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Optimization of Spacing and Effect of Organic and Inorganic Phosphorus Level for Growth and Yield of Irrigated Blackgram

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ABSTRACT: Pulses are second important sources of human food next to cereals and also important crop to meet the dietary part of vegetarian. The productivity of pulses in India is below the global average mainly due to improper fertilization and crop spacing. In order to improve the productivity of blackgram a field experiment was conducted to study the effects of spacing and different levels of organic and inorganic phosphorus during *Rabi* season of 2022-23 at Karunya Institute of Technology and Sciences, Coimbatore. The experiment was laid out in Randomized Block Design which was replicated thrice and having 10 treatments consisting of 5 different spacing *viz*., 20 × 20 cm^2, 25 × 25 cm^2, 30 × 30 cm^2, 35 × 35 cm^2 and 30 × 10 cm^2 and 2 level of phosphorus *viz*., 100% RDP through inorganic (DAP) and 50% RDP through inorganic (DAP) + 50% RDP through organic (Vermicompost). According to the findings, the application of 100% RDP through inorganic + 20cm × 20 cm resulted in the higher growth and yield attributes. Grain yield (964 kg/ha), and stover yield (2554 kg/ha) were also found to be higher in 100% RDP through inorganic + 20cm × 20 cm resulting in higher gross return (62660 Rs/ha), net return (41858 Rs /ha) and B: C ratio (2.01).

Keywords: DAP, Vermicompost, RDP, Blackgram, Yield.

INTRODUCTION

India has made remarkable strides in achieving self-sufficiency in food grain production and has attained a growth rate that is adequate to fulfill the needs of its growing population. India is the largest producer of pulses with 25% of the world total production and also largest importer (27 %) of pulses in the world. However, during last decade pulse production has remained stagnant around 13 to15 million metric tons. In India Pulses are cultivated both as *Rabi* and *Kharif* crop. They play an significant role in Indian cuisine and provide 30% of the daily requirement for protein. Even though production is more, the supply of pulses per capita is substantially lower (30g) than the WHO's recommendation (80g). Recommended dietary allowance of protein for an average Indian adult is 0.8 to 1 g per kilogram of body weight. Therefore, in order to meet out protein requirement of the country's growing population agriculture scientist must develop strategies to increase the production and productivity of pulses.

Blackgram (*Vigna mungo*) is one of the important pulse crop originated in India. It is a self-pollinated and short duration leguminous crop. The seeds are generally black or very dark brown. It is commonly known as "*urd*" or "*urd* bean" and it is highly prized pulse among all the pulses. Blackgram is a protein rich food. It contains about 26% protein, 1.2% fat and 56.6% carbohydrates on dry weight basis and it is also rich source of calcium, iron and phosphoric acid among the pulses being five to ten times richer than in others.

Important reasons for low average yield of blackgram at farmer's field were the continuous cultivation of low potential cultivars, use of low seed rate and improper agronomic practices (Veeramani, 2019). Among many crop production constraints, appropriate crop spacing and phosphorus levels are the most important, which contribute substantially to the seed yield of blackgram (Rashmitha *et al.,* 2021). Proper fertilization is essential to improve the productivity of black gram. Application of phosphorus to pulse crop is one of the most important strategies to increase the productivity of pulses in India.

Nutrient availability in plants can be added either by applying organic or inorganic forms of fertilizers or both in combination. Both organic and inorganic

fertilizers provide plants with the nutrients needed to grow healthy and strong.

Organic manures like vermicompost are eco-friendly and economically viable. It also plays a significant role in soil biology and microbial activity. Also, vermicompost is enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K (Shrimal and Khan 2017). Among inorganic/chemical fertilizers, DAP is the main source of phosphorus applied to plant, besides other chemical fertilizers like ammonium phosphate (23% P), single super phosphate (7% P), triple super phosphate (20% P). Integration of recommended dose of chemical fertilizers along with vermicompost will result in better yield of blackgram. Besides P application the yield potential of blackgram depends on maintenance of optimum spacing and population. It is required to maintain spacing and variety for obtaining higher yield (Singh and Singh 2021). In view of these, a field experiment was under taken to study the optimization of suitable spacing and effect of organic and inorganic phosphorus levels for growth, yield and economics of irrigated blackgram.

MATERIALS AND METHODS

The filed experiment was conducted out during *Rabi* season of 2021-2022, at south farm in Karunya Institute of Technology and Science, Coimbatore. The experimental site is geographically located in the western agro-climatic zone of Tamil Nadu at 10°56′N latitude and 76°44′E longitude at an elevation of 474 m above mean sea level. During the cropping period, the minimum and maximum temperatures ranged from 18.41°C to 26.27°C respectively. The total rainfall received during the cropping period in 2022-2023 was 436.80 mm. The mean RH ranged from 86.65 %. The soil of experimental plot was sandy clay loam in texture, neatly neutral in soil reaction (8.15 pH) (Jackson, 1973), Medium organic carbon (0.28%) (Walkley, 1934), Low available N (182.0 kg/ha) (Subbiah 1956), Medium available P (17.2 kg/ha) (Olsen, 1954) and high available K (495.2 kg/ha) (Stanford and English 1949). The experiment was laid out in randomized block design with three replications, comprising ten treatments *viz.*,T_1-100 % RDP Through Inorganic + 20cm × 20cm, T_2 -100 % RDP through Inorganic + 25cm × 25cm, T_3 -100 % RDP through Inorganic + 30cm x 30cm, T_4 -100 % RDP through Inorganic + 35cm × 35cm, T_5 -50% RDP Through Inorganic + 20cm × 20cm + 50% vermicompost through organic, T_6 -50 % RDP through Inorganic + 25cm × 25cm + 50% vermicompost through organic, T_7 -50 % RDP through Inorganic + 30cm × 30cm + 50% vermicompost through organic, T_8 -50 % RDP through Inorganic + 35cm × 35cm + 50% vermicompost through organic, T_9 -100 % RDP through Inorganic + 30cm × 10cm (control) and T_{10} -50 % RDP Through Inorganic + 30cm × 10cm (control) + 50% vermicompost through organic. VBN (Bg) 8 variety of blackgram was used as the test variety. A uniform and recommended dose of 25 kg N/ha through urea and 25 Kg K_2O/ha through muriate of potash was applied as basal dose. Phosphorus was applied as diammonium phosphate (DAP) and Vermicompost as per the treatment. Irrigation was done based on the necessity and as per the time of sowing. The growth parameters *viz.,* plant height, number of branches per plant and dry matter production was recorded periodically. The yield parameters *viz.,* number of pod cluster per plant, number of pods per cluster, number of seeds per pod, grain yield, Stover yield, harvest index, gross returns, net returns and benefit cost ratio were also recorded with standard process of observation. The observed data was statistically analyzed using analysis of variance (ANOVA) as applicable to randomized block design (Gomez and Gomez 1984).

RESULT AND DISCUSSION

A. Growth attributes

Growth parameters of blackgram, *viz*., plant height (cm), number of branches per plant and dry matter (kg/ha) varied due to the application of different sources of phosphorus along with different spacing. Data presented in Table 1, indicated that the plant height is maximum (39.26 cm) with the treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) which is followed by treatment T_2 (100 % RDP through inorganic + 25cm × 25cm) (38.04 cm) and the minimum plant height (29.47 cm) was recorded with treatment T_{10} (50 % RDP through inorganic + 30cm × 10cm (control) + 50% vermicompost through organic). An increase in plant height (cm) with closer geometry levels was potentially due to inter and intra-plant competition for sunlight, water, nutrients, and space. This competition at closer spacing may have facilitated self-thinning of branches and encouraged vertical growth, as opposed to horizontal growth (Thavaprakaash, 2017). Application of treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) recorded higher number of branches per plant (6.00) which is statistically at par with treatment T_2 (100 % RDP through inorganic + 25cm × 25cm) (4.60) at harvest.

Among the treatments dry matter production was higher (3530 kg/ha) in treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) and lowest (1510.99 kg/ha) was recorded in treatment T_{10} (50 % RDP through Inorganic + 30cm × 10cm (control) + 50% vermicompost through organic). The results are in close conformity with the findings of (Swamy *et al.,* 2020) in greengram.

B. Yield attributes

Yield attributes such as number of pod cluster per plant, number of pods per cluster and number of seeds per pod was significantly affected due to the application of different source of phosphorus along with spacing (Table 2). Significantly higher number of pod clusters per plant (16.50) and number of pods per cluster (4.80) was recorded in treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) followed by treatment T_2 (100 % RDP through inorganic + 25cm × 25cm) (15.90 and 4.72, respectively) while minimum number of pod clusters per plant (11.7) and number of pods per cluster

was recorded (4.80) in treatment T_{10} (50 % RDP through inorganic + 30cm × 10cm (control) + 50% vermicompost through organic). The increased number of pods per plant may be attributed to the plants enhanced vigor and strength, which are results of optimal photosynthetic activity due to adequate light availability and balanced nutrient supply during the growth stages. This ultimately leads to an increase in number of pods. This is in line with (Pandey and Singh 2022).

The data pertaining to the number of seeds per pod was not significantly influenced by different source of phosphorus and spacing. Higher number of seeds per pod (6.50) was also found in treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) and the lower number of seeds per pod (5.5) was obtained in treatment T_{10} (50 % RDP through inorganic + 30cm × 10cm (control) + 50% vermicompost through organic). According to the findings of Khan *et al*. (2017) optimal photosynthetic activity due to appropriate lighting and plant spacing contributed to the plants vigor and growth, resulting in a greater number of seeds per plant. The favorable effect on the yield characteristics could also be due to the sufficient and accessible supply of nutrients to the plants, which helped improve their yield attributes.

C. Yield

Grain yield and stover yield was significantly influenced by different phosphorus sources and spacing treatments. A significantly higher grain yield (964 kg/ha) was observed in treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) and the lower grain yield (713 kg/ha) was recorded in treatment T_{10} (50 % RDP through inorganic + 30cm × 10cm (control) + 50% vermicompost through organic). The presence of phosphorus in the soil can enhance the yield of crops as it promotes the development of a well-established root system, increases nitrogen fixation, makes nutrients more available to the plants, and creates favorable conditions in the rhizosphere (Lokhande *et al.*, 2018). Similarly, Ganiger *et al.* (2003) reported that utilization of an optimal plant population, spacing, and effective weed management practices resulted in a higher seed yield of blackgram. This may be attributed to the enhanced vegetative growth and fewer yield-reducing factors due to reduced competition between plants.

The stover yield of blackgram was significantly impacted by the different phosphorus sources and spacing treatments. Treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) recorded higher stover yield of 2554.60 kg/ha and it was on par with treatment T_2 (100 % RDP through inorganic + 25cm × 25cm) (2324.81 kg/ha). The results were similar with the findings of Sathyamoorthi *et al.* (2008) were stover yield of greengram was higher due to closer spacing which could be attributed to higher population and accumulation of nutrients per unit area compared to wider spacing. Also, the application of phosphorus resulted in an increase in stover yield, which may be attributed to the source and sink relationship. It is likely that greater translocation of photosynthates from the source to the sink increased the yield (Balai *et al.*, 2017).

D. Economics

The data on the economics of different source of phosphorus along with spacing are furnished in the Table 3. The application of treatment T_1 (100 % RDP through inorganic + 20cm × 20cm) resulted in the higher gross return of Rs. 62,660/ha and net return of Rs. 41,858/ha in blackgram. Additionally, the higher B:C ratio of 2.01 was also observed in blackgram with treatment T_1 (100 % RDP through inorganic + 20cm × 20cm). The increase in gross return, net return and B:C ratio was due to the optimal fertilizer dose and increased plant population, as well as the higher spacing (Swamy *et al.*, 2020).

Table 1: Effect of optimization of spacing and phosphorus through organic and inorganic phosphorus level on growth attributes at harvest of irrigated blackgram.

Treatments	Plant height (cm)	No. of Branches / Plant	Dry Matter Production (Kg/ha)
T_1-100 % RDP Through Inorganic + 20cm × 20cm	39.26	6.00	3530.80
T_2-100 % RDP Through Inorganic + 25cm × 25cm	38.04	5.80	3057.88
T_3-100 % RDP Through Inorganic + 30cm × 30cm	30.50	4.40	1675.80
T_4-100 % RDP Through Inorganic + 35cm × 35cm	34.01	4.70	1904.48
T_5- 50% RDP Through Inorganic + 20cm × 20cm + 50% vermicompost through organic	34.21	5.20	2220.48
T_6-50 % RDP Through Inorganic + 25cm × 25cm + 50% vermicompost through organic	36.72	5.40	2492.47
T_7-50 % RDP Through Inorganic + 30cm × 30cm + 50% vermicompost through organic	30.70	4.40	1827.84
T_8-50 % RDP Through Inorganic + 35cm × 35cm + 50% vermicompost through organic	37.50	5.50	2817.36
T_9-100 % RDP Through Inorganic + 30cm × 10cm (control)	37.87	5.60	2937.60
T_{10}-50 % RDP Through Inorganic + 30cm × 10cm + 50% vermicompost through organic	29.47	4.60	1510.99
Mean	34.83	5.16	2397.57
SEd	2.95	0.51	252.97
Cd(P=0.05)	6.17	1.07	528.47

Table 2: Effect of optimization of spacing and phosphorus through organic and inorganic phosphorus level on yield and yield attributes at harvest of irrigated blackgram.

Treatments	No. of Pod clusters/ plant	No. of Pods/ cluster	No of Seeds/ pod	Grain Yield (kg /ha)	Stover Yield (kg/ha)
T_1-100 % RDP Through Inorganic + 20cm × 20cm	16.50	4.80	6.50	964	2554.6
T_2-100 % RDP Through Inorganic + 25cm × 25cm	15.90	4.72	6.40	887.33	2324.81
T_3-100 % RDP Through Inorganic + 30cm × 30cm	12.16	3.80	5.61	796.14	1935.09
T_4-100 % RDP Through Inorganic + 35cm × 35cm	15.49	4.49	5.87	803.26	2000.3
T_5- 50% RDP Through Inorganic + 20cm × 20cm + 50% vermicompost through organic	15.51	4.51	5.97	814.06	2035.83
T_6-50 % RDP Through Inorganic + 25cm × 25cm + 50% vermicompost through organic	15.67	4.55	5.98	837.89	2136.62
T_7-50 % RDP Through Inorganic + 30cm × 30cm + 50% vermicompost through organic	15.48	4.50	5.72	801	1995.32
T_8-50 % RDP Through Inorganic + 35cm × 35cm + 50% vermicompost through organic	15.83	4.68	6.23	846	2098.9
T_9-100 % RDP Through Inorganic + 30cm × 10cm (control)	15.83	4.68	6.30	871.66	2257.61
T_{10}-50 % RDP Through Inorganic + 30cm × 10cm + 50% vermicompost through organic	11.17	3.72	5.58	713.68	1891.21
Mean	14.95	4.45	6.02	833.502	2123.03
SEd	1.46	0.22	0.57	43.72	111.48
Cd(P=0.05)	3.07	0.48	NS	91.34	232.89

Table 3: Effect of optimization of spacing and phosphorus through organic and inorganic phosphorus level on economics of irrigated blackgram.

Treatments	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
T_1-100 % RDP Through Inorganic + 20cm × 20cm	62660.00	40769	1.86
T_2-100 % RDP Through Inorganic + 25cm × 25cm	57676.67	35785	1.63
T_3-100 % RDP Through Inorganic + 30cm × 30cm	51761.67	29856	1.36
T_4-100 % RDP Through Inorganic + 35cm × 35cm	52216.67	30319	1.39
T_5- 50% RDP Through Inorganic + 20cm × 20cm + 50% vermicompost through organic	52931.67	26103	0.97
T_6-50 % RDP Through Inorganic + 25cm × 25cm + 50% vermicompost through organic	54463.03	27643	1.03
T_7-50 % RDP Through Inorganic + 30cm × 30cm + 50% vermicompost through organic	52086.67	25274	0.94
T_8-50 % RDP Through Inorganic + 35cm × 35cm + 50% vermicompost through organic	55011.67	28187	1.05
T_9-100 % RDP Through Inorganic + 30cm × 10cm (control)	56658.33	34767	1.59
T_{10}-50 % RDP Through Inorganic + 30cm × 10cm + 50% vermicompost through organic	46388.33	19569	0.73

CONCLUSIONS

From the investigation it can be recommended that growing of blackgram with a spacing of 20cm × 20cm along with the application of 100% recommended dose of phosphorus (T_1) improves crop growth, yield and income.

FUTURE SCOPE

Extended-term studies could be performed to evaluate the influence of different management practices, such as irrigation, fertilization, and weed management, on the growth and productivity of crops cultivated under various spacing and phosphorus levels. Furthermore, these investigations could examine the long-term sustainability and economic feasibility.

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Conflict of Interest. None.

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