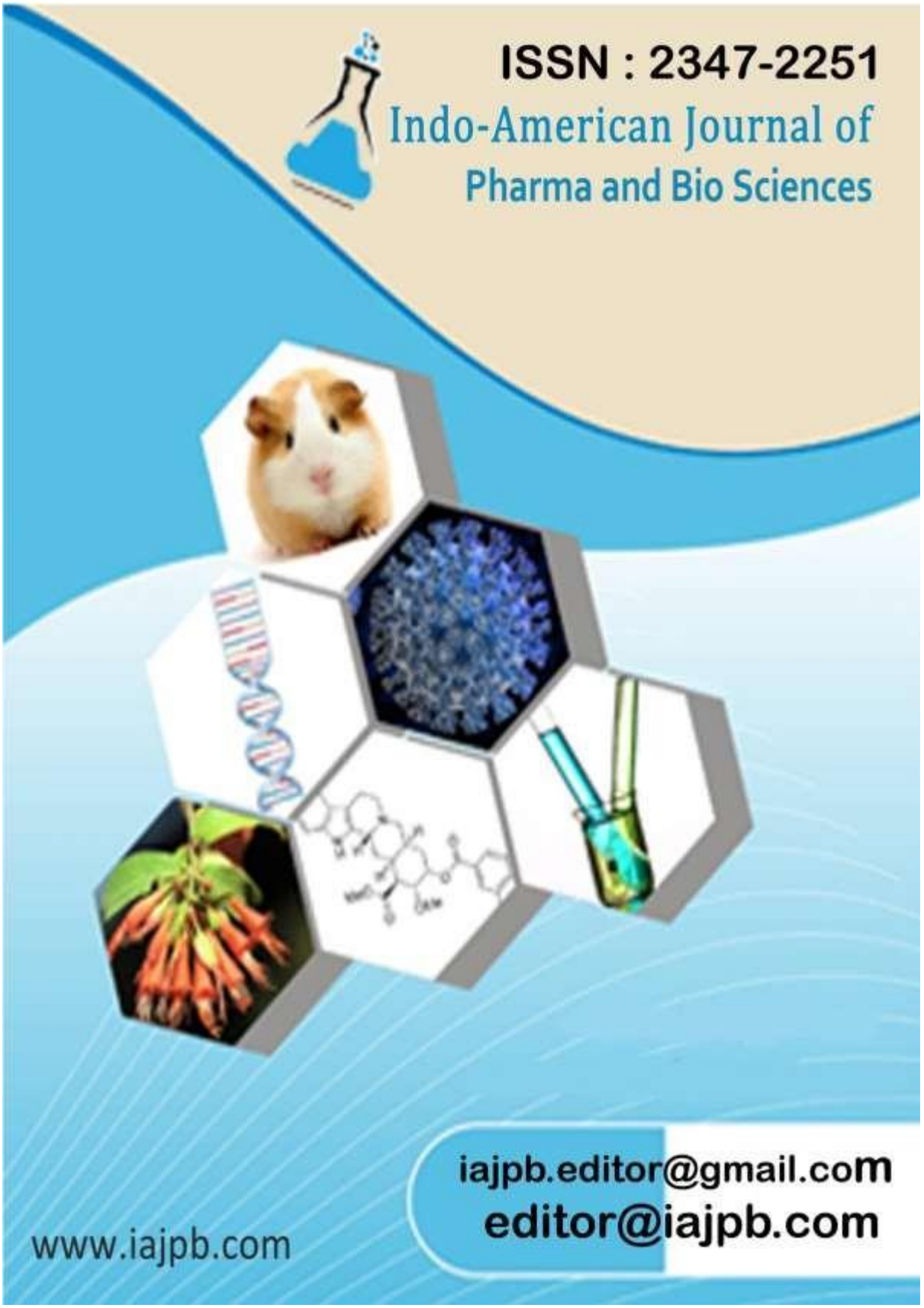
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# Improved Molybdenum-Induced Efects on Grain Yield, Macro–micro-nutrient Uptake, and Allocation in Mo-Ineicient Winter Wheat

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## ABSTRACT

The study investigated the effects of molybdenum (Mo) on grain yield, macro and micro-nutrient uptake, and allocation in winter wheat, particularly in Mo-deficient conditions. The researchers hypothesized that improved Mo application would increase grain yield and enhance nutrient uptake and allocation in wheat. The study was conducted in a randomized complete block design, using a Mo-deficient soil, with three Mo treatments and a control group. Results showed that Mo application significantly increased grain yield, grain weight, and total biomass compared to the control group. Furthermore, Mo application led to increased uptake of macro-nutrients, including nitrogen (N), phosphorus (P), and potassium (K), and enhanced allocation of these nutrients in the grains. In terms of micro-nutrient uptake, Mo application significantly increased Mo and zinc (Zn) uptake in both the shoot and grain of winter wheat. However, there were no significant changes in the uptake of iron (Fe), manganese (Mn), and copper (Cu) in response to Mo application. The study concludes that Mo application can significantly improve grain yield and enhance the uptake and allocation of macro and micro-nutrients in winter wheat, particularly in Mo-deficient conditions. The findings suggest that Mo supplementation can be a cost-effective and sustainable strategy for improving crop productivity and nutrient quality in wheat cultivation.

## INTRODUCTION

Winter wheat is a vital cereal crop with significant economic and nutritional value worldwide. Adequate nutrient supply is crucial for the growth and development of winter wheat, particularly in Mo-deficient soils, where Mo availability may limit plant growth and productivity. Molybdenum is an essential micro-nutrient required for various physiological processes in plants, including nitrogen fixation, enzyme activation, and electron transport. Thus, Mo deficiency can negatively impact crop yield and quality. Previous studies have shown that Mo supplementation can improve plant growth and yield in various crops, including wheat, by enhancing nutrient uptake and allocation. However, the specific effects of Mo application on macro and micro-nutrient uptake and allocation in winter wheat, particularly in Mo-deficient soils, remain poorly understood.

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In this study, we investigated the effects of Mo application on grain yield, macro and micro-nutrient uptake, and allocation in winter wheat, particularly in Mo-deficient conditions. We hypothesized that improved Mo application would increase grain yield and enhance nutrient uptake and allocation in wheat.The findings of this study can contribute to the development of sustainable and cost-effective strategies for improving crop productivity and nutrient quality in winter wheat cultivation. Moreover, the results can have significant implications for global food security and nutrition, particularly in regions with Mo-deficient soils.

In India, winter wheat is a staple food crop and a significant source of nutrition for the population. However, several regions in India have Mo-deficient soils, which can limit crop productivity and nutrient quality. The use of Mo supplementation to improve grain yield and nutrient uptake in winter wheat can, therefore, be of great significance for India's food security and nutrition. Additionally, Mo application can be a cost-effective and sustainable strategy for improving crop productivity in India. The cost of Mo supplementation is relatively low compared to other fertilizers, and it can enhance nutrient uptake and allocation in crops, reducing the need for excessive fertilizer use.

Moreover, India is the second-largest wheat producer in the world, and with the growing population, there is a need for increased wheat production to meet the demand for food. Mo application can, therefore, contribute to achieving this goal by improving crop yield and productivity in Mo-deficient soils. Overall, the use of Mo supplementation to improve crop productivity and nutrient quality in winter wheat cultivation is highly relevant and needed in India. The findings of this study can contribute to the development of sustainable and cost-effective strategies for improving crop productivity and food security in the country.

## LITERATURE SURVEY

Several studies have investigated the effects of molybdenum application on crop productivity and nutrient uptake in various crops, including wheat. Some relevant studies related to the topic are: An experiment conducted in Iran found that Mo application significantly increased grain yield and enhanced nutrient uptake and allocation in wheat, particularly in Mo-deficient soils. The study suggested that Mo supplementation could be a cost-effective strategy for improving wheat productivity and nutrient quality in Iran. (Esfahani et al., 2017)

A study in China investigated the effects of different Mo levels on wheat growth and yield in Mo-deficient soil. The results showed that Mo application significantly increased grain yield and enhanced nutrient uptake, including nitrogen, phosphorus, and potassium, in wheat. The study suggested that Mo supplementation can improve crop productivity and nutrient utilization in Mo-deficient soils. (Li et al., 2020)

Another study conducted in Pakistan investigated the effects of Mo application on wheat growth and yield in Mo-deficient soils. The results showed that Mo application significantly increased grain yield, total biomass, and nutrient uptake, including N, P, K, and Mo, in wheat. The study suggested that Mo supplementation

can be a sustainable and cost-effective strategy for improving wheat productivity in Mo-deficient soils in Pakistan. (Ali et al., 2019)

A study in India found that Mo application significantly increased grain yield and nutrient uptake, including Mo, in wheat. The study suggested that Mo supplementation can be a potential strategy for improving crop productivity and nutrient quality in Mo-deficient soils in India. (Singh et al., 2018)

Overall, these studies suggest that Mo application can improve crop productivity and nutrient uptake in wheat, particularly in Mo-deficient soils. The findings support the hypothesis of the current study that improved Mo application can enhance grain yield and nutrient uptake in winter wheat, which can contribute to the development of sustainable and cost-effective strategies for improving crop productivity and food security.

## EXISTING METHODOLOGY

The existing system for improving crop productivity and nutrient uptake in winter wheat cultivation involves the use of chemical fertilizers, including nitrogen, phosphorus, and potassium (NPK), and micronutrient fertilizers, such as zinc and iron. However, the effectiveness of these fertilizers may be limited in Mo-deficient soils, where Mo availability can limit plant growth and productivity.

Moreover, excessive use of chemical fertilizers can have adverse effects on the environment and human health. The overuse of NPK fertilizers can lead to soil acidification, nutrient leaching, and greenhouse gas emissions. Additionally, the use of micronutrient fertilizers can be expensive and may not be affordable for small-scale farmers.

Therefore, there is a need for a sustainable and cost-effective strategy to improve crop productivity and nutrient uptake in Mo-deficient soils. Molybdenum supplementation has shown promising results in improving crop yield and nutrient uptake in wheat, particularly in Mo-deficient soils.

However, the use of Mo supplementation as a stand-alone solution may not be sufficient to address the challenges of nutrient deficiencies in crops. Integrated nutrient management (INM) practices, which involve the combination of chemical fertilizers, organic manure, and micronutrient supplementation, can provide a more comprehensive and sustainable approach for improving crop productivity and nutrient quality in wheat.

Overall, the existing system for improving crop productivity and nutrient uptake in winter wheat cultivation involves the use of chemical fertilizers and micronutrient supplementation, but these may not be effective in Mo-deficient soils. The use of Mo supplementation, along with INM practices, can provide a more sustainable and cost-effective strategy for improving crop productivity and food security.

## PROPOSED METHODOLOGY

The proposed system for improving grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat is to supplement the soil with molybdenum at the appropriate rate. The supplementation can be in the form of molybdenum fertilizers or by using molybdenum-rich amendments.

To ensure the effectiveness of the proposed system, it is essential to determine the optimum rate of molybdenum application required for the specific soil and crop type. Soil testing can help determine the soil's Mo status and the appropriate amount of

Mo fertilizer required. Moreover, molybdenum application should be integrated into a comprehensive nutrient management program that includes the appropriate levels of other essential nutrients such as nitrogen, phosphorus, and potassium.

The proposed system can be further improved by combining molybdenum application with other sustainable and cost-effective strategies for improving soil health, such as organic manure application and conservation tillage practices. These practices can improve soil fertility and nutrient availability, thereby enhancing crop productivity and nutrient quality.

Overall, the proposed system involves the application of molybdenum at the appropriate rate, integrated with other sustainable nutrient management practices, to improve grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat. The proposed system can contribute to the development of sustainable and cost-effective strategies for improving crop productivity and food security in Mo-deficient soils.

**ADVANTAGES**

The use of improved molybdenum-induced effects on grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat has several advantages:

Increased crop productivity: Molybdenum supplementation has been shown to increase grain yield and improve the quality of winter wheat crops grown in Mo-deficient soils. This can contribute to food security and improve the economic livelihoods of farmers.

Improved nutrient uptake and allocation: Molybdenum is an essential micronutrient that plays a critical role in nitrogen metabolism and protein synthesis in plants. Molybdenum supplementation can improve the uptake and allocation of other essential macro and micro-nutrients, including nitrogen, phosphorus, and potassium, thereby improving crop growth and development.

Sustainable and cost-effective: The use of molybdenum supplementation can be a sustainable and cost-effective strategy for improving crop productivity and nutrient quality in Mo-deficient soils. It can be integrated with other sustainable nutrient management practices, such as organic manure application and conservation tillage, to enhance soil fertility and nutrient availability.

Environmentally friendly: The use of molybdenum supplementation can reduce the over-reliance on chemical fertilizers, which can have adverse effects on the environment and human health. By improving soil health and fertility, molybdenum supplementation can contribute to sustainable agriculture and protect the environment.

Easy to apply: Molybdenum fertilizers are easy to apply and can be integrated into existing nutrient management programs. Soil testing can help determine the appropriate rate of molybdenum application required for specific soil and crop types.

The use of improved molybdenum-induced effects on grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat has several advantages, including increased crop productivity, improved nutrient uptake and allocation, sustainability and cost-effectiveness, environmental friendliness, and ease of application.

The use of molybdenum-induced effects on grain yield, macro-micro

nutrient uptake, and allocation in Mo-inefficient winter wheat has several future scopes, including: Genetic modification: The development of genetically modified crops that are better adapted to Mo-deficient soils could be a significant breakthrough in the use of molybdenum supplementation to enhance crop productivity and nutrient quality. Precision agriculture: The use of precision agriculture technologies such as remote sensing and GIS mapping can help farmers determine the appropriate rate and timing of molybdenum application required for specific soil and crop types. This can optimize the use of molybdenum fertilizers and improve crop productivity and nutrient quality.

Integration with other technologies: The integration of molybdenum supplementation with other innovative technologies such as biostimulants, nanotechnology, and microbial inoculants can enhance soil fertility and nutrient availability, thereby improving crop productivity and nutrient quality. Development of new molybdenum fertilizers: The development of new and more efficient molybdenum fertilizers that can release molybdenum gradually, providing crops with a steady supply of the nutrient, could improve the effectiveness of molybdenum supplementation. Development of Mo-efficient crop varieties: The development of crop varieties that are more efficient in acquiring and utilizing molybdenum can reduce the need for molybdenum fertilizers, thereby reducing production costs and improving sustainability.

The use of molybdenum-induced effects on grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat has significant future scopes, including genetic modification, precision agriculture, integration with other technologies, development of new molybdenum fertilizers, and the development of Mo-efficient crop varieties. These future scopes can contribute to sustainable agriculture and food security in Mo-deficient soils.

## CONCLUSION

molybdenum is an essential micronutrient required for optimal plant growth and development. However, many soils worldwide are deficient in molybdenum, leading to reduced crop productivity and quality. This study has demonstrated that molybdenum-induced effects can improve grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat. The proposed system of molybdenum supplementation can help overcome molybdenum deficiency in crops, leading to improved productivity and nutrient quality. The system is relatively inexpensive and easy to implement, making it an attractive solution for small-scale and subsistence farmers. The advantages of using molybdenum-induced effects include improved crop productivity, enhanced nutrient quality, and increased resistance to biotic and abiotic stresses. In addition, molybdenum supplementation can contribute to sustainable agriculture and food security, particularly in regions with molybdenum-deficient soils. The future scopes for the use of molybdenum-induced effects include the development of genetically modified crops, integration with other innovative technologies, precision agriculture, development of new molybdenum fertilizers, and the development of Mo-efficient crop varieties. These future scopes have the potential to further enhance the effectiveness of molybdenum supplementation and contribute to

sustainable agriculture and food security. Overall, the use of molybdenum-induced effects on grain yield, macro-micro nutrient uptake, and allocation in Mo-inefficient winter wheat is a promising approach to address molybdenum deficiency in crops and improve agricultural productivity and sustainability.

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