Effect Of Micronutrients on Crop Growth Attributes and Yield of Rice Fallow Black gram (*Vigna Mungo* L.)

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Introduction

Rice fallow black gram refers to the practice of cultivating black gram (*Vigna mungo* L.) in the residual moisture and nutrients present in rice fields after the harvest of the monsoon (kharif) rice crop. These lands would otherwise remain fallow during the post-rainy (*Rabi*) season. This system is particularly prevalent in South and Southeast Asian countries, including India, where a significant area of rice-fallow land exists (Suryakala *et al*., 2021).

Micronutrients play a crucial role in maximizing the growth attributes and yield of black gram, especially when grown in rice fallow systems, where soils can often be deficient in these essential elements. The residual moisture and nutrient status after rice cultivation may not be sufficient to meet the demands of a high-yielding black gram crop (Kiruthika *et al*., 2024). Here's a breakdown of the impact of key micronutrients on black gram growth and yield in rice fallow systems, based on research:

General Importance of Micronutrients in Black Gram

- **Enzymatic Activities:** Micronutrients act as cofactors in numerous enzymatic reactions vital for plant metabolism, photosynthesis, respiration, and nutrient assimilation.
- **Hormone Synthesis:** They are involved in the synthesis of plant growth hormones, which regulate cell division, elongation, and overall plant development.
- **Nutrient Uptake and Translocation:** Adequate supply of micronutrients facilitates the uptake and efficient translocation of both macro and other micronutrients within the plant.
- **Reproductive Development:** Many micronutrients are critical for flowering, pollen viability, fertilization, pod setting, and seed development.
- **Stress Tolerance:** They help plants withstand various abiotic (e.g., moisture stress) and biotic (e.g., disease) stresses (Marimuthu and Surendran, 2015).

Specific Micronutrients and Their Effects

Zinc (Zn)

Role: Zinc is involved in auxin production, dehydrogenase enzyme activation, ribosomal fraction stabilization, chlorophyll formation, and carbohydrate synthesis and translocation. It is vital for maintaining the integrity of plant bio-membranes (Radhika *et al*., 2023).

Impact on Growth: Studies consistently show that zinc application (especially foliar) leads to:

- Increased plant height.
- More branches per plant.
- Higher dry matter accumulation.
- Enhanced root development and nodulation (indirectly improving nitrogen fixation).

Impact on Yield: Zinc significantly boosts yield attributes and final grain yield:

- Increased number of pods per plant.
- Higher number of seeds per pod.
- Improved 100-seed weight (test weight).
- Higher seed and haulm yield.

Application: Both soil application (e.g., $ZnSO_4$ @ 25-50 kg/ha) and foliar application (e.g., 0.5% $ZnSO_4$ spray at critical growth stages like flowering and pod filling) have proven effective. Foliar application can be particularly efficient in correcting deficiencies quickly and in cases were soil conditions limit uptake.

Boron (B)

Role: Boron is crucial for cell division, cell wall formation and integrity, sugar translocation, pollen germination, pollen tube growth, and seed set. It's essential for reproductive growth.

Impact on Growth: While less directly linked to vegetative growth parameters like height or branches as compared to Zn, Boron deficiency can lead to overall stunted growth and abnormal development.

Impact on Yield: Boron deficiency severely limits reproductive yield. Its application can lead to:

- Significant increase in the number of pods per plant.
- Higher number of seeds per pod.
- Improved 100-seed weight.
- Enhanced grain yield, often due to better pollination and seed formation.

Application: Foliar spray (e.g., 100 ppm Boron or 0.25% Borax) during flowering and pod formation stages is highly recommended, especially in areas prone to moisture stress, as

it directly aids reproductive processes. Soil application (e.g., 0.5 to 2.5 kg B/ha) can also be effective.

Molybdenum (Mo)

Role: Molybdenum is a critical component of two key enzymes in legumes (Jongrauaysup *et al*., 1997):

- **Nitrogenase:** Essential for symbiotic nitrogen fixation by *Rhizobium* bacteria in root nodules. Without adequate Mo, nitrogen fixation is severely impaired.
- **Nitrate Reductase:** Involved in the reduction of nitrates to nitrites, a crucial step in nitrogen assimilation.

Impact on Growth: Molybdenum deficiency can lead to:

- Symptoms resembling nitrogen deficiency (yellowing of older leaves, stunted growth).
- Reduced dry matter accumulation.
- Poor nodulation.

Impact on Yield

- Directly enhances seed yield by ensuring efficient nitrogen fixation and assimilation.
- Increases number of pods per plant and seeds per pod.
- Improves protein content in seeds.

Application: Seed treatment with molybdenum (e.g., 4 g Mo per kg of seed) is a highly effective and economical way to supply this micronutrient, ensuring its availability from the early stages of symbiotic nitrogen fixation. Foliar application can also be used.

Iron (Fe)

Role: Iron is essential for chlorophyll synthesis, electron transport in photosynthesis and respiration, and various enzyme activities.

Impact: Deficiency leads to interveinal chlorosis (yellowing between veins) of young leaves. While the search results didn't detail its specific role in rice-fallow black gram, in general, iron application can improve overall plant health and photosynthetic efficiency, leading to better growth and yield.

Importance of Foliar Application in Rice Fallow Systems

Many studies highlight the efficacy of foliar application of micronutrients in rice fallow black gram (Vijay kumar *et al*., 2020). This is particularly beneficial because:

- **Quick Uptake:** Nutrients are absorbed directly by leaves, leading to faster correction of deficiencies.
- **Overcoming Soil Issues:** In rice fallow soils, factors like soil compaction, high pH (alkaline soils), or interactions with other nutrients (e.g., high phosphorus fixing zinc) can limit soil-applied micronutrient availability. Foliar sprays bypass these limitations.
- **Targeted Delivery:** Nutrients can be applied precisely at critical growth stages (e.g., flowering, pod filling) when demand is high.
- **Economical:** Lower quantities of nutrients are generally required compared to soil application.

Conclusion

Micronutrients, particularly Zinc, Boron, and Molybdenum, are indispensable for optimizing the growth attributes (plant height, branching, dry matter) and yield components (pods per plant, seeds per pod, test weight) of black gram cultivated in rice fallow systems. Addressing their deficiencies, often through targeted foliar application, is a key strategy for enhancing productivity and profitability in this important cropping system.

References

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TNAU Agritech Portal - Blackgram section (Specific advisories)

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