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Greengram Cultivation in India: The Critical Role of Micronutrient Foilar Feeding- A Review

Satyarth Gupta[1], Shubham Kumar[2] and Yagvendra Saubhari[3],
[123]Department of Genetics and Plant Breeding, SHUATS Prayagraj-211007 U.P,India

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Abstract

The essential role of micronutrient foliar feeding in enhancing green gram cultivation in India, a vital crop in the country's dietary culture. Despite India's prominence as the largest producer and consumer of pulses, including green gram, low average yields present an opportunity for improvement through innovative agronomic techniques. The research problem addressed in this study is the potential for yield enhancement in green gram cultivation through micronutrient foliar feeding. The aim is to explore the impact, benefits, and optimal practices of foliar feeding on green gram yield. The methodology involves a detailed examination of case studies to illustrate the effects of foliar feeding on green gram cultivation, comparing traditional practices with modern techniques and emphasizing the importance of selecting the right nutrient formulations and application timings. The results highlight that foliar feeding significantly improves nutrient efficiency, crop yield, and quality, offering economic and environmental advantages. The implications of this study underscore the critical role of micronutrient foliar feeding in enhancing the nutritional quality, yield, and overall health of green gram crops in India, providing a more efficient and environmentally approach to crop nutrients.

Keywords: Green gram, Vigna radiata, pulses, agronomic techniques, foliar feeding, nutrient efficiency, crop yield, micronutrients, India.

Introduction

Green gram, also known as Vigna radiata, is more than just a pulse crop in India; it's a significant part of our dietary culture, providing a high-quality protein source that remarkably contains about 25% protein, 1.3% fat, 3.5% minerals, 4.1% fiber, and 56.7% carbohydrate. Furthermore, the protein content in green gram is notably two to three times more than that of cereals, making it an indispensable nutrient powerhouse in our homes, whether consumed as whole grains or dal. Despite India's standing as the world's largest producer and consumer of

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pulses, including greengram and mung bean, the average yield remains low, presenting a vast potential for yield improvement through innovative agronomic techniques.

This article explores the pivotal role of micronutrient foliar feeding in elevating greengram cultivation. We delve into the essence of this method, its implementation, and the undeniable benefits it brings to the growth and yield of greengram. Through a close examination of case studies, the impact of foliar feeding on greengram yield is brought to light. Further, the discussion extends to comparing traditional cultivation practices with modern techniques, shedding light on the optimal micronutrient solutions, their types, composition, and the best practices for their application in greengram cultivation.

Understanding Micronutrient Foliar Feeding

Understanding the process and benefits of micronutrient foliar feeding in agriculture, particularly in the cultivation of greengram, involves a detailed look at how this method impacts plant health, yield, and the quality of produce. Here, we delve into the specifics:

Mechanism of Action:

- Micronutrients, including zinc, boron, copper, iron, manganese, molybdenum, and others, are essential for plant metabolism, chlorophyll production, and overall growth. These nutrients can be absorbed either through plant leaves or from the soil solution, but they must penetrate the leaf's waxy cuticle or enter through the stomata for absorption.
- Foliar feeding involves the application of nutrient solutions directly onto the foliage of plants, allowing for quicker absorption and assimilation compared to soil application. This method is particularly effective for crops with limited root systems or when soil-applied nutrients are inadequate or impaired.

Benefits of Foliar Feeding:

- **Enhanced Nutrient Efficiency**: Foliar-applied nutrients are 4 to 30 times more efficient than soil-applied nutrients, significantly reducing the risk of groundwater contamination. This method also allows for the correction of nutrient deficiencies, improving crop yield and enhancing overall plant health.
- **Improved Crop Yield and Quality**: Studies have shown that foliar feeding with a multi-element foliar fertilizer can significantly increase the concentration of essential micronutrients like Fe, Zn, K, Cu, and Mn in crops such as eggplant, which is indicative

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of its potential benefits for greengram cultivation as well. Additionally, the application of micronutrients during the plant's reproductive stages can increase fruit yield due to improved yield parameters.

- **Economic and Environmental Advantages**: The foliar application of nutrients is an efficient and economic method of supplementing the nutrient requirement of crops, leading to enhanced yield. It offers the advantage of quick and efficient utilization of nutrients, eliminating losses through leaching and fixation, and regulating the uptake of nutrient by plants.

Optimal Application Strategies:

- The effectiveness of foliar feeding depends on several factors, including the type of crop, the nutrient solution, and the application method. For optimal results, a multi-nutrient product such as MNENPK should be applied at critical growth stages, such as flowering and fruiting, combined with the recommended doses of NPK fertilizers.
- Micronutrients often become "unavailable" in soils with high pH levels (above 7.5), making foliar application a crucial strategy in such scenarios. Proper formulation for foliar application, such as iron or zinc chelate, is essential for the leaves to absorb these micronutrients effectively.

This detailed examination of micronutrient foliar feeding underscores its critical role in improving the nutritional quality, yield, and overall health of greengram crops in India. By adopting this method, farmers can ensure a more efficient and environmentally friendly approach to crop nutrition, leading to higher quality produce and increased yields.

Implementing micronutrients foilar feeding

Implementing micronutrient foliar feeding in greengram cultivation requires careful consideration and strategic planning. The following points outline the essential steps and precautions for effective foliar feeding:

Steps for Implementing Micronutrient Foliar Feeding

1. **Decision Making**:
   - Recognize that foliar feeding crops is a management decision influenced by individual preferences and the potential return on investment.
2. **Pre-Application Assessment**:
   - Conduct tissue sampling to identify specific nutrient needs before application.

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- Consider environmental conditions and crop health, noting that moisture-stressed plants may be less efficient at transporting nutrients, potentially reducing the effectiveness of foliar feeding.

3. **Nutrient Selection**:
   - Based on soil and tissue analysis, select specific nutrients for application. In Iowa, for example, sulfur applications are recommended for corn and alfalfa, and zinc for corn, depending on soil test results.

Precautions and Best Practices

Application Timing and Conditions:

- Avoid foliar spraying during hot, dry mid-day temperatures or under windy conditions to prevent evaporation and drift.
- Early foliar applications can enhance crop growth and yield potential, making timing critical.

Application Technique:

- Ensure uniform spray pattern and reduce product drift by adjusting boom height above plant canopy.
- Clean application equipment thoroughly before spraying to prevent unintentional product mixing and ensure all hoses, pumps, or pipelines are thoroughly drained and flushed with water before use.

Product Handling:

- Always follow label instructions and application guidelines when using foliar liquid fertilizers.
- Flush residual amounts of fertilizer solution from aluminum equipment with water after use to prevent corrosion.

Optimizing Foliar Feeding Efficacy

- **Nutrient Mobility and Availability**: Foliar feeding is particularly beneficial for nutrients that have low soil mobility or are less available due to environmental conditions, such as zinc (Zn) and boron (B), which significantly impact fruit set and fruitlet abscission.
- **Yield and Quality Improvement**: Research indicates that periodic applications of certain nutrients can positively affect the quantity and quality of fruits, nuts, vegetables, and grain crops, including improvements in yield, quality, and shelf life.

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- **Efficient Nutrient Use**: Foliar feeding allows for precise doses and critical timing for each crop, ensuring efficient nutrient use and minimizing waste.

Implementing micronutrient foliar feeding in greengram cultivation involves a series of strategic decisions and careful practices. By following the outlined steps and precautions, farmers can optimize the benefits of foliar feeding, enhancing greengram yield and quality through improved nutrient management.

The Benefits of Foliar Feeding for Green Gram

Foliar feeding plays a pivotal role in enhancing the yield and overall health of green gram crops through various mechanisms and strategic applications. The benefits of this agricultural practice are multi-faceted, directly impacting crop productivity, nutrient management, and economic returns:

Yield Improvement and Nutrient Management:

- **Increased Yield Attributes**: Application of foliar feeding has been shown to significantly enhance yield attributes, including the number of pods per plant, seed yield, and haulm yield, thereby contributing to a higher overall yield of green gram.
- **Nutrient Loss Reduction**: By minimizing nutrient loss through leaching and fixation, foliar feeding ensures more efficient nutrient uptake. This quick and efficient absorption of nutrients directly through the leaves regulates nutrient uptake, optimizing plant growth and yield.
- **Enhanced Nutrient Efficiency**: The foliar application of plant growth regulators and water-soluble fertilizers containing both macro and micro-nutrients at critical growth stages boosts the productivity of green gram. This method proves particularly beneficial under rainfed conditions, where moisture scarcity can limit nutrient availability from the soil.

Economic Benefits and Crop Quality:

- **Higher Net Returns and BC Ratio**: Specific combinations, such as DAP @ 2% + salicylic acid @ 75 ppm applied at flower initiation, have been found to significantly improve growth and yield, resulting in higher net returns and a favorable benefit-cost ratio for farmers.
- **Improved Plant Growth Parameters**: The line sowing method combined with foliar spray of pulse wonder @15 DAS (days after sowing) significantly enhances growth

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parameters such as plant height, dry matter production, and net assimilation rate, contributing to the overall health and productivity of the crop.

- **Increased Photosynthetic Rate and Nutrient Translocation**: Foliar application boosts the photosynthetic rate and facilitates nutrient translocation from the leaves to the developing seeds, which is crucial for seed development and yield.

Strategic Application and Supplement to Soil Nutrition:

- **Foliar Spray as a Supplement**: While not a substitute for soil application, foliar spray serves as an essential supplement, especially when soil nutrient availability is limited or environmental conditions restrict nutrient uptake from the soil.
- **Importance of Timing and Product Selection**: The effectiveness of foliar feeding is maximized by selecting the right nutrient formulations and applying them at critical growth stages. The foliar application of TNAU Pulse wonder, for example, has shown to significantly increase yield attributes such as the number of pods per plant and grain yield.

This comprehensive analysis underscores the critical role of foliar feeding in greengram cultivation, offering a practical and efficient method to improve nutrient management, enhance crop yield and quality, and provide economic benefits to farmers. Through strategic implementation and careful selection of foliar nutrient solutions, farmers can significantly impact the success of their greengram crops.

Case Studies: The Impact of Foliar Feeding on Green Gram Yield

In exploring the impact of foliar feeding on green gram yield, several case studies conducted across different regions of India provide compelling evidence of its effectiveness. These studies, employing various combinations of micronutrients and application timings, underscore the potential of foliar feeding to enhance green gram cultivation significantly.

Study Highlights from Various Regions:

- Anbil Dharmalingam Agricultural College and Research Institute observed that the combined application of marine gypsum with 1% MKP + 100 ppm Salicylic acid + 0.5 ppm Brassino steroid led to increased plant height, number of branches, nodules, and leaf area index in green gram.
- At the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, the application of 150 ppm salicylic acid at 25 and 45 DAS significantly

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enhanced growth parameters and yield attributes, recording a seed yield of 1346.67 kg/ha.

- Navsari Agricultural University's field experiment revealed that green gram variety GM –6 with a foliar application of 2% DAP twice at branching and pod initiation stages increased all growth parameters over the control.

Comparative Analysis of Foliar Nutrition Impact:

Treatment	Region	Impact on Green Gram Yield
1% MKP + 100 ppm Salicylic acid + 0.5 ppm Brassino steroid	Tamil Nadu	Increased plant height, branches, nodules, leaf area index.
150 ppm Salicylic acid at 25 and 45 DAS	Uttar Pradesh	Higher growth parameters, seed yield (1346.67 kg/ha)
2% DAP at branching and pod initiation stages	Gujarat	Enhanced growth parameters over control
Foliar spray of 19:19:19 (1%) + panchagavya (5%)	Not specified	Significantly higher grain yield and economic returns

Key Observations and Outcomes:

- The application of RDF + foliar spray of TNAU Pulse wonder, seaweed extract, humic and fulvic acid, particularly on 30 and 45 DAS, recorded the highest growth attributes and yield, demonstrating the importance of selecting the right nutrient formulations and application timings.
- Foliar spray of panchagavya not only increased the number of pods per plant but also enhanced the test weight, indicating an improvement in the quality of the yield.
- The study conducted by Mori Milan B, Deshmukh Swapnil P, Thakor Bharvi K, and Patel Upasana J highlighted that strategic foliar nutrition could substantially increase green gram growth parameters, suggesting an avenue for yield improvement under south Gujarat conditions.

These case studies collectively illustrate the transformative potential of micronutrient foliar feeding in green gram cultivation. By carefully selecting nutrient combinations and timing their application, farmers can achieve substantial improvements in yield, quality, and economic returns, emphasizing the critical role of foliar feeding in modern agronomic practices.

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Micronutrient Solutions: Types and Composition

In the context of greengram cultivation, understanding the types and compositions of micronutrient solutions is crucial for effective foliar feeding. These solutions are tailored to address specific nutrient deficiencies and promote optimal plant health and productivity. Below is a detailed overview of essential micronutrients and commercially available micronutrient solutions:

Essential Micronutrients for Greengram:

- **Boron (B)**: Vital for crop growth, boron exists in soil solutions as the BO_3^{-3} anion, playing a key role in cell wall formation and reproductive tissue development.
- **Copper (Cu)**: Activates enzymes and catalyzes reactions in plant-growth processes, essential for vitamin A production and protein synthesis.
- **Iron (Fe)**: Plants absorb iron as the ferrous (Fe^{2+}) cation, crucial for energy transfer, nitrogen reduction and fixation, and lignin formation.
- **Manganese (Mn)**: Functions in enzyme systems, activating metabolic reactions, enhancing photosynthesis, and improving phosphorus and calcium availability.
- **Molybdenum (Mo)**: Required for nitrate reductase synthesis and activity, crucial for symbiotic nitrogen fixation in legume root nodules.
- **Zinc (Zn)**: Absorbed as the divalent Zn^{+2} cation, zinc is essential for plant growth and commonly limits yields.
- **Chlorine (Cl)**: Existing as the chloride (Cl-) anion in soil, chlorine is essential for osmoregulation and stomatal function.
- **Nickel (Ni)**: A component of the urease enzyme, nickel is crucial in very small amounts for plant nitrogen metabolism.

Commercially Available Micronutrient Solutions:

- **Convoy® Charged**: A liquid nitrogen-based fertilizer with seaweed extract and protein hydrolysate, promoting plant growth and early vigor. Suitable for both foliar and in-furrow applications.
- **Homestretch® Series**:
  - **Homestretch®**: Formulated for foliar delivery of manganese, zinc, and boron to all crops.
  - **Homestretch® 10% Boron**: Provides a readily available source of boron for soil and foliar applications.

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- **Homestretch® B-MO**: Offers maximum nutrient mobility and performance, combining boron and molybdenum for efficient uptake.
- **Homestretch® FE 2.1% & 6% EDDHA**: Liquid products with iron EDDHA chelates, designed for soil and foliar applications to prevent or correct iron deficiency.

Application Insights:

- **Timing and Dosage**: Selecting the right time for application, typically during critical growth stages such as flowering or fruit setting, maximizes the effectiveness of these solutions. Following manufacturer guidelines for dosage is crucial to avoid toxicity.
- **Compatibility and Mixing**: Ensuring compatibility with other agrochemicals and proper mixing is essential for the effectiveness of foliar applications. Tank mix compatibility tests or consulting product labels can prevent adverse reactions.

By integrating these micronutrient solutions into foliar feeding practices, farmers can address specific nutrient deficiencies effectively, enhancing the health, yield, and quality of greengram crops.

Best Practices for Foliar Feeding in Green Gram Cultivation

For effective foliar feeding in green gram cultivation, adhering to best practices is essential for maximizing the potential benefits. These practices involve a combination of pre-sowing treatments, precise application of fertilizers and biofertilizers, and strategic foliar applications to enhance growth and yield. The following points outline these practices based on cited research:

Pre-Sowing and Basal Fertilizer Application:

Seed Treatment:

- Treat green gram seeds with Rhizobial culture CRM 6 and Phosphobacteria, each at 200 g/ha, along with PGPR (200 g/ha) using rice kanji as a binder to enhance nitrogen fixation and phosphorus solubilization.

Basal Fertilizers:

- For rainfed conditions, apply 12.5 kg N, 25 kg P2O5, 12.5 kg K2O, and 10 kg S per hectare. For irrigated conditions, the recommended doses are 25 kg N, 50 kg P2O5, 25 kg K2O, and 20 kg S per hectare.
- Under irrigated conditions, apply 25 kg ZnSo4 per hectare to address zinc deficiency.

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Foliar Spray Applications:

Nutrient Sprays:

- Apply TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM. Prepare enriched FYM at a 1:10 ratio of MN mixture and FYM; mix at friable moisture and incubate for one month in shade.
- A foliar spray of 1% urea on 30 and 45 days after sowing is recommended to enhance nitrogen availability.
- For top dressing, an extra dose of 25 to 30 kg through urea is advised to meet the nitrogen demand during growth.

Strategic Foliar Applications for Enhanced Yield:

Growth and Yield Enhancement:

- Foliar spray of NAA 40 mg/litre and Salicylic acid 100 mg/litre once at pre-flowering and another at 15 days thereafter can significantly influence flowering and pod setting.
- Application of pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/lt once at flowering and another at 15 days thereafter has shown to improve yield attributes.
- Foliar application of panchagavya @ 3% along with 75% recommended dose of fertilizer impacts all growth and yield attributes positively.
- Nanourea @ 0.5% foliar application with 75% recommended dose of fertilizer significantly influences growth and yield parameters.
- TNAU Pulse wonder @ 2 kg ac-1 at 15, 30, 45, and 60 DAS significantly increases growth parameters and grain yield.
- Foliar application of a comprehensive nutrient solution (T6: 2% MAP + 1% KCl + 1% FeSO4 + 1% ZnSO4 + 1% CaCl2 + 40 ppm NAA) at peak flowering and pod formation stage recorded the highest yield and pod setting percentage.

Implementing these best practices for foliar feeding in green gram cultivation can lead to significant improvements in plant health, nutrient efficiency, and overall yield. The strategic application of micronutrients and biofertilizers, combined with the careful timing of foliar sprays, provides a comprehensive approach to enhancing the productivity of green gram crops.

Challenges and Solutions in Foliar Feeding

Foliar feeding in green gram cultivation presents a unique set of challenges alongside its numerous benefits. Addressing these challenges effectively is crucial for optimizing nutrient

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uptake and ensuring the health and productivity of crops. The following outlines key challenges encountered in foliar feeding and strategic solutions to mitigate these issues:

Challenges in Foliar Feeding:

- **Ionic Salt Sensitivity**: Leaves are susceptible to salt burn from fertilizers that are ionic salts, posing a risk of damage to the foliage.
- **Cuticle Barrier**: The plant leaf's waxy cuticle layer, designed to protect the plant, can hinder the entry of nutrients, especially in older or stressed plants due to its thickness and the small size of pores.
- **Charge Repulsion and Mobility**: The negative charges on leaf pores repel negatively charged nutrients, making entry difficult. Additionally, strongly charged ions like Ca++ may attach to cells, complicating their transport to the vascular system.

Solutions to Optimize Foliar Feeding:

Strategic Nutrient Formulation:

- Utilize products like TimaUp, which complexes foliar nutrients with amino acids and marine sea plant extract to create a neutral charge, facilitating rapid nutrient entry through leaf pores.
- Employ wetting agents and surfactants to enhance leaf coverage and uptake, ensuring a more uniform application and efficient nutrient absorption.

Application Techniques:

- Apply foliar sprays during cooler parts of the day, preferably between 06:00 – 08:00 in the morning or 18:00 – 20:00 at night when humidity is high, to reduce evaporation and extend the duration of nutrient presence on the leaf for better absorption.
- Focus applications on young, developing leaves where the cuticle may be thinner, and pores are more readily accessible for nutrient entry.

Environmental and Plant Considerations:

- Select drought-tolerant, climate change-resilient, and semi-arid climate-suitable green gram varieties to enhance climate adaptation and ensure effective nutrient uptake under varying environmental conditions.
- Consider factors such as crop type, leaf area and morphology, soil moisture, soil nutrient level, and the nature of the applied substance when evaluating the potential benefits of foliar fertilization.

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Conclusion

Greengram cultivation in India, pivotal for both nutritional and economic reasons, benefits significantly from the adoption of micronutrient foliar feeding practices. The exploration of these techniques, from understanding their mechanisms to their strategic applications, reveals a clear path toward enhancing yields, improving crop quality, and ensuring environmental sustainability. By adhering to best practices and addressing the encountered challenges with innovative solutions, such as employing amino acid-complexed nutrients and efficient application timings, farmers can optimize the benefits of foliar feeding, propelling green gram cultivation into a more productive future.

The significance of this agronomic strategy extends beyond immediate yield improvements, promising a transformative impact on the socio-economic fabric of rural India and the global positioning of Indian agriculture. As we gauge the success of foliar feeding through various case studies and comparative analyses, the compelling evidence underscores its efficacy as an indispensable tool in modern agricultural practices. By embracing these enhanced cultivation techniques, the journey towards achieving food security and sustainable agriculture inches closer, marking a pivotal chapter in the evolution of green gram cultivation in India.

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