

VOL VII

Estudos em Ciências Agrárias e Ambientais

Eduardo Spers
(Organizador)



EDITORA
ARTEMIS

2026

VOL VII

Estudos em Ciências Agrárias e Ambientais

Eduardo Spers
(Organizador)



EDITORA
ARTEMIS

2026



O conteúdo deste livro está licenciado sob uma Licença de Atribuição Creative Commons Atribuição-Não-Comercial NãoDerivativos 4.0 Internacional (CC BY-NC-ND 4.0). Direitos para esta edição cedidos à Editora Artemis pelos autores.

Permitido o download da obra e o compartilhamento, desde que sejam atribuídos créditos aos autores, e sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

A responsabilidade pelo conteúdo dos artigos e seus dados, em sua forma, correção e confiabilidade é exclusiva dos autores. A Editora Artemis, em seu compromisso de manter e aperfeiçoar a qualidade e confiabilidade dos trabalhos que publica, **conduz a avaliação cega pelos pares de todos manuscritos publicados, com base em critérios de neutralidade e imparcialidade acadêmica.**

Editora Chefe	Prof. ^a Dr. ^a Antonella Carvalho de Oliveira
Editora Executiva	M. ^a Viviane Carvalho Mocellin
Direção de Arte	M. ^a Bruna Bejarano
Diagramação	Elisangela Abreu
Organizador	Prof. Dr. Eduardo Eugênio Spers
Imagem da Capa	Bruna Bejarano, Arquivo Pessoal
Bibliotecário	Maurício Amormino Júnior – CRB6/2422

Conselho Editorial

Prof.^a Dr.^a Ada Esther Portero Ricol, *Universidad Tecnológica de La Habana “José Antonio Echeverría”*, Cuba
Prof. Dr. Adalberto de Paula Paranhos, Universidade Federal de Uberlândia, Brasil
Prof. Dr. Agustín Olmos Cruz, *Universidad Autónoma del Estado de México*, México
Prof.^a Dr.^a Amanda Ramalho de Freitas Brito, Universidade Federal da Paraíba, Brasil
Prof.^a Dr.^a Ana Clara Monteverde, *Universidad de Buenos Aires*, Argentina
Prof.^a Dr.^a Ana Júlia Viamonte, Instituto Superior de Engenharia do Porto (ISEP), Portugal
Prof. Dr. Ángel Mujica Sánchez, *Universidad Nacional del Altiplano*, Peru
Prof.^a Dr.^a Angela Ester Mallmann Centenaro, Universidade do Estado de Mato Grosso, Brasil
Prof.^a Dr.^a Begoña Blandón González, *Universidad de Sevilla*, Espanha
Prof.^a Dr.^a Carmen Pimentel, Universidade Federal Rural do Rio de Janeiro, Brasil
Prof.^a Dr.^a Catarina Castro, Universidade Nova de Lisboa, Portugal
Prof.^a Dr.^a Cirila Cervera Delgado, *Universidad de Guanajuato*, México
Prof.^a Dr.^a Cláudia Neves, Universidade Aberta de Portugal
Prof.^a Dr.^a Cláudia Padovesi Fonseca, Universidade de Brasília-DF, Brasil
Prof. Dr. Cleberton Correia Santos, Universidade Federal da Grande Dourados, Brasil
Dr. Cristo Ernesto Yáñez León – New Jersey Institute of Technology, Newark, NJ, Estados Unidos



Prof. Dr. David García-Martul, *Universidad Rey Juan Carlos de Madrid*, Espanha
Prof.ª Dr.ª Deuzimar Costa Serra, *Universidade Estadual do Maranhão*, Brasil
Prof.ª Dr.ª Dina Maria Martins Ferreira, *Universidade Estadual do Ceará*, Brasil
Prof.ª Dr.ª Edith Luévano-Hipólito, *Universidad Autónoma de Nuevo León*, México
Prof.ª Dr.ª Eduarda Maria Rocha Teles de Castro Coelho, *Universidade de Trás-os-Montes e Alto Douro*, Portugal
Prof. Dr. Eduardo Eugênio Spers, *Universidade de São Paulo (USP)*, Brasil
Prof. Dr. Eloi Martins Senhoras, *Universidade Federal de Roraima*, Brasil
Prof.ª Dr.ª Elvira Laura Hernández Carballido, *Universidad Autónoma del Estado de Hidalgo*, México
Prof.ª Dr.ª Emilas Darlene Carmen Lebus, *Universidad Nacional del Nordeste*, Argentina
Prof.ª Dr.ª Erla Mariela Morales Morgado, *Universidad de Salamanca*, Espanha
Prof. Dr. Ernesto Cristina, *Universidad de la República*, Uruguay
Prof. Dr. Ernesto Ramírez-Briones, *Universidad de Guadalajara*, México
Prof. Dr. Fernando Hitt, *Université du Québec à Montréal*, Canadá
Prof. Dr. Gabriel Díaz Cobos, *Universitat de Barcelona*, Espanha
Prof.ª Dr.ª Gabriela Gonçalves, *Instituto Superior de Engenharia do Porto (ISEP)*, Portugal
Prof.ª Dr.ª Galina Gumovskaya – *Higher School of Economics*, Moscow, Russia
Prof. Dr. Geoffroy Roger Pointer Malpass, *Universidade Federal do Triângulo Mineiro*, Brasil
Prof.ª Dr.ª Gladys Esther Leoz, *Universidad Nacional de San Luis*, Argentina
Prof.ª Dr.ª Glória Beatriz Álvarez, *Universidad de Buenos Aires*, Argentina
Prof. Dr. Gonçalo Poeta Fernandes, *Instituto Politécnico da Guarda*, Portugal
Prof. Dr. Gustavo Adolfo Juarez, *Universidad Nacional de Catamarca*, Argentina
Prof. Dr. Guillermo Julián González-Pérez, *Universidad de Guadalajara*, México
Prof. Dr. Håkan Karlsson, *University of Gothenburg*, Suécia
Prof.ª Dr.ª Lara Lúcia Tescarollo Dias, *Universidade São Francisco*, Brasil
Prof.ª Dr.ª Isabel del Rosario Chiyon Carrasco, *Universidad de Piura*, Peru
Prof.ª Dr.ª Isabel Yohena, *Universidad de Buenos Aires*, Argentina
Prof. Dr. Ivan Amaro, *Universidade do Estado do Rio de Janeiro*, Brasil
Prof. Dr. Iván Ramon Sánchez Soto, *Universidad del Bío-Bío*, Chile
Prof.ª Dr.ª Ivânia Maria Carneiro Vieira, *Universidade Federal do Amazonas*, Brasil
Prof. Me. Javier Antonio Albornoz, *University of Miami and Miami Dade College*, Estados Unidos
Prof. Dr. Jesús Montero Martínez, *Universidad de Castilla - La Mancha*, Espanha
Prof. Dr. João Manuel Pereira Ramalho Serrano, *Universidade de Évora*, Portugal
Prof. Dr. Joaquim Júlio Almeida Júnior, *UNIFIMES - Centro Universitário de Mineiros*, Brasil
Prof. Dr. Jorge Ernesto Bartolucci, *Universidad Nacional Autónoma de México*, México
Prof. Dr. José Cortez Godinez, *Universidad Autónoma de Baja California*, México
Prof. Dr. Juan Carlos Cancino Diaz, *Instituto Politécnico Nacional*, México
Prof. Dr. Juan Carlos Mosquera Feijoo, *Universidad Politécnica de Madrid*, Espanha
Prof. Dr. Juan Diego Parra Valencia, *Instituto Tecnológico Metropolitano de Medellín*, Colômbia
Prof. Dr. Juan Manuel Sánchez-Yáñez, *Universidad Michoacana de San Nicolás de Hidalgo*, México
Prof. Dr. Juan Porras Pulido, *Universidad Nacional Autónoma de México*, México



Prof. Dr. Júlio César Ribeiro, Universidade Federal Rural do Rio de Janeiro, Brasil
Prof. Dr. Leiníg Antonio Perazolli, Universidade Estadual Paulista (UNESP), Brasil
Prof.ª Dr.ª Livia do Carmo, Universidade Federal de Goiás, Brasil
Prof.ª Dr.ª Luciane Spanhol Bordignon, Universidade de Passo Fundo, Brasil
Prof. Dr. Luis Fernando González Beltrán, *Universidad Nacional Autónoma de México*, México
Prof. Dr. Luis Vicente Amador Muñoz, *Universidad Pablo de Olavide*, Espanha
Prof.ª Dr.ª Macarena Esteban Ibáñez, *Universidad Pablo de Olavide*, Espanha
Prof. Dr. Manuel Ramiro Rodriguez, *Universidad Santiago de Compostela*, Espanha
Prof. Dr. Manuel Simões, Faculdade de Engenharia da Universidade do Porto, Portugal
Prof.ª Dr.ª Márcia de Souza Luz Freitas, Universidade Federal de Itajubá, Brasil
Prof. Dr. Marcos Vinicius Meiado, Universidade Federal de Sergipe, Brasil
Prof.ª Dr.ª Mar Garrido Román, *Universidad de Granada*, Espanha
Prof.ª Dr.ª Margarida Márcia Fernandes Lima, Universidade Federal de Ouro Preto, Brasil
Prof.ª Dr.ª María Alejandra Arecco, *Universidad de Buenos Aires*, Argentina
Prof.ª Dr.ª Maria Aparecida José de Oliveira, Universidade Federal da Bahia, Brasil
Prof.ª Dr.ª Maria Carmen Pastor, *Universitat Jaume I*, Espanha
Prof.ª Dr.ª Maria da Luz Vale Dias – Universidade de Coimbra, Portugal
Prof.ª Dr.ª Maria do Céu Caetano, Universidade Nova de Lisboa, Portugal
Prof.ª Dr.ª Maria do Socorro Saraiva Pinheiro, Universidade Federal do Maranhão, Brasil
Prof.ª Dr.ª MªGraça Pereira, Universidade do Minho, Portugal
Prof.ª Dr.ª Maria Gracinda Carvalho Teixeira, Universidade Federal Rural do Rio de Janeiro, Brasil
Prof.ª Dr.ª María Guadalupe Vega-López, *Universidad de Guadalajara*, México
Prof.ª Dr.ª Maria Lúcia Pato, Instituto Politécnico de Viseu, Portugal
Prof.ª Dr.ª Maritza González Moreno, *Universidad Tecnológica de La Habana*, Cuba
Prof.ª Dr.ª Mauriceia Silva de Paula Vieira, Universidade Federal de Lavras, Brasil
Prof. Dr. Melchor Gómez Pérez, *Universidad del Pais Vasco*, Espanha
Prof.ª Dr.ª Ninfa María Rosas-García, Centro de Biotecnología Genómica-Instituto Politécnico Nacional, México
Prof.ª Dr.ª Odara Horta Boscolo, Universidade Federal Fluminense, Brasil
Prof. Dr. Osbaldo Turpo-Gebera, *Universidad Nacional de San Agustín de Arequipa*, Peru
Prof.ª Dr.ª Patrícia Vasconcelos Almeida, Universidade Federal de Lavras, Brasil
Prof.ª Dr.ª Paula Arcoverde Cavalcanti, Universidade do Estado da Bahia, Brasil
Prof. Dr. Rodrigo Marques de Almeida Guerra, Universidade Federal do Pará, Brasil
Prof. Dr. Saulo Cerqueira de Aguiar Soares, Universidade Federal do Piauí, Brasil
Prof. Dr. Sergio Bitencourt Araújo Barros, Universidade Federal do Piauí, Brasil
Prof. Dr. Sérgio Luiz do Amaral Moretti, Universidade Federal de Uberlândia, Brasil
Prof.ª Dr.ª Silvia Inés del Valle Navarro, *Universidad Nacional de Catamarca*, Argentina
Prof.ª Dr.ª Solange Kazumi Sakata, Instituto de Pesquisas Energéticas e Nucleares (IPEN)- USP, Brasil
Prof.ª Dr.ª Stanislava Kashtanova, *Saint Petersburg State University*, Russia
Prof.ª Dr.ª Susana Álvarez Otero – *Universidad de Oviedo*, Espanha
Prof.ª Dr.ª Teresa Cardoso, Universidade Aberta de Portugal

Prof.ª Dr.ª Teresa Monteiro Seixas, Universidade do Porto, Portugal

Prof. Dr. Valter Machado da Fonseca, Universidade Federal de Viçosa, Brasil

Prof.ª Dr.ª Vanessa Bordin Viera, Universidade Federal de Campina Grande, Brasil

Prof.ª Dr.ª Vera Lúcia Vasilévski dos Santos Araújo, Universidade Tecnológica Federal do Paraná, Brasil

Prof. Dr. Wilson Noé Garcés Aguilar, *Corporación Universitaria Autónoma del Cauca*, Colômbia

Prof. Dr. Xosé Somoza Medina, *Universidad de León*, Espanha

**Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)**

E89 Estudos em ciências agrárias e ambientais VII [livro eletrônico] /
Organizador Eduardo Eugênio Spers. – 1. ed. – Curitiba, PR:
Editora Artemis, 2026.

Formato: PDF

Requisitos de sistema: Adobe Acrobat Reader

Modo de acesso: World Wide Web

Edição bilingue

Inclui bibliografia.

ISBN 978-65-82858-08-6

DOI 10.37572/EdArt_260626086

1. Ciências agrárias. 2. Ciências ambientais. 3.
Sustentabilidade. 4. Agricultura. I. Spers, Eduardo Eugênio.

CDD 630

Elaborado por Maurício Amormino Júnior – CRB6/2422



PRÓLOGO

As Ciências Agrárias e Ambientais ocupam um papel estratégico na compreensão e no enfrentamento dos desafios contemporâneos relacionados à produção de alimentos, à conservação dos recursos naturais, à sustentabilidade dos sistemas produtivos e à promoção da saúde e do bem-estar das populações. Em um contexto marcado pelas mudanças climáticas, pela crescente demanda por alimentos, pela necessidade de uso racional dos recursos naturais e pela incorporação de novas tecnologias aos processos produtivos, torna-se cada vez mais importante fortalecer a produção e a difusão do conhecimento científico voltado para o desenvolvimento sustentável.

É nesse cenário que se insere o volume **VII de Estudos em Ciências Agrárias e Ambientais**, reunindo contribuições de pesquisadores de diferentes instituições e países que abordam, sob múltiplas perspectivas, temas relevantes para a agricultura, o meio ambiente, a biotecnologia e a produção animal. A diversidade dos estudos aqui apresentados evidencia a natureza interdisciplinar das Ciências Agrárias e Ambientais e sua capacidade de integrar conhecimentos biológicos, tecnológicos, sociais e produtivos em busca de soluções para desafios complexos.

A obra inicia-se com reflexões relacionadas aos recursos naturais, à sustentabilidade e à saúde ambiental. Os trabalhos deste primeiro eixo destacam a importância da agroecologia como alternativa para reduzir os impactos dos pesticidas sobre a saúde humana e o meio ambiente, ao mesmo tempo em que analisam percepções e atitudes ambientais de estudantes, ressaltando o papel da educação na construção de uma consciência ecológica capaz de contribuir para sociedades mais sustentáveis.

Em seguida, o volume direciona seu olhar para a produção vegetal, a inovação e a sustentabilidade dos sistemas agrícolas. Os capítulos desta seção abordam estratégias voltadas ao manejo sustentável de cultivos, incluindo o uso de biofertilizantes, a aplicação de insumos orgânicos e inorgânicos, aspectos fisiológicos e bioquímicos de espécies agrícolas e florestais, bem como os desafios e oportunidades associados à Agricultura 4.0. Em conjunto, esses estudos evidenciam a busca por sistemas produtivos mais eficientes, resilientes e alinhados às demandas contemporâneas de sustentabilidade.

O terceiro eixo reúne pesquisas relacionadas à genética, à biotecnologia e ao melhoramento de cultivos, com destaque para estudos envolvendo híbridos de milho azul. Os trabalhos apresentados demonstram a relevância da caracterização físico-química, molecular e genômica para o desenvolvimento de materiais genéticos de interesse agrônomo, contribuindo para avanços no melhoramento vegetal e para a ampliação do conhecimento sobre recursos genéticos de elevado potencial produtivo e nutricional.

Por fim, a obra contempla estudos voltados à produção animal, à nutrição e aos sistemas aquícolas. Os capítulos discutem alternativas sustentáveis para a alimentação e o manejo de animais de produção, bem como estratégias inovadoras aplicadas à aquicultura, envolvendo o uso de probióticos, diferentes fontes de carbono e sistemas biofloc. Essas pesquisas reforçam a importância de práticas produtivas capazes de promover eficiência, saúde animal e sustentabilidade econômica e ambiental.

Ao reunir investigações que transitam entre a sustentabilidade ambiental, a produção agrícola, a inovação tecnológica, a biotecnologia e a produção animal, este volume reafirma o compromisso da comunidade científica com a geração de conhecimento aplicado e socialmente relevante. Mais do que apresentar resultados de pesquisa, os trabalhos aqui reunidos contribuem para o fortalecimento do diálogo entre ciência, tecnologia e sociedade, oferecendo subsídios para a construção de sistemas produtivos mais sustentáveis, eficientes e comprometidos com o futuro.

Esperamos que esta obra possa servir de fonte de consulta, reflexão e inspiração para pesquisadores, estudantes, profissionais e demais interessados nas Ciências Agrárias e Ambientais, estimulando novas investigações e contribuindo para o avanço do conhecimento científico na área.

Eduardo Eugênio Spers

Esalq/USP

SUMÁRIO

RECURSOS NATURAIS, SUSTENTABILIDADE E SAÚDE AMBIENTAL

CAPÍTULO 1..... 1

LA AGROECOLOGÍA COMO SOLUCIÓN A LOS PROBLEMAS DE SALUD RELACIONADOS CON EL USO DE PESTICIDAS

María José de Dios Duarte

 https://doi.org/10.37572/EdArt_2606260861

CAPÍTULO 2.....25

ACTITUDES AMBIENTALES EN ESTUDIANTES DEL NIVEL MEDIO SUPERIOR AL NOROESTE DE TAMAULIPAS

Catalina Vargas Ramos

Graciela Hernández Moreno

Ma. De la Cruz Galindo Ceja

Alan León González Almaguer

Jorge Alejandro Gallegos de la Cruz

 https://doi.org/10.37572/EdArt_2606260862

PRODUÇÃO VEGETAL, INOVAÇÃO E SUSTENTABILIDADE DOS SISTEMAS AGRÍCOLAS

CAPÍTULO 3..... 34

BIOFERTILIZANTES COMO SUSTITUTO PARCIAL EN LA FERTILIZACION CONVENCIONAL DEL CULTIVO DE ARROZ EN EL CARIBE COLOMBIANO

Eliecer Miguel Cabrales Herrera

Laura Sofia Osorio Barcenas

 https://doi.org/10.37572/EdArt_2606260863

CAPÍTULO 4..... 50

APLICACIONES DE ENMIENDAS ORGÁNICAS E INORGÁNICAS EN GRANADO (*Punica granatum* L.) 'WONDERFUL': CONCENTRACIÓN DE NUTRIENTES EN HOJA

Rosa María Yáñez Muñoz

Juan Manuel Soto Parra

Esteban Sánchez Chávez

Ana Lilia Santana Díaz

Laura Raquel Orozco Meléndez

Ramona Pérez Leal
Nubia Guadalupe Torres Beltrán
Julio César Oviedo Mireles

 https://doi.org/10.37572/EdArt_2606260864

CAPÍTULO 5..... 69

MORPHOLOGICAL AND BIOCHEMICAL BEHAVIOR OF THE OLIVE TREE IN SEMI-ARID AREAS OF ALGERIA

Dhia Gharabi
Magheni Benchohra
Ahmed Bellhabib
Abdelkarim Hassani

 https://doi.org/10.37572/EdArt_2606260865

CAPÍTULO 6.....87

EFFECT OF GIBBERELIC ACID AND SILVER NITRATE ON THE GERMINATION OF *PINUS PSEUDOSTROBUS* LINDL.

Diana Gisselle Calderón Mejías
Lourdes Georgina Iglesias Andreu
Laura Yasmin Flores López

 https://doi.org/10.37572/EdArt_2606260866

CAPÍTULO 7.....97

DESARROLLO DE HABILIDADES DIGITALES EN LA AGRICULTURA 4.0: OPORTUNIDADES PARA AMÉRICA LATINA

Lourdes Mateos-Espejel

 https://doi.org/10.37572/EdArt_2606260867

GENÉTICA, BIOTECNOLOGIA E MELHORAMENTO DE CULTIVOS

CAPÍTULO 8..... 113

CARACTERES FISICOQUÍMICOS Y ANTOCIANINAS EN SEMILLAS DE LOS GENOTIPOS PARENTALES DEL HÍBRIDO DE MAÍZ AZUL DRÁCULA H 13

José Luis Arellano-Vázquez
Germán Fernando Gutiérrez-Hernández
Martín Filiberto García-Mendoza
Estela Flores-Gómez

 https://doi.org/10.37572/EdArt_2606260868

CAPÍTULO 9.....122

IDENTIFICACIÓN FÍSICA Y MOLECULAR DE LAS LÍNEAS Y CRUZAS QUE CONFORMAN AL HÍBRIDO DE MAÍZ AZUL VAMPIRO H10

Germán Fernando Gutiérrez-Hernández

José Luis Arellano-Vázquez

Estela Flores-Gómez

Aída Margarita Zamora-Contreras

Patricia Vázquez-Lozano

 https://doi.org/10.37572/EdArt_2606260869

CAPÍTULO 10.....129

GENÓMICA Y POTENCIAL FISIOLÓGICO DE LAS SEMILLAS DE LOS PARENTALES DEL HÍBRIDO DE MAÍZ AZUL VAMPIRO H10

Germán Fernando Gutiérrez-Hernández

José Luis Arellano-Vázquez

Estela Flores-Gómez

Aída Margarita Zamora-Contreras

Patricia Vázquez-Lozano

 https://doi.org/10.37572/EdArt_26062608610

PRODUÇÃO ANIMAL, NUTRIÇÃO E SISTEMAS AQUÍCOLAS

CAPÍTULO 11.....136

ACEITES ESENCIALES Y ÁCIDOS ORGÁNICOS: ALTERNATIVA A LOS ANTIBIÓTICOS COMO PROMOTORES DE CRECIMIENTO EN LOS CERDOS

Elmer Bonilla-Valverde

Juan Manuel Romo-Valdez

Jesús José Portillo-Loera

Ana Mireya Romo-Valdez

Laura Francisca Espinoza-Aguirre

Javier Alonso Romo-Rubio

 https://doi.org/10.37572/EdArt_26062608611

CAPÍTULO 12.....162

COMPARACIÓN DE LA DENSIDAD Y POTENCIAL REPRODUCTIVO DE *Daphnia pulicaria* EN DIFERENTES FUENTES DE CARBONO CON LA INCORPORACIÓN DE LA BACTERIA *Burkholderia cepacia* COMO PROBIÓTICO

Jorge Castro Mejía

Germán Castro Mejía

María del Carmen Monroy Dosta
José Antonio Mata Sotres
Andrés Elías Castro Castellón
Arnulfo Misael Martínez Meingüer
José Alberto Ramírez Torrez

 https://doi.org/10.37572/EdArt_26062608612

CAPÍTULO 13..... 175

DENSIDAD POBLACIONAL Y POTENCIAL PRODUCTIVO DE *Daphnia magna* UTILIZANDO CINCO ALIMENTOS INERTES (SALVADO DE TRIGO, LEVADURA, FRIJOL, ARROZ Y RÁBANO) Y DOS MICROALGAS (*Chlorella vulgaris* y *Navicula spp*), EN TINAS DE 120L (20°±2°C) Y 180 L (23°±2°C)

Jorge Castro Mejía
Germán Castro Mejía
José Antonio Mata Sotres
María del Carmen Monroy Dosta
Andrés Elías Castro Castellón
Arnulfo Misael Martínez Meingüer
José Alberto Ramírez Torrez

 https://doi.org/10.37572/EdArt_26062608613

CAPÍTULO 14..... 190

COMPARACIÓN DEL CRECIMIENTO DE *Oreochromis niloticus* EN UN BIOFLOC INCORPORANDO LA BACTERIA *Burkholderia cepacia* Y CUATRO FUENTES DE CARBONO

Germán Castro Mejía
Jorge Castro Mejía
Andrés Elías Castro Castellón
Arnulfo Misael Martínez Meingüer
María del Carmen Monroy Dosta
José Antonio Mata Sotres
José Alberto Ramírez Torrez

 https://doi.org/10.37572/EdArt_26062608614

SOBRE O ORGANIZADOR.....205

ÍNDICE REMISSIVO206

MORPHOLOGICAL AND BIOCHEMICAL BEHAVIOR OF THE OLIVE TREE IN SEMI-ARID AREAS OF ALGERIA

Data de submissão: 02/05/2026

Data de aceite: 19/05/2026

Dhia Gharabi

Laboratory of Molecular and Cellular Biology
Faculty of Nature and Life Sciences
Ibn Khaldoun University, 14000
Tiaret, Algeria
<https://orcid.org/0000-0002-0194-0091>

Magheni Benchohra

Ibn Khaldoun University
Tiaret, Algeria
<https://orcid.org/0000-0002-0980-5679>

Ahmed Bellhabib

National School of Agronomy 16000
Algiers, Algeria

Abdelkarim Hassani

Laboratory of Agrobiotechnology and Nutrition in Dry Areas
Ibn Khaldoun University 14000
Tiaret, Algeria

ABSTRACT: In Algeria, as in many agricultural regions of the Mediterranean countries, the cultivation of the olive tree (*Olea europaea*

L.) has an important place in sustainable development, the economy, and in combating desertification. The Algerian government has implemented an olive tree planting program with an area of 900,000 ha by 2024. In this regard, the present study aims to determine the variability of the morphological and biochemical parameters of 10 varieties of olive tree of Algerian origin: Hamra, Sigoise, Aimel, Longue de Meliana, Mission, Guergour, Manzanite, Agnoun, Chemlal and Sofiana, having been the subject of an extension to the level of the semi-arid zone, carried out intensively, under localized irrigation, with controlled fertilizer inputs. The experiment started with on-site morphological measurements of tree height, trunk height and canopy circumference followed by laboratory analyzes by determining leaf area, relative water content and content in chlorophyll pigments. Graphical representations, comparisons of means, minimums and maximums, one-way analysis of variance on the one hand and PCA and AHC on the other hand were established between the studied parameters, in order to assess their variability. The results obtained showed that even if the olive tree is grown under the same growing conditions; varieties behave in different ways. These differences must be taken into account when choosing varieties in the plantation of mono-varietal or multi-varietal olive orchards.

KEYWORDS: steppe; olive tree; morphology; physio-biochemical; PCA.

COMPORTAMENTO MORFOLÓGICO E BIOQUÍMICO DA OLIVEIRA EM ZONAS SEMIÁRIDAS DA ARGÉLIA

RESUMO: Na Argélia, tal como em muitas regiões agrícolas dos países mediterrânicos, o cultivo da oliveira (*Olea europaea* L.) ocupa um lugar importante no desenvolvimento sustentável, na economia e no combate à desertificação. O governo argelino implementou um programa de plantação de oliveiras com uma área de 900.000 ha até 2024. Neste contexto, o presente estudo tem como objetivo determinar a variabilidade dos parâmetros morfológicos e bioquímicos de dez variedades de oliveira de origem argelina: Hamra, Sigoise, Aimel, Longue de Meliana, Mission, Guergour, Manzanite, Agnoun, Chemlal e Sofiana, tendo sido alvo de uma extensão à zona semiárida, realizada de forma intensiva, sob irrigação localizada, com aportes controlados de fertilizantes. A experiência começou com medições morfológicas no local da altura da árvore, altura do tronco e circunferência da copa, seguidas de análises laboratoriais através da determinação da área foliar, do conteúdo relativo de água e do teor de pigmentos clorofilinos. Foram estabelecidas representações gráficas, comparações de médias, mínimos e máximos, análise de variância a um critério, bem como ACP e CHA entre os parâmetros estudados, a fim de avaliar a sua variabilidade. Os resultados obtidos mostraram que, mesmo quando a oliveira é cultivada nas mesmas condições de crescimento, as variedades comportam-se de maneiras diferentes. Estas diferenças devem ser tidas em conta na escolha das variedades para plantação de olivais mono-varietais ou multi-varietais.

PALAVRAS-CHAVE: estepe; oliveira; morfologia; fisiobioquímica; ACP.

1. INTRODUCTION

The cultivation of the olive tree is very closely linked to the Mediterranean region; In addition to its economic, social and ecological interest, the olive fruit and oilseed cultivation has a prominent place in Algeria. The consumption of olive oil has also grown in traditionally non-producing countries such as the USA, Australia and Japan (Pineli et al. 2003).

The Algerian olive grove represents around 33% of tree production. The favorable climate and ancestral olive-growing traditions constitute competitive advantages for the development of the olive sector and for contributing to self-sufficiency in vegetable oils (Hadj Sadok et al., 2018). Olive growing in Algeria covers an area of 432 961 ha producing 684 461 tonnes or 3.3% of world production for the year 2017 (FAO, 2019).

The olive tree and other fruit trees (almond trees, pistachio trees, etc.) play a vital role in the balance of the semi-desert ecosystem (Lazzeri, 2009). The olive tree in particular is resistant to arid conditions where it is left to itself to give fruit one year out of two, but if we give it a lot of care and patience it will develop in an extraordinary way and produce olives in sufficient quantity and of good quality.

The wilaya of Tiaret, located between the massif of Western “Ouarsenis” to the north and the semi-arid highlands from the south to the west of Algeria, is characterized by its varied relief and an altitude between 800-1200 m. The commune of Rechaiga is part of the wilaya of Tiaret and it is characterized by a dry and hot climate. The selected olive trees are cultivated in a farm in this region, yet they are irrigated and fertilized in fall and spring.

The main objectives of the study at hand are threefold: (1) to make a comparison of the 10 varieties of olive tree (Hamra, Sigoise, Aimel, Longue de Meliana, Mission, Guergour, Manzanite, Agnoun, Chemlal and Sofiana); introduced by the Technical Institute of Fruit and Vine Arboriculture; (2) to determine which ones have adapted very well to the new conditions in the area; and (3) to classify them according to their morphological, biochemical and physiological expressions in the arid zone.

2. MATERIALS AND METHODS

The experiment of this study was carried out on a young olive farm (130 ha olive trees) located in northwestern Algeria, more precisely in a semi-arid zone in the commune of Rechaiga, Wilaya of Tiaret. This farm was planted intensively in 2017 under localized irrigation at a planting density of 400 trees/ha and a spacing of 4/5 m.

The experimental orchard of our study consists of ten varieties of olive (Hamra, Sigoise, Aimel, Longue de Meliana, Mission, Guergour, Manzanite, Agnoun, Chemlal and Sofiana).

This work was carried out in April 2021. A total of 130 trees were sampled using exclusively vegetative and clonal sampling to avoid genetic change. For a detailed description of tree shape, we measured the following parameters.

Since the canopy was fully visible, we measured canopy height, canopy circumference, tree height, trunk height, and trunk diameter. At the same time, we sampled 13 leaves per adult tree from the middle part of the most representative shoots chosen at breast height. The collected samples were placed inside labeled bags, carefully labeled with their identifying names.

The harvested and labeled plant material was transported to the laboratory of the Faculty of Nature and Life Sciences, Ibn Khaldoun University, Tiaret, Algeria, for the determination of chlorophyll and carotenoid contents.

The results were subjected to statistical analysis using R software (version 4.1.2), including one-way ANOVA, correlations between variables, and principal component analysis (PCA).

2.1. MORPHOLOGICAL PARAMETERS

Plant height was measured using a TRUPULSE 200L dendrometer rangefinder, with much improved accuracy.

The height of the trunk was determined using a graduated board.

The height of foliage is the distance between the end of the bole and the top of the tree; measured with a dendrometer, by the difference between two measurements.

The foliage circumference was measured using a measuring tape graduated in centimeters.

The diameter of the trunk was measured by a digital caliper.

Leaf area was directly measured by the LICOR-3000A electronic planimeter (Cheverry, 1995) with a resolution of 1 mm².

2.2. BIOCHEMICAL PARAMETERS

2.2.1. Content of chlorophyll pigments

The method of LICHTENTHALER, (1987) and Shabala et al (1998) was used to determine the contents of pigments (chlorophylls, chlorophyll a, chlorophyll b and carotenoids).

100 mg of the middle part of the penultimate leaf was placed in a test tube containing 10 ml of 95% acetone at 4°C. The tubes are placed in the dark for 48 hours.

After 48 hours, the optical density (OD in nm) was read using a spectrophotometer (Pharmacist biotech NOVASEC II type) at wavelengths of 663, 645 and 470 nm which correspond to the peaks of absorption of chlorophyll “a”, chlorophyll b and carotenoid pigments. And finally, we calculated the quantities of chlorophylls a and b (expressed in µg/g FW) by the following formulas:

- ✓ $\text{Chl a} = 9.78 \times \text{OD}_{663} - 0.99 \times \text{OD}_{645}$
- ✓ $\text{Chl b} = 21.42 \times \text{OD}_{645} - 4.65 \times \text{OD}_{663}$
- ✓ $\text{Carotenoids} = [1000 \times \text{OD}_{470} - 1.90 \times \text{Chl a} - 63.14 \times \text{Chl b}] / 214$

2.3. PHYSIOLOGICAL PARAMETERS

2.3.1. Relative water content (RWC)

Relative water content (RWC) was determined by the method of Barrs and Weatherley (1962) according to the formula of Clark and McCaig (1982) and used by Rascio et al. (1988).

After leaf excision, the initial fresh weight (IFW) was determined. Then the leaf was placed in a test tube containing distilled water. The tube was kept in the dark at 4 °C for 12 hours.

The leaves were then reweighed to obtain the full turgor weight (WFT). The dry weight (DW) was obtained by drying the leaves in an oven at 80 °C for 48 hours.

The relative water content was calculated using the following equation:

$$\text{RWC (\%)} = [(IFW - DW) / (WFT - DW)] \times 100$$

3. RESULTS

- a. Plant height.** The data displayed in (figure 1) indicate that there are variations in. The results of the analysis of variance with one classification criterion (table 1), reveal very significant differences ($F = 34.65$ and $P = 00$) between the genotypes for plant height (at the binary error threshold 5%).

Figure 1: Histogram representing plant height of the studied varieties.

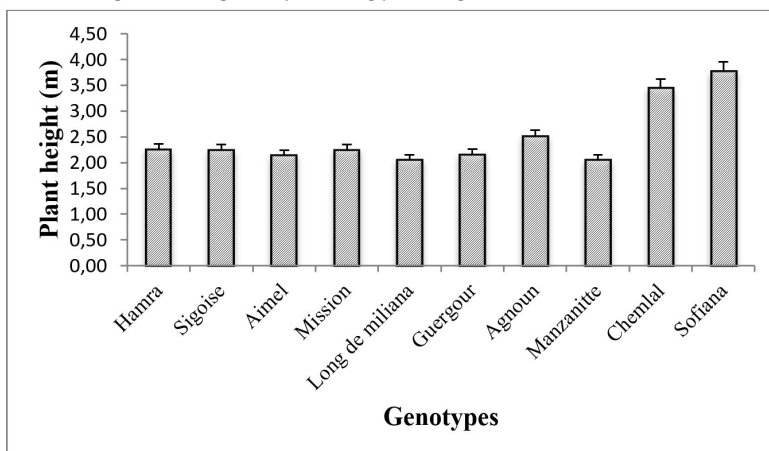


Table 1: Results of the one-way analysis of variance for the plant height trait of the studied genotypes.

	SS	df	MS	F	p-value
Total genotypes	1157.357	1	1157.357	1338.625	0.000000
genotypes	111.990	9	12.443	14.392	0.000000

- b. Height of the trunk.** The histogram (figure 2) shows that there are variations in the height of the trunk of the ten studied genotypes. The results of the analysis of variance with one classification criterion (table 2), reveal very highly significant differences ($F = 9.566$ and $p = 0.0000$ at the 5% error threshold) for the varietal effect for the height of the genotypes studied.

Figure 2: Histogram representing trunk height of the studied varieties.

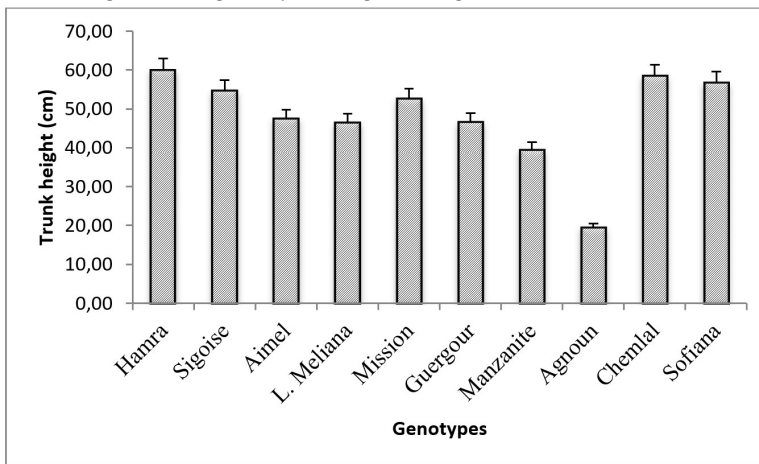


Table 2: Results of one-way analysis of variance for the height trait of the studied genotypes.

	SS	df	MS	F	p-value
Total genotypes	298677.8	1	298677.8	1614.519	0.0000
genotypes	15927.7	9	1769.7	9.566	0.0000

- c. Canopy height.** The obtained results in (figure 3) demonstrate that the height of canopy of each genotype varies. The same effect (table 3) is observed during the one-way variance analysis of crown height at the error threshold of 5%. The statistical results seem very strongly significant ($p = 0\%$), for the varietal effect on the height of the crown of the varieties studied.

Figure 3: Histogram representing canopy height of the studied varieties.

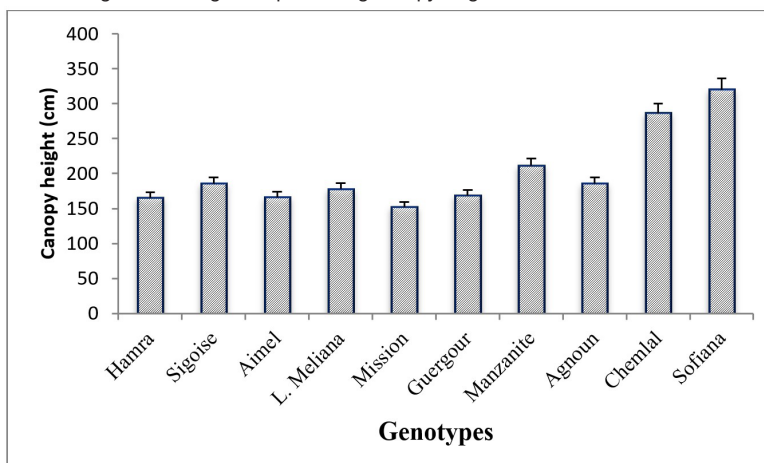


Table 3: Results of the one-way analysis of variance for the crown height trait studied genotypes.

	SS	df	MS	F	p-value
Total genotype	5261690	1	5261690	4369.674	0.0000
genotypes	380386	9	42265	35.100	0.0000

- d. The foliage circumference.** The histogram (figure 4) represents the circumference of the foliage. It also shows variation for the ten genotypes studied. The results of the analysis of variance with one classification factor (Table 4), reveal very strongly significant differences ($F = 7.1114$ and $p = 0.0000$ at the error threshold of 5%) for the varietal effect for the circumference of the canopy, the genotypes studied.

Figure 4: Histogram representing foliage circumference of the studied varieties.

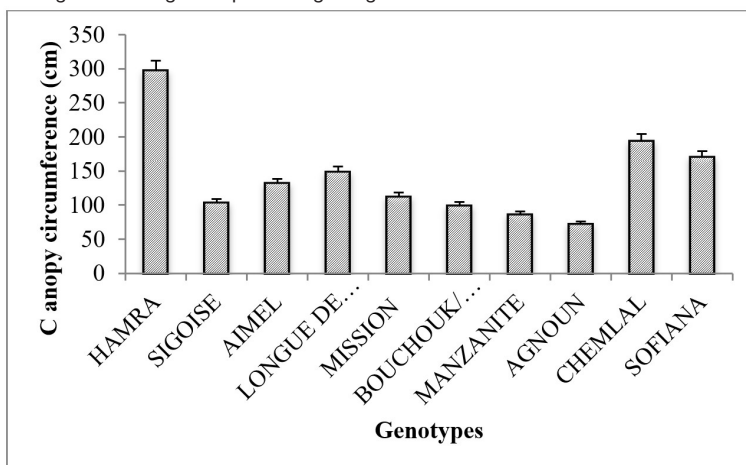


Table 4: Results of the one-way analysis of variance for the leaf circumference character of the studied genotypes.

	SS	df	MS	F	p-value
Total genotypes	2582208	1	2582208	330.5531	0.000000
genotypes	499973	9	55553	7.1114	0.000000

The comparison of the minimum and maximum means (figure 4) of the canopy circumference shows an average of 141.02 ± 62.24 cm with a maximum recorded by the **Hamra** variety of 297.15 cm and a minimum of 73.67 cm recorded by the variety **Agnoun**.

- e. Diameter of the trunk.** the graphic representation (figure 5) of the diameter of the trunk shows that the ten genotypes studied show variations. The

results of the analysis of variance with a classification factor (Table 4), reveal very highly significant differences ($F = 54.103$ and $p = 0.0000$ at the 5% error threshold) for the varietal effect for the circumference of the canopy, the genotypes studied.

Figure 5: Histogram representing trunk diameter of the studied varieties.

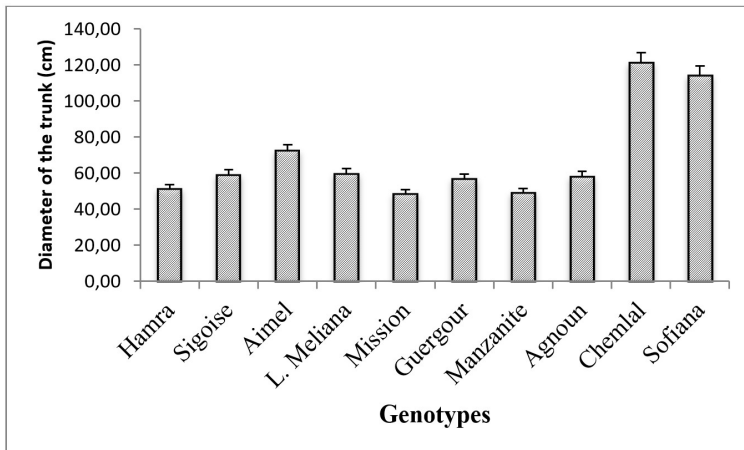


Table 5: Results of the one-way analysis of variance for the trunk diameter character of studied genotypes.

	SS	df	MS	F	p-value
Total genotype	607463.6	1	607463.6	3703.649	0.0000
genotypes	79864.8	9	8873.9	54.103	0.0000

f. The content of chlorophyll pigments.

- i. **Chlorophyll a.** The representation of the chlorophyll content in (figure 6) also varies for the ten genotypes selected. The results of the analysis of variance with one classification criterion (table 6), reveal very highly significant differences ($F = 106.492$ and $p = 0.0000$ at the 5% error threshold) for the varietal effect for the content of chlorophyll a, of the genotypes studied.

Figure 6: Histogram representing chlorophyll a content of the studied varieties.

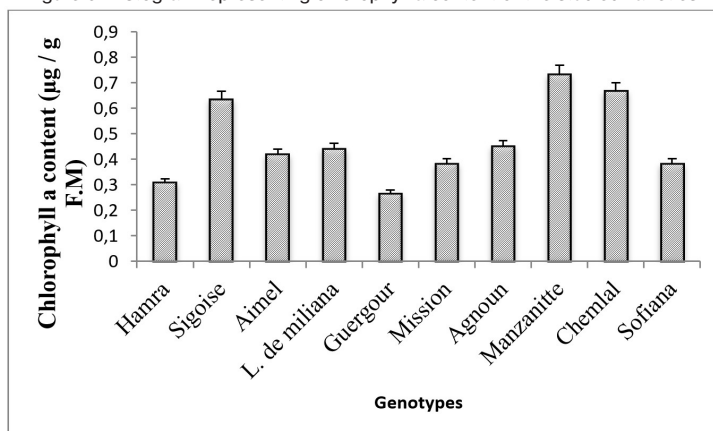


Table 6: Results of the one-way analysis of variance of the chlorophyll a content variable, of studied genotypes.

	SS	df	MS	F	p-value
Total genotype	29.284816	1	29.28482	9771.224	0.0000
genotypes	2.87244	9	0.31916	106.492	0.0000

- ii. **Chlorophyll b.** the graphic representation (figure 7) of the content of chlorophyll b; shows that the ten genotypes studied present variations. The results of the analysis of variance with one classification criterion (table 7), reveal very highly significant differences ($F = 100.357$ and $p = 0.0000$ at the 5% error threshold) for the varietal effect for the content of chlorophyll b, of the genotypes studied.

Figure 7: Histogram representing chlorophyll b content of the studied varieties.

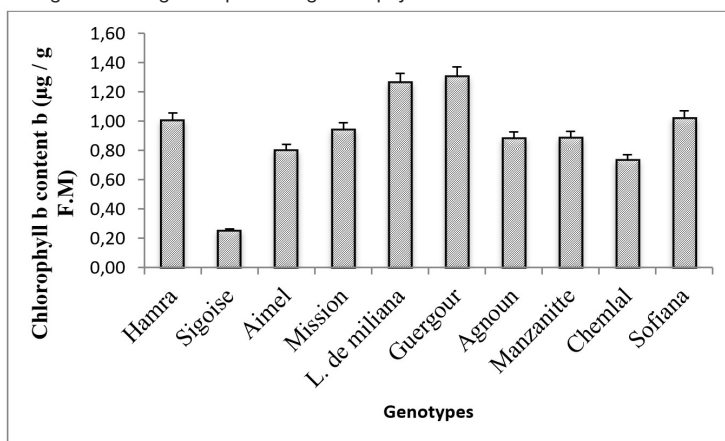


Table 7: Results of the one-way analysis of variance for the chlorophyll b content trait of the studied genotypes.

	SS	df	MS	F	p-value
Total genotype	107.3319	1	107.3319	9457.359	0.0000
genotypes	10.2506	9	1.1390	100.357	0.0000

iii. **Carotenoids.** It is clearly shown in Figure 8 that the carotenoid content of the ten genotypes studied differs. The results of the analysis of variance with one classification criterion (table 7), reveal very highly significant differences ($F = 25.63388$ and $p = 0.0000$ at the 5% error threshold) for the varietal effect for the content of chlorophyll b, of the genotypes studied.

Figure 8: Histogram representing carotenoid content of the studied varieties.

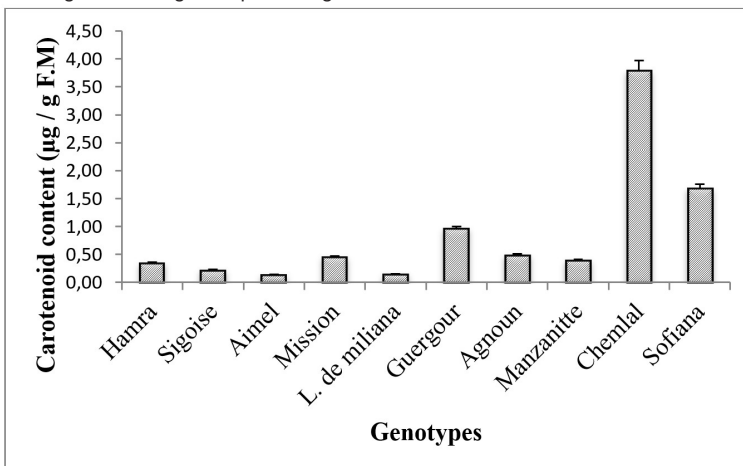


Table 8: Results of the one-way analysis of variance for the chlorophyll b character of the studied genotypes.

	SS	df	MS	F	p-value
Total genotype	1116.248	1	1116.248	44.15517	0.000000
genotypes	5832.249	9	648.028	25.63388	0.000000

g. **Leaf area.** Concerning the leaf area, the data gathered for each genotype in (figure 9) represents variation. The results of the analysis of variance with one classification criterion (tab. 9), reveal a strong influence of the leaf area by the nature of the genotypes tested ($F = 14.392$ and $p = 0.0000$ at the threshold of error 5%).

Figure 9: Histogram representing leaf area of the studied varieties.

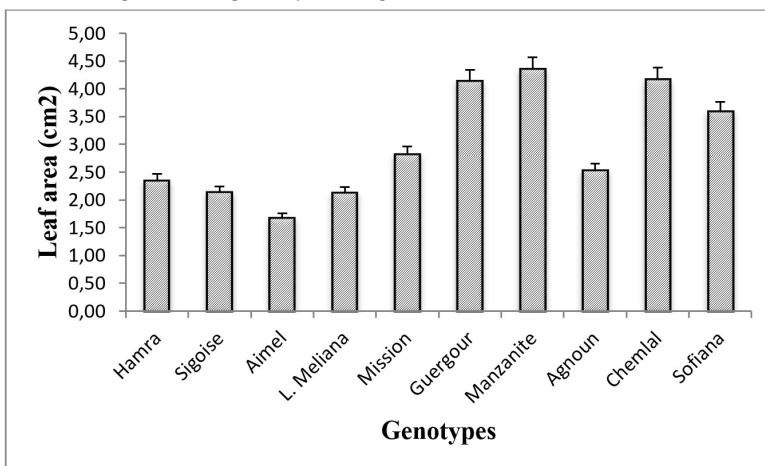


Table 9: Results of the one-way analysis of variance for the leaf area character of the studied genotypes.

	SS	df	MS	F	p-value
Total genotype	1157.357	1	1157.357	1338.625	0.000000
genotypes	111.990	9	12.443	14.392	0.000000

- h. Relative water content.** For the representation of the relative water content in (figure 10); it can be seen that there are also differences for the chosen genotypes. The results of the analysis of variance with one classification criterion (table 10), reveal a strong influence of the Relative Water Content by the nature of the genotypes tested ($F = 31.598$ and $p = 0.0000$ at the threshold error 5%).

Figure 10: Histogram representing relative water content of the studied varieties.

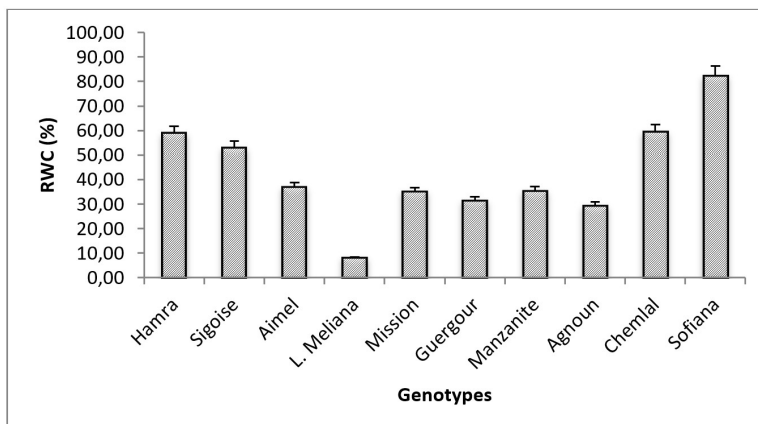


Table 10: Results of the one-way analysis of variance for the Relative Water Content trait of the studied genotypes.

	SS	df	MS	F	p-value
Total genotype	265111.2	1	265111.2	2232.023	0.0000
genotypes	33777.8	9	3753.1	31.598	0.0000

4. DISCUSSION

The comparison of the behavior of plants is made, by a succession of studies at the cellular, sub-cellular and molecular levels which depend on the genetic potentialities of the species which result in morphological and physiological differences determining the specific characteristics of the individual.

This work was carried out on the morphological, physiological and biochemical behavior of a varietal collection of olive trees grown in Algeria in a steppe region, intensively under controlled conditions (irrigation, optimal fertilization and phytosanitary treatment, etc.). The results obtained showed a great variability of the morphological, physiological and biochemical parameters depending on the variety and the tree. The results of the Principal Component Analysis indicate:

1. Study of variables

The main plane is the one formed by axes 1 and 2 on which the maximum information is found (67.22% of the general information). The variables which have the strongest coefficients in absolute value are those which contribute the most to the formation of a given axis and are the most linked to it: the height of the plant, the diameter of the trunk, the relative water content, the height of the canopy the height of the trunk and the circumference of the canopy, contributed the most to the formation of axis 1. Thus, axis 1 is mainly characterized by the variables cited. Examination of the quality of representation identified the following groups: plant height ($r=0.96$), trunk diameter ($r=0.92$), relative water content ($r=0.87\%$), canopy height ($r=0.72$) and trunk height ($r=0.68$). On the other hand, axis 2 is characterized by variables chlorophyll content a and b. Examination of the quality of representation revealed two groups: chlorophyll a ($R=0.85\%$) and chlorophyll b (-0.26%). (Figure. 11).

2. Study of individuals

Although all the varieties are grown under the conditions, it can be noticed that, for the plane formed by axes 1 and 2, representing the varieties studied, that the varieties Chemlal and Sofiana are positively correlated with the axis F1 and the varieties Agnoun, Manzanite, Aimel, Mission, Guergour, Longue de Miliana and Sigoise are negatively

correlated with the same axis F1. This quality of representation informs us about the existence or not of significant differences between the varieties studied.

3. Superposition of variables and individuals:

Axis 1 is characterized by the variables plant height, canopy height, leaf area, relative carotenoid, water content and trunk diameter. The Chemlal and Sofiana individuals are on the right side of axis 1 and have high values of plant height, canopy height, leaf area, relative water content carotenoids and trunk diameter while the individuals and Agnoun, Manzanite, Aimel , Mission, Guergour, Longue de Miliana and Sigoise are to the left of axis 1, which have a low value for these variables. Axis 2, which is characterized by variables chlorophyll a, trunk height, canopy circumference includes, at the top, Agnoun which has the values of canopy circumference, lower trunk height and Hamra at the bottom of the axis 2 with the highest values for these same variables. (Figures 12 and 13).

Figure 11: Correlation circle between variables and factors 1 and 2.

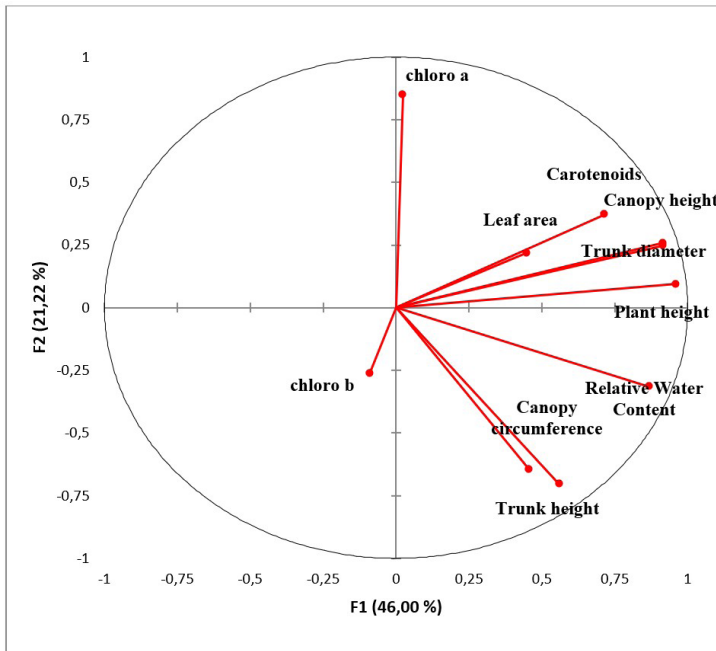


Figure 12: Coordinates of individuals on factors 1 and 2.

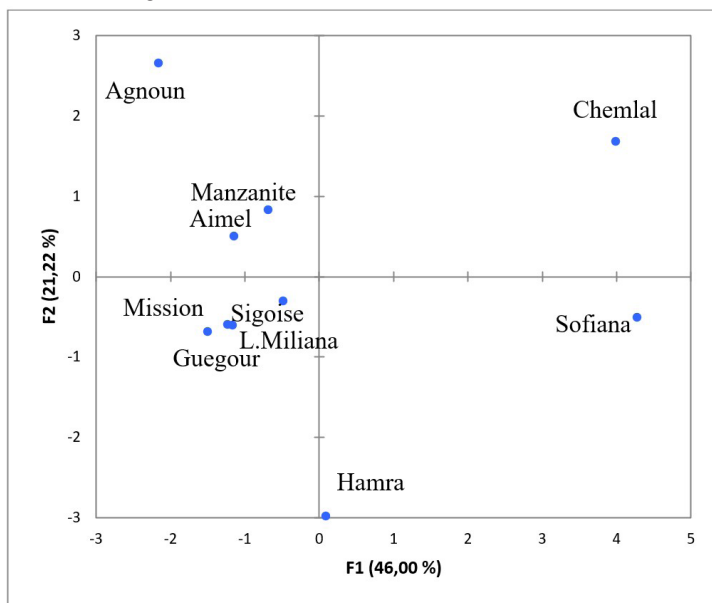
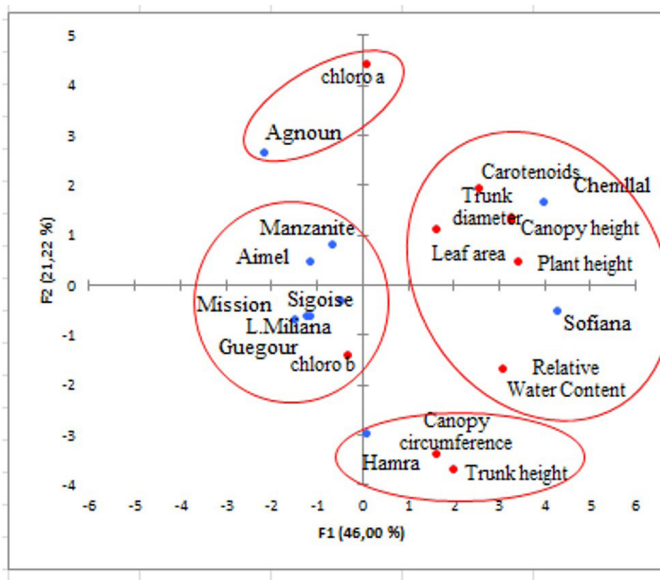


Figure 13: Superposition of variables and individuals on factors 1 and 2.



Indeed, our results show that the development of the tree is influenced by a multitude of endogenous and exogenous factors; in particular, the morphological growth and development in length and width of the plant and trunk, the circumference and height of the canopy, and the secondary growth expansion of the trunk in thickness are related

to the varietal potential (**Aiachi M., and al.; 2009**); Palease A.M., and al.; 2010, **Bamouh A., and al, 2012, Masmoudi-Charfi C., 2012**. However, several factors interfere and make the tree response analysis more complex **Connor D.J., Fereres E., 2005, Fernandez J.E., 2006, Castillo-Llanque F.J., and al., 2005, Castillo-Llanque F.J., 2008, Chehab H., 2007, and Martin-Vertedor A.I., and al. 2011**.

Simultaneous measurements of the biochemical and physiological parameters (chlorophyll pigments and relative water content) of the trees grown under the same growing conditions show that these factors are closely linked to the growth parameters of the tree and are inter-correlated with each other and with the varietal potential (Amouretti, 1985).

Hamra and Agnoun individuals are well represented on axis 2 1 and 4, which provides (21.22%) information. Chemlal, Sofiana, Agnoun, Manzanite, Aimel, Mission, Guergour, Longue de Miliana and Sigoise individuals are well represented on axis one which provides (46.00%) information. It appears, through the two axes, on the one hand that the Chemlal, Sofiana individuals form a group which is characterized by a height of the plant, diameter of the trunk, height of canopy, relative water content and foliar surface, more important, on the other hand, we find the Manzanite, Aimel, Mission, Guergour, Longue de Miliana and Sigoise individuals, which are distinguished by a low value of these variables. On the other hand, that the individual Hamra forms a group which is characterized by high values of the circumference and the height of the trunk unlike the individual Agnoun which is distinguished by low values for the same variables.

The distribution of the classes shows four classes. **The first class**, with higher values, consists of the varieties Chemlal and Sofiana. It forms a group which is characterized by a height of the plant, diameter of the trunk, height of canopy, relative water content and foliar surface. In contrast, **the second class**, with lower values for the same variables, is composed of the varieties Manzanite, Aimel, Mission, Guergour, Longue de Miliana and Sigoise. **The third class** has the highest values (circumference and the height of the trunk) as opposed to the fourth class which includes the Agnoun variety and has low values for the same variables.

5. CONCLUSION

This work is a contribution to the study of phenotypic diversity through the comparison of the morphological and physio-biochemical parameters of ten varieties of olive trees (Hamra, Sigoise, Aimel, Longue de Meliana, Mission, Guergour, Manzanite,

Agnoun, Chemlal and Sofiana) grown under controlled conditions; in a steppe zone with an arid climate and degraded soil in the wilaya of Tiaret commune of Rechaiga.

At the end of this study, which focused on the morphological and physio-biochemical characterization of some varieties of olive trees in a characterized region of arid zone of western Algeria, there is a significant morphological variation for most of them. traits studied. This variability is the result of a biological richness that we consider important. Even under the same conditions, each variety shows its own particularities which are expressed in morphological characters (growth in length, height and diameter of the trunk, canopy volume, leaf surface, etc.) and physio-biochemical (Relative content in water, synthesis of chlorophyll pigments).

The one-factor ANOVA study All the morphological, physiological and biochemical parameters studied without exception show highly significant differences ($p < 0.001$) depending on the variety studied.

The study of the correlations between the variables (figure 11) shows; on the one hand the Relative Water Content is positively correlated with the variables with the height of the plant ($r=0.82$), height of foliage ($r=0.76$), the diameter of the trunk, height ($r=0.71$) and trunk height ($r=0.67$); plant height is positively correlated with canopy height ($r=0.98$), trunk diameter ($r=0.90$) and carotenoid content ($r=0.60$) variables and canopy height with trunk diameter ($r = 0.89$).

The principal component analysis (PCA) allowed us to identify four groups composed of Chemlal and Sofiana form a group which is characterized by plant height, canopy height, leaf area, relative water content, carotenoid content and diameter of the largest trunk, while at the opposite we find the individuals Agnoun, Manzanite, Aimel, Mission, Guergour, Longue de Miliana and Sigoise a third class having the most important values (circumference and height of the trunk) unlike the fourth class with low values for the same variables composed of the Agnoun variety.

These differences in physio-biochemical morphological behavior are probably due to inter-varietal genetic variability or variety-environment interaction.

Given the little work done in the field of the characterization of Algerian varieties, apart from the main denominations (cultivars), then a characterization study of Algerian varieties is necessary.

It is desirable to extend this study to a qualitative and quantitative characterization of the organs (leaf, inflorescence, fruit and kernel), fruit and oil yields in addition to a characterization of the physicochemical properties of their oils.

REFERENCES

- Aïachi-Mezghani, M., Sahli, A., Grati, N., Ben Amar, F., Ben Ali, S., Ben Amor, R., Labidi, F., & Ouled Amor, A. (2009). Olive trees characteristics (*Olea europaea* L.) cultivated under intensive conditions in Tunisia (Sfax site). In For a renovate, profitable and competitive Mediterranean olive growing sector. Olivebioteq 2009, Sfax, Tunisia, 15-19 December 2009, Book of proceedings, 443-447.
- Amouritti, M., & Comet, G. (1985). *Le livre de l'olivier*. Edisud. 76p.
- Angelopoulos, K., Dichio, B., & Xiloyannis, C. (1996). Inhibition of photosynthesis in olive tree (*Olea europaea* L.) during water stress and rewatering. *Journal of Experimental Botany*, 47, 1093-1100.
- Bamouh, A., Ezzahouani, A., & ELhatmi, S. (2012). Les besoins en eau de l'Olivier sur la base de son taux de couverture du sol dans la zone de Béni Mellal. HTE, N° 151, Mars 2012.
- Ben Ahmed, C., Ben Rouina, B., Sensoy, S., Boukhris, M., & Ben Abdallah, F. (2009). Changes in gas exchange, proline accumulation and antioxidative enzyme activities in three olive cultivars under contrasting water availability regimes. *Environmental and Experimental Botany*, 67, 345-352.
- Castillo-Llanque, F.J., Rapoport, H.F., & Navarro, C. (2005). Caracterización de la ramificación del olivo: influencia de diferentes fechas de recolección y estados de carga. In Congreso Iberico de Ciencias Hortícolas, May 2005, Porto, Portugal, 1-7.
- Castillo-Llanque, F.J., Rapoport, H.F., & Navarro, C. (2008). Interaction between shoot growth and reproductive behaviour in olive trees. *Acta Horticulturae*, 791, 453-457.
- Chehab, H. (2007). Etude écophysiological, agronomique, de production et relation source-puits chez l'Olivier de table en rapport avec les besoins en eau (Doctoral thesis). Institut National Agronomique de Tunisie.
- Chevery, J.L. (1995). Planimètre électronique LICOR-3000A: manuel d'utilisation. (À compléter: éditeur, lieu).
- Connor, D.J., & Fereres, E. (2005). The Physiology of Adaptation and yield Expression in Olive. *Horticultural Review*, 31, 155-229.
- FAO (2019). Food and Agricultural Organization. <http://www.fao.org/faostat/fr/#data>
- Fernandez, J.E. (2006). Irrigation Management in Olive. Olivebioteq, Book of Abstracts, 295-305.
- Giorio, P., Sorrentino, G., & d'Andria, R. (1999). Stomatal behaviour, leaf water status and photosynthesis responses in field-grown olive trees under water deficit. *Environmental and Experimental Botany*, 42, 95-104.
- Hadj Sadok, T., Rebiha, K., & Terki, D. (2018). Caractérisation physico-chimique et organoleptique des huiles d'olive vierges de quelques variétés algériennes. *Revue Agrobiologia*, 8(1), 706-718.
- Lazzeri, Y. (2009). Les défis de la mondialisation pour l'oléiculture méditerranéenne, l'olivier en Méditerranée. Centre culturel Français de Tlemcen-Algérie, p. 24.
- Martin-Vertedor, A.I., Perez Rodriguez, J.M., Prieto Losada, M.H., & Fereres Castiel, E. (2011). Interactive responses to water deficits and crop load in olive (*Olea europaea* L., cv. Morisca). I - Growth and water relations. *Agricultural Water Management*, 98, 941-949.

Masmoudi-Charfi, C. (2012). Quantitative analysis of soil water content in young drip irrigated olive orchards. *Advances in Horticultural Sciences*, 26(3-4), 138-147.

Palese, A.M., Nuzzo, V., Favati, F., Pietrafesa, A., Celano, G., & Xiloyannis, C. (2010). Effects of water deficit on the vegetative response, yield and oil quality of olive trees (*Olea europaea* L., cv. Coratina) grown under intensive cultivation. *Scientia Horticulturae*, 125, 222-229.

Philippeau, G. (1986). Comment interpréter les résultats d'une analyse en composantes principales. Collection STAT-ITCF. Paris: ITCF, 63 p.

Pinelli, P., Galardi, C., Mulinacci, N., Vincieri, F.F., Cimato, A., & Romani, A. (2003). Minor polar compounds and fatty acid analyses in monocultivar virgin olive oils from Tuscany. *Food Chemistry*, 80(3), 331-336.

SOBRE O ORGANIZADOR

Eduardo Eugênio Spers realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

ÍNDICE REMISSIVO

A

Aceites esenciales 136, 137, 140, 142, 143, 144, 150, 151, 153, 158, 160
Ácidos orgánicos 136, 137, 139, 146, 147, 148, 149, 150, 151, 153
Actitudes ambientales 25, 26, 27, 28, 29, 30, 31, 32, 33
Actividad antimicrobiana 137, 145, 147, 148
Acuicultura 163, 164, 169, 171, 178, 192, 204
Agricultura 1, 2, 4, 6, 22, 23, 35, 45, 64, 65, 97, 98, 99, 100, 101, 102, 103, 109, 110, 131, 135
Agricultura sostenible 2, 35
Agroecología 1, 2, 4, 5, 22
Alimento vivo 162, 163, 164, 175, 190, 192
Almidón 113, 115, 116, 119, 135, 192
Antocianinas 113, 114, 115, 117, 119, 120, 122, 123, 131, 135

B

Bioestimulante 51, 64
Biofloc 162, 173, 175, 190, 191, 192, 200, 201, 202, 203, 204
Biomasa 36, 66, 134, 164, 176, 177, 178, 184, 185, 186, 187, 191, 194
Burkholderia cepacia 162, 163, 165, 166, 175, 176, 178, 190, 191, 193, 194

C

Características físicas 123, 124, 135

D

Daphnia magna 169, 171, 172, 173, 174, 175, 176, 177, 179, 184, 187, 188, 189
Daphnia pulicaria 162, 163, 169, 171
Desarrollo sustentable 25, 27, 28, 33
Difusión 97, 99, 100, 103, 104, 106, 108, 111
Dureza de grano 113

E

Educación ambiental 25, 27, 28, 31, 32

F

Fuentes de carbono 162, 163, 164, 165, 167, 171, 175, 176, 178, 181, 182, 184, 186, 190, 192,

193, 201, 202, 204

G

Germinación 95, 128, 130, 135

H

Huella genómica 123, 124, 125, 129, 130, 132

Humus sólido y líquido 51

I

Identidad genética 122, 130, 132

Innovaciones 97, 99, 100, 101, 103, 104, 106

Integridad intestinal 137, 152

Inteligencia Artificial 97, 100, 102

In vitro culture 87, 88

L

Larvicultura 176, 187

M

Macroalga 162, 163, 165, 167, 168, 192

Maíz azul 113, 114, 115, 116, 120, 122, 123, 124, 129, 131, 132, 135

Microalgas 164, 165, 169, 175, 176, 177, 178, 179, 184, 185, 186

Microbioma intestinal 1, 8, 10, 11, 12, 14, 15, 16, 20, 21, 143, 150, 170

Morphology 69, 156, 157, 160, 161

N

Nutrición sostenible 35

Nutrientes 14, 20, 34, 36, 37, 41, 44, 47, 50, 51, 52, 59, 63, 64, 139, 143, 149, 151, 153, 169, 178, 185, 201, 202

O

Olive tree 69, 70, 71, 85

Oreochromis niloticus 172, 188, 190, 191, 192, 202, 203, 204

Oxidation 87, 159

P

PCA 69, 71, 84

Physio-biochemical 69, 83, 84

Pinus 87, 88, 94, 95, 96

Plaguicidas 1, 4, 5, 6, 8, 15, 18, 19

Precisión 51, 97, 98, 100, 101, 102, 110, 111, 112

Problemática ambiental 25, 27, 28, 31

Producción de arroz 34, 35

Proteína 15, 53, 58, 65, 113, 115, 116, 118, 139, 140, 144, 145, 146, 177, 185, 191, 192

R

Rendimiento de arroz 35

Rendimiento productivo 136, 137, 138, 150, 152, 153

S

Salud 1, 2, 3, 4, 5, 6, 10, 13, 14, 16, 18, 20, 21, 22, 23, 27, 35, 36, 37, 122, 123, 137, 138, 139, 142, 146, 150, 151, 152, 153, 202

Salud del suelo 35, 36, 37

Seeds 87, 88, 89, 91, 92, 114, 123, 130

Steppe 69, 80, 84

Suelos de Monteria 35

Sulfato de calcio 51, 53

Sulfato de Potasio 51, 53, 58

U

Uso de biofertilizantes 35

Z

Zea mays 113, 114, 120, 122, 123, 128, 130, 135

Zea mays L. 113, 114, 120, 122, 123, 128, 135



**EDITORIA
ARTEMIS**
2026