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Studies of Plant Geometry on Growth and Yield of Different Greengram Varieties

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ABSTRACT

Greengram, an important pulse crop of the world, helps in fixing atmospheric nitrogen through symbiotic nitrogen fixation and is an important green manuring crop. A field experiment was conducted to study the effect of different geometry on growth and yield of different greengram varieties at Agriculture Farm, Lovely Professional University, Phagwara, Punjab, India. Total six treatment combinations of greengram varieties and spacing with four replications comprising: T_1–SML 668 + spacing 1 (30 x 10 cm), T_2–SML 668 + spacing 2 (40 x 20 cm), T_3–ML 818 + spacing 1 (30 x 10 cm), T_4 – ML 818 + spacing 2 (40 x 20 cm), T_5–PAU 911 + spacing 1 (30 x 10 cm), and T_6 – PAU 911 + spacing 2 (40 x 20 cm) were applied. Sixteen plant and soil characters were recorded and analyzed in factorial randomized complete block design. The results indicated that treatment T_5–PAU 911 + spacing 1 (30 x 10 cm) performed better than other treatments and gave best results in growth and yield parameters such as plant height (75.09 cm), maximum number of leaves (49.07), maximum number of branches (36.38), length of the pod (9.98 cm), number of seeds per pod (10.25), number of pods per plant (32.17), grain yield (641.26 kg/ha), straw yield (1610.35 kg/ha), biological yield (2262.45 kg/ha), harvest index (28.96) and 1000 seed weight (39.53 g). Moreover, this treatment performed better in terms of soil health parameters like maximum available N (366.56 kg/ha), available P (17.10 kg/ha), soil pH (8.40) and soil EC (0.43 dS/m). However, maximum available K i.e. (288.40 kg/ha) was recorded in treatment T_3 variety ML 818 + spacing 1 (30 x 10 cm) as compared to other treatments. Low potential varieties and improper spacing as well as agronomic practices can be a serious threat in low productivity of greengram. Therefore, it can be recommended that greengram variety PAU 911 should be grown at a spacing of 30 x 10 cm.

Key words: Crop geometry, greengram, spacing, available nutrient, yield

INTRODUCTION

Greengram (*Vigna radiata* L.) is a major pulse crop grown in India. It belongs to the family Fabaceae. Greengram has been cultivated widely in India since ancient times and is broadly cultivated throughout Asia, including India, Bangladesh, Pakistan, Sri Lanka, Malaysia, Thailand, Indonesia, Vietnam and South China. The regular productivity of greengram over the globe is 577 kg/ha, whereas in India it is 548 kg/ha, which is less (Anonymous, 2021). It is a small herbaceous annual vine with yellow flowers and fuzzy brown pods, which grows at a height of 15-125 cm. There are three sub-groups of *Vigna radiate,* out of these sub-groups, one is cultivated (*Vigna radiata* subsp. *radiata*) and other two are wild ones (*Vigna radiata* subsp. *sublobata* and *Vigna radiata* subsp. *glabra)* as Patel *et al. (*2020). Pulses offer good scope for crop intensification and diversification.

Crop geometry is the number of crops planted in a unit area and is the distance between one plant to another. Some agriculturlists have recommended the spacing of specific crops which is based on research and the findings with a view to exploiting better crop yields (Manoharan *et al.,* 2020). Farmers do not grow greengram with proper spacing, they just broadcast the seeds or use direct seedlings for planting in the field. Some farmers do not follow recommended spacing which results in low yield and attack of pests and diseases so using row planting with suitable spacing can help to ensure optimal plant population per unit area of greengram (Maitra *et al.*, 2020). Also, when crops are planted close to one another, it may be difficult for the farmer or the grower to walk about in the farm layout for weeding, spraying of pesticides, or during crop check. Therefore, crop spacing or geometry is important while sowing crops because it helps in nutrient uptake, disease management, ease in

weeding, ease of harvest and increase yield (Hangsing *et al.*, 2020). To further increase productivity and obtain a desirable yield one can manipulate agronomic practices such as spacing and crop geometry (Keerthi *et al.*, 2015). Plant spacing plays a vital role in the suppression and dominance during competition. Ideal plant geometry is significant for better and more efficient utilization of available plant growth resources in order to get the highest yield or maximum productivity in crops.

The growth and stages of plants are directly influenced by space available to the plants although the response to species or cultivar specific. When the field is too overcrowded with plants, there is competition for the essential nutrients for the plants to grow, leading to stunted crop growth and poor yield. Optimum spacing allows the plants to develop their roots to their fullest potential which allows the roots to acquire sufficient nutrients for their growth and development (Singh *et al.*, 2022). Therefore, this experiment has planned to check the effect of different spacing and geometry on different parameters of mungbean varieties.

MATERIALS AND METHODS

A field experiment was conducted at College Farm, Lovely Professional University, Phagwara, Punjab (31°22′ 31.18″ N latitude 75°23′ 3.02″ E longitude; 252 MSL), India. The field was prepared and ploughed with the help of a tractor. The experiment was carried out in a randomized complete block design with four replications. The whole plot was divided into sub-plots of the size of 4 x 4 m^2. The spacing that was used for this experiment was 30 x 10 cm and 40 x 20 cm and the varieties that were used in this experiment were SML 668, ML 818 and PAU 911. Line sowing was carried out with hand at a depth of 4-5 cm (two seedlings/hill). The experiment consisted of six treatment combinations viz., T_1–SML 668 + spacing 1 (30 x 10 cm), T_2–SML 668 + spacing 2 (40 x 20 cm), T_3–ML 818 + spacing 1 (30 x 10 cm), T_4–ML 818 + spacing 2 (40 x 20 cm), T_5–PAU 911 + spacing 1 (30 x 10 cm) and T_6–PAU 911+ spacing 2 (40 x 20 cm). Hand weeding was done after 30 days interval in each treatment. All other practices were followed to keep plant in proper condition. From each treatment, five plants were randomly selected and observations were recorded on growth and yield characters. The data on yield were recorded at the time of harvest. The pH of soils was calculated by Glass Electrode Method (Patel *et al.,* 2022). Electrical conductivity was measured by EC meter (Prithivi *et al.*, 2021), available nitrogen was measured by alkaline potassium per manganate method (Lalrinfela *et al.,* 2016), available phosphorus was measured by Olsen's method (Muchomba *et al.,* 2023), available potassium was measured by Flame Photometer Method (Kumar *et al.,* 2022). Recorded data were statistically analyzed.

RESULTS AND DISCUSSION

In all stages of plant growth, the maximum 75.09 cm plant height was observed in treatment T_5 – PAU 911 with spacing 30 x 10 cm (Table 1) and the minimum plant height 56.23 cm was recorded in treatment (T_2). Maximum plant height in greengram might be due to the plant attaining full benefit of available resources and sunlight. However, the minimum plant height might be due to the genetic characteristic which was not compatible with the variety and spacing of greengram. This result was similar to the findings of Singh *et al.* (2017). The number of leaves varied in all the different combinations of treatments. The maximum number of leaves (49.07) was observed in treatment T_6 and the minimum number of leaves (40.58) was in treatment T_2 at harvest. This may be due to the variety being significantly influenced by the spacing. Similar result was also observed by Kumar *et al.* (2019).

Treatment T_5–PAU 911+spacing 30 x 10 cm recorded maximum number of branches (36.38) in both 30 days after sowing and at the time of harvest stage, while lowest number of branches (26.78) was attained by treatment T_2–SML 668 + spacing 40 x 20 cm (Table 1). The reason for attaining highest number of branches might be due to the plants grown at desired spacing got a better chance in availing maximum space, nutrients and light which led to producing a greater number of branches. These experimental results are similar to the findings of Gohil *et al.* (2017). The maximum pod length (9.98 cm) was observed in treatment T_5, which was followed by treatment T_6 with 9.83 cm. However, minimum pod length (8.85

Table 1. Effect of different greengram varieties and crop geometry on growth parameters plant height, number of leaves, number of branches and length of pod

Treatments	Plant height (cm)		Number of leaves		Number of branches		Length of pod (cm)
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At Harvest	At harvest
T_1	29.60	64.98	17.82	44.42	14.88	30.83	9.34
T_2	26.94	56.23	19.63	40.58	12.86	26.78	8.85
T_3	32.15	68.30	23.63	48.16	17.23	36.16	9.42
T_4	30.00	69.80	21.64	42.90	16.53	35.69	9.55
T_5	34.38	75.09	24.21	47.74	16.27	36.38	9.98
T_6	31.90	70.63	22.40	49.07	17.73	36.00	9.83
C. D.	NS	NS	NS	NS	NS	NS	NS
C. V.	8.14	9.65	8.39	11.71	10.51	9.37	8.06
S. Em±	1.254	3.257	0.904	2.662	0.836	1.576	0.832

T_1–SML 668+spacing 1 (30 x 10 cm), T_2–SML 668+spacing 2 (40 x 20 cm), T_3–ML 818+spacing 1 (30 x 10 cm), T_4–ML 818+spacing 2 (40 x 20 cm), T_5–PAU 911+spacing 1 (30 x 10 cm) and T_6–PAU 911+spacing 2 (40 x 20 cm).

cm) was attained in treatment T_2. This result was similar to Raj *et al.* (2019). Difference in pod length of mungbean might be due to the different spacing and variety which might not be compatible.

The combination of varieties and spacing significantly affected the number of pods per plant (Table 2). Maximum number of pods per plant (32.17) was noted in treatment T_5–PAU 911 and spacing 30 x 10 cm, while the minimum number of pods per plant (23.71) was recorded in treatment T_2–SML 668 and spacing 45 x 20 cm. This result was similar to the findings of Nair *et al.* (2021) in mungbean. The combination of varieties and spacing significantly affected the number of seeds per pod. Wherein, the maximum number of seeds (10.25) was produced in T_5 and the minimum (8.53) seeds per pod were recorded in T_2. Similar result was also reported by Nair *et al.* (2021). This variation in seeds per pod might be due to the genetics of varying varieties and inter row spacing which had a significant impact on the number of seeds per pod.

The maximum 1000-seed weight (39.53 g) was recorded in treatment T_5–variety PAU 911 at the spacing of 30 x 10 cm, while the minimum 1000-seed weight (28.30 g) was obtained in treatment T_1–variety SML 668 at spacing of 30 x 10 cm. This result agrees with that of Nair *et al.* (2021). Moreover, maximum grain yield (641.26 kg/ha) was recorded at closer spacing 30 x 10 cm in variety PAU 911 (T_5) and the minimum grain yield (448.05 kg/ha) was recorded from treatment T_2–spacing 45 x 10 cm in variety SML 668. This result was similar in response to the findings of Sathiyavani *et al.* (2016). Optimum spacing effectively utilized the growth resources. However, lesser yield attributes might be due to severe competition between plants (Latha *et al.*, 2019).

Maximum straw yield (1610.35 kg/ha) was observed by treatment T_5, which was closely followed by treatment T_6 (Table 2). The

Table 2. Effect of different greengram varieties and plant geometry on number of pods per plant, number of seeds per pod,1000-seed weight, grain yield, straw yield, biological yield and harvest index

Treatment	No. of pods/ plant	No. of seeds/ pod	1000-seed weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
T_1	27.70	9.44	28.30	467.86	1350.66	1822.02	25.85
T_2	23.71	8.53	29.59	448.05	1291.09	1739.12	25.68
T_3	29.28	9.60	35.50	563.87	1485.84	2066.99	28.09
T_4	27.88	9.49	31.52	517.59	1470.12	2035.01	27.70
T_5	32.17	10.25	39.53	641.26	1610.35	2262.45	28.96
T_6	31.93	10.04	34.35	622.53	1565.85	2202.03	28.85
C. D.	NS	NS	3.80	NS	21.97	24.47	NS
C. V.	7.16	8.18	7.61	8.13	1.00	0.80	0.44
S. Em±	1.030	0.391	1.260	22.101	7.290	8.119	0.061

Treatment details are given in Table 1.

Table 3. Effect of different green gram varieties and plant geometry on soil pH, EC and available N, P and K in soil

Treatment	Soil pH	Electrical conductivity (dS/m)	Available nitrogen (kg/ha)	Available phosphorous (kg/ha)	Available potassium (kg/ha)
T_1	8.14	0.40	270.48	11.05	245.84
T_2	8.06	0.42	353.02	13.82	269.92
T_3	8.08	0.43	343.26	15.67	288.40
T_4	8.00	0.42	360.13	14.48	267.12
T_5	8.40	0.43	366.56	17.10	277.20
T_6	8.21	0.43	365.50	16.25	262.08
C. D.	NS	NS	41.70	1.59	NS
C. V.	6.89	7.02	8.06	7.17	9.33
S.Em±	0.280	0.016	13.834	0.528	12.526

Treatment details are given in Table 1.

minimum straw yield (1291.09 kg/ha) was recorded in treatment T_2. This might be due to the crop attaining full benefits in utilizing the resources available. This result was similar to the findings of Ghoshal *et al.* (2018). The productivity of a crop was highly determined by the biological yield. The variety PAU 911 with spacing 30 x 10 cm spacing (T_5) gave the maximum biological yield (2262.45 kg/ha). However, minimum biological yield (1739.12 kg/ha) was recorded in T_2 when spaced at 45 x 10 cm for SML 668 variety. This was in close relation to the finding of Ghoshal *et al.* (2018). Moreover, for harvest index the maximum value was attained by treatment T_5 (28.96%) and the minimum harvest index (25.68%) was recorded by treatment T_2. This variation might be due to the genetic effect of variety and spacing effect to enhanced vegetative growth and lesser yield quality leading to severe competition among plants. This result has the partial agreement with results recorded by Singh *et al.* (2018).

The soil pH ranged from 8.00 to 8.40. The maximum soil pH (8.40) was recorded in treatment T_5 and the minimum soil pH (8.00) was recorded from treatment T_4 (Table 3). The variety of the crop and different spacing played a vital role in determining the pH of the soil. Application of organic manures improved the soil properties to sustain the productivity of the soil and may also improve the soil pH. Similar findings were also recorded by Islam *et al.* (2017). The soil EC ranged from 0.40 to 0.44 dS/m. The maximum soil EC (0.44 dS/m) was observed in treatment T_5 and the minimum soil EC (0.40 dS/m) was recorded in treatment T_2. Varieties of the crop and different spacing played a vital role in determining the EC of the soil. Application of organic manures improved the soil properties and sustained the productivity of the soil and also improved the soil EC. Similar findings were also recorded by Islam *et al.* (2017).

The highest available nitrogen was observed after the harvest of greengram (Table 3). Maximum available nitrogen (366.56 kg/ha) was recorded in T_5 and the minimum available nitrogen was reported in T_1, that was 270.48 kg/ha. This might be due to the increased root nodules and the activity of microbes which might be influenced by the nutrient content in the soil. This result is in accordance with the findings of Rajeshkumar *et al.* (2017). The maximum available phosphorus (17.10 kg/ha) was recorded in treatment T_5 after harvest. However, the minimum available P (11.05 kg/ha) was recorded at treatment T_1. Better growth with better nutrient availability to crops resulted in increased uptake of nutrient. Tomar *et al.* (2022) reported superior available nutrient with closer spacing. The maximum available potassium (288.40 kg/ha) was recorded in T_3. Whereas the minimum available potassium (245.84 kg/ha) was recorded in T_1. Soil available potassium was markedly influenced by different crop spacing with a different variety. Kesare *et al.* (2015) reported higher available nutrients with closer spacing.

CONCLUSION

It can be concluded that variety PAU 911 with spacing 30 x 10 cm gave more yield and performed better in all the morphological and yield parameters viz., plant height, number of branches, number of leaves, length of pod, number of seeds per pod, number of pods per plant, grain yield, straw yield, biological yield,

harvest index and 1000-seed weight. Moreover, mungbean variety PAU 911 with spacing 30 x 10 cm also performed better in all soil attributes like available N, available P, soil pH and soil EC which contribute to soil health. However, in available K variety ML 818 recorded the maximum available potassium. Therefore, it is recommended that greengram variety PAU 911 should be grown at a spacing of 30 x 10 cm and is a suitable combination for cultivating greengram in Punjab region.

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