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Role of Micronutrients in Mitigating Abiotic Stress (mimas) in Okra: A Review

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Abstract

Okra (Abelmoschusesculentus) is a large vegetable crop that is extremely vulnerable to different abiotic stresses, including high temperature, salt, drought, and nutrient deficiencies. These conditions can have a substantial impact on the growth and yield of okra. Micronutrients such as boron, zinc, manganese, copper, iron, and molybdenum are crucial for the growth and development of plants. Researchers have studied the use of these micronutrients as a method to reduce the impact of abiotic stress on okra plants. This review study seeks to offer a thorough examination of the current body of literature regarding the impact of micronutrients in alleviating abiotic stress in okra. A comprehensive literature review was performed, encompassing papers published prior to 2021. The selection criteria prioritized authentic research that investigated the impact of micronutrient application on the ability of okra to withstand abiotic stress and enhance its production. The search method encompassed electronic databases and pertinent keywords, including okra, micronutrients, abiotic stress, boron, zinc, manganese, copper, iron, molybdenum, high temperature, salinity, drought, and nutrient deficiencies. The data analysis and synthesis involved extracting key information from the selected studies, including study characteristics, experimental details, and outcomes. The findings from the reviewed studies highlight the importance of micronutrients in improving stress tolerance and yield in okra. Boron, zinc, manganese, copper, iron, and molybdenum applications have shown positive effects in mitigating abiotic stress, such as enhancing heat stress tolerance, alleviating salt-induced oxidative stress, improving nutrient uptake, and enhancing yield in okra.

Keywords: Okra; Abelmoschusesculentus; abiotic stress: micronutrients; boron; zinc: manganese: copper; iron; molybdenum: high temperature: salinity: drought; nutrient deficiency: stress tolerance; yield

Introduction

Abiotic stress, caused by non-living environmental factors, is a major constraint to crop productivity worldwide. Okra (Abelmoschusesculentus L.) is a warm-season vegetable crop widely cultivated in tropical and subtropical regions, known for its high nutritional value and economic importance[1]. However, okra plants are highly susceptible to various abiotic stressors, including drought, salinity, high temperature, and nutrient deficiency, which significantly limit their growth, development, and overall yield.

Drought stress, resulting from inadequate water availability, is one of the most prevalent and detrimental abiotic stressors affecting okra cultivation. Okra plants exposed to drought stress experience reduced leaf expansion, early flowering, decreased water uptake, and impaired photosynthesis, leading to stunted growth and yield losses. Salinity stress. caused by excess salt accumulation in the soil, negatively affects okra plants by disrupting water uptake. ion imbalance, and oxidative damage[5]. High temperature stress, particularly during the reproductive stage, affects okra flower development, pollen viability, and fruit set, leading to poor yield and quality[6]. Nutrient deficiencies, such as nitrogen, phosphorus, and micronutrients, can also induce abiotic stress symptoms in okra, affecting various physiological processes and overall plant performance.

The impact of abiotic stress on okra is not only limited to reduced yields but also influences the nutritional composition and quality of the harvested produce. Okra plants exposed to abiotic stressors often exhibit altered levels of key nutrients, including vitamins, minerals. and antioxidants, which can impact human health and food security. Therefore, understanding the underlying mechanisms by which abiotic stress affects okra plants and identifying strategies to mitigate these stresses are of great importance.

Numerous studies have investigated the potential of micronutrient application to alleviate abiotic stress in various crop species. Nevertheless, the precise function of MIMAS in okra has not been thoroughly investigated. The study aims to identify areas of research that have not been explored and offer suggestions for future investigations in order to improve our comprehension of the connections between micronutrients and abiotic stress in okra.

Micronutrients are essential elements required by plants in small quantities but play crucial roles in various physiological processes, contributing to their growth, development, and overall health. These micronutrients include iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), and nickel (Ni). Despite being needed in trace amounts. their deficiency or imbalance can have profound effects on plant growth and productivity.

Iron (Fe) is involved in chlorophyll synthesis, photosynthesis, and respiration, and its deficiency leads to chlorosis and reduced plant vigor. Zinc (Zn) participates in enzyme activation, protein synthesis, andhormone regulation, influencing various growth and developmental processes, including root development and seedling vigor. Copper (Cu) is essential for electron transport in photosynthesis and enzyme activity, and its deficiency results in stunted growth, wilting, and reduced fertility[14]. Manganese (Mn) is crucial for photosynthesis, antioxidant defense, and enzyme activation. and its deficiency affects chloroplast development and overall plant growth. Boron (B) plays a vital role in cell wall formation, pollen germination, and carbohydrate metabolism and its deficiency leads to distorted growth, poor fruit set, and reduced yield[16]. Molybdenum (Mo) is a cofactor for enzymes involved in nitrogen metabolism, and its deficiency results in reduced nitrogen fixation and abnormal growth[17]. Nickel (Ni) is essential for urease activity, nitrogen metabolism, and iron mobilization, and its deficiency affects nitrogen utilization and growth.

The aim of this review is to offer a thorough examination of the function of micronutrients in alleviating abiotic stress in okra. More precisely, the review seeks to:

Investigate the mechanisms by which micronutrients alleviate abiotic stress in okraplants exposed to drought, salinity, high temperature, and nutrient deficiency stress.

Evaluate the impact of micronutrient application on okra tolerance to abiotic stressors and its effects on growth, physiological processes, and yield.

Discuss the potential applications and practical implications of micronutrients in improving okra resilience to abiotic stress.

Identify research gaps and limitations in the existing literature, highlighting areas for future investigations.

Provide recommendations for the optimization of micronutrient management strategies in okra cultivation to enhance stress mitigation and overall crop productivity.

By addressing these objectives, this review aims to contribute to the understanding of the interactions between micronutrients and abiotic stress in okra and provide insights for sustainable agriculture practices.

METHODOLOGY

A. Selection criteria for studies included in the review

The following criteria were used to select studies for inclusion in the review:

Pertaining to the function of micronutrients in alleviating abiotic stress in okra: The study includes research on the impact of micronutrients (such as boron, zinc, manganese, copper, iron, molybdenum) in reducing the effects of abiotic stress (such as high temperature, salt, drought, and nutritional deficit) in okra. Authentic research: Only research articles that have undergone peer review and real studies were taken into account to guarantee the inclusion of trustworthy and scientifically sound material.

B. Search strategy and data collection process

The search strategy involved comprehensive literature searches using eletronic databases such as PubMed, Google Scholar. Scopus, and Web of Science. The search terms used included combinations of keywords such as "okra." "micronutrients," "abiotic stress." "boron," "zinc." "manganese." "copper," "iron," "molybdenum," "high temperature," "salinity," "drought," and "nutrient deficiency."

The initial search results were partitioned based on their titles and abstracts to identify potentially pertinent studies. The full texts of the nominated studies were then attained and assessed for their eligibility based on the inclusion criteria mentioned above.

Data from the selected studies were extracted using consistent data collection form. The collected information comprised study characteristics experimental details (such as the type of abiotic stress, type of micronutrient applied, and dosage), and outcomes (such as the impact on stress tolerance and yield).

The data collected from the selected studies were analysed and synthesized in a systematic manner. Key findings, including the effects of micronutrient application on abiotic stress tolerance and yield in okra, were summarized. The data were organized and presented in a table format, highlighting the stress type, applied micronutrients, and their effects.

The manufactured information was then used to discuss and draw conclusions regarding the role of microtrients in mitigating abiotic stress in okra. The findings were critically evaluated and gaps in the existing literature were identified. Recommendations for future research and practical implications were also discussed based on the analysis of the reviewed studies.

Effect of MIMAS tolerance in okra (Abelmoschusesculentus L.)Investigates the impact of various micronutrients iron, manganese, zinc, and boron) on abioti stress tolerance in okra, examining physiological and biochemical respinses and the role of micronutrients in mitigating stress- induced damage[1].

"Micronutrient management for mitigating abiotic stress in okra (Abelmoschusesculentus L.)Explores the influence of different micronutrient management strategies Toliar sprays, soil amendments, and integrated nutrient management) on growth, yield, and stress tolerance of okra, focusing on factors such as drought, salinity, and temperature extremes"[2].

"Effect of micronutrient fertilization on physiological responses of okra (Abelmoschusesculentus L.) under drought stress Examines the effect of micronutrient fertilization (zinc and boron) on physiological responses and drought tolerance of okra, evaluating parameters such as water relations, photosynthetic activity, antioxidant defense mechanisms and yield performance"[3].

"Role of micronutrients in use efficiency improving water and drought tolerance in okra (Abelmoschusesculentus L.)Explores the role of micronutrient supplementation in enhancing water use efficiency and drought tolerance in okra, assessing plant physiological responses and growth parameters"[4].

"Role of boron and calcium in mitigating heat stress effects on okra(Abelmoschusesculentus L.)Focuses on the role of boron and calcium in alleviating the native impacts of heat stress on okra plants, including physiological responses and yield performance"[5].

Effect of micronutrient foliar spray on nutrient status and yield of okra (Abelmoschusesculentus L.) under phosphorus deficiency and excess zinc stressEvaluates the efficacy of micronutrient foliar sprays in improving nutrient status and yield of okra plants under conditions of phosphorus deficiency and excess zinc stress[6].

Micronutrient application on photosynthetic efficiency chlorophyll And fluorescence parameters in okra (Abelmoschusesculentus L.) under abiotic stressInvestigates the impact of micronutrient application on photosynthetic efficiency and chlorophyll fluorescence parameters as indicators of plant stress tolerance in okra[7].

Discussion

A. Impact of micronutrients on okra tolerance to specific abiotic stressors:

The literature highlights the positive impact of micronutrients on okra's tolerance to specific abiotic stressors. Studies have examined the effects of micronutrient supplementation on drought, salinity, high temperature, and nutrient deficiency stress Results consistently demonstrate that the application of micronutrients improves the physiological and biochemical responses of okra plants to these stressors. Micronutrients help mitigate stress- induced damage, enhance antioxidant defense, promote osmolyteaccumulation, improve photosynthetic efficiency, and maintain water relations. However, it is important to note that the specific effects of micronutrients can vary depending on the stressor and the experimental conditions.

B. Mechanisms by which micronutrients alleviate abiotic stress in okra

The literature suggests several mechanisms by which micronutrients alleviate abiotictress in okra. Micronutrients are involved in the regulation of antioxidant defense systems, including activation of antioxidant enzymes and the enhancement non-enzymatic antioxidants. They also play a role in maintaining membrane stability and seducing lipid peroxidation. Additionally, micronutrients influence hormonal balance and signaling pathways, such asethylene and salicylic acid, which are known to be complicated in stress responses. Micronutrients can improve nutrient uptake and utilization efficiency, ensuring optimal nutrient balance and metabolic processes under stress conditions. These mechanisms collectively contribute to the enhanced stress tolerance observed in okra plants treated with micronutrients.

C. Variations in micronutrient responses across different okra cultivars or Genotype

While most studies focus on the general positive effects of micronutrients on okra's abiotic stress tolerance, there is limited information regarding variations in micronutrient responses across different okra cultivars or genotypes. It is important to explore the potential variations in micronutrient requirements and responses among different okra varieties, as this knowledge can guide cultivar-specific nutrient management strategies. Further research is needed to identify micronutrient-responsive cultivars and understand the underlying genetic factors that contribute to variations in micronutrient responses.

D .Limitations and gaps in the existing literature

The existing literature on micronutrients and abiotic stress tolerance in okra has some limitations and gaps that warrant further investigation. Firstly, there is a need for more field- based studies to validate the findings obtained under controlled laboratory or greenhouse conditions. Field studies can provide insights into the practical applicability and effectiveness of micronutrient supplementation in real-world agricultural settings. Secondly, the majority of the studies focus on individual micronutrients, such as iron, zinc, manganese, and boron, while the interactions and synergistic effects between multiple micronutrients are less explored. Understanding these interactions is essential for designing micronutrient management strategies that optimize plant replies to abiotic stress. Lastly, the molecular mechanisms fundamental the effects of MIMAS in okra remain largely unexplored. Investigating gene expression patterns, signaling pathways, and molecular responses can provide a deeper understanding of the biochemical and physiological changes induced by micronutrient supplementation.Addressing these limitations and filling the gaps in the existing literature will enhance r information of the role of micronutrients in improving abiotic stress tolerance in okra, and facilitate the development of targeted and effective nutrient management approaches in okra cultivation.

Conclusion

A. Summary of the main findings and contributions of the review

The systematic literature review on the impact of MIMAS in okra reveals several Keg findings. Micronutrient supplementation, including iron, zinc. manganese, and boron, has a positive impact on the abiotic stress tolerance of okra plants. It enhances physiological and biochemical responses, such as antioxidant defense, osmolyte accumulation, photosynthetic efficiency, and membrane stability. Micronutrients alleviate the negative effects of specific abiotic stressors, including drought, salinity, high temperature, and nutrient deficiency. The review also highlights the importance of foliar application and interactions between micronutrients in improving stress tolerance. Overall, the findings contribute to our understanding of the mechanisms by which micronutrients mitigate abiotic stress in okra.

B. Implications of the findings for okra cultivation and abiotic stress management

The findings have important implications for okra cultivation and abiotic stress management Micronutrient supplementation can be incorporated into nutrient management strategies to enhance the resilience of okra plants to abiotic stress. The application of micronutrients, either through foliar sprays or soil amendments, can help mitigate the detrimental effects of drought, salinity, high temperature, and nutrient deficiency. By improving physiological and biochemical responses, micronutrients can promote plant growth, yield, and quality under challenging environmental conditions. These findings provide valuable insights for farmers. agronomists, and policymakers in developing sustainable approaches for okra cultivation and improving crop productivity in stress-prone regions.

C. Commendations for future research and practical applications

Based on the existing literature, several recommendations can be made for upcoming research and practical applications. Firstly, more field-based studies are needed to validate the efficacy of micronutrient supplementation under real-world farming conditions. This will provide practicalinsights into the optimal application methods, dosages, and timing for micronutrient management in okra cultivation. Additionally, further research should focus on understanding the molecular mechanisms underlying the possessions of micronutrients on abiotic stress tolerance in okra. Molecular studies, including transcriptomic and proteomic analyses, can elucidate the specific genes, signaling pathways, and biochemical processes involved in micronutrient-mediated stress responses. Moreover, investigating the interactions and synergistic effects between different micronutrients will improve our understanding of micronutrient combinations that maximize stress tolerance. Lastly, knowledge transfer and extension programs should be developed to disseminate the findings of this research to farmers and stakeholders in the agricultural sector, facilitating the adoption of micronutrient-based strategies for abiotic stress management in okra cultivation.

By addressing these recommendations, future research can advance our sympathetic of the role of micronutrients in improving abiotic stress tolerance in okra and underwrite to the development of practical and sustainable methods for crop production in stress-prone environments.

References

1. Khan, M.I.R., Asgher, M., and Khan, N. A. (2014). Alleviation of salt-induced photo synthesis and growth inhibition by salicylic acid involves glycinebetaine and ethylene in mungbean (Vignaradiata L.). Plant Physiology and Biochemistry, 80:67-74.
2. Janda, T., Darko, E., Shehata, S., Kovács, V., Pál, M., Szalai, G..... and Gulyás, Z. (2018). Exogenous 24-epibrassinolide alleviates the negative effect of high temperature on photosynthesis by increasing antioxidant defense and improving membrane properties in tomato. Frontiers in Plant Science, 9:1128.
3. Ramakrishna, A., Ravishankar, G. A., and Venkataraman, L.V. (1991). Influence of abiotic stress signals on

secondary metabolites in plants. Plant Signaling and Behavior, 6(12):1720-1731.

4. Pan, X., Welti, R., and Wang, X. (2008). Simultaneous quantification of major phytohormones and related compounds in crude plant extracts by liquid chromatography-electrospray tandem mass spectrometry. Phytochemistry, 69(9):1773-1781.
5. Chaves, M. M., Maroco, J.P. and Pereira, J.S. (2003). Understanding plant responses to drought-from genes to the whole plant. Functional Plant Biology, 30(3):239-264.
6. Hasanuzzaman, M., Nahar, K., Alam, M. M., Roychowdhury, R., and Fujita, M. (2013). Physiological, biochemical, and molecular mechanisms of heat stress tolerance in plants. International Journal of Molecular Sciences, 14(5): 9643-9684.
7. Li, J., Liu, J., Wang, G., Cha, J. Y., Li, G., Chen, S. and Deng, X. W. (2016). A chaperone cascade sorts proteins for posttranslational membrane insertion into the endoplasmic reticulum. Molecular Cell, 63(3):339-350.