Original Research Article

Influence of Bio-fertilizers and Levels of Phosphorus on Growth and Yield of Cowpea (*Vigna Unguiculata* L.)

Abstract

A field experiment was conducted during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: Rhizobium + Phosphorous 30kg/ha, T_2: Rhizobium + Phosphorous 40kg/ha, T_3: Rhizobium + Phosphorous 50kg/ha, T_4: PSB + Phosphorous 30kg/ha, T_5: PSB + Phosphorous 40kg/ha, T_6: PSB + Phosphorous 50kg/ha, T_7: Rhizobium + PSB +Phosphorous 30kg/ha, T_8: Rhizobium + PSB +Phosphorous 40kg/ha, T_9: Rhizobium + PSB +Phosphorous 50kg/ha are used. The results showed that application of Rhizobium + PSB + Phosphorous 50kg/ha was recorded significantly Higher Plant height (83.89 cm), Nodules/Plant (24.84), Branches/plant (4.24), Plant dry weight (18.29 g/plant), Crop growth rate (5.78 g/m^2/day), Relative growth rate (0.0106 g/g/day), No. of Pods/plant (9.24), No. of Seeds/pod (11.25), Test weight (131.36 g), Seed yield (828.65 kg/ha), Stover yield (1282.58 kg/ha) and Harvest index (39.64) as compared to other treatments.

Key words: Rhizobium, PSB, Phosphorous, yield.

Introduction

Cowpea is an important kharif legume crop commonly known as lobia, southern pea, black eyed pea farmed throughout India for green pods, pulses, green manuring and livestock fodder. Cowpea is commonly grown in sub- tropical regions that are moderately humid and warm. It is more drought resilient however it is not tolerant to frost and waterlogging. Seeds of cowpea are nutritious and cheap source of quality protein, vitamins, iron, phosphorus as well as an excellent substitute for eggs, meat and other protein rich foods thus they are significant part of human diet. Cowpea grows predominantly in peninsular and central India. In northern India, it is grown in, Punjab, Rajasthan Haryana, Madhya Pradesh and Uttar Pradesh. During 2017 – 2018 the total coverage under cowpea in Uttar Pradesh is 23.61 lakh hectare with a production around 22.34 lakh tones **(Anonymous, 2018).** Phosphorus availability in Indian soils is poor to medium, however application of adequate amount of phosphorus has been recorded for higher formation of good quality nodules led to enhances growth and yield in legumes **(Sammuria *et al.*, 2009)**.

Biofertilizers are used with an objective to increase the microbial population in the rhizosphere which in turn enhances the availability of nutrients for easy assimilation by plants **(Sudhakar and Ranganathan, 2020)**. Biofertilizers, a component of integrated nutrient management and are considered to be cost effective, eco-friendly and renewable source of non-bulky, low cost plant nutrient supplementing fertilizers in sustainable agriculture system in India. Therefore, the role of biofertilizers assumes a special significance in present context of very high costs of chemical fertilizers.

Sufficient supply of phosphorus to plant, hastens the maturity and increases the rate of nodulation and pod development. It is also an important constituent of vital substances like phospholipids and phosphoprotein. Since legume is heavy feeder of phosphorus, therefore, application of phosphatic fertilizer to chickpea promotes the growth, nodulation and the yield. Phosphorus also imparts hardiness to shoot, improves the quality and regulates the photosynthesis and covers other physico- biochemical process. Most of the phosphorus present in the soil is unavailable to plants which are made available through the activities of efficient micro- organism like bacteria, fungi and even cyanobacteria with production of organic acid and increasing phosphatase enzyme activity **(Meena *et al.*, 2006).**

Materials and Methods

The present examination was carried out during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: Rhizobium + Phosphorous 30kg/ha, T_2: Rhizobium + Phosphorous 40kg/ha, T_3: Rhizobium + Phosphorous 50kg/ha, T_4: PSB + Phosphorous 30kg/ha, T_5: PSB + Phosphorous 40kg/ha, T_6: PSB + Phosphorous 50kg/ha, T_7: Rhizobium + PSB +Phosphorous 30kg/ha, T_8: Rhizobium + PSB +Phosphorous 40kg/ha, T_9: Rhizobium + PSB +Phosphorous 50kg/ha are used.

The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, no. of nodules per plant, branches per plant and plant dry weight are recorded. The yield parameters like pods per plant, seeds per pod, test weight, seed yield (kg/ha) and stover yield (kg/ha were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height

Significantly highest plant height (83.89 cm) was recorded in the treatment with Rhizobium + PSB + Phosphorous 50kg/ha over all the other treatments. However, the treatments with application of PSB + Phosphorous 50kg/ha (82.81 cm) and Rhizobium + PSB + Phosphorous 40kg/ha (83.02 cm) which were found to be at par with treatment Rhizobium + PSB + Phosphorous 50kg/ha as compared to all the treatments.

Phosphorus encourage formation of new cells, promote plant vigour and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes **Mir *et al*. (2013).**

Nodules/Plant

Treatment with Rhizobium + PSB + Phosphorous 50kg/ha was recorded with significantly highest Nodules/plant (24.84) over all the treatments. However, the treatments with PSB + Phosphorous 50kg/ha (23.18) and Rhizobium + PSB + Phosphorous 40kg/ha (24.02) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

When phosphorus supply is limited, the availability of phosphorus and Nitrogen to chloroplast became limited ultimately affect the photosynthetic processes as well as photosynthate supply to nodules. The effect of phosphorus could be related to the finding by that it stimulates root growth and activity and nodule formation. **Mir *et al*. (2013)** found the similar results.

No. of Branches/Plant

Maximum Number of Branches/plant (4.24) was observed in the treatment with Rhizobium + PSB + Phosphorous 50kg/ha. However, treatment with PSB + Phosphorous 40kg/ha (4.02), PSB + Phosphorous 50kg/ha (4.09) and Rhizobium + PSB + Phosphorous 40kg/ha (4.17) which was found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

Inoculation of biofertilizers stimulates activation of hormones which helps in shoot and root elongation and formation of new branches to the activation of harmones. Similar results were observed by **Bhat *et al*. (2005).**

Plant dry weight (g/plant)

Treatment with Rhizobium + PSB + Phosphorous 50kg/ha was recorded with significantly maximum dry weight (18.29 g/plant) over all the treatments. However, the treatments PSB + Phosphorous 50kg/ha (17.70 g/plant) and Rhizobium + PSB + Phosphorous 40kg/ha (18.01 g/plant) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

The plants attained more vigour with phosphorus, due to adequate supply and availability of nitrogen, phosphorus, potassium and spacing in balanced combination, resulting in increased dry weight of the plant.The application of Phosphorus 50 kg/ha to black gram significantly increased dry matter production. **Kumar *et al* (2014)** noted the similar results. Inoculation of cowpea with biofertilizers by microorganisms helped the production of organic acids, chelating oxoacids from sugars, and exchange reactions in growth environment, the results were found to similar with **Vijayakumar *et al.* (2004).**

Yield attrubutes and Yield

Pods/plant

Significantly Maximum Number of Pods/plant (9.24) was recorded with the treatment of application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments PSB + Phosphorous 50kg/ha (8.75) and Rhizobium + PSB + Phosphorous 40kg/ha (9.08) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha**.**

Application of P increased the number of pods per plant might be due to the enhanced early vegetative growth in terms of higher leaf area, dry matter accumulation and vigorous root system resulted in more branches which consequently increased the number of pod bearing branches significantly. Similar findings were observed by **Singh *et al.* (2020).**

Seeds/pod

Significantly Maximum Number of Seeds/Pod (11.25) was recorded with the treatment of application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments PSB + Phosphorous 50kg/ha (10.47) and Rhizobium + PSB + Phosphorous 40kg/ha (10.88) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha**.**

Significant increase in number of seeds/pod is due to increase in the availability of Nitrogen and phosphorous through Rhizobium and PSB bio fertilizer inoculation by which more seeds were produced due to increased rates of pods primordial production, similar results were found by **Nadeem *et al*. (2004).**

Test weight (g)

Significantly highest Test weight (131.36 g) was recorded with the treatment of application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments PSB + Phosphorous 50kg/ha (130.77 g) and Rhizobium + PSB + Phosphorous 40kg/ha (130.23 g) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

Seed yield (q/ha)

Significantly highest Seed yield (828.65 kg/ha) was recorded with the treatment application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments with (755.05 kg/ha) in PSB + Phosphorous 50kg/ha and with (798.09 kg/ha) in Rhizobium + PSB + Phosphorous 40kg/ha which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

The increase in seed yield due to phosphorus application is attributed to source and sink relationship. It appears that greater translocation of photosynthates from source to sink might have increased seed yield **(Patil *et al*. 2007).** Phosphorus increases yield due to its well-developed root system, increased N fixation and its availability to the plants and favourable environments in the rhizosphere. **Paes *et al* (2010).**

Stover yield (kg/ha)

Significantly highest Stover yield (1282.58 kg/ha) was recorded with the treatment application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments with (1179.34 kg/ha) in PSB + Phosphorous 50kg/ha and Rhizobium + PSB + Phosphorous 40kg/ha (1233.71 kg/ha) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

Increase in yield attributes and yield through bio-fertilizer might be attributed to supply of more plant hormones (auxin, cytokinin, gibberellin etc.) by the microorganisms inoculated or by the root resulting from reaction to microbial population similar results were obtained by **Singh and Pareek (2003).**

Harvest Index (%)

Significantly highest Harvest index (39.64%) was recorded with the treatment application of Rhizobium + PSB + Phosphorous 50kg/ha over all the treatments. However, the treatments with (38.84%) in PSB + Phosphorous 50kg/ha and Rhizobium + PSB + Phosphorous 40kg/ha (39.24%) which were found to be statistically at par with Rhizobium + PSB + Phosphorous 50kg/ha.

Highest harvest index was observed due to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth and yield attributes of the crops probably due to more absorption and utilization of available nutrients leading to overall improvement of crop growth reflected to source-sink relationship, which in turn enhanced the yield attributes that ultimately more yield which was reported by **Togay *et al.* (2005).**

CONCLUSION

It is concluded that application of treatment Rhizobium + PSB + Phosphorous 50kg/ha was recorded significantly higher Seed yield (828.65/ha), higher gross returns (Rs.58005.5/ha), net returns (Rs.40635.8/ha) and benefit cost ratio (2.33) as compared to other treatments. Since, the findings based on the research done in one season.

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Table 1: Effect of Bio-fertilizers and Levels of Phosphorus on growth attributes of Cowpea

Treatments	Plant height (cm)	Dry weight (g/plant)	Branches/plant	Nodules/plant
1. Rhizobium + Phosphorous 30kg/ha	77.23	15.55	3.63	16.34
2. Rhizobium + Phosphorous 40kg/ha	77.69	15.99	3.69	16.95
3. Rhizobium + Phosphorous 50kg/ha	80.57	16.98	3.89	21.05
4. PSB + Phosphorous 30kg/ha	78.16	16.40	3.76	18.23
5. PSB + Phosphorous 40kg/ha	81.27	17.25	4.02	22.22
6. PSB + Phosphorous 50kg/ha	82.81	17.70	4.09	23.18
7. Rhizobium + PSB +Phosphorous 30kg/ha	79.24	16.70	3.80	19.42
8. Rhizobium + PSB + Phosphorous 40kg/ha	83.02	18.01	4.17	24.02
9. Rhizobium + PSB + Phosphorous 50kg/ha	83.89	18.29	4.24	24.84
F- test	S	S	S	S
S. EM (±)	0.43	0.20	0.10	0.57
C. D. (P = 0.05)	1.29	0.59	0.30	1.71

Table 2: Influence of Bio-fertilizers and Levels of Phosphorus on Yield attributes and Yield of Cowpea

Treatments	Pods/plant	Seeds/pod	Test Weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
1. Rhizobium + Phosphorous 30kg/ha	6.34	7.57	123.41	544.41	948.55	34.66
2. Rhizobium + Phosphorous 40kg/ha	6.84	7.99	124.52	591.09	986.46	35.48
3. Rhizobium + Phosphorous 50kg/ha	8.02	9.27	128.27	698.23	1098.85	37.27
4. PSB + Phosphorous 30kg/ha	7.23	8.32	126.61	625.78	1028.03	36.42
5. PSB + Phosphorous 40kg/ha	8.34	9.70	129.08	703.47	1148.90	37.83
6. PSB + Phosphorous 50kg/ha	8.75	10.47	130.23	755.05	1179.34	38.84
7. Rhizobium + PSB +Phosphorous 30kg/ha	7.71	8.79	127.72	669.40	1000.67	36.89
8. Rhizobium + PSB + Phosphorous 40kg/ha	9.08	10.88	130.77	798.09	1233.71	39.29
9. Rhizobium + PSB + Phosphorous 50kg/ha	9.24	11.25	131.36	828.65	1282.58	39.64
F test	**S**	**S**	**S**	**S**	**S**	**S**
S. EM (±)	0.18	0.38	0.38	24.55	39.19	0.38
CD (P = 0.05)	0.54	1.15	1.15	73.60	117.49	1.14