The Bioscan 15(2): 199-203, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

RESPONSE OF DIFFERENT GREENGRAM (*Vigna radiata* L. Wilczek) CULTIVARS TO VARYING PLANT POPULATIONS

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KEYWORDS
Greengram
Plant density
Cultivars
Protein

Received on :
14.02.2020

Accepted on :
21.05.2020

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ABSTRACT

Results revealed that greater plant height was obtained from plant density of 3.33 lakh plants/ha where as lower plant density of 2.22 lakh plants/ha produced significantly higher growth and yield attributes *viz*., number of branches/plant, pod length, number of seeds/pod and number of pods/plant over higher plant density. Plant density of 3.33 lakh plants/ha gave 25.93, 17.36 and 20.11 per cent higher seed, stover as well as protein yield, respectively over plant density of 2.22 lakh plants/ha. Significantly higher nitrogen, phosphorus and potassium uptake by plant was noted with plant density of 3.33 lakh plants/ha. Greengram variety GM 4 registered significantly taller plants at harvest, as also greater pod length and number of seeds/pod. The variety GM 4 took significantly lower number of days to 50 per cent flowering and physiological maturity and produced highest number of pods/plant, seed index, seed, stover and protein yield. GM 4 performed better by recording 12.93, 9.70 and 9.96 percent higher seed, stover and protein yield, respectively over variety Meha. Variety GM 4 significantly higher nitrogen, phosphorus and potassium uptake by plant was observed..

INTRODUCTION

The India is the largest producer and consumer of pulses, accounting about 27 per cent of total production and about 30 per cent of the total consumption in the world (DE&S, 2014). However, availability of pulses per capita in the country is much lesser (30-35 g/capita) than the recommendations of WHO (80 g/capita) and thereby around 80 million children of the country are still protein energy under-nourished (Mondal *et al*., 2004). Hence, there is a need for increasing average pulse productivity to fulfill protein requirement.

Greengram (Vigna radiata) is commonly known as moong, goldengram, mung and is one of the most important pulse crop, grown in almost all parts of the country over a wide range of agro-climatic conditions. India is the largest producer of greengram in the world. In India, greengram occupies an area of about 3.50 million hectare producing 1.61 million tonnes, whereas, in Gujarat it is grown over 0.20 million hectare with a production of 0.11 million tonnes. The productivity of greengram, in India and Gujarat is 473 and 546 kg/ha, respectively (DE&S, 2014). In Gujarat, yield of greengram is low as its cultivation is mainly confined under rainfed condition and in poor textured soil. Because of the short-duration and adjustability under different cropping systems or situations, greengram has enormous potential in future which needs to be capitalized.

Among several crop production factors *viz*., selection of variety, spacing, sowing time, dose of fertilizer, method and time of fertilizer application and irrigation etc., play important role in maximizing production of greengram per unit area. The genotypes can express their full potential only when grown under optimum weather conditions and at optimum plant density. Optimum plant density ensures proper utilization of inputs *viz*., nutrients, moisture and light, which result in better performance of plants in the community. Plant density plays significant role in providing the optimum space to individual plant, which is the main pre-requisite to obtain maximum yield for any crop. Plant densities are known as the growth modifiers of individual plant. Greengram with a good leaf canopy is much affected by the space available per plant. The greengram grown in summer primarily utilize land and water resources, which are usually, remain unused.

Development of short duration photo- and thermo-insensitive varieties of greengram offers an excellent opportunity for its cultivation in both kharif as well as summer seasons, where, adequate irrigation facilities are available. These can easily be knit in multiple cropping systems, when fields are left fallow in summer season. Recently, many high yielding, early maturing and disease resistant varieties suitable for spring or summer cultivation have been evolved, which have to be evaluated for different agro-climatic regions. Singh *et al*. (2007) studied the response of mungbean varieties to plant populations in summer season and observed significant influence in terms of growth and yield.

Research studies also revealed that most of the growth and yield contributing attributes are significantly and positively correlated with the grain and yield of mungbean crop (Siddique *et al*., 2006). Among many other crop production constrains, approprite varieties and inter-row spacing are the most important, which contribute sustainatially to the seed yield of mungbean (Rasul *et al.*, 2012).

The whole scenario and context clearly reflect that due emphasis must be given to these parameters so that the treats to the management practices which reduce yield per unit area can be encountered. Therefore, the present study was initiated to find out the optimum requisite plant densities of greengram varieties under North Gujarat climatic condition.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 2016 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the response of different greengram (*Vigna radiata* L. Wilczek) cultivars to varying plant populations. The Sardarkrushinagar located at 24°19′ North latitude and 72°19′ East longitude with an elevation of 154.52 metre above the mean sea level. The climate of this region is sub-tropical monsoon type and falls under semi-arid region. The soil of the experimental field was loamy sand, low in organic carbon (0.22 %) and available nitrogen (160.7 kg/ha), medium in available phosphorus (38.79 kg/ha) and available potash (286.12 kg/ha). Alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Watanabe and Olsen, 1965), Neutral normal Ammonium Acetate extract using flame photometer (Hanway and Heidel, 1952) and Walkely and Black method (Jackson,1967) for the determination of available nitrogen (N), phosphorus (P_2O_5) potassium (K_2O) and organic carbon, respectively. The pH and EC of experimental site was determined through 1:2.5 soil and water suspension method (Jackson, 1967). The pH and EC (ds/m) of experimental soil was 7.56 and 0.12, respectively.

Nine treatment combinations comprising of three plant densities *viz*., 4.44 lakh plants/ha (P_1), 3.33 lakh plants/ha (P_2) and 2.22 lakh plants/ha (P_3) and three varieties *viz*., Meha (V_1), GM 4 (V_2) and GAM 5 (V_3) were evaluated in split plot design with four replications by keeping plant density as main plot and variety as sub-plots. Size of gross plot was 6 m × 4.5 m. A fertilizer dose of 20 kg/ha N and 40 kg/ha P_2O_5 in the form of urea and DAP respectively was given to all the treatments at the time of preparation of field. All other cultural practices were performed uniformly for all treatments. Green gram varieties were dibbled on 6th March, 2016 using different seed rates as per treatments. Intercultural operations like weeding, mulching,irrigation and pest control practices done as and when necessary for healthy plant growth and development. The crop was harvested at different dates as per maturity of different varieties when 90% pods were matured. Observations on different growth and yield parameters were recorded from five randomly selected plants in each net plot and seed yield was recorded. Then harvested crop was properly dried in the sun before threshing. The data recorded were tabulated and analyzed statistically using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

RESULTS AND DISCUSSION

Effect of plant densities

The data on plant height measured at 30 DAS under different plant densities was found non-significant, while, 45 DAS and at harvest were found significant (Table 1). A 45 DAS and at harvest, significantly greater plant heights 37.1 cm and 60.4 cm, respectively have produced under plant density of 3.33 lakh plants/ha which were at par with plant density of 4.44 lakh plants/ha (34.9 cm and 55.4 cm, respectively). This was apparently because individual plant from the plots with the highest plant population did not get opportunity to proliferate laterally due to closer spacing. Hence, plants were compelled to grow more in upward direction for the fulfillment of light requirement for photosynthesis. This result is accordance with the findings of Patel (2013), Amruta *et al*. (2015) and Sonani *et al*. (2016) in greengram with respect to plant height.

Table1: Growth and yield parameters of summer greengram with different cultivars and plant densities

Treatments		Plant height (cm)			Number of branches /plant	Number of root nodules /plant	Dry weight of root nodules / plant (mg)	Days to 50 per cent flowering	Days to physiological maturity	Pod Length (cm)	Number of pods/ plant	Number of seeds /pod	Seed index (g)
		30 DAS	45 DAS	At harvest									
A]	Main plot treatments (Plant Densities : P) :												
	P_1 : 4.44 lakh plants/ha	21.6	34.9	55.4	5.19	22.77	15.91	41	70	6.33	19.4	8.39	3.72
	P_2 : 3.33 lakh plants/ha	22.7	37.1	60.4	5.7	23.98	16.59	41	70	7.3	23.62	9.28	3.78
	P_3 : 2.22 lakh plants/ha	21.1	32.3	51.8	6.11	24.83	17.47	40	69	8	25.62	9.97	4
S.Em. ±		0.83	1.01	1.51	0.18	0.7	0.36	0.47	0.53	0.2	0.55	0.27	0.09
C.D. at 5 %		NS	3.51	5.22	0.61	NS	NS	NS	NS	0.7	1.9	0.93	NS
C.V. %		13.15	10.1	9.36	10.82	10.13	7.54	4	2.66	9.66	8.3	10.13	7.81
B]	Sub plot treatments (Varieties : V) :												
	V_1 : Meha	21.5	32.9	53.2	5.45	23.45	16.23	44	76	6.84	21.73	8.83	3.58
	V_2 : GM 4	22.1	36.3	58.1	5.58	24.25	17.04	37	63	7.46	24.15	9.78	4.19
	V_3 : GAM 5	21.9	35.1	56.3	5.97	23.88	16.7	40	69	7.33	22.75	9.03	3.73
S.Em. ±		0.66	0.83	1.31	0.13	0.65	0.3	0.43	0.22	0.17	0.46	0.26	0.07
C.D. at 5 %		NS	2.47	3.88	0.37	NS	NS	1.27	0.67	0.5	1.37	0.77	0.21
P × V Interaction :													
S.Em. ±		1.15	1.44	2.26	0.22	1.13	0.52	0.74	0.39	0.29	0.8	0.45	0.12
C.D. at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %		10.52	8.29	8.09	7.62	9.5	6.28	3.65	1.12	8	7	9.73	6.44

Table 2: Quality parameters and yield of summer greengram by different plant densities and cultivars

Treatments			Protein content (%)	Protein yield (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)	HI (%)
A]	Main plot treatments (Plant Densities : P) :						
	P_1 :	4.44 lakh plants/ha	22	232.22	1056	1863	36.18
	P_2 :	3.33 lakh plants/ha	21.42	253.62	1185	1994	37.33
	P_3 :	2.22 lakh plants/ha	22.45	211.15	941	1699	35.66
S.Em. ±			0.25	7.06	30.46	62.95	0.71
C.D. at 5 %			NS	24.44	105.41	217.83	NS
C.V. %			3.92	10.53	9.95	11.77	6.78
B]	Sub plot treatments (Varieties : V) :						
	V_1 :	Meha	22.22	221.18	997	1762	36.12
	V_2 :	GM 4	21.66	243.2	1126	1933	36.81
	V_3 :	GAM 5	21.98	232.6	1060	1861	36.24
S.Em. ±			0.14	4.73	19.49	44.07	0.65
C.D. at 5 %			0.42	14.04	57.92	130.95	NS
P × V Interaction :							
S.Em. ±			0.24	8.19	33.76	76.33	1.13
C.D. at 5 %			NS	NS	NS	NS	NS
C.V. %			2.22	7.05	6.37	8.24	6.2

Table 3: Nutrient content of summer greengram by different plant densities and cultivars

Treatments			Nutrient content (%)					
			N		P		K	
			Seed	Stover	Seed	Stover	Seed	Stover
A]	Main plot treatments (Plant Densities : P) :							
	P_1 :	4.44 lakh plants/ha	3.52	1.06	1.01	0.53	0.33	0.63
	P_2 :	3.33 lakh plants/ha	3.43	1.03	1	0.52	0.32	0.62
	P_3 :	2.22 lakh plants/ha	3.59	1.09	1.03	0.54	0.34	0.64
S.Em. ±			0.04	0.01	0.01	0.01	0.004	0.01
C.D. at 5 %			NS	NS	NS	NS	NS	NS
C.V. %			3.92	4.71	2.47	4.18	3.94	3.52
B]	Sub plot treatments (Varieties : V) :							
	V_1 :	Meha	3.56	1.07	1.04	0.54	0.34	0.64
	V_2 :	GM 4	3.47	1.04	1	0.52	0.32	0.62
	V_3 :	GAM 5	3.52	1.06	1.02	0.53	0.33	0.63
S.Em. ±			0.02	0.01	0.01	0.004	0.002	0.004
C.D. at 5 %			0.07	0.02	0.02	0.01	0.01	0.01
P × V Interaction :								
S.Em. ±			0.04	0.01	0.01	0.01	0.004	0.01
C.D. at 5 %			NS	NS	NS	NS	NS	NS
C.V. %			2.22	2.55	1.94	2.4	2.1	2.02

Table 4: Nutrient uptake of summer greengram by different plant densities and cultivars

Treatments			Nutrient uptake (kg/ha)								
			N			P			K		
			Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
A]	Main plot treatments (Plant Densities : P) :										
	P_1 :	4.44 lakh plants/ha	37.15	19.72	54.85	10.71	9.84	20.55	3.51	11.7	15.21
	P_2 :	3.33 lakh plants/ha	40.58	20.58	58.89	11.88	10.33	22.21	3.82	12.32	16.16
	P_3 :	2.22 lakh plants/ha	33.78	18.4	50.3	9.64	9.2	18.84	3.19	10.9	14.1
S.Em. ±			1.13	0.48	1.34	0.31	0.24	0.5	0.12	0.3	0.36
C.D. at 5 %			3.91	1.64	4.64	1.07	0.84	1.74	0.4	1.05	1.24
C.V. %			10.53	8.41	8.49	9.92	8.58	8.48	11.55	9.03	8.21
B]	Sub plot treatments (Varieties : V) :										
	V_1 :	Meha	35.39	18.85	52.25	10.32	9.43	19.75	3.35	11.19	14.54
	V_2 :	GM 4	38.91	20.1	56.86	11.18	10.07	21.25	3.64	12	15.68
	V_3 :	GAM 5	37.22	19.74	54.93	10.74	9.87	20.61	3.52	11.73	15.25
S.Em. ±			0.76	0.34	0.88	0.2	0.17	0.29	0.07	0.22	0.25
C.D. at 5 %			2.25	1.01	2.61	0.59	0.52	0.87	0.22	0.65	0.73
P × V Interaction :											
S.Em. ±			1.31	0.59	1.52	0.34	0.3	0.51	0.13	0.38	0.42
C.D. at 5 %			NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %			7.05	6	5.56	6.39	6.14	4.96	7.41	6.46	5.59

All growth and yield attributing parameters *viz.*, number of branches/plant, pod length, pods/ plant and number of seeds/ pod were significantly influenced by different plant densities but, number of root nodules/plant, dry weight of root nodules/ plant, days to 50 per cent flowering, days to physiological maturity and seed index were not influenced by plant density (Table 1). Number of branches/plant (6.11) and pods/plant (25.62) was significantly higher under plant density of 2.22 lakh plants/ha as compared to rest of plant densities but number of branches/plant (5.58) was at par with plant density of 3.33 lakh plants/ha plant densities. The pod length (8.00 cm) and number of seeds/pod (9.97) were also found significantly higher under the lowest plant density of 2.22 lakh plants/ha, but was statistically at par with plant density of 3.33 lakh plants/ ha. The increase in number of seeds/pod at lower plant density was because of reduced inter-plant competition for light, moisture and nutrients as more space was available for growth of individual plant. These findings are substantiated with those reported by Patel (2013), Singh and Singh (2014), Amruta *et al*. (2015) and Khanvilkar (2015) and Sonani *et al*. (2016) in greengram.

It is evident from the results presented in Table 2 that there was a significant difference in seed and stover yield of greengram due to plant densities but not harvest index. Plant density of 3.33 lakh plants/ha recorded significantly higher seed yield (1185 kg/ha) as compared to plant density levels of 4.44 lakh plants/ha and 2.22 lakh plants/ha. The magnitude of increase in seed yield under treatments P_2 and P_1 was to the extent of 25.93 and 12.22 per cent, respectively over P_3. Stover yield was significantly higher under plant density of 3.33 lakh plants/ha (1994 kg/ha) followed by 4.44 lakh plants/ha. This is due to reduction in plant population per unit area under lower plant density. Increase in plant population resulted in sharp decline in the yield due to severe inter-plant competition which resulted in vegetative growth. The results were in line of those reported by Rasul *et al*. (2012), Chaudhary *et al*. (2014), Singh and Singh (2014), Kadam and Khanvilkar (2015) and Sonani *et al*. (2016).

The quality parameter and nutrient content in seed and stover were not significantly influenced due to different plant density levels but nutrient uptake by seed, stover and total uptake were significantly influenced due to planting density levels (Table 2, 3 and 4). Maximum nutrient uptake by seed, stover and total by the crop was noted under plant density of 3.33 lakh plants/ha, but statistically at par with plant density of 4.44 lakh plants/ha.

Effect of varieties

An appraisal of the data presented in Table 1 indicated that periodical height of greengram plant was significantly influenced due to varieties at all growth stages, except 30 DAS. Variety GM 4 registered significantly taller plant height at 45 DAS (36.3 cm) and at harvest (58.1 cm), which was remained at par with variety GAM 5 at 45 DAS and at harvest. The corresponding value of at par treatment was 35.1 and 56.3 cm, respectively. Significant difference in plant height in different varieties was observed due to their genetic potential in different growth habit and not due to treatment effects. Similar results were also reported by Tekale *et al*. (2011), Patel *et al*. (2013), Rathod and Gawande (2014), Singh *et al*. (2014), Solunke *et al*. (2015) and Patel *et al*. (2016).

Growth and yield attributes of green gram were significantly influenced due to different varieties but There was no significant difference among varieties in number of root nodules/plant and dry weight of root nodules/plant at 45 DAS (Table 1). Significantly higher number of branches/plant (5.97) was observed in variety GAM 5 over variety GM 4 and Meha. Significantly less number of days to 50 per cent flowering (37) and physiological maturity (63) were observed with variety GM 4 as compared to variety Meha and GAM 5. The variety GM 4 had the highest pod length (7.46 cm) and number of pods/plant. However varieties GM 4 and GAM 5 were comparable in the case of number of seeds/pod. Variation observed among the varieties was due to inherent characteristics of particular variety. These findings are in close agreement with those reported by Patel *et al*. (2013), Gorade *et al*. (2014), Singh et al. (2014) and Patel *et al*. (2016).

The difference in seed and stover yield of summer greengram due to different varieties was found significant (Table 2). Variety GM 4 recorded higher seed yield (1126 kg/ha) as compared to variety GAM 5 and Meha. The magnitude of increase in seed yield under treatments V_2 and V_3 was to the extent of 12.93 and 6.31 per cent, respectively over V_1. Variety GM 4 gave significantly higher stover yield (1933 kg/ha) which was statistically at par with variety GAM 5. This was due to a variety differed in its genetic built-up and hence resulted in the yield potential. The above findings are in complete agreement with earlier work of Gorade *et al*. (2014), Rathod and Gawande (2014), Solunke *et al*. (2015) and Patel *et al*. (2016).

An appraisal of data in the Table 2 indicated that the differences in the protein content and yield due to different varieties were significant. The highest protein content (22.22 %) was recorded in variety Meha which was at par with variety GAM 5 (21.98 %), but significantly better than variety GM 4 (21.66 %). Increase in protein content may be due to increased N concentration in grain. Protein yield showed a different tread, as it was dependent on seed yield. Variety GM 4 produced significantly higher protein yield (243.20 kg/ha) which was statistically at par with variety GAM 5 (232.60 kg/ha). Per cent increase in protein yield under treatments of V_2 and V_3 was to the extent of 9.95 and 5.16, respectively over V_1. These findings are also in close agreement with those reported by Singh and Singh (2014).

The perusal of data presented in Table 3 and 4 indicated that nutrient content and uptake in seed and stover was significantly influenced by different varieties. Significantly higher N, P and K content in seed and stover was registered with variety Meha which was statistically at par with variety GAM 5, while significantly the highest nutrient uptake by seed, stover and total crop was noted in variety GM 4 which was statistically at par with variety GAM 5. These differential uptakes by different varieties may be due to the significant yield variation between varieties.

These results are in accordance with the results of those reported by Patel *et al*. (2016) with respect to N and P uptake.

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