

## Effect of Cultural Practices and Integrated Nutrient Management in Green gram cv. BGS-9 on Plant Growth and Seed Yield Parameters

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**ABSTRACT:** A field experiment was conducted during the summer season of 2016-17 to study the effect of dates of sowing, planting geometry and integrated nutrient management in green gram (*Vigna radiata*) cv. BGS-9 during the summer season on plant growth attributing characters. Six levels of fertiliser doses, three different dates of sowing and three spacing levels were imposed along with control under split plot design with three replications. Field data were recorded on plant height at 30, 60 DAS and at harvest, number of branches per plant, days to 50 per cent flowering, pod length, number of pods per plant and seed yield per hectare. Results revealed that all the characters significantly differ among the treatments. Early sowing during summer *i.e.* on March 30<sup>th</sup> with the spacing of 30 x 10 cm and seeds treated with rhizobium (20g kg<sup>-1</sup> of seeds) and phosphate solubilising bacteria (20g kg<sup>-1</sup> of seeds) + 100 % recommended dose of fertilizer (RDF) as basal + borax spray (100 ppm) at flower initiation was recorded higher plant height at 30, 60 days after sowing (DAS) and at harvest [(30.86, 39.42 and 44.04 cm), (30.12, 39.50 and 43.88 cm), (30.17, 40.04 and 44.33 cm, respectively)], maximum number of branches per plant (4.33, 4.45 and 4.39, respectively), lesser number of days to taken 50 per cent flowering (33.76, 33.65 and 29.54, respectively), highest pod length (10.33 cm, 10.41 cm and 10.42 cm, respectively), maximum number of pods per plant (12.93, 12.84 and 14.84, respectively) and higher seed yield per hectare (682 kg, 676 kg and 751 kg, respectively). Early sowing on March 30<sup>th</sup> with the spacing of 30 x 10 cm and seed treatment with rhizobium and phosphate solubilising bacteria (PSB) + RDF as a basal + borax spray (100 ppm) at flower initiation stage found best among all the treatment combinations for achieving higher plant growth and higher yield

**Keywords:** Green gram, Rhizobium, Plant growth, Spacing, Date of sowing, Phosphate solubilizing bacteria, Season, Seed yield

Green gram {*Vigna radiate* (L.) Wilczek} is one of the most ancient and extensively grown leguminous crops of India. According to Vavilov [1], it is a native of India and Central Asia. It is a short duration crop and rich in protein and vitamin B. In India, it is cultivated in Maharashtra, Andhra Pradesh, Rajasthan, Orissa and Karnataka. It can be grown under a wide range of soil types. It is usually grown as rainfed crop and can also be grown as pre-monsoon and late monsoon crop. It occupies an area of 3.0 million area with a production of 1.24 million tonnes and the average productivity of 425 kg per ha. Whereas, in Karnataka, it occupies an area of about 5.28 lakh ha with production of about 1.08 lakh tonnes and the average productivity of 205 kg per ha [2]. The factors attributed to low yields of pulses in India is mainly due to non-availability of quality seeds of improved and short duration varieties. Hence, there is a

scope for improving the production potential of this crop by use of organic manures, inorganic manures and bio-fertilizers.

The use of biofertilizers can be more eco-friendly. They can play a significant role in fixing atmospheric nitrogen, production of plant growth promoting substances and making phosphorus available to plants by bringing about a favourable change in soil micro-environment leading to solubilization of insoluble organic phosphate sources. Microbial organic acids can dissolve fixed phosphate. The application of bio-fertiliser is essential because the insoluble phosphate which is not directly available to plants comprises around 95-99 per cent of the total soil phosphorous [3].

The basic concept of integrated nutrient management is the supply of the required plant nutrients for sustaining

the desired crop productivity with minimum deleterious effect on soil health environment. Integrated nutrient management intended for four major goals to be achieved. These are; to maintain soil productivity, to ensure sustainable productivity, to prevent degradation of the environment and to reduce expenditure on the cost of chemical fertilisers. The production and productivity of green gram are reported to be low in the northern eastern transition zone of Karnataka due to non-availability of suitable green gram variety for late summer-sown conditions. The yield ability of green gram is mainly dependent on the date of sowing. Hence, new green gram variety BGS-9 evaluated with three dates of sowing to standardise the time of sowing during summer situation.

## MATERIALS AND METHODS

The field experiment was conducted, during March 2016, which coincides with the summer season. The objective of the study is to investigate the effect of date of sowing, spacing and integrated nutrient management in green gram (*Vigna radiata* (L.) Wilczek) cv. BGS-9 on seed yield attributing characters. The field trial was laid in plot size of 4.0 x 2.5m in split plot design with three replications each of the treatments. Six different fertilizer levels viz., 100 % recommended dose of fertilizer (RDF) as basal (25kg N + 50kg P<sub>2</sub>O<sub>5</sub>/ha), seed treatment with rhizobium and phosphate solubilizing bacteria (PSB) alone, seed treatment with rhizobium and phosphate solubilizing bacteria + RDF as basal, seed treatment with rhizobium and PSB + 150% RDF as basal, seed treatment with rhizobium and PSB + RDF as basal + borax spray (100 ppm) at flower initiation along with control (without basal fertilizer, seed treatments and borax spray). The crop was raised in three different spacings between plants viz., 25 x 10 cm, 30 x 7 cm, 30 x 10 cm (between rows x between plants) and on three different sowing dates viz., 20<sup>th</sup> March 2016, 30<sup>th</sup> March 2016 and 10<sup>th</sup> April 2016.

## RESULTS AND DISCUSSION

### Effect on Growth Attributes

Significantly higher plant height at 30, 60 days after sowing (DAS) and harvest was recorded in seeds sown on 30<sup>th</sup> March (30.86, 39.42 and 44.04 cm), with spacing S<sub>3</sub> (30.12, 39.50 and 43.88 cm) and seed treatment with (F<sub>6</sub>) seeds treated with rhizobium and phosphate solubilising

bacteria (PSB) + RDF as basal dose + borax spray (100 ppm) at flower initiation (30.17, 40.04 and 44.33 cm). While, lower plant height was recorded in date of sowing D<sub>3</sub> (21.10, 38.39 and 43.16 cm), with a spacing of S<sub>1</sub> (30.12, 39.50 and 43.88 cm) and seeds treated with F<sub>1</sub>- no fertiliser application (27.98, 37.44 and 42.76 cm) (Table 1, 2 & 3). The increase in plant height was possibly attributed to intermodal elongation by cell division and synthesis of higher photosynthates due to an optimum dose of NPK and availability of energy sources for a prolonged time from an integrated source of nutrient and due to fixation of atmospheric nitrogen by rhizobium and release of phosphorus by addition of PSB [4-5].

Significant difference was recorded for number of branches per plant at harvest it was maximum (4.33) in date of sowing D<sub>2</sub>- 30<sup>th</sup> March, with the spacing S<sub>3</sub> (4.45) and treatment (F<sub>6</sub>) seeds treated with rhizobium and phosphate solubilising bacteria (PSB) + RDF as basal dose + borax spray (100 ppm) at flower initiation (4.39) (Table 4). While, lower number of branches obtained with the date of sowing D<sub>1</sub> - 20<sup>th</sup> March (4.31) and D<sub>3</sub> -10<sup>th</sup> April (4.16) and spacing S<sub>1</sub> (4.16) and S<sub>2</sub> (4.18) and treatment (F<sub>1</sub>) control no fertilizer application (4.21). A number of branches per plant might be due to less inter-nodal elongation and higher nutrient availability [6-7]. This indicated the need for adding organic manures to soil conjunctive with inorganic fertilisers, which increased the availability of nutrients over a long period, have a positive effect on growth parameters [8-9]. Goyal *et al.* [10] in chickpea and Ihsanullah *et al.* [11] in green gram reported that levels low competition for space, mutual shading effect, nutrients and moisture in wider spacing due to reduced plant density per unit area.

A significant difference was recorded in a number of days taken to 50 per cent flowering (Table 5). The lesser number of days in date of sowing D<sub>2</sub> (33.76) and spacing S<sub>3</sub> (33.65) taken for 50 per cent flowering followed by the seeds treated with rhizobium and phosphate solubilising bacteria (PSB) + RDF as a basal dose + borax spray 100 ppm at flower initiation time (data not given) F<sub>6</sub> (29.54). While, number of days (32.27) recorded in case of seeds treated with Rhizobium and phosphate solubilising bacteria (PSB) + RDF + 50 per cent more as the basal dose (F<sub>5</sub>). Induction of early flowering due to the application of bio-fertilizers was mainly ascribed to the process of bioregulators which influence early flower initiation [12].

**Table 1.** Plant height (cm) at 30 DAS as influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Plant height (cm) at 30 DAS							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	27.72	28.39	28.67	28.91	28.91	30.10	28.78	29.41
	S <sub>2</sub> : 30 cm x 7 cm	28.71	29.35	29.37	29.49	30.05	30.90	29.65	
	S <sub>3</sub> : 30 cm x 10 cm	29.01	29.28	29.42	30.00	30.07	31.21	29.83	
	Mean	28.48	29.00	29.15	29.46	29.67	30.73		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	28.30	29.14	29.49	30.02	30.09	30.42	29.58	30.86
	S <sub>2</sub> : 30 cm x 7 cm	28.18	29.13	26.98	30.39	30.31	31.09	29.35	
	S <sub>3</sub> : 30 cm x 10 cm	29.15	29.30	29.73	31.20	30.98	31.59	30.33	
	Mean	28.54	29.19	28.73	30.53	30.46	31.03		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	26.21	26.64	27.04	27.27	27.90	27.80	27.14	29.10
	S <sub>2</sub> : 30 cm x 7 cm	26.89	26.97	28.01	28.71	28.66	29.13	28.06	
	S <sub>3</sub> : 30 cm x 10 cm	27.07	27.51	27.64	28.61	29.21	29.35	28.23	
	Mean	26.7	27.04	27.56	28.19	28.59	28.76		
Mean (F)		27.98	28.41	28.48	29.40	29.57	32.17		
Mean of S <sub>1</sub>		28.77		29.58		30.99		29.47	
Mean of S <sub>2</sub>		29.64		30.68		28.06		29.78	
Mean of S <sub>3</sub>		30.83		30.33		28.24		30.12	
Sources			SEm(±)				CD (p=0.05)		
Date of sowing			2.65				7.98		
Spacing			0.95				2.87		
Fertilizer			2.03				6.10		
D x S			2.30				NS		
D x F			2.87				NS		
S x F			2.34				NS		
D x S x F			4.06				NS		

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 2.** Plant height (cm) at 60 DAS as influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Plant height (cm) at 60 DAS							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	36.43	36.44	36.77	37.33	38.10	38.82	37.31	39.07
	S <sub>2</sub> : 30 cm x 7 cm	37.44	38.07	38.40	38.59	39.17	39.86	38.48	
	S <sub>3</sub> : 30 cm x 10 cm	36.52	37.38	37.96	38.95	39.56	40.42	38.32	
	Mean	36.79	36.79	37.71	38.29	38.49	39.70		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	37.27	37.79	38.99	39.65	39.69	38.08	38.57	39.79
	S <sub>2</sub> : 30 cm x 7 cm	37.71	38.44	39.61	39.97	39.43	40.67	39.30	
	S <sub>3</sub> : 30 cm x 10 cm	38.39	39.50	40.35	40.68	41.24	41.62	40.29	
	Mean	37.79	38.57	39.56	40.10	40.12	40.12		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	37.24	37.95	38.27	39.15	39.80	40.17	38.76	38.39
	S <sub>2</sub> : 30 cm x 7 cm	38.11	39.09	39.07	39.37	40.14	40.32	39.35	
	S <sub>3</sub> : 30 cm x 10 cm	37.85	38.45	38.69	38.39	39.10	40.38	38.31	
	Mean	37.73	38.49	38.67	38.97	39.68	40.29		
Mean (F)		37.44	38.12	38.68	39.15	39.94	40.66		
Mean of S <sub>1</sub>		37.32		38.58		38.76		38.49	
Mean of S <sub>2</sub>		38.59		39.39		39.35		39.27	
Mean of S <sub>3</sub>		38.47		40.30		38.86		39.50	
Sources			SEm(±)				CD (p=0.05)		
Date of sowing			0.01				0.05		
Spacing			0.02				0.08		
Fertilizer			0.05				0.17		
D x S			0.52				NS		
D x F			0.07				NS		
S x F			0.06				NS		
D x S x F			0.11				NS		

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 3.** Plant height at harvest (cm) as influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Plant height (cm) at harvest							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	42.11	42.63	42.98	43.07	44.07	43.55	43.07	43.70
	S <sub>2</sub> : 30 cm x 7 cm	42.34	42.92	43.38	43.40	43.91	43.65	43.27	
	S <sub>3</sub> : 30 cm x 10 cm	41.92	42.34	42.92	43.40	44.24	44.07	43.15	
	Mean	42.12	42.63	43.09	43.29	44.07	43.76		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	42.92	43.15	43.21	43.57	44.07	43.49	43.40	44.04
	S <sub>2</sub> : 30 cm x 7 cm	43.44	43.74	43.78	44.01	44.66	45.06	44.12	
	S <sub>3</sub> : 30 cm x 10 cm	43.57	44.03	44.22	44.70	45.38	44.30	44.37	
	Mean	43.31	43.64	43.74	44.09	44.70	44.28		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	42.42	42.80	43.44	44.03	44.18	44.30	43.53	43.16
	S <sub>2</sub> : 30 cm x 7 cm	43.00	43.01	43.45	44.24	44.16	44.24	43.68	
	S <sub>3</sub> : 30 cm x 10 cm	43.13	43.55	43.66	44.05	44.30	44.68	43.90	
	Mean	42.85	43.12	43.52	44.11	44.21	44.41		
Mean (F)		42.76	43.13	43.45	43.83	44.15	44.33		
Mean of S <sub>1</sub>		43.07		43.39		43.53		43.33	
Mean of S <sub>2</sub>		43.27		44.11		43.69		43.69	
Mean of S <sub>3</sub>		43.15		44.61		43.81		43.88	
Sources			SEm(±)					CD (p=0.05)	
Date of sowing			0.01					0.06	
Spacing			0.00					0.01	
Fertilizer			0.08					0.26	
D x S			0.74					NS	
D x F			0.04					NS	
S x F			0.09					NS	
D x S x F			0.16					NS	

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 4.** Number of branches per plant influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Number of branches plant <sup>-1</sup>							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	4.50	4.13	4.00	4.13	4.25	4.13	4.19	4.31
	S <sub>2</sub> : 30 cm x 7 cm	4.00	4.25	4.63	4.25	4.25	4.25	4.27	
	S <sub>3</sub> : 30 cm x 10 cm	4.75	4.63	4.75	4.25	4.38	4.38	4.52	
	Mean	4.42	4.34	4.46	4.21	4.29	4.25		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	4.13	4.25	4.13	4.13	4.13	4.25	4.17	4.33
	S <sub>2</sub> : 30 cm x 7 cm	4.00	4.38	4.00	4.75	4.38	4.50	4.34	
	S <sub>3</sub> : 30 cm x 10 cm	4.25	4.75	4.25	4.13	4.25	4.88	4.42	
	Mean	4.13	4.46	4.13	4.34	4.25	4.54		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	3.75	3.75	4.13	4.38	4.13	4.63	4.13	4.16
	S <sub>2</sub> : 30 cm x 7 cm	3.88	3.50	4.13	3.75	4.25	4.13	3.94	
	S <sub>3</sub> : 30 cm x 10 cm	4.63	4.63	4.63	4.13	4.13	4.38	4.42	
	Mean	4.09	3.96	4.30	4.09	4.17	4.38		
Mean (F)		4.21	4.25	4.29	4.21	4.24	4.39		
Mean of S <sub>1</sub>		4.19		4.17		4.13		4.16	
Mean of S <sub>2</sub>		4.27		4.33		3.94		4.18	
Mean of S <sub>3</sub>		4.52		4.42		4.42		4.45	
Sources			SEm(±)					CD (p=0.05)	
Date of sowing			0.02					0.08	
Spacing			0.01					0.04	
Fertilizer			0.05					0.16	
D x S			0.16					NS	
D x F			0.07					NS	
S x F			0.05					NS	
D x S x F			0.09					NS	

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 5.** Number of days to 50% flowering as influenced by date of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Number of days to 50% flowering							Mean (F)	Mean (D)
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>			
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	34.61	33.44	33.86	32.96	34.30	33.15	34.05	34.04	
	S <sub>2</sub> : 30 cm x 7 cm	33.76	33.44	32.96	32.00	34.81	33.55	33.59		
	S <sub>3</sub> : 30 cm x 10 cm	34.55	34.55	34.67	33.14	35.22	34.81	34.43		
	Mean	34.31	33.81	33.83	32.70	34.78	34.85	34.43		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	34.61	34.90	34.94	33.41	34.55	33.76	34.36	33.76	
	S <sub>2</sub> : 30 cm x 7 cm	34.06	34.23	34.44	33.02	35.31	33.90	34.16		
	S <sub>3</sub> : 30 cm x 10 cm	34.94	34.11	32.97	32.05	35.37	33.72	34.03		
	Mean	34.54	34.41	33.45	32.83	35.08	34.79	34.16		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	34.61	33.44	33.86	32.96	34.30	33.15	34.05	34.18	
	S <sub>2</sub> : 30 cm x 7 cm	33.76	33.44	34.96	32.00	34.11	32.97	33.21		
	S <sub>3</sub> : 30 cm x 10 cm	32.05	35.37	34.61	33.44	31.23	33.86	33.43		
	Mean	33.47	34.08	34.81	32.80	33.21	33.99	33.43		
	Mean (F)	34.11	34.10	34.60	32.91	34.60	33.71			
	Mean of S <sub>1</sub>		34.05		33.59		34.49		34.16	
	Mean of S <sub>2</sub>		34.36		34.16		34.03		34.18	
	Mean of S <sub>3</sub>		34.05		33.21		34.01		33.65	
	Sources		SEm(±)				CD (p=0.05)			
	Date of sowing		0.03				0.10			
	Spacing		0.01				0.03			
	Fertilizer		0.19				0.58			
	D x S		0.71				NS			
	D x F		0.07				NS			
	S x F		0.22				NS			
	D x S x F		0.38				NS			

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

### Effect on Yield Attributes

Significantly maximum number of pods per plant was recorded in the date of sowing D<sub>2</sub>- 30<sup>th</sup> March (12.93) and spacing S<sub>3</sub> (12.84) with treatment (F<sub>6</sub>) seeds treated with Rhizobium and phosphate solubilising bacteria (PSB) + RDF as basal dose + borax spray (100ppm) at flower initiation(14.84) (Table 6). While, lower number of pods per plant was recorded in the date of sowing D<sub>3</sub> 10<sup>th</sup> April (12.19) and spacing S<sub>1</sub>(12.42), with treatment (F<sub>1</sub>) control no fertiliser application (10.48). A significant difference was observed in pod length at harvest (Table 7). Among the dates of sowing the crop sown on 30<sup>th</sup> March (D<sub>2</sub>) resulted in pod length (10.33 cm), with spacing S<sub>3</sub> (10.41 cm) and seed treatment with F<sub>6</sub> seeds treated with rhizobium and phosphate solubilising bacteria (PSB) + RDF as basal dose + borax spray (100ppm) at flower initiation stage (11.68 cm).

Significantly higher seed yield per hectare was recorded in the date of sowing, D<sub>2</sub> 30<sup>th</sup> March (682.87 kg), with spacing, S<sub>3</sub> (676 kg) and the fertilizer level of F<sub>6</sub> (751.81 kg) seed treated with rhizobium and PSB + RDF as basal

dose + borax spray (100ppm) at flower initiation (Table 8). Where as lower seed yield recorded in D<sub>3</sub> date of sowing, 10<sup>th</sup> April (572.79kg) and spacing S<sub>1</sub> (604.18 kg) with the seed treatment F<sub>1</sub> (533.59kg) control no fertiliser application. Higher seed yield may be due to enhanced vegetative growth, synergistic effect of combined use of biofertilizers and inorganic manures [13]. Further, increased in the adsorption power of soils for cations and anions, particularly phosphate and nitrate with organic manures and also these were released slowly for the benefit of the crop during the growing period and better translocation of photosynthates by co-inoculation of biofertilizers leading higher seed yield [14].

### CONCLUSION

Thus the study revealed that the crop sown on 30<sup>th</sup> March with spacing of 30x10cm and seeds treated with rhizobium and phosphate solubilizing bacteria + RDF as basal dose + borax spray (100 ppm) at flower initiation recorded higher plant growth and seed yield parameter. Even though the the summer sowing resulted lesser

**Table 6.** Number of pods per plants influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Number of pods plant <sup>1</sup>							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	11.11	11.36	11.93	12.47	13.13	14.56	12.43	12.60
	S <sub>2</sub> : 30 cm x 7 cm	11.18	11.20	11.56	12.56	13.36	14.93	12.47	
	S <sub>3</sub> : 30 cm x 10 cm	11.67	11.49	12.20	13.11	14.22	14.78	12.91	
	Mean	11.32	11.35	11.90	12.71	13.57	14.76		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	9.96	11.82	11.98	14.11	13.91	15.27	12.84	12.93
	S <sub>2</sub> : 30 cm x 7 cm	10.44	11.24	12.09	12.78	14.20	15.44	12.70	
	S <sub>3</sub> : 30 cm x 10 cm	10.51	12.51	12.44	13.64	14.71	15.71	13.25	
	Mean	10.30	11.86	12.17	13.51	14.27	15.47		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	9.64	11.18	11.38	13.07	13.33	14.24	12.14	12.19
	S <sub>2</sub> : 30 cm x 7 cm	10.20	10.62	11.71	12.09	13.27	14.62	12.09	
	S <sub>3</sub> : 30 cm x 10 cm	9.64	11.78	11.89	12.89	13.82	14.04	12.34	
	Mean	9.83	11.19	11.66	12.68	13.47	14.30		
Mean (F)		10.48	11.47	11.91	12.97	13.77	14.84		
Mean of S <sub>1</sub>		12.42			12.84		12.14		12.47
Mean of S <sub>2</sub>		12.46			12.70		12.09		12.42
Mean of S <sub>3</sub>		12.91			13.25		12.34		12.84
Sources			SEm(±)				CD (p=0.05)		
Date of sowing			0.68				2.08		
Spacing			0.05				0.20		
Fertilizer			0.21				0.65		
D x S			0.13				NS		
D x F			0.30				NS		
S x F			0.24				NS		
D x S x F			0.42				NS		

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 7.** Pod length (cm) as influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Pod length (cm)							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	9.30	9.67	9.90	10.40	10.90	11.43	10.26	10.32
	S <sub>2</sub> : 30 cm x 7 cm	8.87	9.70	9.73	10.03	10.93	12.10	10.22	
	S <sub>3</sub> : 30 cm x 10 cm	9.30	9.93	9.90	10.43	11.33	12.00	10.48	
	Mean	9.16	9.77	9.84	10.29	11.05	11.84		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	9.00	9.63	9.83	10.07	10.67	12.10	10.21	10.33
	S <sub>2</sub> : 30 cm x 7 cm	9.13	9.47	10.07	10.03	10.93	11.70	10.22	
	S <sub>3</sub> : 30 cm x 10 cm	9.50	9.80	9.80	10.77	10.93	12.33	10.52	
	Mean	9.21	9.63	9.90	10.29	10.84	12.04		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	8.97	9.80	10.27	10.10	10.83	11.93	10.31	10.08
	S <sub>2</sub> : 30 cm x 7 cm	9.30	8.33	9.27	9.50	10.40	11.67	9.74	
	S <sub>3</sub> : 30 cm x 10 cm	8.97	9.66	9.70	10.37	10.97	11.63	10.21	
	Mean	9.08	9.26	9.75	9.99	10.73	11.74		
Mean (F)		9.13	9.56	9.83	10.19	10.88	11.68		
Mean of S <sub>1</sub>		10.27			10.22		10.28		10.26
Mean of S <sub>2</sub>		10.23			10.22		9.70		10.07
Mean of S <sub>3</sub>		10.48			10.53		10.21		10.41
Sources			SEm(±)				CD (p=0.05)		
Date of sowing			0.14				0.49		
Spacing			0.07				0.22		
Fertilizer			0.08				0.25		
D x S			0.13				NS		
D x F			0.14				NS		
S x F			0.14				NS		
D x S x F			0.25				NS		

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

**Table 8.** Seed yield kg per has influenced by dates of sowing, spacing and different fertilizer levels in green gram during summer 2016

Treatments		Seed yield kg ha <sup>-1</sup>							
Date of sowing (D)	Spacing (S)	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	Mean (F)	Mean (D)
D <sub>1</sub> : 20 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	438.00	586.33	638.00	650.33	715.66	706.67	622.49	664.53
	S <sub>2</sub> : 30 cm x 7 cm	614.12	636.00	646.22	692.00	721.00	792.23	683.59	
	S <sub>3</sub> : 30 cm x 10 cm	534.78	622.00	692.76	684.32	767.64	823.29	687.46	
	Mean	528.97	614.78	658.99	675.55	734.77	774.06		
D <sub>2</sub> : 30 <sup>th</sup> March	S <sub>1</sub> : 25 cm x 10 cm	548.67	565.70	623.72	667.27	670.00	746.00	636.49	682.87
	S <sub>2</sub> : 30 cm x 7 cm	593.66	645.35	657.63	677.59	727.00	777.63	679.81	
	S <sub>3</sub> : 30 cm x 10 cm	621.00	646.65	698.31	744.50	796.15	884.66	731.87	
	Mean	587.78	619.23	659.89	696.45	731.05	802.76		
D <sub>3</sub> : 10 <sup>th</sup> April	S <sub>1</sub> : 25 cm x 10 cm	486.32	527.38	511.59	546.69	591.58	655.23	553.13	572.79
	S <sub>2</sub> : 30 cm x 7 cm	464.51	505.52	535.58	570.27	607.00	657.00	556.69	
	S <sub>3</sub> : 30 cm x 10 cm	501.51	542.23	578.00	625.50	681.21	723.15	608.60	
	Mean	484.11	525.04	541.72	580.82	626.60	678.46		
Mean (F)		533.59	586.40	620.14	650.92	697.51	751.81		
Mean of S <sub>1</sub>		622.50		636.88		553.06		604.18	
Mean of S <sub>2</sub>		683.66		679.83		556.55		640.01	
Mean of S <sub>3</sub>		687.44		731.88		608.66		676.00	
Sources			SEm(±)				CD (p=0.05)		
Date of sowing			13.76				53.75		
Spacing			9.00				27.44		
Fertilizer			8.18				25.15		
D x S			15.59				NS		
D x F			14.17				NS		
S x F			14.17				NS		
D x S x F			24.54				NS		

**Fertilizer levels:** F<sub>1</sub>: Control (No fertilizer application) F<sub>2</sub>: RDF F<sub>3</sub>: Rhizobium + PSB F<sub>4</sub>: RDF + Rhizobium + PSB  
 F<sub>5</sub>: RDF + Rhizobium + PSB + 50% more basal dose F<sub>6</sub>: RDF + Rhizobium + PSB + Borax spray at flowering (100 ppm)

yields as comparable to *kharif* sowings, but the land can be very well used for raising the crop during summer thereby minimising storage losses and thus it can be a good option to supply good quality seeds for next season.

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