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Effect of different spacings under varying fertility levels on summer greengram (*Vigna radiata* L.)

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Abstract
A field experiment was carried out at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer 2020-21 to investigate the effect of different spacings under varying fertility levels on summer greengram (*Vigna radiata* L.).Twelve treatment combinations comprising of four spacings S_1 (30 cm × 10 cm), S_2 (30 cm × 20 cm), S_3 (45 cm × 10 cm) and S_4 (45 cm × 20 cm) and three fertility levels viz., F_1 (75% RDF), F_2 (100% RDF) and F_3 (125% RDF) were evaluated in factorial randomized block design with three replication. Almost all the growth and yield attributes of summer greengram were significantly influenced by spacing. Plant population (at 15 DAS and at harvest), plant height (at 30 DAS and at harvest), seed yield (1133 kg/ha), stover yield (2293 kg/ha) the significantly higher under 30 cm × 10 cm spacing. While number of branches per plant, number of pods per plant and pod length recorded significantly higher under 45 cm × 20 cm spacing. Treatment (S_1) 30 cm × 10 cm spacing recorded maximum net realization (₹ 56596/ha) and benefit: cost ratio (2.85). Among the fertility levels application of 100% RDF (20-40-00 N-P_2O_5-K_2O kg/ha) recorded significantly higher plant height, number of branches per plant, number of pods per plant, pod length, seed yield (1081 kg/ha), stover yield (2229 kg/ha). Treatment (F_3) 125% RDF recorded net realization (₹53579/ha) and benefit: cost ratio (2.80) of summer greengram. An interaction effect between different spacings and fertility levels were found significant with respect number of branches per plant at harvest under treatment combination S_4F_2 (45 cm × 20 cm spacing with application 100% RDF) followed by S_4F_3 (45 cm × 20 cm spacing with application of 125% RDF), S_3F_2 (45 cm × 10 cm spacing with application of 100% RDF) and S_2F_3 (30 cm × 20 cm spacing with application of 125% RDF). Thus, from the foregoing results of one year experiment, it is concluded that for securing higher seed yield and net realization from summer greengram should be sown at the spacing of 30 cm × 10 cm along with application of 100%RDF(20-40-00 N-P_2O_5-K_2O kg/ha) in loamy sand soil.

Keywords: Spacings, varying fertility levels, summer greengram, *Vigna radiata* L

Introduction

Pulses are wonder gift of nature to the living universe and are the real gateway of sustainable agriculture. Food legumes constitute an important dietary ingredient of Indian diet as they supply protein and essential amino acids and play significant role in Indian farming. Pulses are the cheapest source of quality protein for the human beings. The protein hunger is common problem in India, where majority of the people have vegetative diet. Greengram native is India and central Asia. Greengram is cultivated in the countries of India, Burma, Srilanka, Pakistan, China, Fiji, Queens land and Africa. Greengram (*Vigna radiata*) is commonly known as moog, golden gram, mung. It's belongs to family leguminosae. It is third important pulse crop after chickpea and pigeonpea, cultivated throughout India for its multipurpose uses as vegetable, pulse, fodder and green manure crop. Its seed is more palatable, nutritive, digestible and non-flatulent than other pulses grown in the world. Spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and high infestation of diseases. On other hand very low plant population will also reduce the yield. Due to this reason normal population is necessary for high yield. Advantage of optimum spacing under irrigated conditions is due to reduced competition for light because when the moisture is lacking, light is no longer limiting factor and advantage of uniform spacing is lost (Ihsanullah *et al.* 2002) [9]. It is the most important non monetary input, which can be manipulated to attain the maximum production per unit area (Jain and Chauhan, 1988) [10]. Fertilizer play important role for obtaining crop production. For greengram, 15-20 kg nitrogen, 30-40 kg phosphorus should be applied at sowing time. It is advisable to use fertilizers on the basis of soil test and recommendations, normally 100 kg DAP/ha is enough for one hectare the fertilizer should be applied by drilling either at the time of sowing or just before sowing in such way that they are placed about 2-3 cm below the seed.

Material and Method

The field experiment was conducted in Plot No. C-5 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkhrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer season of year 2020. The experiment field was fairly leveled and uniform. The soil of the experimental plot was loamy sand in texture and slightly alkaline. The soil was low in organic carbon and available nitrogen, medium in available phosphorus and high in potassium status. Twelve treatments were laid out in Randomized Block Design with factorial concept with three replication. The four levels of spacings (S_1-30 cm × 10 cm, S_2-30 cm × 20 cm, S_3- 45 cm × 10 cm and S_4-45 cm × 20 cm) and three levels of fertility levels (F_1-75% RDF, F_2- 100% RDF and F_3-125% RDF). The greengram variety GM 6 was sown on 4th march 2020.

Results and Discussion

Effect of spacings on growth parameters

Plant population

The data on number of plant per net plot of greengram (Table 1) were significantly influenced due to different spacings at 15 DAS and at harvest. Significantly higher plant population under spacing treatment (S_1) 30 cm × 10 cm at 15 DAS and at harvest was recorded 316 and 311, respectively as compared to other treatments. This might be due to different spacing because plant population increased with narrow spacing. The lowest plant population was recorded at 15 DAS (118) and at harvest (115) under 45 cm × 20 cm (S_4) spacing. The similar results were found by Patel *et al.* (2012) [20], Patel *et al.* (2013) [22] and Gurjar *et al.* (2018) [7].

Plant height

A perusal of data (Table 1) indicated that different spacings had significant effect on plant height recorded at various stages of crop growth. Among the different spacings 30 cm × 10 cm (S_1) spacing recorded the highest plant height (21.69 cm and 39.93 cm) at 30 DAS and 60 DAS though it was at par with (S_2) 30 cm × 20 cm. At harvest stage the highest plant height (49.84 cm) registered under (S_1) 30 cm × 10 cm spacing and it was at par with (S_2) 30 cm × 20 cm and (S_3) 45 cm × 10 cm spacing. Wider spacing (S_4) 45 cm × 20 cm recorded the lowest plant height at 30 DAS, 60 DAS and at harvest (17.64 cm, 31.95 and 41.51 cm). The plant height significantly maximum under the plots having narrow spacing of 30cm × 10cm because individual plant from plots with closer spacing did not get opportunity to proliferate laterally due to the less lateral space. Hence, plants were competing to grow more in upward direction for completion of light requirement for photosynthesis. These results are in full agreement with the findings of Gohil *et al.* (2017) [6], patel *et al.* (2013) [22], Murade *et al* (2014) [17] and Amruta *et al.* (2015) [1].

Effect of spacings on yield attributes and yield

Number of branches/plant

The data (Table 2) revealed that different spacings had significant effect on number of branches per plant observed at harvest. Significantly the maximum number of branches per plant (5.78) was recorded under 45 cm × 20 cm (S_4) spacing and it was at par with 45 cm × 10 cm (S_3) and 30 cm × 20 cm (S_2) spacing. The lowest number of branches per plant (3.33) at harvest was noticed under spacing 30 cm × 10 cm (S_1) in summer greengram. The reason may be explained that plant grow with wider spacing (S_4) 45 cm × 20 cm reduced competition for moisture, light and nutrient and providing better availability of maximum space, light, water and nutrients leading to higher branches per plant. Similar results were reported by Chaudhary *et al.* (2015) [3] and Kalsaria (2017) [13].

Number of pods per plant

The mean data (Table 2) on number of pods per plant was significantly influence by different spacings. Among different spacings, significantly higher number of pods per plant (38.83) was recorded under wider spacing (S_4) 45 cm × 20 cm and it was at par with (S_3) 45 cm × 10 cm and (S_2) 30 cm × 20 cm because under the wider spacing reduced inter and intra plant competition for resources i.e. light, water and nutrients as more space available for plant growth and accelerate photosynthetic activity and more light interception for photosynthesis which ultimately produced more number of pods per plant. The lowest number of pods per plant (31.42) was produced under (S_1) 30 cm× 10 cm treatment. The magnitude of increase in number of pods per plant under treatment S_4, S_3 and S_2 over S_1 was to the extent of 23.58, 17.44 and 10.15 percent, respectively. These results are in agreement with Kadam and Khanvilhar (2015) [12], and Sonani *et al.* (2016) [26].

Pod length

The data presented in Table 2 showed significant effect on pod length due to different spacing. Among different spacing 45 cm × 20 cm (S_4) registered significantly maximum pod length (11.07 cm) which was statistically at par with 45 cm × 10 cm (S_3) and 30 cm × 20 cm (S_2). This might be due to beneficial effect of optimum spacing for growth and development of crop plant. The magnitude of increase pod length under treatment S_4, S_3 and S_2 over S_1 was to the extent of 26.36, 14.61 and 4.22 percent, respectively. The lowest pod length (8.76 cm) recorded under 30 cm × 10 cm (S_1) spacing. Similar finding were also supported by Bunkar *et al.* (2013) [2], Chaudhary *et al.* (2015) [3] and Kalsaria (2017) [13], Patel *et al.* (2018) [21] in cowpea

Seed yield

Data furnished in Table 2 indicated that seed yield was influenced significantly by different spacings. Among the different spacings S_1 (30 cm × 10 cm) registered significantly higher seed yield (1133 kg/ha) and it was at par with S_3 (45 cm × 10 cm) and S_2 (30 cm × 20 cm). This was due to higher number of plants in unit area under narrow spacing as compared to wider spacing, which could led to produced higher seed yield of greengrm. The lowest seed yield of 812 kg/ha was obtained under 45 cm × 20 cm (S_4). These results are also in agreement with findings of Patel *et al.* (2012) [20], Gohil *et al.* (2017) [6] and Kalsariya (2017) [13].

Stover yield

An appraisal of data in Table 4.8 revealed that stover yield of greengram was affected significantly due to different spacings. Significantly higher stover yield (2293 kg/ha) was produced under 30 cm × 10 cm (S_1) and it was at par with 45 cm × 10 cm (S_3) and 30 cm × 20 cm (S_2) spacing. The lowest stover yield (1640 kg/ha) produced under 45 cm × 20 cm (S_4) spacing. The remarkable increase in stover yield under 30 cm × 10 cm (S_1) spacing might be due to higher plant population per unit area of greengram. Similar results were reported by Ibrahimi *et al.* (2017), Gohil *et al.* (2017) [6], Kalsariya (2017) [13] and Singh *et al.* (2020) [25].

Harvest index

The mean data pertaining to harvest index given in Table 2 showed non-significance effect due to different spacings. However, numerically higher harvest index (33.11%) was noted with 45 cm × 20 cm (S_4) spacing followed by 30 cm × 10 cm spacing (S_1: 33.07%). The lowest harvest index (32.01%) observed with 45 cm × 10 cm (S_3) spacing. Similar results were obtained by Kalsaria (2017) [13].

Effect of spacings on economics

The data presented in Table 4 showed that the narrow spacing 30 cm × 10 cm secured maximum net realization (₹56596/ha) with B: C ratio of 2.85 followed by 45 cm × 10 cm spacing (S_3) with net realization(₹51035/ha) and B: C ratio of 2.76. The lower net realization (₹34780/ha) and B: C ratio (2.25) were observed under (S_4) 45 cm × 20 cm spacing due to lower plant population gave lower yield thus lower net realization and B: C ratio of greengram. These results confirmed with the finding of Srivastav *et al.* (2017) [27] and Kumar *et al.* (2018[a]) [14].

Effect of fertility levels on growth parameters

Plant population

The data presented in Table 1 indicated that plant population per net plot did not surpass the level of significance at 15 DAS and at harvest under varying fertility levels. The results showed that there was no adverse effect of fertilizer application on plant population. Similar results were reported by Shelke (2011) [24] and Kalsaria (2017) [13].

Plant height

Data presented on Table 1 revealed that periodical plant height was significantly influenced due to varying fertility levels at 30 DAS, and at harvest of greengram except at 60 DAS. Significantly highest plant height (20.90 cm and 49.30 cm) under application of F_3 (125% RDF) at 30 DAS and at harvest, respectively and it was at par with F_2 (100% RDF). This might be due to higher availability of nutrients which encourage vegetative growth and made taller than those plants receiving less quantity of fertilizer. The treatment F_1 (75% RDF) recorded the lowest plant height (17.94 cm and 40.43 cm, respectively) at 30 DAS and at harvest. Similarly findings were observed by Meena *et al.* (2020) [16] in cowpea

Effect of fertility levels on yield attributes and yield

Number of branches/plant

An appraisal of data in Table 2 showed that the number of branches per plant at harvest was found significant. The maximum number of branches per plant (5.20) was noted with application of 100% RDF (F_2) and it was statistically at par with F_3 (125% RDF). The maximum branches per plant with application of 100% RDF because inorganic nutrient increase the use efficiency of added nutrients and supply it continuously to the plant throughout crop growth period and promoted various physiological activities in plant which are being considered indispensable for proper growth and development of branches per plant. Similarly findings were also observed by Shelke (2011) [24], Jat *et al.* (2012) [11], Choudhary *et al.* (2011) [4] in cowpea and Kalsaria (2017) [13] in greengram.

Number of pods per plant

A perusal of data in Table 2 revealed that number of pods per plant significantly influenced due to different fertility levels. Application of 125% RDF (F_3) produced significantly higher number of pods per plant (38.01) but it was at par with 100% (F_2) RDF. The probable reason for higher number of pods per plant due to better nutrient availability in soil during entire plant growth. The lowest number of pods per plant (32.27) was recorded with application of 75% RDF (F_1). These results are corroborated by the findings of Ghule *et al.* (2020) [5], Rai *et al.* (2020) [23] and Meena *et al.* (2020) [16].

Pod length

Appraisal of data revealed that varying fertility levels showed significant on pod length. The highest pod length (10.38 cm) was recorded with application of 125% RDF (F_3) and it was at par with 100% RDF (F_2). These might be due to availability of higher plant nutrient in soil accelerates the rates of plant growth leading to a rapid photosynthetic process in which the greater growth were increase pod length at harvest. The lowest pod length (8.63 cm) was observed under 75% RDF (F_1). The results are in full agreement with the findings of Ghule *et al.* (2020) [5], Meena *et al.* (2020) [16] and Rai *et al.* (2020) [23].

Seed yield

The data on seed yield presented in Table 2 revealed that varying fertility had significant effect on it. Significantly higher seed yield (1081 kg/ha) recorded under 125% RDF (F_3) and was at par with 100% RDF (F_2). It might be due to balanced fertilizer application provided better nourishment to plant and higher nutrients are play role in greengram seed formation, overall an increase seed yield. The lowest seed yield (808 kg/ha) recorded under 75% RDF (F_1). The magnitude of increase in seed yield under treatment F_3 and F_2 was to extent of 33.78 and 29.20 percent, respectively over F_1.These results are in close conformity with Meena and Varma (2016) [15], varma *et al.* (2017) [28] and Ghule *et al*. (2020) [5].

Stover yield

A perusal data furnished in Table 2 indicated that significantly higher stover yield (2229 kg/ha) recorded under 125% RDF (F_3) and was at par with 100% RDF (F_2). This could increase in vegetative growth and yield attributes due to presence of higher nutrients lead to luxury consumption of nutrients would increased photosynthesis and improved the plant capability to produced carbohydrates had play important role in increased stover yield of greengram. The lowest stover yield (1660 kg/ha) was obtained under application of 75% RDF (F_1). Similar results were observed by Varma *et al.* (2017) [28], Meena *et al.* (2020) [16] and Ghule *et al.* (2020) [5].

Harvest index

Analysis of data in Table 2 showed that harvest index did not differ significant due to varying fertility levels. Though the numerically higher harvest index (32.76%) was obtained under application of 100% recommended fertilizer dose (F_2) followed by application of 75% recommended fertilizer dose (F_1: 32.73%). Similar results were also reported by Kalsaria (2017) [13] and Shelke (2011) [24].

Effect of fertility levels on economics

Analysis of data presented in Table 4 showed that the application of 125% RDF (F2) recorded maximum net realization (₹53579/ha) with B: C ratio 2.80 followed by application of 100% RDF (F2) with net realization (₹51305/ha) and B: C ratio (2.76). The minimum net realization (₹33712/ha) with B: C ratio (2.18) was registered under 75% RDF (F1). The reason may be mainly due to lower seed yield resulted in minimum net realization and B: C ratio under application of 75% RDF to greengram. These results confirmed with the finding of Meena *et al.* (2020) [16], Meena *et al.* (2013) [15] in cowpea.

Interaction effect

The interaction effect between spacings and fertility levels was found to be significant in respect of number of branches per plant. Data presented in Table 3 revealed that treatment combination S_4F_2 (45 cm × 20 cm spacing with 100% RDF) gave significantly higher number of branches per plant (6.20) at harvest and was remained at par with S_4F_3 (45 cm × 20 cm spacing with 125% RDF) (6.13), S_3F_3 (45 cm × 10 cm spacing with 100% RDF) (5.70) and S_2F_3 (30 cm × 20 cm spacing with 125% RDF) (5.60). The reason may be mainly due to interaction effect of higher nutrient availability and optimum space occupied by crop resulted in increase the number of branches as lateral plant growth. The significantly lowest number of branches per plant (2.83) was registered with treatment combination S_1F_1 (30 cm × 10 cm with 75% RDF) at harvest. These results are in agreement with Kalsaria (2017) [13] and Muthu *et al.* (2016) [18].

Table 1: Effect of spacings and fertility levels on growth of summer greengram

Treatment	Plant population (per net plot)		Plant height (cm)		
	At 15 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest
Spacings (S)					
S_1: 30 cm × 10 cm	316	311	21.69	39.93	49.84
S_2: 30 cm × 20 cm	160	158	19.34	33.74	47.95
S_3: 45 cm × 10 cm	238	236	17.95	31.99	42.47
S_4: 45 cm × 20 cm	118	115	17.64	31.95	41.51
S.Em. ±	12.72	16.17	1.16	2.42	2.83
C.D. (P=0.05)	37.31	47.43	3.40	7.08	8.28
Fertility levels (F)					
F_1: 75% RDF	203	201	17.94	33.13	40.43
F_2: 100% RDF	212	208	18.62	34.71	46.60
F_3: 125% RDF	209	207	20.90	35.37	49.30
S.Em. ±	11.02	14.01	1.00	2.09	2.45
C.D. (P=0.05)	NS	NS	2.94	NS	7.18
Interaction (S × F)					
S.Em. ±	7.34	9.34	0.67	1.39	1.63
C.D. (P=0.05)	NS	NS	NS	NS	NS
C.V.%	6.11	7.88	6.05	7.02	6.22

Table 2: Effect of spacings and fertility levels on yield attributes and yields of summer greengram

Treatments	No. of branches at harvest	No. of pods per plant	Pod length (cm)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Spacings (S)						
S_1: 30 cm × 10 cm	3.33	31.42	8.76	1133	2293	33.07
S_2: 30 cm × 20 cm	4.81	34.61	9.13	927	1907	32.70
S_3: 45 cm × 10 cm	5.00	36.90	10.04	1037	2202	32.01
S_4: 45 cm × 20 cm	5.78	38.83	11.07	812	1640	33.11
S.Em. ±	0.45	2.21	0.67	107.04	221.13	3.48
C.D. (P=0.05)	1.32	6.49	1.95	314	649	NS
Fertility levels (F)						
F_1: 75% RDF	3.98	32.27	8.63	808	1660	32.73
F_2: 100% RDF	5.20	36.04	10.25	1044	2142	32.76
F_3: 125% RDF	5.01	38.01	10.38	1081	2229	32.65
S.Em. ±	0.39	1.92	0.58	92.70	191.55	3.02
C.D. (P=0.05)	1.15	5.62	1.69	272	562	NS
Interaction (S × F)						
S.Em. ±	0.26	1.28	0.38	61.80	127.70	2.01
C.D. (P=0.05)	0.76	NS	NS	NS	NS	NS
C.V.%	9.55	6.25	6.82	10.95	11.00	10.65

Table 3: Effect of spacings × fertility levels interaction on number of branches per plant at harvest of summer greengram

Spacings/Fertility levels	S_1: 30cm × 10cm	S_2: 30cm × 20cm	S_3: 45cm × 10cm	S_4: 45cm × 20cm
F_1: 75%	2.83	3.53	4.57	5.00
F_2: 100%	3.60	5.30	5.70	6.20
F_3: 125%	3.57	5.60	4.73	6.13
S.Em. ±	0.26			
C.D.(P=0.05)	0.76			
C.V.%	9.55			

Table 4: Effect of spacings and fertility levels on economics of summer greengram

Treatments	Yield (kg/ha)		Gross realization (₹/ha)	Cost of cultivation (₹/ha)	Net realization (₹/ha)	B: C ratio
	Seed	Stover				
Spacing (S)						
S_1: 30 cm × 10 cm	1133	2293	87268	30672	56596	2.85
S_2: 30 cm × 20 cm	927	1907	71432	29173	42259	2.45
S_3: 45 cm × 10 cm	1037	2202	79977	28942	51035	2.76
S_4: 45 cm × 20 cm	812	1640	62540	27760	34780	2.25
Fertility levels (F)						
F_1: 75%	808	1660	62260	28548	33712	2.18
F_2: 100%	1044	2142	80442	29137	51305	2.76
F_3: 125%	1081	2229	83304	29725	53579	2.80

Conclusion

On the basis of findings of the present investigation it is concluded that for getting higher seed yield and net realization of summer greengram should be sown at 30 cm × 10 cm spacing and fertilized with 100% RDF (20-40-00 N-P_2O_5-K_2O kg/ha) under loamy sand soil.

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