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Redox-Couple Mediation: A promising strategy to enhance the electrocatalytic performance of Surface-Active ionic liquid interfaces

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ABSTRACT

The unique characteristics of the aqueous interfacial and micellar aggregates of surface-active ionic liquids (SAILs) endow them with excellent electrocatalytic properties, selectivity and efficiency toward electrochemical transformations. However, the low electron-tunnelling probability on account of the significant spatial separation between the electrode and the bulky SAIL-bound electroactive analytes is expected to render the SAILs with an apparent electrocatalytic performance that is significantly lower than their true potential. The availability of appropriate redox-mediators in the vicinity of SAIL-bound electroactive analytes is a possible strategy to bridge this undesired mismatch between the apparent and the expected electrocatalytic performance from the aqueous micellar solutions of SAILs. In anticipation of this presumption, the current work was designed to explore the potential utility of a well-known redox mediator, $K_4[Fe(CN)_6]$, to enhance the electrocatalytic performance of aqueous micellar solutions of SAILs. The impact of $K_4[Fe(CN)_6]$ over the surface activity, self-aggregation characteristics and electrocatalytic performance of 1-Dodecyl-3-methylimidazolium chloride ([DDMIM]Cl) was investigated using conductometry, voltammetry and scanning electrochemical microscopy (SECM). The carried-out investigations suggest that the ion-pairing of the negatively charged redox mediator with the imidazolium head groups at the electrode/electrolyte and micelle/water interface-localized SAIL units significantly enhances the electrocatalytic performance of aqueous micellar solutions of [DDMIM]Cl toward electro-dehalogenation of halocarbons, oxygen reduction reaction (ORR) and electrochemical sensing of nitrite ion. We demonstrate that the redox couple mediation in SAIL micellar solutions ensures electrocatalytic reduction of water-insoluble toxic halocarbons, 4-electron ORR and electrocatalytic oxidation of toxic nitrite ions over non-catalytic electrode surfaces. Importantly, the $K_4[Fe(CN)_6]$ mediation in aqueous micellar solutions of [DDMIM]Cl is demonstrated to ensure selective and sensitive electrochemical sensing of nitrite ions with a sensitivity as high as 0.52 μA nM^{-1} and limit of detection as low as 0.2 nM (the best to be reported till date). The presented work, the first of its kind we believe, presents an innovative strategy to improve the electrocatalytic performance of aqueous micellar solutions of SAILs that shall have far-reaching implications over their use as green sustainable electrocatalytic solvent systems for large-scale practical applications.

1. Introduction

Surface active ionic liquids (SAILs), the amphiphilic analogues of ionic liquids (ILs), have emerged as promising replacements to conventional surfactants [1,2]. Besides their unique IL inherited characteristics like a broad electrochemical window, the ability to stabilize electrogenerated intermediates, etc., SAILs due to their superior surface activity and enhanced control over the shape, size, or stability of their aggregates outperform conventional surfactants in the practical applications [3,4]. Accordingly, aqueous micellar solutions of SAILs are

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Research Article

Synthesis and Design of New 1,3,4-Oxadiazole Benzimidazole Hybrids as Potential Antibacterial Agents Against MRSA by Targeting FabI

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"Salvation through Culture and Literature : Reading Matthew Arnold as a Culture Critic"

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Victorian era is characterized by a unique Victorian sensibility acquired by how society and religion were undergoing colossal change; religion was subjected to moral revival and the methods of production and distribution of wealth were revolutionizing. It was also a long period of peace, prosperity, progress, refined sensibilities and national self-confidence for Britain. Additionally, a lot of interconnected ideas and forces were working simultaneously on the Victorian mind in the fields of science, politics, education, ethics and moral system that created a sense of vagueness, incoherence and indirection. G.M. Young writes :

> "English society was poised on a double paradox which its critics, within and without, called hypocrisy. Its practical ideas were at odds with its religious professions, and its religious belief was at issue with its intelligence." (16)

Doubt, however, was the fuel on which Victorian generation was interminably bred. People found themselves in a very awkward situation when being right was a difficult necessity. "The diffusion of scientific knowledge among the educated, the spread of old fashioned rationalism downwards through the masses, had created a new problem for the religious teacher." (69)

Literary greats like Charles Dickens, Thomas Carlyle, John Ruskin, Matthew Arnold and many others were conscious of the changes the society was going through and the mind set it was fashioning forth. Hence, a need was strongly felt to reconstruct a spiritual edifice on the basis of scientific revelation. Matthew Arnold saw redemption possible in the discovery of 'new rulers with new faith.' Sydney Eisen observes that "religion was not only a matter of belief but also an integral part of personal and public morality, family life, social position, occupation, and friendship, not to mention education and party politics."(3)

Matthew Arnold was a religious humanist and an ethical idealist. His literary powers find full flowering in his criticism of English life at large. Russel remarks :

> "In all questions affecting national character and tendency, the development of civilization, public manners,

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Strigolactones in Plants: From Development to Abiotic Stress Management

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Riti Thapar Kapoor, Parvej Alam, Yinglong Chen & Parvaiz Ahmad

Abstract

Strigolactones are a group of carotenoid-derived phytohormones which are synthesized in plastids and cytosol. Strigolactones also act as molecular cue that assist plants to liaise with surroundings. These active biomolecules are also called as non-traditional phytohormones or plant growth regulators. Strigolactones are generated in roots mainly and released into rhizosphere, although their synthesis has been reported in other plant parts in trace amount. More than one thousand types of strigolactones are reported in plants but only 30 strigolactones have been identified yet. Strigolactones play a significant role in regulation of biochemical processes such as seed germination, plant growth and development (root system architecture, shoot branching and tillering), and delaying leaf senescence during

Editorial: Rhizospheric interactions: integrating plant-microbe signaling during stresses

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Editorial on the Research Topic
Rhizospheric interactions: integrating plant-microbe signaling during stresses

The agricultural sector has been greatly influenced by industrialization and globalization. It is important to understand plant interactions and the effect these have on the ecosystem. Plants are under continuous stresses, either biotic or abiotic, and they have direct influence on their overall productivity and yield. This impact can be observed on a global scale. There are impairments in plant's biochemical, physiological, and molecular characteristics that hinder their overall traits. The usage of chemically synthesized pesticides and fertilizers hinders soil fertility and contaminates the environment (Khan et al., 2021). Therefore, it is advisable to use eco-friendly, toxin-free, and sustainable practices for agricultural purposes. It is crucial, then, to explore rhizospheric interactions to unravel the inter-communications and complex interactions. These interactions occur via a wide network of signals and chemical and physical footprints along with microbial activities for the regulation of various ecological processes (Ali et al.).

There are root exudations within the rhizosphere that play a prominent role in nutrient acquisition/cycling, inter-communications, and signal transductions within the soil and roots. These exudations create a microbial niche for better physical, chemical, and biological interactions within the rhizosphere. Root exudations shape the rhizosphere and its microbial communities in order to enable plants to grow while modulating nutrient acquisition as well as stress resistance within them. Rhizospheric microbes are potent candidates for plant safeguarding during various types of stresses (Liu et al., 2020). They also regulate phytohormone levels, phosphate solubilization, secondary metabolite synthesis, antioxidant defense responses, nitrogen fixation, and siderophore production. Moreover, they stimulate the resistance towards stresses through induced systemic resistance mechanisms and systemic acquired resistance mechanisms (Shah et al., 2021). Kumawat et al. reported that halo-tolerant rhizobacteria improved crop productivity, nutrient acquisition, volatile organic compounds, osmolytes, antioxidants, phytohormones, extracellular polymeric substances, and ACC-deaminase activity along with regulating ion homeostasis.

However, Wang et al. conducted a study revealing the role of allelochemicals and their autotoxicity with soil microbes in *Atrctylodes lancea* rhizosphere. Similarly, Yasmin et al. found that *Rhizoctonia solani*, a pathogenic fungi affecting maize, can cause banded leaf disease, but the volatile organic compounds released by rhizobacterial strains possess an antagonistic effect towards these pathogens by modulating their antioxidative defense system and overall growth and metabolism.

The interplay among plants and microbes within the rhizosphere is crucial for sustainable agricultural practices and could illustrate their potential as an alternative to traditional methods. The root acts as a meta-organism for widening our knowledge about the rhizosphere and ecosystem services (Ali et al.) (Figure 1). With the advent of technological advancements, there is a desire to understand the rhizospheric activities, its diversities, and functionalities about plants, microbes, and the environment. In-depth knowledge about the rhizospheric and phytomicrobiome is still in its infancy because of limited processes. The signal cascade and mechanistic pathways are linked with root colonization within the rhizosphere through different processes such as quorum sensing, biofilm formation, root exudation, and chemotaxis. All these processes lead to tripartite interactions within the root-soil-interface during stresses.

Plant Physiology and Biochemistry
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Potential of melatonin and *Trichoderma harzianum* inoculation in ameliorating salt toxicity in watermelon: Insights into antioxidant system, leaf ultrastructure, and gene regulation

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Plant Stress
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Review

Comprehensive approaches of phytonanoparticles for stress tolerance, growth performance, and improving oil yield in Sesame (*Sesamum indicum*): Mechanism, applications and future prospects

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Melatonin induced reversibility of vanadium toxicity in muskmelon by regulating antioxidant defense and glyoxalase systems

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Plant Physiology and Biochemistry
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Vanadium toxicity was alleviated by supplementation of silicon in tomato seedlings: Upregulating antioxidative enzymes and glyoxalase system

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South African Journal of Botany
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Modulation of the polyamines, osmolytes and antioxidant defense system to ameliorate drought stress tolerance in *Hordeum vulgare* L. using ascorbic acid

Mohammad Aijaz Ahmad [a], Ammara Saleem [a], Minahil Tahir [a], Sheza Ayaz Khilji [b], Zahoor Ahmad Sajid [a] ✉, Koloko Brice Landry [c], Mohamed A. El-Sheikh [d], Parvaiz Ahmad [e]

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What do these dates mean?

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Environmental Pollution
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Phytomelatonin maintained chromium toxicity induced oxidative burst in *Brassica juncea* L. through improving antioxidant system and gene expression ☆

Jaspreet Kour [a], Tamanna Bhardwaj [a], Rekha Chouhan [b], Arun Dev Singh [a], Sumit G. Gandhi [b], Renu Bhardwaj [a], Abdulaziz Abdullah Alsahli [c], Parvaiz Ahmad [d]

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Plant Physiology and Biochemistry
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Exploring the role of 28-homobrassinolide in regulation of temperature induced clastogenic aberrations and sugar metabolism of *Brassica juncea* L.

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Plant Physiology and Biochemistry
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Deciphering the alleviation potential of nitric oxide, for low temperature and chromium stress via maintaining photosynthetic capacity, antioxidant defence, and redox homeostasis in rice (*Oryza sativa*)

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Physiological and Molecular Plant Pathology
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Melatonin as a modulator of MAPK cascade and ROS-RNS feedforward loop during plant pathogen interaction

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Journal of Environmental Management
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Research article

Comprehensive transcriptome, physiological and biochemical analyses reveal that key role of transcription factor WRKY and plant hormone in responding cadmium stress

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Journal of Hazardous Materials
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Integrated transcriptomic and physio-molecular studies unveil the melatonin and PGPR induced protection to photosynthetic attributes in *Brassica juncea* L. under cadmium toxicity

Tamanna Bhardwaj [a], Jaspreet Kour [a], Rekha Chouhan [b], Kamini Devi [a], Harpreet Singh [c], Sumit G. Gandhi [b] ✉, Puja Ohri [d], Renu Bhardwaj [a] ✉, Abdulaziz Abdullah Alsahli [e], Parvaiz Ahmad [f]

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Aquaporin mediated silicon-enhanced root hydraulic conductance is benefit to cadmium dilution in tobacco seedlings

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Silicon improves salt resistance by enhancing ABA biosynthesis and aquaporin expression in *Nicotiana tabacum* L

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What do these dates mean?

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Ameliorative effect of melatonin on different tomato genotypes to induce heat stress tolerance by modulating growth and physiological attributes

Hafiz Muhammad Tayyab Khan [a], Syed Ayyaz Javed [b], Muhammad Tauseef Jaffar [c], Rashad Mukhtar Balal [a] ✉, Qurat ul Ain [d], Alaiha Asif [e], Muhammad Adnan Shahid [e], Mohamed A. El-Sheikh [f], Parvaiz Ahmad [g] ✉

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Research Paper

Mitigating chromium stress in tomato plants using green-silicone nanoparticles: Enhancing cellular oxidative stress management and chromium reduction

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Environmental Pollution
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Hydrogeochemical properties, source provenance, distribution, and health risk of high fluoride groundwater: Geochemical control, and source apportionment ☆

Muhammad Ayub [a], Hira Javed [a], Abdur Rashid [b c d] ✉, Wardah Hayat Khan [b], Asif Javed [e], Tariq Sardar [f], Ghulam Mujtaba Shah [a], Ajaz Ahmad [g], Jörg Rinklebe [h], Parvaiz Ahmad [i]

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Environmental Pollution
Volume 362, 1 December 2024, 125000

Hydrogeochemical properties, source provenance, distribution, and health risk of high fluoride groundwater: Geochemical control, and source apportionment ☆

Muhammad Ayub [a], Hira Javed [a], Abdur Rashid [b c d] ✉, Wardah Hayat Khan [b], Asif Javed [e], Tariq Sardar [f], Ghulam Mujtaba Shah [a], Ajaz Ahmad [g], Jörg Rinklebe [h], Parvaiz Ahmad [i]

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Plant Stress
Volume 14, December 2024, 100631

Mitigation of microplastic toxicity in soybean by synthetic bacterial community and arbuscular mycorrhizal fungi interaction: Altering carbohydrate metabolism, hormonal transduction, and genes associated with lipid and protein metabolism

Muhammad Asad [a], Zeeshan Khan [a], Tariq Shah [b] ✉, Muhammad Abdullah Shah [c], Ayesha Imran [a], Salman Rasool [a], Jabar Zaman Khan Khattak [d], Shah Rukh Khan [a], Ajaz Ahmad [e], Parvaiz Ahmad [f] ✉

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ELSEVIER

Volume 338, 1 December 2024, 113732

Research Paper

Nanoplastics negatively affect nitrogen assimilation and metabolism in soybean roots more than in nodules

Tariq Shah [a], Zeeshan Khan [b], Zainullah Bacha [c], Zahwa Zaffar [b], Fazal Munsif [a], Ajaz Ahmad [d], Parvaiz Ahmad [e]

https://doi.org/10.1016/j.scienta.2024.113732

Highlights

- Soybean plants showed differential response to polystyrene nanoplastics (PSNPs).
- PSNPs enhance oxidative stress biomarkers and activate antioxidant defense system.
- Nitrogen metabolism is strongly modulated by PSNPs presence in nodules and roots.
- Polyamine contents differently responded toward PSNPs-stressed soybean plants.

Journal of King Saud University - Science
Volume 36, Issue 11, December 2024, 103544

Deciphering the role of exogenously-applied vanillic acid in regulating drought stress tolerance in pea (*Pisum sativum* L.): Key growth and physio-biochemical attributes

Abdul Rahman [a], Nudrat Aisha Akram [a], Muhammad Ashraf [b], Abdulaziz Abdullah Alsahli [c], Parvaiz Ahmad [d]

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Abstract

To investigate the impact of exogenously applied vanillic acid (VA) in mitigating the adverse effects of drought stress, a greenhouse experiment was conducted on pea plants (*Pisum sativum* L.). The pea seeds were primed for 14h in varying concentrations (0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0mM) of VA Then, thirty-five days old pea plants were subjected to control (100% field capacity) and water deficit conditions (60% F.C.). After thirty days of water stress treatments, the data showed a notable reduction in

Journal of Hazardous Materials
Volume 480, 5 December 2024, 136064

Research Article

Unraveling the impact of high arsenic, fluoride and microbial population in community tubewell water around coal mines in a semiarid region: Insight from health hazards, and geographic information systems

Abdur Rashid [a b d], Muhammad Ayub [c], Xubo Gao [a], Yaoyang Xu [b], Zahid Ullah [a], Yong Guan Zhu [b], Liaqat Ali [d], Chengcheng Li [a], Ajaz Ahmad [e], Jörg Rinklebe [f], Sardar Khan [g], Parvaiz Ahmad [h]

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Highlights

- 24.6% and 64% of groundwater exceeded the WHO limit of As 10µg/L, and F 1.5mg/L.

Advances in Agronomy
Volume 189, 2025, Pages 1-61

Chapter One - Zinc in soil-crop-animal-human health continuum

Nanthi Bolan [a b c], Ch. Srinivasarao [d], Claudia Rocco [e f], Shiv Bolan [a b c], Sheikh Mansoor [g], Owais Ali Wani [h], Parvaiz Ahmad [i], Dominik Weiss [e], George Northover [e], José Tonatiuh Sánchez-Palacios [j], Miaomiao Cheng [j], Richard Bell [j], G. Ranjith Kumar [d], G. Mohan Naidu [k], Deyi Hou [l], Xiyue Jia [l], Yanhai Xie [m], Hailong Wang [m n], Vasileios Antoniadis [o], Tatiane Medeiros Melo [p]...Kadambot H.M. Siddique [a b]

https://doi.org/10.1016/bs.agron.2024.09.004

Abstract

Globally, zinc (Zn) deficiency in soils, and subsequently crops, has emerged as one of the most prevalent among micronutrients, resulting in a severe decline in crop yields and nutritional quality and in adversely affecting animal and human health. Worldwide, more than half of the agricultural soils are inherently deficient in Zn, and the health of about one-third of the global human population is impacted by Zn deficiency. Zinc is an essential micronutrient for animal and human health, and, in the developing world, Zn deficiency has been identified as the fifth cause of disease and death for humans. The World Health Organization (WHO) reports that annually more than 800,000 people, including around 450,000 children under the age of 5, die due to Zn deficiency. Zinc

LWT
Volume 215, 1 January 2025, 117253

Transcriptional, physiological and ultrastructure levels revealed silicon enhanced cadmium detoxification and functional compound accumulation in pakchoi

Zhiguo Liu [a b], Mengzhan Qin [a], Runze Li [a], Yusong Zhou [a], Jiyuan Yan [a], Parvaiz Ahmad [c], Mohamed A. El-Sheikh [d], Long Yang [a], Peng Liu [a] ✉, Qinghua Shi [b]

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Journal of Hazardous Materials
Volume 482, 15 January 2025, 136489

Combined application of earthworms and plant growth promoting rhizobacteria improve metal uptake, photosynthetic efficiency and modulate secondary metabolites levels under chromium metal toxicity in *Brassica juncea* L

Pooja Sharma [a b c], Palak Bakshi [b], Rekha Chouhan [d], Sumit G. Gandhi [d], Rupinder Kaur [c], Ashutosh Sharma [e], Renu Bhardwaj [b] ✉, Abdulaziz Abdullah Alsahli [f], Parvaiz Ahmad [g] ✉

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Scientia Horticulturae
Volume 341, 1 February 2025, 113930

Research Paper

Innovative strategies for alleviating chromium toxicity in tomato plants using melatonin functionalized zinc oxide nanoparticles

Shabnam Sharma [a], Vaseem Raja [b] ✉, Sushma [a], Aashaq Hussain Bhat [c], Naveen Kumar [b], Abdulaziz Abdullah Alsahli [d], Parvaiz Ahmad [e f] ✉

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Journal of Hazardous Materials
Volume 483, 5 February 2025, 136693

Integrated physiological, transcriptomic, and metabolomic investigation reveals that MgO NPs mediate the alleviation of cadmium stress in tobacco seedlings through ABA-regulated lignin synthesis

Mengzhan Qin [a], Jiyuan Yan [a], Runze Li [a], Tao Jia [a], Xiaodong Sun [a], Zhiguo Liu [a], Mohamed A. El-Sheikh [b], Parvaiz Ahmad [c], Peng Liu [a]

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Journal of Hazardous Materials
Volume 484, 15 February 2025, 136665

The induction of polyamines metabolism pathway and membrane stability with silicon alleviate the vanadium toxicity in pepper plants

Naveed Mushtaq [a b], Muhammad Ahsan Altaf [a b], Huangying Shu [a b], Xu Lu [a b], Shanhan Cheng [a b], Mohamed A. El-Sheikh [c], Parvaiz Ahmad [d], Huizhen Fu [a b] ✉, Zhiwei Wang [a b] ✉

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Plant Stress
Volume 15, March 2025, 100710

Zinc-chitosan nanocomposites as guardians against the dreaded phytopathogenic fungus *Macrophomina phaseolina* in *Vigna radiata* L.

Uswa Fatima [a], Amna Shoaib [a], Qudsia Fatima [a], Abdulaziz Abdullah Alsahli [b], Parvaiz Ahmad [c]

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Environmental Pollution
Volume 368, 1 March 2025, 125616

Efficacy of salicylic acid (SA) in modulating the dynamics of pesticide-thiamethoxam-induced stress responses in *Brassica juncea* L. insights from biochemical and molecular dissection ☆

Arun Dev Singh [a], Nancy Sharma [b], Kamini Devi [a], Jaspreet Kour [a], Sumit G. Gandhi [b], Renu Bhardwaj [a], Abdulaziz Abdullah Alsahli [c], Parvaiz Ahmad [d e]

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Journal of Hazardous Materials
Volume 487, 5 April 2025, 137265

Hormesis effect of cadmium on pakchoi growth: Unraveling the ROS-mediated IAA-sugar metabolism from multi-omics perspective

Runze Li [a], Mengzhan Qin [a], Jiyuan Yan [a], Tao Jia [a], Xiaodong Sun [a], Jiawen Pan [a], Wenwen Li [a], Zhiguo Liu [b], Mohamed A. El-Sheikh [c], Parvaiz Ahmad [d], Peng Liu [a]

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Strain engineering on the electronic bands, mechanical stability, thermal, vibrational and thermoelectric response of PtScSb half-Heusler semiconductor

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ABSTRACT

The noteworthy and dynamic aspects of materials science is to predict an innovative and versatile compounds that enfolds the colossal reaction by the executions of applied stress that imparts the gateway in applied fields. A prompt illustration for enhancement of variability of materials is characteristically established on first principles technique for enlightenment in the variability of compounds. The present manuscript delivers a widespread examination of strain dependent properties including lattice dynamics, thermophysical, mechanical and most significant thermoelectric properties at various levels of PtScSb Heusler material. The impact of applied isotropic strain ranging (−12 % to +4 %) has been keenly scrutinized. From the calculated elastic parameters including Pugh ratio, Young's modulus, Poisson ratio etc., we noticed that a decline trend is observed with the tensile strain and reveals an escalation with the compressive strain. The calculated mechanical parameters (Pugh's and Poisson) validated that the present material is brittle by the application of applied strain. With the intensification in the strain typically up to −12 %, material displays a ductile performance. Additionally, with the escalation of +4 % of tensile strain the present alloy lends towards brittle one. From the examination of bands, the energy band gap drops significantly with intensification in the tensile strength and the escalations of the strain factor. The applied strain effect on lattice dynamics approves the robust stability of PtScSb half Heusler material. The thermoelectric parameters including (lattice thermal conductivity, Seebeck coefficient, electrical conductivity, figure of merit) have been keenly checked at numerous strain levels that approves the material for waste heat recovery systems and as well as technological aspects. The parameters like Debye temperature, Grüneisen parameter etc., have also been predicted at various strain levels to check its thermal stability.

1. Introduction

Greater emphasis has been implemented to advance the energy harvesting technological aspects that can energetically produce numerous vital forms of energy typically taken from the environmental traits that can renovate it into beneficial electricity. These sophisticated technologies mostly include the spintronics, magnetoelectrics, piezoelectrics, thermoelctrics, which exploit mechanical vibrations, electromagnetic waves; thermal energy etc. [1–5]. The perception of thermoelectric taken from the roots of Seebeck effect for the betterment and enhancement of solid state renovation of waste heat into beneficial electricity [6–8]. The quest for technologically aspect physical as well as functional fascinating materials has lately impoverished ample recommendations of numerous projected materials possessing interesting

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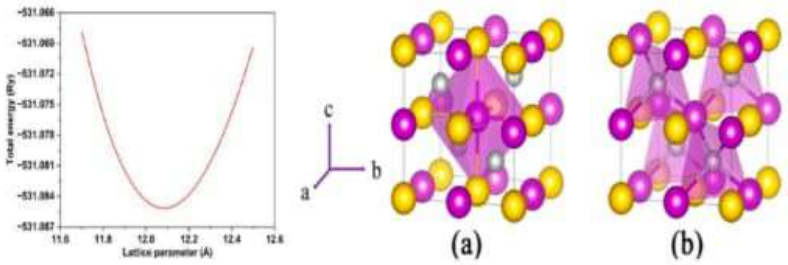

Fig. 1. The optimization curve and as well as the geometric crystal structure of PtScSb alloy distinguishing the octahedral (a) and as well as tetrahedral (b) positions. The colour Yellow, Purple and Gray balls symbolize Pt, Sc and Sb atoms, respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

properties through first-principles approach. In that scenario, electronic structure has been widely prolonged to intend novel materials in recognizing the geometric structural configuration, in pursuit of numerous beneficial functional compounds [9–12]. Recently reported 235 materials that are stable thermodynamically and electronic band profile of 18 additional compounds were examined, pursuing good potential novel materials functionalities within this field by *Zhang* et al. [13]. Among these, half Heusler materials deliver expanded to a database of numerous ones due to exhibition of their impressive applications including superconductivity, thermopower, topological effects, magnetism (ferri/anti-ferro/ferro), spin polarization [14–18]. Besides shape memory and spintronic alloys, half Heusler materials are typically explored or prospective for fascinating thermoelectric applicability as some of these materials demonstrate good values of Seebeck coefficient as well as electric conductivity [19–22]. A high ZT of 2.68 achieved through first principles approach has been predicted by *Sakurada* et al. for KBiBa Heusler [23]. Similarly, FeNbSb based alloys typically deliver a ZT value > 1 [24]. A peak ZT of ~1.5 is reached at 1200 K for $FeNb_{0.88}Hf_{0.12}Sb$ and $FeNb_{0.86}Hf_{0.14}Sb$, ~40 % higher than that of Ti-doped FeNbSb, and the ZT are remarkably higher than other well-known state-of-the-art *p*-type high-temperature thermoelectric materials over the whole temperature range [25]. However, inspecting XiSb (X = Ti, Zr, Hf) Heusler materials by the execution of high-throughput density functional theory approach, ZT in *p*-type doping material of XiSb (X = Ti, Zr, Hf) achieved of 1.0 at a temper-

approximation (GGA) using the Perdew-Burke-Ernzerhof (PBE) functional with norm-conserving Troullier-Martins pseudopotential. To attain the geometric optimized configurations, the basic unit cells configurations of a material under concern were simulated alongside the axial direction till the applied stress components are 1 GPa. The configuration of atomic alignments have been optimization by consuming gradient that precedes the deprivation of str[illegible] metry restraints until the forces employed takes the v[illegible] 0.02eV/Å executed on discrete atoms. The potential co[illegible] Muffin tin sphere and the contributions from non-spheric[illegible] charge density were normally lengthened up to $l_{max} = 11$, potential and as well as charge density are prolonged a[illegible] possessing the wave vector of $G_{max} = 12$. A standardized [illegible] × 12 robotically *k*-point generation, subsequent follow t[illegible] and Pack at the Γ-symmetry points for integration over the Brillioun zone, were taken with the convergence of energy of 10^{-6} *Ry*. The elastic constants are typically obtained via cubic elastic code for the current set of material [32–34]. By expending the band profile calculations, the prominent Boltzmann theory [35,36] is being castoff to fetch out the numerous transport parameters.

2. Results and discussion

This portion conveys the numerous results [illegible] as well as their un-

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Documenting the Green Wealth of Tral: A Comprehensive Study of the Macroflora at Government Degree College Tral Campus

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Abstract: ***Studies on the macroflora of the campus of Government Degree College Tral (geographical coordinates 33.945682N/75.131888E west, 33.943771N/ 75.132538E south, 33.946626N/75.133959E east and 33.946924N/ 75.133118E north) was conducted between October 2022 and October 2023. The species were identified with the help of available floristic literature and comparison of the specimens in the herbarium of Centre for Plant Taxonomy (KASH), University of Kashmir. The angiosperms were arranged according to the classification of Takhtajan (2009). While gymnosperms, pteridophytes, bryophytes, fungi-lichens and algae were classified according to the classification of Sporne (1956), Reimers (1954), Proknaur (1957), Ainsworth and Bisby (2008) and Fritsch (1935) respectively. As many as 170 species (angiosperms 147) representing 143 (122 angiosperm) genera belonging to 63 families (46 angiosperm) were collected and identified. Among them 128 species were dicotyledonous and 19 were monocotyledonous. Besides these there were 4 gymnosperm, 3 pteridophytes, 5 bryophytes, 3 macrofungal, 7 lichen and 1 algal species. The dominant families in terms of number of species were Rosaceae (19), Asteraceae (15) and Poaceae (15). Most of the genus present were monospecific but some genera had more than one species. Some species including gymnosperms, ornamental and fruit bearing species had been deliberately introduced.***

Keywords: Tral, flora, biodiversity survey, plant taxonomy, Kashmir, plant species, campus vegetation

1. Introduction

Species diversity is one of the frequently measured aspects of biodiversity [1, 2]. The floristic studies which enlist the species diversity are considered as the backbone of the assessment of phytodiversity, conservation management and sustainable utilization [3]. The knowledge of biodiversity plays important role for the survival of future [4] and the floristic surveys are the only means by which we can achieve this goal [5]. A healthy ecosystem can be build when maintained in a sustainable manner [6] thus floristic wealth is an indispensable part of the natural balance that interprets the effects of the total environment [7]. The loss of biodiversity may alter the functioning of ecosystems [8]. Biodiversity education is very important to create interest, knowledge and necessary skills to solve biodiversity problems [9]. Biodiversity conservation is a critical environmental challenge, with accurate assessment being essential for conservation efforts [10]. Authentic identification, documentation and characterization of floras are of paramount importance for future studies that would help to formulate strategies for their management of biodiversity. The region of Kashmir (in which the present study was carried out) being at the crossroads of the Eurasian and Palaeotropical bio-realms, has been a crucible of floristic diversity [11] and hence warrant more attention in this regard. Keeping in view these facts, floristic studies (of macroflora) of the campus of Government Degree College Tral were carried out systematically between October 2022 to October 2023. The present study was an attempt to compile and enlist the macroscopic flora of the campus in order to spread the awareness about the available plant diversity and to prepare a sample study for future studies which was currently lacking.

Location and Geography

Government Degree College Tral (with an area of 96 kanals, about 5 hectares) was established in 1988 and shifted to the present location in year 2005. The geographic coordinates of the college include 33.945682N/75.131888E west, 33.943771N/ 75.132538E south, 33.946626N/75.133959E east and 33.946924N/ 75.133118E north (Fig. 1). The college is located about 2.5 Km from main town Tral in north-east direction, near Bajwani area of Tral. The campus is located on the gentle slope of the extension of the kerawa (plateau) on which Tral town is located. The kerawa is connected to the nearby extension of Zanskar mountain range of Himalayas. The campus has a mostly sandy loam soil with gravels and stones in the subsoil area. Of the total area, about 20% is built-up area. The remaining area of this college is occupied by natural vegetation, playground and patches of plantation maintained by Social Forestry Department, J&K Government. The average elevation of the campus is about 1700 metres above mean sea level. The annual mean highest (day temperature) temperature is 17.68 °C and mean lowest (night temperature) temperature is 6.59 °C (Fig. 2). The warmest month is July (average highest day temperature 29.1 °C) and the coldest month is January (average lowest night temperature -4.2 °C). The wettest month is March (with average monthly precipitation 49.41 mm) while the driest month is October (with average monthly precipitation 7.25 mm). The average annual number of days with precipitation (≥ 1.0 mm) are 49.47 days (13.55%). The a[illegible] annual monthly precipitation is 33.85 [illegible] https://weatherandclimate.com/jammu-an[illegible]

Data Collection and Analysis

The task of documentation of the pla[illegible] campus was undertaken systematically an[illegible] October 2022 to October 2023, to cover mo[illegible] flowering and fruiting stages and also to cover various

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Research Article

Grasslands: Productivity and Biomass

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Abstract

Grassland is one of the most widespread vegetation types worldwide and plays a prominent role in ecological security and human development. Three important factors have been responsible for the evolution and maintenance of the grassland ecosystem: drought, fire and grazing. The naturally occurring grasslands, primarily determined by climate, occur in areas where growth of forests is prevented by non-availability of sufficient soil water. In addition to the climatically determined natural grasslands, successional grasslands are maintained by removal of original forest vegetation as a consequence of grazing, mowing or burning. For their importance in ecological productivity, studies of their biomass and ecological productivity is very important. A number of different methods and models have been used to estimate their biomass production and productivity. Every method has its own merits and demerits. Even though alternatives to the conventional harvesting methods have been devised, the conventional harvesting methods for ecological productivity are still in vogue. The research attributes the role of precipitation and temperature in regulating productivity in grasslands. Probably because of more favourable environmental conditions throughout the year, tropical grasslands are more productive on an annual basis than their other counterparts. Similarly different species in a grassland may respond differently to the amount, occasions and type of precipitation. The plant biomass and productivity in grasslands is not affected only by present year precipitation but also by previous year precipitation amount and pattern. The productivity of C_3-species and C_4 species also respond differently to mean annual temperature and mean annual precipitation. Different types of biotic stresses also affect plant biomass and primary productivity the most important biotic stress among them is grazing. Although heavy grazing and no grazing in general decreases productivity, moderate grazing has positive effects on productivity. Aboveground and below ground biomass is also affected by both abiotic and biotic factors. The outcome of different ecological factors result in the amount and ratio of aboveground and belowground (living and dead biomass)

Keywords: *Grassland, biomass, aboveground, belowground, productivity, grazing.*

Introduction

Grassland is one of the most widespread vegetation type worldwide [1] and plays a prominent role in ecological security and human development [2, 3]. Grasslands constitute an ecosystem characterized by grass dominance with little tree cover [4, 5]. UNESCO (https://www.unesco.org/en.) defines grassland as "land covered with herbaceous plants with less than 10 per cent tree and shrub cover". Gibson [6] defined grassland 'as any plant community, including harvested forages, in which grasses and/or legumes make up the dominant vegetation'. White *et al.* [7] also defined grassland as "terrestrial ecosystems dominated by herbaceous vegetation". They are among the most widespread biomes worldwide and in general have n… plant species. This vegetation type har… diversity of plant species that mostly … spatial scales because grasslands … structurally simpler at coarser scales [… varied estimates about the area oc…

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