2nd International Conference of

Plant Science and Management of Drylands for Agriculture and Biodiversity: A Step towards Sustainable Development

May 18-20, 2026

Abstract

Department of Botany
University of Balochistan
Quetta

https://uob.ac.pk/conference_portal/

Message of the Patron in Chief

The *2nd International Conference on Plant Science and Management of Drylands for Agriculture and Biodiversity: A Step towards Sustainable Development* is organized by the Department of Botany, University of Balochistan. This Higher Education Commission-sponsored conference focuses on eight major themes related to advances in plant sciences, agriculture, biodiversity conservation, livestock production, and the challenges posed by climate change and population growth. It also addresses mining-related environmental and agricultural issues, along with exploring the potential of the herbal industry in dryland regions. Most importantly, the themes of this conference align with five Sustainable Development Goals (SDGs), namely: No Poverty (Goal 1), Good Health and Well-Being (Goal 3), Decent Work and Economic Growth (Goal 8), Climate Action (Goal 13), and Life on Land (Goal 15). With significant participation from scientists, students, and teachers from various parts of the country, including Balochistan, this important event will substantially contribute to improving the quality of education and public awareness, both directly and indirectly, regarding issues related to agriculture, livestock production, and biodiversity conservation. Notably, by highlighting Balochistan's rich diversity of medicinal and herbal plant species, this conference will contribute to the development and strengthening of the province's herbal industry and its economic potential.

Professor Dr. Zahoor Ahmed Bazai
Vice Chancellor
University of Balochistan

Message of the Chief Organizer

In academia, international conferences play pivotal role in promoting research and teaching. These events are important avenues for learning through interaction between faculty, researchers and students from different organizations across the country and abroad. Therefore, such events play a significant role in developing a learning culture in academia and motivation for research in students and academia, which is crucial for the growth of education sector. Furthermore, these activities are also highly important in developing awareness in youth about recent advances in research in a given domain of science and technology. The theme of a conference needs to be the one that well-appeals the current socio-economic status/issues of province of a country where the conference is conducted. The agriculture sector of Pakistan contributes 18.9% to GDP and accounts for providing employment to approximately 43% of the country's labor. However, more than 90% of the country has arid to semi-arid climatic conditions. Salinity is another limiting factor that has affected large area of the country for agriculture. Furthermore, unmanaged anthropogenic disturbance has affected the rangelands of this country, which poses a serious threat to the biodiversity and the environment as a whole. In Balochistan, which is the largest province of the country, extensive mining activities are further aggravating the problems to environment, agriculture and food quality. This international conference will provide an awesome opportunity and platform for the scientists of Balochistan to find solution for these serious issues via communicating with the experts in the field of agriculture, environment and rangeland management. Furthermore, Balochistan is blessed with innumerable species of medicinal plants. This is the need to time to highlight their existence, medicinal importance and potential utilization in future. This conference will be an important avenue for the stakeholders and scientists to utilize this precious resource for the economic growth of this province.

Students are the assets of nation. International conferences provide an excellent opportunity for the students to share their research work and exchange ideas with each other. Their interaction with scientists creates motivation in them and get them acquainted of opportunities to pursue higher education. The interaction of scientists during the event will help develop a Memorandum of Understanding between universities to share pedagogical resources, develop programs and courses and facilitate student exchanges. Moreover, since this conference will focus on plant science, biodiversity, environment and agriculture in dry areas, the knowledge from this conference will greatly help promote research in addressing problems related to the sector of agriculture, biodiversity conservation and environment in Balochistan. The outcome of this conference in the form of research grants, enrolment of students in MPhil and PhD degree programs and production of research articles in high impact factor journals will eventually help raise the ranking of University of Balochistan and enhance growth of the sector of education of this province.

Dr. Shamim Gul
Associate Professor (Tenured)
Department of Botany, University of Balochistan
Email: shamim.gul@mail.mcgill.ca; Phone: 03362005882

Disclaimer

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The official website for this conference is https://uob.ac.pk/conference_portal/

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Dr. Muhammad Zeeshan, Department of Linguistics and Philology
Professor Dr. Muhammad Ayub Kakar, Institute of Biochemistry, University of Balochistan
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Professor Dr. Imran Ali, Department of Bioengineering, College of Life Sciences and Agri-Forestry, Southwest University of Science and Technology, Mianyang, China
Dr. Tariq Ziad, Agricultural Research Institute, Quetta
Professor Dr. Muhammad Anwar Panezai, Institute of Biochemistry, University of Balochistan

SECRETARY

Dr. Shazia Saeed, Department of Botany, University of Balochistan

OTHER ORGANIZERS

Dr. Basira Sher, Department of Botany, University of Balochistan
Mrs. Palwasha Achakzai, Department of Botany, University of Balochistan
Dr. Bakht Zareen, Department of Botany, University of Balochistan
Dr. Kanval Shaukat, Department of Botany, University of Balochistan
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Dr. Samira Khaliq, Instotute of Biochemistry, University of Balochistan
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Dr. Shaista Anjum, Department of Botany, University of Balochistan
Dr. Tariq Ismail, Department of Botany, University of Balochistan
Dr. Shahjahan Shabbir Ahmed Rana, Department of Biotechnology, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta
Dr. Naeem Shahwani, Department of Biotechnology, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta
Technology, Engineering and Management Sciences, Quetta
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Dr. Shazia Irfan, Department of Plant Sciences, Sardar Bahadur Khan Women's University
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Dr. NaqeebUllah, Department of Chemistry, UoB

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Dr. Alia Ahmed, Department of Botany, UoB
Mrs. Palwasha Achakzai

STAGE COMMITTEE

Dr. Shazia Saeed, Department of Botany, University of Balochistan
Dr. Ayeesha Masood, Department of Botany, University of Balochistan

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Mr. Muhammad Salal Khan, Director, Department of Information Technology, UoB
Dr. Abdul Basit Achakzai, Department of Computer Science, University of Balochistan
Dr. Muzamil Ali Bokhari, Director Office of Research Innovation and Commercialization, University of Balochistan

Conference plan

Conference Day 1, Monday May 18, 2026	
Inauguration **Venue:** Main Auditorium, University of Balochistan **Organizers**: Dr. Shazia Saeed, Dr. Alia Ahmad, Dr. Kanval Shaukat, Dr. Shaista Anjum, Mrs. Palwasha Achakzai **Stage Secretary:** Dr. Ayeesha Masood	
Registration and Gathering	9:00 - 10:30 am
Recitation of Holy Qur'an	10:30 - 10:35 am
National Anthem	10:35 - 10:37 am
Talk by Chief Conference Organizer Dr. Shamim Gul	10:37 - 10:45 am
Talk by Dr. Shazia Saeed, Department of Botany, UoB	10:45-10:47 am
Talk by International Keynote Speaker Professor Dr. Joann Karen Whalen, McGill University, Quebec, Canada	10:47 - 11:20 am
Talk by Keynote Speaker Jelle Beekma, Team Leader RBWRP-TA EU	11:20 - 11:35 am
Speech by Vice Chancellor	11:35 - 11:45 am
Speech by Chief Guest	11:45 - 11:55 am
Shield Distribution and Group Photo	11:55 am - 12:10 pm
Tea Break	12:10 - 12:30 pm
Session 1 **Theme 1: Plant Physiology, Pathology and Biotechnology** **Venue: Venue:** HBL Seminar Room, Institute of Management Sciences, University of Balochistan **Chair and Co-Chair:** Shahjahan Shabir A. Rana and Dr. Abdul Wali Tareen from Balochistan University of Information Technology, Engineering and Management Sciences, Quetta **Organizers:** Dr. Abdul Kabir Khan Achakzai, Dr. Ali Akbar, Dr. Ayeesha Masood, Dr. Alauddin, Dr. Naqeebullah, Dr. Samiullah and Dr. Atiq ur Rehman	
Speech by Guest Speaker Dr. Syed Shujaat Ali Zaidi, University of Texas	12:30 - 12:45 pm
Speech by Guest Speaker Professor Dr. Ali Akbar, University of Swat (KPK)	12:45 - 1:00 pm
Systematic Profiling of Conserved microRNAs in *Zea mays*: Functional Targets and Experimental Validation via RT-PCR Abdul Baqi, Samiullah, Naqeebullah Khan and Attiq-Ur-Rehman	1:00 - 1:10 pm
Exploring the Hidden World of miRNAs - Identification and Characterization of Evolutionary Conserved Muskmelon Non-coding miRNAs and Their Target Proteins Abdul Ghaffar, Naqeebullah Khan, Samiullah *et al.*	1:10 - 1:20 pm
Effects of Light Regime and Selenium Nanoparticles on Antioxidant and Hypoglycemic Potential in *in-vitro* grown *Caralluma tuberculata* Amir Ali, Zia-ur-Rehman Mashwani	1:20 pm - 1:30 pm

Parallel Session 2 **Theme 2: Biodiversity and Conservation - Problems and Solutions** **Theme 3: Medicinal Plants of Drylands: Production, Utilization Potential and Herbal Industry** **Venue:** Media Study Center, University of Balochistan **Chair and Co-Chair:** Dr. Jahangir Khan from Balochistan Agricultural research and Development Center and Dr. Tariq Ziad from Agricultural Research Institute **Organizers:** Dr. Shamim Gul, Dr. Shazia Saeed, Dr. Aliya Ahmed, Dr. Tariq Ismail, Professor Dr. Saeed ur Rehman Kakar from Department of Botany, University of Balochistan, Dr. Umbreen Shaheen, Department of Zoology, University of Balochistan	
Speech by Keynote Speaker, Dr. Sarfaraz Ahmad	12:30 - 12:45 pm
Speech by Keynote Speaker, Dr. Muhammad Islam	12:45 - 1:00 pm
Speech by Keynote Speaker, Dr. Muhammad Azam kakar	1:00 - 1:10 pm
Seasonal Variation in Composition and Aboveground Plant Biomass Production in Tomagh Rangeland Area, Asghara Valley, Sinjavi, of Balochistan Dr. Farhat Abbas	1:10 - 1:17
Development of Oil Based Black Quarter Vaccine in Farm Animals Maina Akbar, Muhammad Shafee, Muhammad Naeem *et al.*	1:17 - 1:25 pm
Influence of Dried Citrus Pulp Bio-waste as a Concentrate Replacement on Performance in Lactating Buffaloes Muhammad Sharif, Sarmad Yasin, Fawad Ahmad *et al.*	1:25 - 1:30 pm
Parallel Session 3 **Theme 4: Farming Systems of Drylands - Opportunities for Better Economy and Livestock Production** **Theme 5: Effect of Climate Change on Arid Agroecosystems and Mitigation Options** **Venue:** Smart Room, Centre of Excellence for Result Based Management (CERBM), University of Balochistan **Chair and Co-Chair:** Dr. Hidayatullah Kakar from Agricultural Research Institute and Mr. Abdullah Baloch from Balochistan Agricultural Research and development Center, Quetta **Organizers:** Dr. Basira Sher, Dr. Bakht Zareen, Dr. Kanval Shaukat, Dr. Shaista Anjum	
Speech by International Guest Speaker Haruna Gado Yakubu, University of Cape Coast, Ghana	12:30 - 12:45 pm
Speech by Guest Speaker Professor Dr. Muhammad Arif, University of Agriculture, Peshawar	12:45 - 1:10 pm
Investigating the life cycle of the major insect pests affecting dry fruits of Quetta Balochistan Afroz Nisa, Nosheen Rafiq	1:10 - 1:20 pm
Eco-Friendly Management of *Fusarium* Wilt of Cucumber Using Botanical Extracts under *In Vitro* and High Tunnel Conditions in Uplands of Balochistan Adnan Baloch, Bashir Ahmed Bangulzai, Muhammad Waris	1:20 - 1:30 pm
Lunch and Prayer Break	1:30 - 2:30 pm

Evening Session 1 **Theme 1: Plant Physiology, Pathology and Biotechnology** **Venue:** HBL Seminar Room, Institute of Management Sciences, University of Balochistan **Chair and Co-Chair:** Shahjahan Shabir A. Rana and Dr. Abdul Wali Tareen from Balochistan University of Information Technology, Engineering and Management Sciences, Quetta **Organizers:** Dr. Abdul Kabir Khan Achakzai, Dr. Ali Akbar, Dr. Ayeesha Masood, Dr. Naqeebullah, Dr. Samiullah and Dr. Atiq ur Rehman	
Elderberry-Based Nanostructures: Physicochemical Properties, Biological Activities, and Biomedical Applications - A Systematic Review Fareeha Goher, Wajiha Hasan, Khizra Sohail *et al.*	2:30 - 2:40 pm
ABA and Relevant Genes Downregulate the Hydraulic Conductivity Causing Stomatal closure and Reduce Pollen Viability and Yield in Two Cultivars of *Avena nuda* L. Huma Batool, Xiangwen Fang, Tayyaba Yasmina	2:40 - 2:50 pm
Identification of Cold Tolerance Related Genes in Tomato Ibrar khan, Rashid Mehmood Rana, Munir Ahmad *et al.*	2:50 - 3:00 pm
Exploring the antibacterial potential of Guava leaves (*Psidium guajava*) Maham Sheikh, Muhammad Shafee, Shabbir Ahmad, Abid Hussain, Sahiba Muhammad Khan, Zoha Usman	3:00 - 3:10 pm
Climate Smart Varieties of Castorbean: Potential and Opportunities for Marginal, Low Intensity, Degraded and Normal Soils Mahmood-Ul-Hassan	3:10 - 3:20 pm
An overview on the green synthesis of selected nanomaterial from wild desert plant *Aerva javanica* (Burm. f.) Juss. ex Schult.) and their benefits in biological system Muhammad Shafiq, Muhammad Zafar Iqbal, Mohammad Athar	3:20 - 3:30 pm
First Comprehensive Molecular and Pathogenic Characterization of *Colletotrichum* Species causing Bitter Rot of Apple in Quetta, Pakistan Muhammad Shahid, Farah Naz, Sadia Sana *et al.*	3:30 - 3:40 pm
Isolation and Prevalence of Multi Drug Resistance *Salmonella typhi* among Adults of Quetta Nabila Nisar, Samina Ali	3:40 - 3:50 pm
Quercetin Verses Metformin, Comparative Efficacy on the Lipid Metabolism Gene Expression in Different Organs of Diabetic Wistar Rats Nayab Khan, Asmatullah Kakar, Imtiaz Rabbani *et al.*	3:50 - 4:00 pm
Physiological Responses of Plants to Water Stress in Dryland Agriculture Nabgha Imran, Dr. Muhammad Ashfaq Wahid, Bilal Ahmed	4:00 - 4:10 pm
Phylogenomic Insights into the Genus *Chrozophora*: Leveraging the *C. sabulosa* Chloroplast Genome for Sustainable Dryland Plant Management Nida Javaid, Musarrat Ramzan, Shagufta Jabeen *et al.*	4:10 - 4:20 pm
In Process Control and Comparative Analysis of High Biomass Production of *Pasteurella multocida* Using Biofermenter Palwasha Khan, Muhammad Shafee, Muhammad Naeem *et al.*	4:20 - 4:30 pm

Deep Learning-Based Detection and Severity Assessment of *Alternaria alternata* in Postharvest Fruit of Peach Using Image Analysis Raheem Uddin, Gulshan Irshad, Adnan Baloch *et al.*	4:30 - 4:40 pm
Evaluating the Impact of Natural Growth Regulators in Improving Heat Tolerance and Yield of Sesame Shakeel Imran, Ahmad Raza, Muhammad Talha Ramzan	4:40 - 4:50 pm
Phytochemical Characterization and Therapeutic Potential of ***Pistacia khinjuk*** Hull and Kernel Essential Oil Sundus Shahid, Ali Akbar	4:50 - 5:00 pm
Distribution of prizes, certificates and shields	5:00 - 5:10 pm
Evening Parallel Session 2 **Theme 2: Biodiversity and Conservation - Problems and Solutions** **Theme 3: Medicinal Plants of Drylands: Production, Utilization Potential and Herbal Industry** **Venue:** Media Study Center, University of Balochistan **Chair and Co-Chair:** Dr. Jahangir Khan from Balochistan Agricultural Research and Development Center and Dr. Tariq Ziad from Agricultural Research Institute **Organizers:** Dr. Shamim Gul, Dr. Shazia Saeed, Dr. Aliya Ahmed, Dr. Tariq Ismail, Professor Dr. Saeed ur Rehman Kakar from Department of Botany, University of Balochistan, Dr. Umbreen Shaheen, Department of Zoology, University of Balochistan	
In silico based profiling of bioactive compounds from *Calotropis procera* against anti-inflammatory and antibacterial activities Abdul Hakeem and Naqeebullah Khan	2:30 - 2:40 pm
Ethnobotanical Knowledge and Conservation Challenges of Medicinal Plants in Subtropical Forests, Lesser Himalayas Pakistan: Implications for Sustainable Management Bilal Ahmad, Said Latif Ullah, Ali Akbar	2:40 - 2:50 pm
Traditional Milk-Based Sweets (Barfi) from Dryland Regions Jamila Tabassum, Muhammad Shafee, Muhammad Aziz	2:50 - 3:00 pm
Investigating Anticancer Potential of Red Algae (*Rhodophyceae*) from Gwadar Sea Shore Mahnoor M. Rahim, Asad Ullah *et al.*	3:00 - 3:10 pm
Pistacia khinjuk Seed Oil as Potential Anti-Dementia candidates Marina Panzai, Nazima Yousaf khan, Muhammad Aziz	3:10 - 3:20 pm
Biotechnological Evaluation of *Curcuma longa* L. Extracts as Natural Sensitizers for Sustainable Photovoltaic Applications Muhammad Ayaz, Jafar Khan Kasi, Ajab Khan Kasi *et al.*	3:20 - 3:30 pm
Computational Screening of Phytochemicals from Medicinal Plants of Drylands in Balochistan, for Anticancer Potential Muhammad Aziz, Ashif Sajjad	3:30 - 3:40 pm
Drought-Proofing the Rangelands: Adaptability Potential of Different Accessions of *Cenchrus ciliaris* L. for Climate-Resilient Forage Under Water Deficit Naila Sarwar, Muhammad Jamil, Musarrat Ramzan *et al.*	3:40 - 3:50 pm
Comparative Study on the Health Benefits of Tea Prepared from Different Plant Raw Materials Nazima Yousaf khan, Muhammad Aziz, Marina panzai	3:50 - 4:00 pm

Comparative evaluation of Oil based Vaccine Adjuvanted with Montanide and Eolane -150 against Hemorrhagic Septicemia in Farm Animals Rehana Noor, Muhammad Shafee, Muhammad Naeem *et al.*	4:00 - 4:10 pm
Exploring the Antibacterial Potential of Indigenously Cultivated Olive Tree Leaves Sahiba Muhammad, Muhammad Shafee, Shabbir Ahmad *et al.*	4:10 - 4:20 pm
Effect of watering, Biofertilizer and NPK fertilizer on Rosemary (*Rosmarinus officinalis* L.) growth and production in highlands of Balochistan, Pakistan Shazia Irfan, Sarfaraz Ahmed Mufakhira Jan Durrani (Late)	4:20 - 4:30 pm
Distribution of prizes, certificates and shields	4:30 - 4:40 pm
Evening Parallel Session 3 **Theme 4: Farming Systems of Drylands - Opportunities for Better Economy and Livestock Production** **Theme 5: Effect of Climate Change on Arid Agroecosystems and Mitigation Options** **Venue:** Smart Room, Center of Excellence for Result Based Management (CERBM) University of Balochistan **Chair and Co-Chair:** Dr. Hidayatullah Kakar, from Agricultural Research Institute and Mr. Abdullah Baloch from Balochistan Agricultural Research and development Center, Quetta **Organizers:** Dr. Basira Sher, Dr. Bakht Zareen, Dr. Kanval Shaukat, Dr. Shaista Anjum	
Speech of Guest Speaker Professor Dr. Hidayat Ullah, University of Swabi, Peshawar	2:30 - 2:45 pm
Speech of Guest Speaker Dr. Masood Ahmad, University of Agriculture, Peshawar	2:45 - 3:00 pm
Speech of Guest Speaker Professor Dr. Saima Hashim, Environmental Specialist	3:00 - 3:15 pm
Investigating the life cycle of the major insect pests affecting dry fruits of Quetta Balochistan Afroz Nisa, Nosheen Rafiq	3:15 - 3:25 pm
Boron Status in Soil and Plant Tissue of Mango Orchards in Sindh Mohammad Naseem Kakar, Mehrunesa Memon, Tariq Ziad *et al.*	3:25 - 3:35 pm
Maize Cultivation and Consumption Practices in Azad Jammu and Kashmir: Insights from Farmers Muhammad Shehzad, Aqeel Ahmad, Muhammad Jamil *et al.*	3:35 - 3:45 pm
Boron forms Spatial Distribution in Apple Orchards of Pishin, Balochistan Tariq Ziad, Shamim Gul	3:45 - 3:55 pm
Climate Change and Restoring Drylands: Livestock the Backbone of Balochistan's Economy in perspective of Sustainable Development Goals (SDGs) Habib ur Rehman, Niamatullah Kakar, Jameel ur Rehman *et al.*	3:55- 4:10 pm
Influence of cultivation of olive groves in Balochistan on soil organic carbon and biological indicators of soil health - implications for climate change mitigation Hazeezullah Khoshal, Shamim Gul	4:10-4:20 pm

Assessing Plant Adaptability and Phytoremediation Potential in Dryland Agroecosystems: Implications for Ecosystem Services and Climate Change Resilience Shagufta Jabeen, Shujaul Mulk Khan, Nida Javaid *et al.*	4:20 - 4:30 pm
Thermo-tolerance Induction in Cotton through Natural Growth Enhancers Shakeel Imran, Muhammad Farhan, Muhammad Talha Ramzan	4:30 - 4:40 pm
Distribution of Prizes, certificates and shields	4:40 - 5:00 pm
Conference Day 2: May 19, 2026	
Theme 6, Biowastes in agriculture: sustainable solution for agriculture, economy and environment **Theme 7: Mining activities: influences on agriculture in Balochistan and attenuation options** **Venue:** Institute of Management Sciences (IMS) **Chair and Co-Chair:** Professor Dr. Shahjahan Shabir A. Rana (BUITEMS) and Dr. Abdul Wali Tareen (BUITEMS) **Organizers:** Dr. Abdul Kabir Khan Achakzai, Dr. Ayeesha Masood, Dr. Tariq Ismail, Department of Botany, University of Balochistan, Dr. Ttariq Ziad ARI, Quetta, Dr. Naqeebullah, Dr. Samiullah and Dr. Atiq ur Rehman from Department of Chemistry, University of Balochistan	
Speech by International Guest Speaker Professor Dr. Imran Ali, Southwest University of Science and Technology, Mianyang, China	9:15 - 9:35 am
Speech by national Guest Speaker Dr. Masood Ahmad	9:35 - 9:50 am
Evaluation of biochars produced from six different feedstocks on soil quality of alkaline soil Iram Sonia, Misbah Manzoor	9:50 - 10:00 am
Silica Nanoparticles supplementation for sustainable agriculture in the saline and drylands regions of Balochistan, Pakistan Ayesha Mushataq, Sabeena Rizwan, Nayyab Hina *et al.*	10:00 - 10:10 pm
Assessment of Atmospheric Dispersion and Uptake Pattern of PAHs in Vegetation around Brick Kilns in Balochistan, Pakistan Khanoranga and Nelofer Jamil	10:10 - 10:20 am
Plant physiology of garlic and rhizosphere soil processes under influence of two years biochar-based field amendments in calcareous soil Pashtana Sahibjan, Shamim Gul	10:20 - 10:30 am
Utilization of Citrus Pulp Bio-waste as a Concentrate Replacement and its Impact on *In-situ* Digestion Kinetics in Buffalo Bulls Muhammad Abdullah, Muhammad Sharif, Safdar Hassan *et al.*	10:30 - 10:40 am
The phytoremediation, Nutritional and Medicinal Potential of Fruit Crop *Carica papaya* L. (Pawpaw) of Tropical and Subtropical Region including, Pakistan – A Review Muhammad Shafiq, Muhammad Zafar Iqbal, Mohammad Athar	10:40 - 10:50 am
Estimation of the Efficacy of Bio-Waste Treated Soil on the Growth of *Trigonella foenum-graecum:* A strategy in Waste Management Nelofer Jamil, Sakina Ali, Sehrish, Imama	10:50 - 11:00 am
Production of polyhydroxy butyrate by agriculture waste using solid state fermentation Shagufta Saeed, Sadia Nawaz, Muhammed Tayyab *et al.*	11:00 - 11:10 am

Biochar-based amendments in chromite-contaminated soil - Influence on soil properties, fruit yield and nutrient uptake of tomato under field conditions Palwasha Achakzai, Shamim Gul, Kanval Shaukat	11:10 - 11:20 am
Distribution of prizes, certificates and shields	11:20 - 11:30 am

Poster Competition
Venue: Institute of Management Sciences (IMS)
Poster Evaluators: Professor Dr. Ali Akbar, Professor Dr. Hidayat Ullah, Dr. Masood Ahmad, Professor Dr. Muhammad Arif, Dr. Muhammad Islam, Professor Dr. Naeem Shahwani (BUITEMS), Professor Dr. Shahjahan Shabir A. Rana (BUITEMS), Dr. Saima Hashim, Dr. Sarfraz Ahmad
Organizers: Dr. Basira Sher, Dr. Bakht Zareen, Dr. Kanval Shaukat, Dr. Shaista Anjum, Dr. Ayeesha Masood, Mrs Palwasha Avhakzai, Dr. Tariq Ismail
Time: 11:30 am - 12:30 pm

Current Nanotechnology Scenario in Biomedical Sciences, Genomics, and Regenerative Medicine Arifa Ghafoor, Hasnain Raza and Umbreen Shaheen
Alleviatory Effects of PGRs (Plant Growth Regulators) Priming on Cobalt-Induced Stress in Lentil Variety Faisal Khan, Kanval Shaukat, Abdul Samad *et al.*
Comparative Phenolic Profiling of S*esamum indicum* Seed Oils from Ten Varieties of Pakistan Faryal Yusuf, Ayeesha Masood
Copper–Peptide Nanocomplexes for Targeted Cancer Therapy via Cuproptosis Muhammad Irfan, Jahanzaib and Umbreen Shaheen
Role of Plant Growth Regulators in Alleviating Cadmium Toxicity in Lentil: A Foliar Application Approach Mohammad Siraj, Kanval Shaukat, Abdul Samad *et al.*
Assessment of Exotic Wheat Genotypes for Stripe Rust Resistance and Yield Performance under Field Conditions Rozia Gull, Rizwana Maqbool, Sabeela Yaqoob
Comparative Efficiency of Salicylic Acid and Ascorbic Acid Seed Priming on Morpho-Physiological Attributes of Maize under Zinc Toxicity Tauqeer Ahmed, Kanval Shaukat, Abdul Samad *et al.*
Comparative analysis of Soil Physicochemical Properties at Varying Depth in Sra Ghurghai and Hanna district Quetta, Balochistan Meraj-Ud-Din, Ayeesha Masood
Impact of Fire on the Nutritional Quality of Pine Nut Seeds (*Pinus gerardiana* Wall. ex D. Don) of Zhob, Balochistan Momina Rozi Khan, Misbah Manzoor, Asadullah, Ayesha Masood *et al.*
A scientific study of Flora and fauna of Chiltan Mountain ranges Quetta Balochistan Naila Naheed, Faizan Ali, Hina Barozai *et al.*
Aboveground vegetation biomass, plant species composition, invertebrate and vertebrate animals and soil properties of 53-years protected cold-winter desert of Balochistan, Pakistan Najeeb Ullah, Shamim Gul
Stay-Green Related Traits and Their Association with Phenology and Yield Performance in Wheat Genotypes under Terminal Water Stress Shabana, Shaista Anjum, Jahangir Khan *et al.*

Effects of Nanoemulsions Using Basic Essential Oils for the Shelf Life Extension of Indian Mackerel *(Rastrelliger kanagurta)* Fehmeeda Yousuf, Umbreen Shaheen
Physicochemical and Phytochemical Evaluation of Open and Branded Black Tea from Quetta City Ghulam Qadir, Shaista Anjum, Abid Ali *et al.*
Quantification of the antioxidant activity of three medicinal plant extracts Hameeda Jabeen, Saeed ur Rehman Kakar, Siraj Ahmed Kakar *et al.*
Antibacterial activities and phytochemical screening of three wild herbs of cold mountainous regions of Balochistan, Pakistan Hameeda Jabeen, Saeedu ur Rehmn Kakar, Rasool Bakhsh Tareen *et al.*
Green Nanotechnology Meets Herbal Medicine: Biosynthesis of Silver Nanoparticles from *Berberis lycium* with Enhanced Antibacterial and Wound Healing Potential Jahan Zaib, Hifza Taj and Dr. Umbreen Shaheen
Clove oil reduced silver nanoparticles (CSNPs) showed 100% larvicidal activity against mosquito larvae compared to clove oil itself Muhammad Nawaz and Dr Umbreen Shaheen
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Address by Vice Chancellor, University of Balochistan	12:55 - 1:00 pm
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Tackling Drought and Nutrient Management in Drylands: A Plant-Microbial Perspective

Whalen, J.K.[1]
[1]Department of Natural Resource Sciences, Macdonald Campus of McGill University, Canada
E-mail: Joann.whalen@mcgill.ca

Abstract

Approximately 40% of the Earth's arable and agricultural lands are affected by aridity, making them vulnerable to the effects of drought. Lack of water also affects nutrient acquisition and use during plant growth, which can limit the development and yield of grain, seed and fruit. The objective is to present integrated approaches that can practically tackle the drought and nutrient management challenges from a plant-microbial perspective. This relies on understanding of the symbiotic and free-living microorganisms that colonize the root system, and the mechanisms of how rhizosphere microorganisms provision the plant with water and nutrients. Agronomic practices that enhance the root-microbial associations, thereby en enhancing the water and nutrient uptake functions, will be discussed. This may inform the development of drought-resistant crops and cropping systems, to maintain or improve yields in water- and nutrient-limited environments.

Role of Extremophilic Fungi in Climate Change Challenges

Dr. Imran Ali, Distinguished Associate Professor, Department of Bioengineering, College of Life Sciences and Agri-Forestry, Southwest University of Science and Technology, Mianyang, China
E-mail: ali.i@swust.edu.cn
Cell: +86-13088107801

Abstract
One of the most difficult issues confronting humanity in the twenty-first century is climate change and the ensuing environmental degradation. The causes of climate change are complex and stem from human activity, which raises greenhouse gas levels in the atmosphere and causes weather drifts and global warming. Extremophilic fungi have great potential to mitigate the effects of climate change because of their remarkable ability to survive in extreme environments. This review sheds light on the possible uses of extremophilic fungi in mitigation plans for climate change. They can safely store carbon and lessen its release into the atmosphere as harmful greenhouse gases by metabolizing organic biomass and breaking down carbon compounds. Additionally, they have extremozymes that degrade resistant organic species, such as hydrocarbons and lignocellulosic biomass. These extremophilic fungi are equipped with enzymatic machinery to carry out the bioremediation of contaminated environments. Additionally, a variety of biological interventions, including biofuels, bioplastics, and other bioprocessing applications, can be made using extremophilic fungi. These fungi, however, represent an important but underutilized resource in the toolbox of climate change mitigation techniques.

Keywords: Exthermophil fungi, hydrocarbons, legnocellulosic biomass

Phosphorus and *Serendipita indica* synergism augments arsenic stress tolerance in rice by regulating secondary metabolism related enzymatic activity and root metabolic patterns

Syed Shujaat Ali Zaidi
University of Texas, MD Anderson
E-mail: sazaidi@mdanderson.org

Abstract

The multifarious problems created by arsenic (As), for collective environment and human health, serve a cogent case for searching integrative agricultural approaches to attain food security. Rice (*Oryza sativa* L.) acts as a sponge for heavy metal(loid)s accretion, specifically As, due to anaerobic flooded growth conditions facilitating its uptake. Acclaimed for their positive impact on plant growth, development and phosphorus (P) nutrition, 'mycorrhizas' are able to promote stress tolerance. Albeit, the metabolic alterations underlying *Serendipita indica* (*S. indica*; *S.i*) symbiosis-mediated amelioration of As stress along with nutritional management of P are still understudied. By using biochemical, RT-qPCR and LC-MS/MS based untargeted metabolomics approach, rice roots of ZZY-1 and GD-6 colonized by *S. indica*, which were later treated with As (10 µM) and P (50 µM), were compared with non-colonized roots under the same treatments with a set of control plants. The responses of secondary metabolism related enzymes, especially polyphenol oxidase (PPO) activities in the foliage of ZZY-1 and GD-6 were enhanced 8.5 and 12-fold, respectively, compared to their respective control counterparts. The current study identified 360 cationic and 287 anionic metabolites in rice roots, and the commonly enriched pathway annotated by Kyoto Encyclopedia of Genes and Genomes (KEGG) analysis was biosynthesis of phenylalanine, tyrosine and tryptophan, which validated the results of biochemical and gene expression analyses associated with secondary metabolic enzymes. Particularly under As+*S.i*+P comparison, both genotypes exhibited an upregulation of key detoxification and defense related metabolites, including fumaric acid, L-malic acid, choline, 3,4-dihydroxybenzoic acid, to name a few. The results of this study provided the novel insights into the promising role of exogenous P and *S. indica* in alleviating As stress.

Keywords: Nutrient-microorganism synergism, *Serendipita indica*, arsenic stress, rice

Enhancing Tropical Livestock Productivity and Reducing Emissions through Silvopastoral Systems

Haruna Gado Yakubu[1], Stephen Batsa Ami-Teye[1], Emmanuel Korang Appiah[1], Cornelius Urakpa[1], Mwantor Adams[1]
[1]Department of Animal Science, School of Agriculture, University of Cape Coast, Cape Coast, Ghana
E-mail: haruna.gado@ucc.edu.gh; Tel: +233244528735

Abstract
Tropical livestock production faces increasing pressure to reduce greenhouse gas (GHG) emissions while maintaining productivity and supporting rural livelihoods. Uncontrolled grazing systems often contribute to deforestation, soil degradation, and methane emissions, intensifying climate change impacts within the tropics. This paper evaluates silvopastoral livestock systems (SPS) as a climate mitigation strategy in tropical animal production systems, examining their potential to reduce emissions, enhance carbon sequestration, and improve overall system resilience. A synthesis of recent empirical studies (2020-2025) was conducted to assess the environmental and productive performance of SPS compared to conventional pasture-based systems. Key indicators reviewed include soil organic carbon sequestration potential, enteric methane emissions reduction potential, forage productivity, animal performance, and biodiversity outcomes. Evidence indicates that integrating trees, shrubs, and improved forages into livestock grazing systems significantly enhanced carbon sequestration in both biomass and soils. SPS can reduce enteric methane emissions intensity through improved pasture quality and increased animal productivity. Additionally, tree cover moderates microclimatic conditions, improves soil fertility through nutrient cycling, and reduces erosion. These ecological benefits are often accompanied by improved weight gain or milk yield, and diversified farm income streams. Silvopastoral systems represent a viable climate mitigation and adaptation pathway for tropical livestock production. By simultaneously increasing carbon sinks, lowering emissions intensity, and improving productivity, SPS offer a scalable, nature-based solution aligned with sustainable development and climate goals. Policy support, technical capacity building, and context-specific design are critical to accelerating adoption.

Keywords: Greenhouse gas emissions, silvapastoral system, livestock production

Biofilm Forming Bacteria in Drinking Water System and Their Control

Dr. Ali Akbar
Faculty of Allied Health Sciences University of Swat, Charbagh Swat Khyber Pakhtunkhwa Pakistan
E-mail: aliakbar.uob@gmail.com

Abstract

Different bacterial groups have the potential to form biofilm over the hard surfaces, particularly in aqueous environment. The biofilm helps them enhance their survival and act in a synchronized way to respond to any undesirable situation for the bacterial communities. Presence of biofilm forming bacteria can potentially harsh the conditions in clinical and sterile sittings. A study has been conducted to isolate and identify the biofilm form bacterial communities in the drinking water supply system in Quetta Balochistan. The isolates were challenged with the presence of antibiotic gentamicin and ciprofloxacin in this study. Samples (n=100) of drinking water were collected from ten different locations of distribution pipelines from Quetta citym and were subjected to analysis. *E. coli* (25%), *S. aureus* (9%), *Klebsiella pneumoniae* (13%), *Shigella dysentery* (10%), *Salmonella typhi* (12%), *Enterobacter aerogenes* (4%), *Candida albicans* (2%), *Staphylococcus lentus* (4%), *Pseudomonas oryzihabitans* (13%) and *Staphylococcus hemolyticus* (8%) were initially isolated and conformed. The isolates were evaluated for biofilm formation through slide dip and microtiter plate methods, where all the isolates were found positive for biofilm formation potential, except three (*S. lentus, S. hemolyticus, C. albicans*). MIC and MBC of gentamicin and ciprofloxacin against selected bacteria were determined through tube dilution method; the isolates were challenged for biofilm formation in the presence of gentamicin and ciprofloxacin MIC, and the processed for microscopic assay using compound and Scanning electron microscopy. The antibiotic was found active against the biofilm formation and can be used in close water circulation system for the cleaning of complex machinery in industries to avoid environmental exposure of the antibiotic.

Keywords: Microorganism, food safety, drug resistance, Pathogens, water quality

Tarnab Rehbar: A Climate-Resilient, Zinc-Biofortified and Rust-Resistant Bread Wheat Variety for Sustainable Wheat Production in the Drylands of Khyber Pakhtunkhwa, Pakistan

Iltaf Ullah[1] and Hidayat Ullah[2,*]
[1]Agriculture Research Institute (ARI), Tarnab, Peshawar-Khyber Pakhtunkhwa, Pakistan
[2]Department of Agriculture, Faculty of Sciences, The University of Swabi, Anbar-23561, Swabi, Khyber Pakhtunkhwa, Pakistan
E-mail: drhidayat@uoswabi.edu.pk; Phone: 03339196096

Abstract

Sustainable wheat production in dryland and irrigated agro-ecosystems is increasingly threatened by climate variability, nutrient deficiencies, and the emergence of devastating wheat rust diseases. Developing climate-resilient and nutritionally enriched wheat varieties is therefore essential for ensuring food security, environmental sustainability, and improved human health. In response to these challenges, the Agriculture Research Institute (ARI), Tarnab, Peshawar in collaboration with breeder from the University of Swabi developed and released a new bread wheat variety, Tarnab Rehbar (varietal code TRB-2-103), for late-sown and irrigated areas of Khyber Pakhtunkhwa. Tarnab Rehbar demonstrated superior grain yield performance compared with the check variety Pirsabak-15, producing 27.3% and 10.8% higher yields in preliminary (2017-2018) and regular yield trials (2018-2019), respectively. The variety further exhibited stable performance and broad adaptability during outstation yield trials conducted across 14 locations in Khyber Pakhtunkhwa (2019-2020) and 31 and 40 locations nationwide during 2020-2021 and 2021-2022, respectively. Simultaneously, agronomic field evaluations and grain quality analyses confirmed its desirable production and nutritional traits. Morphologically, Tarnab Rehbar possesses medium plant height, dark green foliage at booting stage, strong stems, well-developed peduncles, moderately awned spikes, and bold white grains with high thousand-grain weight. The variety also exhibited enhanced protein content, zinc biofortification potential, and durable resistance against major wheat rusts. DNA fingerprinting analysis differentiated Tarnab Rehbar from 21 previously registered wheat varieties, confirming its distinct genetic background. Based on its consistent yield performance, disease resistance, nutritional quality, and adaptability under diverse environments, Tarnab Rehbar was approved by the Provincial Seed Council in 2023 for commercial cultivation in the late and irrigated areas of Khyber Pakhtunkhwa. The adoption of this variety can contribute significantly to sustainable dryland agriculture by reducing fungicide dependence, minimizing environmental contamination, improving nutritional security through zinc enrichment, and strengthening climate resilience in wheat-based production systems.

Keywords: Tarnab Rehbar, bread wheat, irrigated, dry lands, zinc bio-fortified, climate resilient, sustainable agriculture

Unlocking the Yield Potential of Hybrid Wheat under Limited Water Supply and Expanded Sowing Windows

Muhammad Arif[1] and Mehran Anjum[1]
[1]Department of Agronomy, the University of Agriculture, Peshawar
E-mail: marifkhan75@aup.edu.pk

Abstract

Wheat productivity in Pakistan remains substantially lower than that of many wheat-growing countries, primarily due to water scarcity, suboptimal agronomic practices, and limited availability of high-yielding and stress-tolerant cultivars. Hybrid wheat has emerged as a promising innovation to bridge this yield gap through superior yield potential, enhanced resource-use efficiency, and greater resilience to abiotic stresses. The present study evaluated the performance of Chinese hybrid wheat lines under varying sowing windows and irrigation regimes to optimize yield under semi-arid conditions of Peshawar, Pakistan. Field experiments were conducted during the 2018–19 and 2019–20 cropping seasons at the Agronomy Research Farm, Peshawar, using a split-plot RCBD with three replications. Four irrigation regimes (from single irrigation at tillering to four irrigations up to grain filling) were assigned to main plots, three sowing dates (15 November, 30 November, and 15 December) to sub-plots, and two hybrid wheat lines (18A-1 and 18A-2) along with a local check (Ghaneemat-e-IBGE) to sub-sub plots. Key phenological, yield, and quality parameters were recorded. Results revealed that hybrid wheat lines significantly outperformed the local check across all sowing dates and irrigation levels. Hybrid 18A-2 produced up to 77% higher grain yield, followed by 18A-1 with a 50% increase compared to the local cultivar. Early sowing (15 November) resulted in maximum grain and biological yields; however, hybrid lines maintained a comparatively stable yield even under delayed sowing, indicating their wider sowing adaptability. Irrigation at three critical growth stages (tillering, booting, and flowering) increased grain yield by 13%, while four irrigations further enhanced yield by 15% compared to single irrigation. The study concludes that hybrid wheat offers substantial potential for enhancing wheat productivity in Pakistan, particularly under limited irrigation and flexible sowing windows. Wider evaluation and large-scale adoption of hybrid wheat could play a pivotal role in ensuring national food security while optimizing water use.

Keywords: Hybrid wheat, yield potential, arid climatic conditions

From barren marginal lands to green farmlands - Plantation of olive grove in Balochistan as a potential solution to economic growth of farmers in a climate change scenario

By. Dr. Khair Muhammad Kakar
Technical Member-Chief Minister Inspection Team-CMIT. Government of Balochistan-Pakistan
E-mail: agrarian69@gmail.com

Abstract
In the prevailing scenario, where one part of the country is facing severe drought while 2nd part of the country is badly affected by flood. The climate change challenges are declared serious threats for agrarian and environment specialists. The coping patterns changed at alarming rate. While, the overall environment for survival of both flora and fauna resulted a great question mark for custodians of the sector concerned. Keeping the importance of above facts and figures. Diversification towards sustainable dryland management in affected areas has been addressed properly plus wisely by the custodians of the sector concerned through low delta, high commercial value, market oriented, demand driven, environment friendly Horticulture commodity with high efficiency irrigation system termed as "Olive". High commercial value with less rather zero water requirements, environment friendly Horticulture commodity known as olive entirely changed the landscape of the targeted areas in the region. More commercial value of the diversified Horticulture commodity is that none of plant has been grown on regular agricultural land but it has been successfully grown with efficient irrigation system on entirely" Marganalised Land". Throughput the region. Now, through several research techniques/ Trials, new innovations are being carried out at farmers field. The most important are:
A: innovation of olive oil extraction machine termed as expeller through reverse engineering and cost of one expeller is Rs:22 crore. Whereas, through reverse engineering the innovative one is with cost of Rs, 30 lac only.
B: The olive plant could be grown in three years in normal nursery condition. Whereas, through "Warm Bench". It could be grown only on three months.
C: The olive plants can produce fruit after plantation of 6 to 7 years. Whereas, the innovative one can give fruit after just plantation.
Similarly, certain innovations are under trial and very soon the region would be entertained through receiving of olive carbon credits.

Keywords: Olive groves, soil carbon sequestration, marginal lands

Use of Biochar Amendments for Improving Phosphorus Availability in alkaline calcareous soils

Prof. Dr. Khalid Saifullah Khan
Institute of Soil & Environmental Sciences, PMAS Arid Agriculture University Rawalpindi, Pakistan
E-mail: khalidsaifullah@uaar.edu.pk

Abstract

The bioavailable form of phosphorus (P) is deficient in nearly 30-40% of the world's agricultural soils adversely affecting soil ecosystem functioning and crop yield. Biochar is considered as a potential soil amendment to improve soil conditions and nutrients availability. Feedstock type and pyrolysis temperature are the key factors controlling biochar properties. These properties may influence P sorption-desorption in soil thereby affecting P bioavailability. Limited information is available about the impact of biochar types on P transformations and availability in alkaline calcareous soils. This presentation focuses on P sorption-desorption behavior of the biochars prepared from different feedstocks at two different pyrolysis temperatures, i.e., plant-based biochars, and animal-based biochars prepared at 400 °C and 600 °C. Results depicted that the pyrolysis temperature decreased surface functional groups, specific surface area, CEC, volatile matter, yield, and total organic C of the biochars, but increased pH, fixed C, and nutrient content. Manure-based biochars (FMB and PMB) had higher functional groups, yield, ash content, pH, and nutrients but lower surface area than plant-based biochars. Biochars at 400 °C had higher P binding energy, leading to 2-25% more P sorption than at 600 °C. High-temperature biochars (600 °C) increased P desorption by 16%. Manure-based biochars showed 25% more P sorption and 13% more desorption than plant-based biochars. Biochars also significantly increased microbial biomass P (MBP), alkaline phosphatase activity (APA), and dehydrogenase activity (DHA) in soil. Bioavailable P fractions were higher in all biochar-amended soils. With time, the exchangeable-P and Al/Fe-P fractions decreased while the Ca-P and residual-P increased. The exchangeable P was 9% higher in soils amended with biochars at 400 °C than at 600 °C. The biochars exerted significant positive impact on microbial biomass P and enzyme activities in soil, which are critical for P redistribution in soil. Overall, the biochar can be a promising soil amendment for improving P availability in soil under alkaline calcareous conditions.

Keywords: Biochar, soil soluble phosphorus, calcareous alkaline soil

Innovative Climate-Smart Floriculture for Sustainable Agriculture and Livelihoods in Khyber Pakhtunkhwa

Dr. Masood Ahmad
Department of Horticulture the University of Agriculture Peshawar
E-mail: masoodhort@aup.edu.pk

Abstract
Khyber Pakhtunkhwa (KP), with its diverse agro-ecological zones from tropical to temperate, offers significant potential for climate-smart floriculture. Traditionally overlooked in favor of fruits and vegetables, floriculture is emerging as a resilient and sustainable sub-sector that supports income diversification, rural employment, and responsible land use. This paper explores innovative approaches, including off-season flower production in protected structures, cultivation of climate-resilient varieties, and water-efficient management, that enhance productivity while conserving natural resources. It also highlights value addition strategies such as floral arrangements, dried flower products, essential oil extraction, and post-harvest management to reduce losses and extend vase life. Key areas of focus include nursery development, seed and bulb production, propagation of commercially important ornamental plants, and storage technologies that strengthen sustainable production systems. By integrating floriculture into climate-smart agricultural models, this sector can indirectly support food security through livelihood resilience and foster green entrepreneurship, particularly for youth and women in rural and urban communities.

Keywords: Climate smart, floriculture, sustainable agriculture

FAO Balochistan and Dryland Plant Science: A Pathway to Sustainable Agriculture and Biodiversity

Dr Muhammad Azam Kakar
Food & Agriculture Organization (FAO) Pakistan
E-mail: muhammad.kakar@fao.org

Abstract

Balochistan's arid and semi-arid landscapes face growing challenges from climate change, land degradation, water scarcity, and biodiversity loss, threatening agricultural productivity and rural livelihoods. FAO Balochistan and Dryland Plant Science: A Pathway to Sustainable Agriculture and Biodiversity represents a strategic initiative to address these challenges through integrated and sustainable approaches. The program applies dryland plant science, climate-smart agriculture, and sustainable land and water management practices to restore degraded ecosystems, conserve native plant species, and strengthen agricultural resilience. Core interventions include rangeland rehabilitation, improved dryland cropping systems, conservation of indigenous biodiversity, and capacity development for local institutions and communities. By combining scientific innovation with traditional knowledge and evidence-based planning, the initiative enhances food security, ecosystem services, and adaptive capacity to climate variability. This FAO-led approach contributes to long-term sustainable development in Balochistan, aligning with national priorities and global sustainable development goals.

Keywords: Dryland Plant Science, Sustainable Agriculture, Biodiversity Conservation, Climate Resilience, FAO Balochistan

Community-based breeding program related to Pakistan

Dr. Muhammad Islam
International Center for Agricultural Research in Dry Areas (ICARDA), Islamabad, Pakistan
E-mail: mu.islam447@gmail.com

Abstract

Community-Based Breeding Programs (CBBPs) are a farmer-led approach to improving the genetic potential of small ruminants, particularly goats and sheep. Unlike conventional breeding schemes that rely on centralized stations and high investment, CBBPs are designed to work directly with rural communities. Farmers themselves define breeding goals, select superior animals, and manage cooperatives. This participatory model ensures that genetic improvement is not only technically sound but also socially acceptable and sustainable. By combining modern genetic evaluation tools with traditional knowledge, CBBPs create a balance between science and community ownership, making them highly relevant for Pakistan's livestock sector. The concept of CBBPs was first developed in Ethiopia in the early 2000s, where ICARDA and partners introduced the model after conventional breeding programs failed to deliver results for resource-poor farmers. Ethiopia later adopted CBBPs as a national strategy, and the approach was successfully replicated in Bolivia, Mexico, and Peru. In Pakistan, CBBPs were formally introduced in 2025 through ICARDA's collaboration with the Australian Centre for International Agricultural Research (ACIAR), Pakistan Agricultural Research Council (PARC), Sindh Agriculture University (Tandojam), Punjab Livestock Department, and Shaheed Benazir Bhutto University of Veterinary & Animal Sciences (Sakrand). Pilot programs were launched in Sindh and Punjab, focusing on goats due to their economic importance and adaptability to diverse agro-ecological zones. The objectives of CBBPs in Pakistan are clear and multifaceted. They aim to improve indigenous breeds through systematic sire selection and genetic evaluation, empower farmers through cooperatives and collective decision-making, and prevent inbreeding by rotating and replacing sires. They also integrate feeding, health, and market interventions so that genetic progress translates into tangible benefits. Capacity building of farmers, enumerators, and extension agents is another key objective, alongside ensuring sustainability and scalability across Pakistan's diverse agro-ecological zones. These objectives align with national priorities for agricultural development, poverty reduction, and climate resilience. Implementation of CBBPs in Pakistan follows a structured process. Sites and breeds are selected based on community needs and production potential. Awareness campaigns and consultations are conducted to secure farmer participation and ownership. Informal cooperatives are formed, which later evolve into formal producer organizations. Enumerators are recruited from within communities to manage animal identification, pedigree recording, and performance monitoring. Certified sires are procured, validated through genetic evaluation, and allocated to cooperatives. Sire rotation and replacement strategies are enforced to maintain genetic diversity. Integration with feeding, health, and market interventions ensures that genetic gains are supported by better management practices. Farmer selection is based on willingness to participate, ability to manage breeding animals, and commitment to cooperative principles. Farmers must agree to follow program guidelines, including sire management, culling practices, and record-keeping. Gender-inclusive participation is encouraged, recognizing the role of women in small ruminant management. Farmers are also expected to contribute financially or in-kind to cooperative activities, ensuring sustainability. Selection favors households with breeding females, as they form the foundation of mating groups and cooperative structures. Animal selection is guided by breeding objectives and community preferences. Superior sires are chosen based on estimated breeding values, pedigree records, and performance traits such as growth rate, reproductive efficiency, and milk yield. Morphological traits, including coat color and body conformation, are also considered to align with community preferences. Non-selected males are castrated or isolated to prevent uncontrolled breeding. Replacement strategies ensure continuous improvement, with promising lambs or kids selected to replace older or defective animals. Certification of sires validates their genetic merit and suitability for breeding, ensuring transparency and trust among farmers.

Keywords: Community-based breeding program (CBBP), livestock production, capacity building

Climate-Smart Hydro Solutions for Water-Productive and Resilient Dryland Agriculture in Balochistan

Dr Saima Hashim
E-mail: saimahashim@gmail.com

Abstract

Balochistan receives highly variable annual rainfall (30–350 mm), with a recent province-wide assessment identifying 10,180 natural springs concentrated in middle mountain zones (0.11 springs/km²) – a significant untapped resource for climate-resilient water management. Groundwater is critically over-exploited; districts such as Quetta rely solely on groundwater for drinking and irrigation, yet natural recharge remains insufficient despite monsoon flooding. Under RCP 8.5, Pakistan's heatwave-exposed population is projected to increase by 36% by 2050, with Balochistan already recording temperatures 4–7°C above normal. A World Bank case study (2020) documented that of approximately 3,000 traditional karez systems in Balochistan in 1970, only one-third remain functional due to groundwater depletion and recurrent droughts. However, recent rehabilitation efforts demonstrate potential: the karez at Chashma Achozai now serves over 3,000 residents across approximately 500 acres. A 2023 study of 1,080 wheat farmers in Balochistan further demonstrated that solar-powered irrigation significantly increases technical efficiency compared to diesel pumps ($p < 0.01$). Genotype evaluations identified Punjab-2024 as a high-performing rainfed variety (grain yield 520 g/m²), while the local Balochistan-2020 showed lowest adaptability – indicating substantial potential for varietal improvement. Climate-smart implementation requires integration of modern technology and data-driven analysis, including remote sensing for groundwater monitoring, AI-based seasonal forecasting, soil moisture sensors for precision irrigation, and GIS-based springshed management – enabling real-time decision-making beyond conventional static planning. Documented interventions with proven impact include nature-based solutions (NbS) such as percolation pits (Zai pits) demonstrated in farmer field schools, alongside hard engineering solutions including government-piloted recharge wells that have conserved over 10 million gallons of water from approximately 50 wells in less than one year, FAO-implemented 99 climate-adaptive animal shelters with rooftop water harvesting, and trickle irrigation for high-value crops such as onions – improving both water productivity and household income. Nationally, women constitute 67.9% of the agricultural workforce (Labour Force Survey 2020-21). In Balochistan, approximately 70% of the female labour force is engaged in agriculture, despite rural female literacy rates of only 1.75% – highlighting a critical entry point for gender-responsive interventions that must include digital literacy and access to agro-advisory data.This paper synthesizes these findings into an integrated framework combining modern technologies (solar irrigation, drought-tolerant varieties, recharge wells, remote sensing, AI forecasting) with nature-based solutions (springs management, karez restoration, percolation pits, native tree planting) and community-based governance. The framework contributes to SDG 2 (zero hunger), SDG 6 (clean water), SDG 13 (climate action), and SDG 15 (life on land).

Keywords: Climate-smart agriculture; on-farm water management; solar-powered irrigation; groundwater recharge; nature-based solutions; Balochistan

Medicinal and Aromatic Plants for Dryland Farming Systems in Balochistan

Sarfraz Ahmad[1], Muhammad Islam[2] and Nadeem Sadiq[3]
E-mail: s_ahmadazrc@yahoo.com

1. Ex-Member Natural Resources, PARC, Islamabad
2. Ex-Director Rangeland Management and Forestry, PARC, Islamabad
3. Director General, Balochistan Agricultural Research & Development Centre, Quetta

Abstract

The demand of medicinal and aromatic plants is increasing both in developed and developing countries. Most of the raw materials of medicinal plants are collected from forests and rangelands and few medicinal plants are cultivated. Deforestation, over-exploitation, overgrazing, and conversion of natural habitats to agricultural fields resulted scarcity of medicinal plants. About 6000 plant species have been reported in Pakistan and among these about 3200 species have medicinal uses in Unani, allopathic, and homeopathic medicines and 300 species are used in traditional medicines. However, the cultivation potential of few species is exploited and 90% of the country's medicinal herb requirement is imported. Trade in medicinal herbs is growing in volume and in exports. Efforts are required to increase the production in Pakistan by observing the WHO guidelines of good agricultural, collection and processing practices. Balochistan has diverse flora of medicinal plants. In Balochistan, various medicinal plants are being collected and sold in the local market. However, very limited knowledge is available on the multi-purpose herbs which can be cultivated and utilized for different purposes. Research studies showed that medicinal and aromatic plants can be cultivated in various agro-ecologies of Balochistan for commercial scale production and marketing. The suitable species can be classified into four main groups: culinary herbs, medicinal herbs, perfumery herbs, and herbal teas. Germplasm of (*Cuminum cyminum, Nigella stavia, Foeniculum vulgare, Linum usitatissimum, Anethem sowa, Carum copticum*) was evaluated for various growth parameters and yield potential in Balochistan. Based on adaptability and yield potential all these medicinal plants can be grown both in highlands and plains areas of Balochistan. These crops required less water as compared with other irrigated crops. In rainfed condition the seed yield of cumin ranged from 500-600 kg/ha. The Fennel seed yield ranged from 1500 to 2000 kg/ha and the Kalonji seed yield ranged from 800 to 1000 kg/ha. Thyme, Oregano, Rosemary, Marjoram, Tarragon are common perennial culinary herbs. Production potential of these herbs was evaluated in various trials and results are very encouraging. These herbs can successfully be grown in highlands of Balochistan. Two to three cuttings of leaves can be obtained before the start of winter season. English Thyme and German Chamomile are the two most common herbal teas in many parts of the world. German chamomile has shown excellent production potential. The fresh flower production of German Chamomile under rainfed conditions was recorded 1500 kg/ha with 10 days flower picking intervals. In irrigated conditions the fresh flower production ranged from 4000-6000 kg/ha. Thyme, French Lavender, English Lavender, Hyssop, German Chamomile, Marjoram, Anise, Chicory, Yarrow, Rosemary, Lemon Balm, Comfrey, Saffron, Oregano and Ispaghol can successfully be grown in Balochistan. However, better marketing and prices may encourage the farmers to grow these medicinal plants.

Keywords: Medicinal herbs, herbal industry, arid climate

Theme 1

Plant Physiology, Pathology, Biotechnology and Nano Biotechnology

Systematic Profiling of Conserved microRNAs in *Zea mays*: Functional Targets and Experimental Validation via RT-PCR

Abdul Baqi[1,2], Samiullah[2], Naqeebullah Khan[2] & Attiq-Ur-Rehman[2]

[1]Colleges, Higher and Technical Education Department, Balochistan, Quetta-87300, Pakistan
[2]Department of Chemistry, University of Balochistan, Quetta-87300, Pakistan
E-mail: arkakar10@gmail.com

Abstract

MicroRNAs (miRNAs) are small, endogenous, non-coding RNA molecules, typically 18–26 nucleotides in length, that regulate gene expression at the post-transcriptional level through mRNA degradation or translational repression. These molecules are evolutionarily conserved and play a crucial role in identifying and predicting novel miRNAs across various plant species. Maize (*Zea mays*), one of the world's most important food and forage crops, has been extensively studied to understand the functional significance of miRNAs in plant growth and stress responses. In the present study, a total of 66 conserved miRNAs belonging to 65 distinct miRNA families were identified in maize using multiple genomics-based approaches. These predicted miRNAs were subsequently validated through RT-PCR using randomly selected primers. Furthermore, target prediction analysis using the psRNA Target tool revealed 10,294 unique protein targets associated with these miRNAs. Functional annotation of these targets indicated their involvement in 55 Gene Ontology (GO) categories, encompassing key biological processes, cellular components, and molecular functions. Notably, several newly identified maize miRNAs were found to regulate critical physiological processes. For instance, zma-miR6224a is implicated in reproductive functions, while zma-miR11339, zma-miR2922, and zma-miR6253 are associated with ageing, chemotaxis, and karyogamy, respectively. Additionally, certain miRNAs such as zma-miR1439 and zma-miR9774 are predicted to inhibit the activity of voltage-gated ion channels and carbon–sulphur lyase enzymes, respectively. Overall, the identification and functional characterization of these novel maize miRNAs highlight their significant regulatory roles in diverse genetic and physiological pathways. These findings provide valuable insights into the molecular mechanisms underlying maize development and stress adaptation, thereby offering potential strategies for enhancing crop productivity and resilience.

Keywords: Conserved microRNAs, *Zea mays*, chemotaxis, karyogamy, gene ontology

Exploring the Hidden World of miRNAs - Identification and Characterization of Evolutionary Conserved Muskmelon Non-coding miRNAs and Their Target Proteins

Abdul Ghaffar, Naqeebullah Khan, Samiullah, Irshad Ali and Attiq ur Rehman
Department of Chemistry, University of Balochistan
E-mail: arkakar10@gmail.com

Abstract
The miRNAs are small, endogenously encoded RNAs, containing 18 to 26 nucleotides which have the ability to control gene expression post-transcriptionally, either through translational inhibition or through endonucleolytic degradation of target mRNA. Muskmelon is one of the most frequently cultivated fruit crops of the Cucurbitaceae family. Although of great significance, only 120 miRNAs belonging to various families are reported in muskmelon till date. 40 novel noncoding miRNAs predicted in muskmelon, through operating several genomic tools. For obtaining the precursor as well as mature sequences of muskmelon miRNAs, microRNA registry database was used and analyzed through the basic local alignment search tool (BLASTn). After removal of all non-coding regions, the remaining sequences were subjected to analysis with the help of MFOLD for designing secondary structure of newly predicted muskmelon miRNAs. Further validation of newly predicted muskmelon miRNAs was done through five randomly selected primers for RT-PCR. GO analysis revealed 89 target genes related to the newly predicted muskmelon miRNAs. Genes coding for transcription factors also have an important role to play in the growth and development of plants. Furthermore, the miR4249 is seen to target the same set of genes in muskmelon plants that have been associated with cell communication and transcription factors. These target genes are essential for various biological functions such as plant growth, development, metabolism, aging, pathogen resistance, and resistance to environmental stressors such as salinity, cold, and oxidative stress. Hence, the results from this research indicate that this technique not only ensures high-quality produce but also increases production levels.

Keywords: Muskmelon, non-coding miRNAs, MFOLD, GO analysis, Cucurbitaceae

Effects of Light Regime and Selenium Nanoparticles on Antioxidant and Hypoglycemic Potential in *in-vitro* grown *Caralluma tuberculata*

Amir Ali, Zia-ur-Rehman Mashwani
Department of Botany, PMAS Arid Agriculture University, Rawalpindi
Email: mashwani@uaar.edu.pk

Abstract

In vitro plant cultures have emerged as a viable source of biomass enriched with potent secondary metabolites, holding significant promise for medicinal applications. This study aimed to explore the antioxidative and hypoglycemic potential of selenium nanoparticles (SeNPs) and light stressed mediated in vitro cultures of *Caralluma tuberculata* callus extract. The morphological and physicochemical features of biogenic selenium nanoparticles were evaluated by UV–Visible spectrophotometry, Scanning Electron Microscopy, Energy Dispersive X-rays, Fourier-transform infrared spectrometry, and Zeta Potential. The development of optimal callus was achieved through a two-week incubation in a dark environment and shifted to normal condition by using Murashige and Skoog (MS) media supplemented with 100 µg/L of Selenium NPs, along with 0.5 mg/L of 2,4-Dichlorophenoxyacetic acid and 0.5 mg/L of 6-Benzyladenine, resulting in maximum biomass production at 56 days. This well-developed callus, rich in secondary metabolites, was selected to evaluate its antioxidative and hypoglycemic properties. The antioxidative potential of the callus extract was assessed through various tests, including ABTS+ scavenging, hydrogen peroxide inhibition, hydroxyl radical scavenging, and reducing power. Likewise, the hypoglycemic capacity of the callus extract was probed through assays involving alpha-amylase, alpha-glucosidase, glucose absorption by yeast cells, anti-sucrase, and anti-lipase activities. Notably, concentrations of 200 and 800 µg/ml exhibited pronounced efficacy in mitigating radical species. To delve into the hypoglycemic effects of the callus extract, assessments involving alpha amylase, alpha-glucosidase, and glucose absorption by yeast cells were performed across varying glucose concentrations (5 mmol/L, 10 mmol/L, and 25 mmol/L). The outcomes consistently demonstrated a dose-dependent relationship, with higher concentrations of the callus extract exerting potent inhibitory effects on the catalytic sites of the enzymes. The findings of this study propose a mechanism wherein selenium nanoparticles and light stressed mediated in vitro callus cultures of C. tuberculata potentially interact with charged species, operating as competitive inhibitors. This interaction retards the enzyme-substrate reaction, thereby impeding enzymatic degradation. These noteworthy outcomes hold promising implications for future medical applications of extract derived from callus cultures under the nanoparticles and light stressed condition.

Key words: *Caralluma tuberculata*, antidiabetic, antioxidant, Selenium nanoparticle

Current Nanotechnology Scenario in Biomedical Sciences, Genomics, and Regenerative Medicine

Arifa Ghafoor, Hasnain Raza and Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: nainsomro2019@gmail.com

Abstract

Nanotechnology is revolutionizing biomedical science, enabling accurate diagnosis, targeted drug delivery, effective treatment and regenerative medicine. Multifunctional Nano carrier have increased the precision of treatment and reduced toxicities. In genomics, Nano pore technology has enabled real-time sequencing of DNA and RNA. Personalized medicine is now benefiting from nanoparticles-based therapies that are tailored to an individual's genetics profile. Lipid nanoparticle systems have also improved the accuracy of CRISPR (Clustered Regularly Interspace Palindromic Repeats) in gene editing. Wearable Nano sensors in the medicine enable continuous health monitoring. Furthermore, Nano composite scaffolds aid in tissue repair. AI-based nanomedicine, nanorobotics, nanovaccinology and green bionanotechnology highlight recent innovations. Overall, nanotechnology has shown immense potential to improve modern healthcare and medicine.

Key words: Nanotechnology, Nanoparticles, Nanosensing, Nanomedicine, Nanovaccinology

Alleviatory Effects of PGRs (Plant Growth Regulators) Priming on Cobalt-Induced Stress in Lentil Variety

Faisal Khan, Kanval Shaukat, Abdul Samad, Tauqeer Ahmed, Noor Ahmed, Muhammad Siraj, Ali Ahmed, Tariq Ismail
Department of Botany, University of Balochistan
E-mail: kanval_shaukat777@yahoo.com

Abstract

Cobalt is a heavy metal that negatively influences plant growth and development. It interrupts many physiological and biochemical processes that are important for normal plant functioning. A pot experiment was conducted at Department of Botany, University of Balochistan Quetta to evaluate the impact of plant growth regulators (PGRs) i.e., Salicylic acid (SA), Moringa leaf extract (MLE) and Thiourea (TU) on the morphophysiological attributes of lentil *var.*, Black Panjgur under Cobalt stress (30µM). Before sowing seeds were primed with SA (250µM), MLE (10%) and TU (10µM). The design of the experiment was completely randomized design with three replications. After 15 days of seed germination cobalt stress was applied in comparison to control. After one week of cobalt stress plant was harvested for various morphological and physiological attributes. Data revealed that cobalt caused a noticeable reduction in all morphophysiological attributes of lentil seedling. However, primed seedlings had improved plant growth and all physio-biochemical attributes validating that priming helped plants to withstand the stress more efficiently. MLE outperformed in comparison to other PGRs in improving seedling growth, photosynthetic pigments and biochemical attributes. Thus the study suggests that priming with PGRs is an effective strategy for mitigating cobalt stress thereby enhancing tolerance potential of lentil in contaminated soils. Further research is required to explore tolerance potential of lentil at molecular level and comparing and identifying the best variety that can withstand cobalt toxicity.

Keywords: Cobalt toxicity, Seed priming, *Lens culinaris*, PGRs

Elderberry-Based Nanostructures: Physicochemical Properties, Biological Activities, and Biomedical Applications - A Systematic Review

Fareeha Goher[1], Wajiha Hasan[2*], Khizra Sohail[1], Muhammad Anas Awan[3], Muhammad Irfan Iqbal[4]

[1]Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Karachi, 75270 Karachi, Pakistan.

[2]Department of Biotechnology, Ziauddin University, Karachi, 75000, Pakistan.

[3]Department of Pharmacy, Hamdard University, Karachi, 74600, Pakistan

[4]Faculty of Pharmacy, University of Karachi, 75270 Karachi, Pakistan.

E-mail: wajiha.22026@zu.edu.pk, wajihahasan00@gmail.com

Abstract

Plant-based nanoparticle delivery systems have attained profound attention for their ability to potentiate stability, efficacy, and bioavailability. This systematic review focused on recent advancements in the synthesis of nanoparticles from Sambucus species (elderberry), specifically Sambucus ebulus and Sambucus nigra, and assessed their biological activities and physicochemical properties. Eleven studies in total satisfied the inclusion criteria, with most publications appearing after 2014, reflecting a growing interest in elderberry-mediated nanomaterials. The provided review highlighted the synthesis of a wide variety of nanosystems, including gold nanoparticles (AuNPs), silver nanoparticles (AgNPs), poly (lactide-co-glycolide) (PLGA) nanoparticles, phospholipid nanoparticles, nanophytosomes, and gelatin nanofibers. Characterization techniques such as UV–Vis spectroscopy, scanning and transmission electron microscopy (SEM/TEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and zeta potential results confirmed the successful formation of nanoparticles having approximately 4 to 108 nm size range with a predominantly spherical shape. Surface plasmon resonance peaks typically appeared between 412–480 nm for AgNPs and around 526 nm for AuNPs, whereas negative zeta potential values suggested favorable colloidal stability. Elderberry-mediated nanoparticles exhibited diverse biological activities, including antimicrobial properties against multidrug-resistant pathogens, profound antioxidant capacity, enzyme inhibition (collagenase, elastase, tyrosinase, and acetylcholinesterase), anti-inflammatory effects by lowering cytokines such as IL-6 and TNF-α, and cytotoxic effects against certain cell lines while maintaining safety toward healthy cells. Other applications included photocatalytic dye degradation, biosensing, and enhanced mitochondrial and metabolic control. In conclusion, *Sambucus*-based nanomaterials possessed profound physicochemical stability and multifunctional bioactivities, indicating promising potential for biomedical, pharmaceutical, and environmental applications. However, further in vivo investigations and clinical studies are required to confirm their safety and therapeutic effectiveness.

Keywords: Nanostructures, Nano formulations, Elderberry, Sambucus, TMPRSS2

Comparative Phenolic Profiling of S*esamum indicum* Seed Oils from Ten Varieties of Pakistan

Faryal Yusuf, Ayeesha Masood
Department of Botany, University of Balochistan
Email: ayeeshamasood@gmail.com

Abstract

This study evaluated the proximate composition and total phenolic content (TPC) of ten sesame (*Sesamum indicum L.*) seed varieties to assess their nutritional and biochemical diversity. Parameters analyzed included ash, crude fiber, crude protein, moisture, and oil content. Results revealed notable variation among the samples. Ash content ranged from 2% (S-17) to 7% (Niab-Pearl and TH-6), while crude fiber varied between 7% and 10% across varieties. Crude protein ranged from 12% (S-17) to 15% (Niab-Sesame, Niab-Pearl, and Black-Till), indicating moderate differences in protein levels. Moisture content showed pronounced variability, with the lowest in Niab-Sesame (3.01%) and the highest in TS-5 (25.90%). Oil content ranged from 37.66% (TH-6) to 51.01% (Till-18), highlighting Till-18 as the most oil-rich variety. The total phenolic content of sesame seed oils also differed significantly, varying from 0.23 mg GAE/100 mg (TS-3) to 6.06 mg GAE/100 mg (S-17). This indicates considerable diversity in antioxidant potential among the varieties. Overall, S-17, Local-White, and Till-18 demonstrated superior nutritional and bioactive profiles, suggesting their potential suitability for nutritional enrichment and industrial applications. The observed compositional differences underline genetic and environmental influences on sesame seed quality.

Keywords: *Sesamum indicum* L., phenolic profiling, antioxidant

ABA and Relevant Genes Downregulate the Hydraulic Conductivity Causing Stomatal closure and Reduce Pollen Viability and Yield in Two Cultivars of *Avena nuda* L.

Huma Batool[abc], Xiangwen Fang[b], Tayyaba Yasmina[a]
[a]COMSATS University, Islamabad, Pakistan
[b]Lanzhou University, Lanzhou, Gansu Province 730000, People's Republic of China.
[c]Sardar Bahadur Khan Women's University Quetta, Balochistan, Pakistan

Abstract

Oat is gaining recognition as an important nutritious food around the world. Naked oats is fetching more importance due to its health benefits for different diseases also. In the present study Dy7 which is a new variety and believed to be more drought tolerant as compared with Ym which is an old variety of oat, were tested for their terminal drought responses. The factors assessed were ψleaf, Kleaf, ABA leaf concentration was measured at different ψleaf and NCED which is the most important gene in biosynthesis of ABA in plastids was also measured by qPCR. The yield was recorded to be better in Dy7 as compared to Ym, pollen viability, and pollen germination tests also confirmed better terminal drought tolerance in Dy7. The greatest % germinated pollens recorded for WW Dy7 was 86 ± 2.65 while for Ym WW it was 81 ± 2.65 %. The % of germinated pollens decreased in both cultivars but Ym exhibited more predisposed to to drought and the pollen germination and viability % decreased greatly in WS Ym plants. Very similar pollen viability recorded in WW Dy7 plants which were 85 ± 2.65 % while 83 ± 2.65 % for WW Ym plants. The expression of NCED increased immediately in both the cultivars under water stress, the highest fold change at -3.5 MPa was 48 ± 0.15 and 33 ± 0.13 in Dy7 and Ym leaf samples respectively. However, ABA8′OH2 consistently exhibited an extremely low expression throughout the drought period the fold change in control plants was 1 while it dropped below 0 in treated samples, even though its expression in control plants differed significantly at $P > 0.05$ with the WS plant samples in all treatments of both cultivars. Kleaf, ABA, OP, Pn, E and Gs all declined with decline in leaf. in both cultivars important determinant for all the drought responses in both cultivars but then again ABA8′OH2 remained more silent during the terminal drought events.

Keywords: Oat, ψleaf, Kleaf, hydraulic conductivity, *Avena nuda* L., pollen viability

Identification of Cold Tolerance Related Genes in Tomato

Ibrar khan[1], Rashid Mehmood Rana[1], Munir Ahmad[1], Muhammad Tahir Akram[1], Muhammad Saqib Naveed[2,] Muhammad Tahir natiq[2]
Department of Plant Breeding & Genetics, PMAS-Arid Agriculture University, Rawalpindi, Pakistan
Department of Horticulture, PMAS-Arid Agriculture University, Rawalpindi, Pakistan
E-mail: ibrarkhanpk99@gmail.com

Abstract
Cold stress is a significant abiotic factor that has a detrimental effect on tomato (*Solanum lycopersicum*) germination, growth, productivity, and sustainable production. Cold tolerance is genetically controlled, and many genes involved in it have been identified in model plants like Arabidopsis thaliana. It is important to identify the genes of cold tolerance in tomatoes for the improvement of cold tolerance. Therefore, the research was done to mine and profile the genes related to cold tolerance. The 37 genes cold tolerance gene was mined in various plant species by using publicly available databases such as NCBI, Google Scholar, and PubMed. All 37 cold tolerance gene was used to find homologous sequences in tomatoes was retrieved by using BLAST. The bioinformatics tool ProSite.Expasy was used to conduct functional domain analysis in tomato genes or proteins. The subcellular localization provides information where the particular protein present in cell compartment, therefor for sub cellular localization the bioinformatics tool soft berry ProtComp v. 9.0 was use to compile data of sub cellular localization. In silico gene expression profiling in tomatoes involved the use of different bioinformatics tools like Gene Expression Omnibus (GEO) and Sol Genomics for genomic data retrieval and processing. I was obtained gene expression data by using the GSE8203, GPL1901, and GPL1902 files, which helped in shortlisting 9 differentially expressed genes (DEGs) in tomatoes. The comprehensive literature survey was conducted to mine 37 cold tolerance genes across various plant species. At the resulted 9 genes identified in tomatoes, including CAS15, ICE1, AtMYB15, HSP70, OSMYB30, SUSY, GMMYB76, RAB18, and BAM3, which are responsible for cold tolerance in tomato. All differently express genes (DEGS) in tomato were used to predict the 3-D structure using bioinformatics tool, template-based modeling, and Swiss modeling to understand protein domains and motifs arranged at the cellular level. Expression profiling in response to cold stress was used extreme three tomato genotypes such as Naqeeb, Nadir and Grande a cold-sensitive variety and a cold-tolerant variety. The expression profiling was conducted by subjecting the plants to cold stress in a growth chamber through four different cold stress treatments, sampling was done immediately in liquid nitrogen in 6hours,12hours,24hours, and recovery period of room temperature 48hours then perform sampling. The total RNA was extracted from leaf tissue samples using the TRIzol method at different time periods. The extracted RNA was converted into cDNA using the reverse transcriptase enzyme. This cDNA further utilized for gene expression profiling through semi-quantitative RT-PCR to validate the gene expression levels in the tomato genotypes. The Overall, this study aims to identify high-potential candidate genes and pathways associated with cold tolerance in tomatoes. These findings can be used as targets for future breeding endeavors aimed at developing cold-tolerant tomato varieties.

Keywords: Tomato; Cold Stress; Gene Expression Profiling; Bioinformatics; CAS15

Climate Smart Varieties of Castorbean: Potential and Opportunities for Marginal, Low Intensity, Degraded and Normal Soils

Dr. Mahmood-Ul-Hassan
Plant Breeding and Genetics Division, NIAB, FAISALABAD
Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad
E-mail: mhj407jb@yahoo.com

Abstract
Creation of genetic variability through induced mutation to achieve desirable traits in plants is an affective breeding technique. Using gamma radiations for induced mutation in castorbean, we have developed climate smart varieties viz. NIAB GOLD, NIAB Castor-2023 and NIAB Spineless Castor. By breaking genetic barrier of multiple years growing period of conventional wild type (Jangli varieties), having low yield (~300 to 400 kg per acre yield) and low oil in seed (~30 %), mutant varieties have been developed and released for commercial cultivation having unique traits of short maturity period (~140 days), higher yield (~1600-2000 kg per acre in one cutting and double yield in case of two cuttings) and higher oil content in seed (~50%). These varieties are getting rapid adoption by farmers due to best fit-in different cropping zones of Pakistan with high economic returns. Castorbean is high value industrial oilseed crop with around 300 value-added products. R&D on some value-added products and seed supply system of castorbean varieties is also in progress in NIAB, Faisalabad. Major kharif crops are vulnerable to diseases, low fruit setting leading towards low yield under climate shifts in this region. Climate smart castorbean varieties of NIAB will be game changer for this region.

Keywords: Castrobean, genetically modified, NIAB, mutant varieties

Copper–Peptide Nanocomplexes for Targeted Cancer Therapy via Cuproptosis

Muhammad Irfan, Jahanzaib and Dr. Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: irfansarparah939@gmail.com

Abstract

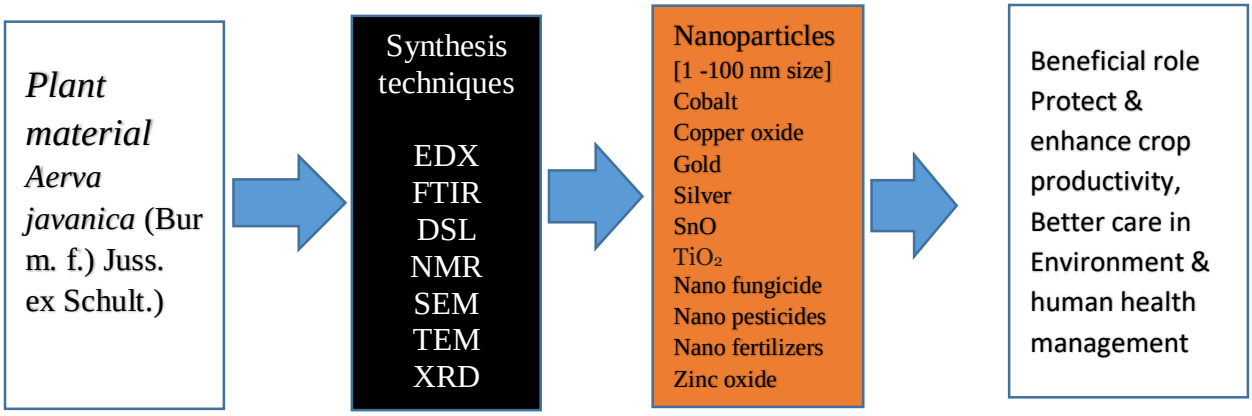
This study presents a biogenic strategy for synthesizing a stable copper–peptide nanocomplex with anticancer potential. Elemental copper (Cu^0) was converted into a biofunctional form using venom-derived enzymes—metalloproteinases, hyaluronidases, phospholipases A_2, serine proteases, and L-amino acid oxidases—as natural reducing and capping agents, enabling green synthesis without harsh chemicals. The resulting complex exhibited enhanced chemical stability due to peptide-mediated passivation, consistent with dynamic bond-driven encapsulation. UV–Visible spectroscopy confirmed complex formation via a characteristic 400 nm ligand-to-metal charge transfer peak. Functionally, the nanocomplex induces selective cancer cell death through cuproptosis, triggering mitochondrial dysfunction and metabolic collapse. Toxicological evaluation indicates activity within a tolerable biological threshold (~122.5 ppm). These findings support its potential as a bio-inspired platform for targeted oncological therapy.

Keywords: Copper–peptide nanocomplex; Biogenic synthesis; Buthidae venom enzymes; Metalloproteinases; Phospholipase A_2; L-amino acid oxidase; Passivation; Ligand-to-metal charge transfer; Cuproptosis; Targeted cancer therapy

An overview on the green synthesis of selected nanomaterial from wild desert plant *Aerva javanica* (Burm. f.) Juss. ex Schult.) and their benefits in biological system

Muhammad Shafiq[1*], Muhammad Zafar Iqbal[2], Mohammad Athar[3]

Email address: shafiqeco@yahoo.com ; orcid.org/0000-0002-0488-8946
[2]Department of Botany, University of Karachi, Karachi-75270, Pakistan.
[3]California Department of Food and Agriculture, 3288 Meadowview Road, Sacramento, CA 95832, U.S.A



Graphical abstract

Abstract

In recent years, the use of nanoparticle through nanotechnology in modern science showed a significant contribution to protect crops, human health and environment. The introduction of various types of climate change, indiscriminate discharge of pollutants from the industrial and anthropogenic activities affecting the environment at global and regional levels. The use of nanoparticles are proving efficiently helpful in solving these problems. In this context, the potential of an important medicinal plant species, *Aerva javanica* (Burm. f.) Juss. ex Schult.) (perineal Kapok bush or desert cotton) for synthesis of different types of nanoparticles such as, silver, copper, cobalt and zinc oxide (NPs) was systematically briefly reviewed in this document. The peer reviewed research articles on the synthesis of nanoparticles from *A. javanica* were retrieved from English data base such as google, google scholar, science direct. Taken together, the findings of the current survey of literature provided a valuable information about the synthesis of nanoparticles from *A. javanica*. This documents might be help full for researchers, soil and plant scientists, policy decision makers, farmers, and horticulturists, environmental managers working towards for the sustainable environment, food securities, and better health care.

Keywords: Environment and health management, green material, pollution, metallic particles,
Other keywords: Aerva, biosynthesis, nanoparticles; AgNPs, CoNPs, CuO NPs, AuNPs, ZnO NPs, crops, pollution, Nano biopesticides, Nano insecticides, Nano fungicides, Nano nematicides and Nano fertilizers, leafy green vegetables

Role of Plant Growth Regulators in Alleviating Cadmium Toxicity in Lentil: A Foliar Application Approach

Mohammad Siraj, Kanval Shaukat, Abdul Samad, Noor Ahmed, Faisal Khan, Tauqeer Ahmed
Department of Botany, University of Balochistan
E-mail: kanval_shaukat777@yahoo.com

Abstract

Cadmium (Cd) is a highly toxic heavy metal that severely impairs plant growth and development by disrupting morphological, physiological, and biochemical processes. Phytohormones and plant growth regulators (PGRs) play a crucial role in enhancing plant tolerance to abiotic stresses, including heavy metal toxicity. The present study was conducted as a pot experiment at the Department of Botany, University of Balochistan, Quetta, using a completely randomized design (CRD) with three replications to evaluate the ameliorative effects of selected PGRs on lentil (*Lens culinaris* L.) under cadmium stress. Lentil seeds were grown under cadmium stress (250 µM), and different plant growth regulators (PGRs), including salicylic acid (SA, 250 µM), Ascorbic acid (ASA, 200 µM), Thiourea (TU) and moringa leaf extract (MLE, 10%), were applied as foliar sprays. Cadmium exposure (Cd^{2+}) significantly reduced key growth parameters, including root and shoot length, dry biomass accumulation, and photosynthetic efficiency, along with associated metabolic activities. However, exogenous application of PGRs markedly alleviated the deleterious effects of Cd stress by enhancing morphophysiological attributes and improving plant metabolic performance. Among the treatments, thiourea (TU) foliar spray showed the most pronounced positive effect compared to other PGRs. The findings suggest that foliar application of TU is a promising and effective strategy for mitigating cadmium-induced toxicity and enhancing the growth and productivity of lentil under heavy metal stress conditions.

Keywords: Cadmium toxicity, plant growth regulators, ascorbic acid

First Comprehensive Molecular and Pathogenic Characterization of *Colletotrichum* Species causing Bitter Rot of Apple in Quetta, Pakistan

*[1]Muhammad Shahid, [2]Farah Naz, [3]Sadia Sana, [4]Aliya Tariq, [2]Beenish Gul
[1]Department of Plant Pathology, Balochistan Agriculture College, Quetta, Pakistan
[2]Department of Plant Pathology, PMAS Arid Agriculture University Rawalpindi, Pakistan
[3]Faculty of Agricultural Sciences, University of Hohenheim, Germany
[4]Plant Protection Department, Government of Punjab, Pakistan
*Correspondence: shahid.baloch092@gmail.com

Abstract

Bitter rot disease of apple, caused by *Colletotrichum* species, has emerged as a serious threat to apple production in District Quetta, Balochistan, with 100% disease prevalence recorded across ten surveyed locations. The mean disease incidence was 39.22% and 32.56% during 2016 and 2017 respectively. Symptomatic apple fruits displaying characteristic sunken, brown lesions (1–4 cm diameter) with minute, black, pinhead-sized acervuli were collected and transported to the Fungal Plant Pathology Laboratory, PMAS-Arid Agriculture University, Rawalpindi. A total of 130 fungal isolates were obtained and purified on potato dextrose agar. Based on cultural and morphological characteristics, the isolates were grouped into three distinct categories. Group A (47 isolates) exhibited pale white mycelial growth, orangish globular margin, off-white to yellowish ooze, and orangish reverse coloration on PDA, with mean conidial dimensions of 13.5–18.7 ± 1.5–5.6 µm × 3.4–6.3 ± 0.5–3.8 µm (tubular, tapered, hyaline, non-septate), and mean appressorial dimensions of 4.5–10.5 ± 0.7–3.8 µm × 4.7–7.5 ± 0.9–2.8 µm (obovate to ellipsoid, brown, lacking setae). Group B (41 isolates) showed grayish-white aerial mycelium, 3–4 pale yellowish fluffy concentric rings, whitish margin, and pale yellowish reverse, with conidia measuring 11.2–15.8 ± 1.1–3.5 µm × 3.7–5.6 ± 0.6–2.8 µm (cylindrical with oblong ends, hyaline, non-septate), and appressoria measuring 5.4–9.3 ± 0.5–3.6 µm × 3.5–7.5 ± 0.4–2.6 µm (ovate to obovate, medium brown, with saw-like, septate setae). Group C (42 isolates) displayed pale brown cottony aerial mycelium, grayish margin, 2–3 central brown fluffy rings, and brownish reverse, with conidia measuring 11.2–14.7 ± 0.9–2.8 µm × 3.5–5.5 ± 0.4–2.6 µm (cylindrical with oblong ends, hyaline, non-septate), and appressoria measuring 5.5–10.9 ± 0.9–4.6 µm × 4.3–6.8 ± 0.7–2.8 µm (elliptic, dark brown, lacking setae). Based on taxonomic keys Groups A, B, and C were identified as *Colletotrichum acutatum*, *Colletotrichum gloeosporioides*, and *Colletotrichum siamense* respectively. Pathogenicity of all isolates was confirmed in triplicate. Ten representative isolates per group underwent molecular analysis (ITS, TUB, GAPDH sequencing and phylogeny). Obtained GenBank accessions for *C. acutatum* (ITS: OM765045–OM765054; TUB: ON862015–ON862024; GAPDH: ON861880–ON861889), *C. gloeosporioides* (ITS: OL875152–OL875161; TUB: ON861995–ON862004; GAPDH: OL989891–OL989900), and *C. siamense* (ITS: OL875246–OL875255; TUB: ON861920–ON861929; GAPDH: ON886012–ON886021) showed 99-100% homology with reference sequences. To our knowledge, this is the first comprehensive study on the etiology, morpho-molecular characterization, and pathogenicity of *Colletotrichum* species associated with bitter rot disease of apple in Quetta, Pakistan.

Keywords: *Malus domestica, Colletotrichum acutatum, C. gloeosporioides, C. siamense,* Multi-locus phylogeny (ITS, TUB, GAPDH), Pathogenicity

Genome-wide association study of the SRO gene family in soybean (*Glycine max* L.) and functional identification of SRO-1 involvement in Salinity tolerance

Muhammad Umer Khan[1*], Muqadas Aleem[1], Bebagar[2], Muhammad Uzair[1], Khudai e Rahim [1]

[1] Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Punjab, Pakistan

[2] Department of Plant Breeding and Genetics, Faculty of Agriculture, Lasbela University of Agriculture, Water & Marine Sciences, Uthal, Las Bela, Balochistan, Pakistan

E-mail: umernb33@gmail.com

Abstract

Soybean, (*Glycine max* L.), also called soya bean, is an annual legume crop and belongs to Fabaceae family. Its seed is edible, and has economic importance for global population, providing vegetable oil and protein for millions of masses, feed for livestock and ingredients for chemical products. However, the production of soybean in Pakistan and worldwide is very limited because of biotic and abiotic stresses. Among abiotic stresses, salinity adversely affects land utilization capability and ultimately soybean crop yield. So, finding out highly resistant genes like SRO-1 in soybean germplasm is of great significance for breeding new cultivars with salt-stress resistant and yield. Understanding the defense mechanism of soya bean for salt resistance will help in designing salt-stress tolerant plant by over expression of SRO-1 gene. In present era, Single Nucleotide Polymorphism (SNP) and Simple Sequence Repeats (SSR) based for genome-wide association study (GWAS) is a basic tool to dissect genetic architecture for quantitative as well as qualitative traits of soybean genotypes. The study carries out to characterize soybean germplasm based on various agronomical, molecular as well as biochemical analysis. Moreover, the functional analysis and mining of SRO genes family for salt resistance of soybean by genome-wide association study (GWAS) and merging of genotyping and phenotyping data for halophytic resistant. It has a potential to facilitate breeding by deploying Marker Assisted Selection (MAS) of selected traits. Furthermore, these obtained results could be helped to understand molecular mechanism of salt-stress resistant among various soybean genotypes and provide further theoretical basis for molecular genetic improvement in soybean.

Keywords: Genome-wide association studies (GWAS), Single Nucleotide Polymorphism (SNP), Functional Identification, SRO genes family, Salt-Stress Resistant, Soybean

Isolation and Prevalence of Multi Drug Resistance *Salmonella typhi* among Adults of Quetta

Nabila Nisar, Samina Ali
Government Girls Postgraduate College, Quetta Cantonment
E-mail: nisarnabila1@gmail.com

Abstract

Salmonella is a species of motile bacteria that goes to the *Enterobacteriaceae* household. These are the gram-negative bacteria that give humans typhoid fever. Even though typhoid fever is no longer a preventable disease in poor nations, it nevertheless contributes significantly to morbidity and mortality in adult populations. Typhoid infection is an oral transferrable ailment that is frequently associated with eating animal-derived food products. Poultry products are the main source of this disease, followed by beef, fish, and other foods like fruits and vegetables. *Salmonella* typhi is the bacteria that causes this infectious disease. Eating tainted food and drinking dirty water are the usual causes. Even though typhoid fever is no longer a preventable disease in poor nations, it nevertheless contributes significantly to morbidity and mortality in adult populations. Typhoid malaise is an oral catching sickness that is frequently associated with eating animal-derived food products. Poultry products are the main source of this disease, followed by beef, fish, and other foods like fruits and vegetables. *Salmonella typhi* is the bacteria that causes this infectious disease. Eating tainted food and drinking dirty water are the usual causes. The establishment of strains of *Salmonella typhi* that are strong to remedies can be controlled with a complex treatment plan, but the spread of the disease cannot be stopped by vaccination. The possibility of multi-drug unaffected (MDR) *Salmonella* anxieties and the growth of antibiotic struggle are noted, even though antibiotics are the main treatment for *Salmonellosis*. The resolution of this reading is to isolate *Salmonella typhi* from blood samples. Eight of the fifty samples that we gathered for this purpose were positive for bacterial growth. Unfortunately, *Salmonella* can spread due to antibiotic abuse, and it can be challenging to treat. Typhoid fever can be prevented by improving inadequate sanitation, using safe drinking water, providing access to clean water and proper sanitation, encouraging food handler cleanliness, and receiving a typhoid immunization.

Keywords: Bacteria, infectious disease, multi drug resistance, *Salmonella typhi*, tainted food,

Quercetin Verses Metformin, Comparative Efficacy on the Lipid Metabolism Gene Expression in Different Organs of Diabetic Wistar Rats

Nayab Khan[1], Asmatullah Kakar[1], Imtiaz Rabbani[2], Mahrukh Naseem[1], Irfan Shahzad Sheikh[3], Tahir Yaqub[4], Muhammad Imran[5]

[1]Department of Zoology, University of Balochistan

[2]Department of Physiology, University of Veterinary and Animal Sciences, Lahore, Pakistan

[3]Center for Advanced Studies in Vaccinology and Biotechnology (CASVAB), University of Balochistan

[4]Institute of Microbiology, University of Veterinary and Animal Sciences, Lahore

[5]Institute of Biochemistry and Biotechnology, University of Veterinary and Animal Sciences, Lahore

E-mail: nayabkhan1919@yahoo.com

Abstract

Type 2 Diabetes mellitus, is a metabolic disorder responsible for disturbance in carbohydrates, protein and lipid metabolism. The objective of current study was to evaluate the effect of Quercetin and Metformin on serum lipid profile and gene expression involved in lipid metabolism. Sixty-four (64) Wistar rats in a range of live body weight 196.75-198.19 grams, were divided in eight (8) groups (n=8 each); CONTROL, DIABETIC, DIAB+MET, DIAB+25Q, DIAB+50Q, NONDIAB+MET, NONDIAB+25Q and NONDIAB+50Q. A single dose of Streptozotocin drug @ 35 mg per kg was used for the induction of diabetes. The particular doses of Metformin and Quercetin were given by gavage on daily basis in their respective groups till the end of 14-week trial. In case of FAS gene expression in liver, DIAB+MET (1.26±0.03), DIAB+25Q (1.31±0.02) and DIAB+50Q (1.19±0.04), suppresses the elevated expression compared to Diabetic group, while in case of SREBP-1c, both DIAB+MET (1.31±0.05) and DIAB+50Q (1.38±0.04) showed predominant results compared to DIAB+25Q. Moreover, for PPAR-α, DIAB+MET (0.87±0.06) exhibited considerable upregulation in comparison with DIAB+25Q (0.65±0.03) and DIAB+50Q (0.76±0.04). In adipose, FAS gene was significantly downregulated in DIAB+50Q (1.28±0.03) group as compared to other two diabetic treatment groups, however, for PPAR-γ gene, in term of significance both DIAB+MET (0.84±0.05) and DIAB+50Q (0.88±0.06) displayed statistically similar level of upregulation. In muscles, PPAR-α expression was best observed in DIAB+50Q (0.80±0.03) and DIAB+MET (0.76±0.02) compared to DIAB+25Q (0.59±0.03). Moreover, serum lipid profile (TC, HDL, TG, LDL and VLDL) was also significantly improved in Metformin and Quercetin treatment groups. In non-diabetic treatment groups, a non-significant difference was observed when compared to CONTROL group.

Keywords: Diabetes, Lipid, Metabolism, Metformin, Quercetin

Physiological Responses of Plants to Water Stress in Dryland Agriculture

Nabgha Imran[1*], Dr. Muhammad Ashfaq Wahid[1], Bilal Ahmed[1]
Department of agronomy, University of Agriculture, Faisalabad
E-mail: nabgaimran173@gmail.com

Abstract

Water stress is a major constraint limiting crop productivity in dryland agriculture, is aggravated by climate change and increased atmospheric water demand. This study highlights the key physiological responses of plants to water deficit conditions, with emphasis on adaptive mechanisms that underpin stress tolerance. Plant respond to drought stress through processes such as stomatal regulation, osmotic adjustment, antioxidant defense, enhanced root growth and reduced photosynthetic activity, which collectively contribute to the maintenance of cellular homeostasis under water-deficit condition. Additionally, the role of stress hormones, particularly abscisic acid, is crucial in regulating plant responses under limited water availability. Integrating these physiological insights, the study highlights their implications for enhancing water use efficiency and guiding the development of drought-resilient cropping systems. Integrating these physiological insights, the study highlights their implications for enhancing water use efficiency and guiding the development of drought-resilient cropping systems. Improvement of drought resilience involves the convergence of molecular breeding tools i.e. genome editing, transgenic strategies and marker-assisted selection; physiological trait selection such as root system architecture and leaf anatomical modifications; and sustainable agronomic practices, including precision agriculture to optimize plant performance under water-limited conditions. Such an integrated approach provides a strong foundation for developing sustainable management strategies in dryland agriculture under increasing climatic variability.

Keywords: Drought, climate change, physiological aspects, mitigation strategies

Phylogenomic Insights into the Genus *Chrozophora*: Leveraging the *C. sabulosa* Chloroplast Genome for Sustainable Dryland Plant Management

Nida Javaid, Musarrat Ramzan, Shagufta Jabeen, Naila Sarwar, Fatima Khalid
The Islamia University Bahawalpur, Pakistan
E-mail: Nida Javaid (nidajatala1@gmail.com)

Abstract

Chrozophora sabulosa Kar. & Kir. is a medicinally significant biennial herb adapted to dryland environments. Despite its ecological value, the evolutionary position of the genus *Chrozophora* within the Euphorbiaceae family has remained uncertain, hindering effective biodiversity management and genetic conservation. This study addresses this gap by sequencing the complete chloroplast (cp) genome of *C. sabulosa* using the NGS Illumina platform to establish a genomic foundation for sustainable dryland plant science. The results reveal a 156,488 bp genome with a characteristic quadripartite structure (87,696 bp LSC; 19,494 bp SSC; and 24,649 bp IRs). The genome encodes 113 unique genes, including 79 CDS, 30 tRNA, and 4 rRNA genes, with notable losses of introns in *petD*, *petB*, *rpl2*, and *rps16*. To support dryland biodiversity monitoring, we identified 93 SSR loci and 78 oligonucleotide repeats as potential molecular markers. Comparative phylogenomic analyses with members of the Euphorbiaceae and Phyllanthaceae families including Ka/Ks substitution rates, InDel investigations, and IR boundary analysis confirm that *Chrozophora* evolved paraphyletically. Significantly, we identified six highly polymorphic regions (*rpl33-rps18*, *rps18-rpl20*, *rps15-ycf1*, *ndhG-ndhI*, *psaI-ycf4*, *petA-psbJ*) that serve as precise molecular identifiers for the genus. As the first reported cp genome for the genus, this research provides the essential genetic toolkit required for the taxonomic identification, conservation, and sustainable utilization of *Chrozophora* species in arid ecosystems. These findings represent a critical step toward the integrated management of dryland biodiversity and the discovery of genetic resources for sustainable development.

Keywords: Dryland Biodiversity; *Chrozophora sabulosa*; Chloroplast Genomics; Sustainable Management; Molecular Identifiers; Euphorbiaceae.

In Process Control and Comparative Analysis of High Biomass Production of *Pasteurella multocida* Using Biofermenter

Palwasha Khan, Muhammad Shafee, Muhammad Naeem, Rehana Noor, Maina Akbar, Shaista Nasir
[1]Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan
Email: palwashabarech474@gmail.com

Abstract
Hemorrhagic septicemia (HS) is a highly fatal disease affecting cattle and buffalo, particularly in regions of Asia and Africa, and is primarily caused by *Pasteurella multocida* serogroup B:2. Due to the significant economic importance of livestock in these regions, effective control of *P. multocida* infections relies heavily on vaccination strategies. Conventional vaccine production typically employs standard culturing techniques; however, these methods often result in inconsistent biomass yields. Therefore, optimizing growth conditions and production methods is essential to improve vaccine efficiency and cost effectiveness. In the present study, *Pasteurella multocida* (Robart B strain) was cultured using two different growth media: Brain Heart Infusion (BHI) broth and Casein Sucrose Yeast (CSY) broth. Prior to culturing, the bacterial strain was activated in mice. The organism was subsequently isolated from the heart blood of infected mice and confirmed using both conventional and molecular approaches. Presumptive identification was performed through culture characteristics and microscopy, while molecular confirmation was achieved using polymerase chain reaction (PCR). Additionally, the absence of bacterial growth on MacConkey agar further supported the identification of the organism. The study evaluated the effects of key growth parameters, including pH, temperature, and agitation on biomass production. Comparative analysis was conducted between conventional flask culture methods and a controlled biofermenter system. The results demonstrated that optimal growth conditions for both methods were achieved at a pH of 7.2, temperature of 37°C and agitation speed of 500 rpm. These findings highlight the importance of maintaining a neutral pH, moderate temperature, and controlled agitation to support optimal bacterial proliferation. Biomass production was assessed after 16 hours of incubation using a spectrophotometer (Shimadzu UV-VIS-1700) at a wavelength of 450 nm. The results indicated that the biofermenter system yielded higher biomass (2.737 mg/ml) compared to the conventional flask method (2.205 mg/ml). Furthermore, CSY broth consistently produced greater biomass than BHI medium under similar conditions. Following biomass production, the bacterial culture were subjected to inactivation using variable concentrations (0.4%, 0.5%, and 0.6%). The inactivation process was monitored over a period upto 120 hours. Complete inactivation indicated by the absence of bacterial growth, was achieved at a concentration of 0.5% formalin, demonstrating its effectiveness for vaccine preparation. In conclusion, the findings of this study emphasize the advantages of using a biofermenter system over conventional culturing techniques for the production of *P. multocida* biomass. The optimized growth parameters and the superior performance of CSY medium contribute to higher yield, which is critical for large scale vaccine production. These results support the adoption of biofermentation technology as a cost effective and efficient approach for improving HS vaccine manufacturing.
Key Words: Biofermenter, HS, Vaccine, Biomass

Deep Learning-Based Detection and Severity Assessment of *Alternaria alternata* in Postharvest Fruit of Peach Using Image Analysis

Raheem Uddin, Gulshan Irshad, Adnan Baloch, Amar Mehmood, syed Zulfiqar, Mohammad Waris, Jobia jabean, shadad
Directorate of Vegetable Seed Production, Agriculture Research Institute, Quetta
E-mail: adnanbaloch@hotmail.com

Abstract

Postharvest fungal diseases significantly reduce fruit quality and marketability, contributing to global losses of 20–40%. Among these, infections caused by Alternaria alternata are particularly destructive, leading to black spot and rot in a wide range of fruits. Conventional diagnostic methods are time-consuming, subjective, and often ineffective for early-stage detection. This study presents an artificial intelligence (AI)-based image learning system for the detection and severity assessment of *A. alternata* in postharvest fruits. A dataset of 1,200 fruit images (apricot-based, aligned with your research) was generated under controlled storage conditions, including healthy, early infection (24–48 h), and advanced infection (72–120 h) stages. Images were captured using standardized lighting and annotated into three classes. A deep convolutional neural network (CNN) model based on a modified ResNet-50 architecture was trained using 80% of the dataset, while 20% was used for validation and testing. The trained model achieved an overall accuracy of 96.4%, with precision (95.8%), recall (96.1%), and F1-score (95.9%). Class-wise accuracy was 97.8% for healthy samples, 94.6% for early-stage infection, and 96.9% for severe infection. Misclassification was minimal and mainly occurred between early and intermediate infection stages. Furthermore, a regression-based module for lesion quantification showed a strong correlation ($R^2 = 0.92$) between predicted and manually measured lesion diameters. The developed AI system enables rapid, non-destructive, and highly accurate detection of *A. alternata* infections and provides reliable severity estimation. This approach can be integrated into smart postharvest management systems and mobile-based applications for real-time disease monitoring. The findings demonstrate the potential of deep learning tools to improve disease diagnostics and reduce postharvest losses in fruit supply chains.

Keywords: *Alternaria alternate*, Peach, postharvest quality

Assessment of Exotic Wheat Genotypes for Stripe Rust Resistance and Yield Performance under Field Conditions

Rozia Gull[1], Rizwana Maqbool[1], Sabeela Yaqoob[2]
[1]Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad
[2]Department of Agronomy, University of Agriculture, Faisalabad
E-mail: roziagull65@gmail.com

Abstract

Wheat (*Triticum aestivum* L.) is a major staple crop increasingly threatened by stripe rust (*Puccinia striiformis*) under changing climatic conditions. study evaluated exotic wheat genotypes for yield potential and rust resistance. A field experiment was conducted during Rabi 2023–24 at the University of Agriculture, Faisalabad, using a Randomized Complete Block Design with three replications. Data on major agronomic traits were recorded, and Analysis of Variance revealed significant genetic variability among genotypes. Rust severity, assessed using the Modified Cobb Scale. AKBAR-19 showed the highest susceptibility (40%), followed by UAF-22-10 (20%), while UAF-22-2 and UAF-22-7 exhibited strong resistance. The maximum value of grain yield per plant was observed for UAF-22-7 and UAF-22-2 (36.88 g to 36.0g) while the minimum value for grain yield per plant was observed for UAF-22-10 and Akber-19 (23.28g to19.4g). The results indicate substantial genetic diversity and identify promising genotypes for developing high-yielding, rust-resistant wheat genotypes under changing climatic conditions.

Keywords: *Triticum aestivum L.*, stripe rust, genotypes

Evaluating the Impact of Natural Growth Regulators in Improving Heat Tolerance and Yield of Sesame

Shakeel Imran[1, *] Ahmad Raza[1], Muhammad Talha Ramzan[1]
[1]Department of Agronomy, University of Agriculture Faisalabad, Punjab, Pakistan
E-mail: shakeel.imran@uaf.edu.pk

Abstract

Sesame (*Sesamum indicum* L.) is a globally significant oilseed crop constrained by inherently low productivity, declining soil fertility, and heightened susceptibility to heat stress. The reliance on synthetic fertilizers necessitates the identification of sustainable, plant-based biostimulants to enhance physiological resilience and yield formation. A field experiment was conducted during spring 2025 at the Agronomic Research Area, University of Agriculture Faisalabad, to evaluate the efficacy of foliar-applied natural extracts on sesame performance. The trial employed a randomized complete block design with three replications, comprising six treatments: untreated control, distilled water spray, sugar beet root extract (2%), ginger extract (0.5%), spinach leaf extract (3%), and *Ziziphus* (beri) leaf extract (1%). Plot dimensions were maintained at 3.35 m × 3.35 m gross area. Among the evaluated botanical extracts, the foliar application of 2% sugar beet root extract demonstrated superior agronomic response. This treatment significantly enhanced reproductive efficiency, recording the highest number of pods per plant (50.3), maximum 1000-seed weight (9.4 g), and a grain yield of 2.11 t ha^{-1}. Concomitant improvements were observed in biological yield (4.6 t ha^{-1}) and harvest index (46.9%) relative to the control and other extract applications. The findings substantiate that exogenous application of 2% sugar beet root extract serves as an effective agronomic intervention for mitigating stress-induced yield penalties and optimizing sesame productivity within semi-arid cropping systems.

Keywords: *Sesamum indicum* L., Botanical biostimulants, Foliar spray, Sugar beet root extract, Yield attributes, Heat stress mitigation

Phytochemical Characterization and Therapeutic Potential of *Pistacia khinjuk* Hull and Kernel Essential Oil

Sundus Shahid[1], Ali Akbar[1,2]

[1]Department of Microbiology, University of Balochistan, Quetta, Pakistan
[2]Centre for Biotechnology and Microbiology, University of Swat, Khyber Pakhtun Khwa
E-mail: sundus.khawaja16@gmail.com

Abstract

Plant-derived essential oil is gaining attention due to their therapeutic and nutritional potential. *Pistacia khinjuk* is a medicinal plant with promising bioactive properties. This study aimed to evaluate the phytochemical composition and functional bioactivities of essential oil extracted from the hull and kernel of *P. khinjuk* fruit. Essential oil was extracted using the Soxhlet method. Total phenolic content (TPC) and total flavonoid content (TFC) were quantified. Antioxidant activity was assessed using DPPH radical scavenging and ferric reducing antioxidant power (FRAP) assays. Antimicrobial activity was evaluated against *Escherichia coli, Salmonella typhi, Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Staphylococcus aureus* using the well diffusion method, while antifungal activity was tested against *Aspergillus niger* and *Mucor* species. Antileishmanial activity was determined using the promastigote assay. Chemical composition was analysed by GC–MS. Hull essential oil showed higher TPC (12.76 ± 0.57 mg GAE/mL), while kernel oil exhibited higher TFC (8.49 ± 0.60 mg QE/mL). Antioxidant activity was comparable, with DPPH IC_{50} values of 35.6 mg/mL (hull) and 37.4 mg/mL (kernel). Kernel oil demonstrated stronger antibacterial activity, particularly against *S. aureus* (22 ± 1.09 mm), and higher antifungal activity (53.1% inhibition against *A. niger*). In antileishmanial assays, kernel oil showed greater potency (IC_{50} = 1.667 mg/mL) than hull oil (2.510 mg/mL). GC–MS identified diverse bioactive compounds in both oils. *Pistacia khinjuk* essential oils possess significant antioxidant, antimicrobial, antifungal, and antileishmanial activities, supporting their potential application in pharmaceutical and nutraceutical industries.

Keywords: Antileishmanial activities, essential oil, phytochemical, therapeutic potential, *Pistacia khinjuk*

Comparative Efficiency of Salicylic Acid and Ascorbic Acid Seed Priming on Morpho-Physiological Attributes of Maize under Zinc Toxicity

Tauqeer Ahmed, Kanval Shaukat, Abdul Samad, Phan Van Thanh., & Tariq Ismail
Department of Botany, University of Balochistan
E-mail: kanval_shaukat777@yahoo.com

Abstract

Zinc is essential micronutrient for cereal crops like wheat, rice and maize. In plants it plays a vital role in many enzyme activities and metabolic processes although plants need zinc in small amounts. However enhanced levels of Zn in soils are phytotoxic, cause several structural as well as functional abnormalities, eventually weakening the plant performance. Plant growth regulators are chemical messenger that improve plant parameters under control and stress conditions. A pot experiment was performed in Department of Botany University of Balochistan, Quetta. Maize plant grown under Zinc stress (300µM) and seeds were primed with PGRs (SA and AsA). After 5days of seed germination, seedlings were subjected to zinc stress, after week of Zn stress plant was harvested to analyze the morpho-physiological attributes. Zinc stress inhibited the maize growth, physiological parameters, metabolites and nutrients. However, PGRs improved the growth and all other parameters of Maize. Results revealed that seed priming with both SA and AsA significantly improved germination rate, plant growth attributes and biomass compared with non-primed stressed maize. Primed plants also exhibited enhanced physiological performance suggesting better stress tolerance mechanism. Overall the study concludes that SA and AsA seed priming can be adopted as a simple and effective strategy to ameliorate zinc toxicity and improve Maize performance under zinc stress.

Keywords: Zinc Toxicity, Seed Priming, Salicylic Acid, Ascorbic Acid, Zea Mays

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Theme 2

Biodiversity and conservation – problems and solutions

a. Current scenario of dryland ecosystems
b. Livestock grazing management and rangeland ecosystem restoration
c. Ecosystem services of rangelands for agriculture – natural pest invasion control
d. Management options for dryland ecosystem restoration while maintaining sustainable livelihood

Seasonal Variation in Composition and Aboveground Plant Biomass Production in Tomagh Rangeland Area, Asghara Valley, Sinjavi, of Balochistan

Dr. Farhat Abbas
Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB)
E-mail: farhatabbas2005@gmail.com

Abstract

Globally it is reorganized that abiotic stress caused by increasing temperature and drought is a major limiting factor for rangeland productivity and wheat productivity. Twenty six percent of the ice free land surface provides the grazing facility to livestock. The ecosystem composition and processes are mainly affected by biotic and abiotic factors. In intensive grazing, the shift in species composition frequently involves the replacement of palatable species by unpalatable species. The differences in grazing intensity were responsible for plant diversity. The expansion of livestock development sector can contribute to deforestation, while intensification of livestock production can cause overgrazing in others. In developing countries most of the rangelands are facing the problem of persistent drought, land degradation, desertification and land fragmentation. In last two decades, many projects have been initiated for rehabilitation of degraded rangelands but after completion of the projects, all efforts had been failed because donor agencies has concentrated on the physical and technical side instead of their socio-economic and cultural needs of the local people. In some areas, rehabilitation of degraded rangelands by enclosing social enclosures by local communities is gaining success and combating land degradation in rangelands. It looks that specified areas closed from grazing for a specified duration of time according to their ecology to allow the regeneration of vegetation may be one option for the restoration of degraded. It is suggested that if flock sizes remain large and productive area for grazing constantly decline, the accumulative impacts of grazing further degrade the rich flora of the area and degrade rangeland biomass quantity, quality, and will be alarming to sustain current grazing levels in future.

Keywords: Plant biomass, rangeland, seasonal variation, nutritional status, palatable

Development of Oil Based Black Quarter Vaccine in Farm Animals

Maina Akbar, Muhammad Shafee, Muhammad Naeem, Rehana Noor, Raheel Mehboob and Palwasha Khan
[1]Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan
E=mail: mainaakbar06@gmail.com

Abstract
Black quarter (BQ) remains a serious threat to dairy industry over the globe and endemic in low-income countries such as, Pakistan. This study was aimed to characterized the *C.chauvoei* as vaccine candidate and prepare oil based monovalent vaccine. The seed was cultured anaerobically through classical bacteriological techniques using Reinforced Clostridium Medium (RCM) and was further reconfirmed through PCR with specific primers amplifying 509 bp product. The seed was then passed through series of experiments and finally inactivation of biomass carried out using 0.5% formaldehyde. The antigen dose was standardized using spectrophometer. Finally, the Montanide based vaccine was prepared and all quality control parameters (Safety, Potency, and Sterility) were evaluated. Similarly, RCM medium proved better than Thioglycolate media for the dense growth. Use of oil based BQ vaccine in farm animals is highly recommended to produce immunity for longer time and control the disease in animals.

Key Words: Black Quarter, *Clostridium. chauvoei* Vaccine, Oil based, Montanide

Comparative analysis of Soil Physicochemical Properties at Varying Depth in Sra Ghurghai and Hanna district Quetta, Balochistan

Meraj-Ud-Din, Ayeesha Masood
Department of Botany, University of Balochistan Quetta
E-mail: ayeeshamasood@gmail.com

Abstract

This study investigates the physicochemical properties and mineral composition of soils collected from Sra Ghurghai and Hanna areas of District Quetta, Balochistan, Pakistan, at varying depths (15 cm and 30 cm). Laboratory analyses, including X-ray diffraction (XRD), pH measurement, electrical conductivity (EC), water-holding capacity (WHC), and organic matter (OM) determination, were conducted to assess soil quality, fertility, and compositional characteristics. XRD results revealed that Sra Ghurghai soil is rich in Calcite ($CaCO_3$), Graphite (C), Dolomite ($CaMg(CO_3)_2$), and Quartz, indicating a carbon-rich and calcareous nature. In contrast, Hanna soil exhibited a shallow marine carbonate system dominated by Calcite, Ankerite, Phengite, and Chlorite. The pH values ranged from 6.8 to 7.5, indicating slightly alkaline to neutral conditions favorable for plant growth. Electrical conductivity values (0.05–0.07 dS/m) suggested low salinity and good soil drainage. Water-holding capacity ranged from 13.9% to 34.8%, while organic matter content varied between 0.14% and 1.15%, influencing soil fertility and moisture retention. Textural analysis identified soil classes as sandy loam, loamy sand, and silty loam, with sand content ranging from 20%–40%, silt from 28%–36%, and clay from 28%–42%. The overall assessment indicates that the soils of District Quetta possess favorable physicochemical characteristics, suitable for agricultural use and capable of supporting a range of crops and orchards. The study recommends implementing sustainable agricultural practices, such as crop rotation and optimized fertilizer application, to maintain soil health and productivity in the region.

Keywords: Sra Gurgai, soil nutrients, soil texture, Quetta District

Allelopathy Interaction of some Plants of Hazarganji on their Associated and Test Species

Misbah Manzoor[1], Dr. Farida Behlil[2] and Ayesha Masood[3]
[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
[3]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract

In the present study, Allelopathic interaction of three plants were studied on monthly biomass production of associated and test Species.In the laboratory experiments, allelopathic effects of (Leaves,Stem,Litter and Flower) aqueous extract, rain leachate,litter bed,Soil bed, Mulching and Soil extracs of *Pistacia khinjik* Stocks (Anacardiaceae), *Fraxinus xanthoxyloides* Wallex.G.Don (Oleaceae), *Sophora mollis* Royle (Papilionaceae) showed inhibitory or stimulatory effects on the seeds germination and growth of three test species; *Lactuca sativa* (Salad), *Pennisitum americanum* (Bajra) and *Steria italic* (Kangni).It was noted that the aqueous extracs at the concentration of 0.5,1.0 and 1.5g and with 24,48 and 72 hrs soaking duration had inhibotory effects and result was found significantly different than control. The order of inhibition was Litter>stem>Leaves>Fower. *Lactuca* was most sensitive species than *Pennisetum* and *Setaria*.The toxicity was species and part specific. As compared to duration effect concentration effect was more significant.Beneath and outside of the canopy of *Pistacia* and *Fraxinus* a great difference in species biomass and in their important value were recorded.Pythotoxins in some concentrations showed stimulating effect in test species especially elongation of radicle and Plumule in *Pennisitum* and *Setaria* and *Lactuca*.Phytochemical analysis showed that alkaloids were present in all parts of Plants.Tannins were present in all parts of *Pistacia,*in Litter and fllower of *Fraxinus,*and were present in stem and litter of *Sophora.*Flavonoids were also present but Saponins were completely absent in all parts of Plants.It was concluded that these phytochemicals might be responsible for allelopathic effects.

Keywords: *Pennisitum,* Allelopathic, *Fraxinus and Lactuca*

Impact of Fire on the Nutritional Quality of Pine Nut Seeds (*Pinus gerardiana* Wall. ex D. Don) of Zhob, Balochistan

Momina Rozi Khan[1], Misbah Manzoor[1], Asadullah[2], Ayesha Masood[2], Irum Akrum[2]
[1]Department of Plant Sciences, Sardar Bahadur Khan Women's University, Quetta
[2]Department of Botany, University of Balochistan, Quetta
E-mail: alfa_botany@yahoo.com

Abstract

The current study demonstrated how fire affected the quality of pine nut seeds (*Pinus gerardiana* Wall. ex D. Don) that were gathered from the Zhob area of the Sulaiman Mountain range in Balochistan, Pakistan. For sample collection, Chilgoza seed were taken both before and after the fire in November 2021 and October 2023, were extracted by using methanol, acetone, ethanol and water. Phytochemicals screening, mineral composition, antioxidant activity, total flavonoid content (TFC), total phenolic content (TPC), and anticancer potential were evaluated. After being exposed to fire, important components did not significantly decrease ($p > 0.05$), according to mineral analysis, suggesting that seed minerals are thermally resilient. A decrease in several heat-sensitive elements was revealed by qualitative phytochemical screening. However, after exposure to fire, terpenoids showed improved stability. TPC and TFC significantly increased ($p < 0.001$) after fire, with acetone extracts exhibiting maximum levels, as per quantitative analysis. Higher levels of flavonoids and phenols were positively linked with improved antioxidant activity, according to DPPH radical scavenging tests.The Acetone and aqueous extracts had improved anticancer effectiveness against SW480 colorectal cancer cells after fire, as demonstrated by reduced IC50 values. The results indicate that the *Pinus gerardiana* seeds exhibit adaptive biochemical responses to fire stress that improve their anticancer and antioxidant qualities whereas preserving their nutritional quality.

Keywords: Anticancer activity, *Pinus gerardiana*, fire stress, TPC

Impact of Substituting Spineless Cactus Pear for Oaten or Lucerne Green Forage in Grain-Based Supplements for Small Ruminants during Winter in Dry Areas of Pakistan

Muhammad Islam[1], Abdul Razzaq[2]
[1]International Center for Agricultural Research in Dry Areas (ICARDA), South Asia, Islamabad, Pakistan
[2]Animal Sciences Division, Pakistan Agricultural Research Council, Islamabad
E-mail: mu.islam447@gmail.com

Abstract
The current study investigated the effects of incorporating spineless cactus pear (*Opuntia ficus-indica*) instead of oat (*Avena sativa*) or lucerne (*Medicago sativa*) forage in a grain-based supplement for foraging small ruminants during winter in Pakistan. Does and ewes grazing freely in nearby rangelands were fed a grain-based supplement containing cactus pear, lucerne or oats as green fodder or were unsupplemented, when penned at night for 60 days in Chakwal, Pakistan. All supplemented groups gained more weight during the study than the control. Towards the end of experiment, supplemented ruminants showed significantly higher weight gains than control. These results indicate that cactus pear can satisfactorily replace lucerne or oat forage in grain-based supplements for small ruminants grazing pasture in winter. Further studies would be needed to determine the benefits from adding cactus to the grain-based supplement before this practice could be recommended to farmers. Similarly, the value of cactus pear as a supplement in conjunction with a high protein source, e.g. pods and leaves from leguminous trees, should be investigated.

Key words: weight gain, livestock production, does and ewes, kids and lambs, livelihoods

Influence of Dried Citrus Pulp Bio-waste as a Concentrate Replacement on Performance in Lactating Buffaloes

Muhammad Sharif, Sarmad Yasin, Fawad Ahmad, Muhammad Tayyib, Mudasir Nazar and Safdar Hassan
Institute of Animal and Dairy Sciences, Lecturer, University of Agriculture Faisalabad.
E-mail: Safdar Hassan sh.shakir@uaf.edu.pk, (+92419200161)

Abstract
This study was planned to investigate the effect of dried citrus pulp as an alternate energy source for nutrients intake, digestibility, nitrogen metabolism, milk yield, milk composition and economics of diets in buffaloes. Twenty early lactating *Nili Ravi* buffaloes were divided into four groups of five buffaloes each. Four iso-caloric and iso-nitrogenous diets were formulated containing roughages and concentrate. The concentrate contained 10, 20, 30 and 40% dried citrus pulp. The experiment lasted for 80 days. Forages were offered *ad libitum*. During collection period, feces and urine of three animals from each group were collected to determine nutrients digestibility and nitrogen balance. The feed and fecal samples were dried and ground to analyze dry matter, organic matter, crude protein, neutral detergent fiber and acid detergent fiber. Milk yield of each buffalo was recorded in the morning and evening. Milk samples were collected fortnightly for determining its composition (milk fat, protein, total solids and solids not fat). Total feed cost of citrus pulp based diets were also calculated. The data thus collected for each parameter was subjected to Analysis of Variance (ANOVA) using general linear model procedure of SPSS and means were compared by Duncan's Multiple Range Test. The results of this study showed a non-significant effect of various levels of dried citrus pulp on nutrient intake. Similarly, nutrient digestibility was not affected by different levels of dried citrus pulp. Nitrogen retention was also remained unaltered among all treatments. Similarly, different levels of dried citrus pulp in diet had no significant effect on milk yield, milk composition and blood metabolites. However, dried citrus pulp being an agro-industrial by-product resulted in cost effective ration formulation. In conclusion, dried citrus pulp can be used up to 40% to formulate economical ration for lactating buffaloes without any adverse effects on their performance.

Key words: Bio-waste utilization, Concentrate replacement, Animal nutrition, Agro-industrial by-products

A scientific study of Flora and fauna of Chiltan Mountain ranges Quetta Balochistan

Naila Naheed, Faizan Ali, Hina Barozai, Muhammad Idress and Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: nailabughti@gmail.com

Abstract

In order to integrate traditional knowledge with contemporary scientific techniques, we investigated the flora and fauna of the Chiltan mountain ranges and did their GPS mapping. This study is based on extensive field study using quadrat sampling, GPS mapping, and questionnaire-based data collection from local herbalists, along with herbarium preparation and insect preservation. A total number of 17 plant species are collected, and 8 of them have medicinal properties. While a total of 14 arthropods were collected, 13 of them are insects, and 1 arachnid was identified across three ecological layers, showing variation in frequency and distribution. Most frequently insects found are from beetle species. The above result underscores the dependence of communities in using medicinal plants to cure animal diseases, in addition to the value of biodiversity. Challenges include over-exploitation, loss of habitat, and environmental changes. The plants found in the Chiltan mountains have effects on disease curing, like inflammation, swelling, hypertension, digestive problems, and respiratory disorders, and they possess antimicrobial and antifungal properties and one of them is used traditionally in memory enhancement and nervous disorders. *Sophora mollis fabaceae* has shown some activity against cancer cells in lab studies. *Ficus carica is* used in diabetic patients. This research will help contribute to conservation within veterinary medicine and biodiversity through the incorporation of traditional knowledge into technologies, including GPS technology and nanotechnology in drug delivery systems. These techniques will be used in helping the local community and the scientific field as well.

Key words: *Sophoramollis fabaceae*, Chiltan mountain ranges, *Ficus carica*, medicinal plants

Drought-Proofing the Rangelands: Adaptability Potential of Different Accessions of *Cenchrus ciliaris* L. for Climate-Resilient Forage Under Water Deficit

Naila Sarwar[1*], Muhammad Jamil[1], Musarrat Ramzan[1], Nida Javaid[1], Shagufta Jabeen[2], Asma Yaqoob[1]
[1]The Islamia University of Bahawalpur, Punjab, Pakistan
[2]Quaid e Azam University, Islamabad, Pakistan.
E-mail: naila.sarwar@iub.edu.pk

Abstract
Adaptability potential of ten different accessions of *Cenchrus ciliaris* collected from different areas of the Cholistan desert was evaluated against three different levels of water stress i.e. watering with 2 days interval (T1), 4 days interval (T2), 6 days interval (T3), along with a control (T0). Various morpho-anatomical and physiological parameters were recorded at vegetative growth and at the maturity of plants. In T0, accession numbers DR2/3 collected from Darawar Fort, KP1/2 collected from Kaley Pahar, SL1/2, collected from Singhar Lattan, LS2/3 collected from Lal Suhanra and SZE1/15 collected from Sheikh Zaid Enclosure appeared as the best accessions. For T1, accession numbers SZE1/13 collected from Sheikh Zaid Enclosure, KP2/2 collected from Kaley Pahar, SL1/2, collected from Singhar Lattan, SZE1/15 collected from Sheikh Zaid Enclosure and KP2/4 collected from Kaley Pahar appeared as the best accessions. For T2, accession numbers KP2/4 collected from Kaley Pahar, KP1/2 collected from Kaley Pahar, SL1/2, collected from Singhar Lattan and SZE1/9 collected from Sheikh Zaid Enclosure appeared as the best accessions while SZE1/15 collected from Sheikh Zaid Enclosure and DR2/3 collected from Darawar Fort appeared as second best accessions. For T3, accession numbers KP2/4 collected from Kaley Pahar, KP2/2 collected from Kaley Pahar and SL1/2, collected from Singhar Lattan appeared as the best accessions while KP1/2 collected from Kaley Pahar, SZE1/15 collected from Sheikh Zaid Enclosure and SZE1/13 collected from Sheikh Zaid Enclosure appeared as second best accessions. Thus it is concluded that SL 1/2 (Singhar Lattan) is the best accession among all because it can cope well with all the stresses implied. Second best accession is SZE 1/15 (Sheikh Zaid Enclosure). It can be concluded here that drought stress caused a significant influence on earing, maturity, morpho-anatomy and physiology of different accessions of *Cenchrus ciliaris* depending upon the environmental conditions, plant growth pattern and plant life cycle. According to the results, the relic population of *Cenchrus ciliaris* holds enough genetic diversity but human interferences, heavy grazing, prolonged droughts and salinity is marking long lasting effects on its genetic structure. It is emphasized that the germplasm of *C. ciliaris,* adapted in hot and punishing climate of Cholistan desert, has a lot of potential for its further evaluation against multiple stresses such as drought, salinity and high temperature to sort out the best genotypes, which will ultimately be helpful in greening the degraded rangelands of the Cholistan desert. It is also recommended that ex-*situ* and *in-situ* conservation should be done and diverse germplasm collection from a large number of colonized habitats should be done to screen out accessions with broader ecological amplitude. An insight into growth changes in these desert plants under drought stress is need of the hour to dry-land research information. Such studies will serve as a guideline in setting priorities for germplasm acquisition, reclamation of habitat loss and high fodder production in arid range lands of the Cholistan desert.

Keywords: *Cenchrus ciliaris,* Cholistan dessert, climate resilient forage, drought resistant

Aboveground vegetation biomass, plant species composition, invertebrate and vertebrate animals and soil properties of 53-years protected cold-winter desert of Balochistan, Pakistan

Najeeb Ullah[1], Shamim Gul[1,2]
[1]University of Balochistan, Department of Botany, Quetta, 87300, Pakistan
[2]McGill University, Department of Natural Resource Sciences, MacDonald Campus, Sainte-Anne-de-Bellevue, H9X 3V9, Quebec, Canada
Email: shamim.gul@mail.mcgill.ca

Abstract

Rangelands provide number of ecosystem services to mankind. Degradation of rangelands have deleterious effects on climate and human wellbeing. The protection of rangelands is important to maintain their ecosystem services. Karkhasa National Park is a cold-winter desert in the District Quetta, Balochistan, Pakistan. This rangeland is protected from anthropogenic disturbances since 1972. This study evaluated aboveground vegetation biomass; number of species of plants, invertebrates and vertebrates; soil organic carbon (SOC), Olsen phosphorus, potassium and clay contents of soil of Karkhasa. These properties of protected rangeland site were further compared with the same properties of a degraded rangeland site Sra Ghurgai, situated in the same region, under similar climatic conditions. Our results revealed that the 53 years of protection of this cold-winter desert has increased the aboveground vegetation biomass by 397 - 993% ($P<0.05$). The protected site had more than 40 plant species, more than 35 invertebrate species belong to all trophic levels and vertebrate species of amphibian, reptile and mammal groups. Contrary to the protected site, degraded site had only four herbaceous plant species and four animal species (three invertebrates and one vertebrate). The SOC contents were 83% higher in the protected relative to unprotected rangeland site ($P<0.05$). The protected rangeland site had 8% higher Olsen P, 121% higher clay and 22% lower sand contents compared to the degraded rangeland site ($P<0.05$). Our results reveal that protection of this cold-winter dessert for 53 years improved aboveground vegetation biomass, number of plant, invertebrate and vertebrate species and soil properties such as accrual of SOC and high nutrient and clay contents indicating an improved ecosystem functioning relative to degraded rangeland site.

Keywords: Rangeland protection, Invertebrates, SOC, Trophic levels, Grazing, Rangeland degradation

Comparative evaluation of Oil based Vaccine Adjuvanted with Montanide and Eolane -150 against Hemorrhagic Septicemia in Farm Animals

Rehana Noor, Muhammad Shafee, Muhammad Naeem, Raheel Mehboob, Shaista Nasir, Palwasha Khan
[1]Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan
Email: rnkkakar@gmail.com

Abstract
Hemorrhagic septicemia (HS), a lethal disease due poses serious threat to farm animals. The present work was focused on the development and assessment of the efficacy, of two oil-adjuvanted vaccine formulations with Montanide ISA-50V2 and Eolane-150. Vaccine was prepared with three different concentrations (1.5, 2.0, and 2.5 mg/ml) with OD_{450}. Sterility, organoleptic stability, and emulsion integrity of the vaccine were evaluated. Different parameters such as, storage upto 90 days on room temperature and refrigeration temperature (4-8°C), phasial separation or any contamination were evaluated and found satisfactory results. The immunogenicity of all vaccines was tested in rabbits using the Indirect Hemagglutination Assay (IHA). Montanide ISA-50V2 yielded higher antibody titers in all doses, with peak CGMT of 6.85×10^{10} being 2.5 mg/mL, comparable to that of the commercial vaccine employed as a positive control. Similarly, the Eolane-150 also exhibited promising results with peak CGMT at 2.5 mg/mL (2.1×10^{9}) up to 120 days. In conclusion, Montanide and Eolane based HS Vaccine as acceptable for humoral immunity production. Furthermore, 2.0 mg/ml concentration of antigen is more suitable and recommended for desirable results of durable immunity production.

Keywords: HS Vaccine, Montanide, Eolane, animal

Rangeland Ecosystems, Services, Restoration and Impact on Livelihood in Balochistan

Sarfraz Ahmad[1], Muhammad Islam[2] and Nadeem Sadiq[3]
1. Ex-Member Natural Resources, PARC, Islamabad
2. Ex-Director Rangeland Management and Forestry, PARC, Islamabad
3. Director General, Balochistan Agricultural Research & Development Centre, Quetta
Email: s_ahmadazrc@yahoo.com

Abstract

Rangelands in Balochistan cover 32.3 Mha (93%) out of the total 34.7 Million hectares. Out of this range area, about 21 Mha (65%) is considered grazing land. Critically threatened ecosystems in Balochistan are Chagai Desert, Balochistan Juniper Forest, Chilghoza Forest, Sub-Tropical Forest and Balochistan Rivers. Rangeland ecosystems are degrading rapidly due to increasing human and livestock population, climatic factors, urbanization and un-planed natural resources utilization. The current forage production of the different range types ranges from 0.3 to 0.5 T/ha and the potential ranges from 1.00 to 2.5 T/ha. The major ecosystem services of rangeland of Balochistan are pastoral livelihood 32.934 m heads, household energy 7.3 million, wildlife 11,000 heads, watershed conservation of 18 basins, mazri forest produce 27000 tons, carbon sequestration, biodiversity and many more. Rangeland resources degradation is posing serious ecological threats for the ecosystem services and livelihood of approximately 0.800 million rural households in the province. Restoration and rehabilitation are the two main procedures for regeneration of a degraded rangeland. Biological recovery of vegetation studies were carried out in shrub and grasslands at various sites (Mastung, Ziarat (Tomagh), Loralai) in Balochistan. The initial dry matter forage production was 80, 60 and 184 kg/ha, respectively at Mastung, Ziarat and Loralai. After three years protection the dry matter forage production was recorded 230, 484 and 864 kg/ha At Mastung the dominated range vegetation is Artemisia and Haloxolon species while at Tomagh and Loralai perennial grasses (*Cymbopogon jwarancusa* and *Chrysopogon aucheri*) is dominant. Rainfall distribution during vegetative growth period plays a critical role. At highly degraded sites artificial plantation with suitable plant species is possible. However, must be carried out by considering water availability and water harvesting techniques. Drought tolerant multipurpose fodder species like (*Atriplex* species, *Salsola vermiculata*) have shown good results. Management and restoration of native vegetation require knowledge of seed dispersal, soil seed bank, seedling recruitment and survival. Rangeland ecosystem management in the province may consider ecological sustainable development, building resilience in rangeland ecosystem, prevention of resources degradation, involvement of various stakeholders, area specific management plans and continuous monitoring and re-adjustment of management plans.

Keywords: rangeland ecosystem services, Balochistan, grazing management, palatable plant species, *Chrysopogon aucheri, Cymbopogon jwarancusa*

Stay-Green Related Traits and Their Association with Phenology and Yield Performance in Wheat Genotypes under Terminal Water Stress

Shabana[1], Shaista Anjum[1], Jahangir Khan[2], Syed Riaz Ahmed[2], Javed Ahmed[2], Nadeem Sadiq[2]
[1]University of Balochistan, Quetta, Pakistan
[2]Balochistan Agricultural Research and Development Center Quetta, Pakistan
Email: shaista.alizai@yahoo.com

Abstract

The annual genetic gain in wheat yield is estimated at approximately 1.6%, which must be substantially enhanced to meet the projected food demand of 9 billion people by 2050. Improving grain number and grain weight requires strategic selection of traits that optimize assimilate partitioning toward grain. In this context, the present study evaluated 22 wheat genotypes along with two check varieties under the semi-arid conditions of Balochistan to identify stay-green-related traits associated with yield performance. Field experiments were conducted at the Balochistan Agricultural Research and Development Center (BARDC), Quetta, during the wheat growing season. Stay-green related traits were assessed using Normalized Difference Vegetation Index (NDVI) across six growth stages, along with canopy temperature (CT) and phenological development (days to 50% heading). Genotypic variation and trait associations were analyzed at the genotype level. Analysis of variance revealed significant differences ($p < 0.05$) among genotypes for NDVI at specific growth stages (NDVI-3, NDVI-4, and NDVI-5), as well as for days to heading, biological yield, and grain yield, while early-stage NDVI, late-stage NDVI (NDVI-6), and canopy temperature showed non-significant variation. Among the evaluated genotypes, BARDC-W22, BARDC-W20, BARDC-W17, BARDC-W15, and BARDC-W13 exhibited comparatively higher grain and biological yields under terminal water stress conditions. The results further indicated that wheat genotypes displayed stage-dependent sensitivity to water stress, with mid-growth stages showing greater physiological differentiation. NDVI measurements at these critical stages provided useful insights into canopy status and genotype performance, although their association with grain yield remained moderate and inconsistent. Overall, the findings suggest that stay-green related traits, particularly NDVI-based canopy assessments when interpreted alongside phenological traits, can support the identification of high-performing wheat genotypes in semi-arid environments. However, their standalone predictive capacity for grain yield appears limited

Keywords: Grain yield, phenology, wheat genotypes, yield, semi-arid

Theme 3

Medicinal plants of drylands: production, utilization potential and herbal industry

In silico based profiling of bioactive compounds from *Calotropis procera* against anti-inflammatory and antibacterial activities

Abdul Hakeem and Naqeebullah Khan
Faculty of Life Science, Department of Chemistry, University of Balochistan, Quetta
Email: abdulhakeemtareen93@gmail.com

Abstract

The plant *Calotropis procera* contains a variety of bioactive compounds that could be used for medicinal purposes. In the present study, we selected two compounds Hexahydrofarnesyl and 2,4-dimethylbenzo[h]quinoline. Various computational techniques such as pharmacokinetics and toxicity predictions, molecular docking, and density functional theory (DFT) calculations were used to evaluate their drug-likeness and potential therapeutic activities. ADME (absorption, distribution, metabolism, and excretion) and toxicity predictions were made using SwissADME, pkCSM, and ProTox web servers, and molecular docking was performed to explore interactions with protein targets involved in inflammation and infectious diseases. The outcomes suggested that CP-1 has significant anti-inflammatory activity and good blood-brain barrier permeability, making it a potential candidate for neurological indications, while CP-2 has good antibacterial activity but is comparatively more toxic. Both exhibited reasonable pharmacokinetics, suggesting their potential for experimental verification as potential drug candidates. This study offers theoretical insights into the development of new drugs from *Calotropis procera*.

Keywords: *Calotropis procera*, bioactive compounds, density functional theory, therapeutic activities, antibacterial activity.

Ethnobotanical Knowledge and Conservation Challenges of Medicinal Plants in Subtropical Forests, Lesser Himalayas Pakistan: Implications for Sustainable Management

Bilal Ahmad[1, †, *], Said Latif Ullah[1†], Ali Akbar[2,*]
[1]Department of Agriculture Sciences & Forestry, University of Swat, Swat 19120, Pakistan,
bilalforester89@yahoo.com, latifkhan1357a@gmail.com
[2]Department of Biotechnology and Microbiology, University of Swat, Swat 19120, Pakistan,
ali.akbar@um.uob.edu.pk

Abstract

Medicinal plants constitute a critical component of traditional healthcare systems and play a significant role in supporting rural livelihoods and biodiversity conservation worldwide. The present study investigates the traditional ecological knowledge, utilization patterns, and conservation status of medicinal plants in a subtropical forest ecosystem. Ethnobotanical data were collected through semi-structured interviews and field surveys involving 50 informants, complemented by plant specimen collection and taxonomic identification. There were 58 medicinal plant species found, all belonging to 40 families. This shows that there is a lot of floristic diversity and a lot of ethnomedicinal richness. The findings reveal a strong dependency of local communities on forest resources, primarily for fodder and fuelwood, with medicinal plant use integrated into broader subsistence strategies. The majority of respondents had moderate knowledge of traditional practices, indicating a potential decline in indigenous practices. However, the distribution of traditional knowledge was found to be uneven. Herbal medicine remains the dominant healthcare approach, often complemented by allopathic and belief-based treatments. Leaves were the most frequently utilized plant part, suggesting relatively sustainable harvesting practices. However, the study identifies significant threats to the conservation of medicinal plants, such as fuelwood extraction, overgrazing, overharvesting, and climate-related disturbances. The dominance of herbaceous species reflects both ecological availability and ease of access, but also raises concerns regarding vulnerability to anthropogenic pressures. These findings emphasize the urgent need for integrated conservation strategies that incorporate community participation, sustainable harvesting practices, and the preservation of traditional knowledge systems. The study contributes to the growing body of evidence supporting the role of ethnobotanical knowledge in biodiversity conservation and provides a framework for sustainable management of medicinal plant resources in similar ecological settings.

Keywords: Biodiversity of plants, medicinal properties, Subtropical forests, ethnobotanical knowledge

Effects of Nanoemulsions Using Basic Essential Oils for the Shelf Life Extension of Indian Mackerel (*Rastrelliger kanagurta*)

Fehmeeda Yousuf, Umbreen Shaheen
Department of Zoology, University of Balochistan Quetta.
E-mail address; Fehmiyousuf9@gmail.com

Abstract

For the people around the world, seafood is a vital source of nutrition. Consequently, preserving the quality of seafood items by extending shelf life would be of industrial importance to achieve the best needs of customers. Nanoparticles are employed in food processing technologies for storage, disease detection, packaging systems, and other purposes in addition to improve flavor, color and antimicrobial qualities. The purpose of this research work is to determine whether olive oil based nanoemulsions can effectively enhance the fish shelf life. This study aims to offer a viable and efficient way to enhance fish preservation and lower food waste in the seafood supply chain by clarifying the workings and advantages of employing olive oil-based nanoemulsions. By investigating novel uses of nanoemulsions for preservation, this research study contributes to the developing field of nanotechnology in food technology. The objectives of this research are to synthesize and characterize olive oil nanoemulsions processed by spontaneous emulsification method, to examine the impacts of olive oil nanoemulsions on microbial, biochemical and sensory quality parameters of Indian mackerel and to compare and evaluate the shelf life extension of fish samples treated with olive oil nanoemulsion with untreated fish. The analysis of the impacts of nanoemulsions on the extension of life span/shelf life of *Rastrelliger kanagurta* (Indian Mackerel) has an important relevance to several stakeholders in fishing industry. This research could help fish processors, fishermen and retailers to maximize profit and minimize losses by extending shelf life of Indian mackerel and other fish species and contribute to the economic stability of fishing industry. Olive oil based nanoemulsions used in fish preservation could encourage sustainable methods to minimize the need for chemical preservatives and increase the fish demand.

Keywords: Olive oil, plant-based essential oils, *Mackerel (Rastrelliger kanagurta)*

Physicochemical and Phytochemical Evaluation of Open and Branded Black Tea from Quetta City

Ghulam Qadir[1], Shaista Anjum[*1], Abid Ali[1], Sumera Ishaq[1], Muhammad Asim[1]
[1]Department of Botany, University of Balochistan, Quetta-87300, Pakistan
E-mail: shaista.alizai@yahoo.com

Abstract

This study assessed and compared the physicochemical and phytochemical quality attributes of open and branded black tea samples collected from local markets in Quetta City. The objective was to evaluate the effects of processing, blending, and packaging on tea quality and to identify differences across market categories. Physicochemical analyses included pH, color intensity, turbidity, browning index (BI), and total soluble solids (TSS), while phytochemical profiling involved total phenolic content (TPC), total tannin content (TTC), total soluble phenolic compounds, and caffeine concentration. Results showed that all tea infusions were mildly acidic, with pH values ranging from 4.5 to 5.7. Color intensity ranged from 3.06–3.91 in open teas and 3.12–3.71 in branded teas, indicating comparable but slightly more consistent values in branded samples. Turbidity was higher in open teas (0.19–0.41) than in branded teas (0.17–0.25), suggesting poorer filtration and processing quality in open-market samples. In contrast, browning index values were higher in branded teas (8.09–10.07) compared to open teas (6.16–8.36), reflecting improved fermentation and color development. Total soluble solids ranged from 0.29–0.71 in open teas and 0.26–0.52 in branded teas. Phytochemical analysis revealed that TPC varied from 2.85–3.51 mg GAE/g in open teas and 2.52–3.98 mg GAE/g in branded teas. TTC ranged between 0.20–0.37 mg/mL in open teas and 0.10–0.36 mg/mL in branded teas. Caffeine content was recorded as 1.35–2.10 mg/mL in open teas and 1.42–2.65 mg/mL in branded teas. Overall, branded tea samples demonstrated more consistent physicochemical and phytochemical profiles, indicating the positive impact of standardized industrial processing and packaging. The study highlights the importance of quality control, proper processing, and storage practices to ensure consumer safety and maintain tea quality in local markets.

Keywords: Black tea, Physicochemical properties, Phytochemical analysis, Phenolic content, Caffeine, Quality assessment

Quantification of the antioxidant activity of three medicinal plant extracts

Hameeds Jabeen[1,2], Saeed ur Rehman Kakar[1], Siraj Ahmed Kakar[3], Shamim Gul[1], Tariq Ismail[1]
[1]Department of Botany, University of Balochistan
[2]Department of Plant Sciences, Government Girls Postgraduate College, Quetta, Cantonment
[3]Government Boys Degree College, Quetta
Email: shamim.gul@mail.mcgill.ca

Abstract

Traditional medicine around the world is being revalued as a result of substantial research into various plant species and their therapeutic properties. Medicinal plants have been employed since prehistoric times as important sources of medicinal chemicals for disease treatment and health maintenance. Approximately 80% of the world's population depends on natural therapies. They include bioactive secondary metabolites, which are required for the development of modern medications. Experimental data revealed that reactive oxygen species (ROS) and free radicals (FR) may be involved in a wide range of numerous chronic illnesses, such as cancer, heart disease, diabetes, and neurological problems. This study aimed to evaluate the antioxidant activity, total phenolic content (TPC), and total flavonoids content (TFC) of the methanolic extracts of three wild medicinal plants including Cotoneaster fghanica, Astragalus hostilis, ans Salsola Montana. The antioxidant activity was evaluated using DPPH assay i.e 1,1-diphenyl-2-picryl-hydrazyl (DPPH) free radical was used to measure free radical scavenging activity, while the TPC and TFC were evaluated using Folin-Ciocalteu's and Aluminium chloride colorimetricmethods respectively. The results revealed that the plant extract showed various degree of antioxidant activity. *Salsola Montana* was found to the highest value of TPC 627.66±30 mg GAE/ml, followed by *Astragalus hostilis* 616.33± 19.85, and *Cotoneaster afghanica* 342.33±30.73. The highest value of TFC was found in *C. afghanica* (695.66 ± 19.13 ug CE/ml) followed by S.montana(257.33± 13.31 ug CE/ml) and A. hostilis(219 ± 8.14 ug CE/ml). The overall antioxidant activity of Astragallus hostilis (81 % DPPH Inhibition) was the strongest, followed in descending order by Salsola Montana (79.6 % DPPH)Inhibition and Cotneaster afghanica (21 % DPPH Inhibition). All the methanolic extracts exhibited antioxidant activity significantly. High phenolic and flavonoid contents are consistently associated with strong antioxidant properties, suggesting their potential for usage in food fortification and medical applications.

Keywords: *Astragalus hostilis, Cotoneaster afghanica,* Medicinal plants, *Salsola Montana,* antioxidant activity

Antibacterial activities and phytochemical screening of three wild herbs of cold mountainous regions of Balochistan, Pakistan

Hameeda jabeen[1*], Saeedu ur Rehmn Kakar[1], Rasool Bakhsh Tareen[1], Siraj Ahmed Kakar[2], Shamim Gul[1], Muhammad Shafee[3], Kalsoom Anwer[1]
[1]Department of Botany, University of Balochistan, Quetta, Pakistan
[2]Government Postgraduate Science College Quetta Balochistan, Pakistan
[3]CASVAB University of Balochistan, Quetta Pakistan
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Medicinal plants play a major role in the delivery of healthcare, particularly among the rural population of Balochistan. This study aimed to investigate the antibacterial activity of three medicinal plant species; *Astragalus hostilis*, *Salsola montana*, and *Cotoneaster afghanica*. The alkaloids, flavonoids, and saponins were 3.07%, 4.51% and 1.68% respectively in *Astragalus hostilis*; 2.42%, 5.29% and 1.27% respectively in *S. montana* and 4.96%, 7.27% and 2.24% respectively in *C. afghanica.* The *in-vitro* antibacterial activities of the crude methanol extract (CME) of these plants were evaluated against bacterial strains; *Escherichia coli, Staphylococcus aureus, Streptococcus pyogenes, Pseudomonas aeruginosa, Klebsiella pneumoniae, and Bacillus subtilis* using disc diffusion technique. The extracts were tested to determine the minimum inhibitory concentration (MIC) for each bacterial strain using agar plates. The antibacterial activity of the samples was more effective inhibiting the growth of gram-positive than gram-negative bacteria. The highest antimicrobial potentials were observed for the extracts of *C. afghanica* with 22mm zone of inhibition against *S. aureus*. The CME had MIC values ranging from 1.04 mg/mL to 16.66 mg/mL. The least MIC value was 1.04 mg/mL shown by *C. afghanica* against *Staphylococcus aureus,* while *S. montana* had the highest MIC value of 16.66mg/mL against *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Antibacterial efficacy shown by these plants provide a scientific basis and thus validates their traditional uses as homemade remedies.

Keywords: Medicinal plants, Ziarat, Balochistan, antibacterial, *Astragalus hostilis, Salsola Montana, Cotonester afghanica*.

Green Nanotechnology Meets Herbal Medicine: Biosynthesis of Silver Nanoparticles from *Berberis lycium* with Enhanced Antibacterial and Wound Healing Potential

Jahan Zaib, Hifza Taj and Dr. Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: jjbaloch1112@gmail.com

Abstract

The present study explores the green synthesis of metal nanoparticles using the medicinal plant *Berberis lycium* and evaluates their biomedical potential. Medicinal plants remain a critical source of therapeutic agents, particularly in developing regions where traditional healthcare systems are widely practiced. *Berberis lycium*, a plant indigenous to South Asia, is enriched with bioactive constituents such as berberine, flavonoids, and alkaloids, which are known for their antimicrobial, anti-inflammatory, and wound healing properties. In the present work, plant material was collected, shade-dried, and processed to obtain aqueous extracts rich in phytochemicals. These extracts were utilized for the eco-friendly biosynthesis of silver nanoparticles (AgNPs), where phytoconstituents functioned as both reducing and stabilizing agents. The synthesized nanoparticles were comprehensively characterized using UV–visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Transmission Electron Microscopy (TEM), and X-ray Diffraction (XRD) to determine their optical properties, morphology, and crystalline nature. The biological efficacy of the synthesized nanoparticles was assessed through antibacterial assays against both Gram-positive and Gram-negative bacterial strains using agar well diffusion and minimum inhibitory concentration (MIC) methods. Additionally, in vivo wound healing potential was evaluated using experimental animal models. The findings revealed that plant-mediated AgNPs exhibited significantly enhanced antibacterial activity and superior wound healing performance compared to the crude plant extracts. Overall, this study highlights the potential of *Berberis lycium* as a sustainable bioresource for nanoparticle synthesis. The integration of traditional medicinal knowledge with modern nanobiotechnology offers a promising, cost-effective, and environmentally friendly approach to the development of novel antimicrobial and therapeutic agents.

Keywords: Green synthesis; *Berberis lycium*; Silver nanoparticles (AgNPs); Nanobiotechnology; Antibacterial activity; Wound healing; Phytochemicals; FTIR; TEM; XRD; Minimum inhibitory concentration (MIC)

Application of *Achillea wilhelmsii* as a Natural Antifungal Agent to Enhance Shelf Life of Traditional Milk-Based Sweets (Barfi) from Dryland Regions

Jamila Tabassum[1], Muhammad Shafee[1], Muhammad Aziz [2]
[1]Center for Advanced Studies in Vaccinology and Biotechnology, University of Balochistan, Quetta, Pakistan
[2] Pakistan Chemical Computational Society
E-mail: maazjamila@yahoo.com

Abstract

Dryland regions face significant challenges in food preservation due to high temperatures, microbial contamination, and limited access to synthetic preservation technologies. The present study investigates the antifungal potential of the medicinal plant Achillea wilhelmsii, commonly found in arid and semi-arid environments, as a sustainable natural preservative for traditional milk-based sweets (barfi). The primary objective was to evaluate the effectiveness of Achillea wilhelmsii dry powder in delaying fungal growth and extending the shelf life of dairy products while reducing reliance on synthetic preservatives. The study employed an integrated biological, chemical, and computational approach. Methanolic and aqueous extracts of Achillea wilhelmsii were analyzed using Fourier Transform Infrared (FTIR) spectroscopy and Gas Chromatography–Mass Spectrometry (GC–MS) to identify key bioactive constituents. Major phytochemicals detected included phenolic compounds, flavonoids, terpenoids, and indole alkaloids, particularly 5,6-dimethoxyindole derivatives. Molecular docking studies demonstrated favorable binding interactions between indole alkaloids and lanosterol 14α-demethylase, an essential fungal enzyme, suggesting a plausible antifungal mechanism. Antifungal bioassays using the agar well diffusion method revealed strong inhibition activity of methanolic extracts against Candida albicans, with inhibition zones measuring up to 37 mm, while aqueous extracts showed negligible activity. To assess practical applications, barfi samples were prepared with varying concentrations of Achillea wilhelmsii dry powder (0%, 0.5%, 1%, and 1.5%) and stored under controlled temperature conditions (28–30°C). Shelf-life evaluation indicated a clear concentration-dependent delay in visible fungal growth. The control sample exhibited fungal contamination within 5 days, whereas samples fortified with higher concentrations extended fungal-free storage up to 10 days. Statistical analysis revealed a strong positive correlation ($r = 0.99$) between plant concentration and shelf-life extension, with regression analysis indicating that each 1% increase in plant powder delayed fungal growth by approximately 0.48 days. These findings highlight the significant preservative potential of Achillea wilhelmsii derived from dryland flora. This research demonstrates that native dryland plants such as Achillea wilhelmsii can serve as eco-friendly and sustainable alternatives to synthetic preservatives in traditional food systems. The application of plant-based antifungal agents supports biodiversity utilization, enhances food safety, and contributes to sustainable agricultural and food management practices in dryland ecosystems.

Keywords: *Achillea wilhelmsii*, antifungal, drylands, sustainable agriculture

Exploring the antibacterial potential of Guava leaves (*Psidium guajava*)

Maham Sheikh[1], Muhammad Shafee[1], Shabbir Ahmad[1], Abid Hussain[2], Sahiba Muhammad Khan[1], Zoha Usman[3]

[1]Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan
[2]Balochistan Agricultural Research & Development Center (BARDC), Quetta
[3]CVAS, Jhang Campus, Sub-Campus UVAS, Lahore
E-mail: shafeedr73@gmail.com

Abstract

Guava leaves (*Psidium guajava*) are used in folk medicine and contain different bioactive compounds. These compounds provide a variety of pharmacological benefits, such as antidiabetic, anticancer, antioxidant, antimicrobial, and antidiarrheal activities. This study was assessed to evaluate the antimicrobial activity of *P. guajava* leaf extracts against different microorganisms that include *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus,* and *Streptococcus mutans*. The *P. guajava* leaves were collected, dried, ground into a powder, and plant extract were made with ethanol and water. The extract was then concentrated with a rotary evaporator. Antibacterial activity was tested using the well diffusion method and susceptibility testing was performed on nutrient agar plates. Results showed potential antimicrobial activity for both extracts against the tested bacteria; however, the ethanol extract exhibited greater antimicrobial activity than the aqueous extract. In ethanolic extract *Streptococcus Mutans, Staphylococcus aureus* had a greater sensitivity to *P. guajava* leaves than any of the other tested microorganisms. Both *Escherichia coli* and *Klebsiella pneumoniae* were moderately sensitive to the guava leaf extracts, while *Pseudomonas aeruginosa* showed the least sensitivity. However, aqueous extracts exhibited moderate activity against *Streptococcus mutans, Staphylococcus aureus* and *Pseudomonas aeruginosa.* However, no visible zones of inhibition against *Escherichia coli* and *Klebsiella pneumonia* was noticed. In conclusion, the result of this study demonstrates that *Psidium guajava* extracts have great antibacterial properties and ethanolic extracts had superior efficacy as compared to aqueous extracts suggest that *Psidium guajava* leaves may serve as a natural antimicrobial agent.

Keywords: *Psidium guajava,* antimicrobial, *Klebsiella pneumonia*

Investigating Anticancer Potential of Red Algae (*Rhodophyceae*) from Gwadar Sea Shore

Mahnoor M. Rahim[1], Asad Ullah[1], Zunera Tanveer[2], Hina Ali Ahmed[3], Pari Gul[4], Shereen Abdul Baqi[1]
[1]Centre for Advanced Studies in Vaccinology and Biotechnology (CASVAB), University of [2]Balochistan, Quetta, Pakistan
[3]Department of Physiology, Bolan Medical College, Quetta
[4]Department of Zoology, Sardar Bahadur Khan Women's University, Quetta
Institute of Biochemistry, University of Balochistan, Quetta
E-mail: bmahnoor278@gmail.com

Abstract

Cancer is one of the most dangerous disease in the world due to its poor prognosis, negative treatment outcomes, and medication resistance. Nowadays, many chemical therapies and harsh techniques are used to cure cancer, which can affect the body's other healthy cells. For this reason, red algae is the potential treatment option. The red algae have a low calorie content and are high in antioxidants, poly unsaturated fatty acids, proteins, minerals, vitamins, and soluble dietary fibers. However, just like other plants, their nutrient contents are affected by outside variables like the season, environment, geographic location, and sampling conditions. The purpose of this study was to check the anticancer activity of red algae (*Rhodophyceae*) which were collected from the sea shore of Gwadar Balochistan Pakistan. Five grams of the powder algae was macerated by immersing it in fifty milliliters of solvent (methanol 100%, chloroform/methanol (3: 2), and dichloromethane 100%) for seventy-two hours. Than the samples were filter and a rotary evaporator operating at low pressure at 30 to 35°C was used to dry out the resulting algae extracts. The Cancerous cells which were used to check the anticancer potential of extract obtained from red algae. MTT assay was used to check the anticancer activity. Results was calculated with the help of IC50 calculation and from IC50 calculation the percent viability of cells was obtained.

Key words: Gwadar, Red algae, Anticancer, MTT assay, Breast cancer, Cell viability

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Pistacia khinjuk Seed Oil as Potential Anti-Dementia candidates

Marina Panezai [1], Nazima Yousaf khan [1], Muhammad Aziz[2]
[1]Institute of Biochemistry, University of Balochistan, Quetta
2 Pakistan chemical computational society
E-mail: marinapanezai@gmail.com

Abstract
Dry land plant species an important natural resource for sustainable agriculture, biodiversity conservation, and medicinal compound discovery. *Pistacia khinjuk* (wild pistachio) is a drought tolerant plant widely distributed in arid and semi-arid regions of Balochistan, Pakistan, and traditionally valued for its nutritional and therapeutic importance. The present study was designed identify, bioactive phytochemicals from *P. khinjuk* seed oil with potential neuroprotective properties. Seed oil was extracted using the cold press method and analyzed through Gas Chromatography (GC) and GC–MS techniques for compound identification. Among the detected constituents, two major phytochemicals, α-eudesmol (sesquiterpenoid) and terpinen-4-ol, were selected. In this comparative study, two phytochemicals from *Pistacia khinjuk*, were comparatively evaluated for anti-dementia potential in scientific literature.The outcome highlights *P. khinjuk* as a valuable dryland plant with promising phytochemicals for neurodegenerative disorder research. The findings support further experimental validation and encourage the utilization of dry land biodiversity for sustainable pharmaceutical exploration.

Keywords: *Pistacia khinjuk*, wild pistachio, dryland medicinal plants, dementia.

Biotechnological Evaluation of *Curcuma longa* L. Extracts as Natural Sensitizers for Sustainable Photovoltaic Applications

Muhammad Ayaz[1], Jafar Khan Kasi[1], Ajab Khan Kasi[1], Muzamil Ali[1], Muhammad Sohail[1], and Gerrit Boschloo[2]
[1]Department of Physics, University of Balochistan, Quetta, Pakistan
[2]Department of Chemistry - Ångström Laboratory, Uppsala University, Sweden
E-mail: muhammadayazphy@gmail.com

Abstract
The development of sustainable and cost-effective energy solutions is a critical frontier in plant biotechnology. We investigated the potential of Curcuma longa L. (turmeric) as a natural sensitizer for dye-sensitized solar cells (DSSCs). Turmeric contains curcumin, a bioactive secondary metabolite with high light-absorption properties, making it a viable, non-toxic alternative to synthetic ruthenium-based dyes. In this research, curcumin was extracted from Curcuma longa rhizomes and characterized for its optical properties. The extract was integrated into a DSSC assembly to evaluate its light-harvesting efficiency and photostability under simulated solar conditions. The study successfully achieved a power conversion efficiency (PCE) of 1.03%, a fill factor of 71.45%, a current density of 2.3 mA/cm2, and a voltage of 0.607 V, demonstrating significant electron injection capabilities and promising stability, as shown in the figure below. These findings demonstrate that bioprospecting dryland flora, such as Curcuma longa, can yield high-performance, eco-friendly materials for the next generation of photovoltaic devices. This biotechnological approach not only reduces the environmental footprint of solar technology but also adds industrial value to botanical resources in arid and semi-arid regions.

Keywords: Curcuma longa L., natural sensitizers, plant biotechnology, dye-sensitized solar cells (DSSCs), sustainable energy.

Computational Screening of Phytochemicals from Medicinal Plants of Drylands in Balochistan, for Anticancer Potential

Muhammad Aziz[1]*, Ashif Sajjad[1]
[1]Institute of Biochemistry, University of Balochistan, Quetta, Pakistan
E-mail: aziz1sh@hotmail.com

Abstract

Dryland ecosystems of balochistan are rich sources of medicinal plants that produce diverse phytochemicals with potential therapeutic value. The flora of Balochistan, Pakistan, represents an underexplored reservoir of bioactive compounds that may contribute to sustainable healthcare and biodiversity based drug discovery. This study was designed to computationally screen phytochemicals derived from selected medicinal plants of Balochistan to identify compounds with potential anticancer and anti-inflammatory activities. A comprehensive literature survey was conducted to identify plant species native to dryland regions with reported phytochemical constituents. A total of twelve plant families were selected based on their ethnomedicinal importance and availability in arid and semi-arid environments. Three-dimensional molecular structures of selected phytochemicals were constructed and optimized using molecular modeling tools. Molecular docking studies were performed against selected cancer-related protein targets, including HMG-CoA reductase, histone deacetylase (HDAC), BCL-2, and MDM2 enzymes, to evaluate binding affinities and interaction patterns. In addition to docking studies, pharmacokinetic and toxicity predictions were carried out using ADMET analysis to assess drug-likeness, oral absorption, and safety profiles of selected compounds. Quantum mechanical calculations were further applied to estimate molecular parameters such as chemical potential, hardness, and softness, which contribute to understanding molecular reactivity and stability. Selected compounds demonstrated stable binding interactions with key target enzymes and exhibited favorable pharmacological properties, suggesting their suitability for further biological validation.The findings highlight the potential of dryland medicinal plants as sustainable sources of novel bioactive compounds. This computational approach supports biodiversity utilization and provides a scientific foundation for future experimental validation, in vivo studies, and natural product-based drug development. The study emphasizes the importance of conserving dryland plant biodiversity while promoting its utilization in pharmaceutical and biomedical research.

Keywords: Medicinal plants, Drylands, Phytochemicals, Molecular docking, Anticancer compounds, Biodiversity, Balochistan

Clove oil reduced silver nanoparticles (CSNPs) showed 100% larvicidal activity against mosquito larvae compared to clove oil itself

Muhammad Nawaz and Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: umber_nibge@yahoo.com

Abstract

Mosquitoes are a threat to human beings and animals across the globe as they are vectors/carriers for many life threatening parasites and pathogenic viruses causing malaria, filariasis, dengue, West Nile and Zika virus diseases respectively. Due to Malaria and dengue alone, millions of people die every year. Moreover, due to overpopulation and pollution, mosquito control has become a challenge to the developing countries. Conventional techniques for controlling mosquito borne diseases includes; repellents, biological control (fishes, frogs) and bed nets. Nanotechnology has emerged as an effective, environment friendly and cheap option to address this biological challenge. Sliver nanoparticles (SNPs) impregnated bed nets already in use. ‘‘Green nanotechnology’’ uses the bacterial, fungal and plant extracts for the formation of nanoparticles. We have made clove oil reduced Silver Nanoparticles (CSNPs) by using commercially available clove oil. These CSNPs showed 100% larvicidal activity against mosquito larvae compared to that shown by the clove oil, silver solution and commercial product controls at 2 hours’ time lapse study. It is because of the adsorption of eugenol, the most abundant and active biocidal compound found in clove oil, on the surface of CSNPs. We have also prepared different sizes of CSNPs simply by changing the pH of the precursor silver solution. By increasing the pH, the size of CSNPs was also increasing but not that significant. Integration of traditional herbal knowledge with the nanotechnology has great potential and hence revolutionized the modern medicinal and chemical industry.

Key words: Green nanotechnology, clove oil, sliver nanoparticles, mosquito control

Comparative Study on the Health Benefits of Tea Prepared from Different Plant Raw Materials

Nazima Yousaf khan[1], Muhammad Aziz[2], Marina panzai[1]
[1]Institute of Biochemistry, University of Balochistan, Quetta
[2]Pakistan Chemical Computational Society
E-mail: nazimakhan_chem@yahoo.com

Abstract

Tea is among the most widely consumed plant based beverages worldwide and plays a significant role in traditional medicine and functional nutrition. Plant derived teas are prepared from diverse raw materials including leaves, flowers, roots, bark, fruits, and seeds, each contributing unique phytochemical profiles and therapeutic benefits. This study presents a comparative evaluation of tea prepared from different plant parts, emphasizing their nutritional value and bioactive potential for human health. Leaf-based teas such as green tea *(Camellia sinensis*), mint *(Mentha spp*.), and moringa (*Moringa oleifer*a) are rich in polyphenols, catechins, and flavonoids, offering strong antioxidant activity, improved metabolism, and cardiovascular protection. Flower based teas including chamomile (*Matricaria chamomilla*) and hibiscus (*Hibiscus sabdariffa*) which are associated with relaxation, anti-stress effects, and blood pressure regulation. Root based tea such as ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) provide potent anti-inflammatory and immune-supportive properties due to compounds like gingerols and curcumin. Bark-based teas, particularly cinnamon (*Cinnamomum verum*), are recognized for antimicrobial activity and metabolic support, especially in glucose regulation. Fruit and seed-based teas including fennel *(Foeniculum vulgare)* and citrus (*Citrus limon*) are valuable for digestive health, respiratory support, and vitamin enrichment. The comparative assessment highlights that leaf teas are most suitable for long-term antioxidant supplementation, while root and bark teas exhibit stronger medicinal properties for inflammation and metabolic disorders. Flower teas provide superior calming effects, whereas fruit and seed teas are highly effective for digestion and immunity. Overall, plant-based teas represent a sustainable and accessible functional beverage system with significant relevance for dryl and biodiversity utilization, herbal product development, and public health promotion.

Keywords: Herbal tea, plant raw materials, phytochemicals, antioxidants, medicinal plants, functional beverages.

Nutritional Value and Antioxidant Properties of *Pistacia Khinjuk* Stocks. (Fruits) of Zhob District, Balochistan

[1]Rahila Mandokhail and [2]Dr.Misbah Manzoor

[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract

Pistacia khinjuk stocks. is a deciduous shrub or tree of cashew family Anacardiaceae. The plant was collected from Zhob district of Balochistan (Suleiman Range) along with the bordering regions of Dera Ismail Khan in 2022 for the purpose to find and report the nutritional analysis and chemical properties of this plant. *Pistacia khinjuk stocks.* antioxidant activity were studied to understand the mechanism of the DPPH method, MTT assay, total phenolic content, total flavonoid content, antioxidant capacity and anticancer potential. Four different solvents (Ethanol, Methanol, Acetone and water extracts) were used for each analysis respectively. The elemental composition of the fruit *Pistacia Khinjuk stocks.* showed high contents of micro-element Carbon with 51.6% and the macro-element Potassium with 18531 mg/kg. Qualitative phytochemicals analysis confirmed the existence of phenols, flavonoids, alkaloids, tannins, terpenoids, coumarins, and phytosterols. Anthocyanins were not identified in any of the extracts. Quantitative analysis exposed that the methanol and acetone extract had the maximum TPC with value (1197 and 248 mg GAE/g) and total flavonoid content with value (923 and 625 mg GAE/g) however, the ethanol and water extracts had significantly reduced phenolic contents with value (39 and 92 mg GAE/g, individually) and flavonoid contents with value (130 and 8 mg GAE/g, individually). Similarly the methanol and acetone extracts showed the lowest IC_{50} values (10.59 µg/mL and 6.53 µg/mL respectively), which indicate that they had the strongest antioxidant potential. The anticancer activity results showed similar trends, the acetone and methanol extracts were the most effective, with less IC_{50} values of 6.53 µg/mL for acetone and 10.59 µg/mL for methanol respectively against Colorectal cancerous cell lines (SW480). This study showed that plant is nutritionally attractive dried fruit and have great antioxidant and anticancer potential that promote the plant nutritional and pharmacological values.

Keywords: Nutritional, Antioxidant, Phenolic and *Pistacia Khinjuk stocks.*

Exploring the Antibacterial Potential of Indigenously Cultivated Olive Tree Leaves

Sahiba Muhammad[1], Muhammad Shafee[1], Shabbir Ahmad[1], Shafiq Ahmad[2], Maham Sheikh[1]
[1]Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan
[2]Balochistan Agricultural Research & Development Center (BARDC), Quetta
E-mail: shafeedr73@gmail.com

Abstract
Olea europaea (Olive) oil have traditionally been used widely for the treatment of different ailments as a folk medicine throughout the world. Its leaves and fruits both are of great antimicrobial potential containing different bioactive compounds. This study was designed to explore the antimicrobial potential of olive leaves cultivated indigenously in the province. Both aqueous and ethanolic extract of leaves was used using Kirby baur method/ disc diffusion method. The shade dried leaves were grinded to fine powder before preparing the extract. Results revealed substantial potential of olive leaves with both aqueous and ethanolic extract against different microbes. Leaves aqueous extracts showed significant antimicrobial activity against *E. coli* and S*taphylococcus aureus*, with weak activity against *streptococcus mutans* and *klebsiella pneumoniae* while no activity against *Pseudomonas aeruginosa*. Conversely, the leaf ethanolic extract showed promising activity against all tested organisms except *E. coli*. The obtained results support the fact that olive leaves possess antibacterial properties that could potentially be utilized in the development of antibiotics and alternative antibacterial therapies amid rising antibiotic resistance and can be used as herbal tea against different common diseases.
Key Words: Olive, leaves, antimicrobial, ethanolic extract.

Quantitative Ethnobotanical Assessment of Medicinal Plants used by Indigenous Communities at Sardar Bahadur Khan Women's University, Quetta Pakistan

Sana Farooq[1], Misbah Manzoor[2]*, Burooj Mengal[3]
[1,2,3] Department of Botany, Sardar Bahadur Khan Women University, Quetta, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract
Ethnobotanical knowledge forms an integral part of indigenous knowledge systems, offering valuable insights into the therapeutic use of plants for treating human ailments. The present study was conducted at Sardar Bahadur Khan Women's University (SBKWU), Quetta, with the objective of documenting and evaluating ethnomedicinal practices, as well as quantitatively assessing the cultural significance of medicinal plants.Ethnomedicinal data were collected through open-ended questionnaires, personal interviews, and walk-through surveys involving 110 informants, primarily students. Plant specimens were collected, identified, and preserved in herbarium form at SBKWU. Quantitative analysis was carried out using Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL%), and Family Importance Value (FIV) indices.A total of 51 medicinal plant species belonging to 30 families were documented. The most dominant family was Apiaceae (7 species), followed by Lamiaceae (6) and Asteraceae (3). *Plantago lanceolata L.* was the most frequently cited species (RFC = 0.37), followed by *Foeniculum vulgare Mill.* (0.34) and *Trachyspermum ammi (L.)* (0.32). Herbs were the predominant life form (86%), followed by trees (8%) and shrubs (6%). The seeds were the most frequently used plant part (24%), while leaves accounted for 10 uses. The most common preparation methods were soaking and powdering (12 each), with oral administration being the dominant route (70%), followed by topical application (6%).A total of 46 disease categories were treated, with gastrointestinal disorders being the most frequently cited (15 uses). *Calotropis procera (Ait.) R. Br.* exhibited the highest Use Value (0.75), while *Plantago lanceolata L.* (36.36%), *Foeniculum vulgare Mill.* (34.54%), and *Trachyspermum ammi (L.)* (32.72%) showed the highest Fidelity Levels. Among plant families, Apiaceae exhibited the highest FIV (20.52%), followed by Lamiaceae (13.29%), Asteraceae (12.33%), and Plantaginaceae (7. 89%).This study highlights the dominance of herbaceous species, seed-based remedies, and oral administration practices in local ethno-medicine at SBKWU, Quetta. The findings reaffirm that medicinal plants continue to play a vital role in community healthcare and provide a foundation for future pharmacological investigations and the preservation of ethnobotanical knowledge.

Keywords: Ethnobotany, Ethnomedicinal Knowledge, Medicinal Plants, Fidelity Level, Indigenous Remedies, Traditional Knowledge, Phytotherapy, Sardar Bahadur Khan Women's University, Quetta, Pakistan.

Green Synthesis of Silver Nanoparticles Using *Ephedra intermedia*: A Phytochemical-Driven Nano-Biotechnological Approach

Saqib Khan, Mohammad Irfan and Dr Umbreen Shaheen
Department of Zoology, University of Balochistan
E-mail: irfansarparah939@gmail.com

Abstract

Green synthesis of silver nanoparticles (AgNPs) offers an eco-friendly and cost-effective alternative to conventional chemical methods, using plant phytochemicals as natural reducing and stabilizing agents. *Ephedra intermedia*, a medicinal shrub native to Balochistan, Pakistan, contains bioactive compounds such as flavonoids, phenolics, and alkaloids, making it a promising candidate for nanoparticle synthesis. In the proposed approach, aqueous leaf extract of *E. intermedia* will be reacted with $AgNO_3$ under controlled conditions (60–80°C, pH 7–9), resulting in a visible color change indicating nanoparticle formation. The synthesized AgNPs will be characterized using UV–Vis (Ultraviolet visible spectrometer), FTIR (Fourier-Transform Infrared spectroscopy), XRD (X-Ray Diffraction), SEM (Scanning Electron Microscope), TEM (Transmission Electron Microscopy), and DLS (Duckworth-Lewis-Stren method) techniques. Expected outcomes include spherical nanoparticles of 20–30 nm size, a surface plasmon resonance peak at 400–450 nm and stable colloidal behavior with zeta potential below −30 mV. These nanoparticles are expected to exhibit strong antioxidant and antibacterial activities against both Gram-positive and Gram-negative bacteria. This study highlights *Ephedra intermedia* as a valuable green resource for the synthesis of bioactive silver nanoparticles with potential biomedical applications.

Keywords: Green synthesis; silver nanoparticles; *Ephedra intermedia*; phytochemicals; nanobiotechnology; antimicrobial activity; antioxidant activity; UV–Vis spectroscopy; FTIR; XRD; SEM; TEM; DLS

Medicinal and Aromatic Plants for Dryland Farming Systems in Balochistan

Sarfraz Ahmad[1], Muhammad Islam[2] and Nadeem Sadiq[3]
4. Ex-Member Natural Resources, PARC, Islamabad
5. Ex-Director Rangeland Management and Forestry, PARC, Islamabad
6. Director General, Balochistan Agricultural Research & Development Centre, Quetta
E-mail: s_ahmadazrc@yahoo.com

Abstract

The demand of medicinal and aromatic plants is increasing both in developed and developing countries. Most of the raw materials of medicinal plants are collected from forests and rangelands and few medicinal plants are cultivated. Deforestation, over-exploitation, overgrazing, and conversion of natural habitats to agricultural fields resulted scarcity of medicinal plants. About 6000 plant species have been reported in Pakistan and among these about 3200 species have medicinal uses in Unani, allopathic, and homeopathic medicines and 300 species are used in traditional medicines. However, the cultivation potential of few species is exploited and 90% of the country's medicinal herb requirement is imported. Trade in medicinal herbs is growing in volume and in exports. Efforts are required to increase the production in Pakistan by observing the WHO guidelines of good agricultural, collection and processing practices. Balochistan has diverse flora of medicinal plants. In Balochistan, various medicinal plants are being collected and sold in the local market. However, very limited knowledge is available on the multi-purpose herbs which can be cultivated and utilized for different purposes. Research studies showed that medicinal and aromatic plants can be cultivated in various agro-ecologies of Balochistan for commercial scale production and marketing. The suitable species can be classified into four main groups: culinary herbs, medicinal herbs, perfumery herbs, and herbal teas. Germplasm of (*Cuminum cyminum, Nigella stavia, Foeniculum vulgare, Linum usitatissimum, Anethem sowa, Carum copticum*) was evaluated for various growth parameters and yield potential in Balochistan. Based on adaptability and yield potential all these medicinal plants can be grown both in highlands and plains areas of Balochistan. These crops required less water as compared with other irrigated crops. In rainfed condition the seed yield of cumin ranged from 500-600 kg/ha. The Fennel seed yield ranged from 1500 to 2000 kg/ha and the Kalonji seed yield ranged from 800 to 1000 kg/ha. Thyme, Oregano, Rosemary, Marjoram, Tarragon are common perennial culinary herbs. Production potential of these herbs was evaluated in various trials and results are very encouraging. These herbs can successfully be grown in highlands of Balochistan. Two to three cuttings of leaves can be obtained before the start of winter season. English Thyme and German Chamomile are the two most common herbal teas in many parts of the world. German chamomile has shown excellent production potential. The fresh flower production of German Chamomile under rainfed conditions was recorded 1500 kg/ha with 10 days flower picking intervals. In irrigated conditions the fresh flower production ranged from 4000-6000 kg/ha. Thyme, French Lavender, English Lavender, Hyssop, German Chamomile, Marjoram, Anise, Chicory, Yarrow, Rosemary, Lemon Balm, Comfrey, Saffron, Oregano and Ispaghol can successfully be grown in Balochistan. However, better marketing and prices may encourage the farmers to grow these medicinal plants.

Keywords: Germplasm, medicinal plants, Balochistan, culinary herbs, perfumery herbs

Effect of watering, Biofertilizer and NPK fertilizer on Rosemary (*Rosmarinus officinalis* L.) growth and production in highlands of Balochistan, Pakistan

Shazia Irfan[1], Sarfaraz Ahmed[2], and Mufakhira Jan Durrani[3] (Late)
[*,1] Department of Botany, Faculty of Life Science, Sardar Bahadur Khan Women's University, Quetta Pakistan
[2] Project Director, RADP, PARC, Islamabad
3 Department of Botany, University of Balochistan
E-mail: irfanshazia16@gmail.com

Abstract

Rosmarinus officinalis L. (Rosemary) is an evergreen plant. It is perennial shrub, and native to Mediterranean region, China, Hungary, The Middle East, Portugal, Russia, Romania, Serbia and USA. The leaves of *Rosmarinus officinalis* L. are used as seasonings for soups, meat, fish and poultry. The oil distilled from flowering tops, stems and leaves is used in perfumes, cosmetics and for aromatherapy. The plant and extracts possess antibacterial and antioxidant activity and it is considered good source of nectar for bees. As a medicinal plant, rosemary has been used as an external stimulant and as a relaxant for nervousness, muscle spasms and headaches. Studies were carried out at Arid Zone Research Centre Quetta during the year 2008 and 2009 to determine the effect of Biofertilizer, NPK fertilizer and watering level on growth and production. Separate trials were conducted. Each trial was layout in a Completely Randomized Block Design with three replications. Watering was applied @ 1 liter /plant, 1.5 litter/plant and 2 litter/plant during the entire growth period at 15 days interval. Watering @ 2 litter/plant enhanced the plant height (32.67cm) ,plant total fresh weight (124.83g/plant),plant total dry weight (59.167g), leaves fresh weight (90.53g/plant), leaves dry weight (47.45g/plant) and wood fresh weight (14.93g/plant) and wood dry weight (11.77g/plant) as compared to 1L and 1.5 L watering. Biopride foliar spray has significant effect on all growth parameters as compared to Water Soluble Fertilizer foliar spray and control. Low concentration of NPK Fertilizer i.e. 60Kg /ha have significant effect on all growth parameters as compared to 80Kg/ha and 100Kg /ha. The results indicated that Rosemary has great potential for cultivation in highlands of Balochistan as a multi-purpose plant. However, further studies are required for essential oil content at various growth stages.

Key words: Biofertilizer, fertilizer, water stress, growth parameters, Rosmarry.

Theme 4

Farming systems of drylands – options and opportunities for better economy and livestock production

Eco-Friendly Management of Fusarium Wilt of Cucumber Using Botanical Extracts under *In Vitro* and High Tunnel Conditions in Uplands of Balochistan

Adnan Baloch[1], Bashir Ahmed Bangulzai[1], Muhammad Waris[2]
[1]Directorate of Vegetable Seed Production, Agriculture Research Institute, Sariab, Quetta.
[2]Department of Plant Pathology, Balochistan Agriculture College, Quetta.
E-mail: adnanbaloch@hotmail.com

Abstract

In upland regions of Balochistan, high plastic tunnels are increasingly adopted for cucumber cultivation; however, an important consideration is, the high tunnels create favorable environment along with warm and high humidity that leads to the development of Fusarium wilt of cucumber, caused by *Fusarium oxysporum* f. sp. *cucumerinum (FOC)*, resulting up to 50% losses in growth and yield of cucumber. This study aimed to evaluate the antifungal efficacy of selected botanical extracts against *FOC* under both *in vitro* and high tunnel conditions in Balochistan. *In vitro* assays demonstrated that all tested botanical extracts significantly suppressed the radial growth of *FOC* compared to the untreated control. Turmeric and eucalyptus extracts exhibited the highest antifungal activity, reducing fungal colony diameters to 11 mm and 14 mm, respectively, at 12% concentration, compared to 85 mm in the control. Ginger and red radish showed moderate inhibition, while mint, black pepper, and garlic were the least effective. Based on *in vitro* results, the most effective extracts *viz.*, turmeric, eucalyptus, and ginger were selected for further evaluation under high plastic tunnel conditions. Cucumber plants treated with these extracts exhibited a significant reduction in disease incidence (18.45–48.82%), plant mortality (16.65–36.80%), and root infection (20.32–52.42%) compared to untreated control plants (77.82%, 72.15%, and 75.50%, respectively). Eucalyptus was the most effective treatment across all parameters. Moreover, treated plants showed enhanced vegetative growth, with significant increases in shoot and root length, fresh biomass, and dry matter accumulation. The highest values for all growth parameters were recorded in eucalyptus-treated plants, followed by turmeric and ginger. In conclusion, turmeric and especially eucalyptus extracts show strong potential as eco-friendly solutions for managing Fusarium wilt in cucumber under protected cultivation.

Keywords: Fusarium wilt, management, cucumber, botanical extracts, high tunnel

Investigating the life cycle of the major insect pests affecting dry fruits of Quetta Balochistan

Afroz Nisa, Nosheen Rafiq
Department of Zoology, Sardar Bahadur Khan Women University
Quetta
E-mail: nosheenyasirzafar@gmail.com

Abstract

The diversity, life cycle and seasonal activity of insect pests that infest stored dried fruits in Quetta, Balochistan were studied during March 2024 to February 2025. Infested dry fruit products, including almonds, walnuts, raisins, dates, pistachios, cashew nuts, fig, dried dates, dried apricots and black currents were sampled from 20 local markets and examined in the laboratory of Zoology women's University Quetta Balochistan. A total of 260 insect specimens from three major families i.e. Pyralidae, Tenebrionidae and Silvanidae, representing seven species were identified during current study. The most common species among collected specimens were the sawtoothed grain beetle *(Oryzaephilus surinamensis*) with 118 individuals which was followed by the Indian meal moth (*Plodia interpunctella*) with 53 individuals and (*Ephestia cautella*) with 27 individuals. Least common species were *Tribolium castaneam* (Red Flour Beetle) (16), *Ephestia figulilella* (Raisin Moth) (12) and *Cydia pomonella* (Codling Moth) (11). Every species that was found underwent full metamorphosis (egg, larva, pupa and adult), *Oryzaephilus surinamensis* (35 larvae, 14 pupae and 69 adults)**,** *Plodia interpunctella* (21 larvae, 5 pupae and 27 adults), *Ephestia cautella* (9 larvae, 4 pupae and 14 adults), *Tribolium castaneam* (5 larvae, 1 pupa, 10 adults), *Ephestia figulilella* (2 larvae, 1 pupa, 7 adults), *Cadra cautella* (3 larvae, 0 pupae, 9 adults) and *Cydia pomonella* (3 larvae, 0 pupae, 8 adults). Depending on the environment, life cycle lasts from 24 to 70 days, with developmental times varying among species. Highest Insect activity were recorded in (September 15.65) and significantly decreased in winter, according to seasonal data, which showed a high association with humidity and temperature. The results show high levels of infestation in a variety of regularly consumed dry fruits, with cashew nuts (27%) and dried date (29%) being the most impacted. Under inadequate storage circumstances, the predominance of important pest species and overlapping developmental phases point to ongoing infestation pressure. In order to minimize postharvest losses and preserve the quality of dry fruits, this study highlights the necessity of better storage management, frequent monitoring and focused pest control techniques.

Key words: Investigating, Fig, Dried dates, Cashew nuts, Sawtoothed grain beetle, Indian meal moth

Silica Nanoparticles supplementation for sustainable agriculture in the saline and drylands regions of Balochistan, Pakistan

Ayesha Mushatq, Sabeena Rizwan, Nayyab Hina, Sitara, and Taineait
Department of Biochemistry, SBK Women's University, Quetta, Pakistan
E-mail: ayeshamushtaq2000@yahoo.com

Abstract

Since the beginning of this century, silicon supplementation has gained attention as an effective approach for improving salinity tolerance in plants. In this context, silica nanoparticles (SiO_2 NPs) were explored as a potential intervention to enhance plant performance under saline stress conditions. Wheat (*Triticum aestivum* L.) is a major staple food crop in Pakistan, forming a substantial component of the national diet. Enhancing wheat production on marginal and salt-affected lands through silicon supplementation and improved fertilizer practices offers a promising strategy for increasing agricultural productivity under challenging environmental conditions. Although different silicon sources helped the wheat plants to mitigate the salt stress, but silica nanoparticles had never been used for this purpose. Current study is designed to see the effect of silica nanoparticles on the wheat grown under salt stress, in order to increase wheat production in saline and marginal areas. For this study silica nanoparticles, of 50 nm to 100 nm size, were synthesized by Ultrasonication based Sol-Gel method, with little modification in the Stober process using TEOS (Tetraethylorthosilicate) as a precursor. The synthesized silica nanoparticles were characterized by Transmission Electron Microscopy and X-Ray Diffraction. A completely randomized factorial experiment was designed to grow wheat in winter season in Quetta. When salt stress of 100 mM NaCl was induced, all the agronomical, physiological, chemical and phenological parameters were adversely affected as compared to the control. Different wheat (*Triticum Aestivum* L.) varieties of Balochistan were used in this study to check the effect of NaCl on germination rate and growth of wheat. The wheat grown after priming the seeds in even very minute quantity of silica nanoparticles solution and silica nanoparticles supplementation showed improvement in all the growth parameters under salt stress. All the results are statistically significant at 0.05 level. Silica nanoparticles were used for the first time, as a source of silicon, for growing wheat under salt stress. In all stages in the life cycle of wheat from germination to complete growth, when control compared to treatments containing Si NPs, it was found that Si NPs enhanced the growth rate under salt stressed conditions in all wheat varieties. The seeds primed in silica nanoparticles solution were first to reach the maturity with the highest yield. The findings suggest that silica nanoparticles may serve as an effective and economical silicon source for improving wheat growth under salinity stress. Their supplementation, particularly through seed priming or in combination with NPK fertilizers, could provide a practical strategy to enhance wheat productivity in marginal, saline, and drought-prone areas of Pakistan. Remarkably, even a very minute quantity of silica nanoparticles produced a substantial improvement in wheat growth and yield, indicating their cost-effective potential for seed priming and sustainable crop production.

Keywords: Silica nanoparticles, wheat, salinity stress, seed priming, sustainable agriculture, Balochistan, marginal lands.

Farming systems and soil quality of agricultural lands of Toba Kakari, Killa Abdullah, Balochistan, Pakistan

Mehboob Shah[1], Shamim Gul[1,2*]
[1]Department of Botany, University of Balochistan, Saryab road, Quetta, Pakistan
[2]Department of Natural Resource Sciences, McGill University, Quebec, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Management practices greatly influence the properties of soil of agricultural lands. Toba Kakari is an agrarian region of Balochistan, Pakistan with cold-winter arid climate. This region is one of the major producer of apple and tomato for the country. The management practices and soil properties of agricultural lands of this region has not been documented before. In this study, 10 orchard, 10 cropland and 10 Tree-based intercropping system fields were sampled for soil properties; pH, electrical conductivity, texture, soil organic matter (SOM) and soil organic carbon (SOC) concentrations. Furthermore, the abundances of soil-surface and upper soil layer-dwelling invertebrate fauna (mesofauna and macrofauna) of these lands were evaluated. Our results reveal that most of the orchard fields were the oldest (84 to 37 yrs and three fields were 10 to 15 yrs of age) compared to croplands (1 to 4 yrs) and TBI system fields (2 to 15 yrs). Orchards and TBI-F1 were cultivated on barren rangelands; whereas, croplands and other TBI system fields were cultivated on long-abandoned lands once cultivated with lush green orchards (before 1998 when the drought spell started, which lasted for 8 consecutive years). Some of the orchard fields and all TBI system fields were receiving both synthetic fertilizers and manure with manual shallow tillage. The croplands were under deep mouldboard tillage practice (once in a yr) and only synthetic fertilizers were applied. Our results reveal that the orchard fields receiving manure with synthetic fertilizers had significantly higher SOC (6.49 - 14.03 g kg^{-1}) than the orchard fields receiving no manure (1.68 - 3.39 g kg^{-1}). Orchard-F8 and Orchard-F9, which had the highest concentration of SOC (14.03 and 13.83 g kg^{-1} respectively), also had the highest number of soil invertebrate species. Interestingly, these fields did not have the root parasite white grub cockchafer, which was in abundance in the soil of Orchard-F2 having very low concentration of SOC (2.50 g kg^{-1}). Our study shows that the long-term (over 20 yrs) high application of manure (approximately 18 kg air-dried manure per tree trunk yr^{-1}) promoted soil quality, number of species of soil invertebrate mesofauna and macrofauna and eliminated the presence of root parasitic white grub cockchafer larvae.

Keywords: Management practices, orchards, croplands, TBI system fields, soil invertebrate fauna, white grub cockchafer

Boron Status in Soil and Plant Tissue of Mango Orchards in Sindh

Mohammad Naseem Kakar[1], Mehrunesa Memon[2], Tariq Ziad[1], Hidayatullah Kakar[1]
[1]Directorate of Agriculture Research Soil and Water Testing ARI Sariab Quetta
[2]Sindh Agriculture University Tandojam
E-mail: tariqziad2400@yahoo.com

Abstract

The present study was carried out at Soil Fertility Laboratory Department of Soil Science, Faculty of Crop Production, Sindh Agriculture University Tandojam to evaluate soil and leaf boron status of mango orchards in five districts of Sindh i.e. Mirpurkhas, Naushahroferoze, Nawabshah, Sanghar and Umarkot. Soil samples were collected at 0-15 and15-30 cm depth from six tagged mango trees of each district. A total of 50 soil samples were analysed for particle size distribution, electrical conductivity, pH, calcium carbonate, organic matter and boron following a standard laboratory procedure. Leaf samples (3rd leaf from top) were collected from the same tagged trees of various districts at bud initiation stage. The soils of district Mirpurkhas and sub surface soils of Naushahroferoze were silty clay loams, Nawabshah, Sanghar and Umarkot were silt loams except the sub surface soil in Nawabshah which was a loam. All the soils were non-saline having EC contents below 2.0 dS m^{-1}, moderately calcareous with $CaCO_3$ contents of less than 15%, medium pH of less than 8.0. The minimum and maximum organic matter contents were 1.25% in Naushahroferoze and 1.54% in Nawabshah at surface and 0.88% in Sanghar and 1.01% in Nawabshah at subsurface respectively. The hot-water extractable soil B concentration in all mango orchards was higher at surface compared to sub surface except in case of district Sanghar. The minimum B contents were 1.17 and 0.95 mg kg^{-1} in Umarkot and maximum of 6.02 and 5.90 mg kg^{-1} in Naushahroferoze respectively at surface and surface. The leaf tissue B concentration varied to a large extent among all five districts. The concentrations were more or less similar in Mirpurkhas (111.68 ppm), Naushahroferoze (107.95 ppm) and Umarkot (113.18 ppm) with Sanghar (72.85 ppm) being next and Nawabshah (52.90 ppm) with lowest contents. The hot water extractable B contents of soil, when regressed against leaf tissue B contents in mango orchards gave a positive and linear relationship with r=0.61. It is concluded that mango orchards of district Mirpurkhas, Naushahroferoze, Nawabshah, Sanghar and Mirpurkhas were adequate in supply of B contents in soil and leaf tissue. It is however, suggested that the leaf tissue analysis may be carried out in large number of farms and at various phonological stages of mango growth to have a better view of B status in mango orchards.

Keywords: Boron in soil, mango orchards, Sindh, leaf tissue

Maize Cultivation and Consumption Practices in Azad Jammu and Kashmir: Insights from Farmers

Muhammad Shehzad, Aqeel Ahmad, Muhammad Jamil, Khalid Mehmood
Faculty of Agriculture, Department of Agronomy, University of Poonch Rawalakot
E-mail: m.shahzaduaf@gmail.com

Abstract

Maize (Zea mays L.) has historically been a cornerstone of agriculture in Azad Jammu and Kashmir (AJK), serving as a primary food source and essential livestock feed. This study investigates current farming practices and consumption patterns of maize across AJK's major maize-growing regions. A three-stage stratified random sampling method was employed to select a sample of 175 respondents, and descriptive statistics were used for data analysis. The findings reveal that traditional maize varieties continue to dominate cultivation practices, with 59% of farmers opting for these varieties. On average, farmers use 3.41 kg of seed per kanal, and the application of chemical fertilizers remains minimal, while pesticide use was reported as nonexistent. Despite these traditional methods, an average yield of 401 kg per acre was recorded, although lodging remains a significant challenge hindering higher productivity. Regarding consumption patterns, approximately 82% of the maize crop is consumed domestically, highlighting its continued importance in local diets. A smaller proportion, 6%, is used for seed, and only 10% is sold to other farmers or in markets. These findings underscore the enduring significance of maize as a staple food and its integral role in agricultural livelihoods in AJK. This study provides insights into the current state of maize farming in AJK, emphasizing the need for sustainable agricultural practices to address productivity challenges and ensure food security. It also suggests avenues for future research and policy interventions aimed at enhancing maize cultivation techniques and promoting economic resilience among farming communities in the region.

Key words: maize cultivation, Farmers habits, yield challenges, socio economic factors

Farming systems and soil properties of agricultural lands of warm desert Turbat, Balochistan, Pakistan

Munsif Khan Baloch[1], Shamim Gul[1,2]
[1]Department of Botany, University of Balochistan, Quetta, Pakistan
[2]Department of Natural Resource Sciences, McGill University, Quebec, Canada
Email: shamim.gul@mail.mcgill.ca

Abstract

Agricultural management practices such as tillage systems, fertilizer and residue management and cropping systems significantly impact quality of soil. This study evaluated soil properties (soil organic carbon (SOC), pH, electrical conductivity, texture and abundances and diversity of soil mesofauna and macrofauna) of three agricultural systems; orchards, croplands and tree-based intercropping (TBI) in warm desert Turbat, Balochistan, Pakistan. Orchards were under manual deep soil disturbance practice, which involved the uprooting of old plants. Croplands were under manual shallow tillage; whereas, TBI fields were under both shallow (for the area cultivated with crops) and manual deep soil disturbance (for the area cultivated with trees) practices. Orchards and TBI fields were supplemented with manure plus synthetic fertilizers. Croplands were supplemented with synthetic fertilizers and ~50% residue return after crop harvest. Few orchard fields had severely low SOC contents (3.21 - 4.61 g kg^{-1}); whereas, some TBI fields and croplands had significantly high SOC contents (7.64 - 9.36 g kg^{-1}). On average (pooled data of all values belong to orchards, TBI and croplands), relative to orchards, SOC contents in TBI and croplands were higher by 58 and 50% respectively ($P<0.05$). Twenty four species of soil fauna were found in these fields. No relationship was observed between the abundance and diversity of soil fauna with SOC contents. The centuries old practice of manual deep soil disturbance in orchards may explain reduced SOC contents compared to croplands and TBI fields. Crop diversification, deep and shallow tillage and 50% residue return in TBI fields; likewise, shallow tillage and ~50% crop residue return in croplands might be the reason for relatively high SOC contents than orchards in this warm desert. Our study emphasizes the adoption of TBI system and the use of shallow tillage and organic amendments in the agricultural fields of this warm region to enhance SOC contents.

Keywords: Ants, mesofauna, macrofauna, tillage, SOC, Tree-based intercropping

Inter-relationship between rhizosphere processes and biomass production of garlic in calcareous soil under arid climatic field conditions - influence of two-year amendment of organic and synthetic fertilizers

Pashtana Sahib Jan[1,2], Shamim Gul[1,3*]

[1]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
[2]Department of Plant Sciences, Sardar Bahadur Khan Women's University, Quetta, Pakistan
[3]Department of Natural Resource Sciences, McGill University, Quebec, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Garlic is an economically important crop. Under cold-winter arid climatic field conditions, commonly used fertilizers; compost (Comp), synthetic NPK and biochar (B) and their mixtures (Comp-B, Comp-NPK, NPK-B and Comp-NPK-B) were applied in calcareous soil for two years. The purpose was to test the hypothesis that these organic amendments influence bacterial community composition in the rhizosphere, which in return influence nutrient contents (nitrogen, Olsen phosphorus and potassium). These changes in the rhizosphere biochemical processes ultimately influence the total biomass production of garlic. Using metagenomics, rhizosphere soil samples after the harvest of second year crop were analyzed for community structure and diversity of bacteria. Standard protocols were applied to measure nutrient contents of rhizosphere soil. Total biomass of garlic plot^{-1} was measured after oven drying. Fertilizers significantly influenced bacterial community structure but did not alter the α and β diversities. Highest number of bacterial genera (123) were detected under Comp-NPK treatment than control (117). Relative to control, Comp-NPK-biochar caused significant increase in the abundance of Proteobacteria but reduced the abundance of Actinobacteria. No differences between control and other treatments were observed with regard to the nutrient contents of soil. The Comp-NPK also increased total biomass of garlic than control. Positive relationship between number of bacterial genera detected in the rhizosphere of soil and higher total biomass production of garlic under Comp-NPK than control, without reducing nutrient contents in rhizosphere soil, suggests that this treatment was the best for promoting rhizosphere soil properties and biomass production of garlic.

Keywords: *Allium sativum* L.; Compost; biochar; NPK; Rhizosphere; Metagenomics; Total biomass

Integrated Nutrient Management in Rice under Water Regimes

Sabeela Yaqoob[1], Zubair Aslam[2], Nabgha Imran[1], Rozia Gull[2]
[1]Department of Agronomy, University of Agriculture, Faisalabad
[2]Department of Plant Breeding and Gegentics, University of Agriculture, Faisalabad
E-mail: sabeelayaqoob68@gmail.com

Abstract

Rice is threatened by ineffective inputs of water and fertilizers. Therefore, we detected the effect of integrated application of organic and inorganic fertilizer under two different irrigation options. Thus, our experiment was conducted by Randomized Complete Block Design under factorial arrangement at Agronomic Research Area, Department of Agronomy, Faculty of Agriculture, University of Agriculture, Faisalabad, during the crop season, 2024. The first factor was irrigation method, including two choices: continuous flooding and alternate wetting and drying (AWD). The second factor was integrated nutrient management with three levels: T_0 = Control (100% chemical fertilizer), T_1 = 50% chemical fertilizer and 50% compost, T_2 = 100% compost. The study revealed that T_1 = 50% chemical fertilizer and 50% compost under both irrigations led to obtained more plant height, grain per panicle, 1000-grain weight, paddy yield, straw yield as compared to the others fertilizer application. The AWD significantly increase water productivity than standing water condition in rice. So, integrated use fertilizer with AWD irrigation improves growth and productivity in rice, excellent application potential providing technical support for precision water and fertilizer management in rice.

Keywords: Basmati rice, Integrated nutrients management and AWD

Boron forms Spatial Distribution in Apple Orchards of Pishin, Balochistan

Tariq Ziad[1], [2]Shamim Gul,
[1] Directorate of Agriculture Research Soil and Water Testing, ARI Sariab Quetta
[2] Associate Professor, Botany Department University of Balochistan Qeutta
Email: tariqziad2400@gmail.com

Abstract

Boron availability to the plant is affected by various boron forms and distribution. Understanding boron chemistry, knowledge of boron forms distribution and their relation to soil properties are indispensable. The aim of the study was to (i) establish the relationship between physico-chemical properties and soil B forms, (ii) evaluate the spatial variability of various boron forms in apple orchards. Ninety geo-referenced surface soil samples from apple orchards having area of two hectare at different location were collected from Pishin, Baluchistan. There was a significant ($p<0.05$) correlation of readily soluble boron with clay ($r= 0.45$) and organic matter ($r= 0.34$). Specifically adsorbed boron revealed significant ($p<0.05$) relationship with clay content ($r= 0.52$). Oxide bounded boron presented significant ($p<0.05$) relationship to organic matter ($r= 0.34$) and clay content ($r= 0.42$). Linear correlation of organically bound boron was significant with clay ($r= 0.38$*) and soil organic matter ($r= 0.67$**). Residual boron concentration in soil exhibited positive relationship with soil organic matter ($r= 0.42$*) and clay content ($r= 0.57$*). Regression equation relating to boron forms with soil properties revealed that soil pH, $CaCO_3$, organic matter and clay account the (29, 55, 33, 64 and 65 %) variability in soil boron forms. Best-fitted semivariogram model for boron forms (readily soluble, specifically adsorbed, oxide bound, residual B) was spherical with moderate spatial dependence while organically bound form revealed strong spatial dependence.

Key words: Apple orchards, boron forms, spatial distribution

Elemental Profiling and Multivariate Analysis of Rice Varieties from Balochistan, Pakistan: Insights into Mineral Variability and Nutritional Potential

Zohra Tahir[1], Shaista Anjum[1], Ayeesha Masood[1], Muhammad Saifullah[2], Naila Siddique[2], Munib Ahmed Shafique[2]
[1]Department of Botany, University of Balochistan, Sariab Road-87300, Quetta, Pakistan,
[2]Pakistan Institute of Nuclear Science and Technology (PINSTECH), P. O. Nilore, Islamabad 45650 Pakistan)
E-mail: shaista.alizai@yahoo.com

Abstract
Rice is a major staple crop in Balochistan, Pakistan; however, comprehensive information on the elemental composition of locally cultivated varieties remains limited. This study evaluated the macro- and micronutrient profiles of ten rice varieties collected from different agro-ecological regions using an organic elemental analyzer for CHN determination and inductively coupled plasma–optical emission spectroscopy (ICP-OES) for mineral analysis. Significant variation ($p < 0.05$) was observed among varieties for all analyzed elements. Potassium (K), phosphorus (P), and sulfur (S) were the predominant elements, while calcium (Ca) and magnesium (Mg) were present in moderate amounts. Trace elements, including iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu), also exhibited considerable variability. Among the studied varieties, KSK-282 consistently showed elevated concentrations of key elements, particularly P, K, Ca, and Fe, indicating a comparatively mineral-rich profile. Kisan Super exhibited higher levels of Zn and Mn, whereas Irri-6, Irri-9, and Kianaat displayed relatively lower elemental concentrations. Principal component analysis revealed that the first three components explained 72.48% of the total variance, with PC1 (38.84%) primarily associated with major mineral elements and PC2 (19.96%) influenced by Mg, Mn, and Zn. The PCA biplot demonstrated clear trends among varieties, with KSK-282 distinctly separated due to its strong mineral association, while other varieties formed clusters reflecting moderate to lower elemental profiles. Overall, the findings highlight significant nutritional heterogeneity among rice varieties cultivated in Balochistan and identify specific genotypes with enhanced mineral composition that may be useful for targeted selection and nutritional improvement.

Keywords: Rice Varieties, Balochistan, Elemental composition, Micronutrients, Macronutrients

Theme 5

Effect of climate change on arid agroecosystems and mitigation options

Climate Change and Restoring Drylands: Livestock the Backbone of Balochistan's Economy in perspective of Sustainable Development Goals (SDGs)

Habib ur Rehman[1], Niamatullah Kakar[2], Jameel ur Rehman[3], Mujeeb ur Rehman[3] and Asmatullah Khan[4]
[1]Livestock & Dairy Development Department Balochistan
[2]Natural & basic sciences, University of Turbat
[3]Bolan University of Medical and Health Sciences
[4]Shaikh Khalifa bin Zayed Hospital, Quetta
E-mail: habiburrehman.2085@gmail.com

Abstract
Livestock in Balochistan are a great asset of the pastoral economy, local livelihoods, and unique biodiversity of Pakistan**.** With rangelands covering over 70% of the province, livestock and wildlife are essential for sustenance, income, and ecological balance. Approximately 90% of the livestock population is migratory, making animals a crucial, moveable asset for rural families. Livestock contributes to income through milk, meat, and wool production, providing a safe investment in arid areas. Climate change severely threatens dryland livestock, undermining SDGs 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action). Increased temperatures, droughts, and reduced water availability degrade rangelands and cause heat stress, significantly lowering animal productivity. Sustainable, climate-smart livestock management, including adapted breeds and improved feed, is vital for resilience and food security. Improper and intensive grazing in arid regions is a major driver of land degradation and desertification. It occurs when livestock density exceeds the land's carrying capacity, leading to the removal of vegetation faster than it can recover. This practice triggers a cycle of ecological damage, decreasing the water availability, degrading of vegetation, impacting soil health, biodiversity, and the long-term viability of pastoral livelihoods. Dryland rehabilitation for animals involves restoring degraded arid and semi-arid ecosystems to improve habitat quality, increase forage availability, and boost livestock and wildlife resilience. Key strategies include natural regeneration through area exclosures (fencing off land to allow vegetation recovery), grass reseeding with drought-tolerant/resistant forage species, restoring local water management systems, and livestock management through rotational grazing and reducing overgrazing by establishing public pasturelands to protect forest land.

Key words. Livestock, climate change, dryland, SDGs, nature rehabilitation

Influence of cultivation of olive groves in Balochistan on soil organic carbon and biological indicators of soil health - implications for climate change mitigation

Hazeezullah Khoshal[1], Shamim Gul[1]
[1]Department of Botany, University of Balochistan
Email: shamim.gul@mail.mcgill.ca

Abstract

Soil degradation and declining soil organic carbon (SOC) stocks pose significant challenges to sustainable agriculture in arid and semi-arid regions such as Balochistan, Pakistan. Unmanaged livestock grazing and water scarcity have accelerated rangeland degradation, threatening both ecosystem stability and local livelihoods. In this context, the expansion of olive (Olea europaea L.) cultivation presents a promising climate-resilient land-use strategy with potential ecological and economic benefits. This study aims to evaluate the impact of olive groves on SOC dynamics and biological indicators of soil health across major olive-growing districts of northern Balochistan. A comparative field-based investigation will be conducted in seven districts, where soil samples from olive orchards and adjacent natural rangelands (control) will be analyzed. The study integrates assessments of soil physico-chemical properties, including SOC, nutrient status, aggregation, pH, and electrical conductivity, alongside biological indicators such as microbial biomass carbon (MBC), and the abundance and diversity of soil microfauna (protozoa and nematodes), mesofauna, and macrofauna. Standardized laboratory techniques, including chloroform fumigation-extraction, wet sieving, and microscopy-based identification, will be employed. Statistical analyses will involve ANOVA, non-parametric tests, and regression modeling to determine relationships among soil properties and biological communities. It is hypothesized that olive grove cultivation enhances SOC sequestration and improves soil biological diversity and abundance compared to non-cultivated rangelands. The expected outcomes will provide critical insights into the role of olive-based agroecosystems in restoring soil health, enhancing carbon sequestration, and promoting sustainable land management in arid environments. This research will contribute to global efforts on climate change mitigation and support policy frameworks aimed at expanding climate-smart agriculture in dryland regions.

Keywords: Olive orchards, Balochistan, soil health, soil carbon sequestration, soil fauna

Assessing Plant Adaptability and Phytoremediation Potential in Dryland Agroecosystems: Implications for Ecosystem Services and Climate Change Resilience

Shagufta Jabeen[1*], Shujaul Mulk Khan[1], Nida Javaid[2], Saba Javed[3], Naila Sarwar[2]
[1]Quaid-i-Azam University
[2]The Islamia University Bahawalpur, Pakistan
[3]The Government Sadiq College Women University, Bahawalpur
E-mail: shaguftajabeen703@gmail.com

Abstract

Wastewater irrigation is increasingly adopted in arid and semi-arid regions to combat severe freshwater scarcity; however, its improper use poses significant threats to soil fertility and biodiversity. This study evaluates the ecological impact and adaptive strategies of native flora under wastewater irrigation to advance sustainable dryland management. The research was conducted in two phases: first, a phytosociological survey assessed plant community structures and determined species with the highest Importance Value Index (IVI) in wastewater-affected areas. Second, a comparative morpho-anatomical analysis was performed to evaluate how the dominant species adapted to wastewater compared to those under freshwater irrigation. The phytosociological survey identified 51 plant species maintaining biodiversity in these modified habitats. *Datura inoxia* recorded the highest IVI (28.79), followed closely by *Xanthium strumarium* (24.34), while *Lippia nodiflora* exhibited the lowest IVI (1.86). Morphological growth in *Xanthium strumarium* was higher under freshwater irrigation. Anatomically, wastewater treatment generally induced larger cell sizes and areas in the dermal, ground, and vascular tissues of roots and stems. A similar adaptive pattern was observed in leaf anatomy likely driven by the interaction of arid climatic factors and wastewater though abaxial epidermal, parenchyma, and sclerenchyma values were lower than the control. Sewage water irrigation increased root and stem xylem thickness and the number of vascular bundles across the leaf, root, and stem, though these bundles exhibited a dispersed rather than circular arrangement. *Xanthium strumarium* demonstrated exceptional ecological adaptability under wastewater stress, evidenced by its high relative density, cover, and IVI. These findings suggest that *Xanthium strumarium* holds strong potential for phytoremediation in dryland agriculture. Identifying and utilizing such adaptive species offers a sustainable pathway to manage degraded drylands, conserve biodiversity, and safely recycle non-conventional water resources.

Keywords: Dryland Management, Wastewater Irrigation, *Xanthium strumarium*, Phytosociology, Morpho-anatomical Adaptation, Biodiversity Conservation, Sustainable Agriculture, Phytoremediation.

Thermo-tolerance Induction in Cotton through Natural Growth Enhancers

Shakeel Imran[1, *] Muhammad Farhan[1], Muhammad Talha Ramzan[1]
[1]Department of Agronomy, University of Agriculture Faisalabad, Punjab, Pakistan
E-mail: shakeel.imran@uaf.edu.pk

Abstract

Cotton (*Gossypium hirsutum* L.) remains the cornerstone of Pakistan's agricultural economy, yet rising ambient temperatures increasingly compromise fiber quality and yield potential. This study, conducted at the University of Agriculture Faisalabad, evaluated the efficacy of various botanical extracts as natural growth enhancers to mitigate thermal stress. Six treatments were arranged in a randomized complete block design (RCBD) with three replications: T1 (Control), T2 (Distilled water), T3 (0.5% Colocynth extract), T4 (2% Spinach extract), T5 (2% Sugar beet extract), and T6 (1% Sesbania leaf extract). Experimental data showed germination rates reached 88%, while treated plants achieved a mean height of 145 cm compared to 122 cm in the control. A notable shift in reproductive efficiency was observed, with sympodial branches increasing from 18 to 24 per plant and boll counts rising by 15.4%. Mean boll weight improved significantly, reaching 4.15 g in T4 versus 3.20 g in T1. Consequently, seed cotton yield surged by approximately 18% in the Spinach-treated plots. These results demonstrate that exogenous application of botanical extracts serves as a cost-effective, eco-friendly strategy to enhance the physiological resilience and productivity of cotton under the fluctuating agro-climatic conditions of Punjab, Pakistan.

Keywords: Cotton, organic substances, thermotolerance induction, yield increment, growth establishment

Theme 6

Biowastes in agriculture: sustainable solution for agriculture, economy and environment

Long Term Effects of Biochar on Harvest Index and Macronutrients use Efficiency of Leguminous Crop under Wastewater Irrigation

Anum Bashir[1], Misbah[2] and Shamim Gul[3]
[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
[3]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract
The present study evaluated the influence of two types of biochar (cow manure-derived and wood-derived) on the growth performance (i.e. yield production, phosphorus use efficiency (PUE), nitrogen use efficiency (NUE) and number of nodules) of pea plant (*Pisum sativum* L.) under municipal wastewater irrigation treatments for two consecutive years (2017 and 2019). Biochar were applied at 5 t ha^{-1}, 10 t ha^{-1} and 15 t ha^{-1} rates for these two years (2017-2019) to find the significant difference. In the first year of 2017 the roots biomass (1st and 2nd sampling), shoots biomass (1st and 2nd sampling), weight of 10 pods and number of nodules (1st sampling) had maximum influence with biochar amendments than in the second year (2019). While in the year of 2019 yield (pods yield, number of pods), stover and number of nodules (2nd sampling) had maximum influence with biochar amendment than the year of 2017. The NUE and PUE of pods and stover in second year (2019) crop were considerably high than first year crop however, the Total Nitrogen and Total Phosphorus of pods and stover were significantly lower than the first year (2017) crop. Our results suggest that irrigation treatment under municipal wastewater in long term effect of biochar had more positive influence on number of nodules, NUE, PUE and growth factors.
Keywords: Biochar, Nodules, Wastewater

Influence of organic amendments on plant growth production (shoot, root biomass and numbers of nodules) of leguminous plant and on nitrogen mineralization under ground and wastewater irrigation

Hafeeza[1], Misbah[2] and Shamim Gul[3]
[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
[3]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract
Two years after biochar amendments, there was no significant difference in root and shoot biomass under groundwater irrigation. While, under waste water irrigation, in response of small-particle-sized wood derived biochar have significantly increased the root and shoot biomass. Under both irrigation treatments, biochar amendments have decreased (non-significant) the total number of nodules than control. For the second year of first sampling total number of nodules were increased (non-significantly) under wastewater irrigation than control. Besides of total numbers, irrigation treatments had pronounced influence on the sizes of nodules (Large size under groundwater irrigation and small sized under wastewater irrigation). Irrigation treatments had pronounced influence on soil pH and nitrogen mineralization. Finally, our findings are consistent to the increase in biomass production (shoot, root and number of nodules) and on soil quality (pH and nitrogen mineralization) under wastewater irrigation.

Keywords: Biomass, nodules, nitrogen mineralization, pH, irrigation.

Evaluation of biochars produced from six different feedstocks on soil quality of alkaline soil

Iram Sonia, Misbah Manzoor
Department of Plant Sciences, Sardar Bahadur Khan Women's University, Quetta
E-mail: alfa_botany@yahoo.com

Abstract
In arid and alkaline regions like Balochistan, Pakistan, soil degradation and nutrient depletion are major obstacles. Biochar, a carbon-rich product obtained through pyrolysis of biomass, has recently gained attention as a soil amendment due to its potential to improve soil fertility, water retention, and microbial activity. This study aimed to evaluate the influence of wood-derived biochar on the physical and chemical properties of alkaline soils. Biochar was produced from six wood species and applied to soil at three rates (0%, 10%, 20%) under controlled pot experiments. There were 30 pots set up with three replications for each treatment. pH, electrical conductivity (EC), organic matter (OM), total nitrogen (N), soluble phosphorus (P), and potassium (K) were all measured in soil samples. Results revealed that biochar significantly altered soil properties, with higher application rates improving soil organic matter, available phosphorus, and nitrogen compared to control. However, excessive biochar (20%) sometimes increased EC beyond optimal levels. The effect was different for different wood species, indicating that the choice of feedstock has a significant impact on the results of soil amendment. According to these findings, wood-derived biochar has a significant potential to increase soil fertility in alkaline and arid regions. However, for sustainable soil management, the application rate and biochar source must be carefully optimized.

Keywords: Biochar, feedstock, alkaline soil, soil nutrients, soil pH, soil EC

The Physical and Chemical Properties of Wood Derived Biochar Amended in Alkaline Soil of Arid Climate

Irum Akram[1], Misbah Manzoor[2], Momina Rozi khan[3], Shamim Gul[4] and Ayesha Masood[5]
[1,2,3]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
[4,5]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract

This study evaluated whether locally produced wood-derived biochar made from six different feedstocks and applied at two practical rates can modify soil chemical properties and improve macronutrient availability in a sandy-loam alkaline soil representative of Balochistan. The principal objective was to compare the immediate effects of biochars produced from *Pinus* L. , *Vitis vinifera* L., *Morus alba* L., *Jasminum* L., *Phoenix dactylifera* L. and *Pyrus* L. at 0%, 10% and 20% application levels on soil pH, electrical conductivity (EC), organic matter (OM) and available N, P and K under replicated trial conditions. Two complementary experimental approaches are reported in the thesis. A controlled pot component (reported as 30 poLts with three replicates for each treatment) provided tightly managed observations, while an adjacent field allocation used 2 × 2 m plots arranged as replicated blocks (43 plots total) to capture plot-scale variability; both components applied the same treatment matrix of six feedstocks × two rates plus controls. Soils were sampled monthly from the top 10 cm over a five-month monitoring period and analyzed for standard chemical indicators: pH and EC (pH/EC meters), organic matter (Walkley–Black titration), phosphorus (spectrophotometry), potassium (flame photometry) and total nitrogen (spectrophotometric method at ARI Quetta). Across the experiment, biochar amendments produced consistent and directionally beneficial changes in several soil fertility indicators, although the magnitude and statistical significance depended on feedstock, application rate and the specific batch or replicate set. Changes in bulk soil pH were generally modest; several batches showed no statistically significant pH shift at the group level (overall $P > 0.05$), but *Vitis vinifera* L. treatments repeatedly produced the largest upward shifts in mean pH in multiple batches (e.g., Vv 10% and Vv 20% showing the highest batch means), suggesting a buffering effect that may be cumulative with time. Electrical conductivity (EC) responded more strongly and significantly in several comparisons. In designated batches, wood-derived biochars elevated EC relative to the control but generally remained within agronomic safety limits. For example, *Morus alba* L. at 20% produced the highest EC in one batch (1.487 dS m^{-1}, $P = 0.011$), while *Pinus* L. 20% and *Phoenix dactylifera* L. 20% were prominent in other batches a pattern consistent with feedstock ash release of basic cations (K^+, Ca^{2+}, Mg^{2+}) that raise soluble salt concentrations but can also increase plant-available nutrients in coarse textured soils.

Keywords: *Morus alba, Phoenix dactylifera* L, Biochar, Climate

Assessment of Atmospheric Dispersion and Uptake Pattern of PAHs in Vegetation around Brick Kilns in Balochistan, Pakistan

Khanoranga and Nelofer Jamil
Environmental Sciences Department, SBK Women's University, Quetta, Balochistan
E-mail: khanoranga.achak@gmail.com

Abstract

This study aimed to investigate PAH levels in vegetation growing near operational brick kilns in Balochistan. Brick kilns are considered an important source of PAH pollution due to the combustion of low-quality fuel. Vegetation samples were collected at distances of 100 m, 300 m, and 500 m from the sources to assess atmospheric dispersion. PAH concentrations in the vegetation samples were measured by HPLC. The study's findings confirmed the presence of all six assessed PAHs in the collected vegetation samples, with concentrations increasing with distance from the source. The ∑PAHS at Quetta ranged from 2680 to 17930 µg/kg, at Pishin from 8010 to 17400 µg/kg, and at Mastung from 1410 to 18510 µg/kg, respectively. The dominant PAH congeners in the study area were naphthalene (2 rings), phenanthrene (3 rings), pyrene (4 rings), chrysene (4 rings), and benzo(a)pyrene (5 rings). The results of the study showed variation in toxic equivalent quotient (TEQ) values among the studied plant species, with some plants exhibiting declines with distance, while others showed nonlinear patterns. The plant concentration factor (PCF) indicated variation in PAH accumulation across plant species. Source apportionment of PAHs was assessed using principal component analysis (PCA) at the study sites. The results of the PCA revealed that, across all three sites, coal combustion was the dominant contributor to PAH pollution, as evidenced by the high loadings of B(a)P and CHR. The findings of the study demonstrate that vegetation growing in the vicinity of brick kilns in Balochistan is contaminated with PAHs, and the PCA results further confirmed that coal combustion is the major factor at all study sites. Spatial variations in PAH concentrations, TEQ, and plant accumulation highlight the influence of atmospheric dispersion and plant-specific uptake, highlighting potential ecological risks in the vicinity of brick kilns in Balochistan.

Key Words: Brick Kilns, PAHs, Toxic equivalent quotient, PCA, Atmospheric dispersion

Review Analysis of Biochar Properties

Laiba Noor[1], Bibi Nazia[2], Misbah Manzoor[3] and Ayesha Kasi[4]
[1,2,3,4]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
E;mail: alfa_botany@yahoo.com

Abstract
Biochar is a carbon-rich substance produced by heating organic waste under low oxygen conditions. It improves soil fertility, water retention, and microbial activity while also contributing to carbon sequestration to counteract climate change. Biochar is also utilized to purify water and generate sustainable energy. Key crops having substantial nutritional, financial, and agricultural importance include okra, wheat, maize, chickpeas, cotton, tomatoes, and mangos. Chickpeas supply protein, wheat and maize provide vital crabs, and okra is a vegetable strong in fiber. Cotton is a vital commercial crop, tomatoes are consumed by many, and mangos are a popular tropical fruit. These crops belong to the following plant families: Malvaceae (okra, cotton), Poaceae (wheat, maize), Anacardiaceae (mango), Fabaceae (chickpea), and Solanaceae (tomato). Each family makes a substantial contribution to the production of food, fiber, and industry.
Keywords: Mango, Chickpea, Tomato, Biochar and Carbon

The phytoremediation, Nutritional and Medicinal Potential of Fruit Crop *Carica papaya* L. (Pawpaw) of Tropical and Subtropical Region including, Pakistan – A Review

Muhammad Shafiq[1*], Muhammad Zafar Iqbal[2], Mohammad Athar[3]

[1]Department of Botany, University of Karachi, Karachi-75270, Pakistan.
Email address: shafiqeco@yahoo.com ; orcid.org/0000-0002-0488-8946

Abstract
Carica papaya L. is a member of family Caricaceae and commonly known as Papaya or Papeeta. Papaya is native to tropical region of America and now similarly growing in other parts of under similar climatic condition around the worldwide including, Pakistan. The different parts of *C. papaya* such as leaves, seeds, roots, flowers and fruit traditionally use as medicine and health benefits since long time as compared to synthetic medicine. In recent years, the use of Papaya in modern science showed a significant contribution to food and pharmaceutical industry. According to the retrieved studies, papaya has proven to be an excellent source of bioactive compounds. However, the introduction of various types of climate change, indiscriminate discharge of pollutants from the industrial and anthropogenic activities are affecting the germination and growth of Papaya at global and regional levels. There are few information available on the ecology and phytoremediation potential of *C. papaya*. The papaya also has many benefits for the development of sustainable environment. This brief review provide the recent research activities progress reported on the ecological, nutritional and phytoremediation potential of *C. papaya* with the help of different English data base search engine include, PubMed, Google, Science direct, and Google Scholar. Taken together, the findings of the current survey of literature that might be helpful to researchers, soil and plant scientists, policy decision makers, farmers, and horticulturists, environmental managers working towards for the increase of cultivation of *C. papaya* and development of sustainable environment, food securities, and better health care.

Keywords: bioactive compounds, medicinal plants, nutritional, papain, Pakistan, phytoremediation.
Abbreviation: **CP** - *Carica papaya*;

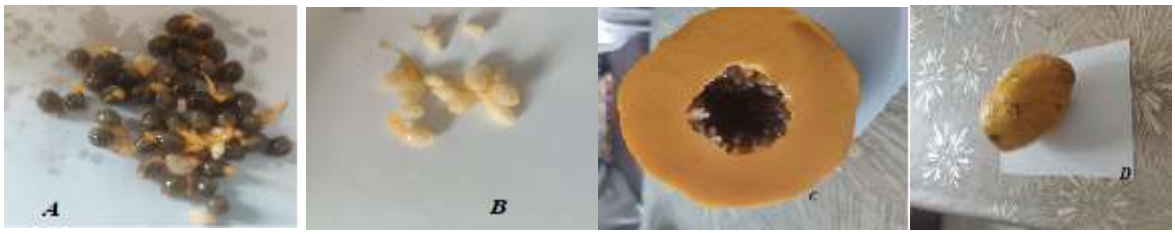

Fig. 1. *Carica papaya* L. [A-ripe seeds; B-unripe seed; C-ripe fruit with seeds; D-ripe fruit of CP]. Photograph by Muhammad Shafiq.

Over Two Years of Biochar Influence on Soil Physiochemical Properties, Underground and Waste Water Irrigation

Nadia Ghafoor[1], Misbah Manzoor[2] Dr. Shamim Gul[3]
[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
[3]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: alfa_botany@yahoo.com

Abstract
In the soil the flow of water, air and solutes are enhanced by the texture, structure, and porosity. Nutrient availability and, in some situations, soil physical features are influenced by soil chemical properties, which are connected to the colloid fraction. Consequently, understanding and perceiving soil properties and their associations with each other is significant for using wise judgment in regards to soil use and the executives. Biochar is strong enough and rich in carbon. The biochar amendment enhance the soil fertility, maintain pH, EC, OM, phosphorus , total nitrogen ,nitrogen nitrate, potassium for first sampling as compare to second sampling of soil fertility. However, for first sample pH rate, EC, OM have shown more productive before harvesting, total nitrogen potassium and total phosphorous showed good enough growth rate. Total nitrogen showed difference between treatments. The first sample of soil and second sample of soil showed some changes. The compost biochar increment the pace of physiochemical boundaries while wood-inferred biochar at lower rate expanded the increment the pace of physiochemical boundaries while wood-inferred biochar at lower rate expanded the boundaries. The results showed that biochar had high physiochemical properties.

Keywords: pH, OM, EC, Phosphorus and Nitrogen.

Plant physiology of garlic and rhizosphere soil processes under influence of two years biochar-based field amendments in calcareous soil

Pashtana Sahibjan[1,2], Shamim Gul[1,3]
[1]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
[2]Department of Plant Sciences, Sardar Bahadur Khan Women's University, Quetta, Pakistan
[3]Department of Natural Resource Sciences, McGill University, Quebec, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Garlic is an economically important crop. Pakistan imports garlic to fulfil population demand. Proper management of agricultural lands can reduce the import of garlic. This two-years field-based study evaluated the influence of commercial compost, synthetic NPK fertilizer, *Acacia nilotica* wood-derived biochar, the mixture of compost with NPK (Comp-NPK), biochar (Comp-B) and with both NPK and biochar (Comp-NPK-B) on the total fresh yield (bulbs plus stover) of garlic and the properties of calcareous soil. Results revealed that some of these amendments caused significant positive influence on growth performance of garlic and/or soil quality over time (for the second year of cropping). The Comp-NPK not only increased significantly the yield of second year crop and two-years cumulative yield by 62 and 53% respectively, it also increased significantly the nutrient use efficiency for nitrogen NUE-N) in the cloves of first and second year crop and in the stover of second year crop by 30, 46 and 87% respectively. The Comp-NPK-B did not increase the total fresh yield of garlic. However, Comp-NPK-B increased the stover biomass, NUE-N of cloves and stover of the second year crop by 118, 13 and 99% respectively. Interestingly, the highest number of bacterial genera in the rhizosphere of garlic was also found under Comp-NPK than control (25 versus 26 under Comp-NPK and control treatments). The beneficial bacterial genera *Amycolatopsis*, *Brachybacterium*, *Clostridia*, *Clostridium XII*, *Dactylosporangium* and *Streptosporangium* were only detected in the rhizosphere under Comp-NPK and Comp-NPK-B, which may explain the significant improvement in garlic growth performance under these treatments.

Keywords: Garlic, rhizosphere soil, bacterial genera, nutrient use efficiency, growth performance

Utilization of Citrus Pulp Bio-waste as a Concentrate Replacement and its Impact on *In-situ* Digestion Kinetics in Buffalo Bulls

Muhammad Abdullah, Muhammad Sharif, Safdar Hassan*, Fawad Ahmad, Muhammad Tayyib, Mudasir Nazar and Ahmad Raza
Institute of Animal and Dairy Sciences, Lecturer, University of Agriculture, Faisalabad.
E-mail: sh.shakir@uaf.edu.pk, (+92419200161)

Abstract
The study was planned to examine the effects of partial replacement of concentrate with dried citrus pulp (DCP) on feed intake, ruminal characteristics and in situ digestion kinetics in cannulated Nili Ravi buffalo bulls. Four iso nitrogenous and iso-caloric diets containing 5, 10, 15 and 20% dried citrus pulp were formulated and represented as low dried citrus pulp (LDCP), medium dried citrus pulp (MDCP), high dried citrus pulp (HDCP) and very high dried citrus pulp (VHDCP), respectively. These diets were fed to cannulated *Nili Ravi* buffalo bulls in 4x4 Latin square design. The experiment was continued for 84 days. Each experimental period was of 21 days. Chemical composition of DCP revealed it an excellent ingredient for ruminant animals. Nutrients intake was significantly higher in buffalo bulls fed HDCP and VHDCP than those fed LDCP and MDCP diets. An increase in rumen pH and rumen ammonia nitrogen was observed as the levels of DCP in the diets were increased. Increasing trends of DM and NDF% degradability and extent of digestion were observed with increasing the levels of DCP in the diet. In conclusion, feed intake, ruminal characteristics and extent of digestion were higher in buffalo bulls fed HDCP and VHDCP diets.

Key words: buffalo bulls, concentrate, nutrient intake, rumen characteristics

Estimation of the Efficacy of Bio-Waste Treated Soil on the Growth of *Trigonella foenum-graecum:* A strategy in Waste Management

Nelofer Jamil[1], Sakina Ali[2], Sehrish[2], Imama[3]
[1]Department of Environmental Science, SBKWU Quetta
[2]Department of Chemistry, SBKWU Quetta
E-mail: nelofer.sbkwu@gmail.com

Abstract
Soil, which is considered to be a natural resource comprising minerals and organic matters, is one of the vast and efficient ways of study. This experiment was conducted in a greenhouse containing 40 different treatments of biowaste to influence the growth of *Trigonella foenum graecum*(fenugreek) in an untreated soil of Hanna urak. Different kitchen biowastes (banana, potato, eggshell, cucumber and tea leaves) were used in powdered form to stimulate plant development. The doses of organic bio stimulants being utilized were (5, 10, 15, 20, 25g). The further study revealed that the parameters needed to determine the growth were GI, GP, MDG, SVI, MGR, MGT, SE, GE, CRG, and T50. Positive results have been observed as the germination of plant increased after the application of bio-waste. Root length, shoot length, and seedling length of cultivated plants were also measured. The overall experiment under above investigation concludes that the tea waste has the highest amount of germination and peak values as indicated through graphs and tables. Furthermore, the combinations of banana peel, potato peel, cucumber peel and tea waste have also shown increment. It is recommended to farmers to expand the implementation of organic fertilizer for farming purposes instead of inorganic fertilizers which pollute environment either directly or indirectly.

Keywords: Bio-waste, *Trigonella foenum-graecum*, Organic fertilizer, Soil fertility, Sustainable agriculture

A Review of Biochar's Efficiency to Improve Water Holding Capacity (WHC) of Soil

Afqah Fatima[1], Sadaf Aslam Ghori[1], Alishba Zahid[1], Malala[1], Shamim Gul[2]
[1]Department of Environmental Sciences, Sardar Bahadur Khan Women's University, Quetta, Balochistan, Pakistan
[2]Department of Botany, University of Balochistan, Quetta, Balochistan, Pakistan
E-mail: sadaf.ghori@yahoo.com

Abstract

This review aims to assess the efficacy of wood-based biochar in augmenting soil water holding capacity (WHC) in water-scarce regions, with a specific focus on the scientific literature. In regions like Pakistan, where agricultural productivity is heavily reliant on monsoon rains, water scarcity poses significant challenges. Biochar, produced through the pyrolysis of biomass including green waste, bamboo shoot shells, mixed wood, and agricultural residues such as sugarcane, rice straw, wheat straw, maize stalk, cotton stalk, and rice husk, has demonstrated potential in enhancing soil fertility and water retention. The analysis revealed that wood-based biochar, particularly derived from green waste and bamboo shoot shells, exhibits noteworthy improvements in WHC, with enhancements ranging from 10% to 74%. Additionally, biochar derived from mixed wood, as well as hardwood species like oak, and softwood species such as pine, manifests promising outcomes by increasing WHC in the range of approximately 1.7% to 62%. These findings underscore the viability of wood-based biochar as a sustainable soil amendment for facilitating water conservation, mitigating irrigation demands, and ensuring future food security within water-limited environments. The study offers valuable insights and recommendations concerning the selection and application of biochar in water-stressed regions, thereby contributing to enhanced soil management practices and the sustainable utilization of water resources.

Keywords: Biochar, Water holding capacity, available water holding capacity, Porosity, Agriculture, Wood, Soil, Feedstock, Pyrolysis

Co-composted biochar as an organic amendment for the cultivation of *Crocus sativus* L. (saffron) in saline soil under arid climatic conditions. A Review

Shagufta Qasim, Shamim Gul
Department of Botany, University of Balochistan, Quetta, Pakistan
E-mail: shagjeeloo123@gmail.com

Abstract

Salinity is one of the main problems in crop production, especially in Mediterranean territories of the world. Due to several factors, there is a universal curiosity in understanding the scenarios for agricultural land degradation. The application of co-composted biochar has significantly augmented agriculture during the last era. We conducted a far-reaching review on the influence of co-composed biochar as an organic amendment for cultivating the most expensive spice, *Crocus sativus* L. (saffron), in saline soil under arid climatic conditions. We explored the positive influences on their production in dry regions where salinity is a limiting factor. Sustainable Agricultural techniques, including consumption and production, must be followed from an integrated and universal perspective. The key inputs for crop production are healthy soil, irrigation practices/techniques, and natural plant resources. As these resources are becoming increasingly scarce in different parts of the world, managing and using them sustainably becomes crucial. Improving and managing techniques on existing agricultural lands, such as refurbishing damaged lands via sound agrarian methods, would reduce the pressure to clear forests for agricultural production (SDG GOAL-2, 5). Though several investigations focused on co-composted biochar production and application so far need to be more comprehensive, there is adequate evidence to enlighten their significance in supporting environmental safety and sustainable farming. Based on the review, we recommended upcoming research to better comprehend the mechanism of co-composed biochar practices and stimulate an understanding of its function over time.

Keywords: *Crocus sativus* L., co-composted biochar, biochar, compost; salinity, organic fertilisers.

Production of polyhydroxy butyrate by agriculture waste using solid state fermentation

Shagufta Saeed*, Sadia Nawaz, Muhammed Tayyab and Sehrish Firyal
Institute of Biochemistry and Biotechnology, University of Veterinary and Animal sciences, Lahore
E-mail: shagufta.saeed@uvas.edu.pk

Abstract

Polyhydroxybutyrate (PHB), a bioplastic, has attracted the attention in the recent years due to its ability to replace the polyethylene, a non-biodegradable plastic. The aim of the present research work was to evaluate the potential of different agricultural wastes like wheat bran, rice polishings and corn cob for the synthesis of PHB by *Bacillus thuringiensis* FCBP-SB-0002 using solid state fermentation. Optimization of different components of basal media and various physical parameters was also performed. Maximum PHB yield (420 mg/100g) was achieved on fermentation of rice polishing at substrate water ratio of 10:36 at 72 hours of incubation time, pH 7, temperature of 30^0C by addition of 1 mL inoculum. Addition of different optimum levels of ionic salts (1.5% of $KH_2PO_4.2H_2O$, 2% $MgSO_4$ and 2% NaCl) and nitrogen sources (0.75% urea and 1% corn steep liquor) increased the PHB production to 680 mg/100g respectively. Identification of PHB was done by FTIR analysis and was found to be 98% pure in comparison to standard by spectrophotometric method. The outcomes of the present study indicated that agricultural wastes can be used for the cheap production of bioplastic. This strategy will also help to reduce environmental pollution caused due to disposal of this waste material.

Keywords: Polyhydroxybutyrate, Agricultural waste, *Bacillus thuringiensis*, optimization, solid state fermentation

Does life history trait of crop determine application rate of organic amendments in space and time in calcareous soil under field conditions?

Shamim Gul[a,b], Abdul Ghani Achakzai[a], Kanval Shaukat[a]
[a] Department of Botany, University of Balochistan, Pakistan
[b] Department of Natural Resource Sciences, McGill University, QC, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Cumin and sweet fennel are two economically important crops. Cumin produces ~3 times less biomass and seeds mature ~2 months earlier than sweet fennel. Three years field study was performed in calcareous soil to assess the impact of wood-derived biochar (WoodB) and dairy manure biochar (ManureB) as sole amendments or co-amended with dairy manure (FYM) on the yield, nutrient uptake and nutrient use efficiency of both crops and soil nutrients. These amendments were applied at ~1.7, 3.3 and 6.7 t ha^{-1} rates for three years. Compared to control, positive influence of these amendments was not apparent in the first and second year for both crops. Most of these amendments increased yield of both crops during third experimental year by 43 - 105% ($P<0.05$). Co-amendment of FYM with wood biochar at ~6.7 t ha^{-1} rate had the highest significant positive influence on the yield of both crops, significantly increased the nitrogen and/or phosphorus use efficiency of crops without reducing nitrogen and phosphorus contents in soil. Our study demonstrates that the influence of these amendments appeared over time and the FYM-WoodB at ~6.7 t ha^{-1} rate showed the most positive influence on both crops. No apparent relationship between biomass production of crops and the application rate of organic amendments was observed; except that WoodB and FYM-ManureB at 3.3 t ha^{-1} rate reduced grain yield of first year crop of sweet fennel (high biomass and prolonged growth period) but did not influence the grain yield of cumin (low biomass and short growth period).

Keywords: Wood-derived biochar, manure-derived biochar, farmyard manure, growth performance, soil nutrients

Influence of Compost Biochar Mixture on the Growth of Spinach and Soil Microbial Processes Under Drought and Salinity Conditions

Shamim Gul[1,2], Joann K. Whalen[2]
[1]Department of Botany, University of Balochistan, Quetta, 87300, Pakistan
[2]McGill University, Department of Natural Resource Sciences, MacDonald Campus, Sainte-Anne-de-Bellevue, H9X 3V9, Quebec, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

This pot-based research is related to investigate the influence of various fertilizers on the growth of spinach, in two soil types (sandy loam and clay loam). The fertilizers were synthetic NPK (control), composted manure (CM) from cow dung applied at 5% amendment rate, mixture of wood-derived biochar and composted manure (1:1 w/w ratio) amended at 5% (CMB5%) and 10% (CMB10%) rates in soil. The plants grown in clay loam soil were given 2 and 4 dS m^{-1}; whereas plants grown in sandy loam soil were given 4 dS m^{-1} salinity stress induction. Results showed that spinach responses to various fertilizers were not consistent in two soil types. In clay loam soil, CMB10% increased ~2 fold the leaf biomass and length of the main root system than control treatment under salinity stress condition. However, leaf biomass under CMB5% treatment was significantly lower than other treatments under all salinity stress inductions (0, 2 and 4 dS m^{-1}) by 60-81% measured after ~4 weeks of germination. However, final harvest revealed no difference between plants of CMB5% and control and CM treatments. The CMB5% treatment also significantly reduced leaf biomass than control at both salinity stress inductions (0 and 4 dS m^{-1}) in sandy loam soil by 40% but showed no difference for root biomass. The tolerance of roots to salinity, measured as the length of main root in clay loam soil and dry biomass in sandy loam soil, was significantly higher under CMB5% and CMB10% treatments than control. Regression analysis revealed strong negative relation between plant biomass and concentration of proline for clay loam soil experiment; whereas, no relationship between the concentration of proline and electrical conductivity of soil was observed. The pH of both soil types had a negative relation with electrical conductivity. As compared to control treatment, CMB5% and CMB10% in clay loam soil; whereas, CM, CMB5% and CMB10% in sandy loam soil caused a significant increase in the concentration of Olsen phosphorus under no to low salinity stress conditions. In conclusion, amendment of biochar+compost mixture at high amendment rate (10%) improved salinity stress tolerance, whereas, at low amendment rate this mixture reduced biomass than control treatment.

Keywords: Spinach, salinity stress, soil texture, root architecture, soil nutrients

Theme 7

Mining activities: influences on agriculture in Balochistan and attenuation options

Analysis of Heavy Metals by Phytoremediation of Sor-Range Habibullah Coal Mines, Quetta

Mehmoona Manan[1], Misbah Manzoor[2]
[1,2]Department of Plant Sciences, Sardar Bhadur Khan Women's University, Quetta, Balochistan, Pakistan.
E-mail: alfa_botany@yahoo.com

Abstract
The Sor-Range Habibullah Coal Mines in Quetta present significant environmental concerns due to heavy metal contamination associated with ongoing mining activities. This study assessed the accumulation of Cu, Mn, Fe, Zn, Cd, Pb, and Cr in soils and in ten naturally occurring plant species—*Hertia intermedia* (Boiss.) Kuntze, *Astragalus strobiliferus* Royle ex Benth., *Orobanche cernua* Loefl., *Marrubium vulgare* L., *Alyssum alyssoides* L., *Achillea wilhelmsii* K. Koch, *Haloxylon griffithii* (Moq.) Boiss., *Artemisia maritima* L., *Sophora mollis* (Graham ex Royle) Baker, and *Peganum harmala* L.—collected from both polluted and non-polluted sites. Metal concentrations in roots and shoots were quantified, and phytoremediation potential was evaluated using the Biological Accumulation Coefficient (BAC), Biological Transfer Coefficient (BTC), and Bioconcentration Factor (BCF). Soils from polluted sites contained markedly higher concentrations of heavy metals compared to non-polluted sites, confirming mining-induced contamination. Essential metals (Mn, Zn, Cu, and Fe) exhibited relatively higher uptake and translocation within plant tissues, whereas toxic metals (Pb, Cd, and Cr) remained predominantly confined to roots, indicating restricted mobility. *Sophora mollis*(Graham. ex Royle.) Baker. emerged as a strong multi-metal phytoextractor, demonstrating the highest uptake and translocation for Mn, Fe, Cu, and Zn among the studied species. *Achillea wilhelmsii* K.Koch. and *Artemisia maritima* L. also exhibited moderate phytoextraction capacity for several micronutrients. Conversely, *Hertia intermedia* (Boiss.) Kuntze, *Marrubium vulgare* L., *Alyssum alyssoides* L., *Orobanche cernua* Loefl., *Astragalus strobiliferus* Royle ex Benth, and *Haloxylon griffithii* (Moq.) Boiss. showed substantial phytostabilization potential, retaining elevated concentrations of Cd, Cr, and Pb primarily in their root systems. These findings underscore the critical role of native plant species in mitigating heavy metal contamination in mining-impacted ecosystems. The distinct metal accumulation patterns observed among species provide a scientific basis for developing targeted, cost-effective, and sustainable phytoremediation strategies suitable for the ecological restoration of coal-mining areas in Balochistan.

Keywords:
Heavy metals, Phytoremediation, Phytoextraction, Phytostabilization, Coal mining, Metal accumulation.

Biochar-based amendments in chromite-contaminated soil - Influence on soil properties, fruit yield and nutrient uptake of tomato under field conditions

Palwasha Achakzai[1], Shamim Gul[1,2], Kanval Shaukat[1]
[1]Department of Botany, University of Balochistan
[2]Department of Natural Resource Sciences, McGill University, Quebec, Canada
E-mail: shamim.gul@mail.mcgill.ca

Abstract

Muslim Bagh, Pakistan is the region of intense chromite mining activities. Farmers of this region transport soil for agricultural purpose. This study evaluated the influence of chromite mine tailing debris contamination at 10 t ha^{-1} yr^{-1} rate and the application of biochar+manure mixture/synthetic NPK and co-composted biochar fertilizers in contaminated soil on soil properties, yield and nutrient uptake of tomato. Contaminated soil without fertilizer applied (CKC) had no negative influence on MBC, yield and uptake of nutrients compared to soil with no contamination and no fertilizer applied (CK0). In contaminated soil, two-years amendment of biochar+manure mixtures/synthetic NPK at 5, 10 and 20 t ha^{-1} yr^{-1} rates and one-year amendment of co-composted biochar with various manures at 10 and 20 t ha^{-1} rate significantly increased soil organic carbon (SOC), microbial biomass carbon (MBC) and the concentration of bioavailable potassium in soil. Very few organic treatments significantly increased the fruit yield of only small tomato fruit variety and increased the uptake of P and K in fruits. Our study provides an insight to the farmers that mining activities may not negatively influence properties of transported soils of agricultural lands of Muslim Bagh for at least 5 years. Biochar+manure mixtures/synthetic NPK and co-composted biochar with various manures have the potential to improve soil properties. Long-term (more than 2 years) studies are required to assess the influence of biochar-based organic amendments on soil properties and the yield of tomato, which is the major vegetable crop of Balochistan for the country.

Keywords: Chromite mine tailing, phosphorus, potassium, nutrient uptake, microbial biomass carbon