The Bioscan 15(4): 521-524, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF PHOSPHORUS AND SPACING ON GROWTH AND YIELD OF GREENGRAM (*Vigna radiata* L.)

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KEYWORDS
Greengram
Phosphorus
Spacing
Growth
yield.

Received on :
16.09.2020

Accepted on :
17.10.2020

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ABSTRACT
A field experiment was conducted during *Zaid* season of 2019 at Crop Research Farm of SHUATS, Prayagraj (U.P). To study the "Effect of Phosphorus and Spacing on growth and yield of Greengram (*Vigna radiata* L.)". The experiment consisted of 9 treatments and replicated thrice. Which includes three levels of phosphorus (30, 40 and 50 kg/ha) and three different Spacing levels of (20 cm x 15 cm), (30 cm x 15 cm) and (40 cm x 15 cm). Results revealed that application of 40 kg/ha Phosphorus + 20 cm x 15 cm recorded significantly maximum plant height (41.33 cm), dry matter accumulation (299 g/m^2) and crop growth rate (2.77 g/m^2/day). As well as, the maximum number of branches per plant (4.82), number of nodules per plant (7.94) and number of pods per plant (18.89) were recorded with application of 40 kg/ha Phosphorus + 40 cm x 15 cm. Whereas, application of 40 kg/ha Phosphorus + 30 cm x 15 cm spacing significantly influenced higher Grain yield (1139.33 kg/ha) and Stover yield (2544.58 kg/ha). However, Net returns (Rs 52126.92/ha) and benefit cost ratio (1.76) was also obtained maximum with the application of 40 kg/ha Phosphorus + 30 cm x 15 cm. This experiment concluded treatment with 40 kg/ha Phosphorus + 30 cm x 15 cm was more productive as well as economic.

INTRODUCTION

Greengram or mungbean (*Vigna radiata* L.) is one of the important pulse crop in India. It is becoming an important crop, as it is the best alternative to meet the food needs of the large population of developing countries due to its nutritional superiority and nitrogen fixing characters (Raza *et al.*, 2012). Greengram is originated from India and Central Asia. In India, Greengram is grown over an area about 4.26 Mha with an average production of 2.01 mt Average grain yield of 472 kg/ ha (Annual report 2017-2018) greengram seeds contain 25% protein, 1-15% oil, 3.5-4.5% ash and 56.7% carbohydrates. High lysine content makes its protein an excellent complement to rice in terms of balanced human nutrition. During 2017-2018 the total coverage under mungbean in uttarpradesh 0.72 Lha with a production 0.40 Lt. and the productivity 555.56 (kg/ha). It is estimated that Indian population will be around 1460 million by 2030 and demand for pulses would further grow in the years to come. The major mungbean growing states are Orissa, Maharastra, Andhra Pradesh, Rajasthan, Madhya Pradesh, Karnataka and Uttar Pradesh. Among different production practices, fertilizer management is one of the important agronomic practices for increasing crop yield and maintaining soil fertility. Growth and development of crops depend largely on the development of root system.

Phosphorus is one of the most important elements among the three macronutrients that plants must require for the better growth and development. Phosphorus application is essential for energy transfer in living cells enhancing root growth besides increasing the mobility of symbiotic bacteria in the root zone which ultimately results in more nitrogen fixation. Summer pulses in India usually respond favourably to phosphorus application indicating that this element is generally deficient in weathered soils of tropical regions. Phosphorus ensures uniform and directly ripening of crop and also involved in transformation of energy in higher value of growth and yield attributes and also that due to phosphorus early development translocation of food materials in plant body resulted in better uptake of nutrients and ultimately in better seeds and stover yield. (Parmar and Thanki, 2007), the yield attributes *viz.* pods/plant, seed and straw yield increased significantly. Phosphorus application also resulted in significant increase in N and P uptake in seed and straw (Gupta *et al.*, 2006).

Spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and high infestation of diseases. On the other hand very low plant population will also reduce the yield. Due to this reason normal population is necessary for high yield. Advantage of optimum spacing under irrigated conditions is due to reduced competition for light because when the moisture is lacking, light is no longer limiting factor and the advantage of uniform spacing is lost (Ihsanullah *et al.*, 2002). Keeping these points in view, a field experiment was conducted to evaluate the effect of Phosphorus and Spacing on growth and yield of Greengram (*Vigna radiata* L.).

MATERIALS AND METHODS

A field experiment was conducted during zaid season of 2019 at Crop Research Farm, Department of Agronomy, Sam

Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25° 39′ 42′′ N latitude, 810 67′ 56" E longitude and 98 m altitude above the mean sea level (MSL). To study the "Effect of Phosphorus and Spacing on growth and yield of Greengram (*Vigna radiata* L.)". Using greengram variety Samrat (PDM- 139). The crop requires about 600-750 mm annual rainfall, optimum temperature (20- 40°C) during crop period for optimum production. The soil of experimental plot was sandy loam in texture, moderately basic pH (7.1), organic carbon (0.474%), available N (219 kg/ha), Phosphorus (18.3 kg/ha) and Potassium (244.6 kg /ha). The treatments comprised of T_1- 30 kg/ha Phosphorus + 20 cm x 15 cm, T_2- 40 kg/ha Phosphorus + 20 cm x 15 cm, T_3- 50 kg/ha Phosphorus + 20 cm x 15 cm, T_4- 30 kg/ha Phosphorus + 30 cm x 15 cm, T_5- 40 kg/ha Phosphorus + 30 cm x 15 cm, T_6- 50 kg/ha Phosphorus + 30 cm x 15 cm, T_7- 30 kg/ha Phosphorus + 40 cm x 15 cm, T_8- 40 kg/ha Phosphorus + 40 cm x 15 cm, T_9- 50 kg/ha Phosphorus + 40 cm x 15 cm. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The recommended dose of fertilizers were applied at the time of sowing in the form of Urea, SSP and MOP. Phosphorus requirement is fulfilled through SSP as per treatment combinations. The seeds were sown as per seed rate kg/ha according to treatment combination.

Chemical analysis of soil

Composite soil samples were collected before layout of the experiment to determine the initial soil properties. The soil samples were collected from 0-15 cm depth and were dried under shade, were powdered with wooden pestle and motar, passed through 2 mm sieve and were used for analysis. Collected soil samples were analyzed for organic carbon by rapid titration method (Sparks, 1996), Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956), available phosphorus by Olsen's method as outlined by Jackson (1967), available potassium was determined by extracting with neutal normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973).

Statistical analysis

Experimental data collected was subjected to statistical analysis by adopting Fishers method of Analysis of variance (ANOVA) as outlined by Gomez and Gomez (2010). Critical Difference (CD) values were calculated the 'F' test was found significant at 5% level.

RESULTS AND DISCUSSION

Plant height (cm)

The results in (Table- 1) revealed that application of 40 kg/ha Phosphorus along with spacing of 20 cm x 15 cm, significantly resulted maximum plant height (41.33 cm). However, 40 kg/ ha Phosphorus + 30 cm x 15 cm (40.52 cm) and 50 kg/ha Phosphorus + 20 cm x 15 cm (39.24 cm) were found to be statistically at par with 40 kg/ha Phosphorus + 20 cm x 15 cm at 60 days after sowing. The increase in plant height may be due to Phosphorus increased photosynthesis activity of plant and helps to develop a more extensive root system and thus enables the plant to extract more water and nutrient from soil depth, resulting in better development of plant growth. Similar results have also been reported by Patel *et al*. (2017). Spacing had significant effect in plant height (cm). This was apparently because individual plant from the plots with narrow spacing did not get opportunity to proliferate laterally due to less lateral space. Hence, plants were compelled to grow more in upward direction for the fulfillment of light requirement for photosynthesis. Similar findings also reported by Kachare *et al*. (2009) in greengram with respect to plant height.

Number of Branches per plant

The analysed data presented in (Table-1) showed at 60 DAS significantly maximum number of branches per plant obtained with application of 40 kg/ha Phosphorus + 40 cm x 15 cm (4.82). However, 40 kg/ha Phosphorus + 30 cm x 15 cm (4.63) and 50 kg/ha Phosphorus + 40 cm x 15 cm (4.50) were found to be statistically at par with 40 kg/ha Phosphorus + 40 cm x 15 cm. It might be due to Phosphorus help in efficient utilization of nutrients, which resulted in attaining better crop canopy Kokani *et al*. (2015). Higher number of branches per plant were observed with wider spacing this might be due to plants grown with wider spacing got better opportunity of availing maximum space, light and nutrients leading to maximum branches per plant. The above findigs is in complete agreement with earlier work by Kabir and Sarkar (2008).

Number of Nodules per plant

In present investigation, number of nodules per plant was increased with increasing crop age upto 45 DAS, thereafter

Table 1: Effect of Phosphorus and Spacing on growth attributes of Greengram.

Treatments	Plant height (cm) at 60 DAS	Number of Branches /plant at 60 DAS	Number of Nodules /plant at 60 DAS	Dry matter accumulation (g/m^2) at 60 DAS	Crop Growth Rate (g/m^2/day) at 45- 60 DAS	Relative Growth Rate (g/g/day) at 45-60 DAS
30 kg/ha Phosphorus + 20 cm x 15 cm	35.26	2.75	4.09	202.5	1.43	0.004
40 kg/ha Phosphorus + 20 cm x 15 cm	41.33	3.62	6.37	299	2.77	0.005
50 kg/ha Phosphorus + 20 cm x 15 cm	39.24	3.25	4.44	258.4	1.61	0.002
30 kg/ha Phosphorus + 30 cm x 15 cm	36.46	4.05	4.66	179.23	1.62	0.005
40 kg/ha Phosphorus + 30 cm x 15 cm	40.52	4.63	7	220.81	2.31	0.005
50 kg/ha Phosphorus + 30 cm x 15 cm	37.19	4.36	5.17	207.66	1.66	0.005
30 kg/ha Phosphorus + 40 cm x 15 cm	32.89	4.2	6.29	142.56	1.88	0.006
40 kg/ha Phosphorus + 40 cm x 15 cm	36.71	4.82	7.94	170.3	1.55	0.004
50 kg/ha Phosphorus + 40 cm x 15 cm	34.15	4.5	5.89	141.01	0.91	0.003
SEm (±)	1.29	0.15	0.52	11.63	0.57	0.002
CD (P=0.05)	3.86	0.45	1.55	34.88	1.72	NS

Table 2: Effect of Phosphorus and Spacing on yield attributes and yield of Greengram.

Treatments	Pods/Plant (Number)	Grains/pod (Number)	Test weight (g)	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Harvest Index (%)
30 kg/ha Phosphorus + 20 cm x 15 cm	12.86	9.67	36.92	856.24	1716.33	31.48
40 kg/ha Phosphorus + 20 cm x 15 cm	16.07	10.07	36.3	1077	2318.57	32.45
50 kg/ha Phosphorus + 20 cm x 15 cm	13.67	10.2	35.95	984.44	1980.87	33.05
30 kg/ha Phosphorus + 30 cm x 15 cm	14.67	9.87	33.56	877.62	2028.82	29.1
40 kg/ha Phosphorus + 30 cm x 15 cm	17.78	9.87	37.09	1139.33	2544.58	33.56
50 kg/ha Phosphorus + 30 cm x 15 cm	16.61	10	35.37	1012	2152	32.26
30 kg/ha Phosphorus + 40 cm x 15 cm	15.87	9.33	35.67	724.67	1621.52	27.65
40 kg/ha Phosphorus + 40 cm x 15 cm	18.89	10.23	37.7	899.96	2078	29.24
50 kg/ha Phosphorus + 40 cm x 15 cm	17.33	10.2	34.83	867.49	1778	31.36
SEm(±)	0.57	0.33	0.89	38.74	65.11	1.72
CD(P=0.05)	1.7	NS*	NS	116.15	195.21	NS

* Non significant

Table 3: Effect of Phosphorus and Spacing on Economics of Greengram.

Treatments	Cost of cultivation	Gross return (Rs/ha)	Net returns (Rs/ha)	B: C Ratio
30 kg/ha Phosphorus + 20 cm x 15 cm	30674.6	61224.05	30549.45	0.99
40 kg/ha Phosphorus + 20 cm x 15 cm	31130.85	77128.93	45998.08	1.47
50 kg/ha Phosphorus + 20 cm x 15 cm	31587.1	70396.45	38809.35	1.22
30 kg/ha Phosphorus + 30 cm x 15 cm	29078.6	62955.02	33876.42	1.16
40 kg/ha Phosphorus + 30 cm x 15 cm	29534.85	81661.77	52126.92	1.76
50 kg/ha Phosphorus + 30 cm x 15 cm	29991.1	72454	42462.9	1.41
30 kg/ha Phosphorus + 40 cm x 15 cm	28322.6	51942.8	23620.2	0.83
40 kg/ha Phosphorus + 40 cm x 15 cm	28778.85	64555.7	35776.85	1.24
50 kg/ha Phosphorus + 40 cm x 15 cm	29235.1	62057.57	32822.47	1.12

they were decreased to 60 DAS when the crop reached the maturity due to degeneration of nodules due to senescence. (Table No.1) showed that significantly maximum number of nodules per plant (7.94) was recorded with application of 40 kg/ha Phosphorus + 40 cm x 15 cm. However, 40 kg/ha Phosphorus + 30 cm x 15 cm (7.00) found to be statistically at par with 40 kg/ha Phosphorus + 40 cm x 15 cm.

Such increase in number of nodulation might be due to Phosphorus plays an important role in nodules formation thereby increases in the phosphorus content enhanced the availability of rhizobia and helps in increasing the formation of root nodules. The results are in conformity to that reported by Prasad *et al*. (2014).

Dry matter accumulation (g/m^2)

The analysed data presented in (Table No-1) shown significant variation among all treatments. At 60 DAS significantly maximum plant dry matter accumulation (299 g/m^2) was recorded with application of 40 kg/ha Phosphorus + 20 cm x 15 cm which is 52.83 % higher than 50 kg/ha Phosphorus + 40 cm ×15 cm.

The increase in dry matter accumulation might be due to the cumulative effect of increasing in plant height and number of branches resulted in increasing the dry matter production of plant Sengupta and Tamang. (2015).

Crop Growth Rate and Relative Growth Rate

The analysed data presented in (Table No-1) shown CGR and RGR from 45-60 DAS. At 45-60 DAS the superior crop growth rate (2.77 g/ m^2/ day) was obtained with application of 40 kg/ ha Phosphorus + 20 cm x 15 cm. which was significantly superior over treatment with application of 50 kg/ha Phosphorus + 40 cm x 15 cm (0.91 g/m^2/day). Where as all other treatments were found to be statistically at par with 40 kg/ha Phosphorus + 20 cm x 15 cm.

At 45-60 DAS the relative growth rate (0.006 g/g/ day) was obtained maximum with application of 30 kg/ha Phosphorus + 40 cm x 15 cm. There was no significant difference between different treatment combinations. Application of phosphorus increased the availability of nutrient which resulted in increased crop growth rate and better translocation of photosynthesis Vikarent and Harbir Singh. (2006) reported similar results.

Yield attributes and yield

The yield attributes and yield of greengram at harvest markedly influenced with Phosphorus and Spacing (Table No- 2) represent that application of 40 kg/ha Phosphorus + 40 cm x 15 cm recorded significantly superior number of pods per plant (18.89) which was 31.92% higher than 30 kg/ha Phosphorus + 20 cm x 15 cm. Non- significant results were registered by the application of Phosphorus along with Spacing on number of Grains/Pod and Test weight (g). The maximum number of grains/pod (10.23) and test weight (37.70) was obtained with application of 40 kg/ha Phosphorus + 40 cm x 15 cm. Significantly superior grain yield (1139.33 kg/ha) was obtained with application of 40 kg/ha Phosphorus + 30 cm x 15 cm. However, 40 kg/ha Phosphorus + 20 cm x 15 cm (1077.00) found to be statistically at par with 40 kg/ha Phosphorus + 30 cm x 15 cm. Stover yield data showing that significant variation among all treatments. Maximum stover yield was obtained with application of 40 kg/ha Phosphorus + 30 cm x 15 cm (2544.58 kg/ha) and none of treatments recorded at par value.

The increase in yield and yield attributing parameters might due to the application of Phosphorus as basal dose along with

Spacing. The primary role of Phosphorus in photosynthesis by way of rapid energy transfer and thereby increased photosynthetic efficiency and thus increased the availability of photosynthesis. This resulted in increase in the total biomass production and there translocation in plant parts Patel *et al*. (2013) and Sipai *et al*. (2015). Spacing remarkably influence the growth and yield attributes were noted higher under wider spacing eventhough it resulted in lower yield because of lower plant population per unit area. These altogether resulted in to overall increase in the above characters similar findings were also observed by Rasul *et al*. (2012). Have also confirmed the results of present study. In case of harvest index it was not significantly affected.

Economics

The data presented in (Tablie- 3) shown economics of greengram. Among the plots application of 40 kg/ha Phosphorus + 30 cm x 15 cm recorded significantly maximum Net returns (52126.92 Rs/ha) and Benefit-Cost Ratio (1.76) whereas, net returns were significantly superior over other treatments except with application of 40 kg/ha Phosphorus + 20 cm x 15 cm (45998.08 Rs/ha).

ACKNOWLEDGMENT

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.) India for providing field, facilities and assistance in conducting this research.

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