

Effect of Varieties and Nutrient Treatments on Physiological and Phenological Parameters of Summer Greengram (*Vigna radiata* L.) at Bawal, Haryana, India

ABSTRACT

The present investigation was conducted during the summer season of 2020 at Regional Research Station (Bawal), CCS Haryana Agricultural University, Hisar to study the response of greengram to different varieties and nutrient treatments. The experiment was laid out in split-plot design with four replications. The main plot consisted of varieties (MH-421, MH-318 and SML-668) and sub-plot consisted of nutrient treatments (Control, 100% recommended dose of fertilizer (RDF), 75% RDF + 25% FYM + *Rhizobium* + phosphate solubilizing bacteria (PSB), 50% RDF + 50% FYM + *Rhizobium* + PSB). The findings suggest that variety MH-318 gave significantly higher no. of branches, leaf area, leaf area index (LAI) and leaf area duration (LAD) as well as phenological traits such as days taken to 50% flowering (days) over SML-668 and MH-421. Among the nutrient treatments, application of 75% RDF + 25% FYM + *Rhizobium* + PSB demonstrated superior performance across physiological (no. of branches, leaf area, LAI and LAD) and phenological traits (50% flowering) over 100% RDF, 50% RDF + 50% FYM + *Rhizobium* + PSB and control. Thus, a combination of variety MH-318 with 75% RDF + 25% FYM + *Rhizobium* + PSB helps in enhancing the physiological and phenological parameters of greengram without negative influence on plant and the environment.

Keywords: Greengram, Nutrient Management, Physiological, Phenological, Variety.

1. INTRODUCTION

Greengram (*Vigna radiata* L.), commonly known as “mung bean” or “moong”, is a highly valued pulse crop that holds a pivotal position in global agriculture. With origins in the Indian subcontinent, greengram has evolved into a versatile and resilient crop (Singh and Singh, 2020). Greengram cultivation in India spanned across 5.5 million hectares, generating a total output of 3.17 million tonnes, with an average productivity rate of 570 kg per hectare during 2022 (Anonymous, 2022). In Haryana, a region known for its semi-arid climate, greengram was grown on approximately 0.079 million hectares, achieving a production of 0.052 million tonnes, with a productivity rate of 661 kg per hectare (Statistical Abstract of Haryana 2021-22, 2023).

Greengram exhibits exceptional adaptability to various agro-climatic conditions, thriving from the dusty plains of the Indian subcontinent to the lush slopes of south-east Asia, including both rain-fed and irrigated ecosystems. This adaptability, combined with its short duration and ability to fix atmospheric nitrogen, makes it an attractive choice for crop rotation and diversification (Dick and Gregorich, 2004).

However, low productivity of greengram is a major challenge to both farmers and scientists. The key factors contributing to low productivity is the lack of high-yielding varieties, coupled with their suboptimal response to fertilizers. However, addressing these challenges through varietal selection and effective nutrient management can significantly enhance the productivity of greengram. By choosing varieties adapted to specific agro-climatic conditions, farmers can achieve desirable traits such as increased leaf area, improved photosynthetic efficiency, and better root development. (Mishra *et al.*, 2018). Therefore, the current investigation was initiated to examine how varieties and nutrient treatments influence the physiological and phenological parameters of summer greengram.

2. MATERIALS AND METHODS

2.1 Description of experiment site

The experiment exploring the combined impact of diverse greengram varieties and nutrient management practices was conducted at RRS (Bawal), CCS Haryana Agricultural University during the summer of 2020. The experiment site is located at 28.07 °N and 76.59 °E in western Haryana. It has an average elevation of 266 m (872 ft) above mean sea level. During summer season, the temperature may go as high as 44 °C in June-July while in winters, it may fall as low as -0.5 °C in December-January. The average annual rainfall ranges from 250 to 300 mm. A total of 174 mm rainfall occurred during summer, 2020. The experiment field boasts loamy sand soil with well-defined characteristics.

2.2 Treatments and experimental design

Three varieties (MH-421, MH-318 and SML-668) were tested alongside four different nutrient management treatment (Control, 100% RDF (20:40:0 kg/ha NPK), 75% RDF + 25% FYM + *Rhizobium* + PSB, 50% RDF + 50% FYM + *Rhizobium* + PSB). The experiment followed a split-plot design with four replications, featuring plots of 3m x 5m each.

2.3 Experimental procedures and field management

The seeds were treated with Bavistin (@ 3 g/kg) to safeguard against seed-borne diseases. The field preparation took place on April 23rd, using a tractor-drawn disc harrow and plunger. On April 25th, 2020, the crop was sown using the pora method, maintaining a row-to-row spacing of 30 cm and a seeding depth of 5-6 cm using a seed rate of 25 kg/ha. To reduce crop-weed competition,

manual hoeing-cum-weeding was performed at 20 days after sowing (DAS). Due to limited rainfall during the crop season, two irrigations were applied after 22 and 45 DAS. Additionally, to control insect pests, a spray of Rogor 30 EC (dimethoate) @ 250 ml was applied on June 4th, 2020. Finally, the crop was harvested on July 4th, 2020.

2.4 Data collected and collecting procedure

The observations for no of branches per plant were recorded from five randomly selected plants from each treatment at various growth stages. The visual observations were taken to estimate the 50% germination and 50% flowering of the crop. The leaf area was measured using leaf area meter at 30, 60, 90 DAS and at harvest and expressed as cm² per plant.

Leaf area index: It is the ratio of leaf area to ground area. It was computed by using following formula:

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Ground area}} \dots\dots\dots \text{(equation 1)}$$

Leaf Area Duration (days): LAD is the ability of a plant to maintain the green leaves over unit area of land during a period of time. It is expressed in days.

$$\text{Leaf area duration} = \frac{LA_1 + LA_2}{2} \times (t_2 - t_1) \dots\dots\dots \text{(equation 2)}$$

Where,

LA₂ and LA₁ are leaf area of plants at time t₂ and t₁, respectively.

2.5 Data analysis

The data analysis relied on ANOVA methods with comparisons made at a 5% significance level. The data obtained in this research were subjected to statistical analysis using the analysis of variance (ANOVA) method for the Split-plot design (Gomez and Gomez, 1984). The F-test at a 5% probability level was employed to ascertain the significance of treatment effects. To assess the notable distinction between the means of two treatments, the critical difference (C.D.) was calculated using the formula below:

$$CD = \sqrt{\frac{2 \times EMS}{n}} \times t \text{ value at 5\%} \dots\dots\dots \text{(equation 3)}$$

Where,

CD = Critical difference.

EMS = Error mean sum of square.

n = Number of observations.

t = Value of t-distribution at 5% level of error degree of freedom

3. RESULTS AND DISCUSSION

3.1 No. of Branches per plant

No of branches plant⁻¹(Table 1) was significantly influenced by variety and nutrient treatments throughout growth (except 30 DAS). Variety MH-318 had significantly higher no. of branches at harvest as compared to SML-668 and MH-421, while the 75%recommended dose of fertilizer(RDF) + 25% FYM + *Rhizobium* +phosphate solubilizing bacteria(PSB) treatment produced the most branches overall. There was no significant difference in no. of branches at 30 DAS in both varieties and nutrient treatments.The higher no. of branches in varietyMH-421 might be attributed to its superior genetic composition, which promotes the development of more branches as suggested by Mote *et al.* (2022), Pareek *et al.* (2023) and Singh and Jambukiya (2020). The superiority of75% RDF + 25% FYM + *Rhizobium* + PSBover other treatmentsuggests that a combination of adequate nutrients, organic matter and beneficial microbes might have promoted higher growth and branching. Similar results were observed by Ranpariya *et al.* (2017),Ghosh *et al.*(2022) and Mondal and Sengupta (2019).

Table 1: Influence of varieties and nutrient treatments on no. of branches and leaf area of summer greengram

Treatments	No. of Branches plant ⁻¹				Leaf Area (cm ² /plant)			
	30 DAS	45 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	At harvest
Varieties								
V1	3.03	4.56	5.05	5.42	160.6	321.5	488.5	409.8
V2	3.22	5.14	5.70	6.14	172.1	334.6	517.6	438.2
V3	3.17	5.08	5.42	5.73	167.8	329.1	503.9	423.3
SEm±	0.17	0.13	0.10	0.15	1.3	2.36	2.65	2.84
CD(p≤0.05)	NS	0.47	0.35	0.52	4.5	8.16	9.16	9.82
Nutrient Treatments								
T1	2.91	4.63	4.83	5.14	144.3	285.0	454.7	368.8
T2	3.25	5.04	5.57	5.95	176.6	349.5	523.7	449.8
T3	3.44	5.25	5.86	6.62	179.9	357.9	539.7	464.4
T4	3.07	4.88	5.30	5.68	166.4	321.2	495.2	411.8
SEm±	0.17	0.16	0.13	0.18	1.2	3.54	4.18	3.71
CD(p≤0.05)	NS	0.47	0.38	0.54	3.45	10.26	12.12	10.8

*Significant at p≤0.05; DAS: Days after sowing; RDF: Recommended Dose of Fertilizer; V1: MH-421; V2: MH-318; V3: SML-668; T1: Control; T2:100% RDF; T3: 75% RDF + 25% FYM + *Rhizobium* + PSB; T4: 50% RDF + 50% FYM + *Rhizobium* + PSB; NS: Non-Significant.

3.2 Leaf Area (cm²/plant)

Leaf area (Table 1. And Fig 1.) increased significantly between 30 and 45 DAS, followed by a period of slower but continued growth until harvest where a decline in leaf area was observed among both varieties and nutrient treatment. Variety MH-318 (438.2) recorded significantly higher leaf area(cm²/plant) at harvest as compared to SML-668 (423.3) and MH-421 (409.8). Similarly, nutrient treatments75% RDF + 25% FYM + *Rhizobium* + PSB (464.4), 100% RDF (449.8) and 50% RDF +

50% FYM + *Rhizobium* + PSB (411.8) demonstrably enhanced leaf area compared to the control (368.8) at harvest. Treatment 75% RDF + 25% FYM + *Rhizobium* + PSB exhibited the highest leaf area at harvest, followed by a statistically significant increase of 25.9% relative to the control. These findings suggest that superior genetic makeup of varieties and strategic nutrient application might have improved no. of branches and leaves on greengram plant which resulted in higher leaf area. Similar findings in leaf area were made by Pandey *et al.* (2019), Nayaket *et al.* (2014) and Patilet *et al.* (2021).

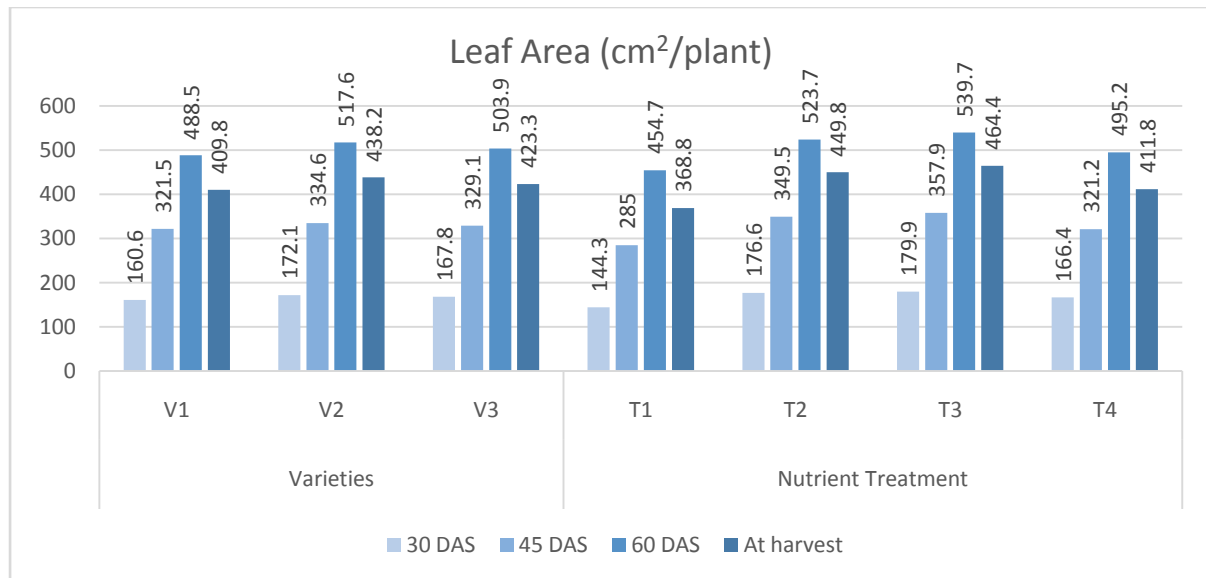


Fig. 1: Effect of varieties and nutrient treatments leaf area of summer greengram at 30, 45, 60 DAS and at harvest

3.3 Leaf Area Index

Table 2. revealed leaf area index(LAI) values for greengram varieties and nutrient treatments measured at various growth stages. MH-318 recorded significantly higher LAI at all growth stages over SML-668 and MH-421, except 30 and 45 DAS where it was at par with SML-668. MH-318 observed 3.5 and 6.9% higher LAI over SML-668 and MH-421 at harvest, respectively. Nutrient treatments 75% RDF + 25% FYM + *Rhizobium* + PSB (1.548), 100% RDF (1.499), 50% RDF + 50% FYM + *Rhizobium* + PSB (1.373) resulted in significantly higher LAI compared to the control (1.229) at all growth stages. Treatment 75% RDF + 25% FYM + *Rhizobium* + PSB resulted in the highest LAI at each stage, with statistically significant differences compared to other treatments except 30 and 45 DAS where they were statistically at par. The increase in LAI may be attributed to increased leaf area under increased nutrient concentration as well better micronutrient availability and varietal characters. Similar findings in leaf area index were made by Moteet *et al.* (2022) and Arutkumaran *et al.* (2023).

Table 2: Influence of varieties and nutrient treatments on leaf area index and leaf area duration of summer greengram

Treatments	Leaf Area Index				Leaf Area Duration (days)			
	30 DAS	45 DAS	60 DAS	At harvest	0-30 DAS	30-45 DAS	45-60 DAS	60 DAS to harvest
Varieties								
V1	0.535	1.072	1.628	1.366	8.03	12.06	20.25	22.46
V2	0.574	1.115	1.725	1.461	8.60	12.67	21.30	23.89
V3	0.559	1.097	1.680	1.411	8.39	12.42	20.82	23.18
SEm±	0.004	0.008	0.009	0.009	0.065	0.09	0.19	0.24
CD(p≤0.05)	0.015	0.027	0.030	0.032	0.225	0.30	0.67	0.82
Nutrient Treatments								
T1	0.481	0.950	1.516	1.229	7.22	10.73	18.49	20.59
T2	0.589	1.165	1.746	1.499	8.83	13.15	21.83	24.34
T3	0.600	1.193	1.799	1.548	9.00	13.45	22.44	25.10
T4	0.555	1.071	1.651	1.373	8.32	12.19	20.41	22.68
SEm±	0.004	0.118	0.014	0.012	0.06	0.13	0.22	0.30
CD(p≤0.05)	0.011	0.034	0.040	0.056	0.173	0.37	0.65	0.86

*Significant at $p \leq 0.05$; DAS: Days after sowing; RDF: Recommended Dose of Fertilizer; V1: MH-421; V2: MH-318; V3: SML-668; T1: Control; T2: 100% RDF; T3: 75% RDF + 25% FYM + *Rhizobium* + PSB; T4: 50% RDF + 50% FYM + *Rhizobium* + PSB; NS: Non-Significant.

3.4 Leaf Area Duration (days)

MH-318 consistently exhibited significantly higher leaf area duration (Table 2.) compared to SML-668 and MH-421, except at 30 and 45 DAS where it was statistically similar to SML-668. At harvest, MH-318 showed 3.0 and 6.3% higher LAD than SML-668 and MH-421, respectively. Among nutrient treatments, LAD was observed maximum under 75% RDF + 25% FYM + *Rhizobium* + PSB at all stages as compared to other treatments. Application of 75% RDF + 25% FYM + *Rhizobium* + PSB exhibited the highest LAD at each growth stage, showing statistically significant differences compared to other treatments, except at 30 and 45 DAS where they were similar. The enhanced LAD may be attributed to improved leaf area index, better varietal characteristics as well as better nutrient availability. Similar findings in leaf area index were made by Biswas *et al.* (2002) and Chaudhary *et al.* (2023).

3.5 Phenological Studies

The data presented in Table 3 revealed that the number of days taken to 50% germination was significantly affected by varieties and nutrient treatment. However, MH-318 (5.8) took least no. of days to germinate followed by SML-668 (5.6) and MH-421 (5.9). Among the nutrient treatments, application of 75% RDF + 25% FYM + *Rhizobium* + PSB (5.6) took least number of days to achieve 50% germination followed by 100% RDF (5.7) while control (6.0) took maximum no. of days. Similar findings have also been reported by Singh *et al.* (2019) and Patel *et al.* (2013).

Days taken to 50% flowering differ significantly with varieties as well nutrient treatment, MH-318 (38.6) recorded significantly lowest number of days to 50% flowering as compared to SML-668

(40.2) and MH-421 (41.0). Among different nutrient treatment application of 75% RDF + 25% FYM + *Rhizobium* + PSB (38.1) recorded significantly less of no. of days to 50% flowering as compared to control which took highest no. of days (41.4) while being at par with 100% RDF (39.6). Similar findings in phenological studies were also made by Phule and Raundal (2022), Pareek *et al.* (2022) and Patel *et al.* (2013).

Table 3: Influence of varieties and nutrient treatments on phenological characters of summer greengram

Treatments	Days taken to	
	50% Germination	50% Flowering
Variety		
V1	5.9	41.0
V2	5.6	38.6
V3	5.8	40.2
SEm±	0.2	0.37
CD(p≤0.05)	NS	1.28
Nutrient Treatments		
T1	6.0	41.4
T2	5.7	39.6
T3	5.6	38.1
T4	5.8	40.7
SEm±	0.2	0.36
CD(p≤0.05)	NS	1.05

*Significant at $p \leq 0.05$; DAS: Days after sowing; RDF: Recommended Dose of Fertilizer; V1: MH-421; V2: MH-318; V3: SML-668; T1: Control; T2: 100% RDF; T3: 75% RDF + 25% FYM + *Rhizobium* + PSB; T4: 50% RDF + 50% FYM + *Rhizobium* + PSB; NS: Non-Significant.

4. CONCLUSION

On the basis of above study, it can be concluded that, variety MH-318 and 75% RDF + 25% FYM + *Rhizobium* + PSB was superior to SML-668 and MH-421 in respect of no. of branches, leaf area, leaf area index and leaf area duration. Similarly, in phenological characters such as 50% flowering MH-318 and 75% RDF + 25% FYM + *Rhizobium* + PSB demonstrated superior performance over other varieties and nutrient treatments, respectively.

5. REFERENCES

- Anonymous (2022). ICAR-Indian Institute of Pulses (<https://iipr.icar.gov.in/mungbean/>)
- Arutkumaran, M., Suseendran, K., Kalaiyarasan, C., Sriramachandrasekharan, S. J., and Thirupathi, M. (2023). Effect of foliar nutrition on growth and yield of irrigated greengram (*Vigna radiata*) cv. Vamban 4. *The Pharma Innovation Journal*, **12**(3): 3584-3588
- Biswas, D.K., Haque, M.M., Hamid, A., Ahmed, J.U., Rahman, M.A. (2002). Influence of plant population density on growth and yield of two black gram varieties. *Journal of Agronomy*, **1**:83-85.
- Chaudhary, K.B., Macwan, S.J., Dhruv, J.J., Ghadiali, J.J., and Shruti, S. (2023). Impact of plant growth regulators and chemicals on growth and quality in green gram (*Vigna radiata* L.) cv. GAM-5. *The Pharma Innovation Journal*, **12**(3), 1938-1941.

Dick, W.A. and Gregorich, E.G. (2004). Developing and maintaining soil organic matter levels. *Managing Soil Quality*. CAB International, 103-120.

Ghosh, D., Brahmachari, K., Sarkar, S., Dinda, N.K., Das, A., and Moulick, D. (2022). Impact of nutrient management in rice-maize-greengram cropping system and integrated weed management treatments on summer greengram productivity. *Indian Journal of Weed Science*, **54**(1): 25–30.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research. John Wiley & Sons: 154-172.

Mishra, A., Rath, B.S., Mukhi, S.K., Mishra, S., Mohanty, S.K., Behera, B., Panda, A., Panda, M.R., and Mohapatra, S. (2017). Variety × Nutrient management interaction in greengram for important yield attributes under rainfed red lateritic inceptisol. *Legume Research*, **41**(6): 854-860.

Mondal, R. and Sengupta, K. (2019). Study on the performance of mungbean varieties in the new alluvial zone of West Bengal. *Journal of Crop and Weed*, **15**(1): 186-191.

Mote, S.M., Bagade, A.B., Thombre, P.R., and Bhadarge, H.H. (2022). Physiological analysis of growth and yield of green gram cultivars. *The Pharma Innovation Journal*, **11**(12): 2238-2241.

Nayak, S., Chavan, D.A., and Waghmare, Y.M. (2014). Effect of different spacings on growth and yield of black gram (*Vigna mungo* (L.) Hepper) varieties. 3rd International Conference on Agriculture & Horticulture (October 27-29, 2014) Hyderabad International Convention Centre, India.

Pandey, O. M., Shahi, S. K., Dubey, A. N. and Maurya, S. (2019). Effect of integrated nutrient management of growth and yield attributes of green gram (*Vigna radiata* L.). *Journal of Pharmacognosy and Phytochemistry*, **8**(3): 2347-2352.

Pareek, A., Satyajeet, S., Bhardwaj, S., and Nagora, M. (2022). Effect of varieties and fertility levels on fodder productivity, NPK content, uptake and protein content of summer green gram (*Vigna radiata* L.). *Forage Research*, **47**(4): 507-512.

Pareek, A., Satyajeet, Kumar, A., Bhardwaj, S., Godara, M., and Abhishek. (2023). Effect of Cultivar and Nutrient Management on Productivity, and Profitability of Summer Greengram (*Vigna radiata* L.) Wilczek. *International Journal of Plant & Soil Science*, **35**(21): 576–582.

Patel, R.D., Patel, D.D., Chaudhari, M.P., Vaishali, S., Patel, K.G. and Andel, B.B. (2013). Response of different cultivars of greengram [*Vigna radiata* (L.) Wilczek] to integrated nutrient management under south Gujarat condition. *AGRES - An International e-Journal*, **2**(2): 132-142.

Patil, V.R., Patil, J.B., Patil, M.J., and Gedam, V.B. (2021). Effect of nutrient management on growth attributes, yield and quality of summer green gram (*Vigna radiata* L.). *International Journal of Agricultural Sciences*, **17**: 150-154.

Phule, K.K., and Raunda, P.U. (2022). Effect of foliar nutrient sprays on summer greengram (*Vignaradiata* L.) under sub mountain zone of Maharashtra. *Journal of Agriculture Research and Technology*, **47**: 200-204.

Ranpariya, V. S., Polara, K. B., Hirpara, D. V. and Bodar, K. H. (2017). Effect of potassium, zinc and FYM on content and uptake of nutrients in seed of summer green gram (*Vigna radiata* L.) and post-harvest soil fertility under medium black calcareous soil. *International Journal of Chemical Studies*, **5**(5): 1055-1058.

Singh, C., and Jambukiya, H. (2020). Effect of foliar application of plant growth regulators on growth and yield attributing characters of green gram (*Vigna radiata* L. Wilczek). *Journal of Crop and Weed*, **16**(2): 258-264.

Singh, R., and Singh, G. (2020). Weed management in greengram: A review. *Indian Journal of Weed Science*, **52**(1): 10-20.

Singh, R. P., Dhillon, B. S. and Sidhu, A. S. (2019). Productivity of summer moong (*Vigna radiata* L.) as influenced by different sowing dates and varieties. *Journal of Pharmacognosy and Phytochemistry*, **8**(3): 781-784.

Statistical Abstract of Haryana 2021-22 (2023). Department of Economic and Statistical Affairs, Haryana. (<https://esaharyana.gov.in/state-statistical-abstract-of-haryana/>)