RESPONSE OF DIFFERENT CULTIVARS OF GREENGRAM [*Vigna radiata* (L.) Wilczek] TO INTEGRATED NUTRIENT MANAGEMENT UNDER SOUTH GUJARAT CONDITION

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ABSTRACT

A field experiment was conducted during summer season of 2011 at the College Farm, Navsari Agricultural University, Navsari, to study the "Response of different cultivars of greengram (Vigna radiata L.) to integrated nutrient management under South Gujarat condition". The soil of the experimental field was clayey in texture having medium to poor drainage, low in available nitrogen, medium in available phosphorus and fairly rich in available potassium and sulphur with 7.8 pH. Twenty treatment combinations consisting of two varieties viz., Meha (V_1) and GM 3 (V_2), three levels of inorganic fertilizer (F_1: 100 per cent RDF i.e. 20-40-00 kg NPK/ha, F_2: 75 per cent RDF and F_3: 50 per cent RDF), three treatments of biofertilizers (B_1: rhizobium seed inoculation, B_2: Phosphate solubilizing bacteria (PSB) seed inoculation and B_3: rhizobium + PSB seed inoculation) and two additional treatments (AT_1- Meha with 100% RDF only) and AT_2 (GM 3 with 100% RDF only) were evaluated in factorial randomized block design with factorial concept in three replications. The results revealed that during summer season, greengram cultivar cv. Meha performed best fertilized with 100 per cent RDF (20-40-0 kg NPK/ha) with dual seed inoculation of rhizobium and PSB. This treatment combination found more productive and economical, which closely followed by the treatment combination of 75 per cent RDF with dual inoculation of rhizobium & PSB and 75 per cent RDF with seed inoculation with PSB indicating 25 per cent saving of inorganic fertilizer through use of dual inoculation of rhizobium and PSB or PSB alone.

KEY WORDS: *Biofertilizer, greengram, integrated nutrient management,*

INTRODUCTION

Greengram is also known as mung, moong, mungo, goldengram, chickasaw pea and oregon pea. Development of short duration as well as photo and thermo insensitive varieties provided excellent opportunity for greengram cultivation both in *kharif* as well as in *summer* season, where adequate irrigation facilities are available. In South Gujarat, greengram is cultivated mainly in summer season because during *kharif*, fields remain wet for a longer time, which is not suitable for this crop.

Fertilizers play key role for obtaining higher crop production. Inadequate and imbalanced nutrient application by farmers is the most important limiting factor in pulses production. It is now increasingly being realized that no single nutrient source could fully meet the nutritional requirement of crop. Moreover injudicious use of chemicals enhanced the soil and plant health problems. In this regard, use of alternative sources of plant nutrients such as biofertilizers is the need of the time. In context of biofertilizers, positive effect of PSB and Plant Growth Promoting *Rhizobacteria* (PGPR) on legume *rhizobia* symbiosis particularly in the early events and synergism between these organisms might increase competitiveness and efficiency of *rhizobium* inoculation in pulse crops. *Rhizobium* inoculation can increase the grain yield of most of the pulse crops to the tune of 10 to 15 per cent (Ali and Chandra, 1985). Also co-inoculation of phosphate solubilizing bacteria has been found to improve nodulation, nitrogen fixation and yield of legumes by increasing phosphorus availability (Alagawadi and Gaur, 1988). Therefore, it becomes imperative to test role of biofertilizers and inorganic fertilizers as a source of nutrients in greengram. With this back ground information, the present experiment was planned at the College Farm, Navsari Agricultural University, Navsari, Guajarat.

MATERIALS AND METHODS

A field experiment was conducted during *summer* season of 2011 at the College Farm, Navsari Agricultural University, Navsari, to study the "Response of different cultivars of greengram (*Vigna radiata* L.) to integrated nutrient management under South Gujarat condition". The soil of the experimental field was clayey in texture having medium to poor drainage, low in available nitrogen, medium in available phosphorus and fairly rich in available potassium and sulphur with 7.8 pH. Twenty treatment combinations consisting of two varieties viz., Meha (V_1) and GM 3 (V_2), three levels of inorganic fertilizer (F_1: 100 per cent RDF i.e. 20-40-00 kg NPK/ha, F_2: 75 per cent RDF and F_3: 50 per cent RDF), three treatments of biofertilizers (B_1: *rhizobium* seed inoculation, B_2: Phosphate solubilizing bacteria (PSB) seed inoculation and B_3: *rhizobium* + PSB seed inoculation) and two additional treatments (AT_1- Meha with 100% RDF only) and AT_2 (GM 3 with 100% RDF only) were evaluated in factorial randomized block design with factorial concept in three replications. Other cultural practices and plant protection measures were taken as per recommendations. The data on plant height, number of branches / plant, dry matter accumulation / plant, number of pods / plant and seed yield / plant were recorded from randomly selected five plants in each net plot and seed yield recorded from net plot and converted on hectare basis. The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1967).

RESULT AND DISCUSSION

Effect of varieties

All growth characters like plant height, number of branches per plant, dry matter accumulation per plant and days to 50 per cent flowering were influenced significantly due to different varieties (Table 1). Variety Meha (V_1) recorded significantly higher plant height (57.35 cm), number of branches per plant (3.71) and dry matter accumulation per plant (18.69 g) as compared to variety GM 3. Significant differences in plant height, number of branches per plant and dry matter accumulation per plant were observed due to their genetic differences in growth habit of two varieties. The difference between two varieties for number of effective root nodules per plant (Table 1) was non-significant. Similar results are reported by Gangaiah and Ahlawat (2008) and Singh *et al.* (2009). Significantly more number of days to 50 per cent flowering (41.26) was recorded in variety GM 3 (V_2) (Table 1). The difference observed in days to 50 per cent flowering between two varieties is only due to its inherent characteristics. Similar observations are also made by Gangaiah and Ahlawat (2008). All yield attributing parameters (Table 2) like pods per plant, number of seeds per pod and test weight were significantly influenced due to different varieties. Significantly higher number of pods per plant (18.23) and test weight (39.68 g) were registered under variety Meha (V_1) as compared to variety GM 3 (V_2). This difference in yield attributing characters between two varieties might be due to genetic constitution of these varieties. These results are in accordance with the findings of those reported by Singh et al. (2009).

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 varieties. The variety Meha (V_1) registered significantly higher seed (1311 kg/ha) and stover yield (3706 kg/ha) as compared to variety GM-3 (V_2) with a seed yield of 1160 kg/ha and stover yield of 2944 kg/ha. This might be 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 Gangaiah and Ahlawat (2008) and Rathi *et al.* (2009). Significantly higher harvest index was recorded under variety GM 3 (28.27) as compared to Meha (26.13). This difference in harvest index may be due to varying capacity of varieties of source-sink relationship. Similar results are also reported by Gangaiah and Ahlawat (2008). An economic analysis of the data revealed that variety (Table 2) V_1 (Meha) secured higher net realization (62182 ₹/ha) and BCR (5.77), while V_2 (GM 3) obtained lower net returns (53108 ₹/ha) and BCR (4.93).

Effect of inorganic fertilizers

Plant height, number of branches per plant and dry matter accumulation per plant (Table 1) were significantly influenced by different inorganic fertilizers. Significantly the taller plant height was recorded by F_1 (100 % RDF) (59.22 cm), which was statistically at par with treatment F_2 (75% RDF) (56.58 cm). Similar results are in accordance with the findings of Chaudhari *et al.* (1998), Singh *et al*. (2004), Ghanshyam *et al*. (2010) and Thenua *et al*. (2010). Maximum number of branches per plant (Table 1) was recorded by 100 per cent RDF (F_1) (3.88), and it was statistically at par with the treatment 75 per cent RDF (F_2) (3.68). These might be due to adequate supply of N and P under higher level. These findings are substantiated with those reported by Patel *et al*. (1992), Chaudhari *et al*. (1998) and Patel *et al.* (2010). Maximum dry matter accumulation per plant was recorded by 100 per cent RDF (F_1) (19.48 g), which was statistically at par with the treatment 75 per cent RDF (F_2) (18.51g). The treatment with 50 per cent RDF (F_3) recorded the lowest dry matter accumulation per plant (14.63 g). These results are also in conformity with the results reported by Kulkarni *et al.* (2000), Singh *et al*. (2004) and Yakardi *et al.* (2004). Significant differences were observed due to different inorganic fertilizers on root nodules per plant (Table 1) at 40 and 60 DAS. The treatment F_1 (100% RDF) recorded maximum number of effective root nodules per plant (29.05), followed by the treatment F_2 (75% RDF) (29.01). The lowest number of root nodules per plant was observed under the treatment F_3 (50% RDF) (22.53). This might be due to beneficial effect of phosphorous on root growth, which provided more root surface for bacterial infection and enhanced the nodulation. Similar observations are also made by Thenua *et al*. (2010) and Singh *et al*. (2011). Treatment F_3 (50% RDF) recorded maximum number of days to 50 per cent flowering (41.78). The treatment F_1 (38.52) recorded minimum number of days to 50 per cent flowering, followed by the treatment F_2 (75% RDF). This might be due to the fulfillment of nutrient requirement leads to early flowering. These results are in accordance with the findings of Chaudhari *et al*. (1998).

The yield attributing parameters like pods per plant, seeds per pod and test weight (Table 2) were significantly influenced by different levels of inorganic fertilizers. Significantly higher number of pods per plant (18.76), seeds per pod (8.01) and test weight (38.21g) were recorded under the treatment F_1 (100% RDF), which was statistically at pat with the treatment F_2 (75% RDF). Both the treatments (F_1 & F_2) were found significantly superior over the treatment F_3 (50% RDF) for these traits. This was largely attributed to better growth of plant which resulted in adequate supply of photosynthates for development of sink under higher level of inorganic fertilizer. Positive response in terms of pods per plant, seeds per pod and test weight to inorganic fertilizers have also been reported by Patel *et al*. (2010) and Patil *et al.* (2011). It is evident from the results presented in Table 2 that there were significant differences in seed and stover yield of greengram due to different inorganic fertilizers. 100 per cent RDF (F_1) registered significantly higher seed (1365 kg/ha) and stover yield (3491 kg/ha), which was statistically at par with treatment F_2 (75% RDF) with respect to stover yield only. Treatment (F_3) (50% RDF) produced the lowest seed (1079 kg/ha) and stover (3111 kg/ha) yield. The results were supported by the findings of Nawange *et al*. (2011) and Singh *et al*. (2011). So far as harvest index is concerned, inorganic fertilizers treatments showed significant effect on this character. This was due to corresponding increase in both seed and stover yield. These results are akin to those reported by Chaudhari *et al.* (1998). Among inorganic fertilizers, F_1 (100% RDF) maintained its superiority by recording the highest net realization (63280 ₹/ha) and BCR (5.29) followed by 75% RDF (F_2). The lowest value of net realization (48806 ₹/ha) and BCR (4.29) were registered with 50% RDF (F_3). Similar results were also reported by Tanwar *et al*. (2010) and Saini and Chongtham (2011).

Effect of biofertilizer

At all the periodical growth stages, plant height, number of branches per plant and dry matter accumulation per plant were significantly influenced by different biofertilizers. Significantly taller plant height was recorded by treatment B_3 (*rhizobium* + PSB) (57.14 cm), which was statistically at par with the treatment B_2 (PSB) (54.76 cm). Treatment B_1 (*rhizobium*) recorded significantly the lowest plant height (51.64 cm) (Table 1). Similarly, maximum number of branches per plant (Table 1) was also recorded by treatment B_3 (*rhizobium* + PSB) (3.72), which was statistically at par with the treatment B_2 (PSB) (3.53). Treatment B_1 (*rhizobium*) recorded the lowest number of branches per plant (3.22). This might be due to dual inoculation benefited the plants by providing atmospheric N and rendering the insoluble phosphorus into available form. The enhanced availability of P favoured N fixation and rate of photosynthesis and consequently led to better plant height and branches per plant. Almost similar findings are also reported by Patel and Patel (1991) and Upadhyay *et al*. (1999). Maximum dry matter accumulation per plant was recorded by the treatment B_3 (*rhizobium* + PSB) (18.53 g) which was significantly at par with treatment B_2 (PSB) (17.62 g). Treatment B_1 (*rhizobium*) recorded the lowest dry matter accumulation per plant (16.46 g). The present results are in accordance with the results of those reported by Sharma *et al*. (2003) and Meena *et al.* (2005). Significant differences were observed due to different biofertilizer on effective root nodules per plant (Table 1) at 40 and 60 DAS. The treatment B_3 (*rhizobium* + PSB) recorded maximum number of effective root nodules plant (28.29), which was remained statistically at par with the treatment B_2 (PSB). The lowest number of root nodules was recorded under the treatment B_1 (*rhizobium*) (24.37). This might be due to more population of *rhizobium* and phosphate solubilizing bacteria and they live in root nodules, their symbiotic relationship with plants and hence number of root nodules increases ultimately with *rhizobium* + phosphate solubilizing bacteria inoculation. Almost similar findings are reported by Balyan *et a*l. (2002) and Prasad *et al*. (2002). Days to 50 per cent flowering was found non significant due to different biofertilizer treatments.

The yield attributing parameters like pods per plant, number of seeds per pod and test weight (Table 2) was significantly influenced by different biofertilizers. Significantly higher number of pods per plant, number of seeds per pod and test weight (18.84, 8.00 and 37.53, respectively) was registered under the treatment B_3, but it was found statistically at par with treatment B_2 with respect to number of seeds per pod (7.82) and test weight (36.44 g) only. Significantly the lowest number of pods per plant, number of seeds per pod and test weight was recorded with the treatment B_1. The results are corroborated the findings of Elkoca *et al.* (2008) and Bhat *et al*. (2010). It is evident from the results presented in Table 2 that treatment B3 (*rhizobium* + PSB) registered significantly higher seed (1345 kg/ha) and stover (3545 kg/ha) yield as compared to other treatments. Treatment B_1 (*rhizobium*) produced the lowest seed (1139 kg/ha) and stover (3100 kg /ha) yield. These might be due to significant and progressive effect of dual inoculation of *rhizobium* + PSB on yield attributes resulted in higher seed and stover yield. Almost similar results are also reported by Dekhane *et al.* (2011) and Sahay *et al*. (2011). So far as harvest index is concerned, biofertilizer treatments showed significant effect on this character. This was due to corresponding increase in both seed and stover yield. These results are corroborated the findings of Singh *et al*. (2004). The results (Table 2) indicated that the highest net realization (63320 ₹/ha) and BCR (5.75) were registered in treatment B_3 (*rhizobium* + PSB) followed by treatment B_2 (PSB). The lowest net realization value (52250 ₹/ha) and BCR (4.79) registered under treatment B_1 (*rhizobium*). These results corroborates with the findings of Patel *et al.* (2010).

Interaction effect

Interaction effects of varieties, inorganic fertilizers and biofertilizers were found to be non-significant in almost all characters except F x B (Table 2) for number of pods per plant and seed yield. The maximum values of number of pods per plant (Table 3) and seed yield (Table 4)were observed with the treatment combination of F_1B_3 (100 per cent RDF with dual inoculation of *rhizobium* and PSB) followed by the treatment combination F_1B_2 (100 per cent RDF with PSB inoculation), F_1B_1 (100 per cent RDF with *rhizobium* inoculation), F_2B_3 (75 per cent RDF with dual inoculation of *rhizobium* and PSB) and F_2B_2 (75 per cent RDF with PSB inoculation) indicating 25 per cent saving of inorganic fertilizer through use of dual inoculation of *rhizobium* and PSB. Almost similar findings were also reported by Sammauria *et al*. (2009) and Gajbhiye *et al.* (2011) with respect to pods per plant and seed yield. Looking to the economics of variety, Meha (V_1) recorded maximum net return (75392 ₹/ha), when fertilized with the application of 100 per cent RDF and inoculated with *rhizobium* + PSB followed by variety GM 3. The net realization of 63206 ₹/ha was noticed under variety GM 3 under similar treatment with refer to BCR, Meha also recorded maximum value of 6.18. These results are in conformity with those reported by Tanwar *et al*. (2010) and Patel *et al.* (2012) with respect to higher net income and BCR.

CONCLUSION

Based on the results from the experimentation, it can be concluded that during summer season, greengram cultivar cv. Meha performed best fertilized with 100 per cent RDF (20-40-0 kg NPK/ha) with dual seed inoculation of *rhizobium* and PSB. This treatment combination found more productive and economical, which closely followed by the treatment combination of 75 per cent RDF with dual inoculation of *rhizobium* & PSB and 75 per cent RDF with seed inoculation with PSB indicating 25 per cent saving of inorganic fertilizer through use of dual inoculation of *rhizobium* and PSB or PSB alone.

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Table 1 : Growth parameters and yield attributes of *rabi* dhaincha as influenced by various Treatments

Treatment	Plant Height (cm)	Number of Branches per Plant	Number of Root Nodules per Plant			Dry Matter Accumulation (g)	Days to 50% Flowering
			20 DAS	40 DAS	60 DAS		
Variety (V)							
V_1 =Meha	57.35	3.71	10.47	21.97	27.85	18.69	38.04
V_2 =GM-3	51.68	3.27	9.94	20.61	25.88	16.37	41.26
S. Em. ±	0.951	0.08	0.19	0.47	0.69	0.39	0.63
C.D. (P=0.05)	2.73	0.23	NS	NS	NS	1.11	1.80
Inorganic Fertilizer (F)							
F_1 (100% RDF)	59.22	3.88	10.49	22.79	29.05	19.48	38.52
F_2 (75% RDF)	56.58	3.68	10.22	22.77	29.01	18.51	38.67
F_3 (50% RDF)	47.75	2.90	9.9	18.30	22.53	14.63	41.78
S. Em. ±	1.17	0.10	0.23	0.58	0.84	0.47	0.77
C.D. (P=0.05)	3.35	0.28	NS	1.66	2.41	1.36	2.20
Biofertilizer (B)							
B_1 = *Rhizobium*	51.64	3.22	10.11	19.57	24.37	16.46	39.61
B_2 = PSB	54.76	3.53	10.12	22.03	27.94	17.62	39.39
B_3 = *Rhizobium* + PSB	57.14	3.72	10.38	22.27	28.29	18.53	39.95
S. Em. ±	1.17	0.10	0.23	0.58	0.84	0.47	0.77
C.D. (P=0.05)	3.35	0.28	NS	1.66	2.41	1.36	NS
CV%	9.07	11.86	9.58	11.54	13.26	11.45	8.19
Interaction							
VXF	NS	NS	NS	NS	NS	NS	NS
VXB	NS	NS	NS	NS	NS	NS	NS
FXB	NS	NS	NS	NS	NS	NS	NS
VXFXB	NS	NS	NS	NS	NS	NS	NS
Control $_1$ (Meha)Vs rest	49.47	3.08	8.68	18.89	23.39	15.06	45.33
Control$_2$ (GM-3) Vs rest	44.27	2.67	8.53	16.51	19.93	12.79	47.00
S.Em.±	1.17	0.09	0.23	0.56	0.81	0.452	0.73
C.D. (P=0.05)	3.35	0.27	0.67	1.61	2.33	1.29	2.10
CV%	9.09	11.96	10.13	11.69	13.47	11.46	7.92

Table 2 : Yield attributes and yield of greengram as influenced by various treatments.

Treatment	No. of Pods per Plant	Number of Seeds per Pod	Seed Index (g)	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Harvest Index (%)	Net Realization (₹/ha)	BCR
Variety (V)								
V_1 =Meha	18.23	7.84	39.68	1311	3706	26.13	62182	5.77
V_2 =GM-3	15.51	7.59	31.83	1160	2944	28.27	53108	4.93
S. Em. ±	0.44	0.11	0.71	24.36	49.45	0.46	-	-
C.D. (P=0.05)	1.26	NS	2.03	70.02	142.12	1.33	-	-
Inorganic Fertilizer (F)								
F_1 (100% RDF)	18.76	8.01	38.21	1365	3491	28.11	63280	5.29
F_2 (75% RDF)	17.79	7.95	36.31	1263	3373	27.24	58237	5.00
F_3 (50% RDF)	14.05	7.18	32.75	1079	3111	25.75	48806	4.29
S. Em. ±	0.54	0.14	0.87	29.84	60.57	0.57	-	-
C.D. (P=0.05)	1.55	0.40	2.49	85.81	174.07	1.63	-	-
Biofertilizer (B)								
B_1 = *Rhizobium*	15.12	7.33	33.30	1139	3100	26.87	52250	4.79
B_2 = PSB	16.66	7.82	36.44	1224	3331	26.87	56962	5.23
B_3 = *Rhizobium* + PSB	18.84	8.00	37.53	1345	3545	27.51	63320	5.75
S. Em. ±	0.54	0.14	0.87	29.84	60.57	0.57	-	-
C.D. (P=0.05)	1.55	0.40	2.49	85.81	174.07	NS	-	-
CV%	13.53	7.58	10.27	10.24	7.73	8.86	-	-
Interaction								
VXF	NS	NS	NS	NS	NS	NS	-	-
VXB	NS	NS	NS	NS	NS	NS	-	-
FXB	S	NS	NS	S	NS	NS	-	-
VXFXB	NS	NS	NS	NS	NS	NS	-	-
$Control_1$ (Meha)Vs rest	15.27	7.52	30.23	1147	2750	29.39	-	-
$Control_2$ (GM-3) Vs rest	13.11	7.12	32.05	1027	2898	26.19	-	-
S.Em.±	0.52	0.13	0.82	28.91	57.65	0.54	-	-
C.D. (P=0.05)	1.49	0.38	2.35	82.78	165.05	1.56	-	-
CV%	13.68	7.51	10.13	10.32	7.67	8.71	-	-

Selling rate of product : Greengram Seed : ₹ 50 kg^{-1} Greengram Stover : ₹ 2 kg^{-1}

Table 3 :Number of pods per plant due to F X B interaction

Treatment	**Biofertilizer**		
Inorganic Fertilizer	B_1 = *Rhizobium*	B_2 = PSB	B_3 = *Rhizobium* + PSB
F_1 (100% RDF)	16.94	17.71	18.80
F_2 (75% RDF)	16.46	17.23	18.32
F_3 (50% RDF)	14.59	15.36	16.46
S.Em.±	0.93		
C.D. (P=0.05)	2.67		

Table 4 : Seed yield as influenced due to F x B interaction

Treatment	**Biofertilizer**		
Inorganic Fertilizer	B_1 = *Rhizobium*	B_2 = PSB	B_3 = *Rhizobium* + PSB
F_1 (100% RDF)	1252	1295	1355
F_2 (75% RDF)	1201	1244	1304
F_3 (50% RDF)	1109	1152	1212
S.Em.±	51.68		
C.D. (P=0.05)	148.64		

[MS received: March 10, 2013] *[MS accepted: April 18,2013]*