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EFFECT OF ROW SPACING, VARIETY AND FOLIAR SPRAY ON QUALITY, NUTRIENT CONTENT AND UPTAKE OF SUMMER GREEN GRAM (*Vigna radiata* L.) UNDER SOUTH GUJARAT CONDITION

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ABSTRACT

A field experiment was conducted during summer season of 2019 on College Farm, Navsari Agricultural University, Navsari on heavy black soil consisting 12 treatments combinations in Randomized block design with factorial concept with three replications. The results revealed that the highest yield and net return of summer green gram was obtained with sowing of GM-7 variety with 30 cm row spacing along with foliar spray of 2 % Enriched banana pseudostem sap. Sowing of green gram at 30 cm row spacing showed significantly higher protein yield (323.07 kg ha^{-1}), seed yield (1408 kg ha^{-1}), haulm yield (2252 kg ha^{-1}), nutrients content and uptake by seed and haulm and maximum net realization of Rs.75673 ha^{-1} with BCR of 3.35. The variety GM-7 gave significantly higher protein yield (277.88 kg ha^{-1}), seed yield (1213 kg ha^{-1}), haulm yield (1945 kg ha^{-1}), nutrients content, uptake by seed and haulm and maximum net realization of Rs. 62597 ha^{-1} with highest BCR 2.83. The foliar spray of 2 % enriched banana pseudostem sap gave significantly higher protein yield (313.92 kg ha^{-1}), seed yield (1352 kg ha^{-1}), haulm yield (2280 kg ha^{-1}), nutrients content, uptake and maximum net realization of Rs. 68660 ha^{-1} with highest BCR 2.63 which remained statistically at par with foliar spray of 2 % Urea. For getting profitable yield of summer green gram can be obtained by sowing GM-7 variety at 30 cm row spacing and foliar spray application of 2 % enriched banana pseudostem sap with recommended dose of fertilizer i.e. 20: 40: 00 N:P_2O_5:K_2O kg ha^{-1} under south Gujarat conditions.

(Key words: Green gram, variety, row spacing, foliar spray, quality, nutrient content and uptake)

INTRODUCTION

Green gram (*Vigna radiata* L.) is one of the most ancient and extensively grown leguminous crops of India. Its native is India and Central Asia and commonly known as mung bean. It is a third important pulse crop after chickpea and pigeonpea, cultivated throughout India for its multipurpose uses as vegetable, pulse, fodder and green manure crop. In India, green gram occupies a total area of 34.37 lakh hectares with the total production of 17.83 lakh tonnes with an average production of 519 kg ha^{-1} and in Gujarat it occupy 0.90 lakh hectares area with production of 0.55 lakh tonnes with an average productivity of 611 kg ha^{-1} in the year 2019-20 (Anonymous, 2020). Green gram has the potential of producing higher seed yield from 1295 to 2261 kg ha^{-1} depending on the genotypes studied. Optimum row spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and can easily be attacked by diseases. Foliar application of nutrients using water soluble fertilizer is one of the possible ways to enhance the productivity of pulses like green gram. Looking into importance of foliar spray of nutrients in enhancing crop productivity of various field crops, a field experiment was conducted with the objective of studying the green gram productivity enhancement through foliar spray of nutrients. Hence, an attempt had been made to study the suitability of both varieties in summer season with row spacing and foliar feeding.

MATERIALS AND METHODS

The field experiment was conducted during summer season of 2019 at the College Farm, Navsari Agricultural University, Navsari, Gujarat. The weekly mean maximum and minimum temperature varied from 31.6 ^{0}C to 39.4 ^{0}C and 12.2 ^{0}C to 24.1 ^{0}C, respectively during the course of investigation. The relative humidity ranged from 80.7 to 94.2 per cent at morning and 38.6 to 65.3 per cent at evening. Bright sunshine hours day^{-1} available in the range of 7.5 to 10.8 were available during the crop period. The evaporation ranged from minimum 4.7 mm to 6.8 mm maximum during the crop period. The soil of the experimental field was clayey in texture having medium to poor drainage, soil pH 7.77, EC

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0.68 dS m^{-1} and organic carbon content 0.52 % with low in available nitrogen (195.34 kg ha^{-1}), medium in available phosphorus (22.45 kg ha^{-1}) and very high in available potassium (302.36 kg ha^{-1}) and slightly alkaline in reaction. The experiment was laid out in RBD (Factorial concept) design with 12 treatment combinations consisting of three factors i.e. two varieties (V_1- GM-6 and V_2- GM-7), two row spacing (S_1- 30 cm and S_2- 45 cm) and three foliar sprays [F_1- Water spray (Control), F_2- 2 % Urea and F_3- 2 % enriched banana pseudostem sap] replicated three times. The entire dose of fertilizer was 20-40-00 N:P_2O_5:K_2O kg ha^{-1}. Foliar sprays of water spray (Control), 2 % Urea and 2 % Enriched banana pseudostem sap were given at 31 DAS and 46 DAS.

The data on seed and stover yield was recorded from the net plot and converted on a hectare basis. The nitrogen content in green gram seed was estimated by micro Kjeldahl's method as described by Jackson (1973). The protein content of the seed was computed by multiplying the nitrogen percentage with 6.25 for each treatment. Chemical studies about nitrogen, phosphorus, potassium content and their uptake by seed and stover and available nitrogen, phosphorus, potassium status in the soil after harvest of the crop were determined as per different methods *viz.,* Modified Kjeldahl's method (For N), Wet digestion (Diacid) Vanado molybdo phosphoric acid yellow colour method (for P) and Flame photometric method (for K). The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1973). The purpose of the analysis of variance was to determine the significant effect of treatments on green gram. Uptake of nutrients by seed and plant was calculated by using following formula:

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)} \times \text{seed / haulm yield (kg ha}^{-1})}{100}$$

RESULTS AND DISCUSSION

Effect of variety

Yield

The result pertaining to yield (Table 1) showed significant response for seed yield and haulm yield of green gram were influenced due to different variety. Significantly higher seed yield (1318 kg ha^{-1}) and haulm yield (2301 kg ha^{-1}) was observed with treatment V_2 (GM-7) as compared to treatment V_1 (GM-6). This was due to better performance of GM-7 in terms of growth parameters and yield attributes resulted into higher seed yield and haulm yield as compared to GM-6. Dash and Rautaray (2017) reported that Pusa Vishal variety gave significantly the highest seed (11.18 q ha^{-1}) and stover yield (48.96 q ha^{-1}) over TARM-1, IPM-02-14, SML-668 and local varieties.

Quality parameters

The data of Table 1 indicated that protein content was not differed significantly due to different varieties. Numerically higher protein content (15.70 per cent) was recorded by variety GM-7 (V_2) than that of variety GM-6 (15.48 per cent). However, protein yield was significantly influenced due to different variety. The treatment V_2 (GM-7) recorded significantly higher protein yield as compared to treatment V_1 (GM-6). It might be due to higher seed yield obtained by treatment GM-7 resulted in higher protein yield as compared to treatment GM-6. Similar reasons have also been reported by Verma *et al.* (2011) for HUM-12 variety, this variety gave the highest protein content and protein yield as compared to K-851 and NDM-1 varieties.

Nutrient content and uptake

An appraisal of data given in Table 2 and 3 revealed that no significant difference was observed in nitrogen, phosphorus and potassium content in seed and haulm and phosphorus uptake by seed due to different varieties. However, significantly higher nitrogen and potassium uptake by seed and nitrogen, phosphorus and potassium uptake by haulm were recorded by treatment V_2 (GM-7) as compared to treatment V_1 (GM-6). This might be due to higher seed and haulm yield obtained by treatment GM-7 as compared to treatment GM-6. These results are in accordance with these reported by Akhila *et al.* (2017) for CO-4 variety. This variety gave the highest N, P and K uptake by seed and stover.

Available nutrient in soil after harvest

The data shown in Table 4 indicated that the effect of different variety on available nitrogen, phosphorus and potassium in soil after harvest of the crop were found non-significant. This might be due to adequate nutrient supply through fertilizer application and continuous transformation of nutrient from soil reserve. These results are in accordance with those reported by Akhila *et al.* (2017) for GBM-1 and CO-4 variety. These varieties gave the highest available nitrogen, phosphorus and potassium in soil.

Economics

It is obvious from the data reported in Table 1 that the maximum net realization (Rs. 69608 ha^{-1}) and BCR (3.03) was obtained by treatment V_2 (GM-7) over treatment V_1 (GM-6) which realized minimum net realization (Rs. 61715 ha^{-1}) and BCR (2.69). This might be due to the higher yields produced by treatment V_2 (GM-7) of green gram. The results are close conformity to these obtained by Jnanesha *et al.* (2019) for SML 668. This variety gave the highest gross return, net return and B:C ratio.

Mendhekar *et al.* (2019) recorded highest gross monetary returns of Rs. 56028 ha^{-1} and net monetary returns of Rs. 40303 ha^{-1} and B:C ratio of 3.56 with variety AKS-207 which was at par to variety Bhima and found significantly superior over PKV (Pink) and AKS-311 in safflower.

Effect of row spacing

Yield

The result pertaining to yield (Table 1) showed that seed and haulm yield of green gram were influenced significantly due to different row spacing. Significantly higher seed yield (1408 kg ha^{-1}) and haulm yield (2252 kg

ha^{-1}) found under row spacing of 30 cm (S_1) over row spacing of 45 cm (S_2). This might be due to fact that proper row spacing or plant population might be attributed to minimum intra row species competition in crop plants and proper utilization of natural resources i.e. space, light, moisture and nutrients which might have remained underutilized due to mutual plant competition developed by more plants in closer row spacing. These results are also in agreement with finding of Sanap *et al.* (2019). They recorded that highest grain yield (26.64 q ha^{-1}) and straw yield (39.91 q ha^{-1}) with drilling distance of 25 cm and found significantly superior over drilling distance of 20 cm but at par with 30 cm drilling distance.

Quality parameters

The data presented in Table 1 showed that different row spacing of green gram crop did not produced protein content in seed significantly, but it was significantly affected on protein yield. Significantly higher protein yield (218.81 kg ha^{-1}) was produced by row spacing of 30 cm (S_1) as compared to row spacing of 45 cm (S_2). The increase in protein yield might be due to increase in seed yield. Gohil *et al*. (2017) recorded highest protein content and yield by row spacing of 30 cm in green gram .

Nutrient content and uptake

An appraisal of data given in Table 2 and 3 revealed that different row spacing were not significantly influenced on N, P and K content in seed and haulm. The result showed that row spacing of 30 cm (S_1) recorded significantly higher N, P and K uptake by seed (35.01, 8.57 and 17.71 kg ha^{-1}, respectively) and N, P and K uptake by haulm (6.15, 11.49 and 42.53 kg ha^{-1}, respectively) as compared to row spacing of 45 cm (S_2). This increase in N, P and K uptake by seed and haulm might be due to cumulative effect of increased seed and haulm yield. The findings are in accordance with those of Gohil *et al.* (2017) for the highest N, P and K content and uptake in seed and haulm under 30 cm row spacing in green gram.

Available nutrient in soil after harvest

The different row spacing was influenced non-significant effect on available N, available P_2O_5 and available K_2O in the soil after harvest of green gram crop. Gohil *et al.* (2017) recorded highest available N, available P_2O_5 and available K_2O in the soil after harvest under 30 cm row spacing.

Economics

The result presented in Table 1 indicated that the maximum net realization (Rs. 74271 ha^{-1}) and BCR (3.09) obtained from 30 cm row spacing. This might be due to higher yields of green gram under 30 cm narrow row spacing. Similar economics benefit of row spacing was reported by Bunkar *et al.* (2012),who recorded that 30 cm of row spacing produced significantly highest net return (Rs. 42,732 ha^{-1}) and B:C ratio (2.58) over 15 and 45 cm row spacing in mungbean.

Effect of foliar spray

Yield

It is evident from the results presented in Table 1 that application of different foliar spray had significant differences on seed yield and haulm yield of green gram. Significantly higher seed yield (1352 kg ha^{-1}) and haulm yield (2280 kg ha^{-1}) was recorded under foliar spray of 2 % enriched banana pseudostem sap (F_3) which was statistically at par with 2 % urea foliar spray (F_2) i.e., seed yield (1286 kg ha^{-1}) and haulm yield (2153 kg ha^{-1}). Foliar spray of water (F_1) recorded significantly the lowest seed yield (1158 kg ha^{-1}) and haulm yield (1936 kg ha^{-1}). The overall improvement in all the growth and yield attributing components might be due to synergistic effect of foliar application at critical crop growth stage. The results were supported by the findings of Patel *et al.* (2017),who recorded significantly highest seed yield (1139 kg ha^{-1}) under spraying of novel liquid fertilizer at 10 ml $liter^{-1}$ of water at branching and flowering, but it was at par with spraying of novel liquid fertilizer at 10 ml $liter^{-1}$ of water at flowering stage. Haulm yield (2368 kg ha^{-1}) of green gram was found numerically higher under spraying of novel liquid fertilizer at 10 ml $liter^{-1}$ of water at branching and flowering.

Deotale *et al*. (2005) reported that foliar spray combination of IAA (50 ppm)+ DAP or urea (2 %), NAA (50 ppm) + DAP or urea (2 %), IAA (50 ppm) or NAA (50 ppm) individually and 6% cow urine + DAP or urea (2 %) along with basal 1/2 RDF (10:20:00 kg NPK ha^{1}) were most effective in increasing yield of green gram over the RDF (20:40:00 kg NPK ha^{1}).

Quality parameters

The data presented in Table 1 showed that different foliar spray on green gram crop did not produced significant effect on protein content in seed, but it was significantly affected on protein yield. Significantly higher protein yield (212.04 kg ha^{-1}) was recorded under foliar application of 2 % enriched banana pseudostem sap (F_3) which was statistically at par with 2 % urea foliar spray (F_2) i.e., 200.85 kg ha^{-1}. Similar results were found by Verma *et al.* (2011) for the highest protein content and yield under foliar spray application of 2 % urea in green gram.

Titare *et al.* (2006) recorded the maximum seed protein content of green gram with 1/2 RDF [recommended dose of fertilizer, i.e. 20:40:00 kg NPK ha^{-1}] + 2% DAP + 50 ppm IAA.

Nutrient content and uptake

The content of nitrogen, phosphorus and potassium in seed as well as in haulm was not affected significantly due to different foliar spray. However, uptake of these nutrients was affected significantly due to different foliar application (Table 2 and 3). Treatment F_3 (2 % enriched banana pseudostem sap) showed superiority over rest of the foliar spray treatments *viz*., F_2 (2 % urea foliar spray) and F_1 (water spray). The higher removal of nitrogen, phosphorus and potassium with this treatment might be due to better development of root and shoot resulted in higher nitrogen, phosphorus and potassium uptake. These results are in accordance with the results of Lakshmi *et al.* (2018), who reported that foliar application of 2% Urea, 2% DAP and 1% KNO_3 as a foliar spray gave highest N, P and K uptake.

Table 1. Effect of variety, row spacing and foliar spray on quality parameter, yield and economics on green gram

Treatments	Protein content(%)	Protein yield (kg ha^{-1})	Yield (kg ha^{-1})		Gross realization (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net realization (₹ ha^{-1})	B:C ratio
			Seed	Haulm				
Variety (V)								
V_1: GM-6	22.85	277.88	1213	1945	84680	22083	62597	2.83
V_2: GM-7	23.06	304.05	1318	2301	92573	22083	70490	3.19
S Em. ±	0.32	8.55	28	47	—	—	—	—
C D at 5 %	-	25.06	81	139	—	—	—	—
Row Spacing (S)								
S_1: 30 cm	22.90	323.07	1408	2252	98276	22603	75673	3.35
S_2: 45 cm	23.00	258.87	1122	1994	78912	22083	56829	2.57
S Em. ±	0.32	8.55	28	47	—	—	—	—
C D at 5 %	-	25.06	81	139	—	—	—	—
Foliar Spray (F)								
F_1: Water spray (Control)	22.61	261.49	1158	1936	81078	23564	57514	2.44
F_2: 2 % Urea	23.07	297.50	1286	2153	90049	23687	66362	2.80
F_3: 2 % Enriched banana pseudostem sap	23.18	313.92	1352	2280	94720	26060	68660	2.63
S Em. ±	0.39	10.47	34	58	—	—	—	—
C D at 5 %	-	30.69	99	170	—	—	—	—
C V %	5.82	12.46	9	9	—	—	—	—
Interaction								
V x S								
S Em. ±	0.45	12.08	39.05	66.99-				
C D at 5 %	-	-	-	-	-	-	-	-
S x F								
S Em. ±	0.55	14.80	47.83	82.04				
C D at 5 %	-	-	-	-	-	-	-	-
F x V								
S Em. ±	0.55	14.80	47.83	82.04				
C D at 5 %	-	-	-	-	-	-	-	-
V x S x F								
S Em. ±	0.77	20.93	67.64	116.0				
C D at 5 %	-	-	-	-	-	-	-	-

Table 2. Nutrient content and uptake by summer green gram as influenced by variety, row spacing and foliar spray

Treatments	N, P and K content (%)					
	Seed			Haulm		
	N	P	K	N	P	K
Variety (V)						
V_1: GM-6	3.66	0.61	1.26	0.28	0.51	1.10
V2: GM-7	3.69	0.62	1.27	0.28	0.51	1.12
S Em. ±	0.05	0.009	0.02	0.004	0.01	0.02
C D at 5 %	-	-	-	-	-	-
Row Spacing (S)						
S_1: 30 cm	3.66	0.61	1.26	0.27	0.51	1.09
S_2: 45 cm	3.68	0.62	1.28	0.28	0.52	1.13
S Em. ±	0.05	0.009	0.02	0.004	0.01	0.02
C D at 5 %	-	-	-	-	-	-
Foliar Spray (F)						
F1: Water spray						
(Control)	3.62	0.61	1.25	0.27	0.51	1.09
F_2: 2 % Urea	3.69	0.62	1.27	0.28	0.51	1.11
F_3: 2 % Enriched banana						
pseudostem sap	3.71	0.62	1.28	0.28	0.52	1.15
S Em. ±	0.06	0.01	0.02	0.005	0.01	0.02
C D at 5 %	-	-	-	-	-	-
C V %	5.82	6.05	5.45	6.16	5.66	6.55
Interaction						
V x S						
S Em. ±	0.07	0.01	0.02	0.01	0.01	0.02
C D at 5 %	-	-	-	-	-	-
S x F						
S Em. ±	0.09	0.02	0.03	0.01	0.01	0.03
C D at 5 %	-	-	-	-	-	-
F x V						
S Em. ±	0.09	0.02	0.03	0.01	0.01	0.03
C D at 5 %	-	-	-	-	-	-
V x S x F						
S Em. ±	0.12	0.02	0.04	0.01	0.02	0.04
C D at 5 %	-	-	-	-	-	-

Table 3. Nutrient uptake by summer green gram as influenced by variety, row spacing and foliar spray

Treatments	N P and K content (%)					
	Seed			Haulm		
	N	P	K	N	P	K
Variety (V)						
V_1: GM-6	44.46	7.44	15.33	5.36	9.91	21.42
V2: GM-7	48.64	8.11	16.76	6.40	11.87	25.89
S Em. ±	1.37	0.23	0.44	0.15	0.34	0.58
C D at 5 %	4.01	-	1.29	0.45	1.00	1.71
Row Spacing (S)						
S_1: 30 cm	51.69	8.57	17.71	6.15	11.49	24.75
S_2: 45 cm	41.42	6.98	14.38	5.60	10.28	22.56
S Em. ±	1.37	0.23	0.44	0.15	0.34	0.58
C D at 5 %	4.01	0.68	1.29	0.45	1.00	1.71
Foliar Spray (F)						
F1: Water spray (Control)	41.84	7.02	14.49	5.28	9.81	21.00
F_2: 2 % Urea	47.60	7.91	16.27	5.95	11.06	23.84
F_3: 2 % Enriched banana pseudostem sap	50.22	8.40	17.37	6.40	11.79	26.13
S Em. ±	1.67	0.28	0.54	0.19	0.42	0.71
C D at 5 %	4.91	0.83	1.59	0.55	1.23	2.09
C V %	12.46	12.62	11.67	11.05	13.29	10.45
Interaction						
V x S						
S Em. ±	1.13	0.33	0.62	0.22	0.48	0.82
C D at 5 %	-	-	-	-	-	-
S x F						
S Em. ±	1.38	0.33	0.76	0.27	0.59	1.01
C D at 5 %	-	-	-	-	-	
F x V						
S Em. ±	1.38	0.40	0.76	0.27	0.59	1.01
C D at 5 %	-	-	-	-	-	-
V x S x F						
S Em. ±	1.95	0.57	1.08	0.38	0.84	1.43
C D at 5 %	-	-	-	-	-	-

Table 4. Effect of row spacing and foliar spray on available nutrient in soil after harvest summer green gram varieties

Treatments	Available N (kg ha^{-1})	Available P_2O_5(kg ha^{-1})	Available K_2O (kg ha^{-1})
Variety (V)			
V_1: GM-6	219.01	25.37	220.95
V_2: GM-7	221.91	26.08	220.10
S Em. ±	5.20	0.59	4.33
C D at 5 %	-	-	-
Row Spacing (S)			
S_1: 30 cm	215.56	25.16	219.48
S_2: 45 cm	225.37	26.28	221.57
S Em. ±	5.20	0.59	4.33
C D at 5 %	-	-	-
Foliar Spray (F)			
F_1: Water spray (Control)	220.03	26.72	223.15
F_2: 2 % Urea	220.35	25.30	219.02
F_3: 2 % Enriched banana pseudostem sap	221.01	25.15	219.41
S Em. ±	6.37	0.72	5.30
C D at 5 %	-	-	-
C V %	10.01	9.74	8.33
Interaction	-	-	-
V x S			
S Em. ±	7.36	0.84	8.55
C D at 5 %	—	—	—
S x F			
S Em. ±	9.01	1.02	10.47
C D at 5 %	-	—	—
F x V			
S Em. ±	9.01	1.02	10.47
C D at 5 %	-	—	—
V x S x F			
S Em. ±	12.44	1.45	14.81
C D at 5 %	-	—	-

Available nutrient in soil after harvest

The different foliar applications were influenced non-significant effect on available N, available P_2O_5 and available K_2O in the soil after harvest of green gram crop.

Economics

An economic analysis of the data (Table 1) revealed that application of 2 % Enriched banana pseudostem sap (F_3) maintained its superiority by recording the highest net realization (Rs.70885 ha^{-1}) and BCR (2.97) followed by 2 % Urea foliar spray (F_2). The lowest value of net realization (Rs. 58113 ha^{-1}) and BCR (2.53) was registered with water spray (Control) (F_1). Similar results were also reported by Patel *et al.* (2017), who recorded maximum net realization of Rs. 52631 ha^{-1} with BCR of 3.43 under spraying of novel liquid fertilizer at 10 ml $liter^{-1}$ of water at branching and flowering stage which was followed by net realization of Rs. 46335 ha^{-1} with BCR of 3.21 under spraying of Novel liquid fertilizer at 10 ml $liter^{-1}$ of water at flowering.

For getting profitable yield of summer green gram can be obtained by sowing GM-7 variety at 30 cm row spacing and foliar spray application of 2 % enriched banana pseudostem sap with recommended dose of fertilizer i.e. 20: 40: 00 N:P_2O_5:K_2O kg ha^{-1} under south Gujarat conditions.

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