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Research Article

EFFECT OF TIME OF SOWING, SPACING BETWEEN PLANTS AND DIFFERENT FERTILIZER LEVELS ON GREEN GRAM (*Vigna radiata* L. Wilczek) IN SEED YIELD ATTRIBUTING CHARACTERS

VAKESWARAN V.*, JERLIN R., SELVARAJU P. AND BHASKARAN M.

Seed Centre, Tamil Nadu Agricultural University, Coimbatore, 641003 Tamil Nadu, India
*Corresponding Author: Email-vakeswaran@gmail.com

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Abstract- A field experiment was conducted during *summer* season of 2015-16 to study the effect of time of sowing, spacing between plants and fertilizer levels of green gram (*Vigna radiata* (L.) Wilczek) on seed yield attributing characters. Five levels of fertilizer doses, three different time of sowing and three spacing levels were imposed along with control under split plot design with three replications. Field data were recorded on pods per plant, number of seeds per pod, seed yield per plant, seed yield per ha. and 1000 seed weight were recorded. Analysis revealed that all the characters are significantly different among the treatments. Early sowing during summer i.e on march 20 th with the spacing of 25 X 10 cm recorded higher pods per plant (18.40), number of seeds per pod (13.08), seed yield per plant (6.9 gm), seed yield per ha.(8.9 q.) and 1000 seed weight (39 gm). Late sowing of green gram during April 10 th recorded lowest in all the characters. Seed treatment with Rhizobium and Phosphate Solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation recorded significantly highest in pods per plant (19.9), number of seeds per pod (14.06), seed yield per plant (8.5 gm) and seed yield per ha.(10.6 q). Early sowing with march 20 th with the spacing of 25 x 10 cm and Seed treatment with Rhizobium and Phosphate Solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation is recorded best among all the treatment combinations for achieving higher seed yield.

Keywords- Greengram, Seed, Time of sowing, Fertilizer levels, Spacing between plants

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Introduction

Green gram is a dry season pulse crop which requires low inputs and serves as an excellent source of seed protein. The productivity gap analysis revealed that the national average yield of green gram is 413 kg ha-1 as against 667 kg ha-1 in Punjab. This indicates the scope for increasing the productivity of green gram by proper management practice.

The low productivity of green gram is due to the cultivation of this crop in marginal and submarginal lands with poor management practices. Agricultural production technology is very important to achieve the full production potential of any variety of any crops. In India, many factors are responsible for improper growth and low yields of green gram. Out of that imbalance application of fertilizers [1], and inadequate planting distance [12] are some of the major factors, which adversely affect the growth of green gram. Among the various agronomic practices, planting time is the most important factor influencing the yield of mungbean [8]. Planting time of green gram differs from one production region to another and also from variety to variety [18]. Region specific and variety specific crop management practices to be developed to achieve the full production potential. Results of combined analysis showed that seed yield was significantly affected by sowing dates. The maximum seed yield (102.9 g m-2) was obtained in June 29 sowing date because the number of pods per plant and 1000-seeds weight were also increased. The study was conducted at Bangladesh; summer mungbean variety BINA moog may be sown during the period from 20 February to 12 March for higher seed yield and for late sowing, BINA moog may be considered as it matures earlier than others [10].

Pandya (1973)[11] opined that green gram can be grown successfully during spring as well as summer under irrigated conditions. April 15th was the optimum sowing time of green gram *cv*. PUSA BAISAKHI during summer season (IARI, 1971)[4]. Subsequently, Singh *et al*. (1980) [23] confirmed the optimum sowing time to be between April 5th and April 25th for summer season green gram for northern and central regions of India. Time of sowing experiments conducted elsewhere revealed that summer green gram must be sown by mid April in Bangladesh [15 and 9]; 20th May in [24], second fortnight to end of March in Pakistan [3] and during wet season in Thailand [13].

The optimum plant density is a pre-requisite for obtaining higher productivity [14]. [13] recorded higher yields of both green gram and black gram grown in garden land soils of Thailand with increasing plant density from 2 to 8 lakhs ha-1 while pod number per plant decreased with increasing plant density. Plant density affects the plant growth as well as grain yield in mungbean [5]. [19] reported that N, P, K and S uptake increased with increase in plant population from 3.33 to 5.0 lakh plants ha-1. Transpiration rate increased with decrease in plant population. Canopy bottom light quantum increased with reduction in population from 5.0 to 3.33 lakh plants ha-1, but the differential light quantum showed reversing trend [20].

Materials and Methods

The field was conducted at the farm of Tamil Nadu Agricultural University, Coimbatore, India during March of 2015, which coincides with the summer season. The objective of study is to investigate the effect of time of sowing, spacing between plants and fertilizer levels of green gram (*Vigna radiata* (L.)

Wilczek) *var.* CO6 on seed yield attributing characters. Genetically pure seeds of green gram *var.* CO 6 was obtained from the Department of Pulses, Tamil Nadu Agricultural University, Coimbatore, India.

Treatments and Experimental Design

The field trial was designed with split plot deign with three replication with the plot size of 3 X 3 m with the following treatments.

Five different fertilizer levels *viz*., 100 % RDF as basal (25 kg N + 50 kg P2O5/ha), Seed treatment with Rhizobium and Phosphate solubilizing Bacteria alone, Seed treatment with Rhizobium and Phosphate solubilizing Bacteria + 100 % RDF as basal, Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal, Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation along with control (No basal fertilizer, Seed treatments and Borax spray) and three different spacing between plants *Viz*., 20X 10 cm, 30 X 7 cm, 40 X 7 cm (between rows X between plants) and three different sowing dates *viz*., March 20 th 2015, March 30 th 2015 , April 10 th 2015.

Table-1 *Effect of date of sowing, spacing and dosage of fertilizer on number of pods per plant in greengram during summer 2015 at TNAU, Coimbatore.*

Treatments	Date of sowing – 20/03/2015			Date of sowing – 30/03/2015			Date of sowing –10/04/2015		
	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm
Control	16.6	15.1	16.8	15.2	15.9	15.8	14.4	13.7	13.5
100 % RDF as basal	16.6	15.4	16.6	15.2	16.1	16.1	14.4	13.8	13.6
Seed treatment with Rhizobium and Phosphate solubilising Bacteria	18.8	15.9	19	15.8	16.5	16.8	15	14.6	14.1
Seed treatment with Rhizobium and Phosphate solubilizing Bacteria + 100 % RDF as basal	19.1	16.1	19.2	16	16.7	16.8	15.3	14.7	14.2
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal	19.4	17.1	19.3	16.3	17.2	17.1	15.4	15	14.5
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation	19.9	17.4	19.8	16.6	17.2	17.4	15.8	15.2	14.8
Mean	18.40	16.17	18.45	15.85	16.60	16.67	15.05	14.50	14.12
	D	S	T	DXS	DXT	SXT	DST		
SEd	3.24	4.52	4.86	4.37	3.68	2.74	3.94		
CD (P=0.05)	6.58	9.18	9.87	8.87	7.47	5.56	8.00		

Table-2 *Effect of date of sowing, spacing and dosage of fertilizer on number of seeds per pod in green gram during summer 2015 at TNAU, Coimbatore.*

Treatments	Date of sowing – 20/03/2015			Date of sowing – 30/03/2015			Date of sowing –10/04/2015		
	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm
Control	11.3	9.8	11.5	9.9	10.5	10.5	9.1	8.4	8.2
100 % RDF as basal	11.2	10.1	11.2	9.9	10.7	10.8	9.1	8.5	8.2
Seed treatment with Rhizobium and Phosphate solubilising Bacteria	13.5	10.6	13.6	10.5	11.2	11.5	9.7	9.3	8.7
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 100 % RDF as basal	13.8	10.8	13.9	10.7	11.4	11.5	10.0	9.4	8.9
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal	14.1	11.8	14.0	11.0	11.9	11.7	10.0	9.7	9.5
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation	14.6	12.1	14.5	11.2	11.9	12.1	10.5	9.9	9.4
Mean	13.08	10.87	13.12	10.53	11.27	11.35	9.73	9.20	8.82
	D	S	T	DXS	DXT	SXT	DST		
SEd	1.12	1.08	1.06	1.28	2.06	1.84	1.44		
CD (P=0.05)	2.27	2.19	2.15	2.60	4.18	3.74	2.92		

Observations made

The following observations were recorded on seed yield attributing characters.

1. Number of pods per plant

The pod numbers were counted during the maturity stage of the crop in the five randomly selected plants per plot.

2) Number of seeds per pod

Number of seeds per pod was counted in the five pods per plant and in each of the randomly selected five plants during the maturity stage of the crop.

3) Seed yield per plant

Seed yield per plant was derived from the five randomly selected plants during the maturity stage of the crop.

4) Seed yield per ha

Seed yield per ha was computed based on the data of the seed yield per plant, seed yield per plot and plant population per unit area.

Result and Discussion

Time of sowing

The results revealed that the early sowing recorded the highest number of pods per plant (16.6), highest number of seeds per pod (11.3), Seed yield per plant (6.9 gm) and 1000 seed weight (39.866 gm) compared to late sowing (14.4, 9.73, 3.6 gm and 39.886 gm respectively.). This is in conformity with Ram and Dixit (2001)[16] stated that dates of sowing showed significant influence on yield attributing parameters *viz* .pods/plant, grains/pod and grain yield. The increase in temperature usually increase photosynthetic rates until photo system destruction begin. The increase in yield attributing parameters under March 30 sowing was due to higher dry matter production which resulted in greater translocation of food materials to the reproductive parts and reflected in superiority of yield attributing parameters (Ram and Dixit, 2001)[16]. [17] recorded low seed yield and low seed quality in late sown green gram crops in Sri Lanka. However, [24] reported no difference in yield of green gram raised during summer and *Kharif* seasons. [6]

reported that green gram and black gram could be successfully grown in the fourth week of March in North Western plains of India, during which period, photothermal requirements were optimum for higher productivity.

Table-3 *Effect of date of sowing, spacing and dosage of fertilizer on seed yield per plant (gm) in green gram during summer 2015 at TNAU, Coimbatore*

Treatments	Date of sowing – 20/03/2015			Date of sowing – 30/03/2015			Date of sowing –10/04/2015		
	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm
Control	5.1	3.5	5.4	3.6	4.5	4.2	2.9	2.1	2.0
100 % RDF as basal	5.1	3.9	5.0	3.6	4.5	4.6	2.9	2.5	2.0
Seed treatment with Rhizobium and Phosphate solubilising Bacteria	7.6	4.4	7.4	4.2	5.1	5.4	3.6	3.0	2.6
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 100 % RDF as basal	7.5	4.5	7.7	4.6	5.2	5.3	3.7	3.4	2.7
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal	8.0	5.6	7.8	4.8	5.6	5.5	3.9	3.4	3.4
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation	8.5	5.9	8.3	5.0	5.8	5.9	4.3	3.7	3.1
Mean	6.9	4.6	6.9	4.3	5.1	5.2	3.6	3.0	2.6
	D	S	T	DXS	DXT	SXT	DST		
SEd	6.32	4.43	4.82	5.16	5.74	4.88	3.77		
CD (P=0.05)	13.21	9.26	10.07	10.78	12.00	10.20	7.88		

Table-4 *Effect of date of sowing, spacing and dosage of fertilizer on seed yield per ha. in greengram during summer 2015 at TNAU, Coimbatore.*

Treatments	Date of sowing – 20/03/2015			Date of sowing – 30/03/2015			Date of sowing –10/04/2015		
	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm
Control	8.7	7.2	8.5	7.7	8.3	8.3	6.8	6.2	5.9
100 % RDF as basal	8.7	7.8	8.3	7.6	8.5	8.5	6.9	6.2	6.0
Seed treatment with Rhizobium and Phosphate solubilising Bacteria	10.5	8.2	10.1	8.2	8.9	9.3	7.4	7.1	6.5
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 100 % RDF as basal	10.5	8.2	10.0	8.5	9.1	9.3	7.8	7.2	6.6
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal	10.3	8.5	11.8	8.7	9.6	9.5	7.8	7.5	7.2
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation	10.6	8.6	12.2	9.0	9.6	9.8	8.2	7.7	7.2
Mean	9.9	8.1	10.2	8.3	9.0	9.1	7.5	7.0	6.6
	D	S	T	DXS	DXT	SXT	DST		
SEd	1.26	2.21	1.63	1.79	2.05	1.72	1.19		
CD (P=0.05)	2.56	4.49	3.31	3.63	4.16	3.49	2.42		

Table-5 *Effect of date of sowing, spacing and dosage of fertilizer on 1000 seed weight (gm) in green gram during summer 2015 at TNAU, Coimbatore.*

Treatments	Date of sowing – 20/03/2015			Date of sowing – 30/03/2015			Date of sowing –10/04/2015		
	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm	Spacing – 25X10 cm	Spacing – 30X7 cm	Spacing – 40X7 cm
Control	38.282	35.098	38.682	38.534	38.972	38.972	38.678	38.786	38.422
100 % RDF as basal	38.886	34.408	38.69	38.626	39.1	39.246	38.777	39.142	38.532
Seed treatment with Rhizobium and Phosphate solubilising Bacteria	39.632	38.972	38.734	39.329	39.264	39.846	38.716	38.524	38.914
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 100 % RDF as basal	40.978	38.192	38.056	39.636	40.274	39.792	39.498	39.637	39.46
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal	41.668	39.538	39.746	39.882	40.674	40.282	39.626	38.934	39.806
Seed treatment with Rhizobium and Phosphate solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation	41.752	39.87	39.934	40.408	40.826	40.678	38.804	39.64	40.121
Mean	41.866	37.679	38.973	39.402	39.851	39.802	38.349	38.610	39.209
	D	S	T	DXS	DXT	SXT	DST		
SEd	0.62	0.68	0.72	0.49	0.41	0.53	0.37		
CD (P=0.05)	1.28	1.40	1.48	1.01	0.84	1.09	0.76		

Spacing between plants

Among the spacing, 40X7 cm spacing recorded the maximum pods per plant (16.8), followed by 25X7 cm spacing (16.6), which are on par and the spacing of 30X7 cm recorded the lowest pods per plant (15.1). 40X7 cm spacing recorded

significantly higher in all the other seed yield attributing characters .The correlation in terms space occupied per plant, this result is in conformity [18] in an experiment studied the effect of plant density on the yield and yield attributes of mungbean and observed that 30x10 cm plant density always showed highest yield performance. As opened by [22] the genotypic expression of green gram could be realized to the full potential only when grown under optimum plant density, which could ensure proper utilization of inputs. However, extensive studies [1] in India showed that 20x10 cm spacing was superior to 30x10 cm in summer season was optimum for obtaining higher grain yields of green gram. The plants under higher population became smaller might be due to shortage of nutrient, water and other related component elements.

Fertilizer dose and seed treatment

Among the treatments, Seed treatment with *Rhizobium* and Phosphate solubilizing Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation recorded the maximum in the seed yield attributing characters. It is in conformity with [7, 16]. Phosphorus is an essential constituent of majority of enzymes, which have great importance in the transformation of energy required in cell division, ATP activation of amino acids for synthesis of protein and in carbohydrate metabolism. The reason stated above is probably responsible for more dry matter production at higher level of phosphorus.

In the interaction, the early sowing (March 20th) with the spacing of 40 X 7 with the Seed treatment with Rhizobium and Phosphate solubilizing Bacteria + 150 % RDF as basal + B In the orax spray (100 ppm) at flower initiation recorded the maximum pods per plant 18.45 followed by 25 X 10 cm spacing (18.40), which are on par.

Conclusion

Early sowing during summer (March 20th) with the spacing of either 25 x 10 cm or 40 x 7 cm with the seed treatment with Rhizobium and Phosphate Solubilising Bacteria + 150 % RDF as basal + Borax spray (100 ppm) at flower initiation is the best combination to achieve the maximum seed yield.

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Authors contributions:

1) Vakeswaran V. and Jerlin R. are the Scientists incharge of the research project and conducted the experiment.

2) Selvaraju P. and Bhaskaran M. are the Nodal officers of this research project

Conflict of Interest: None declared

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