Original Research Article

Impact of Foliar Fertilizer Spraying on Productivity and Economics of Greengram (*Vigna radiata* L.) grown in Rice Fallow Condition

ABSTRACT

The field experiment was conducted at the Tamil Nadu Rice Research Institute, Aduthurai, during the rice fallow season of 2022-23 and 2023-24 to evaluate the impact of foliar fertilizer application on the growth, yield and economic performance of rice fallow greengram. The treatment consists of, Water spray-control (T_1), 2% Urea (T_2), 2% DAP (T_3), 2% NPK 18:18:18 (T_4), 0.5% $ZnSO_4$ (T_5), 2% Urea + 0.5% $ZnSO_4$ (T_6), 2% DAP + 0.5% $ZnSO_4$ (T_7) and 2% NPK 18:18:18 + 0.5% $ZnSO_4$ (T_8). The study was conducted in a randomized block design (RBD) with three replications. The greengram variety ADT 3 is used for this study. The treatments were imposed as per treatment schedule. Among the treatments, foliar application of DAP 2% + 0.5% $ZnSO_4$ (T_7) resulted in superior growth and yield parameters, including plant height (72.5 cm), the number of pods plant^{-1} (56.2), the number of seeds pod^{-1} (13.5), test weight (4.1 g) and higher seed yield of 1175 kg ha^{-1}. These results were comparable to those observed with the NPK 18:18:18 @ 2% + 0.5% (T_8) treatment. Consequently, T_7 achieved the highest economic returns, with a gross income of Rs.82,250 ha^{-1}, a net income of Rs.53,284 ha^{-1} and a benefit-cost ratio of 2.84.

Key words: Economics, Foliar nutrition, Greengram, Rice fallow, Seed yield.

1. INTRODUCTION

Greengram (*Vigna radiata* L.), commonly known as green gram or moong, is an indigenous Indian crop. It is cultivated across 40.38 lakh hectares in India, with a total production of 31.50 lakh tons and an average yield of 7.83 quintals per hectare (Agricultural Statistics at a Glance [1]). This legume is renowned for its high-quality, easily digestible protein and is consumed in various forms, including whole seed, dal and sprouts. Among pulses, greengram ranks second in nutritional value, containing 24-25% protein. Greengram crops typically produce many flowers, but only a few develop into pods. Despite abundant flowering, the crop faces challenges such as excessive vegetative growth, low yield and poor harvest index due to inadequate pod setting. Addressing these yield-limiting factors could significantly enhance both the productivity and quality (Kunjammal and Sukumar [2]. Soil-applied nutrients often undergo changes and losses due to processes like leaching and volatilization. Therefore, foliar nutrient application is essential to mitigate these issues and offers a cost-effective method to meet the nutritional requirements, particularly during critical growth stages. Flower drops significantly influence yield attributes and overall production, while enhanced flower retention leads to higher yields. Numerous studies, both globally and in India, have demonstrated that foliar application of growth regulators and macronutrients during flower initiation and pod development stages can improve flower retention when combined with soil nutrient application. Foliar feeding enables plants to rapidly and efficiently absorb nutrients, reducing losses from leaching and fixation (Manonmani and Srimathi [3]; Sharma *et al*. [4]). Foliar feeding significantly improves nutrient availability, plant health and productivity, especially in regions with suboptimal soil fertility. By addressing the plant's immediate nutrient needs, foliar application optimizes growth and yield. Therefore, ongoing research is essential to refine foliar nutrient spray techniques for greengram, aiming to maximize productivity and ensure better harvests.

2. MATERIALS AND METHODS

The field experiment was conducted at the North Farm of the Tamil Nadu Rice Research Institute, Aduthurai, during the rice fallow seasons of 2022-23 and 2023-24. The study aimed to evaluate the impact of foliar fertilizer application on the growth, yield and economic performance of rice fallow greengram, using the ADT 3 variety. The experimental site is located at 11.0° North latitude and 79.4° East longitude, with an altitude of 19.4 meters above mean sea level. The soil at the site is clay and moderately drained. Soil nutrient analysis followed standard methods. Available nitrogen was determined using the alkaline permanganate method suggested by Subbiah and Asija [5] and expressed in kg ha^{-1}. Available phosphorus was measured using the Olsen method suggested by Olsen *et al.* [6], while available potassium was assessed through neutral normal ammonium acetate extraction and flame photometry suggested by Stanford and English [7], both expressed in kg ha^{-1}. Soil pH was measured according to Jackson [8]. The analysis indicated low available nitrogen (275 kg ha^{-1}), high available phosphorus (46 kg ha^{-1}) and medium available potassium (320 kg ha^{-1}). The recorded soil pH was 7.4, indicating a near-neutral reaction. The experiment involved applying various concentrations of foliar fertilizers during the pre-flowering and pod initiation stages. Eight treatments were tested: Water spray-control (T_1), 2% Urea (T_2), 2% DAP (T_3), 2% NPK 18:18:18 (T_4), 0.5% $ZnSO_4$ (T_5), 2% Urea + 0.5% $ZnSO_4$ (T_6), 2% DAP + 0.5% $ZnSO_4$ (T_7), and 2% NPK 18:18:18 + 0.5% $ZnSO_4$ (T_8). The study was arranged in a randomized block design (RBD) with three replications. Greengram was broadcast at a seed rate of 30 kg ha^{-1} in moist soil conditions, seven days before the paddy crop was harvested. Blackgram was cultivated using residual soil moisture and fertility, benefiting from the fertilizer applied to the preceding rice crop at a rate of 150:50:50 kg NPK ha^{-1}. Treatments were applied following the designated treatment schedule. Growth characteristics, yield attributes and seed yield were recorded at harvest. The experimental data were analysed using the statistical method recommended by Gomez and Gomez [9].

3. RESULTS AND DISCUSSION

3.1 Growth and Yield attributes

The treatment significantly impacted the growth and yield attributes, as shown in Table 1 and depicted in Fig.1. The application of foliar fertilizers had a significant impact on plant height. Among the treatments, spraying 2% DAP + 0.5% $ZnSO_4$ (T_7) resulted in the highest plant height (72.5 cm), which was statistically comparable to T_8 (71.4 cm). The lowest plant height was recorded in the control treatment (T_1) at 60.1 cm. The increase in plant height can be attributed to enhanced meristematic cell activity, along with increased cell division and elongation stimulated by nutrient application. Nutrients play a vital role in boosting metabolic processes, which in turn promote improved vegetative growth. These observations align with the findings of Kumar *et. al.* [10] in blackgram and Sumalatha and Uppar [11] in their studies on soybeans. The 2% DAP + 0.5% $ZnSO_4$ (T_7) treatment recorded the highest values for yield attributes, including the number of pods per plant (56.2), seeds per pod (13.5) and a test weight of 4.1 g. These results were statistically on par with NPK 18:18:18 @ 2% + 0.5% $ZnSO_4$ (T_8) treatment. This might be also due to better translocation of photosynthates from source to sink due to additional supply of nutrients through foliar spray. These results are in close confirmation with the findings of Bhavya *et al*. [12] in green gram and in black gram Jadhav *et al.* [13]. In contrast, the water spray control (T_1) showed the lowest values for yield attributes (Table 1 and depicted in Fig.1).

3.1.1 Seed yield

The foliar spray treatments had a significant impact on seed yield (Table 1 and depicted in Fig.1). The application of 2% DAP + 0.5% $ZnSO_4$ (T_7) resulted in the highest seed yield of 1175 kg ha^{-1}, which was statistically comparable to the NPK 18:18:18 @ 2% + 0.5% $ZnSO_4$ (T_8) treatment. The increased seed yield observed may be attributed to the consistent supply of nutrients provided through foliar sprays during the reproductive stage of the crop. This practice likely enhanced yield components, including the number of pods $plant^{-1}$, seeds pod^{-1} and test weight, which directly contributed to improved seed yield.

Additionally, the efficient uptake and translocation of nutrients from the source to the reproductive parts may have further boosted productivity. The lowest seed yield (965 kg ha^{-1} was recorded in the control treatment (T_1), likely due to the inadequate supply of essential nutrients like phosphorus and nitrogen. This deficiency negatively affected crop growth, yield components, and overall productivity. These results align with the findings of Kushwah *et.al.*[14], Ramesh *et.al.*[15] and Shashikumar *et. al.*[16].

Table 1. Effect of foliar nutrients on growth, yield components and seed yield of greengram (mean of 2 years)

Treatment	Plant height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	seed yield (kg ha^{-1})
T_1 - Water spray	60.1	46.9	9.8	3.0	965
T_2 - 2 % Urea	65.9	50.0	10.2	3.2	1012
T_3 - 2 % DAP	69.2	51.6	10.7	3.6	1086
T_4 - NPK (18:18:18) @ 2 %	69.8	54.8	12.7	3.9	1126
T_5 - 0.5 % $ZnSO_4$	62.8	48.5	10.0	3.8	1054
T_6 - 2 % Urea + 0.5 %	70.7	55.1	12.8	4.0	1120
T_7 - 2 % DAP+ 0.5 % $ZnSO_4$	72.5	56.2	13.5	4.1	1175
T_8 - NPK (18:18:18) @ 2 % + 0.5 % $ZnSO_4$	71.4	55.4	12.9	4.0	1148
S.Em±	1.87	1.44	0.33	0.08	31.06
CD (P=0.05)	4.01	3.10	0.71	0.17	66.64

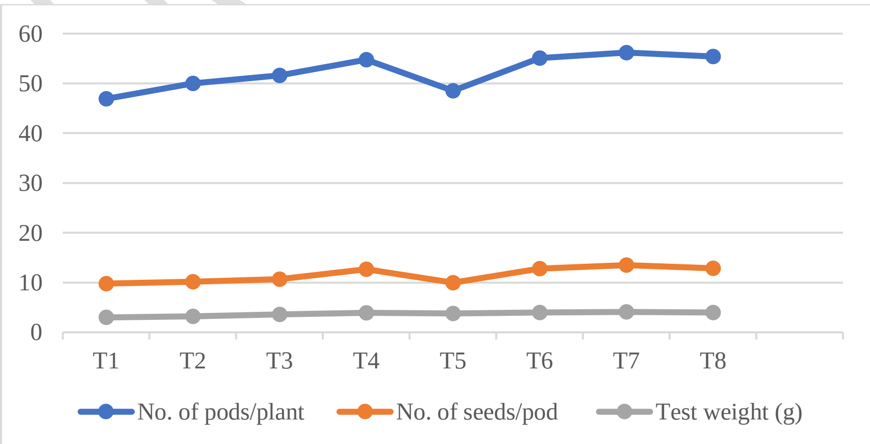

Fig. 1. Effect of foliar fertilizers on yield attributes of greengram

T_1 - Water spray
T_2 - 2 % Urea
T_3 - 2 % DAP
T_4 - NPK (18:18:18) @ 2 %
T_5 - 0.5 % $ZnSO_4$
T_6 - 2 % Urea + 0.5 % $ZnSO_4$
T_7 - 2 % DAP + 0.5 % $ZnSO_4$
T_8 - NPK (18:18:18) @ 2 % + 0.5 % $ZnSO_4$

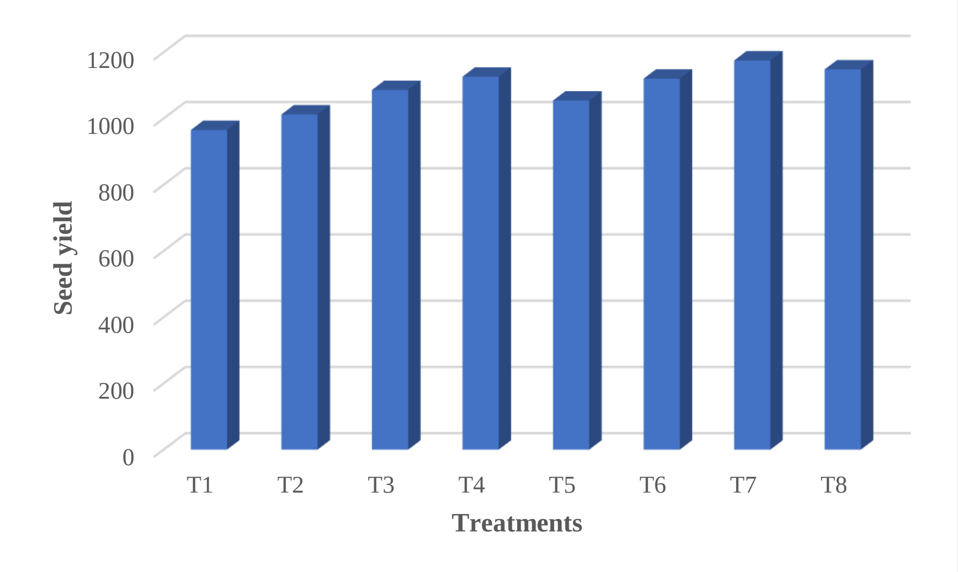

Fig. 2. Effect of foliar fertilizers on seed yield (kg ha^{-1}) of greengram

T_1 - Water spray
T_2 - 2 % Urea
T_3 - 2 % DAP
T_4 - NPK (18:18:18) @ 2 %
T_5 - 0.5 % $ZnSO_4$
T_6 - 2 % Urea + 0.5 % $ZnSO_4$
T_7 - 2 % DAP + 0.5 % $ZnSO_4$
T_8 - NPK (18:18:18) @ 2 % + 0.5 % $ZnSO_4$

4. Economics

The treatment involving the spraying of 2% DAP + 0.5% $ZnSO_4$ (T_7) resulted in the highest gross income (Rs.82,250 ha^{-1}), net income (Rs.53,284 ha^{-1}) and benefit-cost ratio (2.84). This was followed by the NPK 18:18:18 @ 2% + 0.5% $ZnSO_4$ (T_8) treatment, as shown in Table 2 and depicted in Fig. 3.

Table 2. Economic impact of foliar nutrient application on greengram (mean of 2 years)

Treatment	Total cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B: C ratio
T_1 - Water spray	28496	67550	39054	2.37
T_2 - 2 % Urea	28696	70840	42144	2.47
T_3 - 2 % DAP	28766	76020	47254	2.64
T_4 - NPK (18:18:18) @ 2 %	28674	78820	50146	2.75
T_5 - 0.5 % $ZnSO_4$	28555	73780	45225	2.58
T_6 - 2 % Urea + 0.5 % $ZnSO_4$	28755	78400	49645	2.73
T_7 - 2 % DAP+ 0.5 % $ZnSO_4$	28966	82250	53284	2.84
T_8 - NPK (18:18:18) @ 2 % + 0.5 % $ZnSO_4$	28874	80360	51486	2.78

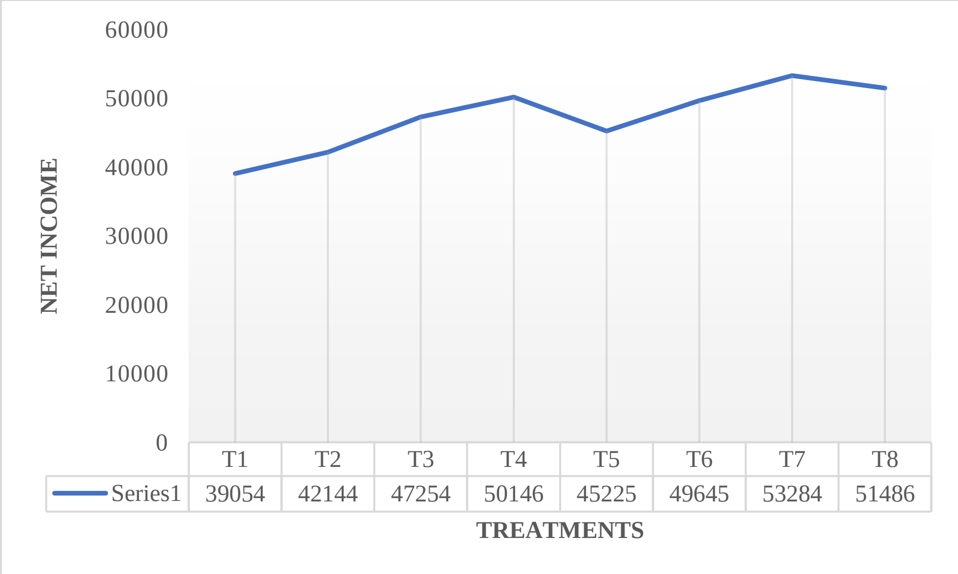

Fig. 3. Effect of foliar fertilizers on net income

T_1 - Water spray
T_2 - 2 % Urea
T_3 - 2 % DAP
T_4 - NPK (18:18:18) @ 2 %
T_5 - 0.5 % $ZnSO_4$
T_6 - 2 % Urea + 0.5 % $ZnSO_4$
T_7 - 2 % DAP+ 0.5 % $ZnSO_4$
T_8 - NPK (18:18:18) @ 2 % + 0.5 % $ZnSO_4$

5. Conclusion

Foliar application of 2% DAP + 0.5% $ZnSO_4$ at the pre-flowering and pod initiation stages resulted in superior growth parameters, enhanced yield attributes and higher seed yield. This treatment also achieved the highest economic returns, with a gross income of Rs.82,250 ha^{-1}, a net income of Rs.53,284 ha^{-1} and a benefit-cost ratio of 2.84. Therefore, it is recommended for rice-fallow greengram cultivation to optimize productivity and profitability.

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