__Original Research Article__

ASSESSING EFFECTS OF NUTRIENT TREATMENTS ON GROWTH, YIELD AND PROFITABILITY OF SUMMER GREENGRAM (*Vigna radiata* L.) VARIETIES

ABSTRACT

The present study was carried out at Research Farm of Regional Research Station, Bawal, CCS HAU,Hisar, Haryana during *summer*, 2020.The study utilized a split-plot design with four replications. The main plot consisted of three different varieties, namely MH-421 (V_1), MH-318 (V_2) and SML-668 (V_3). The 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 study found that both the choice of greengram variety and nutrient treatment significantly affected the growth, yield attributes, yield and economics of summer greengram. MH-318 variety yielded significantly higher seed yield, net return and B:C ratio compared to MH-421 and SML-668. This was due to higher growth and yield contributing attributes. The application of 75% RDF + 25% N/ha (FYM) + ST with*Rhizobium* + PSB resulted in significantly higher yield contributing attributes, seed yield, net returns and B:C ratio compared to other treatments. 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.

KEY-WORDS: Greengram, Seed yield, Varieties, *Rhizobium*,Economics.

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. Greengram (*Vigna radiata* (L.) Wilczek) is a legume crop that is the third most important in India, following chickpea and pigeon pea. Greengram belongs to the family Fabaceae and subfamily Papilionaceae and is believed to benative of India and central Asia (Vavilov, 1926). 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 India, greengramwas cultivated on an area of 5.13mha during 2020-21 which is an increase of about 12 per centas compared to previous year 2019-20 (4.58 mha). It producesannually 30.85 metric tonnes of grain, with an average productivity of 6.01q/ha. In Haryana, total area under greengram is about 0.45mha with an annual production and productivity of 0.31 metric tonne and 6.01 q/ha, respectively (Indiastat.com, 2022).

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 (Rosales *et al.*, 1995).Due to being a short duration, wider adaptability and photo-thermo insensitive nature crop, it can be adjusted in various cropping and intercropping systemsfor example it can be grown as catch crop in rice-wheat cropping system.

Despite of significant importance, the yield of greengram is very low in India. 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 (Lal *et al.,* 2015). Among the various factors responsible for maximization of yield, selection of highyielding variety along with balanced nutrition is essential for high yield (Meena *et al.,* 2016).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 (Bhardwaj *et al.,* 2022). The yield of any crop is product of production potentialof the variety, climatic conditions, soil fertility and management practices to which thevariety is exposed. Some improvements have been made by scientists and researchers to increasethe yield potential of greengram*viz.*, improved breeding methods such as selection,hybridization and mutation have been applied and some additional improvement has also beendone during last two decades (Pareek *et al.*, 2022).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 isconducted to evaluate the effect of varieties and nutrient treatments on growth, yield attributes, yield and economics of summer greengram.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Regional Research Station, Bawal, CCS Haryana Agricultural University, Rewari, Haryanalocated at 28.07 ^{o}Nlatitude 76.59 ^{o}E longitudeand 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 had 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 experiment was conducted using a split-plot design with four replications. The experiment consisted of twelve treatment combinations, with three different varieties, namely MH-421 (V_1), MH-318 (V_2) and SML-668 (V_3), assigned to the main plot. Additionally, there were four nutrient treatments allocated to the subplot, 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). Each plot had a size of 3 m x 5 m. The crop was sown on April 25, 2020with 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 them against diseases transmitted through seeds. The application of fertilizers, organic matter in the form of farmyard manure (FYM)and biofertilizers followed the specified treatments. 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.

RESULTS AND DISCUSSION

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 greater plant height 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 treatments, 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 had a significant impact on dry matter accumulation at all stages, except 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.*, (2011), Ranpariya*et al.*, (2017) and Singh *et al.*, (2019) have also reported similar observations.

Yield attributes

The findings presented in Table 2 demonstrated that crop varieties and nutrient treatment significantly impacted yield contributing attributes. Variety MH-318 showed similar number of pods/plant as SML-668, both of which were significantly higher than MH-421 at 17.9, 16.7 and 14.3, respectively. Additionally, number of pods/plant for MH-318 and SML-668 were significantly higher at 10.6 and 10.1, respectively, when compared to MH-421's 9.85. Pod length (cm) was found to be significantly higher with MH-318 at 8.5 and was statistically similar to SML-668's 7.8 over MH-421's 7.5. The seed index 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 treatments, 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 highest 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 seed index in comparison to the other treatments.The outcomes align with the findings reported by Tyagi and Upadhyay (2015), Prajapati *et al*., (2016), Mondal and Sengupta (2019) and Singh *et al.*, (2018).

Seed Yield and Harvest Index

The findings presented in Table 2 indicate that both varieties and nutrient treatment significantly impact seed yield. 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). 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.

Variety MH-318 (27.1) achieved a 1.6% and 2.1% increase in harvest index over SML-668 and MH-421, respectively. Among the nutrient 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.,* (2019) and Hussain *et al.,* (2017) have also documented comparable findings.

Economics and Nutrient Uptake

Results in Table 2 showed that MH-318 variety had significantly higher net returns compared to SML-668 and MH-421 varieties, with a difference of 6,742 ₹ /ha and 11,074 ₹ /ha, respectively. Similarly, application of 75% RDF + 25% N/ha (FYM) + ST with *Rhizobium* + PSB resulted in the highest net returns, followed by 100% RDF and 50% RDF + 50% N/ha (FYM) + ST with *Rhizobium* + PSB. The benefit-cost ratio was also higher for MH-318 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, followed by 100% RDF.

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.*, (2014), Tambe *et al.,* (2019) and Dubey *et al.*, (2018).

CONCLUSION

In conclusion, the study suggests that cultivating the greengram variety MH-318 during the summer season, with recommended practices such as 75% RDF, 25% N/ha (FYM) and seed treatment with *Rhizobium* and PSB, can lead to higher yields and economic benefits while maintaining soil fertility. These practices improve nutrient absorption and crop growth, resulting in increased yields and better profitability for farmers. Incorporating organic nitrogen sources and balanced fertilization practices also enhances soil health, crop quality and market prices.

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

Treatments	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 treatment on yield attributes, yield and economics of summer greengram.

Treatments	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 Treatment								
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* +	15.8	10.1	7.87	4.79	1024	26.0	42772	2.47

PSB								
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 treatment on N, P and K uptake (kg/ha) by plant of summer greengram

Treatments	**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 Treatment			
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