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Effect of Cultivar and Nutrient Management on Productivity, and Profitability of Summer Greengram (*Vigna radiata* (L.) Wilczek

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out at Research Farm of Regional Research Station, Bawal, CCS HAU, Hisar, Haryana during *summer*, 2020. In this study, main plot consisted of three different varieties, namely MH-421 (V_1), MH-318 (V_2) and SML-668 (V_3) and subplot included four nutrient treatments, namely Control (F_1), 100% RDF (F_2), 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB (F_3) and 50% RDF + 50% N/ha (FYM) + ST with *Rhizobium* + PSB (F_4). The result revealed that, greengram variety and nutrient treatment significantly influenced the growth, yield and economics of summer greengram. Among the greengram variety, MH-318 variety yielded significantly higher seed yield, net return and B:C ratio compared to MH-421 and SML-668. Further,

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application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB resulted in significantly higher yield, and monitory benefits. Therefore, the study suggests that fertilizing MH-318 variety with 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB to obtain higher yield and economic returns of summer greengram.

Keywords: Economics; greengram; rhizobium; seed yield; varieties.

1. INTRODUCTION

Pulses play a crucial role in our foodgrain system along with cereals to stabilize the demand and fulfil nutritional requirements. India holds the top position as both the primary producer and consumer of pulses worldwide. Nevertheless, the per capita availability of pulses has been gradually declining over the years [1]. Greengram (*Vigna radiata* (L.) Wilczek) is the third most important legume crop cultivated in India, followed by chickpea and pigeon pea. It belongs to the family Fabaceae and sub family Papilionaceae and is believed to be native of India and central Asia [2]. This crop is extensively grown across various regions in Asia, encompassing countries such as India, Pakistan, Sri Lanka, Indonesia, Bangladesh, Cambodia, Malaysia, Thailand, Vietnam, Laos and southern China. Additionally, it is also cultivated in certain areas of Africa.

In 2021-22, area and production of greengram in India is 55.07 lakh ha and 31.66 lakh tonnes with productivity of 570 kg/ha, whereas in Haryana it is 0.2 lakh ha and 0.12 lakh tonnes with productivity of 601 kg/ha [3].

Greengram grains typically have a protein content of 23.88%, which is significantly higher compared to wheat (10-11%) and rice (6-7%). Furthermore, it is a valuable source of essential amino acids like tryptophan, lysine and arginine. In addition to its importance in human nutrition, green gram also contributes to enhancing soil fertility through the process of atmospheric nitrogen fixation. It can fix 43-85 kg/ha atmospheric nitrogen annually [4]. Due to its short duration, wider adaptability, photo and thermo insensitive, it can adjust in various cropping systems.

Despite significant importance, the yield of greengram is very low in India [5]. The factors contributing to low productivity include challenges such as susceptibility to pests and diseases, losses caused by shattering, limited availability of high-yielding varieties, reliance on rainfed conditions and cultivation in infertile soils with minimal or no financial inputs [6]. Among the various factors responsible for maximization of yield, selection of high yielding variety along with balanced nutrition is essential for high yield [7]. A strategy that combines diversification, enhanced productivity and improved soil characteristics is needed to address the significant gap between the demand and supply of pulses. This three-pronged approach aims to meet the demand and overcome the gap by incorporating measures to broaden the variety of crops grown, increase the yield of existing crops and enhance the quality of soil [8]. The yield of any crop is product of production potential of the variety, climatic conditions, soil fertility and management practices. Therefore, breeding methods such as selection, hybridization and mutation have been applied and some additional improvement has also been done during last two decades [9]. Similarly, ensuring an adequate supply of nutrients, particularly nitrogen and phosphorus, is essential to prevent any constraints on the growth of greengram. The positive impact of organic manures, including farmyard manure (FYM), on enhancing soil fertility and crop productivity has been extensively documented. Nevertheless, there is limited information available regarding the optimal combination of nutrients from different sources, such as bio-fertilizers, inorganic fertilizers and organic fertilizers, specifically for summer greengram cultivation. Thus, this present study is conducted to evaluate the effect of varieties and nutrient treatments on growth, yield attributes, yield and economics of summer greengram.

2. MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Regional Research Station, Bawal, CCS Haryana Agricultural University, Rewari, Haryana located at 28.07 ^{o}N latitude 76.59 ^{o}E longitude and elevation of 266 m above mean sea level during *summer* of 2020. The experimental site had a loamy sand soil texture with a pH of 8.17 and an electrical conductivity (ECe) of 0.16 dS/m. The soil was characterized by low organic carbon content (0.16%) and

medium availability of nutrients, with 137.3 kg/ha of available nitrogen, 11.18 kg/ha of available phosphorus and 149.1 kg/ha of available potassium at a soil depth of 0-15 cm. The study consisted twelve treatment, main plot occupied by three varieties, namely 'MH-421', 'MH-318' and 'SML-668', and subplots were allotted to nutrient management practices, namely Control (F_1), 100% RDF (F_2), 75% RDF + 25% FYM N/ha + ST with *Rhizobium* + PSB (F_3) and 50% RDF + 50% FYM N/ha + ST with *Rhizobium* + PSB (F_4). The treatment were arranged in split-plot design with four replications. In this study, each plot had a size of 3 m x 5 m. The crop was sown on April 25, 2020 with a row-to-row spacing of 30 cm with a seed rate of 25 kg ha^{-1}. Before sowing, the seeds were treated with Bavistin at a rate of 3 g/kg to safeguard against seedborne diseases. The application of fertilizers, organic matter in the form of farmyard manure (FYM) and biofertilizers followed as per the treatment. One hoeing-cum-weeding was done manually at 20 DAS. After harvesting the crops from each plot, they were carefully bundled and appropriately labelled. Once the second harvest was completed, the produce was sun-dried on the threshing floor. Statistical analysis of data was carried out by "Analysis of Variance" method [10], the data were analyzed statistically using ANOVA and treatment comparison was made at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Table 1 displays plant height (cm) of greengram crop at different growth stages. The data revealed that plant height was significantly influenced by both varieties and nutrient treatment, except at 15 DAS. MH-318 variety exhibited significantly taller plants than SML-668 and MH-421. Application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB resulted in significantly higher plant height at 30, 45 DAS and at harvest, compared to other treatment, except for 100% RDF, where it was at par. The increase in plant height resulting from the application of 75% RDF + 25% FYM + ST with *Rhizobium* + PSB, in comparison to the control, was observed to be 27.45%, 17.83%, 8.95% and 12.17% at 15, 30, 45 DAS and at harvest, respectively.

Table 1 also presents data on dry matter accumulation, indicating a continuous increase as the crop matures until harvest. Varieties and nutrient treatment showed significant impact on dry matter accumulation at all stages, except at 15 DAS. MH-318 and SML-668 demonstrated significantly higher dry matter accumulation than MH-421. The maximum dry matter accumulation was observed with 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB at all growth stages, showing significant differences at all growth stages except 100% RDF, where it was at par. The application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB outperformed other treatments at 30, 45 DAS and at harvest. The combined utilization of inorganic fertilizers, organic manures and seed treatment may have facilitated significant dry matter accumulation by promoting the production of growth-enhancing hormones such as auxins, gibberellins and vitamins through the supplied phosphorus, thus fostering plant growth. Prior studies by Singh et al*.,* [11], Ranpariya et al*.,* [12] and Singh et al*.,* [13] have also reported similar observations.

3.2 Yield Attributes

The data on yield attributes of greengram as influenced by varieties and nutrient management is presented in Table 2. Greengram variety MH-318 (17.9) and SML-668 (16.7) recorded significantly higher pods/plant compared to MH-421 (14.3). Similarly, pod length was found to be significantly higher with MH-318 (8.5 cm) and SML-668 (7.8 cm) over MH-421 (7.5 cm). The 100 seed weight under variety MH-318 and SML-668 was at par and significantly higher over MH-421 at 5.09, 4.81 and 4.48, respectively.

Among nutrient management treatments, plots applied with 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB demonstrated notable superiority in terms of pods/plant (18.1), resulting in a 29.3% increase compared to the control. The higher number of seeds/pod (10.7) was recorded under the treatment of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB. Additionally, for pod length, the most effective treatment was 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB (8.6 cm). Finally, the application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB (5.13 g) resulted in significantly higher 100 seed weight in comparison to the other treatments. The outcomes align with the findings reported by Tyagi and Upadhyay [14], Prajapati et al., [15], Mondal and Sengupta [16] and Singh et al*.,* [17].

Table 1. Effect of varieties and nutrient management practices on plant height (cm) and dry matter accumulation (g/plant) of summer greengram

Treatment	Plant height (cm)				Dry matter accumulation (g/plant)			
	15 DAS	30 DAS	45 DAS	At Harvest	15 DAS	30 DAS	45 DAS	At Harvest
Variety								
V_1 - MH-421	10.7	21.1	33.5	37.5	0.33	1.63	8.19	14.3
V_2 - MH-318	11.3	23.9	36.2	40.5	0.35	1.72	9.01	15.5
V_3 - SML-668	11.0	22.6	35.3	38.1	0.34	1.67	8.53	15.1
CD (p≤0.05)	**NS**	**1.3**	**2.0**	**2.2**	**NS**	**0.06**	**0.36**	**0.91**
Nutrient Treatment								
F_1 - Control	9.4	20.1	33.3	36.3	0.32	1.61	7.84	13.6
F_2 - 100% RDF	11.6	23.5	35.5	39.2	0.34	1.69	8.78	15.4
F_3 - 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB	12.0	23.7	36.3	40.7	0.35	1.70	9.16	16.2
F_4 - 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB	11.1	22.7	34.7	38.7	0.33	1.67	8.51	14.7
CD (p≤0.05)	**NS**	**1.0**	**1.8**	**2.0**	**NS**	**0.06**	**0.39**	**1.19**

**Significant at p≤0.05, RDF: Recommended dose of fertilizer, FYM: Farm Yard Manure, PSB: Phosphorus Solubilizing Bacteria, DAS: Days after sowing, NS: Non-Significant*

Table 2. Effect of varieties and nutrient management practices on yield attributes, yield and economics of summer greengram

Treatment	No. of pods per plant	No. of seeds per pod	Pod length (cm)	100 seed weight (g)	Seed yield (kg/ha)	Harvest index (%)	Net returns (₹/ha)	B:C ratio
Variety								
V_1 - MH-421	14.3	9.9	7.48	4.48	952	25.0	41898	2.68
V_2 - MH-318	17.9	10.6	8.54	5.09	1110	27.1	52972	3.12
V_3 - SML-668	16.7	10.1	7.80	4.81	1013	25.8	46230	2.86
CD (p≤0.05)	1.44	0.54	0.65	0.33	**108.2**	**1.10**	-	-
Nutrient management practice								
F_1 - Control	14.0	9.6	7.22	4.34	689	23.8	27697	2.34
F_2 - 100% RDF	17.3	10.4	8.13	4.91	1117	26.8	54922	3.35
F_3 - 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB	18.1	10.7	8.55	5.13	1269	27.3	62743	3.40
F_4 - 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB	15.8	10.1	7.87	4.79	1024	26.0	42772	2.47
CD (p≤0.05)	1.31	0.48	0.55	0.28	**129.4**	**1.04**	-	-

**Significant at p≤0.05, RDF: Recommended dose of fertilizer, FYM: Farm Yard Manure, PSB: Phosphorus Solubilizing Bacteria, NS: Non-Significant*

Table 3. Effect of varieties and nutrient management practice on N, P and K uptake (kg/ha) by plant of summer greengram

Treatment	Total nitrogen uptake (kg/ha)	Total phosphorus uptake (kg/ha)	Total potassium uptake (kg/ha)
Variety			
V_1 - MH-421	93.7	9.6	31.3
V_2 - MH-318	111.6	13.4	37.8
V_3 - SML-668	102.1	11.2	34.6
CD (p≤0.05)	**6.42**	**0.92**	**2.98**
Nutrient management practice			
F_1 - Control	68.4	7.06	23.4
F_2 - 100% RDF	111.3	12.6	37.4
F_3 - 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB	128.8	14.9	43.2
F_4 - 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB	101.2	10.9	34.1
CD (p≤0.05)	**7.05**	**1.17**	**3.32**

**Significant at p≤0.05, RDF: Recommended dose of fertilizer, FYM: Farm Yard Manure, PSB: Phosphorus Solubilizing Bacteria*

3.3 Seed Yield and Harvest Index

The data presented in Table 2 indicated that both varieties and nutrient treatment significantly impacted on the seed yield of greengram. Among varieties, MH-318 exhibited the highest seed yield (1110 kg/ha), significantly surpassing MH-421 (952 kg/ha) but comparable to SML-668 (1013 kg/ha). Further, application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB resulted in the maximum grain yield (1269 kg/ha), surpassing all other treatments. This treatment showcased an 84%, 62% and 48% increase in yield compared to the control, 50% RDF + 50% N/ha (FYM) + ST with *Rhizobium* + PSB and 100% RDF, respectively. The increase in yield may be attributed to to increased growth parameters. Similar results have been reported by Pareek et al*.,* [9], Pandey et al*.,* [18] and Hussain et al*.,* [19].

Greengram variety MH-318 (27.1) showed 1.6% and 2.1% higher harvest index, respectively over SML-668 and MH-421. Among the nutrient management treatment, application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB (27.3%) and 100% RDF (26.8%) were statistically at par and had a significantly higher harvest index than 50% RDF + 50% N/ha (FYM) + ST with *Rhizobium* + PSB (26.0%) and control (23.75%). High seed yield in greengram can be attributed to the high yield of yield-contributing attributes, including the number of pods/plant, number of seeds/pod and 100-seed weight. Pandey et al*.,* [18] and Hussain et al*.,* [19] have also documented comparable findings.

3.4 Economics and Nutrient Uptake

Monitory analysis of greengram as influenced by varieties and nutrient management is presented in Table 2. Greengram MH-318 variety imparted significantly higher net returns (include data) compared to SML-668 (46,230 ₹/ha) and MH-421 (52,972 ₹/ha). Similarly, application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB resulted in the highest net returns (62,743 ₹/ha), followed by 100% RDF (54,922 ₹/ha) and 50% RDF + 50% N/ha (FYM) + ST with *Rhizobium* + PSB (42,772 ₹/ha). The benefit-cost ratio was also higher for MH-318 (3.12) variety compared to the other two varieties and the highest benefit-cost ratio was observed with the application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB (3.40), followed by 100% RDF (3.35).

The uptake of nutrients in greengram, as demonstrated in Table 3, is a function of biological yield and nutrient content. In particular, variety MH-318 exhibited significantly higher NPK uptake compared to SML-668 and MH-421. Application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB led to significantly higher NPK uptake (128.8 kg/ha), surpassing all other treatments. These findings are consistent with the results reported by Gorade et al*.,* [20], Tambe et al*.,* [21] and Dubey et al*.,* [22].

4. CONCLUSION

In conclusion, the study suggests that cultivation of greengram variety MH-318 during the summer season, with as application of 75% RDF, 25% N/ha (FYM) and seed treatment with *Rhizobium* and PSB would provide higher yields and economic benefits while maintaining soil fertility.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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