Response of Varieties and Nutrient Treatments on Physiological and Phenological Parameters of Summer Greengram (*Vigna radiata* L.)

Abstract

The present investigation was conductedduring summer 2020 to study the response of varieties and nutrientstreatments on physiological and phenological parameters of greengram. 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% RDF, 75% RDF + 25% FYM + *Rhizobium* + PSB, 50% RDF + 50% FYM + *Rhizobium* + PSB). The findings suggest that variety MH-318 recorded significantlyhigher no. of branches, leaf area, leaf area index and leaf area duration as well as phenological characters such as 50% flowering over SML-668 and MH-421.Among the nutrient treatments, application of 75% RDF + 25% FYM + *Rhizobium* + PSB demonstrated superior performance across physiological and phenological traits over 100% RDF, 50% RDF + 50% FYM + *Rhizobium* + PSB and control.

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

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. 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, greengramwas grown on approximately 0.79 lakh hectares, achieving a production of 0.52 lakh tonnes, with a productivity rate of 661 kg per hectare (Statistical Abstract of Haryana2021-22, 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).Varietal selection and proper nutrient management are key factors in enhancing the physiological parameters of greengram. Selecting suitable varieties adapted to specific agro-climatic conditions can lead to improved traits such as increased leaf area, enhanced photosynthetic efficiency, and better root development. Therefore, the current investigation was initiated to examine how varieties and nutrient treatments influence the physiological and phenological parameters of summer greengram.

MATERIALS AND METHODS

The experiment exploring the combined impact of diverse greengram varieties and nutrient management practices was conducted at RRS (Bawal), CCS Haryana Agricultural Universityduring the summer of 2020. The experiment field boasts loamy sand soil with well-defined characteristics. 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. The row to row spacing was 30 cm. The crop was sown on April 25th with specific nutrient and seed treatment protocols.

Sampling 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 cm^2per plant.

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

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Ground area}}$$

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.

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

Where,

LA_2 and LA_1 are leaf area of plants at time t_2 and t_1, respectively.

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) methodfor 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:

$$CD = \sqrt{\frac{2 \times EMS}{n}} \times \text{t value at 5\%}$$

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

RESULTS AND DISCUSSION

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% RDF + 25% FYM + *Rhizobium* + PSBtreatment 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) and Singh and Jambukiya(2020). The superiority of75% RDF + 25% FYM + *Rhizobium* + PSBover other treatment suggests that a combination of adequate nutrients, organic matter and beneficial microbes might have promoted higher growth and branching. Similar results were observed by Ghosh *et al.*(2022) and Mondal and Sengupta (2019).

2. Leaf Area (cm^2/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(cm^2/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 Nayak *et al.*(2014) andPatil*et al.*(2021).

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 Mote*et al.*(2022) andArutkumaran*et al.*(2023).

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* + PSBat 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 nutrientavailability. Similar findings in leaf area index were made by Biswas *et al.*(2002)andChaudhary*et al.*(2023).

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) whilecontrol (6.0) took maximum no. of days.

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) and Patel *et al.* (2013).

CONCLUSION

On the basis of above study, it can be concluded that, variety MH-318 and 75% RDF + 25% FYM + *Rhizobium* + PSBwas superior toSML-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% floweringMH-318 and 75% RDF + 25% FYM + *Rhizobium* + PSB demonstrated superior performance over other varieties and nutrient treatments, respectively.

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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.

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≤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.

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≤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.

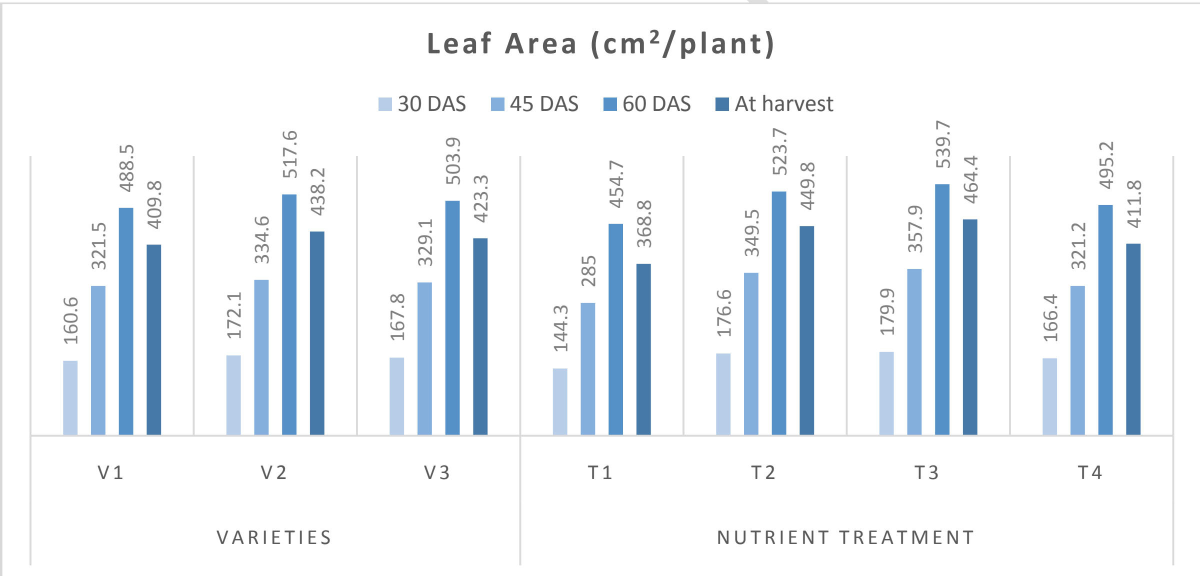

Fig. 1: Effect of varieties and nutrient treatments leaf area of summer greengram at 30, 45, 60 DAS and at harvest