contamination des sols par les ETM en réalisant une analyse par spectrométrie d'absorption atomique (AAS). Quarante-deux échantillons de sols ont été analysés pour leurs concentrations en Pb, Zn et Cu. Les résultats ont révélé que les sols étaient contaminés par ces métaux ayant des concentrations dépassant les seuils de l'OMS et de la FAO ; Aguerd n'Tazoult (Pb = 460,00 ppm, Zn = 2350,00ppm), Tansrift (Cu = 129,00 ppm). De plus, les teneurs en métaux les plus élevées ont été observées

autour de ces deux zones minières. L'évaluation du risque de contamination des sols a également été réalisée à l'aide de l'indice de géoaccumulation (Igeo), du facteur d'enrichissement (EF), du facteur de contamination (CF) et de l'indice de pollution de charge (PLI). Selon ces indices, les sols présentent une contamination modérée à élevée pour les éléments Zn, Pb et Cu respectivement. La pollution polymétallique générée par les rejets miniers des deux sites étudiés constitue une vraie menace sur l'écosystème avoisinant. Malgré un environnement hostile de la région d'étude, plusieurs espèces végétales ont été observées sur les deux sites étudiés et sont parfaitement adaptées aux conditions édapho-climatiques.

Mots-clés : sites miniers, pollution des sols, éléments traces métalliques, espèces végétales, réhabilitation.

New insights into the effects of nickel on biochemical and transcriptomic responses in *Medicago sativa* nodules

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CO-11

Industrial wastes and fertilizers can introduce excessive levels of nickel (Ni) into the environment, potentially causing threats to plants, animals, as well as human beings. However, the number of studies on the effects of Ni toxicity on plant's nodules is fairly limited. To address this issue, the effects of increasing Ni concentration on alfalfa (*Medicago sativa*) nodules were assessed at chemical, biochemical, and transcriptomic parameters. For this purpose, alfalfa plants were grown on contaminated soil with various levels of Ni (50, 150, 250 and 500 mg/kg) against the control amount of 0 mg/kg. First, Ni loads on leaves, roots and nodules were performed. Next, a set of biochemical biomarkers to measure the activity of oxidative stress enzymes and lipid peroxidation in nodules was determined. Finally, gene expression levels of biochemical parameters were assessed. Our data indicated that Ni uptake was dose-dependent manner, with a relatively low concentration of Ni translocated from nodules to roots and leaves. It was found that Ni accumulation increased nodules biomass as well as lipid peroxidation especially in plants exposed to the high concentration. Enzymatic activities

enhanced remarkably, suggesting the occurrence of oxidative damages, with increased glutathione reductase (GR), ascorbate peroxidase (APX) and superoxide dismutase (SOD) activities. Nodule homogluthathione (HGSH) levels increased with the different Ni concentrations, while, the impairment of glutathione (GSH) content and glutathione-S-transferase (GST) activity, despite their upregulation at gene expression levels at the highest Ni concentration, demonstrated a post-translational regulation of its enzymes. The phytochelatins (PC) and metallothioneins (MT) concentrations increased in nodules, which implied the triggering of a cellular protection mechanism for coping with Ni phytotoxicity. Overall, the results suggested that Ni produce a severe oxidative stress in alfalfa nodules, yet the expression of MT and PC to reduce Ni toxicity could be used as Ni-stress bioindicators. In view of the pivotal role of nodules in limiting the hazardous effects of soil contaminants on plants, the findings from our study should be carefully considered.

Keywords: Nickel, *Medicago sativa*, nodules biomass, oxidative stress, gene expression.

Contrasting effects of salinity stress on five 'in vitro' date palm cultivars from southeast Morocco

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CO-12

Exploitation of Oasian soils in Morocco, which is heavily contaminated by dissolved salts, requires a screening of the cultivated varieties in these regions as a basic strategic tool in the promotion of phoenicultural production, given that in these areas' salinity is typically associated to drought stress. For this reason, some Moroccan superior quality cultivars were tested for their tolerance to salinity stress in order to simultaneously contribute to the improvement of yield per tree and therefore improve the financial situation of the farmers. The experimental design comprised 20 salinity regimes [(4 cultivars + a male clone) x 4 separate salinity levels] with 10 randomized replicates, i.e. 40 plants for each of the tested cultivars. Each 15 days, Biometric, physiological and biochemical measurements were carried out in order to be able to estimate the indices of tolerance. Although date

palm is known to be tolerant to salinity stress, our results revealed that the behavior of the investigated cultivars under salinity differed significantly over time and according to several criteria. Moreover, results analysis allowed us to differentiate 2 main groups of cultivars regarding their reaction to the applied stress. A resilient/tolerant group (T) that, within 60 days of treatments, began to exhibit improved biometric and physiological performances, and a non-tolerant group (NT) that includes Majhoul, showing values within stress ranges, particularly for chlorophyll fluorescence, leaf area, number of neofomed leaves, electrolyte leakage, stomatal conductance which appear to be decisive criteria in the screening of this specie for salinity tolerance.

Key words: Date palm, salinity, stress, tolerance, screening, sodium chloride (NaCl).

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CO-13

In the irrigated areas, intensive agriculture has led to soil degradation and declining crop yields, therefore, the durability of soil resources is influenced. To assess soil quality status in the Zemamra area from the highest and irrigated plain of Doukkala (523.000Ha), soil samples taken from the horizon 0-30cm were analysed for physical and chemical indicators (Clay, Sand, Silt, SOM, pH, TN, P₂O₅, K₂O, CEC, MgO, CaO, SAR, Na₂O, EC, CaCO₃, C/N, NO₃-N, NH₄-N, B, Mn, Zn, Fe, and Cu). The data obtained were statistically processed to search for soil quality indices (SQI). The main findings show that the soil surface has more sand than clay (Sand=55%, Clay=31%), an accumulation of phosphorus (P=33.34ppm), moderate SOM (1.789%), and carbonate contents about (2.6%). The soil structural stability index (SSSI) indicated that soil's structure in the area is degraded (SSSI<5%). The soils are not affected by salinity or sodicity problems as SAR, Na₂O and EC are below the salinity norms. The selection of the Minimum Data Set (MDS) allowed retaining four indicators (CEC, B, K₂O, and Mn) reflecting the dynamism of soils under agricultural practices in the area. Three ap-

proaches were tested to transform the MDS into unitless indicators: two linear and one non-linear by assigning the "More is Better" criteria to CEC and K₂O, and the "Less is Better" criteria to B and Mn. The SQIs thus obtained classified the soils as having low to moderate quality (SQI<0.55). To validate the results, a Pearson correlation was performed between indicators and SQIs thus calculated. The following indicators: Sand, P₂O₅, B, Mn, and Zn are negatively correlated to SQIs while clay, F, Silt, CEC, MgO, CaO, pH, SOM, and CaCO₃ are positively correlated. Boron and zinc negatively impact soils at low concentrations. The main factors of soil evolution in the area are; conventional tillage, irrigation, bad crop residue management and excessive fertilisation. The harvesting of sugar beet as an important industrial crop in the area leads to the loss of fine elements (clay and silt) and organic matter that remain attached to the crop pivots. These practices affect vertisols, mollisols, and calciustolls as the most dominant soil types in the area.

Keywords: Soil quality index, Minimum data set, irrigation, fertilisation, semi-arid.

Tillage, residues management and nitrogen fertilization effects on soil organic status, soil quality and soft wheat in the Moroccan semi-arid

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CO-14

Sustainable practices, such as no-tillage, residues and fertilization management can improve soil organic status, soil quality (SQ) and yields. The present study was conducted to test the impact of tillage (conventional (CT) and no-till (NT)), crop residues management (vetch (C₁) and uncover soil (C₀)) and three nitrogen fertilization rates (30, 60 and 90 N kg ha⁻¹) on soil organic carbon (SOC), total nitrogen (TN), C/N ratio, soft wheat yields and SQ. The experiment was established in 2010 in the Moroccan semi-arid. After ten years, the COS concentration was greater under NT (9,4 g/kg) compared to CT (8,4 g/kg). Crop residues also enhanced SOC (10 g/kg) compared to C₀ (8,1 g/kg). Application of N fertilization showed profound effects on total N, increasing levels of N application led to higher total N irrespective of tillage. Crop residues increased TN (0,6 g/kg) better than no cover plots at the horizon 20-40 cm. Soft wheat revealed an improvement in grain yield under NT (4213,8 kg ha⁻¹) compared to CT (3785,6 kg ha⁻¹)

¹). For SQ evaluation through the indexing methods, the principal component analysis was done for eight soil indicators to determine the minimum data set (MDS), which were subsequently normalized and integrated into the non-linear indices, additive (IQS_{ANL}) and weighted (IQS_{WNL}). The NT revealed higher scores (0,52; 0,6) than the CT (0,46; 0,53) for IQS_{ANL} and IQS_{WNL}, respectively, in particular at the horizon 0-20 cm. The presence of a residues layer on the soil surface improved SQI_{WNL} score (0,59) compared to C₀ (0,55). Moreover, the index correlation (r) with yield and the sensitivity calculation (S), allowed us to choose IQS_{WNL}, as the best index (highest r and S) to evaluate soil quality under different agricultural management practices. Indeed, this index revealed an intermediate soil quality under NT and in the presence of crop residues, compared to CT and C₀ (low quality).

Keywords: No-till, Residues; Total organic carbon, Total nitrogen, soil quality, soil quality index

Effect of Banana waste biochar on phytotoxic germination test

CO-15

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Climate change is a huge concern that has resulted in a slew of negative consequences, including land degradation, precipitation loss, and drought. The south of Morocco is just one of those zones; where poor conditions have a negative impact on soil and plant growth. Multiple researchers have discovered that adding organic amendments to soil, including composts and pyrolysis products, rises organic compounds, nutrient benefits, carbon content, and biological properties. Certain biochars, on the other hand, contain toxic compounds like heavy metals. In this survey, banana waste biomass was pyrolyzed under no or limited oxygen, yielding banana waste biochar, which was then tested on three plant spe-

cies before being used in the field. The phytotoxic tests results showed that our pyrolysis product was safe to use, implying that it could be easily used in agriculture.

Keywords: banana waste biochar, phytotoxic germination test, pyrolysis, pyrolysis product.

Phytoremediation of lead mine tailings using *Atriplex nummularia*

CO-16

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Mine tailings are often devoid of vegetation cover and are a cause of environmental contamination by heavy metals due to water and wind erosion phenomenon. The phytoremediation of dumps is a promising and highly recommended strategy to reduce these risks. However, this approach demands careful caution, since mining tailings often provide unfavorable conditions for plant growth, resulting in asphyxiation, dieback and death of plants.

The aim of this work was to investigate the ability of *Atriplex nummularia*, which is a halophyte perennial shrub, to grow in mine waste and to evaluate the effect of two types of amendments (organic and chemical) on growth and accumulation of heavy metals by this plant. Pot experiments were performed with substrate samples collected from the abandoned mine tailings of Zaida (High Moulouya, Morocco). These substrates showed a high level of heavy metals: lead (6632 mg/

kg), Zinc (142 mg/kg) and copper (121 mg/kg) and a low content of organic matter (0.08 %).

Results show that *Atriplex nummularia* tolerate high levels of heavy metals. This is a good candidate for tailings phytostabilisation because heavy metals are concentrated in the root part and their translocation to the aerial parts remains low. Fertilizers had a significant effect on biomass production and heavy metal extraction an accumulation.

Key words: Mine tailings, Phytoremediation, heavy metal, contamination.

Impacts of Biochar on Cd toxicity in earthworm *Eiseniaandrei*

CC-17

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Biochar has acquired considerable attention due to its benefits for agriculture and environment. However, little is known about their non-desirable effects on soil organisms such as earthworms, and especially in case of remediation strategies. Therefore, the aim of the present investigation is to assess the effects of Cd to earthworms *Eiseniaandrei* and to evaluate if presence of biochar can alleviate or contrary increase the potential toxic effects of Cd. For that, *Eiseniaandrei* were exposed for 7 and 14 days to four types of treatments, namely: control soil, soil amended with biochar, soil contaminated with cadmium and finally soil subject to a joint action of biochar and Cd (7 mg kg⁻¹ soil). A battery of biomarkers was applied via the measurement of antioxidative enzymes (Catalase, glutathione-S-transferase) and lipid peroxidation (MDA), cytotoxicity (Lysosomal membrane stability LMS), genotoxicity (Micronuclei

frequencyMNI) and gene expression of CAT and GST targets. The integrated study of biochemical biomarkers revealed that the antioxidative defense system of earthworms was significantly affected by exposure to cadmium. These results were consolidated by cytochemical and genotoxic analyzes which indicated that the worms exposed to soil contaminated with Cd were severely damaged. On the one hand, biochar had increased the bioavailability of Cd to earthworms and this was time-dependent. Consequently, a reduce on LMS and an increase on MNI was observed in earthworms exposed to Cd in presence of biochar. However, biochar had induced a reduce on the activity of antioxidant enzymes. Therefore, our results advance the comprehension about the ecological risk assessment of biochar use in soil amendment.

Keywords: Agricultural soils, Cadmium, Biochar, *Eiseniaandrei*, toxicity.

Sustainable rehabilitation of abandoned mining site using native plants: Bir Nehass Mine

CC-18

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Mining activities are a major anthropogenic source of release of heavy metals into the environment. Mine wastes were generally abandoned in surface without any treatment. They contain high concentrations of toxic metals and there is an urgent need to implement strategies for their rehabilitation. Phytoremediation using native plant species is a low-cost and environmentally friendly technology. The aim of this study was to perform a screening of native plants growing in Bir Nehass abandoned mine-Marrakech for its rehabilitation. Plants and soils were collected and analyzed for Cu, Zn, Pb and Cd concentrations at several points in the tailings and soil surrounding the mine site. Results show that the soil in the vicinity of Bir Nehass mine is deficient in major element and contain high concentrations of toxic metals. Native plants were botanically identi-

fied then classified into 13 species and 11 families. Significant difference ($p < 0.05$) was observed among the average concentrations of the studied metals in plants. 3 plants of 13 namely *Aizoon canariense* L., *Hirschfeldia incana* (L.) Lagrèze-Fossat, *Citrullus colocynthis* (L.) Schrader and *Peganum harmala* L. were considered as the best-performing specimens due to their high ability to accumulate multiple metals in their shoots and roots without any symptom's toxicity. This was confirmed by the translocation and bioconcentration factors. Using the most common criteria to classify the hyperaccumulator plants, these species can be classified as new metal accumulator plants and could be potentially used as rehabilitation tools of polymetallic abandoned sites.

Keywords: heavy metals; mining sites; native plants; phytoremediation; rehabilitation.

Assessment of the phytoremediation potential of *Pinus halepensis* Miller Species for Zinc contaminated soils

CO-19

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The contamination of nature by metallic trace elements is one of the most serious cases of environmental pollution. In spite of the existence of various sources of these pollutants, the anthropic action remains the most intensive because it causes a destruction of the telluric elements either by a defective storage and/or by a release in the natural environment without any treatment. In this regard, in recent years, researchers have shown increased interest in biological remediation methods such as phytoremediation, based on their inoffensiveness and their potentially lower cost than traditional remediation techniques. The objective of the present study was to evaluate the phytoremediation potential of *Pinus halepensis* species to decrease the contamination rate of soils polluted by Zn in a mining site. The experiment pots were conducted for six months in a greenhouse.

The pots were filled with a culture substrate composed of polluted soil diluted with sand in the following proportions (100% (polluted soil)-75%-50%-25%-10%-0% (sand)). The results obtained show that the *Pinus halepensis* plant can tolerate a pollution level of up to 75%. Moreover, the bioaccumulation factors (BAF>1) and translocation factors (TF <1), indicate that *Pinus halepensis* has the capacity to accumulate significant concentrations of Zn in their roots, which makes it suitable to be used in a phytostabilization and/or phytoextraction program. In conclusion, the results of this study revealed that the dilution of polluted soil with sand has a significant effect on the efficiency of the phytoremediation process

Keywords: Aleppo pine; Metallic trace elements; phytoremediation; phytostabilization; pollution.

Ruta angustifolia essential oil as an eco-friendly pesticide against the insect pest *Tribolium castaneum*

CO-20

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Due to their biodegradability and high efficiency, essential oils have gained the interest of many scientists in pest insect control. For these reasons, its efficiency was studied for the control of different classes of insects. Our study presents in the first place, the insecticidal activity of the essential oil of *Ruta angustifolia* on adults of pest insect *Tribolium castaneum* using contact and topical application bioassay. In the other, proposes the behavioural studies with decent focus on the anti-feedant and repellent effect. Contact toxicity was assessed using filter paper assay where three concentrations (0.1, 0.2, and 0.3%) were used. For the topical application bioassay, three concentrations (2, 4, and 8%) of the EO were independently applied to the thorax of insect. For the repellent effect, the bioassay was assessed on filter paper divided into two semi-circle treated respectively with acetone and each of the three concentrations (0.5, 1 and 2%). Antifeedant bioassay was tested using no choice, and two choice tests. For the

Contact toxicity, 100% of mortality was recorded at the highest concentration used (0.3%) after 24h. For the topical application, 70% was the maximum mortality observed after 24h of 8% of the essential oil. *R. angustifolia* acted as a strong repellent to *Tribolium castaneum* where 72% of repellency was observed for the lowest concentration used (0.5%) after 2h. In the antifeedant no choice test, 3% of the essential oil caused a decrease in the order of 2.8 and 3 times respectively for Relative Growth Rate and Efficiency of Conversion of Ingested food. In the two choice antifeedant test, a significant long lasting antifeedant of 80.9, 81.1 and 69.2% was recorded at 2% of the EO respectively after 10, 20 and 30min.

Our results promote the use of *R. angustifolia* essential oil as a bioinsecticide and bioprotectant of Stored products from the invasion of *Tribolium castaneum*.

Keywords: Feeding Deterrent; Toxicity; Repellent; Stored Grain Pest.

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CO-21

Le sol est une richesse naturelle, une source de nourriture, qui produit 95% des aliments. Il est impossible de parler de qualité alimentaire lorsque le sol n'est pas sain. Au cours des dernières décennies, la demande croissante résultant de la croissance démographique et les développements des techniques agricoles ont conduit à une intensification de l'agriculture dans de nombreux pays du monde. Le périmètre de Beni-Moussa au niveau de la plaine de Tadla est l'un des périmètres ayant connu une intensification agricole au Maroc. L'objectif de cette étude est d'évaluer l'adéquation de ces sols à la production agricole à travers 15 indicateurs de qualité à savoir la matière organique (MO), le carbone organique (CO), l'azote (N), le phosphore total (P), le potassium échangeable (K), la capacité d'échange cationique (CEC), l'humidité, le pH, la teneur en carbonates

(CaCO₃), la texture (limon + argile), les types du sol, la salinité, la conductivité électrique (CE), la profondeur et la pente. Le processus d'analyse hiérarchique (PAH) et le système d'informations géographiques (SIG) ont été utilisés pour élaborer les cartes d'adéquation des sols. Les résultats obtenus montrent que 4667,84 ha de la superficie de Beni Moussa sont classés dans la catégorie "Excellente qualité", 12601,19 ha dans la catégorie "Bonne qualité", 52098,99 ha dans la catégorie "qualité moyenne" et 9148,89 ha dans la catégorie "Mauvaise qualité" pour une agriculture intensive durable.

Mots-clés : Qualité des sols, le processus d'analyse hiérarchique (PAH), le système d'informations géographiques (SIG), Activités agricoles

Services écosystémiques fournis par la faune sauvage dans les zones agricoles des vallées haut-atlasiennes de Béni mellal

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CO-22

L'expansion et l'intensification des activités agricoles dans les vallées du Haut-Atlas central de Béni Mellal ont réduit les habitats naturels des espèces animales sauvages en menaçant leurs populations et aggravant leurs conflits avec l'Homme. D'autre part, ces écosystèmes abritent une faune diversifiée (poissons, amphibiens, reptiles, oiseaux et mammifères). Cette diversité constitue une ressource naturelle essentielle, qui apporte des services écosystémiques très importants et qui contribue au maintien des services écologiques des forêts et à la santé des écosystèmes. Pourtant, au niveau des zones agricoles, l'intérêt pour le rôle économique des oiseaux et des autres espèces animales en tant qu'agents de lutte antiparasitaire a diminué à mesure que l'agriculture est devenue plus dépendante de la disponibilité des pesticides efficaces. La modification de l'environnement et l'augmentation des pratiques d'utilisation des produits phytosanitaires et des fertilisants rendent plusieurs espèces sauvages plus menacées d'extinction. Notre étude avait pour objectif de collecter des données sur la richesse spécifique des différentes espèces faunis-

tiques au niveau des deux vallées, et d'identifier leur impact écologique en se concentrant principalement sur les services de soutien qu'elles fournissent au profit des populations locales. Ces données collectées sont basées sur des prospections sur terrain en utilisant la méthode du transect et des points d'écoute, on s'est appuyé également sur la photographie des espèces pour leur identification. Au niveau des zones agricoles, les résultats des prospections nous ont permis d'identifier 75 espèces d'oiseaux, neuf espèces de mammifères, et 11 espèces de reptiles. Plusieurs espèces identifiées ont été mentionnées en tant que fournisseurs de services écosystémiques importants pour l'Homme, alors que d'autres sont considérées en tant qu'espèces nuisibles pour la production agricole, Par conséquent, l'intégration de la faune sauvage, avec ses avantages et ses inconvénients, pourrait être un argument puissant pour parvenir à la coexistence de la faune sauvage dans un paysage façonné par les activités anthropiques.

Mots clés : faune sauvage, oiseaux, mammifères, reptiles, agriculture, services écosystémiques,

Changes of soil properties following spreading of olive mill wastewater (OMW) affects the main morpho-physiological and biochemical parameters of olive trees plants (*Olea europea*. L) and the root abundance of Arbuscular Mycorrhizal Fungi (AMF)

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CO-23

Olive mill wastewater (OMW) constitutes a major environmental problem for Mediterranean countries, where most of the world olive oil production takes place. However, OMW is rich in organic matter as well as in mineral salts of potassium, sodium and magnesium. Thus, OMW is beneficial for soil fertility. The recycling of the OMW and its use as water for irrigation in agriculture, provided that its impact on soil and plant is established, is an attractive possibility for the Mediterranean countries. The response of olive plants (*Olea europea* L.) when irrigated with different concentrations of OMW (50, 100, 150 and 200 m³ ha⁻¹), was studied in a greenhouse. Leaf area, chlorophyll fluorescence, stomatal conductance, chlorophyll content and soluble sugars content were analyzed in leaves, and root colonisation and soil properties. Our results indicated that the use of OMW at doses 50 and 100 m³ ha⁻¹ (after 200 days) is beneficial for irrigation and that the increase in the concentration of OMW in the crop resulted in a parallel

decrease in plant growth parameters and photosynthesis of leaves, at 200 m³ ha⁻¹, the decrease was more than 100% (lethal dose). The 50 and 100 m³ ha⁻¹ OMW doses favor the development of Arbuscular Mycorrhizal Fungi (AMF). The observation of the roots fragments of the control plants (Sc) shows that AMF colonizes exclusively the tip of the root fragments but does not penetrate the central cylinder. While observation of root fragments from plants treated with 50 and 100 m³/ha OMW reveals that AMF colonizes even the central cylinder. These results suggest that altered AMF function should be considered as potential factors mediating the responses of olive trees to agronomic application of OMW when the dose of OMW applied is greater than 100 m³ ha⁻¹.

Keywords: Olive mill wastewater; *Olea europea* L.; Arbuscular mycorrhizal fungi; Roots colonisation; photosynthesis; soluble sugars.

Effect of biochar and sheep manure on maize plants grown in contaminated mine soil

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CO-24

Metallic trace element (MTE) soil contamination is a serious problem needed to be urgently faced to ensure safe food supply and protect human health over the world. The present work is a potting experiment conducted using two levels of biochar (2.5%; 5%) and animal manure (10%; 20%) to investigate their potential role in soil improvement and development of maize seeds grown in a former iron mine soil. Results show that both amendments increased soil pH. A successful growth of maize has been observed in presence of both organic amendments. Plants were well developed with leaves which were large, green, and longer comparing to untreated contaminated soil suggesting that biochar and animal manure reduced physical symptoms of metal toxicity. Biochar and animal manure amendments increased almost all the measured morphological characteristics especially shoot length (biochar: 16.44 cm,

animal manure: 18.26 cm, and untreated soil: 13.37 cm) and dry biomass of shoots (biochar: 0.11 g, animal manure: 0.18 g and untreated soil: 0.05 g) and roots (biochar: 0.29 g, animal manure: 0.17 g, and untreated soil: 0.16 g) as well as length and numbers of leaves and leaf area.

Keywords: Mine soil, Metal toxicity, Zeamays, Morphological-behavior, Plant growth.

Influence of microbial anaerobic metabolism on the mobilization of mercury and its toxicity on former mining sites in French Guiana

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CO-25

Successive years of alluvial gold mining in French Guiana have resulted in soil degradation and deforestation leading to the pollution and erosion of mining plots. Due to erosion and topography, alluvial gold panning sites are submitted to hydromorphy during heavy rainfall and groundwater increases. This original study focused on characterizing the physicochemical quality of rehabilitated mining sites, the impact of hydromorphic anaerobic periods on iron- and sulfatereducing bacteria, and the potential solubilisation and methylation of mercury. We sampled soil from 5 rehabilitated sites in French Guiana, including 2 sites with herbaceous vegetation (NR and Lyc) and 3 sites restored with fabaceous plants, including *Clitoria racemosa* (Cli) monoculture, *Acacia mangium* (Aca) monoculture, and *Clitoria racemosa* and *Acacia mangium* (Mix) bi-culture. We conducted mesocosm experiments where soil samples were incubated in anaerobic conditions for 35 days. To evaluate the effect of anaerobic conditions on the activity of bacterial communities, we measured the following parameters related to iron- and sulfatereducing metabolism throughout the experiment: CO₂ release, carbon dissolution, sulphide

production and sulphate mobilization. We also monitored the solubilization of iron oxyhydroxides, manganese oxides, aluminium oxides, mercury and its potential toxic forms in the culture medium. The results revealed two trends in these rehabilitated sites. In the Aca and Mix sites, bacterial iron-reducing activity coupled with manganese solubilization was detected with no mercury solubilization correlation. In herbaceous sites (NR and Lyc), while the measured anaerobic activity was low, it seemed responsible for sulphide production coupled with twice as much mercury solubilization. These results confirm the presence and activity of ferri and sulphate reductive communities at rehabilitated mining sites and their interactions with the dynamics of metallic elements and mercury. These results also showed the positive impact of ecological restoration applied of mining sites in French Guiana by reducing the potential mobility of mercury and its methylation.

Key words: Tropical soils, ecological rehabilitation, iron-reducing bacteria, sulphate-reducing bacteria, mercury speciation, French Guiana.

Contamination of irrigation water with microcystins (cyanotoxins): Impact on growth, photosynthesis and antioxidative activities of Strawberry (*Fragaria vulgaris*)

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CO-26

Toxic cyanobacterial blooms are more often observed in fresh water bodies and are related to the increased level of eutrophication and the main climatic changes. They are known by the production of Microcystins (MCs), highly toxic secondary metabolites, that are released and contaminating waters. The exposure of agricultural land ecosystem to MCs through irrigation, lead to several adverse effects on terrestrial plants and human health. They induce negative impact on plant morphology and physiology. The present study aimed to investigate the effect of MCs on growth, photosynthetic and biochemical parameters of *Fragaria vulgaris* (strawberry) after irrigation with MCs contaminated water.

For that purpose, strawberry seedlings were exposed to *Microcystis aeruginosa* crude extracts with different MCs concentrations (1, 5, 10, 20 µg/L) for 60 days and placed in controlled culture room.

The results showed that MCs extracts induced significant decrease on plant growth parameters mainly a reduction on root and aerial part lengths, dry and fresh weights and leaves number. MCs also reduced photosynthetic pigments content, stomatal conductance and fluorescence. At the same time, a significant increase in MDA (lipid peroxidation) and polyphenol content was observed. Besides, superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) activities were significantly increased in strawberry plants exposed to MCs. These enzyme activities were higher in plants exposed to 10 and 20 µg/L MCs in the second harvest (After 60 days of exposure) compared to the first harvest (After 30 days).

The obtained results indicated the adverse effects of MCs on *Fragaria vulgaris* (strawberry) growth and the possible negative impact of those contaminant on the environment and public health.

Keywords: *Fragaria vulgaris*, Horticultural; Microcystins; Irrigation water; Plant growth; Biochemical parameters

Effects of urbanization on the degradation the Palm grove around the city of Marrakech

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CO-27

In the last recent years, the city of Marrakech is experiencing a very significant development in terms of urbanization which leads to a significant reduction of the agricultural activity and increase of the rate of metallic pollution in soils. The impact of this metallic pollution on the microbial activity in these soils, in particular the one of Arbuscular mycorrhizal fungi, can negatively affect the growth and the development of the date palm host plants (*Phoenix dactylifera* L). In addition, the urbanization has direct effects on the degradation of palm groves in the Marrakech region, following a decrease in agricultural and forestry productivity after anthropogenic activities which are at the origin of high Metallic trace elements contents in soils. In order to assess the impacts of this pollution, we carried out a study in the rhizospheric soils of the date palm (*Phoenix dactylifera* L) monitoring the levels of heavy metals (Pb, Zn,) and

the density of Arbuscular mycorrhizal fungi spores. Eight sites were chosen, five urban sites (three gardens, two boulevards) and two peri-urban sites (palm groves). The results obtained showed that the frequency of natural mycorrhization is higher in date palm plants in the gardens (61% to 98%) and it remained lower in palm plants in the boulevards and in the two palm grove sites North East and North West (12% to 48%). Similarly, the analysis of metallic trace elements showed that the contents are very high in soils from boulevards (urban sites) compared to soils from gardens (urban sites) and from palm groves (peri-urban sites). The mobility of metallic trace elements in soils is strongly influenced by soil parameters, in particular pH, organic matter and the composition of mineral elements.

Keywords: Boulevards, Drought, Heavy metals, Mycorrhizal, *Phoenix dactylifera* L, Pollution.

Remote sensing and GIS contributions to the development of a soil organic matter recovery plan: a case study of western Morocco

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CO-28

Integrated organic fertilization is vital for restoring soil organic matter (SOM), increasing agricultural yield, minimizing the danger of groundwater contamination, and sequestering greenhouse gases. This study was carried out to estimate the spatial distribution of organic amendments to bring humus to the soil to improve its physical, chemical, and biological properties in the region of Sidi Bennour, Doukkala's irrigated perimeter, Morocco. Because the soils in the studied area are often deficient in OM, the reasoning is mainly focused on the possible recovery or maintenance of the OM content of the soil. This study aims to provide a rationale for the contribution of organic products, which will be used as amendments (manure or compost). GIS tools and remote sensing have shown interest in the characterisation of soil properties for several years. We used the possibilities of these techniques in the spatial establishment of fertilisation recommendation plans. The spatial distribution of OM was generated using Landsat data and the artificial neural network method (previous work). To estimate the organic amendments, the calculation method of the humus balance for a crop rotation over three years was used. The resulting maps were aggregated in

homogenous zones to aid agricultural consultants in disseminating advice to farmers. The results show that the average manure application with residue turning is approximately 30 tons/ha, and without turning is about 45 tons/ha. The average compost application with residue turning was about 15 tons/ha, and without turning was approximately 20 tons/ha. Fersiallitic and immature soils have the highest inputs due to their high mineralizing power, while isohumic soils and vertisols have the lowest inputs because of their low mineralizing power. The results obtained also show that, by adding 0.1% every three years (3 three-year rotations), more than 50% of the soil surface can be restored to 1.5% OM over a period of 9 years. Similarly, to restore more than 80% of the surface area, a period of 15 years would be required, i.e. 5 three-year rotations. Aggregating the findings into homogenous areas might make agricultural advisors' work easier and retain almost identical detailed maps. This method emphasizes the critical importance of geospatial tools and data in developing appropriate fertilizer advice strategies for a given location.

Keywords: soil organic matter, SIG, remote detection, fertilization planning, irrigation perimeter, Doukkala.

Heavy metal accumulation and changes in soil enzymes activities and bacterial functional diversity under long-term treated wastewater irrigation in East Central region of Tunisia (Monastir governorate)

CO-29

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Climate change and population growth generates a decrease in water availability around the world which can compromise the maintenance of sustainable agriculture. Thus, treated wastewater (TWW) became an alternative to minimize water shortage. However, this may indirectly affect the soil's microbial properties. In this study, different soils irrigated for 0, 1, 8 and 20 years with TWW were sampled and from the east central region of Tunisia. The objective was to investigate its effect on heavy metal accumulation and enzyme activities of β -glucosidase, arylsulfatase, acid phosphatase, alkaline phosphatase, urease, dehydrogenase, and fluorescein diacetate (FDA). Moreover, carbon microbial biomass (Cmic) using Substrate induced respiration (SIR) technique and microbial functional diversity using Biolog EcoPlate™ were assessed. Our results had shown a crucial decrease of the enzymatic activities in soils that

were newly irrigated with TWW, while a crucial increase was recorded in soils exposed to TWW for 20 years. In addition, chemical analysis revealed an important accumulation of heavy metals such as Cd, Cu, Zn and Ni along with the irrigation period, especially in 20 years-irrigated soils with TWW. The assessment of the bacterial functional diversity showed an important change in Average well color development (AWCD) and in diversity index values. Besides, substrate utilization profile revealed a significant variation along with the irrigation periods. In conclusion, long-term TWW irrigation has increased the metabolic activities of the soil's microorganisms. Meanwhile, traces elements accumulation could pose a serious threat for biological processes in soils and a limiting factor for the reuse of TWW in agriculture.

Keywords: Treated wastewater, trace elements, microbial biomass, soil enzymes, bacterial functional diversity.

Iron behavior and their relation to the physico-chemical properties in the hydromorphic soils of Beni Moussa perimeter, Tadla plain, Morocco: insight from the multivariate statistical analysis

CO-30

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This study aims to determine the iron behavior in the hydromorphic soil in the Beni Moussa perimeter, Tadla plain, Morocco. The hydromorphic soil was sampled at 17 collected sites in February 2020 to perform analysis of pH, organic matter (OM), Cation Exchange Capacity (CEC), Electrical Conductivity (EC), extractible iron, carbonate content (CaCO₃), granulometry, magnetic susceptibility, and heavy metals content. The results attest that the organic matter shows very high values because the samples collection sites represent the sewerage network. The mass magnetic susceptibility measurements show that all the samples have positive and low values with an abundance of paramagnetic minerals (ilmenite, siderite, and clayminerals, etc.). The iron concentration in hydromorphic soils increases from the top to the bottom of the valleys which shows that the iron migrates in reduced form. Inter relationships between the analyzed parameters and the different samples were investigated by multivariate analyses, principal component analysis (PCA), and hierarchical cluster analy-

sis (HCA). Pearson correlation coefficient indicates that the organic matter (OM) is positively correlated with cation exchange capacity (CEC) ($r = 0.83$) and electrical conductivity CE ($r = 0.85$), but it's negatively correlated with mass magnetic susceptibility high and low frequencies (MSLF and MSHF) ($r = -0.57$) and iron oxide measured by X-ray fluorescence (XRF) ($r = 0.42$). Calcium carbonate content (CaCO₃) is positively correlated with sand ($r = 0.49$), but it's negatively correlated with MSLF and MSHF and frequency dependence (FD) ($r = -0.7$). Fe is positively correlated with FD ($r = 0.7$), but it's negatively correlated with Sand ($r = -0.608$). clay is strongly negatively correlated with silt ($r = -0.88$) and FeO ($r = -0.55$), respectively. All of these findings suggest that the physicochemical features of Beni Moussa hydromorphic soils are strongly linked and that iron in the soil is required for the stability of specific soil components.

Keywords: Beni Moussa perimeter, Inter relationships, hydromorphic soil, multivariate analyses.

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Protection against the effects of radioactive fallout and contamination after a large-scale nuclear accident constitutes a worldwide worrying, particularly in agricultural sector because of resulting contaminated crops. The level of contamination of agricultural products depends on several factors, including the radionuclide deposition, the soil types, texture and chemical properties, the biological characteristics of the growing plants etc. Although the role of those different involved parameters is well understood in temperate region, it still data lack of radionuclide fate in under-explored environments such as arid regions. Many radionuclides may be released in a nuclear accident and with potential significance for agriculture, only a few of them have assumed major significance, specially radiostrontium and radiocesium. In this context, several soil samples from different agricultural regions from Morocco were analyzed to study the Factors that influence the radiocesium and radiostrontium behavior within the Moroccan soil, thus

sorption and desorption of strontium and cesium and the transfer factor.

The physico-chemical analysis were used to determine soil samples characteristics (texture, pH, organic matter and Exchangeable elements), while analysis by qualitative method X-ray diffraction (XRD), quantitative method fluorescence X spectrometry (SFX) and Induced Coupled Plasma coupled with mass spectroscopy (ICP-MS) were employed to identify and measure the concentration of the different soil constituents in the soil.

The results of soil analysis, for the different agricultural sites, were grouped in database, they show a large diversity of soils and its constituent's, X-ray diffraction patterns highlighted peaks of strontium and cesium in some soil samples and the fluorescence spectroscopy confirms this presence of cesium and strontium in those soil samples.

Keywords: Agriculture, Radioactivity, Cesium, Strontium, Soil, Transfer Factor

Science Alimentaire et Nutrition
Food Science and Nutrition.

Thème/Topic



Investigation of physicochemical and biochemical properties, antioxidant potential and antimicrobial activity of some vinegar commercialized in Morocco

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CC-01

Vinegar is a natural product widely used in food and traditional medicine as it contains many bioactive compounds. The raw material and production methods are two factors that play a major role in determining the quality of vinegar. Therefore, this study aims to determine the quality of commercialised vinegar samples purchased from local markets, through determining the physicochemical properties and antibacterial activity of these samples. The antibacterial activity was studied against four pathogenic bacteria and four yeast strains, using disk diffusion method to determine and the microdilution for determinate the Minimum Inhibitory. The results of this study showed a higher acetic acid value ($5.15 \pm 0.20\%$) for the apple cider vinegar (V2) prepared by industrial method. In other hand, the TPC, TFC and CTC in our samples (V4, V9 and V10) was $1154.00 \pm$

$99.68 \mu\text{g GAE/mL}$, $244.53 \pm 11.32 \mu\text{g QE/mL}$ and $84.63 \pm 1.00 \mu\text{g TAE/mL}$, respectively. The results of the antibacterial activity showed considerable activity of apple vinegar on the tested strains. Generally, the *C. albicans* strain appears higher sensitive against all samples, while the other strains have distinct sensitivities depending on the raw material and the method used. A lower MIC recorded in this study was against *S. aureus*. While for the fungal strain studied in this research showed a resistance against all of our samples. The choice of apple variety and production method is therefore an essential step in determining and aiming for the desired quality of apple vinegar.

Keywords: polyphenols, antioxidant activity, vinegar, production methods, antimicrobial activity, Morocco.

Efficacité de la déshydratation osmotique et du séchage des graines de grenade dans des solutions d'immersions à base de polyols, oses et osides

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CC-02

Ce travail vise en premier lieu à optimiser la déshydratation osmotique des graines de grenade en utilisant des édulcorants à faible pouvoir sucrant peu calorique et entrant dans la fabrication des produits « light ou sans sucre ». La déshydratation osmotique des graines a été effectuée en utilisant deux types d'oses (maltose et xylose), un oside (saccharose) et deux polyols (sorbitol et érythritol) à différentes concentrations (20%, 30%, 40%). En deuxième lieu à optimiser le séchage des graines de grenade en utilisant deux méthodes de séchage différentes (entraînement et solaire). Pour chaque méthode, différents paramètres physico-chimiques des graines ont été déterminés. Enfin les graines déshydratées osmotiquement et séchées ont été incorporées dans deux matrices alimentaires (muffin et thé) à différents formes (poudre et entière) et concentrations. L'optimisation de la déshydratation osmotique des graines de grenade a révélé que l'utilisation d'une solution osmotique à base d'érythriol (40°Brix) a permis d'obtenir le maximum de perte en eau (41,34%), le maximum de réduction en poids (40,32%) et le minimum de gain en solides (-0,08 %). L'analyse physicochimique des graines a montré une légère diminution de l'activité de l'eau (0,901) et une perte significative de la fermeté. En

plus, les résultats ont montré une diminution du pouvoir anti-radicalaire des graines, qui se traduit par la diminution de la teneur en polyphénols totaux (0,829 méq acide gallique/ml) et la teneur en anthocyane (0,02 méq cyanidine-3-glucoside/100g). L'optimisation du procédé de séchage nous a permis de qualifier le séchage solaire comme la technique la plus adéquate afin de sécher les graines de grenade durant une courte durée (5h) et avec un minimum de coût énergétique. Les analyses physicochimiques ont montré une amélioration de 4,62% de l'activité antioxydante et une modification significative de la texture et de la couleur des graines.

La valorisation des graines de grenade dans des produits alimentaires, nous a permis pour la première fois, d'élaborer du muffin et du thé infusion à base des graines de grenade light. L'analyse sensorielle des muffins a montré que les dégustateurs ont préféré les échantillons ayant un pourcentage d'incorporation de 10% de graine entière et/ou en poudre. Concernant le thé, les dégustateurs ont préféré l'échantillon issu du mélange 50% thé vert et 50% poudre de graine de grenade.

Mots clés : Graines de grenade, déshydratation osmotique, polyols, séchage, l'activité antioxydante, optimisation

Réglementation relative aux allégations nutritionnelles et de santé

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CC-03

Un grand nombre de nutriments et de substances présents dans les denrées alimentaires peuvent avoir des effets bénéfiques et faire l'objet d'une allégation. En effet, plusieurs textes réglementaires régissant les allégations nutritionnelles et de santé ont été adoptés au niveau international. Nous citons dans ce contexte les directives générales codex concernant les allégations «CAC/GL 1-1979», les directives du codex pour l'emploi des allégations relatives à la nutrition et à la santé «CAC/GL 23-1997», la loi de 1990 sur l'étiquetage nutritionnel et l'éducation adoptée par les Etats-Unis, le règlement n° 1924/2006 et le règlement (UE) n° 432/2012 adoptés par la commission européenne. Au Maroc, le seul texte régissant la matière détaille uniquement les allégations nutritionnelles, il s'agit de l'arrêté

n° 281-16 fixant les prescriptions et les modalités d'indication des informations nutritionnelles dans l'étiquetage des produits alimentaires préemballés. L'absence d'un règlement régissant les allégations de santé risque d'augmenter l'usage des allégations fausses voire même mensongères. Afin de combler ce vide juridique, l'autorité compétente doit élaborer d'autres textes spécifiques et doit renforcer ainsi le contrôle de l'étiquetage des denrées alimentaires portant des allégations afin de s'assurer de leurs exactitudes et de protéger ainsi le consommateur contre les informations trompeuses.

Keywords : Allégations nutritionnelles, allégations de santé, réglementation.

The impact of pedoclimatic factors on bioactive compounds profile in Moroccan olive oil

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CC-04

In recent decades, there has been an increasing interest in olive oil quality and benefits. Although, the data reported are still deficient and incomplete regarding the factors impacting olive oil's quality, mostly climatic and edaphic conditions. Hence, Moroccan olive oil and soil samples were collected from nineteen areas that are well-known by olive culture, and so, high production of olive oil. Using NP-HPLC-FLD and HPLC-PDA-ESI-MS respectively, five vitamin E isomers (α , β , γ , δ -tocopherol and α -tocotrienol) and twenty-three phenolic compounds were detected. The composition of this latter was grouped into four main classes; secoiridoids and derivatives (1112.3 mg kg⁻¹ of total average), phenolic alcohol (68.69 mg kg⁻¹), phenolic acids (20.44 mg kg⁻¹), and flavonoids (10.25 mg kg⁻¹). As well, the statistical analysis; correlation test, and Principal Compo-

nents Analysis (PCA) disclosed significant impact of some pedoclimatic factors on phenolic compounds (Particularly, some secoiridoids, phenolic acids, and flavonoids) in Moroccan olive oil.

Keywords: Olive oil, Phenolic compounds, Tocopherols, pedoclimatic, HPLC-PDA-ESI-MS, NP-HPLCFLD

Proposition d'une approche méthodologique de quantification des flux de matière dans les exploitations agricoles conduites en polyculture-élevage

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CC-05

Les exploitations agricoles ont connu, après la révolution verte, marquée par le développement de la mécanisation et l'essor de la politique productiviste, une tendance vers l'intensification et la spécialisation. Ce processus a généré des territoires uniformes et des systèmes de production qui ne valorisent pas les synergies entre les productions végétales et animales. Bien que cette nouvelle forme d'agriculture ait réussi à répondre aux besoins alimentaires de la population mondiale, de plus en plus d'inquiétudes émergent à propos des coûts sociaux, environnementaux et économiques de ces systèmes surtout avec une démographie croissante et des ressources de plus en plus limitées. La polyculture-élevage semble être une alternative agroécologique prometteuse aux systèmes spécialisés. Il s'agit d'une stratégie de production dans laquelle on associe, à différentes échelles, les activités de productions végétales avec les activités de productions animales. Les animaux d'élevage y jouent un rôle clé, servant à valoriser les produits végétaux non propres à la consommation humaine (résidus de cultures et adventices) pour les convertir en produits de valeur dont le fumier, ce qui contribue dans la circularité des nutriments au sein de l'exploitation, une meilleure valorisation des ressources non renouvelables, et une plus grande résilience de l'ensemble du système face aux risques et crises socio-économiques et climatiques. Dans les systèmes mixtes, et notamment dans les petites exploitations où les ressources sont limitées, les résidus de récoltes, les adventices

ou les résidus de taille sont des sources importantes d'aliments pour ruminants. Étant donné que ces produits, ne consomment pas d'eau supplémentaire, ils représentent une opportunité réelle d'augmenter la productivité de l'eau dans l'ensemble du système. La revue bibliographique des travaux existant laisse apparaître un manque au niveau des approches méthodologiques à adopter afin de quantifier les flux de matières circulant dans une exploitation agricole, ainsi que les volumes d'eau associés à ces flux. Cette étude vise à apporter une contribution à l'élaboration d'une méthodologie à même de répondre à ce manque à travers : i) l'identification des flux de matières entre les composantes du système, ii) l'estimation de leurs volumes et iii) la conversion de ces volumes en quantités d'eau associées. Après une synthèse bibliographique traitant des intérêts économiques et environnementaux des exploitations agricoles mixtes ainsi que leurs classifications et caractéristiques, un ensemble de méthodes et d'outils ont été proposés faisant appel aux normes de productions par espèce d'élevage, selon le mode de conduite, l'âge et l'alimentation comme références afin d'estimer les quantités de fumier produites par exploitation. L'échantillonnage par quadrats est suggéré pour l'estimation de la phytomasse des adventices aussi bien dans les parcelles cultivées ou dans les vergers. Tandis que les estimations des quantités des résidus de cultures se sont basées sur les rendements et les indices de récolte.

Mots clés : polyculture-élevage, flux de matière, circularité, productivité de l'eau, méthodologie.

Valorization of the residue of the red algae *Gelidium sesquipedale* as organic fertilizer

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CC-06

The use of chemical fertilizers affects the environment and human health, therefore there is a need to use biological products such as manure, biofertilizers and organic fertilizers. The cooking stage of the seaweed generates a large amount of residues that are released after the extraction stage. The objective of this study is to characterize and evaluate the fertilizer value of the red algae *Gelidium sesquipedale* residue on strawberry crop. The total nitrogen of the residues was determined by the Kjeldahl method, the phosphorus, calcium and potassium, the microelements (iron, zinc, copper, manganese), were determined by ICP analysis (induced coupled plasma). The strawberry crop was grown in a greenhouse. The residue was applied at a rate of 0g, 70g and 210g per pot. Macroelements and microelements in strawberry fruit and post-harvest soil were determined by X-ray fluorescence spectrometry, and organic matter was determined by titration with potassium

dichromate. Application of *G. sesquipedale* residue significantly improved the number of leaves, flowers, leaf dry weight, and fruit weight of strawberries after harvest for the different treatments compared to the control. Similarly, the residue significantly increased macroelements and microelements in strawberry fruits, in particular (nitrogen, calcium, manganese, iron, and zinc). as well as the application of residue significantly increased soil organic matter, soil macroelements and microelements after the strawberry harvest in particular (nitrogen, calcium, manganese, iron, copper zinc). These results reveal the potential of *G. sesquipedale* residues as organic fertilizer that can reduce the use of chemical fertilizers.

Keywords: *Gelidium sesquipedale* residue, organic fertilizer, macroelements, microelements, strawberry tree.

Utilisation de l'Acide folique dans la prévention des malformations congénitales dans la région de Béni Mellal-Khénifra

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CC-07

L'acide folique (vitamine B9) ou Folate fait partie des vitamines essentielles qui ne sont pas produites par le corps. Il joue un rôle important dans le processus de croissance et du développement du système nerveux et cérébral du fœtus. Par conséquence, un manque d'Acide folique chez la femme enceinte augmente les risques d'une anomalie de fermeture du tube neural (ex : spina bifida chez le fœtus). D'où la nécessité d'une supplémentation avant et pendant la grossesse pour la prévention des malformations congénitales. Le suivi de l'utilisation de ce complément alimentaire chez les femmes enceintes, spécialement les femmes ayant un nouveau-né malformé, est un indicateur majeur pour l'évaluation du Programme National de Lutte contre les Troubles dus aux Carences en Micronutriments. Dans cette perspective qu'en venons la présente étude visant l'utilisation de l'acide folique par les mères ayant données naissance à des nouveau-nés malformés dans la région de Béni Mellal-Khénifra, et par conséquent l'évaluation de la mise en œuvre du programme national au niveau local. Pour atteindre cet ob-

jectif une grille de collecte des données est établie pour extraire les données nécessaires à partir de dossier d'accouchement des mères ayant données naissance à des nouveau-nés malformés dans les structures d'accouchement de la région étudiée. Les résultats ont montré que la région a enregistré 930 cas de malformations congénitales entre Janvier 2017 et Septembre 2020 dont 150 cas d'anomalie de fermeture du tube neural. Seulement 1.5% de ces mères ont utilisé l'acide folique avant la grossesse alors que 1.28% des mères ont consommé ce supplément durant la grossesse, soit 1.18% dans le premier trimestre et 0.2% des mères ont consommé l'acide folique plus tardivement dans la grossesse. Malgré les recommandations de l'organisation mondiale de la santé et du ministère de la santé marocaine, le taux de femmes recevant une supplémentation en acide folique est insuffisant ce qui peut expliquer le nombre important des malformations congénitales dans la région d'étude.

Mots clefs : Acide folique ; Prévention ; Malformations congénitales ; Anomalie de fermeture du tube neural, Béni Mellal-Khénifra.

Detection of *Entamoeba histolytica* in fruit and vegetable wash-water, and correlation of the parasitic contamination with water quality

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CC-08

Consumption of fruits and vegetables is highly beneficial since they form the major component of a balanced healthy diet. However, the unhygienically prepared fruits and vegetables act as a potential source for the spread of food-borne pathogenic microorganisms, such as *Entamoeba histolytica*, an intestinal protozoan parasite that causes widespread mortality and morbidity worldwide. Its transmission occurs through the fecal-oral route, mainly after the ingestion of contaminated food. Generally, an effective way of selecting appropriate intervention steps to reduce this public health problem is to identify the source of contamination. And since it is well-known that vegetables may get exposed to polluted water during their production, preparation and processing, a large number of studies documented the observation of *E. histolytica* in irrigation- and surface-water (Hemmati et al., 2015; Saleh et al., 2018). However, the parasitic quality of the wash-water, as well as the environmental conditions that may favorize the survival of this chlorine-resistant microorganism, remain obscure. Therefore, the aims of this study were to evaluate

the contamination of tap water by *E. histolytica*, and to determine the physico-chemical parameters and/or the microbiological quality of *E. histolytica*-positive samples. In this regard, random tap water samples were collected from South Lebanon, and after concentration, the presence of *E. histolytica* was investigated, and then, various physico-chemical factors (including temperature, pH, TDS, chlorides, nitrates, sulfates, phosphates) and microbiological quality were all tested. Interestingly, our preliminary results showed a high prevalence of this pathogen in the tap water within this geographic region, and a positive correlation with the microbiological profile ($p < 0.05$). In conclusion, our findings suggest a need to improve the quality of the tap water used for washing of freshly consumed fruits and vegetables in order to ensure food safety in Lebanon, and importantly, an indirect parasitic decontamination strategy could be introduced by controlling the newly correlated microbiological characteristics.

Key words: *E. histolytica*, food-borne pathogens, tap water, water quality.

Screening and characterization of *Streptomyces* spp. isolated from Moroccan ecosystems producing a potential inhibitor of the drug efflux pump AcrAB-TolC

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CC-09

Traditional antimicrobial antibiotics are increasingly suffering from the emergence of multidrug resistance among pathogenic microorganisms. The antibiotic era is threatened by the ruthless rise of resistance in bacterial infections. A significant role in these resistance profiles is attributed to multidrug efflux pumps. Hence, much effort is being directed towards developing new compounds to overcome this problem. During our screening program of efflux pumps inhibitors (EPI) produced by bioactive Moroccan Actinobacteria, 210 isolates were screened for their antibacterial activities against a wild-type strain of *Escherichia coli* containing a system of efflux pump AcrAB-TolC fully functional and its mutant inactivated due to the insertion of transposon Tn903 in AcrAB operon, using the method of agar disc. Ob-

tained results showed that 14 isolates were able to produce EPI as they were active against the wild type strain but not against the mutant in comparison with the synthetic inhibitor L-Phe-L-Arg- β -naphthylamide (Pa β N). We focused on the highest EPI activity produced by four strains (Z332, Z35/G, Z385/b and 136). Taxonomic studies and 16S rDNA sequence indicated that these strains belonged to the *Streptomyces* species. This work could contribute significantly to the discovery of a new class of antibacterial agentseading to expand the therapeutic arsenal.

Keywords: Efflux pumps inhibitor; *Streptomyces*; screening, morphological and physiological characterization; molecular identification.

Technological and probiotic features of interactive lactic acid bacteria isolated from camel milk raised in a Moroccan Argane biotope

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CC-10

Camel milk represents a high nutritional value and its composition is an essential factor for human health as well as a source of income. From another hand Lactic acid bacteria (LAB) occupies a central role as starter cultures in fermentation process and for their ability to create a healthy equilibrium between beneficial and potentially harmful microorganism in the gut. The objective of this study was to isolate, identify and characterize the technological and the probiotic properties of the resident lactic flora in camel milk from a Moroccan Argane biotope. A total of 96 strains of LAB, obtained from camel milk characterized by a diet based on Argane by-product, were screened for transit tolerance in simulated upper gastrointestinal tract (GI), for adhesion capacity to human intestinal cell lines, for hydrophobicity, for co-aggregation and auto-aggregation and for antimicrobial activities against three tested pathogenic strains (*E. coli* CIP 53126, *Staphylococcus aureus* and

Salmonella enteric CIP 483 CIP 8039). Evaluation of technological capabilities indicated that all strains showed good acidifying power, while 95.23 % of them are able to produce texturizing agents (exopolysaccharides) suggesting their possible use to manufacture fermented products. Meanwhile, the molecular identification showed that the biodiversity of raw camel milk in the mentioned region is characterized by lactic acid bacteria belonging to the species *Lactobacillus plantarum*, *Lactobacillus brevis* and *Lactococcus lactis* sp. *lactis* l.

Keywords: Antibacterial activity, camel milk, probiotic properties, technological aptitudes.

Chemical composition, nutritional value, and antioxidant capacity of Algerian species of wild growing mushrooms

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CC-11

Desert truffles known as the vernacular “El Terfess” is a rare edible wild mushroom of oddity of nature that belongs to the family of ascomycota; these truffles are well distributed around the globe. The preferred area of these mushrooms is located mainly around the perimeter of the arid, semi-arid and Saharan zones of the Mediterranean Basin (Europe and Maghreb), and in the Middle East: Iraq, Kuwait, the Sahara of the Gulf and the Saudi Arabia. The purpose of this study was to determine the content of primary and secondary metabolites and to evaluate the antioxidant activity of methanol extracts of dried ascocarps from four Truffle species harvested from three Regions of south-western Algeria. *Terfezia boudeiri* from *Tabelbala Béchar* showed a nutritional richness with $13.32 \pm 0.14\%$ of proteins, $5.8 \pm 0.173\%$ of lipids, $6.25 \pm 0.11\%$ of sugars and $7.25 \pm 0.55\%$ of minerals, compared to other species *Tirmania nivea* and *Terfezia claveryi* from Chelala, and *Terfezia arenaria* from Mecheria. The quantitative estimation of flavo-

noids, tannins, vitamin C, carotenoids and total phenols showed that the methanolic extracts were rich in these compounds with different proportions between the four species where *T. boudieri* always showed a preponderance polyphenols and tannins with 53.62 ± 0.26 mg EAG / g and 12.42 ± 0.10 mg EQ / g respectively. For *T. arenaria* and *T. claveryi*, the first have the highest level of flavonoids (19.44 ± 0.30 mg EC / g) and the second the highest level in carotenoids (1.83 ± 0.04 mg / ml). Evaluation of antioxidant potency by the DPPH and FRAP tests indicated that the *T. boudeiri* extract had an antioxidant activity of 90% at the concentration of 1 mg/ml, unlike the other species which showed moderate activity between 42.06 and 77.82% at the same concentration. Ultimately, truffles can be recommended for their nutritional and undeniable therapeutic benefits.

Key words: truffles, *Tirmania*, *Terfezia*, nutritional principles, antioxidant activity, functional food.

Preservation of microbiological and sensory quality of sheep meat by using pomegranate bark extracts

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CC-12

Fresh meat is a sensitive and unstable product over time due to its composition and physicochemical characteristics (pH and aw). The length of storage time depends on temperature, atmospheric oxygen, endogenous enzymes and humidity, light and, above all, the microorganisms initially present. The challenge of preserving meat dates back to antiquity and has now intensified with the industrialization of meat products. Thus, in this work, we studied the conservation of meat by pomegranate bark extract to extend meat storage time, which may be a promising way to promote this coproduct of pomegranate in meat industry. We evaluated the effect of pomegranate bark extract on the growth of microorganisms naturally present in sheep meat. We carried out the microbial germ count by the decimal dilution method. We performed successive dilutions of the sample in sterile

physiological water. Then, we evaluated total aerobic mesophilic flora (TAMF) and total coliforms (TC) The treated meat with three concentrations of extracts (50-25-0.12 mg / ml) were stored at 4°C. We monitored the physicochemical and microbiological modification during 12 days of conservation. The results show that the microbial kinetics of the strains were significantly affected by pomegranate bark extract especially with high concentration (C1 = 50 mg/ml). A significant increase in UFC (colony-forming unit) over time was observed in the untreated meat. In conclusion, pomegranate bark extract has a preservative effect against microbial alteration of raw sheep meat.

Keywords. Pomegranate bark, sheep meat, conservation, microbial alteration.

Contribution to the valorization of some varieties of local cereals from Khénifra and Tétouan regions in Morocco

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CC-13

The Moroccan diet is of Mediterranean type, characterized by biological and cultural diversity and a culinary heritage allowing saving in Moroccan cuisine diversified dishes based on a complementarity between different food groups of which the most present group is that of cereals and cereal products. The objective of this work is to contribute to the identification and the study of knowledge on certain local cereals as well as their use in traditional dishes in two regions of Morocco: Khenifra and Tetouan.

A survey was carried out in two regions, the province of Khénifra in the Middle Atlas and the province of Tétouan in northern Morocco. The survey involved a sample of women and men from 250 urban and rural households in the two provinces. Using a focus group, information were also collected on the cereals' ethnobotanical and culinary knowledge, the period of consumption, uses as well as a description of the recipes that include them, and their consumption now or in the past.

The results show that more than 40 traditional recipes have been recorded, where local cereals are the main ingredi-

ents, especially durum wheat, common wheat, barley, white corn and red corn. Most of the cereals mentioned are eaten frequently, others are less so. Participants report that the latter grains were previously consumed and used in recipes consumed during times of food shortage. A significant diversity of traditions and culinary culture is observed and can explain the dietary diversity observed in the two regions studied, hence the need to enhance by nutritional analyzes on each variety to save this richness.

The results of the study are discussed in relation to the content of each variety analyzed in nutrients in comparison with conventional varieties. These data contribute to the nutritional value of these cereals and the culinary preparations of the dishes which includes them. The enhancement of these varieties would help diversify food, encourage the consumption of local products and fight against the loss of local cereal heritage.

Keywords: Cereals, Variety, Local, Nutritional Valorisation, Diet diversity.

Ethnobotanical Study about knowledge of food plants, and traditional recipes among the population of the Khenifra region in Morocco

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CC-14

The sustainability and protection of food resources and the environment contribute to the nutritional value of foods, plants, and dishes used to safeguard culinary heritage. Khenifra is a mountainous region of Morocco known for its richness in biodiversity. This work is to study the diversity of foods in this population and document ethnobotanical and culinary knowledge.

A survey was carried out in seven communes of the rural and urban areas of the province of Khenifra. The survey covered 58 households and was included a sample of 206 people (women and men) of 66% in rural areas and 34% in urban areas. The data was collected using a questionnaire to request socio-demographic data, a description of the recipes and their preparation, data on ethnobotanical, culinary, and medicinal knowledge of plants and their toxic effects are collected on a focus group.

The results show that more than 60 traditional recipes have been recorded, including those which are still consumed

frequently, those consumed before and the recipes consumed during periods of food shortage, nutritional analyzes are being carried out on some samples collected.

The people of the Khenifra region often use different aromatic and medicinal plants in their daily life. The study also reports a wide food variety and ethnobotanical richness, so far breeding nearly 89 plants belonging to 31 families.

The diversity of traditions and culinary culture explains the dietary diversity observed in this region of Morocco. This draws attention to the importance of safeguarding this wealth, and fighting against the loss of ethnobotanical knowledge.

Keywords: Biodiversity; Khenifra region; Traditional dishes; Food plants; Culinary culture.

Evaluation of phenolic compounds, antioxidant capacity and anti-glycation properties of Moroccan date palm (*Phoenix dactylifera* L.) fruits grown in Zagora region

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CC-15

The fruits of the date palm *Phoenix dactylifera* are one of the most consumed fruits in the world due to their nutritional and therapeutic properties. In Morocco the phoeniculture sector occupies a special place, it has an impact on the local economy of the oasis population and the national economy. However, the majority of varieties and clones that exist in Moroccan oases and that are resistant to biotic constraints, especially “bayoud” disease, are varieties and clones with low commercial potential, which requires other ways of valorization. The objective of the present study was to evaluate the phenolic content in the pulp of two date varieties classified by INRA as varieties with low commercial potential and to determine the antioxidant and anti-glycation activity of the ethanolic extracts. The results showed that the total phenolic content ranged from 117.124 - 153.635 mg gallic acid equivalent (GAE)/100 g dry matter (DM), while the total flavonoids ranged from 71.01 to 94.219 mg quercetin equivalent (QE)/100 g (DM), and condensed tannins content is between 26.565 and 48.428 mg catechin equivalent (CE)/100 g (DM), flavo-

nols and anthocyanins values are between 14.538-23.994 mg CE/100 g (DM) and 1.051-1.223 mg /100 g (DM) respectively. Antioxidant activity ranged from 336.472 to 414.291 μ mol TE/100 g (DM) for DPPH (2,2-diphenyl-1-picrylhydrazyl), from 80.513 to 91.229 μ mol TE/100 g (DM) for ABTS (Trolox equivalent antioxidant capacity), and from 7.302 to 9.022 mM TE/100 g (DM) for FRAP (Ferric reducing antioxidant power). The anti-glycation activity evaluated via the BSA-Fructose model and expressed in mg/ml showed that the Iklane variety has a high glycation inhibiting power (IC50: 84.912 mg/ml) compared to the Bousthammi Noire variety (IC50: 110.516 mg/ml). This study highlighted that those dates are a real source of antioxidant compounds and anti-glycative agents that should be used in the pharmaceutical and nutraceutical industries to develop new drugs and value-added food products.

Keywords: Morocco, *Phoenix dactylifera*, dates, phenolic compounds, antioxidants, anti-glycation.

Profil épidémiologique des femmes enceintes et répercussions sur le poids de naissance des nouveau-nés à la province El Jadida/Maroc (étude cas-témoins)

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CC-16

Le faible poids de naissance (FPN) est un prédicteur important de la morbidité et mortalité néonatale, il reflète de l'état nutritionnel de la mère et de la qualité des prestations sanitaires pendant la grossesse. Il s'agit d'une étude transversale cas-témoins qui a pour objectif d'étudier certains facteurs de risques maternels et socioéconomiques associés au FPN, de comparer les mesures anthropométriques des nouveau-nés à FPN avec ceux des nouveau-nés de poids normal (PN).

L'étude a répertorié 172 parturientes qui ont donné naissance à des nouveau-nés de FPN et 172 parturientes qui ont accouché de nouveau-nés de PN. Les proportions du FPN sont plus grandes chez les primipares (50,6%), les mères analphabètes (59,9%) et les inactives professionnellement (86,6%). Le poids moyen des nouveau-nés de FPN est 2013,95 \pm 372,95g contre 3380 \pm 217,59g pour

les nouveau-nés de PN. Après ajustement par rapport aux variables intégrées dans l'analyse, les facteurs associés au FPN déterminés sont le bas niveau socioéconomique (OR=3,18; IC95%: 1,09-9,23), le suivi insuffisant de la CPN (OR=2,91; IC95%: 1,71-4,95), la provenance du milieu rural (OR=0,52; IC95%: 0,30-0,91) et l'absence d'éducation nutritionnelle (OR=0,17; IC95%: 0,09-0,34). Des actions d'éducation et de sensibilisation bien ciblées et coordonnées sur la grossesse précoce, l'alimentation de la femme enceinte pourraient avoir un impact positif sur l'amélioration du taux des naissances des enfants avec un déficit pondéral.

Mots clés : Femme enceinte, faible poids de naissance, facteurs de risque, mesures anthropométriques, état nutritionnel.

Evaluation de la qualité réglementée et nutritionnelle de l'huile d'olive de la région de Meknès : une première étape vers l'emploi des allégations nutritionnelles et de santé dans l'étiquetage de ce produit

CC-17

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De nos jours, la caractérisation de la qualité de l'huile d'olive vierge et sa richesse en éléments nutritifs et bioactifs suscite un intérêt croissant de la communauté scientifique. A cet effet, en se basant sur des résultats scientifiques qui associent la consommation modérée et quotidienne de l'huile à un large spectre d'activités biologiques (activités antibactériennes, anti-cancérigènes, anti-inflammatoires, anti-oxydantes, etc...), certaines législations ont récemment autorisé la mention d'allégations nutritionnelles et de santé spécifiques liées à la richesse de ce produit en certains composés. Ces allégations constituent un outil important d'incitation à la consommation de l'huile d'olive en particulier dans les marchés émergents. Par conséquent, la caractérisation de la qualité réglementée et nutritionnelle de l'huile d'olive de la région de Meknès (l'une des principales zones oléicoles du Maroc) a un intérêt majeur pour explorer son éligibilité à porter dans son étiquetage une/des allégation(s) nutritionnelle(s) et de santé. Pour faire, 21 échantillons d'olives de la variété 'Picholine Marocaine' ont été prélevés au cours de la campagne 2015-2016. Les huiles d'olive ont été extraites et leur qualité réglementée et nutritionnelle a été étudiée. Les résultats obtenus montrent que, pour les critères de la qualité physico-chimiques, tous les échantillons analysés dans le présent travail peuvent être classés dans la catégorie des huiles d'olive vierge-extra (acidité

libre allant de 0.10 à 0.36%, indice des peroxydes oscillant entre 1.40 et 2.60 meq O₂/kg, et des coefficients d'extinction à l'ultraviolet variant de 0.12 à 0.21 pour K₂₃₂ et de 1.50 à 1.82 pour K₂₇₀). En outre, l'analyse sensorielle des échantillons de l'étude a permis, d'abord, de confirmer la qualité supérieure de ces huiles (absence de défauts organoleptiques ce qui permet de classer ces échantillons dans la catégorie des huiles d'olive vierge-extra), ensuite, de dresser un profil sensoriel typique des huiles d'olive produites dans la région de Meknès. Pour ce qui concerne le profil nutritionnel des huiles étudiées, il a été démontré que celles-ci présentent un profil équilibré en acides gras et une richesse particulière en pigments (variant de 14.50 à 17.51 mg/kg pour les chlorophylles, et de 8.96 à 9.55 mg/kg pour les carotènes), en composés phénoliques (une teneur moyenne en dérivées de l'hydroxytyrosol d'environ 697.21 mg/kg (équivalent à 13.95 mg/20 g)), en tocophérols (avec des valeurs moyennes fluctuant entre 233.71 et 261.71 mg/kg) et en phytostérols (intervalle de variation allant de 1647.42 mg/kg à 1794.50 mg/kg). L'évaluation de ce profil nutritionnel a permis de démontrer l'éligibilité de l'huile d'olive de Meknès à porter dans son étiquetage des allégations nutritionnelles et de santé en relation avec sa teneur en acides gras, tocophérols et composés phénoliques.

Mots clés : huile d'olive, 'Picholine Marocaine', qualité réglementée, profil nutritionnel, allégations nutritionnelles et de santé.

Evolution of the intra-flesh texture under the pectinolytic enzyme activities impact during apricot ripening

CC-18

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The softening of apricot fruit results from significant changes in the cell wall which occurs during maturation. These modifications are essentially the result of enzyme activity modifying the cell walls composition and are involved in the detachment of the cell wall, which promotes tissue extension and growth. In this work, the activities of important pectinolytic enzymes involved in the degradation of the cell wall, and consequently the loss of firmness, namely pectin methylesterase (PME), polygalacturonase (PG) and β -Galactosidase (β -Gal), were monitored during two ripening stages (commercial and consumption) in 10 apricot clones. The overall results suggested that the maturation of the apricots was coordinated by the three pectinolytic enzyme activities, since PME, PG and β -Gal activities

increased during ripening while fruit flesh firmness decreased. In addition, the results showed that apricot softening was more controlled by β -galactosidase and PME. There were large effects of clone, ripening stage and tissue zone on the firmness and enzymatic activities of apricots. For most clones, the firmness levels were higher in peduncle zone, followed by the equatorial zone and at last the pistil zone. Contrariwise, the enzymatic activities were found important especially in pistil zone followed by the equatorial and peduncle zones. The enzymatic activity evolution observed are discussed in relation to published information about ripening of apricots and to results reported using other species.

Keywords: Apricot, texture, quality, enzyme activity, softening.

Impact d'un nouveau éco procédé thermique d'amélioration de la qualité sanitaire sur les propriétés physico chimique, les bioactifs et l'activité antioxydante de la pulpe de l'arganier « *Argania spinosa* L »

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CC-19

Dans le cadre du projet PPR R2B INNOV valorisation par innovation industrielle des produits de terroir marocain : les PAM, cactus, olivier,...et l'arganier sur l'amélioration de la qualité sanitaire par approche Eco décontamination d'une part et formulation innovante de nouveaux produits industriels en bio cosmétique et compléments alimentaires en partenariat avec nos collaborateurs CNRST MENFCESRS, la société IRCOS laboratoires. Après avoir breveté notre éco procédé « BIOSOL » sur la menthe, romarin, le thym... (plus de 3 Thèses et plus de 10 publications,...), nous avons extrapolé notre procédé à d'autres ressources naturelles oliviers, stevea, arganier, tout en poussant notre curiosité scientifique vers l'impact du facteur température sur la qualité physico chimique, bio thérapeutique notamment les polyphénols, l'activité anti-oxydante et d'autres bioactives. La présente étude vise à évaluer l'impact de stress thermique des différentes températures de notre éco procédé bio thermique allant de 40 à 100°C et ce sur les propriétés physicochimiques, la qualité des bioactifs notamment les polyphénols et l'activité antioxydante de la poudre de la pulpe d'argan. La température critique été à 60 et 70°C. L'analyse physicochimique a montré que la teneur en hu-

midité été plus affectée par rapport aux pH, et les solides solubles. L'évaluation biochimique a montré que la teneur en chlorophylles (a, b) de la poudre traitée a été affectée de manière significative, contrairement au couleur (valeur b*). La température 70°C avait la plus haute teneur en polyphénols 349.14 mg EAG/100 g MS par contre la température 100°C a engendré la libération et biosynthèse en flavonoïdes 28.8 mg EC/100 g MS. Même résultats ont été constatés dans nos travaux antérieurs lors de traitement des bioressources naturelles par le rayonnement gamma. Le test de DPPH a montré une perte importante du pouvoir anti radicalaire en fonction de la température. Deux température « 70-80 °C » présenté une forte augmentation de l'activité antioxydante, déterminée par les teste ABTS et FRAB. L'analyse qualitative et quantitative des composées phénoliques et des acides gras à différentes températures par LC-MS et GC-MS a confirmé un impact significatif en fonction de la température de traitement.

Mots clés : *Argania spinosa* (L.), activité antioxydants, LC-MS, GC-MS, polyphénols, analyse chimique.

Impact de température de séchage et la granulométrie de la poudre des feuilles d'olivier variété picholine marocaine sur les bioactifs organiques et leur activité antioxydante

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CC-20

Les sous-produits des industries des plantes aromatiques et médicinales présentent une potentielle énergétique considérable. Parmi ces plantes, l'olivier occupe une importante valeur socioculturelle dans les pays méditerranéens particulier au Maroc, la culture et l'industrie oléicole engendrent des quantités importantes des feuilles d'olivier. L'objectif de ce travail est de suivre la cinétique de séchage classique et d'avoir l'influence de la température de séchage et de la granulométrie de poudre sur la teneur en composés phénoliques et leur activité antioxydant des extraits des feuilles d'olivier variété picholine marocaine.

Les principaux minéraux des feuilles d'olivier déterminé par ICP-MS étaient le calcium (27.1g/kg); potassium (6.68g/kg); magnésium (2,72g/kg); et des oligo-éléments tels que le sélénium (5,35 g/kg) et le zinc (0,02g/kg) ,la teneur en bioactifs organiques le plus élevé est celle de la température de 80 °C avec une concentration des composés phénolique(TPC) de 76 ± 2,1 mg EAG/g de MS et de 45 ± 1, 3 mg Ec/g MS des flavonoïdes(TFC), la taille des particules le

plus petite présente une concentration important par rapport à les autre .L'analyse qualitative et quantitative des composée phénolique à différentes températures par LC-MS a confirmé un impact significatif en fonction de la température . L'activité antioxydant des extraits a été évaluée par trois méthodes, la réduction du fer (pouvoir antioxydant réducteur ferrique ou FRAP), le piégeage du radical libre 2,2-diphényl-1-picrylhydrazyl (DPPH) et 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid (ABTS), les feuilles d'olivier a une activité antioxydant importante avec l'augmentation de la température l'évaluation de l'activité antioxydant des polyphénols totaux révèle des pourcentages inhibition importante. Ceci classe les polyphénols de l'olivier comme antioxydant puissant.

Les mots clés : plantes médicinales, polyphénols totaux, flavonoïdes, granulométrie, activités antioxydants

Preliminary insight into Tunisian consumers' opinions and habits toward organic products

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CC-21

Organic farming is defined as “a production system that is managed to respond to site-specific conditions by integrating cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity”. According to this definition, organic farming would meet the objectives of sustainable agriculture. This research aimed to investigate opinions and habits related to organic products. An online survey, was conducted in April 2021 (21 days) with 211 Tunisian consumer aged between 18 and 60 years. Respondents were asked about their demographic characteristics, consumption of organic products reason (or reasons for non consumption) and habits. Results showed that 44.1% of respondents do not consume organic products and the most reported reason was the price. For organic products consumers (55.9%) main reasons are quality (lack of chemicals and pesticide residues), health and environmental issues. Most bought

organic products are olive oil, fruits and vegetables. Regarding shopping place respondents reported, in order: Local producers, supermarket and stores of organic products. Only 11.4% of respondents consume organic products every day while 76.1% (25% certainly, 51.1% rather yes) of them think that they would increase purchasing of organic products in the future. Results of this study highlight the awareness of Tunisian consumers about the importance of organic products on their health and on the environment. As reported by respondents, high price is the main factor negatively influencing their attitude towards the organic product. Accordingly, more efforts and strategies need to be developed to encourage organic products consumption.

Keywords: Organic products, consumption, survey, consumer attitude, SDG12.

Physicochemical characterizations and drying of Eucalyptus leaves: The incorporation of the dried powder of these leaves in chewing gum without sugar

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CC-22

Food industries are always looking to innovate its products. The idea was to integrate medicinal plants into the chewing gum formulation in order to improve human health specially children. The therapeutic use of the extraordinary virtues of plants for the treatment of human diseases is usually mankind. Currently, aromatic plants have a considerable advantage thanks to the progressive discovery of the applications of their essential oils in health care as well as their uses in other fields of economic interest. The plant utilization is increased that's means that they are demanded on the world markets.

The consumption of chewing gum is increasing day by day especially for adolescents and children. Thus, this product is a source of pleasure. Whose world consumption of chewing gum is half a kilo per person per year. Eucalyptus is one of the most widely used medicinal plants around the world. The extracts of the leaves of this plant have been widely used in traditional medicine

for centuries against influenza, and in particular as an anti-inflammatory. Recent studies point to the antioxidant and antimicrobial properties of these essential oils. This work aims to incorporate Eucalyptus (which is a medicinal plant) powder in chewing gum formulation. Three types of Eucalyptus were chosen in this study (Hawwaria (type1), Makther (type2) and Haffouz (type3)). The physico-chemical characterization of leaves powders shows their richness in fiber and phenol compounds. The new products tested show a good microbiological and physicochemical characterization that showed the richness of type 1 powder in phenol compounds, production trials of new chewing gums based on phenol compounds extraction have been developed.

Keywords: Eucalyptus, phenolic compounds, drying, physicochemical characterization, chewing gums.

Best Pulses For Human and Planetary Health

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CC-23

Food choices are determinant for optimizing human health and environmental sustainability. The nutritional composition of legumes makes them the best allies in promoting health, and their production tends to have lower greenhouse gas emissions. Here, we analyzed 10 legumes, according to 10 main nutritional characteristics highlighted by the Food and Agriculture Organization of the United Nations (FAO) as the main reasons for their consumption, in a step-by-step approach integrating risks and benefits, according to three levels of analysis: Identification of health effects associated with its consumption; Assessment of the nutritional contribution of its consumption to the Daily Reference Value (%DRV); and Integration of health and sustainability components. It was found that all legumes seem to promote improvements in risk factors associated with the development of chronic diseases. As for the nutritional contribution of each legume, analyzed according to official recommendations, considering its protective components (protein, fiber, iron, folate, and

potassium), the Common Lupine, Cowpea and Soybean, were ranked as the most beneficial for health. Considering its components to be limited (glycemic index, saturated fat, cholesterol, and sodium) the Azuki Bean and Chickpea seem to be the least harmful legumes for human health. Regarding the link between the health and sustainability, the pulses presenting better impact for human and planetary health are Fava, followed by Common Lupine and Common Beans, if cooked without salt and produced locally. As an integral part of a balanced dietary pattern, this study strengthens the evidence that the consumption of legumes, which are dense in protective nutrients when compared with the concentrations of harmful nutrients, plays an important role in the promotion of human and planetary health, and its consumption should be privileged and promoted in Portugal.

Keywords: Grain legumes; Pulses; Health effects; Sustainability; risk-benefit.

Assessment of Sensory and Biochemical Profil of a Carob Pulp-Based Beverage

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CC-24

Located in the plains and medium mountains of Morocco, the carob tree is present in the form of natural or artificial plantations. This tree is of considerable socio-economic importance, helping to improve the income of rural populations and to develop the economy of mountain areas.

Despite this socioeconomic importance of carob fruit, the primary uses of the carob's pulp in Morocco are generally limited to animal feed. For humans, carob's pulp has been used primarily to prepare traditional therapeutic drinks. Therefore, the current research aims to propose a novel and optimized ways of processing and valorisation that can help to fully exploit the carob's pulp and present to the consumer a varied range of products with significant nutritional value. The main purpose of this research is to characterize a new formulated carob beverage process and assess its biochemical and sensory quality. Two formulas for the carob beverage were prepared with two different sugar concentrations (formula A: 5 g/100ml sugar; formula B: 10 g/100ml sugar). Measurements of pH, acidity, and colour were used to assess the physico-chemical criteria. Total

polyphenols and tannins contents were determined as important biochemical criteria. Regarding sensory analysis, preference test, triangle test, hedonic test, and descriptive test, were evaluated. The colour of the two formulations was dark red orange, as determined by the physico-chemical characterisation of the beverage. For formulae A and B, the titratable acidity was (1.42±0.031) EACmg/100ml and (1.45±0.031) EACmg/100ml, respectively, and the Brix was (11.67±0.22) Bx° and (15.33±0.22) Bx°, respectively. The polyphenols content was (0.058±0.0019) mg EAG/100ml for formula A and (0.06±0.0017) mg EAG/100ml for formula B. The tannin level was (2.45±0.027) mg EqC/100ml and (2.5±0.017) mg EqC/100ml for the formula A and formula B samples, respectively. The sensory analysis tests revealed that formula B was preferred above formula A, indicating that there was a distinct difference between the two formulae, and that the most prominent features in the drink were colour, smell, flavour, and sweetness.

Keywords: Carob, Formulation, Sensory quality, Biochemical.

Detection of Walnut adulteration by using the FTIR Spectroscopy and PLSR chemometrics

CC-25

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This study focused to create a chemometrics model which has capacity to detect an adulteration of nut oil that has excellent properties of health, about using the FTIR spectroscopy. These falsifications have this time a veritable danger of health sectors. The experimental samples are divided into two sets, 25 calibration samples (Training set), and 7 validation samples (Test set) with a falsification interval of sunflower a 5.80-31.95% and rapeseed oil a 4.33-29.37%.

The treatment of infrared spectral results has been done by chemometrics techniques using the partial least square regression (PLSR) and the principal components regression (PCR). The results show that the perfect model of falsification of nut oil by sunflower -oil and

rapeseed -oil illustrated in the spectral region 3050 to 700 cm⁻¹. The best model selected is the PLSR with an R² of 0.998 for sunflower oil and 0.999 for rapeseed oil.

Keywords: FTIR, PLSR, Nut oil, Adulteration, sunflower oil, rapeseed oil.

New process based on the coupling of an electrochemical sensor and bioanalytical column for determining the antioxidant capacity of foods

CC-26

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A new approach, for antioxidant capacity determination was proposed. It is based on the using of the xanthine-xanthine oxidase system coupled with H₂O₂ electrochemical sensor. The paper presents the preparation and characterization of the H₂O₂ amperometric sensor and its utilization for antioxidant evaluation of some real samples (Garlic, tea and coffee). The obtained results were found in good correlation with reality. A bioanalytical system for the evaluation of the antioxidant capacity has been developed. The main advantage of the new approach is based on coupling the production of radicals, generated by the xanthine-xanthine oxidase enzymatic system, with the electrochemical sensor, for H₂O₂ detection. The immobilization of xanthine oxidase (XOD) on the silica increased the sensitivity of the system in comparison with those where the XOD remained in solution. The results obtained show that the proposed

system is fast, sensitive and better suited than conventional methods.

Keywords: voltammetry; antioxidant capacity; xanthine; xanthine oxidase.

Apport alimentaire et contrôle glycémique chez les enfants diabétiques de type 1 dans la province d'El-Jadida

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CC-27

Le diabète est un véritable problème de santé publique chez l'enfant et l'adolescent en raison de sa chronicité et de la difficulté du contrôle de la glycémie à l'âge pédiatrique. L'objectif de cette étude était d'évaluer le lien entre les caractéristiques sociodémographiques/anthropométriques et le contrôle glycémique tout en évaluant l'apport alimentaire chez les enfants atteints de diabète de type 1 (DT1). L'étude a porté sur un échantillon de 184 enfants atteints de T1D âgés de 15 ans ou moins. Un questionnaire structuré a été utilisé pour recueillir des informations sur le statut sociodémographique. Le poids et la taille ont été mesurés et l'indice de masse corporelle calculé. L'apport alimentaire est évalué à l'aide de trois rappels de 24 heures.

L'âge moyen des patients interrogés était de $8,49 \pm 4,1$ ans ; la majorité (68,5 %) était d'âge scolaire, de sexe féminin (53,2 %) et était de faible niveau socio-économique (83,2 %). Seuls 20,1 % des patients avaient un bon contrôle glycémique. Le surpoids ou l'obésité étaient significativement plus fréquents chez les enfants ayant un mauvais contrôle glycémique par rapport à ceux ayant un bon contrôle glycémique ($P \leq 0,001$). Pour l'apport alimentaire, le mauvais contrôle glycémique

est associé à un apport quotidien plus élevé en glucides et en calories ($P < 0,000$) et plus faible en Cholestérol ($P < 0,008$), Calcium ($P < 0,000$), Zinc ($P < 0,000$), Fer ($P < 0,011$) et Vitamine E ($P < 0,02$) par rapport à ceux ayant un bon contrôle glycémique.

Cette étude montre que chez les enfants étudiés, le diabète est associé au surpoids et à l'obésité, à un apport élevé en glucides et en calories et que la qualité du contrôle glycémique est généralement mauvaise chez ces patients. Les données ont également montré que l'amélioration de la qualité de vie des patients DT1 passe par une bonne éducation thérapeutique, d'où la nécessité de mettre en place une véritable politique nationale.

Mots-clés : diabète de type 1, enfants, surpoids, obésité, contrôle glycémique, apport alimentaire.

**Agroécologie et Changement Climatique /
Agroecology and Climate Change.**

Thème/Topic



Paths to empower the resilience of agricultural systems to the combined COVID-19 crisis and climate change-induced droughts: insights from the Moroccan example

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CC-01

Due to the crucial socio-economic role of the agricultural sector in Morocco, the kingdom is looking forward to the post-Covid crisis era with caution. For Morocco, rethinking the agricultural sector and food system is one of the high priorities of the government and all the involved actors especially that the pandemic outbreak happened in one of the record dry seasons. This paper attempts to discuss some of responses of Morocco's agricultural sector to the pandemic crisis and to the low rainfall, with a focus on the potential improvement opportunities. Under the increasing recurrence of crisis and shocks, the resilience of systems and organizations is becoming an obligation. The Moroccan agriculture is expected to acquire more resilience to climate change-induced extremes, to the dependence toward international agro-input's supply chain, and to the volatility of global food product markets. Moreover, Morocco's ag-

riculture should learn to evolve under uncertainty; to succeed in this task, high level of agility across all components of its value chain is required. Specific leadership and mechanisms should be set up to increase the agility toward unpredictable climate and customers habits; research and development can play an important role in this perspective. In the other part, digitalization can be a real driver of both resilience and agility if adopted across the whole value chain.

Keywords: Climate change, Covid-19, Agriculture, Morocco, resilience, digitalization.

Proposition d'options de système de culture à base d'arganier et des cultures associées (PAM) pour la résilience et l'adaptation de l'Arganiculture

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CC-02

L'exploitation des ressources naturelles évolue continuellement au détriment de l'équilibre écologique, social et économique. A cette forme de dégradation s'ajoute l'impact négatif du changement climatique et de la sécheresse. Notre étude consiste à évaluer l'adaptation d'un modèle de production relevant de l'agroforesterie basé sur l'arganier et la culture de plantes aromatiques et médicinales (PAM associées), proposé comme moyen de résilience, d'atténuation et de valorisation des environnements dégradés.

Il s'agit du suivi du comportement agronomique et physiologique de quelques espèces PAM (Thym, lavande, armoise et câprier) économiquement rentable, cultivées en intercalaire avec de l'arganier cultivé, dans différents périmètres contrastés (Essaouira, Tiznit, Taroudant, Chtouka Ait Baha, Sidi Ifni).

Ce projet vise à encourager la mise en culture des PAM en association avec l'Arganiculture, afin d'enrichir le

calendrier des récoltes et de mettre en place un système de production durable.

Cette option agro-écologique peut être adoptée pour valoriser les zones marginales, contribuant ainsi à la conservation du sol, à la séquestration du carbone et à la réhabilitation des terres dégradées.

Ce travail relève de la convention entre l'INRA et l'ANDZOA pour la mise en œuvre des actions de recherche sur l'arganier dans le cadre du projet de Développement de l'Arganiculture dans les zones Vulnérables « DARED » financé par le Fonds Vert pour le Climat (2020-2023).

Mots clés : Agroforesterie, système de culture, Arganiculture, dégradation, PAM associées, conservation des terres.

Analysis of agricultural drought in Beni Mellal Khenifra region using the Standardized Precipitation Index (SPI)

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CC-03

Drought is defined as a natural hazard that affects the agriculture sector, especially in arid and semi-arid regions. Beni Mellal Khenifra is one of the most vulnerable regions to climate change since agriculture is the main socio-economic activity in the region. Agricultural drought is closely related to meteorological drought because of the decrease of precipitation amounts and shifting seasons over the last decades. One of the most widely used indices to analyze and characterize drought periods is the standardized precipitation index (SPI). This index is a proper tool for representing agricultural droughts since it can be calculated for many time scales ranging from months to years. The Standardized Precipitation Index (SPI) values obtained for the time scales of 3 and 6 months showed that the region

underwent a significant agricultural and methodological drought over the four periods of 1992-1995, 2000-2003, 2005-2008, and 2017-2020, their intensity varies from moderate to severe type. In contrast, the dominant drought category of SPI is moderate. In general, we obtained negative values of all average SPI values in those dry time intervals. Beni Mellal Khenifra, as an agricultural region needs a methodical drought monitoring mechanism to achieve sustainable agriculture, hence the necessity of establishing good management and monitoring of regional water resources. Moreover, it is critical to mitigating climate change's impact by reducing economic and livelihood dependence on rain-fed agriculture, avoiding water-intensive crops and increasing the versatile capacity.

Synthèse sur une nouvelle approche d'estimation des pertes en rendement grain chez l'orge dues à la rayure réticulée causée par *Pyrenophora teres*

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CC-04

La rayure réticulée de l'orge (*Hordeum vulgare* L.) causée par le champignon *Pyrenophora teres*, est une des contraintes majeures de la production de cette culture au Maroc. L'ampleur de la maladie dérive du manque de sa gestion adéquate et la prévalence des cultivars sensibles. Dans un objectif général d'amélioration de l'estimation des pertes en rendement via une méthode joignant la sévérité, les étages foliaires supérieurs et le rendement grain, cette étude a été approchée selon trois essais différents et complémentaires de défoliation (ablation des feuilles) en conditions saines et sous stress biotique de l'inoculation avec *Pyrenophorateres*. Une seule variété (Arig 8) a servi majoritairement à ces études réalisées sous serre et au champ. La défoliation des feuilles est simulée à une perte totale de la surface foliaire supposée due à une sévérité de la rayure réticulée de 100%. Les effets de la défoliation et de la sévérité de la maladie sur le rendement ont aussi été comparés. Sous serre et parmi les trois feuilles supérieures, la feuille drapeau (F1) et la feuille sous-jacente (F2) au stade gonflement, en particulier, ont révélé une importance prééminente pour le rendement et la performance de la plante. Leur perte avant l'anthesis pénalise significativement le rendement. Cela varie considérablement selon la méthodologie suivie (type de talles, stade de croissance, méthode de calcul etc). La feuille F3 est sans importance significative pour la plante à ce stade. D'un autre côté, pour une contribution significative au rendement grain, F1 s'est avérée dépendante des deux autres feuilles (F2 et F3). Notre étude a dé-

terminé des coefficients d'importance de chacune des trois feuilles supérieures pour la plante. Ces coefficients ont révélé un gradient décroissant d'importance allant de F1 à F3. Ils s'accroissent davantage pour F1F2 conjuguées et atteignent leur maximum pour F1F2F3. En considérant la totalité des talles, la feuille drapeau (F1) a été démontrée 2 fois plus importante que F2 et 10 fois plus que F3. En conditions du champ, les pertes en rendement grain n'ont été significatives qu'après que la plante ait perdu plus d'une feuille. La contribution de F1 a été équivalente à la contribution des deux feuilles sous-jacentes combinées. Les pertes en rendement grain dues à la défoliation des trois feuilles supérieures au niveau du champ ont été approximativement similaires aux pertes dues à la rayure réticulée en zones semi-arides du Maroc chez les variétés sensibles (39%). Le développement de la maladie en conditions naturelles équivaut l'effet de l'absence totale de ces trois feuilles supérieures. D'après notre étude, l'évaluation classique de la sévérité de la maladie est surestimée lorsque l'importance des feuilles n'est pas prise en considération. L'ultime objectif était de faire usage des sévérités sur ces feuilles au stade gonflement, leurs surfaces et leurs coefficients d'importance dans une étude de modélisation des pertes en rendement dues à la rayure réticulée de l'orge. Notre approche prévoyait aussi pouvoir restreindre l'évaluation de la maladie aux étages foliaires supérieurs.

Mots clés : Orge (*Hordeum vulgare* L.), Rayure réticulée, Défoliation, Rendement grain, Contribution des feuilles, Coefficients des feuilles.

Analyse écologique et phytodynamique des populations de laurier sauce des Açores (*Laurusazorica* (Seub.) Franco) au Maroc et évaluation de leur potentiel de résilience en vue de la sauvegarde, la restauration et la mise en valeur

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CC-05

Le laurier sauce des Açores (*Laurusazorica* (Seub.) Franco) est l'une des espèces forestières emblématiques du Maroc tellement recherchée et appréciée tantôt pour ses vertus aromatiques et médicinaux que pour ses qualités condimentaires. L'engouement pour ses feuilles et/ou son fruit a fait de cette espèce une plante patrimoniale à grande valeur économique. Elle se répartit principalement dans l'Atlas d'Elksiba (Moyen Atlas méridional) et de Béni Mellal (JbelGhnim) et dans l'Anti Atlas, à l'Est de Tiznite où elle est représentée par quelques individus épars dans un état relictuel.

Depuis des décennies, les prélèvements informels excessifs et anarchiques et les pratiques pastorales inadéquates (espèce palatable par les caprins) ont participé à la dégradation intense de ce patrimoine nationale. Les constatations directes sur le terrain montrent bien que le Laurier sauce des Açores suit une tendance critique qui mène vers son extinction imminente. Le benchmark de la situation actuelle montre que, mis à part les

efforts de répression de délits déployés et certaines tentatives timides pour la protection et la reconstitution de cette plante, aucune autre stratégie de développement, sauvegarde et de restauration de l'espèce n'a été entreprise. Au regard de l'état actuel dans lequel se présente le laurier sauce dans cette zone, des efforts de gestion durable de l'espèce doivent être mis en avant pour la sauvegarde de ce patrimoine biologique et génétique. Ainsi, il serait judicieux de définir dans un premier temps les paramètres écologiques de l'espèce, d'analyser sa répartition biogéographique et chorologique et d'évaluer la résilience des individus et des populations à laurier sauce des Açores dans la situation actuelle et dans le contexte du changement climatique. Ceci, dans l'objectif ultime de sauvegarde et de restauration de l'espèce et éventuellement d'une mise en valeur et création d'un emploi vert et durable.

Mots clés : Laurier sauce des Açores, plantes aromatiques et médicinales, phytodynamique, restauration, valorisation.

Intérêts de la sauvegarde et la valorisation des plantes cactoides du Maroc : Cas de l'*Euphorbia resinifera* dans les provinces de Béni-Mellal et Azilal

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CC-06

Euphorbia resinifera O. Berg est une plante endémique du Maroc qui se répartit majoritairement sur les revers atlantiques du Moyen Atlas méridional et du Haut Atlas Central. Elle se développe généralement sur des roches calcaire-dolomitiques datées du Lias inférieur et moyen. Les observations de sa structure-architecture à l'état naturel en relation avec les activités humaines montrent une situation critique voire celle de disparition dans certaines zones où l'espèce jouait un rôle important en tant que plante mellifère. Sa régénération par semis naturels fait défaut et elle est soumise à une destruction massive et rapide en absence de stratégie et de réglementation de conservation, mise à part son intégration, à l'instar des autres espèces d'euphorbes succulentes, dans la liste des espèces protégées par la convention CITES. Cette situation sera exacerbée par les impacts des changements climatiques dans un proche avenir. Le miel labélisé (IGP) de cette plante est très recherché par les consommateurs, notamment pendant la pandémie du coronavirus (covid19), en l'utilisant comme remède asymptomatique grâce à ses constituants diterpéniques de type phorboïde qui bloquent la réplication virale. Les intérêts d'*E. resinifera* touchent aussi l'aspect environnemental puisqu'elle est considérée comme un tampon face au surpâturage, un réducteur des risques de défrichement et d'incendies des forêts contiguës. Les peuplements d'Eu-

phorbe très serrés forment une belle couverture verte et protectrice des piémonts Atlasiques, en constituant un beau paysage de plantes succulentes en touffes buissonnantes d'aspect cactoides, diminuant l'érosion, neutralisant les dangers d'inondation et contribuant indirectement à la lutte contre les glissements des terrains. Également, elle forme une bordure en brosse sur toute son aire de répartition, sur des dalles calcaire-dolomitique hautement fissurées en augmentant l'infiltration des eaux des pluies vers le karst pour alimenter les sources d'eau le long de l'Accident Nord Atlasique. Cette eau potable naturelle de qualité extrême à usage domestique est utilisée aussi dans l'irrigation d'une grande surface agricole de la plaine de Tadla, qui fournit l'essentiel de l'alimentation de subsistance de la région.

Au regard des usages multiples de cette plante, il serait crucial de repenser les modes de sa gestion à travers sa sauvegarde, sa multiplication et la recherche de nouvelles pistes de sa valorisation et de sa mise en valeur en tant qu'espèce offrant des services écosystémiques multiples à travers ses bienfaits thérapeutiques, médicinaux et socioéconomiques et son rôle écologique clé dans son écosystème.

Mots clés : *Euphorbia resinifera*, sauvegarde, valorisation, Atlas de Béni Mellal, services écosystémiques.

Détermination des besoins thermiques pour la levée de la dormance et la date de pleine floraison chez différentes variétés du pêcher cultivées sous les conditions climatiques de la vallée du Sais

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CC-07

La présente étude vise l'évaluation de l'effet de l'évolution des températures hivernal durant la saison 2020-2021 (besoins en froid et en chaleur) sur la date de la sortie de la dormance et la pleine floraison chez 5 variétés du Pêcher (Early Queen, Early Bomba, Honey Cascade, Pêche locale et Zephyr) sous les conditions climatiques de la vallée du Sais. Les résultats ont montré que les dates moyennes de la levée de la dormance des variétés étudiées varient entre le 22 décembre chez la variété Early Bomba et le 28 Janvier chez les variétés Pêche locale et Zephyr. Selon le modèle Weinberger, la date initiale d'accumulation des besoins en froid des variétés étudiées a commencé à partir du 19 Novembre. Les besoins en froid accumulés ont varié entre 268 heures chez la variété Early Bomba et 461 heures chez la variété Zephyr. Quant aux besoins en chaleur, les valeurs ont oscillé entre 4098 GDH chez la variété Pêche locale et 8541 GDH chez Early Bomba. L'évaluation de la date de pleine floraison a montré que les variétés les plus précoces sont Early Bomba (16 Février), Early Queen (22 Février) et la Pêche locale (25 Février), alors

que les plus tardives sont Zephyr (8 Mars) et Honey Cascade (10 Mars). Le coefficient de corrélation entre la date en pleine floraison et le froid accumulé durant la période de la dormance sont hautement et positivement corrélé ($r^2 = 0.82$), indiquant que les variétés les plus tardives ont des besoins en froids plus élevées. La corrélation calculée entre les dates de pleine floraison et les heures de chaleur accumulées est non significative ($r^2 = -0.06$). Ces résultats indiquent que la date de pleine floraison des variétés du pêcher étudiées sous les conditions climatiques du Sais dépendent essentiellement de la disponibilité du froid (besoins en froid) durant la phase de la dormance que des températures élevées (besoins en chaleur) durant la phase de post-dormance. Les processus physiologiques tels que la dormance, la levée de dormance et la floraison des différentes variétés de pêcher ont montré une forte corrélation avec la température.

Mots clés : Levée de la dormance ; Floraison ; Pêcher ; Besoins thermiques.

Insecticidal activity of *Pseudomonas aeruginosa* extract on the false carmine *Dactylopius opuntiae*

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CC-08

Opuntia ficus-indica is a strong plant with numerous utilization and benefits regard less of giving sweet fruits. However, its productivity has been reduced since 2014 in Morocco due to the massive attacks of the wild cochineal (*Dactylopius opuntiae*). These insects live on the surface of cactus plants, in aggregations or colonies composed of individuals at various stages of development, covering them selves with a white waxy powder that protects them from exposure to sun and rain. They feed on moisture and nutrients present in the cladodes, causing chlorosis and premature fall of the latter. Recently, the Moroccan government started the transplantation of resistant varieties of cactus. However, the

preservation of the rest of *Opuntia ficus-indica* the country is suitable. For this, we evaluated the insecticidal activity of *Pseudomonas aeruginosa* extract on *D. opuntiae* females and nymphs on *in vitro* conditions. The survival of *D. opuntiae* females decreased to 70% after 24 hours and 10% after the second application of the microbial extract after 48h. At the same time, mortality in nymphs reached 90% in 24h and 100% after the second application of the *P. aeruginosa* extract.

Keywords: Cactus plant; pest management; biological control; bioactive compounds.

Spray drying formulation of *Pseudomonas fluorescens* MS01 using total quinoa extract as protective agent

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CC-09

Pseudomonas fluorescens is a gram negative and non-sporulating bacterium, involved in several applications in agriculture where it is used in biological control and as plant growth stimulator (PGPB). The present study describes a novel bacterial protective agent based on quinoa seeds extract for microencapsulation by spray drying process. The formulation of a total quinoa extract with *Pseudomonas fluorescens* aims to provide protection against heat stress during the drying process, ensuring good viability and stability of the bacteria in recovered product.

Like the most gram-negative bacteria, *Pseudomonas fluorescens* is very sensitive to any form of drying especially in the absence of a protective agent. To overcome this challenge, three protective agents were tested: 2% Alginate, 13% maltodextrin and 10% quinoa seeds extract, with determination of spray drying parameters (inlet T°, outlet T° and feed rate). Bacterial solution without the addition of a protective agent was used as a

control. After spray-drying, an enumeration of bacterial cells is carried out in recovered product.

The results showed that the number of viable bacteria after atomization increased by 5 log, 4 log, 4 logs in recovered product with quinoa extract, alginate and maltodextrin, respectively, compared with control without a protective agent. Highest CFU were recorded with the use of quinoa extract (1,4 10⁵CFU g⁻¹). The optimized spray drying parameters were (inlet T° 130, outlet T° 65; and feed rate 10,5 mL/min).

Using quinoa extract as a protective agent for a formulation of bacteria by a spray drying process is promising for the formulation of gram negative and non-sporulating bacteria, which will allow protection against heat stress during the process and ensuring good viability of bacteria in the final product.

Keywords: *Pseudomonas fluorescens*, protective agent, formulation, spray drying, viability.

Effect of arbuscular mycorrhizal fungi inoculation on growth and physiology performance of olive tree under regulated deficit irrigation and partial root zone drying

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CC-10

Olive (*Olea europaea* L., cv Picholine marocaine) trees were grown with (myc+) or without (myc-) *Rhizophagus irregularis* in split-root pots, and subjected to three irrigation methods: full irrigation (Control), partial root-zone drying (PRD) and regulated deficit irrigation (RDI). Stomatal conductance, leaf relative water content, vegetative growth (Shoot length, total leaf area and leaf number), proline, sugar contents and leaf carbon isotope discrimination ($\delta^{13}C$) were measured in order to evaluate the influence of arbuscular mycorrhizal (AM) symbiosis on the tolerance of olive to drought. The low soil moisture under PRD and RDI treatments had a negative effect on all studied parameters. However, the olive plants inoculated with the AM fungi generally had significantly greater growth indices in comparison to the non-inoculated ones. Also, at physiological

(gs and RWC) and biochemical (proline, sugar and $\delta^{13}C$) level, myc+ plants exhibited better performance under drought in comparison with myc- ones. These responses were in the most time, earlier under PRD treatment. Arbuscular mycorrhizal fungi can tolerate better the water deficit stress of RDI and PRD treatments saving 50% of the irrigation water.

Keywords: *Olea europaea*, regulated deficit irrigation, partial root-zone drying, arbuscular mycorrhiza, *Rhizophagus irregularis* sp.

Response of some olive cultivars to different salinity levels under greenhouse conditions

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CC-11

This experiment was carried out during two succession seasons (2019 & 2020) on one year old olive seedling cultivars i.e., Koroneiki, Coratina and Maraki. The studied olive seedlings were similar as possible in shape, height and width. Effect of saline irrigation water levels 2000, 4000 and 6000 ppm and their impact on some seedling vegetative growth plant parameters i.e. [fresh weight (g), dry weight (g), plant high (cm), Trunk diameter (mm), no. of shoots, root length (cm) and no. of roots] and leaf mineral content. Among the three studied cultivars in the present work Maraki and Coratina cultivars exited increasing adaptability and better counteracting the effects of salinity stress. Significant increases in dry weight of olive plant seedling and root percentages while fresh weight and height of plant as well as root length significantly decreased. Mineral N, P, K, Na and Ca leaf content was significantly varied not only among studied olive cultivars but also levels of salinity

used. A high level of salinity significantly reduces the concentration of K in the leaves. However, P leaf content was not affected. From the above result, it could conclude that Maraki olive cv. proved to be a promising salt tolerant olive genotype recommended for cultivation in arid and saline lands.

Keyword: olives, salinity, vegetative growth, mineral content, seedling.

Effects of Different Irrigation Strategies on Water Saving, Growth and Productivity of Melon Crops Cultivated under Mediterranean Climate Conditions

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CC-12

Agriculture is one of the main sectors of the Mediterranean area economy. Climate change has reduced annual rainfall and increased desertification. Currently, one of the main concerns for the grower is water management and crops irrigation. Many technologies and methods of irrigation have been developed to improve water use and production. Moreover, digital agriculture was developed recently, which has resulted in achieving production efficiency. This work is part of the Euro-Mediterranean project entitled DATI or “Digital Agriculture Technologies for Irrigation”, selected by Prima in 2021. This presentresearch which presents a first part of DATI-PRIMA aims to study the effects of several precision irrigation strategies on melons cultivated under Mediterranean climate conditions. The objective is to compare the effects of different irrigation strategies (100% water (which is considered as the control strategy adopted by the grower), 75% and 50% water, as two

irrigation strategies or pilots’ irrigations) on physiology and productivity of melon plants. These first trials were carried out in Driouch area, Northeast of Morocco. The following parameters were considered: water consumption, soil analysis, plant growth and biomass, stress index of leaves based on chlorophyll fluorescence, plant yield and fruit quality. Our results showed differences between the treatments. Finally, the DATI-Prima project is underway for three years experiments, with the aim of collecting data with digital sensors and satellite images and this will allow farmers to make decisions about irrigation management and offer farmers precise irrigation strategies. More details will be discussed.

Keywords: drought, digital, photosynthesis, satellite, sensors, yield.

Monitoring water stress in winter wheat crop by developing water stress indices based on photochemical reflectance index (PRI) and surface temperature (LST)

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CC-13

In semi-arid to arid areas (case of Morocco), crops are subject to a high evapotranspiration, low and irregular precipitation and continuously decreasing in available irrigation water. In this situation, crops development is affected frequently by periods of moderate to severe water stress. In this situation, precision agriculture is one of the main declinations of the field more widely called today "digital agriculture". In this paper, we present and analyze an experiment study of the photochemical reflectance index (PRI) signal of the winter wheat field during two agricultural seasons, in order to understand the dependence of this signal to different agro-environmental parameters (Leaf Area Index LAI, global radiation R_g , Surface temperature LST, Available Water Content AWC, and transpiration). This rather exploratory work demonstrated that LAI has a clear impact on the PRI signal measurements at the season scale, especially for wheat, which is an annual crop. Furthermore, the daily PRI_j index that we were able to develop shows complete independence from structural effects related to LAI and reflects the level of water stress that the wheat

plots were subjected to throughout the experiment. This revealed the ability of the PRI signal to provide information about the level of stress experienced by the wheat field. In addition, a normalized temperature index T_{norm} calculated based on the surface temperature of the wheat was used and could be compared to environmental parameters. This allowed us to demonstrate that T_{norm} is a water stress index that responds to water scarcity with a non-linear variation regards to AWC. By comparing PRI_j with T_{norm} , it became clear that PRI_j is a water stress index that responds to AWC variation over a wide range and provides us with information on the canopy condition at all stages of wheat development. Finally, the use of PRI as a reference water stress indicator can thus help in optimal crop irrigation with timely decision making to avoid crop water stress. A generalization of these tools to other crops than wheat and to other irrigation modes will allow the development of useful water use efficiency indices to optimize irrigation and participate in a rational water management.

Key words: Semi-arid area, Wheat, PRI, Sap flow, LST, water stress.

Cytogenetic response of 5 Tunisian genotypes of barley on the root meristem cells of barley seeds under salinity

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CC-14

Abiotic stresses caused by climate change, such as salinity, drought, low or high temperatures, flooding and frost are predicted to become more severe and widespread. Common cereal members such as wheat (*Triticum* spp.), maize (*Zea mays* L.), rice (*Oryza sativa* L.) and barley (*Hordeum vulgare* L.) are the main important members of most worldwide nations in food and feed system. We aim in this study to understand the effect of salinity stress on the spike developmental stages and the final grain yield of barley, one of the oldest cereal crops known to be cultivated since about 10,000 years.

Cytogenetic response of different NaCl concentrations (0, 50, 100, 150, 200 and 250 mM) on root meristem cells of barley were analysed.

Plants grown on media containing 0, 50, 100, 150, 200 and 250 mM NaCl showed a significant decrease of mitotic index and higher number of chromosomal abnormalities as

compared to those of control conditions, it approximately 50% decreased in treated samples and chromosomal abnormalities almost tripled those of control. The frequency of chromosomal aberrations of seeds germinated in medium with 150 mM NaCl was significantly higher than the control group. The highest concentration of NaCl (250 mM) caused total inhibition of germination. In this study, the intention was to investigate stress salinity on root's mitotic activities of five Tunisian genotypes of barley (Ardhaoui, Kounouz, Lemsi, Manel and Rihane).

These cultivars have been chosen from arid (Ardhaoui) and humid regions (Kounouz, Lemsi, Manel and Rihane) in order to pick out tolerant plants. There is an intra-specific variability against salinity, Ardhaoui seems to be the most tolerant, whereas Lemsi was the most sensitive.

Keywords: Barley, salt, cytogenetic, roots, mitotic index.

Response of plum trees (*Prunus domestica* L.) to deficit irrigation

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CC-15

The purpose of this study was to evaluate eleven plum cultivars (*Prunus salicina* L.) for drought tolerance based on agronomic performance and various physiological traits. The experiment was carried out under field conditions in Sais Plain (NW Morocco) on eight-year-old plum trees under drip irrigation. Two water treatments were applied during the fruit set (late March) to harvest (June): a control treatment fully irrigated at 100 % of seasonal ETc (FI), and a continuous deficit treatment irrigated at 50 % of ETc (DI). The plasticity to drought was assessed through the following traits: yield, fruit weight, number of leaves per 10 cm of shoot, wood density, leaf area, stomatal density, stomatal area, stomatal area index, chlorophyll pigments content (Chl a and Chl b), stomatal conductance and leaf content of cuticular waxes and proline. Results showed significant differences among cultivars in response to water stress re-

garding all the above mentioned traits. The cluster analysis based on mean ratios of DI and FI treatments for all traits highlighted three distinct clusters within the studied cultivars, with regard to drought tolerance level. The PCA analysis using the above-named ratios revealed that water stress effects on fruit weight, leaf area, stomatal density, stomatal area and leaf proline content had the highest impact on discrimination among the cultivars for drought tolerance. The results herein reported identified cultivars, with high degree of plasticity in response to water deficit, suggesting their use in breeding programs aiming at improving the species drought tolerance.

Keywords: *Prunus salicina* L. Drought stress tolerance, Vegetative growth, Productive potential, Physiological screening.

Between the life cycle analysis and the "Bilan Carbone": optimal ways to study the carbon footprint of the argan in Morocco

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CC-16

The management of carbon flows remains a major challenge to be managed in the international context of climate change. The argan tree, an important global tree subject of several scientific research works, is characterized by a value chain of several actors (argan production, argan forest ecosystem, breeding, industrial processing, trade, public and private institutions). Our work focuses on the determination, analysis, and optimization of the ecological footprint of the argan chain. The work is conducted for the first time for the sector of the argan tree. We initially defined the main actors of the sector. The distribution of the actor's was achieved according to their role in the sector, then questionnaires were established to carry out surveys in order to collect data to perform the calculations. Our review shows that ISO

14064 is the international reference standard protocol appropriate for quantifying and reporting greenhouse gas (GHG) emissions. This standard is the basis of the "Bilan Carbone" method that will be used in this investigation. The calculation outputs would be processed against the life cycle analysis approach.

Keywords: Carbone balance, *Argania spinosa* (L.) Skeels, emission factor, Life Cycle Assessment, carbon sequestration.

Ameliorate growth and leaf mineral content of olive seedlings irrigated with saline water by using salicylic acid

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CC-17

The aim of the present investigation was to determine the effect of applying salicylic acid on growth and leaf nutrient content of picual olive seedlings exposed to saline stress grown under shade house condition. Seedlings subjected during two growth seasons (2018-2019) to salicylic acid (SA) which applied as soil application at three concentrations (0, 200, and 400 ppm) on olive seedlings cv. Picual grown under three levels of salinity (0, 2000, 4000 ppm). At the end of each growth season different vegetative growth parameters (plant height increment, leaf dry weight, leaves moist percentage, leaves no. and shoots no.) were determined. Moreover, leaf nutrient status was been estimated. Obtained results indicated that, vegetative growth parameters of olive seedlings cv. Picual show a negative response when irrigated with saline water up to 2000 ppm and increasing salinity in irrigation water from 2000 to 4000 ppm

tended to significantly decrease vegetative growth parameters. Where, exogenous application of salicylic acid with 200 ppm (soil application) on olive seedlings improved most vegetative studied parameters. Also, current study concluded that, exogenous application of salicylic acid on saline stressed picual olive seedling increased nitrogen, phosphor and potassium content in leaves than untreated once.

Keywords: saline water, salicylic acid, phytohormone, antioxidants, soil application, picual olive cv., seedlings, growth performance, nutrient status, NPK.

Prediction of the pluviometry in the guir-ziz- rheris hydraulic basin

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CC-18

Predicting pluviometry plays a very important role in the field of agricultural innovation, especially in conditions of water stress as in the case of the Guir-Ziz-Rhèris hydraulic basin. For this, we carried out analyzes (ACP and PLS) of rainfall data in the Guir-Ziz-Rhèris area, on the basis of 30 years (1984-2015). Climatological locations were found to be classified into the following 2 classes:

* The first class composed of 2 subclasses: The 1st subclass contains, in particular, locations from the Guir and Rhèris geographic zones while the 2nd subclass includes, in particular, locations from the Rhèris and Ziz geographic zones.

* The second class is made up of the remaining individuals.

In fact, we have discussed this classification according to the altitude. In addition, the PLS regression showed some correlations between 30 years of rainfall data (1984-2015). In fact, we observe that there is a more or less strong positive correlation between the 30 years. The PLS allowed us to predict rainfall in the studied 30 years. Such a prediction can be extrapolated for the next 3 decades (2022-2053) in order to have rich and useful information for the benefit of innovation in the agriculture when establishing climate scenarios.

Keywords: Pluviometry; classification; prediction; PCA; PLS; Guir-Ziz-Rhèris basin; altitude.

Agriculture de Précision Modélisation et
Télédétection des Sciences de la Terre

Precision Agriculture Modeling & Earth
Scineces Remote Sensing.

Thème/Topic



Poultry meat classification using Deep Learning

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CC-01

The importance of the meat business in Morocco risks being targeted by fraud and adulteration, leading customers to investigate the authenticity of the meat. The traditional methods for verifying meat types are costly and time consuming. In this work, we propose a method based on computer vision and Deep learning, which allows the classification and differentiation between chicken and turkey meat. We created a model based on a pre-trained model and trained it with a DataSet containing the collected images of the two poultries. The evaluation of this model has given satisfactory results and has demonstrated that the model is able to predict

the meat class with an accuracy of up to 98%. The algorithm can be generalized to differentiate between authentic and fake meat.

Keywords: Computer vision - Deep Learning -Poultry Meat Classification - Meat Authentication.

Prediction of the pluviometry in the Oum Er Rbia hydraulic basin

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CC-02

Climate change is a current issue that challenges both decision-makers and researchers. In fact, modern agriculture optimizes irrigation by rainfall. This work is interested in the prediction of rainfall in Oum Er Rbia basin in Morocco. Rainfall data for the years 1993 to 2019 were collected at the Bouchane –Rhamna station. In order to determine the similarities between years and a correlation between months a principal component analysis (PCA) has been applied. The first results show that the PCA was able to classify the years and determine the correlations. In order to predict the mean annual rainfall (MAR) a partial squares (PLS) regression was applied. This regression allowed us to confirm the similarities between years (1993-2019) and also the correlations between months as determined by the PCA. In fact, the statistical parameters of the model in terms of coefficient of determination and error were relatively satisfactory that the PLS model has been validated. The PLS method would be a fast and robust tool capable of

predicting MAR for all years studied (1993-2019). Other results are being finalized to better understand the issue of the prediction of MAR in the years studied. Thus, the prediction of the MAR for previous years offers rich and useful information in order to predict, also, the next few years and to propose a scenario integrating, in terms of rainfall, both the trend of recent years and climate change. Such important results are in great demand in modern agriculture and agriculture under water stress.

Keywords: Agriculture; water stress; pluviometry; Oum Er Rbia basin; prediction; climate change.

Combination of Sentinel-2 satellite images and meteorological data for crop water requirements estimation in intensive agriculture

CC-03

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In arid and semi-arid regions, agriculture is an important element of the national economy, but this sector is a large consumer of water. In a context of high pressure on water resources, an appropriate management is required. In semi-arid intensive agricultural systems, such as Tadla irrigated perimeter in central Morocco, a large amount of water is lost by evapotranspiration (ET) and farmers need an effective decision support system for good irrigation management. The main objective of this study is to combine high spatial resolution Sentinel-2 satellite and meteorological for estimating crop water requirements in the irrigated perimeter of Tadla and qualifying its irrigation strategy. The dual approach of the FAO-56 model based on the modulation of evaporative demand was used for the estimation of crop water requirements. Sentinel-2A temporal images were used for crops type mapping and deriving Kcb coefficient based on NDVI data. Meteor-

ological data were also used in crop water requirements simulation using SAMIR software. The results allowed the spatialization of crop water requirements on a large area of irrigated crops during the 2016–2017 agricultural season. In general, the crops' requirement for water is maximum during the months of March and April and the critic period starts from February for most crops. Maps of water requirements have been developed. They show the variability over time of crop development and their estimated water requirements. The results obtained constitute an important indicator of how water should be distributed over the area in order to improve the efficiency of the irrigation scheduling strategy.

Keywords: Water management; remote sensing; evapotranspiration; Sentinel-2A; FAO-56.

Synergetic analysis of radar and optical data for early sugar beet mapping

CC-04

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Sugar beet is extremely important to the economy in Morocco, where the provision of reliable real-time information on the development of this crop is essential to facilitate its spatio-temporal monitoring and to popularize field interventions aimed at improving its yield. This study aims to identify sugar beet parcels in an early growing stage. Combination of satellite images from Sentinel-1 SAR and Sentinel-2 optical sensors are used for Pixel and Oriented-Object classification based on SVM classifier. Results showed that using the SAR/optical combination provided the best classification overall accuracy in December (97.62%), compared to the classification result based on an optical image in March, providing an accuracy of 93.73%.

Index Terms: Sugar beet, SAR and Optic combination, SVM, Oriented-Object classification.

Estimation du ruissellement et des rendements sédimentaires par AGWA - KINEROS2 dans le bassin versant de Tleta

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CC-05

Le Maroc est un pays très vulnérable à la variabilité climatique, qui engendre le phénomène de l'érosion, un des principaux facteurs de l'accumulation des sédiments dans les retenues de barrage causant l'envasement de celui-ci et nuit par conséquent au fonctionnement des stations d'épurations, en diminuant la qualité des eaux dans les réseaux hydriques, et contaminant les eaux de surface. Ce qui va automatiquement être néfaste sur la santé publique. Le bassin versant Tleta qui se situe dans le nord-ouest du Maroc, à mi-chemin entre les deux grands centres urbains de Tanger et Tétouan fera l'objet de notre étude, pour le fait qu'il appartient à une chaîne encore jeune (Rif occidental), facilement érodable et fortement menacées par le phénomène d'érosion hydrique. De plus, On note la présence du barrage Ibn Batouta situé à 15 km au Sud de Tanger, construit en 1977 à l'exutoire du bassin qui alimente la région de Tanger, la plus grande ville de la région, avec une capacité initiale de stockage de 45 Mm³, réduite aujourd'hui à 30 Mm³ à cause d'un taux d'envasement annuel représentant 1% du volume. L'étude traite la modélisation de l'érosion hy-

drique ce bassin, par l'outil AGWA et le modèle cinématique d'écoulement et d'érosion (KINEROS2), dans le but de tracer des bonnes stratégies économiques d'adaptation du site, pour le bien de la population qui l'entoure surtout avec le développement urbain rapide et la construction en cours, sur une superficie de 770 ha, de la ville nouvelle de Cherrafat prévue pour accueillir entre 150 000 et 300 000 habitants, d'où la pression intense qui sera sur les ressources en eau. Les simulations du modèle a permis de conclure que la précision prédictive du modèle est prometteuse avec des valeurs des critères d'évaluation R² et NSE élevée (R² = 0.99, NSE = 0.71) et (R² = 0.99, NSE = 0.72) respectivement pour le ruissellement et rendements sédimentaires, ainsi il a été noté que la croissance urbaine et l'augmentation de l'activité anthropique sur le bassin entre (1998-2018) a augmenté la charge sédimentaire transportées vers l'exutoire et par conséquent diminuant sa durée de vie.

Mots clés : Changement climatique, utilisation des sols, érosion hydrique, scénarios, KINEROS2, AGWA, bassin versant de Tleta.

Efficient weed detection using deep learning technology

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CC-06

Nowadays, the collective and growing awareness of the limits of our natural resources and of the harmful effects of soil, water and air pollution, leads to the creation and proliferation of new sustainable agricultural practices. Thus, several technologies are implemented, rhyming agricultural development and environmental preservation. In this article, we present a new approach, based on new technologies of machine vision and deep learning, to detect and identify weeds in different vegetable and cereal crops in real time. The results show a detection accuracy of up to 99%. This solution makes it possible to carry out a specific and localized spraying of herbicides on weeds while sparing crops and areas devoid of vegetation.

Keywords: Vision machine, Precision agriculture, Deep learning, Convolutional neural network, Weed detection.

Quantitative monitoring of winter wheat growth and yield gap analysis by WOFOST in the semi-arid region of Tensift Al Haouz, Marrakech (central Morocco)

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CC-07

Improving winter wheat production is one of the main strategies for food security in Morocco. The major objective of this study was to evaluate the performance of the WOFOST model for estimating leaf area index (LAI), actual evapotranspiration (ET_a), soil moisture content (SM), above-ground biomass levels (TAGP) and grain yield (TWSO) of winter wheat in the semi-arid region of Tensift Al Haouz, Marrakech (central Morocco). We also provide an application in the calculation of the Yield Gap. The model was adjusted on the basis of observations of 8 fields (F1, F2 and F3 for calibration, F4 to F8 for validation) grown during the 2002-2003 and 2003-2004 cropping seasons using the WOFOST implementation in the Python Crop simulation Environment (PCSE). The results obtained show that the WOFOST model simulates well the seasonal growth dynamics of LAI. The means of R², RSME and NRMSE were 0, 91 and 0.57 m²/ m², 41.4%, respectively. Daily seasonal ET_a also showed good agreement between the values simulated by WOFOST and those measured by the Eddy Co-variance system. The two validation fields revealed a good coefficient of determination (0,60 and 0,72), with a RMSE of 0.8mm and

0.7mm and NRMSE equal to 54% and 31%. Very small deviations were found between the observed and measured SM on the two validation fields (RMSE equal to 0.03cm³/ cm³ and 0.05 cm³/cm³). The NRMSE values were 11% and 19%, the R² were 0,48 and 0,49. The calibrated model had a moderate performance in simulating TWSO (R²= 42%, RSME = 512 kg/ha, NRMSE = 19%) and TAGP (R²= 34% and RSME = 936 kg/ha, NRMSE = 16%). After accurate calibration and validation of the WOFOST model, it was used to analyze the yield gap since this model is capable of estimating potential yield. Thus, a value of 7.75 t/ha was found as the potential yield value, which is close to the potential value of 6.270 t/ha in the region. The yield gap analysis reveals a difference of 5.35 t/ha on average between the observed yields and the potential yields calculated by WOFOST. Such a difference is caused by the choice of sowing date, crop cycle management, water supply and fertilization levels, etc.

Keywords: Crop modelling, WOFOST, Tensift Morocco, Crop yield estimation, winter wheat, gap yield

Fast and efficient non-destructive testing of coffee authenticity using deep learning technology

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CC-08

Coffee is a well-known hot drink that is consumed heavily around the world. Because of its economic market size of billions of dollars, ground coffee is prone to fraud by adding coffee beans or other cheaper plants. In this article, we discuss a new technique for detecting adulteration of ground roasted coffee at different blend ratios, using soybeans, wheat, date kernels, and roasted and ground chickpeas as sources of fraud. The characterization of pure coffee and the different adulteration profiles was carried out by a matrix of specific gas sensors on hot coffee samples freshly prepared using a conventional espresso machine. The responses of the sen-

sor matrix were evaluated using new deep learning techniques. The results obtained testify to the efficiency and speed of our model, in terms of recognizing and predicting different mixing proportions, compared to traditional analysis techniques.

This solution allows the realization of an efficient and inexpensive non-destructive quality control tool that can thus offer the general public the possibility of easily evaluating the authenticity of their coffee.

Keywords: Ground coffee, Non-destructive quality control, Artificial intelligence, Deep learning, Convolutional neural network.

Combining multi-source data and machine Learning Approaches to predict cereal yield in Morocco

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CC-09

Cereals are the main cultivated crop in Morocco. Its production exhibits a high inter-annual variability owing to uncertain rainfall and recurrent drought periods. Given the importance of this resource to the country's economy, an accurate forecasting of cereal yields is a critical decision-making tool to pre-empt importation needs. The aims of this work were to develop an early forecasting model of cereal yields at the agricultural province scale over the period 2000 to 2017 for the 15 most productive provinces in Morocco. To this objective, we built on previous works that showed a high linkage between cereal yields and remote sensing-based drought indices (Vegetation Condition Index, Temperature Condition Index and the Soil Moisture Condition Index), weather data (rainfall and air temperature) and regional climate indices (North Atlantic Oscillation, Scandinavian Pattern and the leading modes of Sea Surface Temperature). The combination of the latter three data sets is assessed to predict cereal yields using linear (Multiple Linear Regression, MLR) and non-linear (Support Vector Machine, SVM; Random Forest, RF, and eXtreme Gradient Boost, XGBoost) machine learning

algorithms. The performances of the models were first analyzed as a function of the input data, and as a function of the lead times of forecasting, from 4 months to 2 months before harvest. The results show that combining data from multiple sources outperformed models based on one dataset only. In addition, the satellite drought indices are a major source of information for cereal prediction when the forecasting is carried out close to harvest (2 months before), while weather data and, to a lesser extent, climate indices, are key variables for earlier predictions. The best models can accurately predict yield in January (4 months before harvest) with an $R^2 = 0.88$ and RMSE around 0.22 t. ha^{-1} . The XGBoost method exhibited the best metrics. In conclusion, the results of this study pointed out that combining remote sensing drought indices with climate and weather data using a machine learning technique is a promising approach to predict cereal yield in Morocco.

Key words: Crop yield forecasting; Machine learning; Remote sensing drought indices; Climate indices; Weather data.

Assessment of the water use efficiency and crop productivity of table grapes (*vitis vinifera*) in Mexico: Measurements and modeling

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CC-10

The objective of this work is to evaluate the water use efficiency and crop productivity of table grapes vineyards (*vitis vinifera*) in the arid region of Northwest Mexico. The method was based on the using of the Aqua Crop model developed by the United Nation's Food and Agricultural Organization, which considered as an operational tool for scheduling the amount and timing of irrigation water applications.

The results showed that the recommended seasonal irrigation by the model was about 547 mm, which it is about the half of that given by the farmer (1006 mm). This large difference, which represents approximately 54% of the irrigation supply, is lost through deep percolation and could be saved without vegetation suffering from water stress, and thus maintaining the same yield. This high loss

of water by percolation affects significantly the crop water productivity (WP) which it is about 1.74 Kg/m^3 . If we considered transpiration (WP_{Tr}) and evapotranspiration (WP_{ETa}) losses for WP computing without taking into account the percolation losses, WP clearly improved and equal 3.22 Kg/m^3 for WP_{Tr} and 2.47 Kg/m^3 for WP_{ETa} . This difference between WP_{Tr} and WP_{ETa} , which is about 24% is linked to the soil evaporation losses although the drip irrigation is practiced. Consequently, the Aqua Crop model could be used as a potentially useful tool for planning irrigation schedules and for increasing crop water productivity.

Keywords: crop productivity, table grapes vineyards (*vitis vinifera*), Aqua Crop model,

Evaluation of the effects of optimized sowing date of wheat crop on irrigation management and crop yield in a large irrigation scheme

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CC-11

Wheat is one of the most important crops in the Mediterranean region. However, production remains highly dependent on climatic variability. Previous research recommended optimizing some agricultural practices such as sowing date and irrigation to increase wheat yield. In this context, the aims of this work is to propose a decision support approach based on remote sensing and on the CMA-ES evolutionary algorithm, to optimize the spatiotemporal sowing date distribution of wheat crop in a large irrigation scheme located in Haouz plain (Morocco), considering the different constraints related to the irrigation network as well as the climatic conditions and available water resources.

Different sowing scenarios were simulated to evaluate the effects of this optimization on the irrigation rounds scheduling, on the consumed irrigation water and on the wheat yield. The obtained results showed that the

proportion of plots irrigated in time regarding their relative levels of water stress, can be increased (from 40% to 82%). The results also showed that a reduction of water needs can be achieved (up to -40%) and that early sowing scenarios lead to higher wheat yields compared to the late sowing scenarios (from 7,40 to 5,32 t/ha), which is in agreement with previous research results conducted for the wheat crop in the same study area. Thus, the promising outputs of this work highlighted the interest of the adoption of the suggested approach by irrigation managers and farmers as an efficient tool for adapting agricultural practices to water scarcity conditions and to meet wheat production needs in response to climate change.

Keywords: sowing date; irrigation scheduling; optimization; water resources; wheat; grain yield

Multi-temporal crop classification with machine learning techniques in Google Earth En-

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CC-12

Located in the plains and medium mountains of Morocco, the carob tree is present in the form of natural or artificial plantations. This tree is of considerable socio-economic importance, helping to improve the income of rural populations and to develop the economy of mountain areas.

Despite this

Remote sensing is a key element in assessing crop areas and improving agricultural production. It is based on the use of earth observation data and geospatial analysis tools, which are often known for their long processing times and require powerful computers. Recently, the growing trend of cloud-based geospatial platforms, such as Google Earth Engine (GEE), provides processing tools and cloud storage for remote sensing data without high hardware specifications. In this paper we aim to exploit the efficiency of the Google Earth Engine (GEE) platform when applying multi-temporal Sentinel-2 imagery, vegetation indices, and Machine Learning (ML) algorithms for crop mapping of a highly heterogeneous

and fragmented agricultural region, such as the Tadla Irrigated Perimeter (TIP), in central Morocco. In this investigation, we evaluated three different machine learning algorithms: Random Forest (RF), Support Vector Machine (SVM) and Regression Tree (CART) for mapping TIP crops, using five different cases of band combinations: (1) all Sentinel-2 spectral bands (2) vegetation indices (NDVI, EVI), (3) Water Index (NDMI), (4) Adjusted Soil vegetation index (SAVI) (5) Sentinel-2 spectral bands+indices. The best accuracies we obtained were 96.15% with RF, 92.71% with CART and 89.07% using SVM. We found that GEE provides very good performance in terms of accessing remote sensing products, reduction of processing time, computation, and automation.

Keywords: Google Earth Engine, multi-temporal Sentinel-2 imagery, vegetation indices, Random Forest (RF), Support Vector Machine (SVM), Regression Tree (CART).

An approach for early estimation of wheat yield in semi-arid regions using artificial intelligence and remote sensing

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CO-13

Wheat represents the oldest and most consumed cereal grain in the world and therefore has a significant impact on the food security of countries that rely on it. This food security is threatened by population growth and climate change effects, which are putting more pressure on our food production system to be more efficient and sustainable. Early predictions of wheat yield will be very useful for policymakers in designing informed and rational food policies, import and export policies, regularization of market prices, and, most importantly, the precaution of the socio-economic impact that may occur due to a loss in this essential crop. This is why we propose in this paper a new approach for estimating early wheat yields before harvesting. The first step is to process satellite images to get the

current NDVI time series window, which will be the first input for our discriminator module. The second input is historical data containing the seasonal in-situ NDVI time series and their corresponding yields. The discriminator then measures the similarity between the history and the NDVI time series window using machine learning techniques. The optimally matched yield will be the estimator of wheat yield for the current season. Finally, at the end of each season, the historical dataset will be updated with the obtained yield values. This approach will be tested and validated in our study area, located 40 km east of Marrakech in Morocco.

Keywords: Artificial intelligence, yield estimation, remote sensing, NDVI, smart agriculture, precision agriculture

Risk mapping of water erosion and its impact on the silting up of the Ahmed Elhansali dam (Middle Atlas, Morocco) using the Gavrilovic "EPM" model, GIS and magnetic susceptibility

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CO-14

The Oued Srou watershed is located in the Middle Atlas Mountain of Morocco and has been a subject of serious soil erosion problems due to the combination of natural factors and anthropic activities. The continuous degradation of natural resources in general and of the soil in particular, is a problem that is still difficult to apprehend. Indeed, water erosion of the soil contributes to land degradation, particularly in mountainous areas, and to the silting up of dam reservoirs. Given the dominance of less erosion-resistant rocks in the area in question, the Oued Srou watershed can be considered a major contributor to the silting of the Ahmed El Hansali dam. For this reason, an in-depth study is necessary to quantify and map the risks of water erosion in this watershed. For this purpose, the Gavrilovic's EPM (Erosion potential Method) model and the magnetic susceptibility method were employed, using the geographic information system (GIS). The results showed that the maximum annual soil losses are of the order of $652 \text{ m}^3/\text{km}^2/\text{year}$, the minimum losses are generally less than $5 \text{ m}^3/\text{km}^2/\text{year}$, as well as the total annual losses in the whole watershed are of the order of $73808.91 \text{ m}^3/\text{year}$, which

allows us to say that a large part of these sediments reaches the Ahmed El Hansali dam. The delivery coefficient showed that about 34969 t/year of the sediments reach the Ahmed El Hansali dam. The correlation analysis between all erosion factors revealed the following order of their importance in the water erosion control: soil sensitivity to erosion, soil protection, slope, erosive state, temperature, and precipitation. The magnetic susceptibility technique gave results on the evolution of soils; it showed that the most degraded soils are those with a high rate of erosion. Generally, stable soils that have not been eroded show a progressive evolution of magnetic susceptibility of the parent rock towards the surface; the evolution of magnetic susceptibility of degraded soils is disturbed. The magnetic susceptibility has also made it possible to highlight the source zones of sediments that reach the outlet of the watershed. The magnetic susceptibility technique therefore confirmed the results of Gavrilovic's empirical EPM model.

Key words: Water Erosion, EPM, Magnetic susceptibility, GIS, Oued Srou, Ahmed Elhansali Dam.

Surface soil moisture data assimilation into the FAO-56 for irrigation timing and amounts retrieval in the South Mediterranean Region

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CC-15

Agriculture consumes up to 75% of the world's freshwater and more than 85% in the semi-arid regions of the south-Mediterranean. Irrigation monitoring is therefore important for the optimization of water use, especially in view of the water shortage that semi-arid regions are already facing. In this context, a new approach for irrigation timing and amounts estimation at the field scale is developed and evaluated over several wheat plots in Morocco that cover irrigated (flood and drip) and rainfed fields. The approach is based on the assimilation of surface soil moisture (SSM) derived from Sentinel-1 in the FAO-56 approach using a particle filter technique. The method is first evaluated using in situ measurements of SSM before using SSM products retrieved from Sentinel-1. For the three tested revisit times (3, 6 and 12 days), the obtained results are accurate. With an observation every 6 days (the revisit time of Sentinel-1), the seasonal amounts are retrieved with $R > 0.98$, $RMSE < 32$ mm and bias < 2.5 mm. Likewise, a good agreement is observed at the daily scale for flood irrigation where more than 70% of the

irrigation events are detected with a time difference from actual irrigation events shorter than 4 days, when assimilating SSM observation every 6 days to mimic Sentinel-1 revisit time. Over the drip irrigated fields, the 15-day cumulative amounts are estimated with $R = 0.74$, $RMSE = 24.8$ mm and bias = 2.3 mm. Using the SSM products derived from Sentinel-1, the statistics are still acceptable: $R = 0.64$, $RMSE = 28.7$ mm and bias = 1.9 mm for irrigation amounts cumulated over 15 days. Likewise, the scores on the retrieved seasonal amounts are close to the assimilation of in situ observations with $R = 0.99$, $RMSE = 33.5$ mm and bias = -18.8 mm. In addition to irrigated fields, the application of the developed approach over rainfed fields did not detect any irrigation. This study opens perspectives for the regional retrieval of irrigation amounts and timing at the field scale and for mapping irrigated/non irrigated areas.

Key words: Irrigation, Data assimilation, Particle filter, Sentinel-1, Surface soil moisture, FAO-56.

Spatialisation de la variabilité du taux d'occupation de l'espace agricole dans le périmètre irrigué des Doukkala entre 1998 et 2020

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CC-16

L'intensification agricole est une logique de production qui dépend de plusieurs facteurs. Ces facteurs sont divers et peuvent être économiques, techniques et agro-écologiques. C'est une stratégie opérée pour la rentabilisation des équipements et aménagements hydro-agricoles réalisés et de contribuer à la sécurité alimentaire. Avec les changements climatiques que connaît le Maroc, il semble que le facteur eau est actuellement le plus déterminant. Dans le périmètre irrigué des Doukkala, zone de notre étude qui a bénéficié de grands programmes d'investissements hydro-agricoles, le taux d'utilisation de l'espace agricole connaît une chute durant les dernières décennies. Ce périmètre, qui se trouve à l'Ouest du Maroc, est caractérisé par un climat semi-aride et la dominance de la micropropriété. L'utilisation des données de l'observation de la terre a montré un grand intérêt dans l'étude des espaces agricoles. Ainsi, cette étude vise à mesurer l'évolution spatio-temporelle de l'intensification culturale par une analyse de la dynamique de la couverture végétale en utilisant, durant chaque campagne agricole, des images satellitaires Landsat de 1998 à 2020. La campagne agricole s'étale du mois de septembre de l'année Y au mois d'août de l'année suivante Y+1. Les profils des séries temporelles de NDVI ont été analysés

pour évaluer le changement de l'espace agricole et identifier les groupes de couverts végétaux. Les résultats obtenus montrent que (1) les séries chronologiques d'images satellitaires peuvent être très efficaces pour mesurer l'intensification culturale; (1) l'introduction de l'irrigation a été accompagnée par une forte intensification des activités agricoles qui s'est traduite par la présence, durant presque toute l'année, d'un couvert végétal dense; (2) Durant les deux décennies de la série temporelle, l'utilisation de l'espace agricole a connu des perturbations suite aux effets des changements climatiques (irrégularités et une faiblesse des précipitations durant la première décennie, et une alternance des années pluvieuses et des années de sécheresse durant la dernière). (3) les séries chronologiques d'images satellitaires peuvent être très efficaces pour mesurer l'intensification culturale; Les résultats révèlent aussi que durant les trois dernières campagnes agricoles, le NDVI a chuté dans la zone irriguée suite à l'insuffisance d'eau d'irrigation dans le barrage Al Massira.

Mots clés : Changements climatiques, intensification culturale, réchauffement climatique, images satellitaires, NDVI, variabilité spatio-temporelle, périmètre irrigué des Doukkala.

Implication of Remotely Sensed vs Climate data in assessing Crop Water Ingestion using Machine Learning

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CC-17

Pakistan possesses an agriculture-based economy and in general, its agricultural production is relatively increased during the last decade. Pakistan's agricultural industry is a major contributor to its GDP. It fulfills almost all of the 90% food and fiber requirements. Still, there is a big gap when compared with many countries of the world due lacks to its poor resource management. Irrigated agriculture in Pakistan consumes 93 percent of the available water resources whereas more than 60 percent of irrigation water is lost during the conveyance and application in the field. The major reason for application losses is the lack of knowledge about irrigation scheduling. Other factors are the ever-growing population, urbanization, industrialization, and inadequate storage. Estimation of Crop Water Requirement (CWR) is a basic tool in water resources management which is based on crop evapotranspiration (ET) estimation. Several methods for estimation of crop ET are being used by various researchers, which have their own deficiencies. Under this study, two well known and most reliable methods

i.e., SEBAL and CROPWAT, which use satellite data and climatic data respectively, were tested. Both methods were applied to the estimation of wheat crop ET on the entire district of Peshawar and results were compared to provide the sound basis for ET estimation. It has been observed that both results were compared able with minor deviations. CROPWAT requires a lot of climatic parameters that are difficult to collect due to the involvement of huge labor and instrumentations. To avoid the collection of these data, satellite-based estimation of crop ET through energy balance equation is easy and it gives an actual on-ground estimation of crop ET. This study testifies that satellite base ET estimation is cost-effective, easy to apply and gives more reliable results.

Keywords: CROPWAT, SEBAL, Evapotranspiration, Remote Sensing, Crop Water Requirements (CWR), Crop ET

Économie Agricole /
Agricultural Economy.

Thème/Topic



Estimation des dégâts causés par l'*Orobanche crenata* dans la culture de la carotte au Maroc

CC-01

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L'*Orobanche crenata* est une plante parasite qui attaque principalement les légumineuses au Maroc. Dernièrement, elle s'est introduite à la culture de la carotte en causant d'énormes dégâts qui ne sont pas encore évalués jusqu'à présent. L'étude a eu comme objectif l'estimation des pertes de rendement causées par cette plante parasite dans trois champs de la culture de la carotte de la région de la Chaouia. Les résultats de cette étude ont prouvé que l'attaque des racines de la carotte par l'*O. crenata* réduit significativement tous les paramètres du rendement (biomasse totale, diamètre, longueur et poids de la racine). Les réductions moyennes ont été de l'ordre de 22% pour la biomasse totale, 20 % pour le poids et la longueur et 9% pour le diamètre. Ainsi, l'estimation de la perte moyenne en rendement a été d'environ 24 t /ha et qui est équivalente à une réduction de 18 %. Sur le plan

économique, les pertes moyennes ont été estimées à plus de 29600 DH / ha. Sur le plan qualité des récoltes (élimination des racines attaquées), les pertes moyennes de rendement ont été d'environ 34 t / ha, soit une diminution de 26% et qui correspond à une perte économique de plus de 42000 DH/ ha. Devant cette situation inquiétante, il est indispensable de chercher des moyens de lutte efficaces et durables pour minimiser les pertes de rendement et limiter l'infestation et la dissémination d'*Orobanche crenata*.

Mots-clés : Carotte, *Orobanche crenata*, pertes de rendement, perte économique.

Can frugal innovation save African small holder farmers?

CC-02

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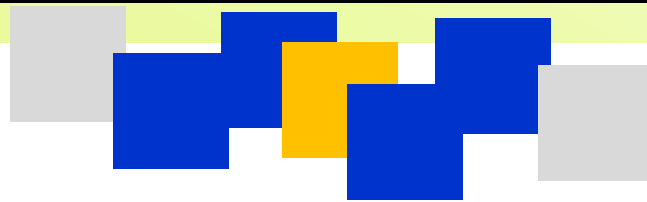
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Despite the number of entrepreneurial programs undertaken by governments and non-profits, the growing rural population of Africa is still struggling. Traditional models of entrepreneurship and innovation were tailored for industrialized economies. Developing world and Africa face different constraints, to cite only low purchasing power and inefficiency of institutions. Frugal innovation is a new paradigm of affordable innovations to deal with resource scarcity in developing economies. Multiple cases show how frugal innovators are delivering high added value for cheaper price. Evidence from a comparative study (Rao 2013) revealed a cost reduction of more than 58% between frugal and standard low-price products in the Indian market. In Africa, Khan (2016) cited the example of Craftskills, a Kenyan social business that manufactures renewable energy equipment in East Africa to plantations, community collectives and small businesses. The purpose of this work is to ex-

plore "how can Frugal Innovation enhance inclusive entrepreneurship in rural Africa?". We argue that the inclusive development and diffusion of mechanized affordable tooling will assist small holder farmers increase the yield of their labor and land. Exploring this potential niche will help practitioner design sustainable entrepreneurial program that benefits rural farming while serving Bottom of Pyramid population in Africa.

Keywords: Frugal Innovation, Small Holder Farmers, Agricultural tooling, Inclusive Entrepreneurship.

Poster communications



**Biotechnologie et amélioration des plantes /
conservation et valorisation des produits
locaux**

**Biotechnology and plant breeding /
conservation and valorization of local
products**

Thème/Topic



Effect of altitude on total polyphenols and flavonoids content and antioxidant activity of *Dallahia* prickly pear fruits in Northern Morocco

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CP-01

Moroccan cactus presents a very high genetic variability, and several cultivars exist. *Dallahia* prickly pear variety, widespread in northern Morocco and characterized by the green pulp color of its fruit, is among the lowest valorized cactus varieties. Therefore, its fruits are mainly used for fresh consumption. The aim of this study is to discuss the effect of the altitude on the total phenolic acid and flavonoid content (TPC and TFC respectively) as well as antioxidant activities of *Dallahia* prickly fruits in northern Morocco. Results show that there is a significant difference in TPC between samples. Contents are ranged from 91.27 to 130.45 GAE/mg respectively for Mestassa and Wah-

ran sites (119 and 482m of altitude respectively). Significant difference in TFC was also noticed between samples. Values range from 18.8 to 19.1 RE/mg. Antioxidant activities showed the same trend for both DPPH and ABTS assays. DPPH inhibition percentage ranges from 8.85% to 19.14% while ABTS inhibition percentage ranges from 41.07% to 54.35%. Nevertheless, the effect of altitude on the different parameters could not be clearly established.

Variabilité des traits morphologiques des populations naturelles d'*Arbutus unedo* L. au Maroc

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CP-02

L'arbousier est un arbre fruitier à haute valeur ornementale, environnementale, économique et médicale en raison des propriétés attribuées à ses différentes parties biologiques. Au Maroc, l'arbousier reste peu étudié et connue et sa consommation reste saisonnière. Tandis que la valorisation des usages de cette espèce reste très limitée et non diversifiée. Or sur le plan d'action, aucun programme de valorisation et de gestion durable d'arbousier au Maroc n'existe pour répondre aux services sociaux, économiques et écologiques. Vu cet intérêt, la présente étude s'intéresse à étudier la variabilité morphologique intra et inter populationnelle de la dite espèce au Maroc.

Et pour cela, on a collecté douze populations provenant de différentes régions écologiques au Maroc : Nord-Ouest, Plateau Central, Pré-Rif et Rif Occidental, Haut et Moyen Atlas avec des surfaces naturelles d'arbousier plus ou moins dense selon le gradient bioclimatique.

L'analyse de la variance des traits morphologiques étudiés a révélé une diversité importante à l'intérieur et entre les populations étudiées. L'analyse en composantes principales (ACP) et la classification hiérarchique par la méthode UPGMA permettent par la suite, la séparation de ces populations en deux principaux groupes indépendamment de leur origine géographique. Cette étude a montré que l'arbousier marocain est une riche source de variation pour les caractères d'intérêt économique. La variabilité morphologique mise en évidence au cours de cette étude pourrait être une approche attrayante pour établir des perspectives de valorisation, de conservation et de sélection des génotypes efficaces avec les caractères recherchés.

Mots clés : arbousier (*Arbutus unedo* L.), traits morphologiques, variabilité morphologique, provenance, Maroc.

Diversity and composition of weed species communities in traditional dryland agrosystems

CP-03

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The influence of agricultural and environmental parameters on weed diversity and composition in dryland traditional agrosystems was investigated. The study was conducted in dryland cereal agro-systems in Guelmim province, southern Morocco. Three types of agroecosystems were selected: Irrigated fields in oases; fields with flood residues called "faïd and maâder"; and cultivated rain-fed rock terraces. A total of 155 cereal fields were surveyed between April 2016 and June 2017. We identified 218 weed species, all inventoried species are angiosperms, of which 89% are dicotyledons and 11% monocotyledons. They are distributed across 34 botanical families and 144 genera. Six families represent 62.4% of the species: *Asteraceae* (22.5%), *Poaceae* (10.1%), *Brassicaceae* (9.2%), *Fabaceae* (8.7%), *Caryophyllaceae* (7.3%) and *Apiaceae* (4.6%). The biological aspect shows a prevalence of therophytes with 78%, followed by hemicryptophytes, chamaephytes and geophytes with 14.6%, 4.3% and 4% respectively. The Mediterranean character of the flora studied is well pronounced. In fact, the Mediterranean (sensu lato) origin is by far the most represented

with 47.9% of the species, of which 24.5% of the species are strictly Mediterranean. The endemic species are represented by one Moroccan endemic species (*Anacyclus maroccanus* (Ball), four Maghreb endemic species (*Perralderia coronopifolia* Coss.; *Heliotropium erosum* Lehm. ; *Diplotaxis pitardiana* Maire ; *Linaria laxiflora* Desf.) and nine endemic species from Ibero-Maghreb. The Shannon diversity index results showed that the weed flora of the terraces was the richest (3 ± 0.07), while that of the "Faïd" was less rich (2.86 ± 0.06) and that of the oasis was the poorest (2.75 ± 0.06). The variation in species composition between agrosystems (β -diversity) was studied using similarity percentage analysis (SIMPER) by Bary-Curtis distance. The results obtained show considerable heterogeneity in floristic composition among the three types of agrosystems. The factorial analysis of correspondences (A.F.C.), allowed to highlight three floristic groups.

Keywords: Weed plants, agrosystems, dryland cereals, Guelmim province.

Biochemical evaluation of the aqueous extract of Moroccan Henna

CP-04

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Medicinal plants are valuable resources for the vast majority of rural populations in Africa. Our scientific study is based on *Lawsonia inermis* plant taken from three Moroccan region, characterized by an arid climate with violent storms in autumn, which negatively affect the water resources as well as on all the ecosystems. The biochemical result showed that the reducing sugar content in LI1 is the highest content with a value of 7.5g/100gDM, while the other samples LI2 and LI3 were characterized by lower values of 6.7g/100gDM and 5.4g/100gDM, respectively. The protein content in these three samples is practically the same. Indeed, LI2 reveals the highest value which is of the order of 3.9g/100gDM, followed by that of LI1 3.5g/100gDM, LI3 is characterized by the lowest content 3.2g/100gDM. The total phenolic content in aqueous extract is 56.4g/100gDM for LI1 and

30.1g/100gDM for the LI3. LI2 was characterised by an average value of 45.2g/100gDM. The total flavonoid content showed that the lowest content is presented by LI3 with a value of 25.8g/100gDM while LI2 and LI1 are characterized by higher values of the order of 40.6g/100gDM and 30.2g/100gDM, respectively. The three samples are in a stress phase, explained by the higher content of the secondary metabolites. The variability of biochemical contents in these three samples is probably due to the genetic variability of the plant, the climate conditions in addition to ecological factor which influence the bioclimatic stages where these plants grow.

Keywords: *Lawsonia inermis*; biochemical characterisation; Morocco

Valorization of the local medicinal plants in Ouarzazat southeast Morocco

CP-05

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The men use plants to medicate themselves, since the earliest of times. Even if the current pharmacopoeia eclipses them, many are those who are seduced by their medicinal skills. Over the last few decades, the medicinal plants perform a return in force, relying on values safe, tested during long dates by our ancestors. As well, medicinal plants represent a treasure of data and information, for those who have decided to cure their daily ills differently, turning back to the chemical arsenal of the current medicine.

This study has been carried out at the scale of the Region of Ouarzazat, which is renowned by a very important botanical biodiversity. We distributed 700 sur-

vey sheets for six months in 50 ethnobotanical categories, these survey sheets were completed by traditional practitioners, herbalists, and users of medicinal plants of the community from “Taznakht” town and its surrounding areas.

The results obtained statistically from the questionnaires sheets, identified the endemic plant species suspected having a caregiver power against various diseases, methods of preparation and biomedical applications.

Keywords: Local Medicinal Plants, Biodiversity, Ethnobotany, Pharmacopoeia.

Antifungal activity of *Gelidium sesquipedale* residue against *Ascochyta rabiei*

CP-06

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Ascochyta blight, caused by *Ascochyta rabiei*, is the most important foliar disease of chickpea that can cause severe yield losses in many countries. Use of chemical pesticides to control plant pathogens is effective but has negative impact on the environment. Therefore, investigation to develop novel biological product using naturel resource becomes important. The objective of this study is to valorize the *Gelidium sequipedale* residue as a source of bioactive compounds against *A. rabiei*. Extractions of residue were done by different solvents: water, dichloromethane, and dichloromethane 50% ethanol 50%. The antifungal activity test was performed *in vitro* on PDA medium amended with different algal extracts at concentrations of 0, 0.5, 1, 2, 4, 6 and 8 mg/ml. Results showed that aqueous extract of *Gelidium sequipedale* residue was the most effective against *A. rabiei* in inhibiting mycelium growth by 80% using the highest dose of 8

mg/ml. Dichloromethane extract was also effective in reducing 53% of mycelium growth using the dose of 8 mg/ml. Therefore, aqueous extracts of *Gelidium sequipedale* residue could be investigated in *in vivo* study as a natural antifungal compound against *Ascochyta* blight disease on chickpea plant.

Keywords: *Gelidium sequipedale* residue, *Ascochyta rabiei*, antifungal activity, chickpea.

Extraction of ten essential oils and their natural pesticidal activities

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CP-07

Investigation to use natural resources to develop biological product become important as alternative for chemicals that cause adverse health and environmental impact. The aim of this study is to contribute to valorization of the Moroccan flora by extracting a series of essential oils from aromatic and medicinal plants that will be used in further studies of biocontrol.

Ten species of aromatic and medicinal plants representing five different families and nine genera were selected for our study (*Artemisia herba-alba*, *Lippia citriodora*, *Cedrus atlantica*, *Eugenia aromatica*, *Myrtus communis*, *Rosmarinus officinalis*, *Thymus satureoides*, *Mentha viridis*, *Mentha pulegium*, *Origanum compactum*). Samples of plants were harvested from their natural habitat in different location in Morocco.

The essential oil was isolated from the dry plant material (leaves or flower parts) by hydrodistillation, using a Clevenger apparatus, then stored at 4°C until use. Evaluation of extracted oil amount in relation to the dry plant matter showed a high variability of yield according to plant species. The yield varied from 0,4% to 15% and the best amount was obtained with *E. aromatica*. Therefore, other technics have to be performed for oil extraction of plant species with low yield like *M. communis* and *M. viridis*. In perspective of this work, the biological activity of these essential oils will be tested against fungus and insects pests of storage legumes for further investigation to develop bio-pesticides.

Keywords: essential oils, pesticidal activities.

Antifungal properties of Thymol and Carvacrol against *Ascochyta rabiei* and *Fusarium oxysporum* f. sp. *ciceri*

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CP-08

Ascochyta blight caused by *Ascochyta rabiei* (Pass.) Labr. and Fusarium wilt caused by *Fusarium oxysporum* Schelecht. sp. *ciceri* are considered to be the most damaging diseases of chickpea in Morocco. The pollution of the environment and the development of resistance forms of pathogens, due to the massive use of chemical fungicides, require the orientation to the biological control and the elaboration of biological products based on naturals active molecules. The aim of this study is to evaluate the antifungal properties of thymol and carvacrol that represent the major compounds of the essential oils of *Thymus vulgaris* and *Origanum compactum*, against *A. rabiei* and *F. oxysporum*. The antifungal activity was determined *in vitro* on CPMA medium amended with different concentrations of thymol and carvacrol. The minimum inhibitory concentration (MIC) was determined by calculating the percentage of inhibition of mycelium

growth (MGI). The fungistatic or fungicidal effect of the thymol and carvacrol was evaluated with Thompson method. Results showed that radial growth of *A. rabiei* was completely inhibited using thymol and carvacrol at low concentrations of 0.15 and 0.4 µL/mL respectively. Against *F. oxysporum*, a complete inhibition was also observed using thymol at 0.3 µL/mL, and carvacrol at a 0.4 µL/mL. Both thymol and carvacrol were classified as fungicidal against *A. rabiei* and *F. oxysporum* at concentrations superior to 0.3 µL/mL. This study encourages testing these compounds in *in vivo* biocontrol study against Ascochyta blight and Fusarium wilt diseases on chickpea plants.

Keywords: Chickpea, antifungal activity, *Ascochyta rabiei*, *Fusarium oxysporum*, Carvacrol, Thymol.

Conservation *in situ*, sélection, production et multiplication des cormes du safran de Taliouine (*Crocus sativus* L.)

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CP-09

Le safran est une plante triploïde stérile qui se propage uniquement par la voie de la multiplication végétative des cormes. Les cormes constituent un organe de stockage et de propagation asexuée. De ce fait, la sauvegarde et la multiplication des cormes est une nécessité stratégique (Conservation *in situ*), ces cormes se sont adaptées depuis plusieurs décennies dans la région de Taliouine, le terroir particulier de production de 95% du safran marocain.

Il s'agit d'un suivi-évaluation du comportement agromorpho-physiologique des cormes de safran issus des 10 origines du terroir de Taliouine et de Taznakht sur deux années consécutives. La plantation dans un même lieu déterminé, plateforme « Ifri-Imadiden, Taliouine », avait comme principaux objectifs : (i) la caractérisation agronomique des différents clones provenant de différentes provenances (ii) la sauvegarde et la conservation de cette diversité (iii) et la sélection et la multiplication des cormes performants.

Durant cette période de suivi de ce matériel végétal, on a pu évaluer le potentiel de production et la variabilité agromorphologique de ces cormes issus de différentes provenances : les observations réalisées ont abouti à l'identification de deux cultivars qui regroupent les cormes des différentes origines dans la plateforme, le

premier cultivar est constitué des cormes issus des provenances appartenant au plateau de moyenne altitude ($\approx 1600\text{m}$), le 2^{ème} cultivar est d'origine des zones de montagnes de haute altitude ($\geq 1900\text{m}$). Ces deux cultivars ont un comportement distinct sur le plan développement des cormes de remplacement, cette diversité d'expression et de développement végétative est d'une grande importance agronomique et suscite la valorisation ce matériel végétal pour les nouvelles plantations de la culture du safran.

Outre la caractérisation et la sélection des cormes de base, cette safranière « Ifri-Imadiden », a constitué aussi une plateforme de démonstration et de transfert des acquis de l'INRA en matière de conduite technique adaptée à la production et la multiplication des cormes. Les connaissances transmises vont servir à viser l'objectif de multiplier et produire les cormes semences à part l'objectif de production du safran « épice ». Ce projet s'intègre dans le cadre d'une convention entre l'INRA et la FIMASAFRAN pour production et la multiplication des cormes, relevant du contrat programme pour le développement de la filière du safran.

Mots clés : Safran, corne, Taliouine, multiplication, caractérisation, sélection

Antifungal and antioxidant combined effect of five essential oils from Moroccan wild plants

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CP-10

Botrytis cinerea is the pathogen of the grey mold disease that can generate drastic economic losses in pre-and post-harvest. *B. cinerea* is reported as a pathogen at "high risk" of resistance development. The objective of this work was to evaluate the effectiveness of the binary mixture of essential oils (EOs) against *B. cinerea* using the agar dilution method. Also, the antioxidant combined effect of EOs was elucidated by DPPH scavenging analysis. Five hydrodistilled EOs were used from Moroccan wild plants (*Anthemis tenuisecta*, *Artemisia herba-alba*, *Cladanthus arabicus*, *Lavendula dentata*, and *T. broussonetii*). The combination index method based on the median concentration (IC_{50}) was used to assess the interaction. The combined effect interactions were not similar

in both activities. Among the tested EO mixtures, three showed a synergistic combined antifungal effect. While in antioxidant activity, only the combination *A. herba-alba* / *T. broussonetii* showed a synergistic interaction. The results would support the combined use of EOs as an alternative to overcome or delay the development of resistance of *Botrytis cinerea* to conventional fungicides.

Keywords: antifungal; *Botrytis cinerea*; antioxidant; combined effect; essential oils.

Host-pathogen coevolution in barley-*Pyrenophora teres* pathosystem: Host effect and evolution of virulence

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CP-11

To prevent harmful effect of cereal diseases, several protection methods are deployed mainly through plant breeding, genetic resistance, agronomics practices or fungicides. Net blotch, caused by *Pyrenophora teres* f. *teres*, is a major foliar fungal disease of barley (*Hordeum vulgare* L.) and one of the main production constraints of this crop worldwide. Disease induces significant losses in grain yield and seed quality mostly in susceptible varieties. For an effective management of durable resistance, efficient protection methods, mainly through plant breeding and cultivars deployment, require sufficient knowledge of the effect and risk of host selection pressure on the pathogen population. The purpose of this research was to investigate the evolution of *Pyrenophora teres* (*P. teres*) virulence with consecutive inoculations of barley host cultivars harboring different resistance levels, and to evaluate changes in quantitative components of pathogenicity of the recovered isolates. Trials, carried out in the greenhouse, aimed to reproduce ten consecutive passages with artificial inoculations of a single isolate of *P. teres* f. *teres* on three susceptible and two resistant barley cultivars. The virulence of the derived isolates was assessed, and detached leaves method was used to reveal changes in pathogenicity of isolates

that reached the tenth generation (G10). Results showed a significant effect of host genotype on isolates virulence. Whether virulence was evaluated as infection types or disease severity, *P. teres* isolates were found to co-evolve into adapted pathotypes that depend on host genetic diversity. Virulence quantification confirmed that virulent strains derived from resistant hosts; Serial passages on the resistant cultivars Heartland and Taffa increased disease severity by 58% and 66% respectively. However, on susceptible hosts (Annaceur, Arig8 and Massine), isolates evolved into avirulent to moderately virulent strains. Detached leaves method revealed that the increased virulence of Heartland G10 isolate was characterized by a short incubation period and an increase in severity. However, less virulent isolates deriving from susceptible hosts induced changes in seven evaluated components of pathogenicity. This work highlights the evidence of *P. teres* adaptation to barley host genotypes and the dynamic character of virulence. Consideration of selection pressure and emergence of new pathotypes, that could overcome genetic resistance, is crucial for an accurate disease management practice.

Key words: Barley, *Pyrenophora teres* f. *teres*, Consecutive inoculations, Adaptation, Evolution of virulence, Durable resistance.

Antioxidant and antibacterial activities of the essential oil of *Lavandula mairei* Humbert

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CP-12

Lavandula mairei Humbert is an endemic medicinal plant, located mainly in the mountains of the Moroccan Anti-Atlas and used in traditional medicine for its numerous therapeutic virtues. The objective of this study is to highlight the antioxidant and antibacterial activities of the essential oil isolated from the leaves of *Lavandula mairei* Humbert. Six tests were performed to investigate the antioxidant activity of the essential oil (DPPH, ABTS, Total Antioxidant Capacity, OH, Reducing Power and β -carotene test). These revealed a significant antioxidant potential. Regarding antibacterial activity, six bacterial strains were isolated (1: *Staphylococcus aureus* (MRSA: methicillin-resistant *Staphylococcus aureus*), 2: *Escherichia coli* (ESBL: extended-spectrum β -lactamases), 3: *Enterococcus faecalis* (VRE: vancomycin-resistant enter-

ococcus), 4: *Klebsiella pneumoniae* (CRK: carbapenem-resistant *klebsiella*), 5: clinical isolate *Staphylococcus aureus* and 6: *Escherichia coli* ATCC 25922), for both disc diffusion assay and macrobroth dilution method. The essential oil showed a strong antibacterial power, the inhibition diameters against bacterial strains are as follows (1 :67,66 \pm 2,5 ; 2 :63,33 \pm 1,52 ; 3 : no growth; 4 :69,66 \pm 1,52; 5 :66,66 \pm 2,88 and 6 :68,33 \pm 2,88 mm). As well as the minimum inhibitory concentrations of the bacterial strains are as follows: (1:15 mg/mL, 2:60 mg/mL, 3:15 mg/mL, 4:15 mg/mL, 5:7.5 mg/mL and 6:3.75 mg/mL).

Keywords: *Lavandula mairei*, Medicinal plant, Antibacterial, Antioxidant, Essential oil, Bacterial strains.

Influence of drying parameters by fluidization on the drying speed and the quality of aromatic and medicinal plants: Moroccan Myrtle leaves (*Myrtus communis* L) and olive leaves (*Olea europaea*)

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CP-13

Aromatic and medicinal plants (AMP) contain a variety of phenolic components to which are attributed multiple biological activities, hence the importance of valorization of these plants. One of the most used operations of valorization is the drying in which the control of parameters affects the polyphenols content of dried leaves. The present study is aimed at evaluating the influence of drying parameters by fluidization, namely speed and temperature of drying air, as well as the effect of the drying mode on polyphenols and flavonoids losses of two aromatic and medicinal plants leaves: *Myrtus communis* L. and *Olea europaea* L.

These two plants leaves were analyzed after several drying treatments at varied values of drying speed and temperature in order to clarify the effects of each one

of the parameters on the polyphenol's loss. Alongside these controlled treatments of drying by fluidization, a solar drying has been carried out. The results showed that polyphenols (TPP) loss, in particular in flavonoids, for both plants leave become more important with rising temperature, while it decreases with relatively high air speeds. The solar drying led to a maximum of TPP and flavonoids losses for myrtle leaves and an average conservation level of these molecules for olive leaves. This is probably due to uncontrolled drying conditions.

Keywords: Fluidization, Myrtle leaves, Olive leaves, Air temperature, Air speed, Total polyphenols, Flavonoids.

Nutritional potential, antioxidant activity and galenic tests of a nutraceutical product: nopal powder capsules

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CP-14

Healthy diet has a prominent role in the quality of human life. The *Opuntia ficus indica* plant is one of the local products considered as a good source of bioactive compounds, minerals and dietary fiber. Further, this species is highly known for their medicinal qualities such as antidiabetic, hypocholesterolemia, antioxidant, and anti-carcinogenic activities. This research aims to develop a novel nutraceutical product (capsules) based on nopal powder with two particle sizes (80 and 100 μm). The physicochemical properties and antioxidant activity were analyzed for each capsule. Referring to the European pharmacopoeia standard tests, samples were analyzed for disaggregation, dissolution, uniformity of content, uniformity of mass, and microdosing of water by Karl Fischer method. Our study shows that capsules based on nopal powder of *Opuntia ficus indica* present an interesting source of mineral nutrients, polyphenols and flavo-

noids with a considerable antioxidant activity. The particle size of nopal powder affects greatly the galenic quality of the capsules. This work revealed the possibility to develop a new economic sector of nutraceuticals based on the valorization of the local products with great health quality.

Keywords: nutraceutical product, nopal capsule, nutritional potential, physicochemical properties, antioxidant activity, galenic testing methods.

Litholytic and antioxidant activities of Quince (*Cydonia Oblonga* Miller) leaf extracts

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CP-15

Kidney stone, also known as renal calculus is a solid concretion or crystal aggregation formed in the kidneys. Most urinary calculi have as main component calcium oxalate, which occurs generally in two crystalline forms: Calcium oxalate monohydrate (whewellite) and calcium oxalate dihydrate (weddellite). The present work was undertaken to check both the antioxidant properties and dissolving activity against kidney stones-calcium oxalate of quince (*Cydonia oblonga* Mill) leaves by in-vitro model. Aqueous, methanol and acetone extracts were prepared from *Cydonia oblonga* Mill (COM) leaves. The phenolic compounds, flavonoids, flavonols and anthocyanins are quantitatively determined in each extract of *C. oblonga* Mill using a spectrophotometric method. The antioxidant capacity was evaluated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay. Litholytic activity of the extracts was

studied using a prepared experimental kidney stone-calcium oxalate. The characterization of the crystals was carried out in parallel by scanning electron microscopy (SEM), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FT-IR). As results, *in vitro* tests, the extracts showed a high antioxidant effect, especially methanol and acetone extracts. *C. oblonga* Mill (COM) leaves have a better effect on dissolution of calcium oxalate stone with dissolution values of 17.83, 20.11 and 15.56% for methanol, acetone, and aqueous extracts respectively.

Keywords: *Cydonia oblonga* Miller, Antioxidant activity, Litholytic activity, Calcium Oxalate stone

Assessment of genetic diversity of Moroccan apples (*Malus domestica* Borkh.) cultivars using pomological traits and ISSR markers

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CP-16

The genetic diversity and structure of 18 cultivars of apple including 14 local and 4 introduced, collected mainly from various geographical locations in central Morocco, were evaluated using 34 pomological traits and 156 ISSRs markers. The results showed considerable genetic diversity. The phenotypic analysis shows that the highest fruit weights were revealed in “Delicious” and “Starking” cultivars while the lowest fruit weights were revealed in “Lahlou” cultivar. The soluble solid content was significantly higher in cultivars “Ahmri 1” and “Ahmri 2”, which implies that they are suitable for processing. The most discriminating pomological traits were fruit weight, length of stalk, number of seeds and titratable acidity. Concerning molecular data, a total of 177 bands was obtained out of which 156 (88.13%) were polymorphic. The number of bands varied from 7 to 16 with an average of 11.8 bands per primer. Based on Nei's gene diversity analysis, a high level of genetic differentiation

among cultivar groups was detected ($G_{st} = 0.27$). Cultivars structure analysis performed using the molecular and pomological data divided the studied genotypes into three major clusters, indicating differences in allelic composition and frequency. It is worthy to mention that the problem of synonyms, homonyms, and/or labeling errors appears in the studied genotypes. Thus, some cultivars with the same denomination are grouped in different clusters, while other cultivars with different names were grouped together, which implies that they could be homonyms and synonyms respectively. These results proved the importance of both pomological and molecular markers to elucidate denomination problems and relationships among apple cultivars

Key Words: *Malus domestica*, ISSR markers, pomological traits, genetic diversity, cultivars

L'effet du type génétique de la poule locale sur la qualité externe et interne des œufs dans le Nord-ouest Algérien

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CP-17

Au total, 300 œufs (100 œufs de chaque génotype de la poule locale, Tête Huppée, Cou Nu et Normal) ont été sélectionnés afin d'évaluer les caractéristiques externes et internes des œufs. Les paramètres observés étaient le poids de l'œuf entier, le poids de la coquille, l'indice de forme de la coquille, le poids de l'albumen, la hauteur de l'albumen, Unités Haugh (HU), le poids du jaune, l'indice du jaune, le rapport jaune/albumen et le pH. L'effet du génotype était significatif ($p \leq 0,001$) pour tous les caractères externes et internes de la qualité des œufs, à l'exception de l'indice de forme de la coquille et de l'indice du jaune. Le génotype Cou Nu a enregistré la moyenne la plus élevée de tous les paramètres à l'exception du pH de l'albumen et du jaune. La corrélation positive la plus élevée a été observée

entre le poids de l'œuf entier et le poids du jaune, tandis que la plus faible a été trouvée entre l'indice de forme de l'œuf et le poids de la coquille. Les caractères de la qualité des œufs avaient quatre facteurs principaux qui avaient des valeurs propres de 4,68 (PC1), 1,68 (PC2), 1,53 (PC3) et 1,05 (PC4). Cumulativement, les quatre facteurs représentaient 74,63 % de la variance totale.

Mots clés : génétique, poule locale, œufs, Algérie

Phenotypic diversity of natural populations of an endemic Moroccan plant (*Euphorbia resinifera* berg)

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CP-18

The *Euphorbia resinifera melliferous* and medicinal plant is one of the endemic species of Moroccan Atlas Mountains. It is very well known for its honey of high nutritional and therapeutic quality. The objective of our study is to characterize and evaluate the phenotypic variation of this spontaneous species. 17 qualitative and quantitative morphological characters related to the bush, stem, spine, flower, and fruit of the plant were used to assess the morphological variability of twelve natural populations collected from its geographical area in Morocco. The results of the analysis of variance showed significant differences between the studied populations for the most examined traits reflecting the existence of a high phenotypic variability within this species. The principal component analysis showed that *E. resinifera* populations constitute three distinct groups. Thus, the present study demonstrates that there is a great phenotypic diversity among the

natural populations of this species in Morocco. The aim of this work was the morphological characterization of *E. resinifera* populations in order to start a program of conservation and protect this species from genetic erosion.

Key words: *Euphorbia resinifera*; Endemic plant; Morocco; Phenotypic diversity.

New sources of tolerance to Shoot fly *Delia* spp. (Diptera, Anthomyiidae) in a barley worldwide germplasm collection under Moroccan conditions

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CP-19

Shoot fly *Delia* spp., is an important insect pest of barley. Its attacks (dead heart) occur at the early seedling stage of barley development and affect yield quantity and quality. In Morocco, barley is one of the most important traditional crops and a major source of proteins and minerals. The development of barley cultivars with improved shoot fly resistance would be facilitated using genetic resources such as landraces. A set of 500 barley traditional landraces, from different origins, conserved at INRA's Gene bank (Morocco) were used in this study. These accessions were pre-screened for resistance/tolerance to shoot fly (*Delia* spp.) during the cropping season 2018/2019 at Sidi Al Aidi experimental station (near Settat – Morocco). Tolerant accessions were selected based on the visual recovery growth (VGR) score. Of the 500 accessions, 20 showed a very high recovery growth; 74 a moderately high recovery growth; 260 a moderate recovery growth; 108 a low recovery growth; and 21 a very low recovery growth. The remaining 17 accessions were destroyed entirely. Besides, the associations between VGR and precocity of flowering (early and late), and between VGR and eco

-geographic origins of the accessions were studied using the Khi2 Test. The results showed a strong association for tolerance character to precocity and eco-geographic origin. The late-flowering accessions exhibited a higher rate of attacks than the early flowering accessions. Furthermore, the highest frequencies of tolerance were recorded in accessions from Northern Europe - Siberia (35 %), from East Africa (31 %), Middle East (12 %) and Morocco (7%). These sources of tolerance could be exploited and used in barley breeding programs to develop Shoot fly resistant/ tolerant varieties.

Keywords: Genetic resources, Shoot fly, visual recovery growth, tolerance, barley

Potential of Moroccan dates of jihel variety

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CP-20

Morocco's phoenicultural heritage is known for its varietal diversity. The present study aims to determine the potential of the Jihel variety of dates, compared to the other most marketable varieties of dates in Morocco. Based on a bibliographic analysis a follow-up of units of dates and an analysis of the surveys were realized along with field data recovery. The present study shows that, dates of Jihel variety have many criteria that permit its position as an important commercial produce. However, many interesting measures must be envisaged, in particular, the respect of the good practices of production, the accompaniment of the phoeniculturists, the encouragement of industrialists and

the promotion of the dates of Jihel variety by the implementation of an appropriate communication approach: advertising campaigns, innovative concepts of packaging and labeling. The results represent an exploitable base to establish a roadmap, aiming for the development of the phoenicultural sector in particular dates of Jihel variety of Morocco.

Keywords: Date, Jihel, Marketing, Morocco, Varieties

L'effet des margines sur la germination des graines : Lentilles et fèves

CP-21

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La filière oléicole représente un véritable défi pour l'environnement en termes de gestion des déchets (margine et grignons). Les margines sont le principal liquide rejeté par les huileries et elles sont déversées sans traitement préalable dans le milieu récepteur.

Les margines avec un caractère acide et une forte charge polluante peuvent avoir un impact négatif sur les milieux récepteurs. Le traitement voire la valorisation de ces margines en agriculture permettra de réduire leur impact environnemental. Notre recherche porte sur l'effet de la margine sur la germination des graines de deux types de légumineuses, à savoir, les lentilles et les fèves. Le but de ce travail est de déterminer la concentration de margine/eau d'irrigation qui

peut fournir un meilleur taux de germination. Le principe consiste en un test de germination de 10 jours sur des graines de lentilles et de la fève ensemencés avec différentes concentrations de margine.

A travers cette expérimentation, nous pouvons noter que l'irrigation des lentilles et des fèves par les margines diluées a permis d'avoir un taux de germination varie de 70% à 100%.

Mots clés : Margine, valorisation, lentilles, Fèves, taux de germination.

Proximate composition, fatty acid profile and oxidative stability of hempseed oil as a local product from northern Morocco

CP-22

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Cannabis sativa was recently reclassified in international agreements by the United Nations Organization, effectively recognizing its medicinal and nutritional value. Hempseeds considered as a by-product by cannabis growers, could be a good source of key nutrients such as long chain fatty acids n-3 and essential amino acids with high bioavailability. The goal of this study was to find out the proximate composition, fatty acid profile, and health lipid indices of hempseed from a local ecotype called "Beldiya" in Morocco's northern region. The results show that the studied hempseeds "Beldiya" has an oil content 30.87% with an oil oxidative stability index at 100°C of 10.82 hours. The average values of dry matter, ash, protein content, and total phenols are 94.08%, 4.04 %, 23.3%, and 191.20 mg/100g, respectively. The fatty acid profile analysis shows that oil of hempseeds "Beldiya" has a poly un-

saturated fatty acid (PUFA)/saturated fatty acids and n-6/n-3 PUFA ratio of 5.12 and 3.48, respectively. These findings demonstrate that hempseed's nutritional and balanced worth as an edible fruit that can contribute to a healthy lifestyle.

Keywords: Hempseed, Proximate composition, Oil, Fatty acids, Phenols

Propagation of saffron (*Crocus sativus* L.) under ex-vitro conditions

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CP-23

Saffron (*Crocus sativus* L.), the most expensive spice in the world derived from the stigmas, is an autumn-flowering and sterile triploid ($2n=3x=24$) geophyte species that belong to the Iridaceae family. It is propagated mainly by vegetative reproduction through the development of daughter corms from the mother corm. Low multiplication rates of daughter corms under natural conditions and fungal infestation reduce productivity, thereby restraining the availability of planting material (corms). Any effort to accelerate their multiplication will be desired. Thus, the main objective of this work is to improve the vegetative propagation of saffron under ex vitro conditions. Preliminary results of the influence of increasing doses of growth regulators (BAP, ANA and GA3) on the growth and multiplication of corms under greenhouse

conditions (ex vitro) are promising. The obtained data shows that the effect of PGR depends on the concentration used and the mode of application. Indeed, BAP showed more encouraging results to improve the multiplication and development of corms.

Key words: Saffron, *Crocus sativus* L., corm, growth regulators, in vitro culture.

Phytochemical characterization, nutraceutical activity, anticancer potential of extracts of *Cannabis sativa* L. seed.

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CP-24

Cannabis sativa L.: better known under the name of Kif in Morocco, plant used for centuries for its high nutritional value and its therapeutic properties. Its crude extracts begin recently to have a lot of interest as a potential source of bioactive natural molecules; they are being studied for possible use in the food, pharmaceutical and cosmetic industries. For that purpose, and within the framework of the valuation of the Moroccan cannabis, we were interested in 5 morphotypes (BT, BBK, KHT, KHK, and AVK) of *Cannabis sativa* L. of 3 different regions of the central Rif. The general objective of the study is the phytochemical characterization of seed extracts of these plants, through a Thin Layer Chromatography and by means of the quantitative analyses (determination of total polyphenols and flavonoids), for an overview of the nature of the constituents that may be encountered in the seeds of these plants and to better understand their

benefits. The classic extractions were realized by two methods: extraction by soxhlet with various solvents (hexane, ethanol, ethyl-acetate, and dichloromethane) and extraction by maceration (aqueous and ethanolic). The extraction yield was also evaluated on the extracts of these five morphotypes, it varies between 34.4 % and 57.2 % by soxhlet, and between 10.5 % and 28.6 % by maceration. Preliminary results from the phytochemical characterization obtained by TLC are promising and demonstrate the existence of a large number of chemical compounds and secondary metabolites.

Keywords: *Cannabis sativa* L., seed extracts, phytochemical characterization, TLC, soxhlet, maceration.

Evaluation de l'activité antioxydante et la composition chimique des extraits méthanoliques de *Myrtus communis* L. au Maroc.

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CP-25

Le myrte commun (*Myrtus communis* L.) est une espèce spontanée de la famille des *Myrtaceae*. C'est un arbuste typique du bassin méditerranéen qui fait partie des plantes aromatiques et médicinales. La plante est largement utilisée en médecine traditionnelle vu ses vertus thérapeutiques, cosmétiques et alimentaires. Les usages multiples de cette espèce sont dus à sa richesse en molécules et composés bioactifs notamment les composés phénoliques. Ces composés, considérés comme des antioxydants puissants, sont parmi les produits les plus utilisés en industrie pharmaceutique. A cet égard, nous avons mené une étude sur l'activité antioxydante et le dosage des composés phénoliques, des flavonoïdes, des protéines et des sucres dans les extraits méthanoliques de myrte provenant de diffé-

rentes régions biogéographiques du Maroc : le Pré-rif, le Rif occidental et le plateau central. Les résultats obtenus montrent une variabilité importante entre les populations pour la plupart des paramètres étudiés ce qui signifie que l'origine des échantillons influence la teneur en différents composés et métabolites secondaires.

Mots clé : *Myrtus communis* L, extrait méthanoliques, polyphénols, flavonoïdes, pouvoir antioxydant, Maroc

Importance of flavonoids compounds in fruit trees resistance and fruit quality: a review

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CP-26

Flavonoids compounds belong to plant secondary metabolites synthesized through the shikimic acid and phenylpropanoid pathways, are found widely in plants and having antioxidant properties, therefore namely bioactive compounds (Abd El-Razek, 2021). They can be divided into subgroups including anthocyanidins, flavonols, flavones, flavanols, flavanones, chalcones, dihydrochalcones and dihydroflavonols. Isoflavonoids and pterocarpanes (Treutter, 2006). They have a main role in fruit trees resistance against numerous stress and diseases. In this respect, between the huge number of phenolic phytoalexins compounds, the isoflavonoids, phenylpropanoids and simple phenolics are well explained (Harborne 1994), whereas the role of flavonoids in defence of fruit trees is less popular, except the catechins and proanthocyanidins (Feucht and Treutter 1999, treutter 2006). They are also beneficial for the plant itself as physiological active compounds, as stress protecting agents, as attractants or as feeding

deterrents, and, in general, by their significant role in plant resistance (Treutter, 2006). Furthermore, flavonoids play a key role to provide pigments to fruits that improve fruit quality particularly the antioxidant attributes and fruit colour of various fruit trees (Abd El-Razek, 2021).

Keywords: Flavonoids, Secondary metabolites, Phenolics, Bioactive compounds, resistance, Stress,

Development of high-yielding and large seed size winter chickpea varieties for Morocco

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CP-27

The main objective of chickpea (*Cicer arietinum* L.) breeding program is development of high-yielding, disease-resistant and stable varieties with acceptable seed quality characteristics. In fact, developments of extra-large seeded Kabuli chickpea cultivars is one of the most viable options as this fetch premium price in market and have consumers' preference. The present investigation was carried out to describe the development of new high-yielding and large seed size varieties that are released in the last decade in Morocco. In this respect, multi-environmental trials were performed between 2015 and 2018 to screen for several abiotic and biotic stresses in the field and greenhouse. This study identified two promising lines that had high grain yield as well as tolerance to drought, resistance to *Aschochyta* blight, and good grain quality. They have the largest seeds among the available varieties, with only slight cost to grain yield, thus corre-

sponding to farmers' demand. Moreover, these lines were approved by the Office National de Sécurité Sanitaire des produits Alimentaires (ONSSA) are targeted for dissemination and adoption by Moroccan farmers.

Keywords: Winter varieties, large seeds, Grain yield, *Aschochyta* blight.

Dunaliella salina : matière première à fort potentiel

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CP-28

Dunaliella salina est une microalgue verte unicellulaire appartenant à la famille des Chlorophycées ayant un pouvoir à tolérer de fortes concentrations de sel. Cette algue possède également une forte activité antioxydante grâce à sa richesse en caroténoïdes, elle est connue pour accumuler des caroténoïdes dans diverses conditions de stress, telles qu'une salinité élevée, une intensité lumineuse élevée et une faible température de croissance. *Dunaliella salina* contient des quantités élevées de Béta-carotène qui est une source importante de nutrition puisqu'il peut être converti en vitamine A. Ces résultats indiquent que cette microalgue a un grand potentiel en tant que complément alimentaire multi nutritif.

L'objectif de ce travail est l'évaluation de la productivité en molécules bioactives chez la microalgue *Dunaliella* isolée à partir des salines au centre et sud du Maroc.

Mots clés : *Dunaliella salina*, microalgue, caroténoïdes, molécules bioactives.

Valorisation de deux plantes aromatiques et médicinales cultivées dans la région de Khénifra

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CP-29

Les plantes aromatiques et médicinales (PAM) présentent l'une des richesses de la province de Khénifra, des études ethnobotaniques ont été réalisées dans ces différentes communes et qui ont inventorié une centaine d'espèces spontanées des plantes médicinales. Plusieurs projets menés dans la région ont visé à contribuer à la conservation de cette biodiversité et à l'augmentation de la valeur des PAM cueillies en milieu naturel et leur accès aux marchés tout en assurant une pérennité de la production. L'association féminine des PAM à El Hammam – M'ritt a été créée pour ce même but, elle exploite quatre plantes qui ont été cultivées, ainsi que d'autres plantes sauvages en appliquant les bonnes manières de cueillette.

Notre but dans ce travail est d'apporter une valorisation scientifique aux plantes exploitées par l'association dans l'espoir de les aider à viser d'autres marchés.

Cette valorisation scientifique repose sur l'identification scientifique des plantes, un screening phytochimique qui est une étude qualitative reposant sur des réactions de complexation et/ou de coloration et permettant d'identifier les métabolites secondaires contenus dans la plante, et une évaluation du pouvoir antioxydant de différents extraits.

Les deux plantes à présenter dans ce travail sont *Rosa damascena* et *Origanum compactum*. Le screening phytochimique a révélé la richesse des deux plantes en stéroïdes, triterpènes, Flavonoïdes, tanins et alcaloïdes. L'évaluation du pouvoir antioxydant a montré une forte activité antioxydante de l'extrait aqueux d'*Origanum compactum*.

Mots clés : Plantes Aromatiques et Médicinales, *Rosa damascena*, *Origanum compactum*, screening phytochimique, activité antioxydante

Identification de marqueurs SSR du palmier dattier par le parcours de son génome

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CP-30

Le palmier dattier est une essence végétale qui a une grande diversité génétique. Il existe actuellement plus de 5000 variétés dans le monde dont plus de 223 au Maroc. En plus d'hybrides qui sont estimés à plus de 2 millions au Maroc. Cette grande diversité, ainsi que les contraintes de sélection liées en particulier au long cycle de vie de cet arbre font qu'on a souvent recours aux marqueurs moléculaires pour les identifier, en particulier les microsatellites. Dans ce travail, on a parcouru le génome du palmier dattier à la recherche de marqueurs SSR y existant. Ces marqueurs sont ensuite classés en fonction de leurs motifs, le nombre de répétitions ainsi que leurs emplacements dans le génome.

Mots clés : NGS, analyses bioinformatiques, palmier dattier, marqueurs microsatellites, SSR

Synthesis and characterization of layered double hydroxides materials containing zinc, cobalt, aluminum and iron and their adsorption performance for lead in aqueous solution

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CP-31

Layered double hydroxides (LDHs) have received considerable attention due to their potential applications in catalysis, photochemistry, electrochemistry, polymerization, magnetization, biomedical science and environmental applications. They are easy and inexpensive to synthesize in laboratory and industrial scales. LDHs have many physical and chemical properties that are surprisingly similar to those of cationic clay minerals. Their layered structure, wide chemical composition (due to variable isomorphous substitution of metal cations), variable layer charge density, ion-exchange properties, reactive interlayer space, swelling in water, rheological and colloidal properties have made LDH clay-mineral-like. The general chemical composition of LDH is $[M^{2+}_{1-x}M^{3+}_x(OH)_2]^{x+}(A^{n-})_{x/n} \cdot mH_2O$, where M^{2+} and M^{3+} are divalent and typically trivalent metal cations, respectively, on the layer; x is the molar ratio of the trivalent cation $[M^{3+}/(M^{2+} + M^{3+})]$; A^{n-} is the interlayer anions with the charge n and m is the amount of interlayer water. The objectives of this study were to synthesize new LDHs materials containing zinc, cobalt, aluminum, and iron

and study the influence of the nature of divalent metals cations (Zn^{II} , Co^{II}) in the composition on LDHs structure organization. These materials were prepared by the coprecipitation by controlling the pH of the solution. X-ray diffraction, vibrational spectroscopy, thermal analysis, scanning electron microscopy, and energy-dispersive X-ray showed a detailed description of the influence of the composition on the structural organization of the LDH. The obtained results showed a strong dependence between the composition of the Lamellar Double Hydroxides phases and their structural properties. The prepared materials were used as adsorbents for the removal of the anionic azo dye, methyl orange (MO), from aqueous solution.

Keywords: Layered double hydroxides, Dyes removal, Kinetics, Methyl Orange.

Morphological characterization of species of the genus *Rosa* at GDA Sidi Amor

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CP-32

A study of morphological variability in 81 rose accessions was carried out on a collection in the Ariana region called GDA Sidi Amor. 79 qualitative and quantitative characters from the UPOV descriptor relating to trees, stems, flowers, leaves, spines and flower buds were measured in order to study the phenotypic diversity between these accessions. Substantial variability was demonstrated between the accessions studied. ANOVA applied to quantitative traits confirms the stability of the traits studied. A structuring of the variability into four distinct groups was observed by both the PCA and the CAH dendrogram. The most discriminating variables in this structure correspond to the diameters of the flowers, heights of the flowers,

types of flower, size of the petal, length of the petal, width of the petal, fragrance, diameter and height of the flower buds, size of the leaves, intensity of the green color on the upper surface of the leaves, the brightness of their upper surfaces, length of terminal leaflets, width of terminal leaflets, length of pedicels, number of prickles and the presence of anthocyanin pigmentations on the stems.

These results effectively contribute to the evaluation of the diversity of roses in Tunisia and constitute the first step in the selection and conservation of the biodiversity of the *Rosa* spp.

Key words: *Rosa* spp., biodiversity, morphological characterization, variability structuration.

Optimisation de l'Extraction d'ADN génomique des feuilles de la vigne, pour identifier génétiquement la vigne cultivée en Algérie.

CP-33

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La vigne fait partie des plantes les plus anciennes sur terre. Aujourd'hui, par ces fruits elle représente la culture fruitière la plus forte valeur de production dans le monde. L'existence des milliers de variété de vigne, conduit à l'apparition de nombreux cultivars qui sont mal identifiés ou appelés sous différents noms selon les régions. Actuellement, grâce aux méthodes de biologie moléculaire qui nécessitent un ADN génomique de bonne qualité et en bonne quantité, on peut identifier génétiquement ces différentes variétés. Notre étude est considérée comme un premier pas vers l'identification génétique des vignes en Algérie et l'optimisation d'un protocole pour une meilleure extraction des acides nucléiques. Notre étude a été réalisée sur 20 cépages de vigne. L'échantillonnage des cépages qui appartenant à la commune d'El-Kantara Willaya de Biskra. Pour cela nous avons fait une optimisation d'un protocole d'extraction d'ADN géno-

mique et aussi nous avons pu améliorer une méthode simple et peu couteuse pour préparer les feuilles, avec l'utilisation des feuilles déshydratées et conservées à température ambiante, qui sont préparées par des simples moyens, un séchage à l'aide d'une étuve ventilée et broyage sans l'utilisation de l'azote liquide. Afin de les utiliser dans n'importe quel moment pour l'obtention d'un ADN génomique intacte. La concentration moyenne, le rendement moyen ainsi que la pureté de l'ADN génomique extrait par le protocole optimisé sont très satisfaisants par rapport le protocole non optimisé. Le résultat obtenu est plus significatif, on a arrivé à optimiser d'un protocole expérimental pour extraction de L'ADN nucléaire où le rendement est acceptable (**2385 µg/g**).

Mots-clés : vigne, caractérisation génétique, extraction d'ADN.

Comparative moisture sorption isotherms and thermodynamics properties of commercial and gamma irradiated Moroccan stevia leaves

CP-34

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Stevia (*Stevia Rebaudiana* Bertoni) is native to certain regions of South America. The genus stevia belongs to Asteraceae family. Currently, for the sweet diterpene glycosides contained in its leaves, stevia has been grown and applied as a natural sweetener in many countries such as Morocco.

To preserve the quality of any dried product during storage, it is necessary to know its water sorption properties. Moisture sorption isotherms present valuable thermodynamic data that are useful for predicting the storage stability of food products. Hence there is a need to study the moisture sorption isotherms of stevia leaves.

In this work, we study and compare water sorption isotherms of commercial and gamma irradiated stevia leaves. Moisture adsorption isotherms of both samples

were determined at three different temperatures (30, 40 and 50 °C) using a gravimetric technique. Experimental data were fitted using GAB (Guggenheim–Anderson–de Boer) model. The sorption isotherms were found to be typical type II sigmoid. Moreover, these experimental data curves allow us to calculate the value of the optimal water activity for the conservation of plant studied. The thermodynamic properties such as net isosteric heat and differential entropy were also determined.

Keywords: GAB equation; Sorption Isotherms; Stevia; Water activity; Thermodynamic properties; gamma irradiation

Effect of drying temperature on biochemicals, physicochemical analysis and antioxidant activity of Jujube leaves *Zizyphus lotus*

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CP-35

At the time the leaves of Jujube *Zizyphus lotus*, are widely used as medicine for their health benefits especially in China, America and the Middle East. To determine the benefits of Jujube leaves, the leaves were analyzed to distinguish certain chemical compounds, antioxidant activity and to study structural morphology. Conventional drying by ovens is a method of preserving nutritious foods, the drying temperature gradient of 10 ° C, has an effect on certain food composition, the case of Jujube leaf the increase in temperature revealed a increased extraction and release of polyphenols, small variation in antioxidant activity, stability of flavonoids, total carotenoids and phyophytins, and degradation of chlo-

rophyll. HPLC analysis showed that the Jujube tree, *Zizyphus lotus*, is very rich in phenolic compounds.

Keywords: *Zizyphus lotus*, valorization, drying, biochemical, antioxidant activity.

Phytochemical screening, quantitative estimation of total flavonoids, total phenols and antioxidant activity of *Laurus nobilis* L.

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CP-36

Reactive oxygen species (ROS) are high reactive molecules involved in many physiological processes and has been associated with many diseases, such as cancer, diabetes, cardiovascular, inflammatory and neurodegenerative diseases. Nowadays, there is an increasing interest in discovering natural antioxidants for use in food and medicinal materials to replace synthetic antioxidants since such antioxidants are being restricted due to their side effects like carcinogenicity. Many studies suggested on medicinal plants and vegetables strongly have supported the idea that plant constituents with antioxidant activity are capable of exerting protective effects against oxidative stress in biological systems. *Laurus nobilis* L. (bay leaves) which commonly known since ancient times as daphne tree, belongs to *Lauraceae* family, being a native plant from the Mediterranean region. It's a plant of industrial importance, used extensively in the food industry as well as in drugs and cosmetics. There are many investigations on antibacterial and antioxidant activities of

the essential oil obtained from *Laurus nobilis* L. However, in Morocco still almost little work has been done about phytochemical screening, polyphenolic compounds and antioxidants activity of this important plant. In this study, we have determined phytochemical compounds include tannins, flavonoids, alkaloids and saponins with different phytochemical methods. Total phenolic was estimated by Foline-ciocalteu method, total flavonoid content was determined by colorimetric method. Extracts were also monitored by their antioxidant ability by using different *in vitro* methods. These results suggest, for the first time, that *Laurus nobilis* L., is a promising source of natural products including phenols, flavonoids and antioxidants that could offer protection against oxidative stress and can reduce free radicals and prevent chronic diseases.

Keywords: Antioxidant activity, *Laurus nobilis* L., phenols, phytochemical screening, total flavonoid

Ressources génomiques et bio-
informatique/ agriculture intelligente

Genomic resources and bioinformatics/
smart agriculture

Thème/Topic



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CP-01

Small ruminants are one of the main sources of meat and milk worldwide. The improvement and conservation of these species are major challenges for the sustainable subsidy of the needs of human populations in these commodities. Some morphological variations of individuals reflect the diversity of their adaptive potential and their zootechnical performance. The objective of this study is to analyze the complete genome data, at a depth of 12X, of 160 unrelated sheep sampled to represent the ecological and geographical diversity of Morocco. It aims at associating the variants of the genomes (SNP) of these sheep, surveyed at the best possible resolution (i.e. sequences of the complete genomes), with a certain number of phenotypic indicators (3 quantitative and 4 qualitative traits), observed in these sheep, which affect the adaptive potential (i.e. length of the

ears) or the productive potential (e.g. height at the withers, girth of the barrel). This association, performed by a genome-wide association approach (GWAS), using GEMMA software, allowed to identify the possible genomic mutations responsible for these phenotypic variations; among which we can identify those involved in the adaptation to the different climatic environments and those linked to the best zootechnical performances. These mutations should make it possible to integrate these variations, after their validation, in selection schemes to improve the productivity of these species and their adaptability to certain climatic conditions.

Keywords: GWAS, Moroccan sheep, SNP, Phenotypes, Adaptation.

Agro-morphological characterization of local *Sulla flexuosa* (*Hedysarum flexuosum* L.) ecotypes in Northern Morocco

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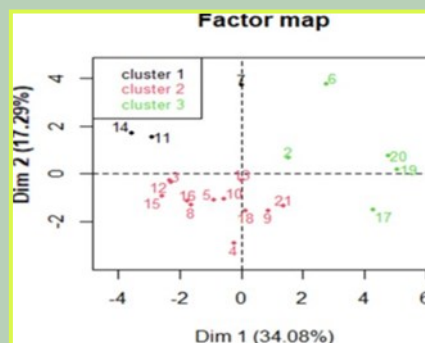
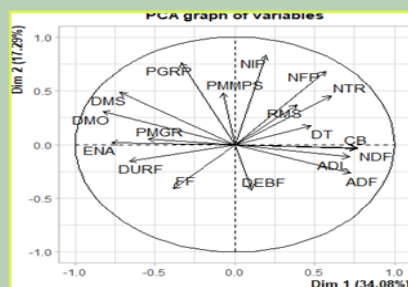
CP-02

The present work is part of the assessment of wild genetic plant resources of forage interest in Northern Morocco and consisted of studying the agro-morphology, phenology and bromatology of *Sulla flexuosa* (*Hedysarum flexuosum* L.) ecotypes. Twenty-one wild *S. flexuosa* ecotypes were collected from 21 sites distant at least 30 km. The edaphic and climatic characteristics of the collection sites were studied and showed a great variability from one site to another, testifying to the remarkable adaptability of *S. flexuosa*.

During two consecutive years, these 21 ecotypes were cultivated on experimental plots at INRA Tangier. The experimental design was in three complete randomized blocks. Phenological characterization of plants was realized for the 21 ecotypes and at three phenological stages (budding, start of flowering, full flowering), plants were cut for agro-morphological characterization. Statistical analysis showed significant variability between the cultivated ecotypes and between phenological stages for all parameters, over the

two years. Green and dry matter yield were influenced by climatic conditions of the years. Edapho-climatic parameters of collection site influenced agro-morphological parameters of ecotypes. Correlation matrix showed interesting correlations between morphological and bromatological parameters. Branched ecotypes had the highest fiber content. Hierarchical classification based on principal component analysis (figures 1 and 2) allowed to distinguish three groups of ecotypes mainly based on bromatological parameters (fibre content and digestibility), forage production (number of leaves per plant and total number of branches) and reproduction (number of inflorescences per plant and weight of thousand seeds and weight of seeds per plant).

Keywords: *Hedysarum flexuosum*; forage; agro-morphology; phenology; Northern Morocco.



Genetic diversity assessment of Spanish and some endangered Tunisian pea (*Pisum sativum* L.) accessions based on microsatellite markers (SSRs)

CP-03

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In the current investigation, 27 accessions of Spanish and Tunisian peas were characterized by eight SSR polymorphic markers to assess their genetic diversity. Many methods have been applied to evaluate these relationships including diversity indices, analysis of molecular variance, cluster analysis, and population structure. The means of diversity indices, the polymorphism information content (PIC), the allelic richness, and the Shannon information index were respectively 0.51, 3.87, and 0.9. These results revealed a large polymorphism (84.15%) which produced a higher degree of genetic distance amongst the accessions. The unweighted pair group approach with arithmetic mean divided the collection of these accessions into three major genetic clusters. Therefore, this paper has clearly demonstrated the usefulness of the SSR markers that can significantly contribute to the management and conservation of

pea germplasm in these countries, as well as to future reproduction.

Keywords: Pea, SSR Genetic diversity, Population structure.

Interactions Plantes - Microorganismes : Biofertilisation et Biocontrôle

Pant – Microorganisms Interactions :
Biofertilization and Biocontrol.

Thème/Topic



Use of soil solarization and organic amendments for controlling sclerotia of *Sclerotium rolfsii* Sacc causal agent of sugar beet (*Beta vulgaris* L.) root rot in Doukkala region (Morocco).

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CP-01

Root rot caused by the soil phytopathogenic fungus *Sclerotium rolfsii* Sacc is a devastating disease of sugar beet in the region of Doukkala in Morocco. The fungus forms sclerotia (dormant structures) which allow it to survive for several years in the soil and germinate myceliogenically in the presence of the host plant and under certain environmental conditions especially temperature and humidity. This study aimed to evaluate the potential of soil solarization combined to organic amendment, for controlling sclerotia germination and their viability in soil under field conditions. The experiment was conducted in a naturally sclerotia-infested field in a complete randomized block design. The soil was irrigated by sprinkler irrigation to saturation at a depth of 30 cm and covered with a transparent polyethylene film of 180-micron thickness during July and August 2020. The treatments SSC (Soil solarized combined to compost amendment) and SSM (Soil solarized combined to sheep manure amendment) treatments were able to significantly ($p < 0,05$) reduce the germination and viability of sclerotia. The reduction rate of sclerotia in the plots solarized and

amended with compost and plots solarized and amended with sheep manure was 89,5 % and 85,72% respectively compared to the control. The impact of the soil solarization on the microbial biomass of the soil was also evaluated. The results of the quantification of bacterial and fungal populations made before and after solarization revealed an increase of number of soil bacteria from $2,1.10^7$ CFU g^{-1} to $5,6.10^9$ CFU g^{-1} and number of soil fungi from $7,8.10^8$ CFU g^{-1} to $4,9.10^{11}$ CFU g^{-1} in SSC treatment compared to control (soil not solarized and not amended). These results suggest that the use of soil solarization combined with organic amendments represents a non-pesticidal promising method for controlling the germination and viability of sclerotia of *Sclerotium rolfsii* Sacc with beneficial effect on microflora soil activity.

Key words: *Sclerotium rolfsii*, Sclerotia, Soil solarization, Organic amendments, Sugar beet, Morocco.

Potential role of rhizobacteria isolated from sugar beet rhizosphere for biological control of sugar beet damping-off and root rot caused by *Rhizoctonia solani*

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CP-02

In Morocco, sugar beet is threatened by several diseases that affect their production, in particular root rot. These are multifactorial diseases mainly attributed to *Rhizoctonia solani*, *Sclerotium rolfsii*, and species belonging to the genus *Fusarium*. *R. solani* is an economically important pathogen of sugar beet (*Beta vulgaris* L.) causing damping-off and root and crown rot. Nowadays, biological control holds a promising control strategy which has shown its great potential as a reliable and environmentally friendly method for managing several diseases. Our objective was to evaluate the biocontrol potential of bacterial isolates against *R. solani* AG 2–2 in the laboratory and under greenhouse conditions. Thus, bacterial strains isolated from the rhizosphere of sugar beet and other soils were screened on the basis of an *in vitro* double culture bioassay with *R. solani*. Out of 198 bacterial isolates, ten isolates were selected and identified based on the 16S rRNA gene. In addition, their possible mechanisms involved in biocontrol and traits favoring plant growth were also studied. The results showed that pectinase and cellulose were produced by seven and six bacterial isolates, respectively. All ten isolates were able to

produce amylase and protease, only four isolates produced hydrogen cyanide, seven isolates had solubilized tricalcium phosphate, and five had the ability to produce indole-3-acetic acid (IAA). In addition, the antagonist bacteria showed a big difference in their ability to produce antimicrobial substances such as bacillomycin (three isolates), iturin (five isolates), fengycin (four isolates), surfactin (six isolates). Regarding the ability of isolates to stimulate plant growth *in vivo*, an increase in parameters of the growth of sugar beet plants was observed by nine bacteria. After forty days of sowing, the ten isolates showed a significant reduction in damping-off caused by *R. solani*. Interestingly, both bacterial isolates N3 and AN5 showed great importance as a biological control agent for root rot caused by *R. solani*, as they significantly suppressed the disease in greenhouse trials. As a result, these antagonistic bacterial strains could be used as a biofertilizer for sustainable agriculture.

Keywords: Biological control, *Beta vulgaris*, root rot, damping off, *Rhizoctonia solani*.

Isolation and characterization of actinomycetes with high hydrolytic and antimicrobial activity to enhance composting

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CD-03

Actinomycetes have a considerable importance in biotechnological processes due to their ability to produce a large number of high-value metabolites. The present work aimed, in a first step, to isolate actinomycete strains from samples of a soil irrigated with margins at a rate of 5 and 10 liters per square meter. In a second step, this study targeted the inventory of hydrolytic and antimicrobial activities of the isolated and characterized strain collection. In order to select the most competent actinomycete strains for composting, a selection pressure was exerted on the strains in order to choose those, which have the capacity to metabolize several carbon sources. For this

purpose, several enzymatic activities were evaluated (Amylase, Cellulase, Xylanase, Gelatinase, Pectinase, Lecithinase, Caseinase, Esterase, Chitinase, Lipase and Unilinase). The results of the antimicrobial activity revealed that the different strains have a good inhibitory activity against several bacteria, mainly Gram positive, pathogens and yeasts. The isolated and characterized actinomycetes recorded a power of biodegradation of different substrates through the production of hydrolytic enzymes.

Keywords: Actinomycetes, Composting, Antimicrobial activity, hydrolysis of biopolymers.

Quantification des composés phénoliques et évaluation de l'activité antioxydante et antibactérienne des extraits des feuilles et des fleurs de *Tamarix africana* Poir.

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CD-04

Cette étude a été menée pour extraire les principes actifs à partir des feuilles et des fleurs de *Tamarix africana* par une extraction assistée par le soxhlet, en utilisant six solvants de polarité croissante. Le potentiel antioxydant de ces extraits a été évalué en utilisant le test du DPPH ; et leur activité antimicrobienne a été évaluée contre les souches bactériennes : *Bacillus subtilis*, *Citrobacter freundii* et *Enterococcus faecalis*. Le rendement d'extraction le plus élevé a été obtenu grâce au méthanol pour les feuilles et les fleurs de *T. africana*. En effet, pour les polyphénols et les flavonoïdes, les résultats ont montré que les extraits méthanoliques affichent les teneurs les plus élevés pour les deux organes (Les polyphénols : 101,80 mg EAG/g.MS dans l'extrait des feuilles et 50,55 mg EAG/g.MS dans ceux des fleurs. Les flavonoïdes : 990,72 µg.Rt/g. MS dans l'extrait méthanolique des feuilles et 630,84 µg.Rt/g.MS dans l'extrait méthanolique des fleurs). L'évaluation de l'activité antioxydante des extraits a montré que l'extrait aqueux des feuilles et des fleurs (1,89 µg/ml et 3,175 µg/ml respectivement) possèdent des activités an-

tioxydantes supérieures à celle de l'acide ascorbique (Vit C : IC₅₀ = 5,23 µg/ml).

Concernant le pouvoir antibactérien des extraits, *Bacillus subtilis* a montré une résistance aux extraits testés. Par ailleurs, pour la souche *Citrobacter freundii*, des zones d'inhibition de 13,75 mm et 14 mm ont été enregistrées par l'extrait méthanolique des feuilles et l'extrait aqueux des fleurs (respectivement). En revanche, les fortes zones d'inhibition enregistrées en présence de la souche *Enterococcus faecalis*, sont de 13 mm enregistrés par l'extrait méthanolique des feuilles, et un diamètre de 11,75 mm par l'extrait du dichlorométhane des fleurs. Concernant la concentration minimale inhibitrice (CMI) et la concentration minimale bactéricide (CMB), les résultats ont montré que les extraits sont de nature essentiellement bactériostatique. Ainsi, nous pouvons conclure que *Tamarix africana*, étant une source potentielle de composés phénoliques aux propriétés antioxydantes et antimicrobiennes.

Mors clés : *T. africana*, Polyphénols, Flavonoïdes, DPPH, CMI, CMB.

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CP-05

Low-cost and environmentally friendly farming practices are receiving increasing attention in these last years. Developing microbial inoculants with P-solubilising bacteria (PSB) provides an emerging biological solution for increased rhizosphere P availability. PSB can increase plants P availability by modifying soil processes in rhizosphere zone, supplying essential nutrients for plants and generating others growth regulators in different production systems. The present study was conducted to explore PSB isolated from soils located at different bioclimatic stages in Morocco occurring in several legume crops rhizospheres. The work targets the improvement of agronomic microbial fertilizers efficiency. In this objective, strains isolated from arid, semi-arid, sub-humid, and humid regions of Morocco were tested for their ability to solubilize P in NBRIP medium with Tricalcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ (TCP) as the only phosphorus source. Bacterial strains with a high P solubility index (PSI) were selected and characterised quantitatively by studying their ability to solubilize TCP. P solubilization activity was estimated by the vanadate-molybdate

method. Besides that, indole-1-acetic acid (IAA), hydrogen cyanide (HCN), and siderophores production by all the isolates was tested to select the competent strains having biotechnological valuation. From all isolated strains (64), nine were screened as promising biotechnological interest because of their performance in growth promoting attributes such as production of indole acetic acid, gibberellin acid, siderophores, hydrogen cyanide and salinity tolerance. In our collection of bacteria the strains WJEF9' showed the most efficiency in abilities to solubilize P in NBRIP solid medium with $\text{PSI} = 3.1$; while the strain WJEF22' was located as the most efficient strain in NBRIP liquid medium by releasing 147.6 mg.l^{-1} of soluble P. Therefore, this study reveals the potential effect of PSBs collection to support traits as growth-promoting rhizobacteria.

Keywords: Inoculants, legumes crops, microbial fertilizers, PSB, rhizosphere, sustainability.

Management des résidus de récolte de la betterave à sucre et son effet sur la fertilité du sol dans le périmètre irrigué des Doukkala au Maroc

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CP-06

Dans la dernière décennie, la mécanisation de l'agriculture a connu une croissance importante au Maroc grâce à la stratégie du Plan Maroc Vert. Dans le périmètre irrigué des Doukkala, l'introduction de l'arrachage mécanique de la betterave à sucre depuis 2012 a incité les betteraviers à restituer les résidus de récolte. Cette pratique agricole pourrait augmenter la teneur des sols en matière organique et en éléments fertilisants. Pour évaluer cette hypothèse, nous avons, d'une part, conduit un suivi de l'évolution de la teneur en matière organique du sol et des éléments fertilisants sur des sols où l'arrachage de la betterave s'est effectué par mécanisation. Le suivi est conduit entre les années 2012 et 2019 sur 420 parcelles représentatives des différentes classes pédologiques de la zone d'étude. D'autre part, nous avons évalué l'effet de la teneur en la matière organique du sol sur la disponibilité des éléments fertilisants et sur les rendements et la qualité technologique de la betterave à sucre. L'étude a montré que le taux de la matière organique dans les parcelles étudiées a connu une augmentation de +28,8 % durant 8 campagnes agricoles. Les parcelles qui n'ont jamais reçu des résidus ont connu

une diminution moyenne du taux de la matière organique de -24 %. Les parcelles, qui ont reçu une restitution des résidus de la betterave 6 fois, ont connu une augmentation moyenne de +194 % de matière organique. La variation la plus marquée de la matière organique a été observée dans les sols à texture grossière. L'étude a montré également qu'il y a des corrélations positives entre la variation de la teneur en matière organique et la variation des paramètres chimiques du sol (Na, Zn, B, MgO, K_2O , P_2O_5 , CaO, et le pH). En plus, d'autres éléments chimiques du sol (l'EC, Fe, Cu, Mn, NO_3 et NH_4) n'ont aucune corrélation signification avec la variation de la teneur en matière organique. La variation de la teneur en matière organique dans le sol est favorisée significativement par la texture grossière du sol et le nombre des restitutions de résidus tandis que cette variation est moins forte dans la texture fine et dans les sols initialement riches en matière organique.

Mots clés : Sol, Fertilité, Matière organique, restitution des résidus, Betterave à sucre, Doukkala, Maroc.

Effet d'un nouvel engrais bio-organique sur la croissance et la qualité nutritionnelle de la betterave rouge en culture réduite

CD-07

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La production d'un fertilisant à base de sous-produits agricoles, qui assure des produits agricoles avec une qualité nutritionnelle élevée, constitue la meilleure solution pour préserver l'environnement et la santé du consommateur. Le but de ce travail est d'évaluer l'efficacité de notre fertilisant bio-organique composé de margine, écorces de riz et la mélasse sur la croissance de la betterave rouge et sa teneur en macronutriments et en composés bioactifs. Un essai agricole composé de 10 pots a été mis en place selon un plan en blocs aléatoires avec trois répétitions de chaque traitement et un seul témoin. L'expérience a consisté en quatre traitements : la fertilisation du sol avec le fertilisant bio-organique obtenu avec trois ratios : 10% (T1), 20% (T2), et 30% (T3), et un essai sans l'ajout du fertilisant (T4). Les paramètres de croissance de la betterave, ont été déterminés par la mesure de la longueur de la tige et de la racine (en cm), le diamètre du tubercule (en cm) et son poids en g. Tandis que la qualité nutritionnelle a été évaluée par la détermination de la teneur en macronutriments : sucres totaux, protéines, minéraux : Na, P, K et Ca, et en composés bioactifs : Nitrates NO_3^- et bêtaïnes. La tendance à une longueur des tiges, un poids et un diamètre des tubercules élevés de la betterave rouge a été observée chez les plantes fertilisées par T1 avec des moyennes respective-

ment de 30.8 cm, 66 g et 5.6 cm. Tandis que la longueur des racines la plus élevée a été enregistrée chez T2 avec une moyenne de 18.45 cm. Seul T1 a abouti à une différence significative en taux des sucres totaux et des protéines par rapport au témoin. Cependant, les teneurs élevées en minéraux P et K sont engendrées par le sol le plus riche en fertilisant T3 avec des moyennes de 283.54 et 366.74 mg/100g respectivement. D'autres part, une légère augmentation du taux du Na, est observée chez le sol T1. Ce taux est passé de 77.94 à 80.76 mg/100g. Les tubercules du traitement témoin T4 ont enregistré la valeur la plus élevée en Ca avec une moyenne de 80.19 mg/100g. Le traitement du sol T1 a pu améliorer la composition de la betterave en composés bioactifs tout en atteignant des valeurs maximales en nitrates et bêtaïnes de l'ordre de 330.54 et 157.3 mg/100g respectivement.

En général, on peut déduire que le pourcentage de 10% est le meilleur taux de fertilisation afin de garantir les meilleurs paramètres de croissance et la meilleure qualité nutritionnelle de la betterave rouge.

Mot clé : fertilisant bio-organique, paramètres de croissances, macronutriments, nitrates, bêtaïnes, betterave rouge.

Stimulation of the defense of tomato plants against the pepino mosaic virus by oxadiazole and thiadiazole derivatives

CD-08

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Tomato (*Solanum lycopersicum*) is one of the widely grown crops worldwide. It is consumed in various forms and has excellent nutritional values. Presently, this crop is facing a serious threat to its yield and survival because of pepino mosaic virus (PepMV).

In the present work, we tried to evaluate the effect of two synthesized chemicals, belonging to the thiadiazole (P2) and oxadiazole (P1) families, with the aim of stimulating the defense of tomato plants against mosaic virus of pepino, using seed treatment at a concentration of 10 and 50ppm.

To study the effect of the products tested, a weekly monitoring of the characteristic symptoms (blistering, nettle heads, necrosis and yellowing of the leaves) of the PepMV

virus was carried out on the plants treated with these products.

Based on symptom development and analyses of the activity of antioxidant enzymes, results showed that P1 had a better protective effect at 10ppm than P2.

Key words: Tomato, Pepino Mosaic Virus, Thiadiazole, Oxadiazole, Symptoms.

Évaluation *in vitro* de l'activité antagoniste de certaines bactéries vis-à-vis de *Pythium schmitthenneri*, agent causal de la pourriture racinaire de l'Olivier

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CD-09

La pourriture racinaire de l'olivier, causée par *Pythium schmitthenneri*, est une maladie destructrice des plantations d'olivier avec une incidence plus élevée sous des conditions de stress biotiques et/ou abiotiques. Cependant, aucune méthode de lutte efficace n'est actuellement confiée à la profession oléicole. Afin de lutter contre cette pathologie, nous avons étudié la possibilité d'exploitation de dix souches bactériennes antagonistes connues pour leur capacité à contrôler d'autres maladies phytopathogènes. Il est donc, légitime de s'interroger quant à l'efficacité de ces bactéries sur l'olivier en effectuant des tests de confrontation entre le champignon en question et les bactéries. Les résultats des tests *in vitro* issus de la confrontation directe, entre l'agent pathogène et les bactéries antagonistes, ont montré que les dix bactéries étudiées ont un taux d'inhibition supérieur à 75% après 5 jours d'incubation à 25 °C. De même pour le

test de confrontation par voie volatile (COV) et le filtrat acellulaire dont les résultats confirment, que les bactéries ont une forte capacité à inhiber la croissance mycélienne de *Pythium schmitthenneri*. Ces résultats suggèrent que ces bactéries peuvent être des candidats potentiels pour le bio-contrôle de la pourriture racinaire d'olivier.

Mots clés : Activité antagoniste, *Pythium schmitthenneri*, pourriture racinaire, Olivier, souches bactériennes.

Isolation of endophytic bacteria from rhizospheric soils of *Anacyclus pyrethrum* in Aguelmam Azegza (Beni Mellal-Khenifra region)

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CD-10

Endophytes are the microorganisms that exist inside the plant tissues without having any negative impact on the host plant. Medicinal plants constitute the host huge diversity of endophytic bacteria of economical importance. These microbes have huge potential to synthesis of numerous novel compounds that can be exploited in pharmaceutical, agricultural and other industries. It is of prime importance to focus the present research on practical utilization of this microbial group. An extensive characterization of diverse population of endophytic bacteria associated with medicinal plants can provide a greater insight into the plant-endophytic interactions and evolution of mutualism. In the present study, we aimed to isolate and to screen for new endophytic bacteria with multiple bioactivities from the rhizospheric soils of *Anacyclus pyrethrum* in Aguelmam Azegza (Beni Mellal-Khenifra region). Different media with the addition of an antifungal agent (K2Cr2O7) at different con-

centrations tested were evaluated. The results indicated that the concentration of 25 µg/mL was the most performed to inhibits the growth of the tested pathogenic microorganisms. Although, from the tested media, ISP2 was the most adapted to the endophytic bacteria isolation noticed after 5 days of cultivation. A total of 100 endophytic bacteria were isolated and screened for their multiple bioactive compounds against various pathogenic bacteria, yeast and fungi. Thus, 18 endophytic bacteria were selected for their effective microbial antagonistic activities. This preliminary work could contribute significantly to the discovery of new endophytic bacteria with new class of antimicrobial agents leading to expand the therapeutic arsenal with medicinal interests.

Keywords: Endophytic bacteria, rhizosphere, *Anacyclus pyrethrum*, medicinal plants, isolation.

Evaluation de l'état micro-nutritionnel des vergers agrumicoles dans la région du Gharb

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CD-11

Une bonne gestion de la fertilité des sols constitue une étape clé dans la production durable des vergers agrumicoles. Malheureusement, peu d'attention est accordée à la fertilité oligo-minérale bien que des symptômes de carence, et parfois de toxicité, aient été souvent signalés. Dans la présente étude nous procédons à une évaluation du statut oligo-minéral des sols et des arbres des vergers agrumicoles, particulièrement d'oranger, dans la région du Gharb, deuxième principale région agrumicole du royaume. Une connaissance préalable de la teneur des oligo-éléments dans le sol et les arbres permettra de mieux raisonner la fertilisation des vergers, et ainsi d'éviter toute carence ou excès nuisible à la plantation et à son environnement. Afin d'adresser notre objectif, nous avons effectué une collecte des échantillons de sol et

feuilles d'arbres dans 20 vergers d'oranger 'Valencia Late'. Le choix de cette variété est expliqué par son importance et sa dominance dans la région. Les prélèvements (sol et feuilles) ont été réalisés simultanément pendant les mois de Novembre-Décembre 2020. Des fiches d'enquête ont été également préparées pour collecter des informations complémentaires sur la conduite et la gestion de la fertilisation des vergers échantillonnés. Les résultats préliminaires confirment l'existence des carences en oligo-éléments, principalement le zinc, le fer et le manganèse, dans la région du Gharb. Les analyses sont en cours pour identifier les causes de ces déficiences et les moyens les plus efficaces pour y remédier.

Mots clés : Fertilité des sols, Oligo-éléments, Agrumes, feuilles, Gharb.

Composition chimique, toxicité orale aiguë et efficacité antimicrobienne *in vitro* des huiles essentielles de deux plantes marocaines de la famille des *lamiaceae* contre des souches microbiennes pathogènes isolées du milieu hospitalier

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CD-12

Le but de ce travail était d'extraire les huiles essentielles en utilisant un appareil de Clevenger à partir des parties aériennes de deux plantes aromatiques et médicinales largement utilisées dans la pharmacopée traditionnelle; *Rosmarinus officinalis* et *Mentha pulegium*, détermine la composition chimique de ces extraits volatils par GC/MS, tester l'activité antimicrobienne vis-à-vis des souches pathogènes isolées de l'environnement hospitalier et étudier la toxicité orale aiguë des huiles sur des rats femelles.

Les résultats de la caractérisation chimique montrent une richesse en certains composés identifiés par chromatographie en phase gazeuse couplée à la spectrométrie de masse (GC/MS), l'abondance du 1,8-cinéole (46,32%), de camphène (13,4%) et d' α -pinène (9,52%) dans l'huile de *R. officinalis* et de R (+)-pulégone (45,48%), de menthone (14,2%), de

pipéritone (8,15%) et d'isomenthone (7,18%) dans celle de *M. pulegium*. Ces métabolites montrent un effet antimicrobien significatif envers les souches testées par rapport aux antibiotiques synthétiques qui semblent être inefficaces contre les microorganismes résistants.

Sur la base d'une DL50 > 5000mg/kg (poids corporel), les huiles ont été jugées marginalement sûres selon les directives de l'OCDE et peuvent être exploitées davantage comme produits biologiques à faible risque.

Keywords: *Mentha pulegium*, *Rosmarinus officinalis*, Essential oil, Antimicrobial activity, Chemical characterization, DL₅₀.

Medicinal plants to sustain biodiversity. Case of *Corrigiola telephiiifolia* Pourr

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CD-13

Corrigiola telephiiifolia is a herbaceous species belonging to *Caryophyllaceae* family. Various parts of this plant, specifically roots enclose important phyto-constituents such as flavonoids, saponins, tannins, quinones, steroids, and alkaloids. It has been used for a long time in traditional medicine to treat multiple health problems like cancer, diabetes, allergy, inflammation, rheumatic and dermatological diseases, etc. Lately, a significant interest was manifested for this plant in order to characterize its chemical composition, identify the main active molecules and also to find other applications than biological ones. The objective of our work is focused on the use of C.

telephiiifoli extracts for the biological control of aphids and the preservation of their native entomophagous biodiversity.

Keywords: *Corrigiola telephiiifolia* Pourr., native entomophagous, aphids, biodiversity, arboriculture.

The impact of fungal treatment on silage of lignocellulosic agricultural products

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CD-14

Utilization of lignocellulosic feedstocks for animal feed in developing countries demands competitive but low-tech conversion routes. Fungal treatment and ensiling are two methods previously investigated for low-tech pretreatment of biomass such as wheat straw (WS) and olive pomace. Ensiling results in an environment acidification that inhibits most of the activities of microorganisms that would otherwise degrade the biomass. It is a very important conservation method to maintain forage value. Even if this silage makes it possible to preserve the fodder but it does not have a significant impact on the increase of the digestibility (IVTD) because of the presence of lignin. In this work, the impact of the fungal treatment was studied on the silage of treated wheat straw (WS) and olive pomace (OP). The treatment was carried out for 2, 4, 6 and 8 weeks with selected *Fusari-*

um solani (FS), a fungus having a significant lignin degrading power. The silage was evaluated by measuring the acidity. The results show that the fungal treatment degraded lignin and improved silage digestibility (IVTD) very significantly ($p < 0.001$). Acidity was significant from one treatment duration to the next. Indeed, the acidity of the silage is very important after a fungal treatment of 8 weeks. The duration of fungal treatment of OP and WS for 6 and 8 weeks has good results compared to the two and three weeks of treatment. Ensiling was significant from one substrate to another.

Key words: fungi, lignin, silage, treatment, lignocellulosic, digestibility

Identification and screening of phosphorus solubilizing actinobacteria isolated from marine fauna of the marchica lagoon for plant growing interest

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CD-15

Since the chemical industry revolution in the 1960s, agriculture has used a significant amount of chemical fertilizers in order to increase productivity. However, this resulted in increased environmental contamination and health issues. So, there is a need for the implementation of alternative fertilizers or sources of plant nutrients that respect the environment, in particular those based on bioactive metabolites of microbial origin. Hence, actinobacteria appear to be an excellent source of bioactive substances for plant growing. Sporulation filamentous of these bacteria are able to bloom in different soils, play an important ecological role in the soil nutrient cycle and are recently considered to be plant growth promoting rhizobacteria (PGPR). The aim of this research is to isolate differ-

ent actinobacteria from marine fauna in the lagoon of Marchica, Nador, for which we identified qualitative phosphorus solubilization performances. Other quantitative tests are in processes to select strains with high phosphorus solubilization activity and could be a new biofertilizer, helping to reduce the use of chemical fertilizers in agricultural practices.

Keywords: biofertilizers, biodiversity, biotechnology, marine, soil, strain.

Lutte biologique contre l'Alternaria par des espèces de bacilles et leurs composés bioactifs et volatiles

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CD-16

L'altérioriose est une maladie fongique causée par les champignons de la famille des *Pleosporaceae*, se manifeste par des lésions au niveau de la tige et les feuilles ainsi que la pourriture des fruits de plusieurs cultures tels que la tomate et les pommes de terre. Et par ce que le bio-control est une bonne alternative au lieu de l'utilisation des produits chimique pour les traiter, l'activité antifongique des bactéries et leurs substances bioactives ont été étudiée par plusieurs chercheurs. Les composés volatiles de la bactérie *Bacillus subtilis* ont montré de bons résultats contre le champignon *Alternaria solani* des tomates. D'autre part les essais agronomiques de la bactérie *Bacillus aryabhatai* comme agent de prévention contre la maladie ont réussie à protéger les plantes de tomates.

Mots clés : *Bacillus subtilis* ; *Bacillus aryabhatai* ; composés bioactifs ; composés volatiles ; biocontrôle.

CD-17

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Earthworms as a dominant macrofauna of many terrestrial soil systems interact with soil microorganisms to promote decomposition, mineralization and recycling of the organic material. Several studies have focused on the study of microorganisms associated with the earthworm's digestive tract. In order to determine functional roles, research must also determine the effects that earthworm's associated microorganisms have on the soil system. In the present work, we were interested in the microorganisms possibly associated with the earthworm at the level of the coelomic liquid, which is in continuous contact with the rhizosphere. Seven bacteria selected previously based on qualitative and quantitative screening of plant growth promoting traits. Bacterial isolates were test-

ed in the greenhouse for their ability to promote plant growth (Corn). In addition, biochemical analyses, showing the effect of the tested bacteria on soil chemical and biological properties were performed. The results of the study showed that this work has highlighted that earthworm, in their coelomic fluid, harbour PGPB, which stimulate plant growth and which could be involved in improving soil fertility and agriculture.

Keywords: Earthworm, Coelomic fluid, microorganisms, molecular identification, PGPR

Amélioration de la production de blé dur par les PGPR en cas de déficit hydrique

CD-18

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Le stress hydrique constitue le principal stress abiotique limitant considérablement la productivité du blé dur (*Triticum durum*) en Algérie. La plupart des travaux de recherche effectués sur le blé dur ont eu durant de nombreuses années pour objectif principal l'augmentation de la productivité, une approche basée essentiellement sur les performances agronomiques. Ces dernières années, un intérêt plus croissant a été porté sur les études qui concernent l'amélioration génétique de la tolérance au stress hydrique dans les programmes d'amélioration du blé. Afin d'améliorer la production de blé dur, l'utilisation des PGPR (Plant Growth Promoting Rhizobacteria) comme une approche biologique semble être la solution prometteuse, des recherches récentes ont prouvé que l'utilisation des PGPR comme inoculant constitue une alternative biologique soutenable pour la production végétale. Les bactéries rhizosphériques qui peuvent affecter positivement la croissance des plantes par plusieurs mécanismes tels que la solubilisation du

phosphate, la production de sidérophores, la fixation biologique de l'azote, la production de 1-aminocyclopropane-1-carboxylate désaminase (ACC), l'interférence du signal et l'inhibition de la formation de biofilm, la production de phytohormone, présentant une activité antimicrobienne, l'induction de la résistance systémique (ISR), la promotion de symbioses végétales-microbes bénéfiques et de nombreux autres mécanismes. C'est le moyen biologique de remplacer l'utilisation d'engrais chimiques, de pesticides dans les pratiques agricoles. Les souches PGPR présentent une grande diversité taxonomique et métabolique. Cette présentation synthétise l'effet du stress hydrique sur la croissance et la production de blé dur et présente les différents aspects des études PGPR, de leurs applications à la tolérance au stress.

Mots clés : PGPR, blé dur, stress hydrique.

**Sol- Systèmes de Contrôle de la Pollution
et de la Réhabilitation.**

**Soil- Pollution Control and Rhabilitation
Systems.**

Thème/Topic



Study of the quality of bouregreg's estuary and the impact of development projects

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CP-01

Population growth and industrial development pose a very dangerous threat to the aquatic ecosystem, as well as to human health at the level of the Oued Bouregreg. The developments, of which the estuaries have been the object since the middle of the last century, have profoundly modified not only their geometry but also the hydrological and natural sedimentological processes. Oued Bouregreg is the second important river in Morocco, rises in the middle atlas at an altitude of 1627m. Three main hydrological arteries drain this basin: Oued Bouregreg, Oued Grou and Oued Korifla. The Sidi Mohammed Ben Abdellah dam was built 24km upstream from the Bouregreg estuary. Which completely disrupted the functioning of the Bouregreg estuary ecosystem? Since 2006, the Bouregreg estuary has recognized development projects in the Bouregreg valley, among these works the

Rabat-Salé marina, the large Burj Mohammed VI, the extension of the Rabat-Salé tram network and the large theater. The objective of our work is to study the impact of these development projects on the quality of sediment and water in the estuary. Analyzes were carried out along the estuary through 9 stations (pk1 to pk 20). The physicochemical parameters performed on water are: turbidity, pH, electrical conductivity, BOD5, COD, salinity, suspended matter and indicators of faecal pollution for bacteriological quality. While, for the sediment the particle size analyzes, the pH, the conductivity, the humidity rate, the organic matter, the coliforms, the fungi, as well as the pathogenic germs.

Keywords: Bouregreg estuary, water and sediment quality, Physicochemical and bacteriological characterization.

Etude de la qualité d'estuaire de bouregreg et l'impact des projets d'aménagements

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CP-02

L'augmentation démographique et le développement industriel provoquent une menace très dangereuse sur l'écosystème aquatique, ainsi sur la santé humaine au niveau de l'oued Bouregreg. Les aménagements, dont les estuaires ont été l'objet depuis le milieu du siècle dernier, ont profondément modifié non seulement leur géométrie mais également les processus hydrologiques et sédimentologies naturels.

Oued Bouregreg est le deuxième fleuve important au Maroc, prend source au moyen atlas a une altitude de 1627m. Ce bassin est drainé par trois principales artères hydrologiques : l'oued Bou-Regreg, l'oued Grou et l'oued Korifla. Le barrage Sidi Mohammed Ben Abdellah a été construit 24km en amont de l'estuaire de Bouregreg. Ce qui a complètement perturbé le fonctionnement de l'écosystème de l'estuaire de Bouregreg. L'estuaire du bouregreg a reconnu depuis 2006, le projet d'aménagement de la vallée du Bouregreg parmi ces travaux la marina, le grand Burj Mohammed VI, l'extension de réseau du tramway Rabat-

Salé et le grand théâtre. L'objectif de notre travail est d'étudier l'impact de ce projet d'aménagement sur la qualité du sédiment et de l'eau de l'estuaire. Les analyses ont été réalisées le long de l'estuaire à travers 9 stations (pk 1 à pk 20). Les paramètres physicochimique Les paramètres physicochimiques qui sont réalisée sur l'eau sont : la turbidité, le pH, la conductivité électrique, la DBO₅, la DCO, la salinité, la matière en suspension et les indicateurs de la pollution fécale pour la qualité bactériologique. Tandis que, pour le sédiment l'analyses granulométrique, le pH, la conductivité, le taux d'humidité, la matière organique, les coliformes, les champignons, ainsi que les germes pathogènes.

Mots clés : Estuaire Bouregreg, eau, sédiment, physicochimique, bactériologique

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CD-03

Assurer une sécurité alimentaire durable est actuellement le souci majeur de l'humanité, surtout dans des conjonctures où la population est en croissance continue et les effets du changement climatique s'aggravent du jour à l'autre. En plus parmi les nombreux facteurs contraignants la productivité des cultures sont les maladies cryptogamiques. Au Maroc, et notamment dans le périmètre irrigué des Doukkala, la pourriture de la betterave à sucre causée par *Sclerotium rolfsii* présente un risque majeur sur la productivité de cette culture. L'objectif de cette étude consiste à identifier à l'échelle du périmètre, la relation entre la fréquence de l'infestation par *Sclerotium rolfsii* et la quantité d'inoculum dans le sol d'une part et avec les différents paramètres physicochimiques du sol d'autre part. Nous avons collecté prélevés et analysés 1786 échantillons dans tout le périmètre irrigué. Les échantillons repartis sur 4 années successives à savoir 2016, 2017, 2018 et 2019 avec 694, 390, 432 et 270 échantillons respectivement. Nous avons réalisé l'extraction des sclérotites viables dans 250 grammes du sol selon la méthode de stimulation de la germination par le méthanol. Nous avons également effectué des analyses au laboratoire des paramètres physicochimiques des sols infestés (Sable, argile, limon, pH, MgO,

K₂O, Fe, Cu, EC, MO, Mn, Zn, B, P₂O₅, CaO et NH₄). L'étude a montré que la fréquence relative d'infestation par *Sclerotium rolfsii* et le nombre des sclérotites viables oscillent inversement et présentent une fréquence relative de 41% en 2019 et de 45% en 2016 et un nombre de sclérotites de 1,46 en 2019 et de 2,05 en 2016. Le nombre des sclérotites viables est positivement corrélé avec la teneur en argile et limon, le pH du sol, MgO, K₂O, Fe et Cu. Par contre, il est négativement corrélé avec la teneur en sable, EC, MO, Mn, Zn, B, P₂O₅, CaO, et NH₄. La baisse constatée des sclérotites viables entre 2016 et 2019 peut être attribuée directement à la baisse du Fe et du Cu dans le sol. Cette baisse est due à la chélation des ions par la matière organique des restitutions humifiées. Il est possible que la matière organique du sol intervienne avec sa fraction humifiée dans la neutralisation du potentiel redox du Fe et Cu qui est impliqué dans la production des sclérotites en condition de stress oxydatif. La bonne maîtrise de la fertilisation surtout organique permet de limiter la production des sclérotites de *Sclerotium rolfsii*.

Mots clés : fertilité du sol, matière organique, betterave à sucre, *Sclerotium rolfsii*, Doukkala, Maroc.

Influence of ripening process on phytochemical compounds and biological properties of carob pods (*Ceratonia siliqua* L.) extracts

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CD-04

Carob fruit constitutes an abundant vegetable material which presents a potential source of bioactive molecules. The present study aimed to characterize aqueous and ethanolic *Ceratonia siliqua* pods extracts in relation to their sugars and phenolic profiles and antiradical, antitumor and antibacterial potential during ripening process. In the three studied maturity stages, sucrose, fructose, glucose, total polyphenol, flavonoids, and condensed tannins were quantified in both extracts. The sucrose content gradually increased during ripening from 15.63 and 48.54 g/kg DW to 119.35 and 147.21 g/kg DW in the ripe pods in ethanolic and aqueous extracts, respectively. In contrast, both monosaccharide and the phenolic compounds tended to decrease. In addition, both extracts showed highest antiradical capacity in the unripe stage. Furthermore, extraction solvent and ripening also altered the antitumor effect, wherein only the

ethanolic extracts showed interesting antiproliferative effect on fish hepatoma cell line (PLHC-1), particularly those obtained from mid-ripe and ripe pods. Concerning the antibacterial activity, all the tested extracts exhibited interesting detrimental impact on the viability of *Photobacterium damsela*, except for the aqueous extract obtained from ripened pods. However, these effects were found to be less intense against *Vibrio harveyi* and *Vibrio anguillarum* using ethanolic extract, while the aqueous extracts were completely innocuous. The present work revealed some interesting finding related to bioactive potential of carob pods at different harvesting stages that could be largely exploited.

Keywords: *Ceratonia siliqua* L.; Extraction solvent; Ripening stage; biochemical composition; Head kidney leucocytes; Cytotoxic effect; Bactericidal activity.

Evaluation of the purifying performance of the wastewater treatment plant by natural lagoon of Zaouiat-cheikh - Morocco

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CP-05

Management and treatment of water is one of the key challenges in the current scenario of environmental protection. In spite of the progress achieved by Morocco in term of wastewater treatment, the development of simple and cost effective biotechnologies such as natural lagoon is particularly interesting especially in small and medium communities. To face this condition, the National office of Drinking Water (ONEP) puts the accent on the biotechnological techniques to reduce the harmful effect which undergoes the receiving environment (Oued Umm Er-Rbia), and to re-use purified water in the field of agriculture. The objective of this work is, to study the performance of the purification plant of Zaouiat-cheikh by the study of physico-chemical analysis data during the period between 2014 and 2020, at the entrance and exit of STEP. The flow measurements are carried out at the entrance to the WWTP via an ultrasonic flow meter permanently installed. The daily flow of wastewater varies between 2221 m³/d and 811 m³/d, with an average of 1350 m³/d. The results obtained

by statistical treatment of physico-chemical quality parameters, BOD (biochemical oxygen demand), COD (chemical oxygen demand), and TSS (Total Suspended Solids) at the output, showed that: The COD Avg = 400.34 mg/l, BOD5 Avg = 157.21 mg/l and the TSS Avg = 140.10 mg/l. In order to have a biodegradability information on the purifying performance, biodegradability-index (ratio) showed that these wastewaters have a high organic load COD / BOD5 between 3,11 and 1,6 TSS / BOD5 = 1.5 to 0,5. In fact, these values of pollution parameters are relatively high compared to the usual average concentrations in Moroccan urban wastewaters, due to the olive mill effluent were drained into the surrounding environment without any treatment. That made it possible to note that this wastewater from the city of Zaouiat-cheikh is relatively charged in various pollutants.

Key words: Wastewater, Natural lagoon, Purifying Performance, Physico-chemical Analysis, Zaouiat-cheikh.

Effet de l'interaction eau-azote sur le rendement de la betterave à sucre conduite sous irrigation localisée au TADLA

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CP-06

L'efficacité de l'utilisation des terres agricoles constitue un objectif primordial de l'agriculture marocaine. Dans le cadre d'un développement durable des ressources naturelles (Eau) et de l'optimisation de l'utilisation des engrais azotés, cette étude a évalué les effets que peuvent avoir la limitation hydrique et azotée sur la production finale en racines et la teneur en sucre de la betterave à sucre dans une région semi-aride de la plaine de Tadla. L'essai a été réalisé selon un protocole en split plot. L'étude a porté sur deux régimes hydriques ; soit T1 : irrigué à 100 % des besoins en eau de la betterave à sucre ; et T2 : irrigué à 60 % des besoins en eau de cette culture. Quatre niveaux de fertilisation azotée ont été appliqués par combinaison : D1 (80 unités/ha), D2 (120 unités/ha), D3 (240 unités/ha) et D4 (320 unités/ha).

Le rendement racine, le développement foliaire, le sucre brut, et la teneur d'azote minéral dans le sol ont été mesurés et discutés. Il apparaît que la réduction de la surface foliaire est étroitement liée au déficit hydrique et au niveau de la fertilisation azotée. L'essai montre que le stress dû à la contrainte hydrique a induit chez la betterave à sucre une baisse du rendement racinaire, pendant que la teneur en sucre a légèrement augmenté en régime hydrique T2. L'expérimentation a montré aussi que le stress hydrique réduit l'absorption d'azote par la plante. L'efficacité d'utilisation de l'azote semble être plus influencée par le régime hydrique que par le niveau de la fertilisation azotée.

Mots clés : Betterave à sucre, fertilisation azotée, stress hydrique, rendement racine, qualité technologique, fertigation.

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La réutilisation des eaux usées dans l'agriculture est largement pratique dans plusieurs pays mais parfois on ne fait pas assez d'attention à la contamination de ces eaux par les polluants comme les métaux lourds. Notre objectif est d'étudier l'effet de l'irrigation d'une culture de menthe par 10ppm de Chrome VI pendant 10jour et évalué la toxicité de Chrome sur cette culture et le risque sanitaire lié à leur consommation. Les résultats montrent que le Cr affecte la teneur des pigments (Chlorophylle a, b et caroténoïdes) et la teneur relative en eau (TRE). Cependant on remarque qu'il y a une légère augmentation de la teneur en sucres solubles totaux, en protéines et en proline par rapport aux plantes témoins. Concernant la bioaccumulation de Chrome on note que le facteur de la

Bioaccumulation est très important (plus de 5) mais le facteur de translocation (FT) est de 0,94 (la majorité de Cr (94%) est stockée dans les racines), malgré la faiblesse de FT on a constaté que la dose journalière de chrome (0,003 mg/kg/jour) est fortement dépassée (0,1262 pour les hommes et 0,1767 mg/kg/jour pour les femmes) donc le risque de la toxicité est hautement probable. Il faut toujours contrôler et vérifier la pureté des eaux d'irrigation pour empêcher la pollution des sols agricoles et par la suite la contamination des végétaux comestibles par l'homme et les animaux.

Mots clés : Menthe ; Chrome VI ; *Mentha spicata* ; Toxicité ; Bioaccumulation.

Monthly variation of yield and composition of sodium alginate from the Moroccan kelp *Saccorhiza polyschides*

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Alginate, known for its biochemical potential, is the major component in marine brown algae (*Phaeophyceae*). In the present study, monthly variations of sodium alginate extracted from the Moroccan kelp *Saccorhiza polyschides* were investigated. Yield and spectroscopic characterization (1H NMR and FT-IR) results showed significant monthly variation. Maximum yield was obtained during summer (August) with 32.44% dw, whereas minimum yield was found at the beginning of spring (March) with 16.74%. Similarities were found between FT-IR spectra of the commercial alginates and that of the monthly extracted alginates. The 1H NMR spectroscopy indicated differences in the block structure of the monthly extracted alginates. The highest M/G ratio value (1.87) was detected for Alginates extracted in April showing the highest rate of mannuronic acid content ($F_M = 65\%$), with fairly abundance of

heteropolymeric fractions ($F_{GM}/F_{MG} = 55\%$). The maximum level of the α -L-guluronic acid ($F_G = 56\%$) was found in June, with low M/G ratio value (0.76) and prominent heteropolymeric fractions ($F_{GM}/F_{MG} = 72\%$) compared to homopolymeric fractions ($F_{MM} = 5\%$; $F_{GG} = 18\%$). In conclusion, the Moroccan *S. polyschides* has proved to be an interesting alginophyte to be potentially used in phycocolloids industry. Results of the seasonal yield and spectroscopic characterization of alginates would help improve the production incomes, and sustainability of species biomass taking into consideration the species life cycle in parallel with the quality of the extracted alginates.

Keywords: *Saccorhiza polyschides*, brown seaweeds, alginates, 1H NMR and FT-IR, Atlantic coast, Morocco.

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CD-09

The current work was aimed to evaluate the toxicity of metals (Cd, Fe and Zn) on the germination and early seedling growth of fenugreek (*Trigonella foenum-graceum*), as well as to analyze the influence of different test substrates (filter paper and soil) in estimation of the phytoecotoxicological effect of metals. Fenugreek seeds were exposed to 8 graduate concentrations of Cd, Fe and Zn (from 0 to 1000 mg L⁻¹ (or mg kg⁻¹ for soil)). The results showed that Cd affects significantly all the parameter tested in both substrates (p=0.000). Seed germination (GP) was the only parameter that not reduced significantly in presence of Zn, in contrast, no effect of Fe in Lufa soil. The results obtained revealed that the substrate used in germina-

tion test is an important factor that limits the effect of metals on plants. The fenugreek seeds germinated in filter paper were judged more sensitive than these grown in lufa soil. The estimated phytotoxicity values of NOEC, EC20, EC50 and PEC/PNEC ratios were extremely high indicating a high risk of metals on fenugreek seedlings.

Keywords: Bioindicator, metal phytotoxicity, morphological changes, soil quality guidelines, soil.

Bioherbicide effects of phenolic compounds from olive mill waste water isolated by membrane processes

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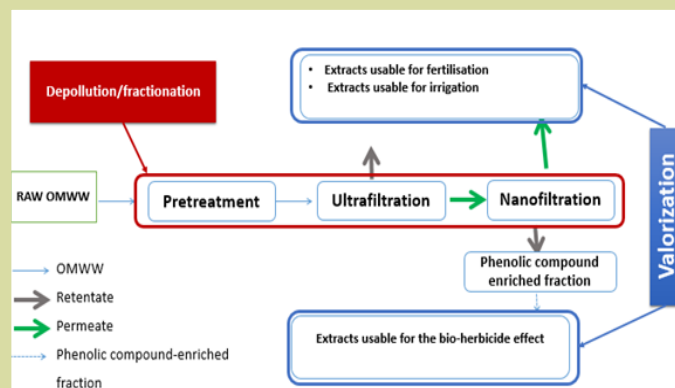
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CD-10

Olive mill wastewater (OMWW) contains a large proportion of phenolic compounds leading to high chemical oxygen demands (COD) (around 110 g-O₂ L⁻¹). The saturation in aromatic molecules makes difficult the treatment of such industrial effluents. Moreover, phenol and its derivatives have antioxidant, phytotoxic and bioactive properties that could be valorized. Membrane technology has been widely developed in recent years. Membrane processes are already used at the industrial level, because they have the advantage of not modifying the structure of the compounds to be concentrated. In this study, a valorization strategy of OMWW by membrane processes has been developed. The concentration of phenolic compounds by an Ultrafiltration - Nanofiltration process has been optimized in order to evaluate the bioherbicidal effect of these compounds (Figure1). The application of OMWW fractions as bioherbicides and replacing artificial herbicides constitutes an innovative zero liquid and waste discharges approach for the agricultural sector. For that, the current work aims to mitigate the environmental impacts of liquid effluents of the olive industry through; i) recovering the phenolic fraction of the OMWW thanks to membrane processes, ii) evaluating the potential of produced extract for phytotoxic applications and iii) using the depleted fraction in phenolic compounds as a soil

amendment. The first tests on the bio-herbicidal potential of the fractions rich in polyphenols applied to the cress seeds were carried out: the analysis of the results obtained on inhibition of germination and root growth validated the choice of the application of the concentrates obtained after Nanofiltration as an effective bioherbicide.

Keywords: Bioherbicide, OMWW, membrane filtration, polyphenols, valorization.



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CD-11

The use of pesticides for agriculture seems to be an effective method against pests. However, the massive application of these products can pose a great risk to human health. The World Health Organization (WHO) estimates that there are 3 million cases of pesticides poisoning each year and up to 220,000 deaths. Copper quinolate (CuQ) is a kind of organic copper fungicide, which can control most bacterial diseases and some fungal diseases and is widely used in the agricultural industry.

The excessive application of this pesticide may result in a variety of adverse effects on non-target organisms, including humans. Our study focused on the evaluation of the toxic effects of the oral administration of three doses of copper quinolate (low; middle and high dose) for 8 weeks on the evolution of body weight and hepatic function in the male Wistar rat for this purpose several biochemical assays were performed. Analysis of the results obtained showed that treatment with CuQ caused harmful effects on the body, resulting in a reduction in body mass in rats treated at high and medium doses compared to controls. The absolute and relative organ mass was impacted by the treatment

revealing a liver mass, particularly in rats treated with (CuQ) at medium and high doses.

The results of the biochemical assays revealed a significant increase in the activity of the hepatic enzymes ASAT, PAL and a decrease in the concentration of ALAT, especially in medium and high dose treated.

The pro-oxidant effect of copper quinolate induced an increase in tissue level of malondialdehyde (MDA). In addition, a decrease in the activity of glutathione peroxidase (GPx) and glutathione-S-transferase (GST) was recorded at high and medium doses. In summary, all of the results clearly showed that exposure to pesticides, in particular copper quinolate, caused disturbances in the body, manifested by an alteration in parameters linked to Hepatic function. And alteration of the system pro-oxidant. From these results, it appears that the doses of copper quinolate tested the high and the medium dose; induce remarkable toxic effects on hepatic function.

Keywords: Copper quinolate, Hepatotoxicity, Biochemical parameters, oxidative stress, Rat.

Base de données géospatiale sur la qualité physico-chimique des zones humides marocaines besoin et défis : la présentation des résultats comme exemple

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CD-12

L'eau naturelle est d'une importance capitale dans toutes des régions du monde. Toutefois, cette ressource qui était jadis de bonne qualité et qui constitue un élément incontournable pour le développement économique, se trouve actuellement menacée par diverses sources de contamination ponctuelles et diffuses. Il convient donc de connaître et suivre la qualité de cette ressource. En effet les études réalisées au Maroc dans le but d'évaluer la qualité de l'eau, ont signalé plusieurs foyers de pollution physico-chimique. L'eau qui devient impropre à la consommation et même inutilisables pour les autres usages. Cette pollution est causée particulièrement par l'intensification des activités agricoles et industrielles.

Le présent travail a fait l'objet d'un Doctorat national en biologie, dans le cadre d'une coopération interuniversitaire entre le laboratoire d'écologie fonctionnelle et environnement de faculté des sciences et techniques de Fès et le département de zoologie et écologie animale de l'institut scientifique de Rabat. Ces travaux ont permis l'élaboration d'une base de données pour un suivi de la qualité physico-chimique des eaux naturelles continentales et estuariennes dans le royaume.

Les analyses physico-chimiques permettent de contrôler la qualité des eaux, et montrer l'évolution spatiotemporelle des paramètres indicateurs de pollution tels que la température, le pH, la dureté, l'oxygène dissous, la demande chimique en oxygène, la turbidité et l'oxydabilité... Les systèmes d'information géographique (SIG) constituent un incontournable outil de stockage, gestion et exploitation des données géocodées. Notre objectif est de fournir une meilleure synthèse physico-chimique, basée sur un SIG à l'échelle nationale et focalisée sur la distribution temporelle et spatiale des principaux polluants de l'eau.

La faisabilité de la base de données connaît plusieurs contraintes, telles que les manières de présentation des résultats de mesures, des paramètres physico-chimiques, qui diffèrent d'une référence à une autre : Tableau ; Courbe ; Histogramme (colonnes, secteur) ;

Carte Diagramme spéciaux (Piper) ACP...

Mots clés : qualité des eaux, physicochimie, pollution, systèmes d'information géographique.

The quantification of hematite and goethite in hydromorphic soils using the sentinel-2 sensor and XRF in the Beni Moussa perimeter, Tadla plain, Morocco

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CP-13

The focus of this research is to assess the Sentinel-2 sensor bands ability to detect and quantify ferrous products in soil using specific spectral indices and iron absorption characteristics in the visible and near-infrared, as well as to propose a method for quantifying ferrous products in ppm using the Sentinel-2 sensor bands in combination with iron content determined by X-ray fluorescence. The hematite index (IHm) developed by Madeira Netto (1993) for the Landsat TM-5 sensor bands, as well as the ferric index (RHGt PF) developed by Baptista and Débora Teobaldo (2017) for the WorldView-2 sensor bands, were adjusted for Sentinel-2 to see if the super-spectral sensor bands of Sentinel-2 could cover the absorption characteristics of ferrous products. To examine the usefulness of Sentinel-2 data in measuring hematite and goethite minerals in Beni Moussa soils using continuum-suppressed spectral feature analysis, organic matter, carbonate, and iron concentrations were measured in soil samples to demonstrate links between them and the spectrum responses measured by the sensor on the soil sample regions. All data were subjected to multivariate statistical analysis to determine the Interrelationships between the different parameters. The iron index (IFe) used to estimate the ratio (hematite/ (hematite + goethite)) was calculated to confirm the results of hematite and goethite mineral quantification. The results show that multispectral data from Sentinel-2 allows the detection of

iron oxides hematite and goethite. With the deployment of the Sentinel 2 super-spectral sensor bands, the spectral features of goethite, centered at 0.48 m, and hematite, centered at 0.53 m, can now be distinguished; this was previously unachievable with other multispectral data. Pearson correlation coefficient indicates that the iron content determined by X-ray fluorescence is positively correlated with the redness index ($r = 0.9485$) and ferruginous minerals determined by the technique based on the depth of spectral characteristics for hematite ($r = 0.8939$) and for goethite ($r = 0.8301$). the redness index is positively correlated with ferruginous minerals determined by the technique based on the depth of spectral characteristics ($r = 0.8499$) for goethite and ($r = 0.8969$) for hematite, but it's negatively correlated with organic matter ($r = -0.5715986$) and CaCO_3 ($r = -0.7796$), indicating that these two elements have a significant impact on the iron concentration and electrometric spectrum of the soil. The strong correlation between the concentrations ratio (hematite/hematite + goethite) given by the iron index ($r = 0.74$) and the ratio (hematite/hematite + goethite) calculated by the concentrations of hematite and goethite estimated by the proposed method shows that the results obtained are more or less representative.

Keywords: Goethite, Hematite, Iron Absorption Characteristics, Multivariate Statistical Analysis, Sentinel-2, X-ray fluorescence

Assessment of the impact of phosphate sludge adding on transformation of vegetable organic matter during composting by the thermal and spectroscopic analysis

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CP-14

Phosphocomposting has been already conducted by using phosphate rock, while this study is the first devoted to conduct phospho-composting by recovering phosphate sludge, a residual fraction from the phosphate industry. Composting process with phosphate sludge CPSOM show to be highly thermophilic ($T^{\circ} \text{max} = 68^{\circ} \text{C}$) and had a distinct maturation phase comparing to composting of organic matter alone COMSW where ($T^{\circ} \text{max}$) had not overcome 54°C and without a clear maturation phase. The decomposition rate 52.7 % and also NTK that show low increase (1.2-1.4%) postulate that there are more production of humic substances as result of organic matter decomposition, when adding phosphate sludge in CPSOM. While, in COMSW, a great decomposition rate (80%) and the increase of NTK (from 1.17-1.79) attest a great decomposition and loss of heat labile fraction that had not humified. In fact, Thermogravimetric (TG, DTG and DTA) and FTIR analysis

demonstrate that in COMSW, there are great losses of labile organic structures (burned at 250°C , absorbed at 1623 cm^{-1}). However, in phospho-compost CPSOM, there are high stabilisation of organic structures (burned at high T° over 780°C , absorbed at 1430 cm^{-1}), due to their linking to mineral components of phosphate sludge PS. Furthermore, this compost becomes, more rich on stabilized structures (absorbed at 1034 cm^{-1}), that take more energy for decomposition, and require higher temperatures for them to be lost (over 600°C). These structures formed correspond to very complex aromatic compounds compared to those in the initial mixtures, which indicates a high OM stabilization after the addition of phosphate sludge PS to organic residues for composting.

Keywords: Phosphate, Humic substances, Organic waste, Bioprocess, Compost

Science Alimentaire et Nutrition
Food Science and Nutrition.

Thème/Topic



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CD-01

L'abeille mellifère est un pollinisateur des plantes le plus important mondialement, le déclin des colonies d'abeilles résulte des plusieurs facteurs interdépendants. Les pathologies sont l'un facteur responsable du déclin observé bien que les maladies de couvain sont l'une des menaces le plus graves pour les abeilles mellifères, et pour lutter contre les agents pathogènes les abeilles utilisent de nombreux mécanismes collectifs, l'un de ces mécanismes c'est élimination du couvain malade d'une colonies ce phénomène qualifié de comportement hygiénique a pour l'objet de réduire les réservoirs d'agent pathogènes, inhibent la propagation des agents infectieux des parasites chez l'abeilles. L'objectif de cette étude est quantifié le comportement chez nos colonies d'abeilles. À cet effet, 40 colonies d'un même rucher ont été identifiées dans l'essai. Elles sont caractérisées par le même nombre de cadres occupés par les abeilles.

Le degré de comportement hygiénique a été déterminé par la méthode de Spivar et Gilliam (1998). Le test de couvain tué par congélation a été effectué en enle-

vant des sections carrées de 5 cm sur 8 cm de rayon contenant environ 100 cellules de couvain operculé de chaque colonie. Les coupes ont été placées dans un congélateur pendant environ 18 heures, puis le couvain a été décongelé et remis dans le cadre duquel il a été retiré. Les pourcentages de prélèvement de couvain dans chaque colonie ont été enregistrés après 24, 48 et 72 h. D'après les résultats obtenus, le taux est très intéressant. Après 24 h, les abeilles ont prélevé 82,455 % des alvéoles au test en septembre et 93,10 % en mars. Des colonies les plus hygiéniques ont moins de varroa. Ce qui confirme que ce critère est considéré comme un réel comportement de résistance contre cette pathologie.

Mots clés : *Apis mellifera*, Comportement hygiénique, couvain, pathologies, Varroa.

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CD-02

Nous avons mené tout d'abord des études d'enquêtes dans 3 unités frigorifiques (Tomour Wahat Aoufous, Difat Ziz et Gheriss Ferkla Amagha) situées à la province d'Errachidia-Maroc. Nous avons diagnostiqué plusieurs défauts (cristallisation des sucres, détachement de l'épicarpe, dessèchement et perte de poids) au cours du stockage post-récolte des dattes qui sont à l'origine de pertes qualitatives et quantitatives considérables. Ceci est engendré par les conditions qui y règnent (température positive allant de 0 à 4 °C et stockage en vrac), la non maîtrise de l'humidité relative et la non existence de barèmes [température-humidité-durée] spécifiques adaptés à chaque catégorie de dattes. Pour faire face à ces problèmes et dans le but de prolonger la durée de conservation des dattes, nous avons étudié l'impact des basses températures (-18, -10 et 4 °C) et du type d'emballage (boîte cartonnée et barquette en plastique) sur les propriétés de la qualité physico-chimique de deux variétés de dattes marocaines de haute valeur marchande (Majhoul et Boufeggous), sur une période de 6 mois. Les dattes collectées sont caractérisées comme suit : $a_w = 0,653$ et $0,598$ / acidité titrable = $0,243$ et $0,282$ (g d'acide citrique/100g) / teneur en eau = $22,5$ et $19,6\%$ / teneur en cendre = $1,92$ et $3,02\%$ / solides solubles totaux = 58 et 54 °Brix / fermeté = $435,95$ et $533,61$ g / couleur HunterLab : $a^* = 12,12$ et $8,44$; $b^* = 11,41$ et $9,06$; $L^* = 26,78$ et $22,36$ / pourcentage de la pulpe = $93,22$ et $88,76\%$ / longueur = $43,5$ et $39,35$ mm / diamètre = $25,2$ et $24,78$ mm et épaisseur = $6,3$ et $4,69$ mm, pour les variétés Majhoul et Boufeggous, respectivement. Le suivi de l'évolution de ces attributs a montré que l' a_w diminue progressivement au cours du stockage et est plus accentuée à 4 °C en utilisant un emballage en plastique (après 6 mois de stockage l' a_w atteint $0,379$ et $0,413$ pour le Majhoul et le Boufeggous, respective-

ment). L'acidité titrable augmente durant le stockage, surtout dans une température de 4 °C où elle atteint, après 6 mois, des valeurs de $0,640$ et $0,729$ g d'acide citrique/100g pour le Majhoul et des valeurs de $0,601$ et $0,576$ g d'acide citrique/100g pour le Boufeggous, emballés en carton et en plastique, respectivement. Quant à la quantité des sucres solubles totaux et aux paramètres (a^* , b^* et L^*) de la couleur HunterLab, nous avons assisté à des fluctuations tout au long de la période de stockage, dues aux réactions chimiques (inversion du saccharose, oxydation, réaction de Maillard) qui se déroulent après récolte et à l'évaporation de l'eau libre. Fait intéressant, la fermeté des dattes des deux variétés a augmenté à la fin de la période de stockage à 4 °C pour atteindre $1430,85$ et 1839 g pour le Majhoul et $1248,55$ et $1595,5$ g pour le Boufeggous, emballés en carton et en plastique, respectivement, par contre les dattes stockées à des températures négatives (-10 et -18 °C) la variation de la fermeté était non significative. De plus, une perte de poids des dattes a été enregistrée à une température de 4 °C pour les deux variétés, toutefois les dattes stockées à -10 et -18 °C ont conservées leur poids initial, avec une légère augmentation pour celles emballées en carton expliquée par l'absorption de l'humidité. D'après le présent travail nous avons conclu que la congélation minimise la chute de l'activité de l'eau et l'augmentation de l'acidité titrable, elle conserve la fermeté de la datte et elle limite le phénomène de l'évaporation de l'eau qui est à l'origine du dessèchement communément observé dans les unités frigorifiques.

Mots clés : Dattes ; Stockage ; Post-récolte ; Conservation ; Congélation ; Emballage.

Impact saisonnier sur l'évaluation des risques liés à la prévalence spatiale des entérovirus dans les huîtres de la lagune de Oualidia au Maroc

CP-03

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Les entérovirus sont des agents pathogènes omniprésents dans le monde entier et ils sont capables de survivre pendant de longues périodes dans un environnement marin. Ils sont transmis par l'eau et les aliments contaminés par des selles. Le but de cette étude était d'évaluer la prévalence des entérovirus dans les huîtres prélevées dans la lagune de Oualidia par RT-PCR en temps réel. Pour atteindre cet objectif, 624 huîtres représentant 52 lots ont été collectées durant la période allant de Mars 2018 à Mars 2019 et testées pour la contamination virale en utilisant la réaction en chaîne par polymérase en temps réel. Les résultats montrent que 32,69% des échantillons testés étaient positifs pour les entérovirus. La distribution spatiale des entérovirus était statistiquement

significative. De plus, une variation saisonnière importante de la contamination par les entérovirus a été observée dans cette étude. La consommation d'huîtres contaminées par ce type de virus présente un risque majeur pour la santé humaine en provoquant des maladies graves telles que la gastro-entérite, l'hépatite et la poliomyélite. La présence d'entérovirus dans les zones de production d'huîtres représente un risque potentiel pour la santé.

Mots-clés : entérovirus ; Huîtres ; contamination virale ; PCR en temps réel ; ressources en eau.

Rheological and biological characterization of chitosans extracted by different acids

CP-04

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Shellfish processing industry produces several million tons of marine waste rich in chitin every year. Chitin is a versatile and ecological polymer with a wide range of applications in industry.

In this study, a valorization of shrimp co-products in the manufacture of high added value products is highlighted, with identification of their physicochemical properties and evaluation of their biological activities. Chitin extraction from shrimp shells was performed in three steps: deproteinization, decolorization and demineralization with two mineral acids and three organic acids. The antimicrobial activities of the different chitosans obtained were evaluated against prokaryotic and eukaryotic microorganisms. The antioxidant capacity was determined by the total antioxidant capacity (TAC) method. A rheological study was carried out in order to determine molecular weight Mw of chitosans obtained. Antibacterial activity of different chitosans evaluated against *Escherichia coli* and *Staphylococcus aureus* strains, is translated

by very high inhibition percentages, ranging from 73.8% to 94.5%. Antifungal activity results show that the different extracts are active on the strain *Aspergillus niger*. Chitosan extracted by citric acid and the one extracted by sulfuric acid have the best antioxidant activities, 163.2 mg AAE/g DM and 147.2 mg AAE/g DM, respectively. Chitosan with the highest intrinsic viscosity and molecular weight is obtained from citric acid demineralized chitin, followed by chitosan extracted with sulfuric acid, whose Mw values are 51046 Da and 27625 Da, respectively. Used acids during demineralization process have a strong effect on biological activities and physicochemical characteristics of chitosans obtained. An extraction of chitosan by an organic acid represents a less expensive, less harmful for the environment and promising way in industry.

Keywords: Chitin, chitosan, mineral acid, organic acid, molecular weight, and biological activities.

Quality parameters evaluation of berries conserved with essential oils after cold storage

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CP-05

Strawberries and raspberries are fruits with a high commercial value. The present study investigated the effect of postharvest essential oil treatments on the fungal development and physicochemical quality of berries after 12 days of cold storage (4 °C). Four hydrodistilled EOs from *Anthemis tenuisecta*, *Artemisia herba-alba*, *Cladanthus arabicus*, and *Thymus broussonetii* were used at three concentrations each. Results indicated that EO treatments generally reduced postharvest rot on raspberries and strawberries during storage at 4 °C. Also, EO treatments of raspberries reduced the change in ripeness index that occurred to

control (untreated raspberries) when treated strawberries did not present similar results.

Keywords: Strawberries; raspberries; essential oil treatments; fungal development; physicochemical quality.

Pertes et gaspillages alimentaires au Maroc : Enjeux liés au consommateur

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CP-06

Nos modes de consommation de produits alimentaires continuent de générer des défis importants en ce qui concerne la sécurité alimentaire et la qualité de notre nutrition. L'Organisation des Nations Unies pour l'Alimentation et l'Agriculture (FAO) estime qu'au niveau mondial un tiers de la production alimentaire destinée à la consommation humaine est perdue ou gaspillée (l'équivalent de 1.3 Milliards de tonnes par an). Cette étude porte sur les pertes et gaspillages alimentaires (PGA) au niveau des ménages marocains. La réflexion se fonde sur les résultats d'une enquête par questionnaire réalisée en ligne via Google Forms, notamment à travers l'identification et la compréhension des facteurs influençant ces PGA au niveau national. Sur les 255 ménages enquêtés, nous avons pu faire un état des lieux sur le niveau de formation et de sensibilisation des Marocains par rapport à cette problématique, sur leurs habitudes d'achat, de préparation et de consommation des produits alimentaires qui peuvent amplifier ce problème

des PGA et finalement nous avons analysé les motivations les plus pertinentes qui peuvent pousser le consommateur marocain à réduire ses PGA. Les résultats obtenus guideront la communauté scientifique, les décideurs et la société civile à mettre en place des plans d'action de formation et de sensibilisation adaptés au contexte marocain, voir même concevoir une stratégie nationale contre les PGA chez les ménages.

Comme perspectives, également, à cette étude nous considérons qu'il est nécessaire de compléter ce travail d'analyse et de compréhension des PGA par la conception et la mise en œuvre d'une méthode de quantification intégrale des PGA chez les ménages marocains.

Mots Clés : Pertes alimentaires, gaspillage alimentaire, production alimentaire, ménages, enquête.

Effect of feeding at different protein pourcentages on the zootechnical performance of oreochromis niloticus (deroua fish farm, Morocco)

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CP-07

In a national context, inland aquaculture is in a start-up phase with the implementation of concessions for the breeding of Nile Tilapia (*Oreochromis niloticus*) in floating cages at Dam Lakes, in concrete basins and in water accumulation basins for irrigation for the benefit of local fishermen's cooperatives. This action, which has proven its technical feasibility and economic profitability, has aroused the initiative of the private sector to venture into this activity. For a national development of this sector, it is necessary to master the nutritional needs and practices as well as the encouragement of the establishment of manufacturing industries of quality foods and at reasonable prices.

The aim of this study is to compare the effect of three feeds with different protein levels (26%, 28% and 31%) on the zootechnical performance of Nile Tilapia (*Oreochromis niloticus*) under rearing conditions in earthen ponds at the Deroua fish farm. 900 male fish with an average weight of 110.5g (min = 85g, max = 157.4g) and an average size of 18.46 cm (min=16 cm; max=21.4 cm) were distributed at a density of 1 fish/3m² over 9 earthen ponds of 300m² each with 3 replicates. These fish were fed with the 3 feeds for 8

weeks at a frequency of 5 times per day (8am; 10:30am; 1pm; 3pm and 6pm). Daily measurement of the physico-chemical parameters of the pond water in situ and in the laboratory. Sampling of about 30 fish is carried out fortnightly for growth measurements. The results obtained showed that the fish fed with a feed containing 31% protein had the best performance in terms of average weight gain (258.022g ± 17.152), daily weight gain (4.30g ± 0.285), specific growth rate (1.229 ± 0.063) and feed conversion rate (1.229 ± 0.063). These performances showed a statistically significant decrease in correlation with the decrease in protein levels (P<0.05). The high value of the protein efficiency coefficient (2.355 ± 0.010) is recorded in fish fed with a feed containing 28% protein. The different protein levels didn't have a significant effect on survival rate of the reared fish. For rearing water quality, the physico-chemical parameters were maintained at the optimal ranges of values recommended for rearing *Oreochromis niloticus*.

Keywords: feed, protein, zootechnical performance, *Oreochromis niloticus*, Deroua fish farm, Morocco

Evaluation de l'activité antioxydante des extraits phénoliques de quelques variétés de figes d'Algérie

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CP-08

En Algérie, les plantes médicinales et les remèdes n'ont jamais été totalement abandonnés et les gens n'ont jamais cessé de faire appel à la médecine traditionnelle, ce qui a conduit à maintenir une tradition thérapeutique vivante malgré le développement spectaculaire de la médecine moderne. Parmi ces plantes, le figuier ; qui appartient à la famille des moracées. Le fruit de ficus carica est doué de plusieurs intérêts biologiques ce qui explique son utilisation durant les divers civilisations dans divers domaine, il est utilisé comme aliment énergétique, émoullient, désinfectant et remède contre la toux, pour son effet bénéfique sur les douleurs gastriques, dans les traitement des hémorroïdes, utilisé pour ses propriétés laxatives, pectorales Elle est en plus allergénique, anticancéreux, antiseptique, aphrodisiaque, déodorant, digestive, diurétique, hypoglycémique, stomachique, tonique et vermifuge. Cependant, il y a un besoin de données plus scientifiques pour appuyer ces diverses allégations de santé. L'objectif de ce travail de recherche est d'étudier les différentes parties de ficus carica vert et noir (épicarpe, pulpes délipidées et non délipidées) par la quantification des extraits phénoliques et d'évaluer leurs activités antioxydantes par deux tests chimiques. Le choix de premier test est fixé sur une analyse mesurant le

pouvoir antioxydant des extraits à balayer le radical stable DPPH., tandis que le deuxième et une technique mesurant la capacité réductrice par l'utilisation de phosphomolybdène. Le dosage des phénols totaux a été effectué à l'aide du réactif de Folin-Ciocalteu) où les résultats ont montré que les valeurs variaient entre 6,44 et 351,71 mg EA-G/100gMV. Tandis que la quantification du contenu en flavonoïdes des différents organes de fruit a été estimée par la méthode du trichlorure d'aluminium (AlCl₃) où les teneurs s'échelonnent entre 8,61 et 40,93 QE/100 g MV). L'évaluation quantitative du pouvoir piègeur des extraits vis-à-vis du DPPH confirme que l'extrait de FB (épicarpe) est le plus actif avec un EC50 de l'ordre de 0,38 mg/ml. Par ailleurs, la capacité réductrice des ions molybdène hexa valent a montré que l'extrait de FTN (épicarpe) est un bon réducteur avec une activité de l'ordre de 1,14 mg/ml, une telle activité est supérieure de 10 fois à celle du BHT (3,60 mg/ml) dans le premier test et 3 fois da le second test. D'après ces résultats, on peut considérer les extraits des fruits des figes comme antioxydants naturelles.

Mots clés : *Ficus carica*, lipides, tocophérols, stérols, activité antioxydante.

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CP-09

Les fraises sont des fruits rouges, peu calorique, par leur apport en qualités organoleptiques et nutritionnelles, elles sont très appréciées par le consommateur au Maroc. La composition des fraises varie en fonction de la saison, des techniques de culture, des périodes de récolte, de conservation et de la région cultivée. Notre étude consiste à la comparaison des caractéristiques organoleptiques, physico-chimiques de trois variétés de fraises cultivées dans trois régions différentes Larache, Benslimane et Moulay Bouselham. La teneur en acidité titrable a été déterminée par titrimétrie. Les teneurs en Magnésium, Calcium, Chlorure, glucose et polyphénols contenus dans les jus de fraises ont été déterminées par la méthode spectrophotométrique, La teneur en Brix a été déterminée par l'analyse de réfraction dans les jus de fraises. La teneur en Fluorure a été déterminée par la méthode potentiométrique.

Les résultats révèlent des taux de Magnésium, Calcium, Chlorure et Fluorure respectivement compris entre 19.4 mg /100g et 34 mg/100g, 13.5 mg/100g

et 48.1 mg/100g, 82 mg/ 100 g et 1609.38 mg/100 g, 0,36 mg/l et 0,45 mg/l chez les différentes de fraises étudiées. Le taux de Brix est compris entre de 0.6 % et 1.3 %. Le taux de glucose est compris entre 1.35 g /100g et 2.45 g/100g. Le taux de polyphénols totaux est compris ente 61.1mg/100g et 151 mg/100g. Les résultats physicochimiques des trois variétés de fraises montrent qu'elles sont de nature sucrée acidulées, riche en polyphénols et minéraux. La variété de fraise d'origine de Moulay Bouselham présente des teneurs de Magnésium, Calcium, Chlorure, glucose, Brix, polyphénols supérieurs à celles des variétés de Larache et Benslimane. Ces résultats permettent de classer les variétés de fraises selon leurs qualités nutritionnelles et d'apporter des critères de sélection selon leur gout sucré, l'aspect, la variété de fraise pour le consommateur.

Mots clés : fraise, composition, minéraux, antioxydants, variétés, Maroc

Physicochemical, biochemical and sensory characterization of Moroccan clementine (*Citrus clementina*) jam

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CP-10

The citrus sector is one of the production sectors that have experienced remarkable development through the efforts of the Green Morocco Plan. However, this sector suffers from several problems of price fluctuation due to overproduction, which leads us to make proposals and practical solution to overcome this problem. Therefore, this study aims to propose different ways of valorization of the clementine by the transformation of this fruit into jam. To achieve this goal, we proceed to a comparison between two jam formulas prepared based on pectin extracted from clementine peels, and another based on commercial pectin (CP). To evaluate the technological and organoleptic quality of the formulated products, the two formulas adopted were characterized from a physicochemical, biochemical and sensory point of view. To assess the physico-chemical criteria, water content, pH, titrable acidity, Brix, coloration and water activi-

ty were determined. Regarding biochemical analyses the content of total polyphenols, vitamin C and the antioxidant activity of the prepared jam were determined. The results of physicochemical characterization showed that both jam formulas have a pH between 3.03 and 3.35 and a stable water activity between 0.73 and 0.75. Concerning the biochemical analysis, the total polyphenol contents of jams prepared from clementine pectin and commercial pectin were 560.10 and 579.66 mg GAE /100g of jam, respectively.

Sensory analysis results on a group of moderately trained tasters showed that the formula based on extracted pectin was highly appreciated by the panel, and there is no remarkable difference in texture, acidity and sweetness between the two formulated products.

Keywords: Clementine, jam, valorization, characterization.

Influence of different drying conditions on volatile composition of Italia raisins

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CP-11

The cultivar 'Italia' is characterised by its outstanding fruity taste and strong Muscat flavour. Despite aroma profile of 'Italia' fresh grapes and wines has been studied, no information is available about the volatiles present in their dried grapes. Thus, the present work evaluated the changes in the volatile profile of raisins obtained from cv. Italia and processed by convective drying at three temperatures (50, 60 and 70°C) and different pre-treatments (un-treated raisins (Un-TR), pre-treated samples with sodium hydroxide solution (SH-TR) and samples pre-treated according to traditional practise (Trad-TR)) using headspace-solid-phase microextraction-gas chromatography-mass spectrometry (HS-SPME-GC-MS). A total of 63 volatile compounds were identified, with terpenes being the most abundantly ones (fresh and dried samples had ranges between 16.62 and 82.06%), followed by furans (7.60-71.15%), aldehydes (3.70-20.25%) and esters (1.37-18.37%). The studied drying conditions resulted in an increase in the total content of furans, aldehydes, esters, alcohols, ketones

and acids, while the total terpene content decreased. In general, drying favoured the synthesis of furans (furfural, 5-HMF and 5-methyl-2-furfural) as well as 1-nonanol, furan linalool oxides and hotrienol responsible for the roasted and floral aromas, respectively. Three volatile components (aniline, methoxy phenyl oxime and 2,6 dimethyl 2,6-octadiene) were identified for the first time in raisins and in particular in samples from cv. 'Italia'. Our findings showed that the application of different drying conditions may result in remarkable changes in the volatile composition of 'Italia' raisins and that Trad pre-treatment allowed the biosynthesis of floral and roasted aromas noteworthy appreciated by consumers. These results are of interest because Trad pre-treatment is considered as a green method, which could substitute chemical pre-treatments widely used in the raisin industry and hence produce healthy and natural raisins.

Key words: volatile; raisins, drying, HS-SPME-GC-MS, aroma.

Simultaneous determination of six organophosphorus pesticides in fresh Peppermint, *Mentha piperita* L. by UHPLC-ESI-MS/MS.

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CP-12

The article demonstrates a method of simultaneous determination for six pesticides residues (Acephate, Azinphos-methyl, Cadusafos, Diazinon, Ethoprophos and Fenamiphos) in Fresh Peppermint, *Mentha piperita* L. using QuEChERS-UHPLC-ESI-MS/MS. Analysis was carried out by UHPLC-ESI-QqQ-MS/MS using Multiple Reaction monitoring (MRM). Good linear relationships were obtained in the range of 10–100 ng/g for both Acephate and Cadusafos, and 5–100ng/g for Azinphos-methyl, Fenamiphos and Ethoprophos pesticides. *Mentha piperita* L. (10 g) has been extracted with 10 ml acetonitrile and cleaned with 0.4 g PSA sorbent. The results showed that the QuEChERS-UHPLC-MS/MS method developed is simple, fast and effective. Average recoveries

are between 80% and 114.5% at three concentration levels (25, 50, 100 ng/g). With corresponding intraday and interday relative standard deviations of 2%–18%, the limits of quantitation were 1.2 ng/g for AC, 3ng/g for AZM, 5ng/g for Ca, 1.4 for DI, 2ng/g for Eth, and 8 for FEN. No organophosphorus pesticides were detected in five samples obtained from local market in Meknes.

Keywords : QuEChERS, UHPLC-ESI-MS/MS, *Mentha Spicata*.L, Organophosphorus.

Mesure du surpoids et de l'obésité : une comparaison des indices anthropométriques chez les migrants subsahariens résidents à la ville d'El Jadida-Maroc

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CD-13

En raison de facteurs à la fois génétiques et environnementaux, la composition corporelle et la topographie des populations sont présumées être différentes dans les différentes populations. En conséquence, les données anthropométriques qui sont mondialement acceptées pour étudier l'état nutritionnel des populations occidentales peuvent être différentes dans les populations africaines. A l'ère de l'émergence rapide des maladies chroniques en Afrique subsaharienne à cause de la transition nutritionnelle, les preuves de la performance de ces marqueurs dans les contextes africains sont essentielles. L'objectif de cette étude était donc la détermination du surpoids et de l'obésité par quatre principaux indices anthropométriques dans la population subsaharienne migrante à la ville d'ELJADIDA au Maroc. Dans cette étude, les données ont été recueillies sur une période d'une année, auprès de 175 subsahariens résidents à EL JADIDA, âgés de 18 ans et plus, en excluant les femmes

enceintes. Quatre marqueurs anthropométriques de surpoids et d'obésité ont été considérés : l'indice de masse corporelle, le tour de taille, le tour des hanches et le rapport taille-hanches. La prévalence pondérée d'une composition corporelle supérieure à la normale était de plus de 20% selon l'indice de masse corporelle, de plus de 25 % selon le tour de taille, et presque la moitié pour le rapport taille/hanches. Les données montrent l'importance de la mesure du Tour de taille dans la détermination des participants hypertendus et diabétiques.

L'étude rapporte un niveau modéré de corrélation et un niveau remarquable de discordance entre les indices anthropométriques concernant la détermination d'une composition corporelle anormale le tour de taille étant un prédicteur important du risque du diabète chez la population de migrants étudiés.

Mots clés : Anthropométrie, Surpoids, Obésité, Migrants, Subsahariens africains

Effet de l'entreposage au froid négatif et du type d'emballage sur la qualité physico-chimique des dattes Majhoul et Boufeggous

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CD-14

Selon une étude d'enquêtes menée aux unités frigorifiques situées dans les zones oasiennes du sud-est marocain, nous avons diagnostiqué plusieurs défauts au cours du stockage des dattes qui sont à l'origine de pertes qualitatives et quantitatives considérables. Ceci est engendré par les conditions qui y règnent, la non maîtrise de l'humidité relative et la non existence de barèmes spécifiques adaptés à chaque catégorie de dattes. Dans le but de préserver la qualité des dattes pendant leur stockage à froid et de prolonger leur durée de conservation, nous avons étudié l'impact de différentes températures (-18, -10 et 4 °C) et du type d'emballage (carton et plastique) sur les propriétés de qualité physico-chimique de deux variétés de dattes marocaines de haute valeur marchande (Majhoul et Boufeggous) sur une période de 6 mois. Les résultats ont montré des effets clairs de la température de stockage sur l'activité d'eau Aw. En effet, au début du stockage l'activité d'eau des dattes était de l'ordre de 0,653 et 0,598 pour les variétés Majhoul et Boufeggous, respectivement. A la fin de la période de stockage, les valeurs de Aw ont

diminué pour atteindre 0,392 ; 0,379 ; 0,513 ; 0,595 ; 0,519 ; 0,520 pour la variété Majhoul et ont atteint les valeurs 0,426 ; 0,413 ; 0,597 ; 0,591 ; 0,598 ; 0,590 pour la variété Boufeggous à 4 °C/carton, 4 °C plastique, -10 °C/Carton, -10 °C/plastique, -18 °C/carton et -18 °C/plastique, respectivement. Les paramètres de couleur (L*, a* et b*) ont été également influencé par la température et la luminosité L* a légèrement augmenté à la fin de la période de stockage. Concernant les autres attributs physico-chimiques (acidité, degré Brix, texture), des variations significatives (p < 0,5) ont été observées pendant la période de stockage, sous les différentes conditions de température et d'emballage, mais les deux variétés ne sont pas comportées de manière similaire. Ainsi, des conditions de stockage personnalisées qui tiennent compte de la spécificité de la variété sont essentielles pour un stockage réussi et une préservation de la qualité des dattes.

Mots clés : Dattes ; Qualité ; Stockage à froid ; Conservation ; Température ; Emballage.

Wild edible plants between valorization and neglect in two different types of population: urban and rural of the region Casablanca Settat.

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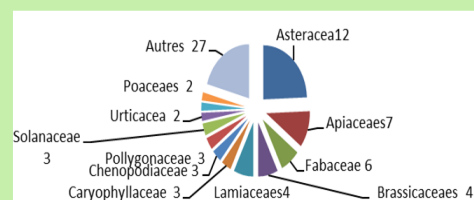
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CD-15

The reason for choosing the pure topic is that today, issues of population nutrition and health still dominate the global landscape on a large scale given that eating habits have changed completely, due to several factors. This change affects the food balance in terms of energy and nutrient intakes. This development testifies the nutritional transition, a phenomenon that can also cause natural imbalances that affect environment and development sustainability in a negative way. This is despite that the study local diet is of Mediterranean type recognized as one of reference dietary models. By the World Health Organizations that also protects local biodiversity and respects seasonality. Wild food plants are part of this diet and biodiversity. Their consumption can meet the nutritional needs of the population and treat problems of malnutrition and problems of nutritional imbalance. The objective of this work is to document these spontaneous plants in a survey population and discover the plant biodiversity of the study area. The results of this research contribute to documenting use patterns with the help of ethnobotanical surveys of these plants

in the study area. A total of 49 recipes were cited including 21 recipes for food use, 7 for medicinal use, 14 for both food and medicinal uses, and 4 recipes for food and other uses, and 4 recipes for food and other uses. Only one recipe for each of the following uses: food/medicinal/cosmetic use, other use, food/medicinal use and other use were identified in the study locations. A total of 78 plant species belonging to 36 families were identified, only those plant species representing a description of use or recipe were considered. This latter can nourish food databases and allow the discovery of biodiversity of Moroccan plants, which represent a wealth that is currently threatened and found neglected by the scientific community.



Determination the adulteration of oleaster oil using ftir and chemometrics

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CD-16

Oleaster is a variety natural of olive; it produces oil important for health who has falsified by producers with cheaper edible oils. It is a natural product that has been used in medicinal, cosmetic, and nutritional applications. It has an interesting value because it contains significant amounts of the main fatty acids, monounsaturated (oleic acid), saturated (palmitic acid), and polyunsaturated (linoleic acid).

This study aims to create a model of oleaster oil simply and reliably, to detect adulteration, which presents a large danger that attacks the food sector and human health, and to know the concentration of the falsifier mixed with this food product. For this reason, we based on the collection of wild olive fruits from the agricultural region Tamchat of Beni Mellal Morocco. The extraction of wild olive oil is done manually so as not to mix this oil with other oils and distorts the results of the study. The falsifiers used during this study are olive oil and soybean oil with a falsification percentage of 1.5-

40%. Using a spectral analysis method Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy ATR- FTIR, which reads the infrared spectra of samples and translates them into spectral data ready to analyze.

The treatment of spectral results has been done by chemometrics techniques using the partial least square regression PLSR and the principal components regression PCR, to develop quantification methods for sake create a relative model that can detect adulteration and know the concentration of falsification. The results of spectral and chemometrics shows that the perfect model of falsification of oleaster oil by olive-oil and soybean-oil illustrated in the spectral region 3050-2700 cm^{-1} , with values of $R^2=0.999$ from PLSR and PCR to soybean-oil, concerning olive-oil shows also the better results for the PLSR technical with $R^2 = 0.995$.

Keywords: oleaster oil, falsification, FTIR, chemometrics.

Utilisation de la luzerne en engraissement des ovins : effet sur les performances d'engraissement, les caractéristiques de la carcasse et le coût alimentaire.

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CD-17

L'objectif de ce travail était d'évaluer l'effet des différents régimes alimentaire à base de la luzerne sur les performances d'engraissement des agneaux. Trente-six agneaux de la race ovine Deroua (une race obtenue par croisement entre les races Boujaad et D'man) ont été utilisés pour cette essai. Les animaux ont été répartis au hasard en trois lots homogènes de 12 agneaux chacun. Chaque lot a été affecté à un régime alimentaire. Trois régimes alimentaires ont été testés : T1 (30% de luzerne, 40% d'orge, 15 % Pulpe sèche de betterave PSB et 5% Tourteau de soja (TS)), T2 (30% de luzerne, 40% d'orge, 15 % Pulpe sèche de betterave (PSB) et 5% Tourteau de tournesol (TTS)), T3 (40% de luzerne, 50% d'orge et 10 % PSB). La durée de l'essai a été de 62 jours durant laquelle les agneaux ont été pesés au début et à la fin de l'essai, ainsi que à des intervalles réguliers de 15 jours. Aussi, l'ingestion a été contrôlée quotidiennement. Les paramètres étudiés sont la croissance journalière (GMQ), indice de consommation (IC); les caractéristiques de la carcasse (rendement, dépôt de

gras, le pourcentage des différentes parties de la carcasse et l'état d'engraissement) et le coût alimentaire.

Les résultats de ce travail montrent l'absence d'effet significatif du régime alimentaire sur le GMQ ; es valeurs enregistrées sont de 215, 215 et 212g/j respectivement pour T1, T2 et T3. Le rendement carcasse le plus élevé a été réalisé par les animaux du régime T1 (47,1 %) contre 46,5 et 45,2 respectivement chez T2 et T3. Pour le gras de rognons et la note d'engraissement, les animaux ayant reçu le régime T3 ont enregistré le poids et le score les plus élevés. Le coût alimentaire le plus faible a été enregistré chez le lot 1 soit 11,7 dh/kg de gain contre 14 et 13 dh/kg de gain respectivement pour T3 et T2. Les résultats de ce travail montrent que la luzerne peut substituer le TTS et le TS, qui sont souvent importés et qui sont couteux, pour l'engraissement des agneaux pour diminuer le coût alimentaire et sans effet sur les performances d'engraissement.

Mots-clés : luzerne – ovins – Engraissement – carcasse - coût alimentaire

Effet du régime alimentaire, le génotype et la manutention durant l'abattage sur le pH ultime de la viande des ovins.

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CD-18

L'objectif de cette étude était d'évaluer l'effet de la manutention des animaux durant l'abattage, du régime alimentaire et le temps d'attente à l'abattoir avant l'abattage sur le pH de la viande des ovins après 24 heures de l'abattage. L'essai a été conduit sur 30 agneaux (232±12 jours) qui ont été engraisés durant 69 jours en utilisant trois régimes alimentaires. Les pH de la viande ont été mesurés au niveau du muscle « Longissimus dorsi » 24 h pré-mortem (pH24). Les valeurs de pH supérieures de 6,0 représentent 3,3% du total alors que celles supérieures à 5,8 représentent 23,3%. Le régime alimentaire, et la manutention des animaux avant l'abattage ont un effet significatif sur le pH24 (P<0,05); alors que le temps d'attente (moins de trois heures) et le génotype

n'ont pas montré un effet significatif sur le pH24 (P>0,05). Les résultats obtenus permettent de prendre des décisions en ce qui concerne la manutention des animaux avant l'abattage, le temps d'attente aux abattoirs et le régime alimentaire pour améliorer la qualité de la viande.

Mots clés : Ovin ; pH de la viande ; Manutention; Temps d'attente; Régime alimentaire.

**Agroécologie et Changement Climatique /
Agroecology and Climate Change.**

Thème/Topic



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CP-01

The production of activated activated carbons based on local biomass was to develop a process for cleaning up wastewater using adsorption. The main biomass used in this case is olive pits.

Accordingly, a series of activated carbons have been produced and three types of coal were targeted. The first one is charcoal carbonized at 600 °C, and the two remaining are chemically pre-treated, one with nitric acid at 10% followed by carbonization at 600 °C, and the other with phosphoric acid (1/1) followed

by carbonization at 600 °C. Afterwards, the characterization of the carbon obtained was carried out later as a second step. The experimental results showed that the carbons obtained could then be used in the treatment of wastewaters.

Keywords: valorisation, carbonization, activated carbons, local biomass, wastewaters, adsorption.

Réponses agro-physiologique et biochimique de l'olivier à l'irrigation déficitaire régulée en conditions semi arides du Maroc

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CP-02

Au Maroc, l'olivier (*Olea Europaea* L.) revêt une grande importance au niveau national et constitue l'une des filières stratégiques et prioritaires de la nouvelle stratégie « Génération Green ». Durant la dernière décennie, les superficies de cette culture ont augmenté pour atteindre environ 1,2 millions d'hectares. Ce qui a mobilisé des ressources hydriques supplémentaires. Toutefois, les changements climatiques ont induit de longue période de sécheresse avec une limitation des ressources hydriques, nécessitant l'adoption de restrictions hydriques raisonnées à travers l'amélioration de l'efficacité de l'irrigation déficitaire et le pilotage de l'irrigation. Cette étude consiste à évaluer les réponses agro-physiologiques et biochimiques des arbres d'olivier à l'irrigation déficitaire régulée (IDR). L'expérimentation a été conduite sur un verger d'olivier adulte de la variété 'Ménara' installé selon une densité de 204 pieds/ha au Domaine Expérimental de Saada de l'INRA de Marrakech. Les régimes d'irrigation ont été étudiés selon la sensibilité des phases phénologiques au stress hydrique avec (PS) 'phase sensible' et (PN) 'phase normale'. Quatre traitements d'irrigation ont été testés : T1(PS :100% ETc- PN :70% ETc), T2(PS :100%ETc- PN :60% ETc), T3 (PS :80%ETc-PN :70%ETc) et T4(PS :80%ETc-PN :60%ETc) en plus d'un témoin T0(100%ETc). Les besoins quotidiens en

eau d'irrigation ont été calculés selon la demande climatique en utilisant la méthode FAO-56.

Les résultats de la première année ont montré que la restriction de 40% des doses d'irrigation au niveau de la phase normale a induit, par rapport au T0, des réductions significatives de la croissance des rameaux (-23.3%), de l'indice foliaire (-9,8%), de la conductance stomatique (-7.1%), de la fluorescence chlorophyllienne (-10,4%), de la teneur des feuilles en chlorophylle (-22.8%) et une augmentation des teneurs des feuilles en proline (+422.3%), en sucres solubles (+60.1%) et en protéines (+37.9%). Alors que la réduction de 30% des doses d'irrigation a induit des perturbations moins intenses de certains paramètres biochimiques (proline, sucres solubles et protéines). Toutefois, en phase sensible, la réduction de 20% des doses d'irrigation n'a pas induit des effets négatifs significatifs sur la plupart des paramètres étudiés. Par conséquent, le traitement T3(PS :80%ETc-PN :70%ETc) constitue le régime optimal à adopter pour assurer une meilleure gestion de l'IDR en conditions semi-arides du périmètre du Haouz.

Mots clés : Olivier (*Olea europaea* L.), changements climatiques, irrigation déficitaire régulée, paramètres agrophysiologiques et biochimiques.

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Cette étude a examiné les assemblages d'oiseaux en comparant la diversité, la composition, l'utilisation de l'habitat et la hauteur des espèces d'oiseaux le long du gradient urbain-rural à Béni Mellal. Les oiseaux ont été étudiés 2019 à 2021 à l'aide de la méthodologie d'Indice Ponctuel d'Abondance (IPA). Un total de 63 espèces a été enregistré sur des placettes d'échantillonnage à 83 points. Parmi toutes les espèces répertoriées, 14 étaient présentes dans tous les habitats et 40 exclusivement dans certains habitats. Sur 40 espèces exclusives, 38 ont

été trouvées dans des habitats ruraux et semi-ruraux, 12 dans des parcs urbains et aucune espèce exclusive n'a été trouvée dans des habitats résidentiels à haute densité. La composition des espèces dans les sites naturels ruraux présentait des assemblages dissemblables par rapport à d'autres types d'habitats, par exemple le déclin des oiseaux insectivores en raison de l'urbanisation croissante. Les différences observées dans les assemblages d'oiseaux reflètent la différentielle disponibilité des ressources le long du gradient d'urbanisation. Les résultats

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Comportement de variétés sélectionnées et population locale de luzerne pérenne en conditions arides et salines du Sud tunisien

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La luzerne est une des plus importantes légumineuses fourragères au niveau mondial connue pour sa forte teneur en protéines, en fibres et en vitamines. *Medicago sativa* ssp. *sativa* à fleurs violacées est la plus cultivée dans les oasis et les périmètres irrigués du Nord Afrique. Les semences utilisées sont des variétés sélectionnées introduites ou des populations locales autoproduites (accessions). Le potentiel génétique des variétés sélectionnées n'est pas toujours adapté aux conditions spécifiques des zones arides marquées surtout par la sécheresse et la salinité. Dans le contexte de réhabilitation des sols salés, une expérimentation dans deux parcelles, du Sud Tunisien, a été effectuée sur six variétés introduites (Ameristand, Sardi10, Adorna, Mamuntanas, CUF101 et Salado) et une accession locale, notée BH, autoproduite depuis 30 ans dans la région de Gabes (environnement méditerranéen aride). Les deux sites différents principalement par la salinité du sol. Le sol du premier site a une salinité normale de 4g/l (Chenchou) et le sol du deuxième site souffre d'une sévère salinité de 58 g/l (Chenini). Les résultats montrent des variations inter-

cultivars et intra-sites significatives pour tous les paramètres étudiés (Croissance, production et rendement grainier). La variation intra-cultivars dépasse la variation inter-cultivars dans les deux sites. Un effet différentiel de la salinité a été enregistré entre les cultivars. Dans le site non salé, l'accession locale et les trois variétés sélectionnées (Ameristand, Sardi10 et Adorna) ont montré une production importante en biomasse frais et en graine. Le nombre des gousses/plante atteint 80 chez la population locale et il est de 60 chez la meilleure des variétés introduites (Adorna). Il est à noter que cette dernière est la seule population qui souffre de problème de verse. Dans la parcelle à forte salinité, une réduction énorme de tous les paramètres a été observée chez les variétés introduites surtout pour la production grainière qui est devenue nulle chez quelques variétés comme Salado et CUF101. Contrairement, l'accession locale BH n'est pas trop influencée par la salinité en gardant une croissance et une production quasi proches à celles obtenues sous la condition non saline. En conséquence, la sensibilité au stress salin est plus prononcée chez les

CP-05

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Salt tolerance is a much-needed potential in cereal crops. Therefore, recent advances in research have focused on the development of breeding programs for tolerant genotypes and varieties to improve both crop tolerance and yield in soils affected by salt. In the present study, we aimed to evaluate in vitro the response of five bread wheat (*Triticum aestivum* L.) varieties by applying a short-term brutal treatment whereby, the cultures are directly subjected to different salinity levels. According to the obtained results, salinity has significantly affected the callogenesis rate. Increasing salinity (especially at 6 and 9 g/l NaCl) in the culture medium also resulted in reducing the calli growth in terms of fresh and dry matter after three and six weeks and changes in their morphologi-

cal aspect. Whereas 12 g/l NaCl was found to be intolerable by all the varieties tested. Furthermore, the effect of salinity was well illustrated according to further parameters, namely the percentage of reduction with respect to the fresh matter and the tolerance index calculated with respect to dry matter.

Keywords: Bread wheat (*Triticum aestivum*); Callogenesis; callus growth; salt tolerance; salt tolerance index; salinity.

Résilience des agroécosystèmes oléicoles aux changements climatiques dans la région de Béni Mellal-Khénifra, Maroc.

CP-06

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Ce travail vise à mettre en évidence les variations du rendement et de la qualité des huiles d'olive de la variété (PM) produites au cours de quatre campagnes agricoles 2017, 2018, 2019 et 2020, par les différents agroécosystèmes de la région Béni Mellal-Khénifra au centre du Maroc, en tenant compte de l'influence des conditions climatiques. A cette fin, plusieurs paramètres ont été évalués, tels que le stade de maturité, les rendements en olives et en huiles d'olive et les indices de qualité. Les résultats obtenus dans cette étude indiquent que la majorité des paramètres étudiés sont influencés par les conditions climatiques (hausse des températures et la réduction des précipitations) de la saison de culture ($p < 0,05$). Cependant, la variété étudiée a montré des stratégies d'adaptation au changement climatique des différents agroécosystèmes de la région et produise une huile

d'excellente qualité avec une composition chimique respectant les exigences recommandées par le Conseil Oléicole International.

Mots clés : Résilience, Agroécosystème, Olivier, Changement Climatique, Béni Mellal khénifra.

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La caractérisation physico-chimique, mais aussi biologique, du sol constitue un outil fondamental dans la détermination de la capacité de ce sol à assurer une production agricole durable. Toutefois, la connaissance de la biologie des sols Marocains reste lacunaire, particulièrement par rapport aux communautés des vers de terre ou lombriciens. Ces organismes sont facilement affectés par les facteurs biotiques et abiotiques, ainsi que les pratiques agricoles adoptées. De ce fait, ils sont considérés comme les indices les plus appropriés pour détecter la détérioration ou l'amélioration de la qualité du sol. Par ce présent travail, nous souhaitons mener une prospection préliminaire pour examiner la diversité des vers de terre dans la région du Gharb et dresser un état de lieu initial sur les espèces qui peuvent exister dans ses vergers agrumicoles. Dans ce sens, vingt vergers d'agrumes ont été sélectionnés dans les provinces de Sidi Slimane et

Sidi Kacem, principales zones agrumicoles dans la région du Gharb. Dans chaque verger, trois points ont été choisis aléatoirement pour procéder à la collecte des vers de terre selon un quadra de 0.16 m² sur une profondeur de 25 cm. Les vers de terre ont été conservés dans une solution d'éthanol (70%), puis ramenés au laboratoire pour identification et mesure de la biomasse. Les résultats obtenus jusqu'à présent ont montré la dominance des espèces endogéniques, principalement *Aporrectodea caliginosa*, avec une présence limitée des espèces anéciques, représentées uniquement par *Aporrectodea longa*. Nous n'avons pas trouvé des espèces superficielles dans les vergers prospectés. Les analyses sont en progression pour étudier la relation entre la diversité, l'abondance, la biomasse des vers de terre collectés et les propriétés des sols des vergers agrumicoles prospectés.

Mots clés : Diversité, Vers de terre, Lombriciens, Agrumes, Sol.

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Several studies were shown that intercropping of cereals and legumes has been largely reported as an eco-functional practice that can improve the land use efficiency and soil fertility, as well as the reduction of damage from diseases, pests and weeds. The research was carried out over two cropping seasons with different N fertilisation levels to compare winter wheat (*Triticum aestivum* L.) cultivar 'Wafia' and faba bean (*Vicia faba* L.) cultivar 'Alfia' cultivated as sole crops or intercropped. The overall aim was to evaluate intercrop efficiency using indices such as the land equivalent ratio (LER) and the interspecific (IE) and intraspecific (IA) interaction indices, and to assess the response of this system to biotic factors. The research results showed that intercropping systems without N fertiliser increased shoot and root biomass of wheat. However, the insertion of wheat in intercropping decreased shoots and root biomass of faba bean. Moreover, the grain yield decreased by inter-

cropping compared to sole crops for both experiments. Eventually, without N input the LER > 1 indicates the most efficient use of environmental resources by intercropping. In the 2nd experiment, the IE of soft wheat was equal to 1 indicating that the presence of legume in the intercropping did not affect wheat plant productivity compared to sole crops in [half density](#). However, in the 1st experiment, the presence of the legume was associated with a greater facilitation effect on wheat intercrop (IE > 1) inducing an increase in yield compared to half density. For both experiments, IA of wheat was less than 1 revealing that the wheat yield in half density was higher than that in sole crops in full density.

Key words: Interspecific and intraspecific interaction, intercropping, land equivalent ratio, *Triticum aestivum*, *Vicia faba*, nitrogen fertilization.

Agriculture de Précision Modélisation et
Télédétection des Sciences de la Terre

Precision Agriculture Modeling & Earth
Scineces Remote Sensing.

Thème/Topic



CP-01

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Milk's ability to clotting is an essential parameter for dairy producers who want to transform their milk into cheese. To achieve the best transformation performance, it is necessary to understand the coagulation process and the parameters that affect it.

In this context, this study aims to determine the effect of physicochemical parameters (pH, temperature, concentration of enzymes, and calcium chloride CaCl₂) on the coagulation time of cow's milk and to optimize this by developing a mathematical model to determine the optimal clotting time of any milk used in the preparation of cheese, depending on the physico-chemical composition of the milk, starting acidity, the type of curd required and enzymatic coagulation force. From the experimental design, and optimiza-

tion equation is determined where it exploited all the physicochemical parameters and their products, which were above the significance level. This model explains 98.13% of the variability in response data around its mean. Based on Pareto analysis, to optimizing clotting time, the pH was the parameter most influencing the clotting time. The enzyme concentration and the temperature came successively after the previous one, unlike calcium chloride, which has a weak effect on clotting time.

Keywords: Milk coagulation, Clotting time, Optimization.

CP-02

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L'amélioration des procédés de production agricole et de conservation des aliments nécessite l'introduction des techniques de chauffage et de climatisation dans les abris serres. Pour développer ces techniques, notre travail propose une conception d'un système solaire intégré et autonome pour le chauffage, la climatisation et la conservation de la production dans une serre agricole. L'air chaud produit par effet de serre pendant le jour, sera évacué vers des compartiments annexes à l'abri serre pour sécher l'excès de production agricole non écoulé sur le marché. Dans ce papier nous allons donner une description de ce système solaire, ainsi la comparaison de l'effet du système solaire durant la période froide sur le climat de la serre agricole.

Mots clés : système solaire - serre agricole - chauffage - système de stockage.

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CP-03

La ville marocaine Boujaad située dans la région de Béni Mellal - Khenifra, cette ville considérée jusqu'à présent comme centre spirituel et culturel important accueillant les voyageurs issus du Royaume en quête de précepte religieux. Des sorties de terrain et des enquêtes tenues dans l'ancienne médina de cette ville marquant la présence de cavités souterraines d'origines naturelle lié à la géologie de la ville, anthropique lié à l'activité humaine, ces cavités causent des effondrements et des dégâts humains et matériels considérables. Dans ce sens une étude géophysique a été réalisée par une investigation par sismique réfraction, complétée par la méthode de prospection électrique du sous-sol, a fin de déterminé les caractéristiques géologiques et géophysiques des cavités sou-

terraines, dans le but de produire une cartographie détaillée des anomalies détectées. L'étude géophysique réalisé montré que l'ancienne médina de Boujaad est constituée par un sous-sol hétérogène, dominé par des formations calcaires, les résultats de chaque méthode géophysique sont présentées par des cartes et des graphes, la superposition des cartes d'anomalies puis la corrélation avec les données de terrain ont permis a réalisé une carte générale de zones caractérisées par la présence des cavités souterraine, ces dernières sont diverses et s'étalent dans la plus grande partie de l'ancienne médina de Boujaad.

Mots clés : Cavité souterraine, Boujaad, méthode électrique, sismique réfraction

Résilience aux changements climatiques par le recours à l'irrigation localisée pour les cultures de la zone semi-aride : Modèle du périmètre irrigué de Tadla (Maroc)

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CP-04

Les changements climatiques ont été élucidés à l'échelle mondiale, par conséquent, il est objet d'étudier leurs impacts à le long- terme sur les modalités projetées de la conduite des irrigations des cultures dans les zones vulnérables, telles celles situées sur le bio-étage climatique semi-aride ; où l'agriculture est devenue depuis lors plus comprise, ce en raison de la tendance de la raréfaction des ressources en eau. A ce propos, il est objet de prendre comme modèle d'étude, la zone modèle agricole potentielle, le périmètre irrigué de Tadla, localisée en un milieu semi-aride en plein centre marocain.

Le présent travail de recherche, s'est fixé l'horizon de l'an 2050, pour établir les prédictions des besoins concernant deux cultures de référence à savoir : la Betterave à sucre (culture annuelle) et les agrumes (culture de l'arboriculture fruitière), moyennant le traitement de données agro-climatiques par l'application informatique afférente au simulateur climatique MOSAICC.

Dans ce sens, à travers les investigations menées et les analyses des résultats expérimentaux dur le terrain en la matière, il a été appréhendé pour étude de possibilité la mesure pratique en résilience aux changements climatiques à long-terme, en vue de contrôler la croissance soutenue des besoins en eau des cultures. A cet effet, il a été établi des réévaluations prévisionnelles possibles pour ces besoins en eau, selon les scenarii alternatifs susceptibles, tout en intégrant l'option pertinente de la substitution du mode d'irrigation classique gravitaire, qui est actuellement plus fréquent dans la zone d'étude par la nouvelle technique de l'irrigation localisée, vu que ce dernier procédé est approuvé pour sa meilleure efficiente en l'utilisation de l'eau en agriculture.

Mots-clés : Changements climatiques, résilience, semi-aride, irrigation, besoins en eau, cultures.

Chocolate spot detection and assessment on *Faba bean* using MATLAB image processing

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CP-05

Fungal diseases are considered as an important biotic stress that can lead to significant yield losses on food legumes in Morocco. On faba bean, chocolate spot (*Botrytis* spp.) is a highly prevalent and destructive disease, causing yield loss up to 60% on susceptible cultivars. Chocolate spot can develop very rapidly at flowering stage under suitable weather conditions. Successful disease management requires a rational use of fungicide in combination with other strategies. Making a decision of fungicide spray at early detection will help to improve efficiency and to reduce cost of treatment. Therefore, farmers need a rapid and automatic tool of plant monitoring for disease detec-

tion and severity assessment. The advanced image processing techniques are used to detect leaf disease automatically. In this study, different segmentation techniques are compared to subdivide an image into components and distinguish disease from background. The value of PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) are used to compare and analyze the image quality after segmentation.

Keywords: *Botrytis* spp., *Faba bean*, MATLAB, PSNR, MSE, segmentation techniques.

Influence of socio demographic characteristics on the use of spontaneous edible plants in some localities of the Casablanca Settat region.

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This study is in the framework to the preservation of traditional knowledge of the spontaneous edible plants use by population in some localities of the region Casablanca Settat. The objective of the present work was to inventory the use of wild edible plants in two different populations and examine the relationship between the knowledge of their uses. An ethnobotanical survey was conducted in different localities selected to cover all the plants in two zones: the commune Oulad Abbou of Berrechid city (zone 1) and the commune Beni hellal of Sidi Bennour city (zone 2). The survey consisted of interviews with the population using a questionnaire to collect information on a list of wild edible plants in the study area as well as the modes of their use and the traditional culinary recipes based on these plants. Several factors: age - sex - place of residence - education level - profession - marital status. The Survey data showed that women were the majority involved in the use of wild edible plants, especially for food and cosmetics while men were more involved in medicinal and other uses. The activities of collecting and marketing wild edible

plants are in principle shared between men and women. The participants are distributed into nine professions with a majority being housewives (48%) and farmers (40%) as 75% of the surveyed population is rural. The remaining 12% are distributed among the administration, region officer, schoolers from different school levels in urban area (25%). Among the wild plants, 78 species were mentioned by the participants aged 41 years old and over and 27 species only, were mentioned by the age group 17-30 years and 31-40 years. These have several modes of use in the past and present in the study region.

The present work revealed a list of wild food plants used by the study population in the region of Casablanca-Settat, that will contribute to document the modes of their use (recipes) and that can feed food composition databases and the plant biodiversity of the Moroccan flora which is a natural and cultural wealth threatened by its neglect by scientific community.

Keywords: Traditional uses, wild plants, biodiversity, ethnobotanical survey.

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Thème/Topic



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La dégradation des ressources naturelles et écologiques entrave le développement humain et économique et menace l'équilibre social. Une sensibilisation massive des opérateurs économiques et de la population en générale, est une nécessité incontournable. En outre, la recherche doit être focalisée sur l'analyse des secteurs porteurs d'une nouvelle dynamique de développement territorial.

Cette étude porte sur le rôle de certaines associations et coopératives de la région de Béni-mellal, dans la mobilisation des potentiels humains et la valorisation des produits du terroir. Elles exercent diverses activités. En écotourisme, on a réalisé des randonnées pédestres dans des circuits touristiques de montagnes et des campagnes de sensibilisation et de suivi pour la protection de l'environnement et la biodiversité.

Ces activités ont entraîné l'adhésion et l'implication massive de la population locale à l'Association ou-chrah qui collabore dans le cadre de partenariats avec l'INDH et l'ANAPEC. En production agricole biologique la Coopérative tagzirte pour l'arbre de caroubier a aménagé de grandes surfaces forestières et particulières. Cette initiative a entraîné l'augmentation du revenu individuel des bénéficiaires.

Mots clés : Ressources naturelles et écologiques, développement humain et économique, produits du terroir, potentiels humains, écotourisme, caroubier, coopérative.

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