

Original Research Article

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Effect of Phosphorus and PSB on Growth, Yield and Quality of Blackgram [*Vigna mungo* (L.) in Inceptisol

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ABSTRACT

A field experiment entitled “Effect of phosphorus and PSB on growth, nutrient content, uptake, yield and quality of black gram (*Vigna mungo* L.) in Inceptisol.” was carried out during the *Kharif* season 2017, at departmental farm of Soil Science and Agricultural Chemistry, College of Agriculture, Latur. The experiment was laid out in RBD with 10 treatment combination along with three replications. The results of field trial on response of black gram to application of different levels of phosphorus and PSB showed beneficial effect on growth, yield and quality of black gram. The growth parameter *viz.* nodulation, root length and chlorophyll content significantly improved due to application of 100% N + 60 kg P₂O₅ ha⁻¹ + PSB followed by application of 100% N + 50 kg P₂O₅ ha⁻¹ + PSB. Application of 100% N + 60 kg P₂O₅ ha⁻¹ + PSB was found to be superior for increase in grain and straw yield followed by 100% N + 50 kg P₂O₅ ha⁻¹ + PSB of black gram and also improve the quality of black gram seed in terms of test weight, protein content and protein yield. Among the treatments, application of 60 kg P₂O₅ ha⁻¹ combination along with PSB inoculation showed superiority over all the treatments for improving yield and quality of black gram grown on inceptisol. Thus, it can be concluded that the application of P (60 kg P₂O₅ ha⁻¹) in combination with PSB recorded statistically superior in growth, yield and quality of black gram as compared to alone application of different levels of P on low P content soils of inceptisol.

Keywords

Black gram, Levels of phosphorus, PSB (Phosphate solubilizing bacteria), Growth, yield and quality

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Introduction

Pulses occupy a unique position in cropping system as a main, catch, cover, green manure and as intercrop. Pulses play an important role in the Indian diet, constituting one of the most effective sources in India. As per recommendation of World Health Organization (WHO), minimum requirement

of pulses is 80 g/capita/day (Anonymous, 2011-12) but the availability of pulses is very low. Among the pulses, black gram (*Vigna mungo* L. Hepper) is one of the important pulse crops grown in India which belongs to the family ‘*Leguminosae*’ and genus ‘*Vigna*’. Black gram is a rich protein food. It contains about 24 percent protein, 1.74 per cent fat, 3.5 percent fiber and 67 per cent carbohydrates

and it is rich source of calcium and iron (Legume Res, 31 (1) 57-59, 2008). Due to high protein and carbohydrate content black gram is used in preparation of Dal makhni in Punjab or the Vada Sambhar, idali, dosa, utthapa in South India. Apart from this, black gram forms excellent forage and it gives a profuse vegetative growth and covers the ground so well that it checks the soil erosion. It also forms a good silage and green manure crop. It has ability to fix about 22.10 kg of atmospheric nitrogen per hectare through its root nodules. In India 29.28 million hectares land is under pulses cultivation which accounts 22.40 million tones of production. The productivity of pulse crop in India is about 765 kg ha⁻¹. In India area under black gram crop is 44.93 lakh ha and production is 29.26 lakh tones with the productivity of 651 kg ha⁻¹. In Maharashtra, 5.75 lakh ha area is under black gram cultivation and production is 3.27 lakh tones with the productivity of 568.70 kg ha⁻¹. India ranks first in production of black gram (Anonymous, 2016).

Phosphorus stimulates the symbiotic nitrogen fixation because in presence of phosphorus bacterial cell becomes mobile which is pre requisite for migration of bacterial cell to root hair for nodulation (Charel 2006). Phosphorus helps in proper root development which increases root nodules and consequently increases nitrogen fixation. It also plays an important role in the process of photosynthesis, energy conservation and transportation, cell division and meristematic growth in living tissues, grain quality and most of physico-bio-chemical activities.

Phosphate Solubilizing Bacteria (PSB) plays an important role in solubilization of soil P through secretion of various organic acids (formic, acetic, butyric, propionic, citric, gluconic, succinic, oxalic, malic, maleic and lactic acids) and make it available to plant (Gaur 1991). Many fungi, bacteria and actinomycetes are potential solubilizers of

bound phosphates in soil. More over use of PSB also reduce the environmental pollution caused by the heavy use of chemical fertilizers. Application of P along with PSB, improved phosphorus uptake by plants and yields indicating that the PSB were able to solubilize phosphates and to mobilize phosphorus in crop plants. Therefore, present study was taken to investigate the effect of levels of phosphorus and PSB on yield and quality of black gram.

Materials and Methods

The present investigation entitled “Effect of Phosphorus and PSB on yield and quality of Black gram [*Vigna mungo* (L.)] in Inceptisol.” was carried out in *kharif* during 2017-2018. Geographically Latur is situated between 18°05' to 18°75' North latitude and 77°36' E longitude. It's height from mean sea level is about 633.85 m and has sub-tropical climate. The experimental soil was clayey in texture, calcareous in nature (5.9%), moderately alkaline reaction (pH 7.95), EC (0.30 dSm⁻¹), low in content of organic carbon (0.50%), available zinc (0.55 ppm), available nitrogen (147.60 kg ha⁻¹), available phosphorous (9.85 kg ha⁻¹) and high in available potassium (322.78 kg ha⁻¹), medium in iron content (4.07 ppm). The experiment was laid out in Randomized Block Design with three replications. The experiment comprised of the ten treatment combinations i.e. control, PSB, 100% N + 30 kg ha⁻¹ P₂O₅, 100% N + 40 kg ha⁻¹ P₂O₅, 100% N + 50 kg ha⁻¹ P₂O₅, 100% N + 60 kg ha⁻¹ P₂O₅, 100% N + 30 kg ha⁻¹ P₂O₅ + PSB, 100% N + 40 kg ha⁻¹ P₂O₅ + PSB, 100% N + 50 kg ha⁻¹ P₂O₅ + PSB, 100% N + 60 kg ha⁻¹ P₂O₅ + PSB.

The pure seed of Black gram (TAU- 1) was obtained from farm section, College of Agriculture, Latur. Seeds were treated with the liquid PSB (strain- *Pseudomonas striata*) @ 100 ml/ 10 kg of seed. Sowing was carried out on 24th June, 2017 by dibbling two seeds at

each hill at specified spacing 30 cm × 10 cm. Recommended dose of fertilizer (25:50:00 kg ha⁻¹) viz., 100 % nitrogen was applied through urea and phosphorus was applied as per the treatment through SSP before sowing seed. All the recommended cultural and plant protection measures were followed throughout the experimentation. The data on root nodules plant⁻¹, root length (cm), chlorophyll content (mg g⁻¹) straw, seed yield (kg ha⁻¹), Test weight (gm), protein content (%) and protein yield (kg ha⁻¹) was also worked out.

Results and Discussion

Application of phosphorus and PSB produced significantly higher root length (cm), number of nodules plant⁻¹, chlorophyll content (mg g⁻¹) of black gram at 45 DAS showed in Table 1.

The maximum number of nodules per plant⁻¹ root length and chlorophyll content were recorded with the treatment T₆-100% N + 60 kg P ha⁻¹ 29.3, 24.5 and (chlorophyll-a 1.10, chlorophyll-b 0.39, total chlorophyll 2.49) followed by T₅-100% N + 50 kg P ha⁻¹ 28.6, 23.9 and (chlorophyll-a 1.09, chlorophyll-b 0.38, total chlorophyll 2.36) respectively over the control.

Further, the application of different P levels in combination with PSB inoculation influenced the root length of black gram. The maximum root length was observed in treatment T₁₀-100% N + 60 kg P ha⁻¹ + PSB 31.4, 26.3 and (chlorophyll-a 1.28, chlorophyll-b 0.48, total chlorophyll 2.66) followed by T₉-100% N + 50 kg P ha⁻¹ + PSB 30.6, 25.7 and (chlorophyll-a 1.26, chlorophyll-b 0.42, total chlorophyll 2.55) respectively as compared to the other treatments.

The increase in growth attributes due to phosphorus helps in early root development and formation of lateral fibrous, healthy roots

and root proliferation. P increases the metabolic activities and amount of naturally occurring phytohormones. PSB strains released greater amounts of available P and this enable the plant to absorb more P resulting in improved growth attributes. Similar results were reported by Niraj *et al.*, (2014), Madholiya (2015) and Vidhyashree *et al.*, (2017).

Data pertaining to the efficacy of P and inoculation of PSB on straw yield and grain yield of black gram presented in Table 2. The straw and grain yield of black gram was significantly increased by the application of different levels of P alone. The maximum increased in straw and grain yield were reported under the treatment T₆-100% N + 60 kg P ha⁻¹ (2268.84 and 1193.60 kg ha⁻¹) followed by T₅-100% N + 50 kg P ha⁻¹ (2208.86 and 1160.79 kg ha⁻¹) over absolute control (1910.22 and 997.08 kg ha⁻¹) respectively.

Whereas, the application of different P dose in combination with PSB inoculation also influenced the straw and grain yield of black gram. The treatment T₁₀-100% N + 60 kg P ha⁻¹ + PSB were recorded maximum increased in straw and grain yield (2407.36 and 1258.91 kg ha⁻¹) followed by T₉-100% N + 50 kg P ha⁻¹ + PSB (2358.08 and 1230.45 kg ha⁻¹) respectively as compared to the rest of the treatments.

Alone application of P levels increased the straw and grain yield in T₆-100% N + 60 kg P ha⁻¹ by (18.7 and 19.7 %) while application of P and PSB also shows significantly increased in straw and grain yield in T₁₀-100% N + 60 kg P ha⁻¹ + PSB by (26.0 and 26.25 %) respectively as compared to the control plot. Due to inoculation of PSB treatment shows 5 percent increase in straw yield over absolute control.

The increased in straw yield might be due to vigorous start to plant and strength straw yield by P application. The application of P through SSP also provides S to the soil and plant which encourages vegetative plant growth, constituent of proteins and enzymes and helps in reduction oxidation system in respiration and increases root growth. Similar results were reported by Appana *et al.*, (2008), Patil *et al.*, (2011) and Gajera *et al.*, (2014). With the application of different P levels and bio-fertilizer increased grain yield these could be due to increased availability of photosynthates

to the reproductive part during pod filling stage. P is a constituent of plant cells and involved in transport and conversion of solar energy into simple sugars and energy compounds like ATP and ADP. Microorganisms through secretion of different organic acids and rhizosphere pH lowering mechanism dissociates the bound form of P among various factors that can contribute to crop yield. These results are in conformity with the Balaguravaviah *et al.*, (1989), Gupta *et al.*, (2016) and Prajapati (2014).

Table.1 Effect of P levels and PSB on root length (cm), number of nodules plant⁻¹, chlorophyll content (mg g⁻¹) of black gram at 45 DAS

Treatments	Root nodules	Root length	Chlorophyll - a	Chlorophyll - b	Total Chlorophyll
T ₁ - Absolute control	24.53	20.7	0.85	0.29	1.75
T ₂ - PSB	25.71	22.7	0.88	0.30	1.84
T ₃ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹	26.79	23.1	0.93	0.35	2.05
T ₄ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹	27.88	23.5	1.01	0.36	2.29
T ₅ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹	28.67	23.9	1.09	0.38	2.36
T ₆ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹	29.33	24.5	1.10	0.39	2.49
T ₇ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹ + PSB	28.41	24.6	1.21	0.41	2.28
T ₈ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹ + PSB	29.49	25.1	1.24	0.40	2.41
T ₉ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹ + PSB	30.69	25.7	1.26	0.42	2.55
T ₁₀ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹ + PSB	31.48	26.3	1.28	0.48	2.66
SE±	0.46	0.35	0.028	0.029	0.038
CD@ 5 %	1.38	1.05	0.079	0.082	0.11

Table.2 Effect of P levels and PSB inoculation on straw and grain yield (kg ha⁻¹) of black gram

Treatments	Straw yield	Grain yield
T ₁ - Absolute control	1910.22	997.083
T ₂ – PSB	2007.89	1019.33
T ₃ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹	2122.54	1084.17
T ₄ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹	2183.92	1132.69
T ₅ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹	2208.86	1160.79
T ₆ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹	2268.84	1193.60
T ₇ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹ + PSB	2247.02	1143.27
T ₈ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹ + PSB	2299.09	1188.91
T ₉ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹ + PSB	2358.08	1230.45
T ₁₀ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹ + PSB	2407.36	1258.91
SE±	17.66	18.73
CD@ 5 %	52.42	55.67

Table.3 Effect of P levels and PSB inoculation on test weight (gm), protein content (%) in seed and protein yield (kg ha⁻¹) of black gram

Treatments	Test weight	Protein content	Protein yield
T ₁ - Absolute control	40.62	20.15	200.81
T ₂ – PSB	41.32	20.36	207.60
T ₃ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹	42.57	20.83	228.42
T ₄ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹	42.79	21.79	248.39
T ₅ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹	43.97	22.10	256.59
T ₆ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹	44.48	22.70	266.66
T ₇ - 100 % N + 30 kg P ₂ O ₅ ha ⁻¹ + PSB	43.50	22.37	255.76
T ₈ - 100 % N + 40 kg P ₂ O ₅ ha ⁻¹ + PSB	43.94	22.81	269.77
T ₉ - 100 % N + 50 kg P ₂ O ₅ ha ⁻¹ + PSB	44.86	23.22	285.91
T ₁₀ - 100 % N + 60 kg P ₂ O ₅ ha ⁻¹ + PSB	45.65	23.77	294.46
SE±	0.83	0.23	6.28
CD@ 5 %	2.49	0.70	18.67

Data regarding the Effect of P levels and PSB culture on test weight, protein content and protein yield of black gram reported in Table 3. Different levels of P alone were significantly increased the test weight. The treatment T₆-100% N + 60 kg P ha⁻¹ (44.48 gm) followed by T₅-100% N + 50 kg P ha⁻¹ (43.97 gm) over absolute control. Whereas, the successive application of different P levels along with PSB also enhance the test weight of black gram. Maximum test weight were observed in treatment T₁₀-100% N + 60 kg P ha⁻¹ + PSB (45.65 gm) followed by T₉-100% N + 50 kg P ha⁻¹ + PSB (44.86 gm) as compared to control, single and combined application of P and PSB.

P application increased the test weight by stimulating flowering and aids in seed formation. Increase in test weight due to more number of heavy weighed and bold seeds with application of P and PSB. Similar results were reported by the Ullah *et al.*, (2010) and Verma *et al.*, (2017).

Protein content in seed and protein yield were significantly affected by the application of various P dose. The higher protein content and protein yield of black gram were observed under the treatment T₆-100% N + 60 kg P ha⁻¹ (22.70 % and 266.66 kg ha⁻¹) followed by T₅-100% N + 50 kg P ha⁻¹ (22.10 % and 256.59 kg ha⁻¹) respectively over absolute control.

The data further revealed that the combined application of P at different levels + PSB inoculation increased the protein content and protein yield of black gra. The higher protein content and protein yield was recorded under the treatment T₁₀-100% N + 60 kg P ha⁻¹ + PSB (23.77 % and 294.46 kg ha⁻¹) followed by T₉-100% N + 50 kg P ha⁻¹ + PSB (23.22 % and 285.91 kg ha⁻¹) respectively over the rest of treatments. The increase in protein content

of seed due to higher supply of N through solubilization function of PSB. P helps in root enlargement, better microbial activities resulted in more availability and uptake of N thereby, increased protein content increase in protein content ultimately resulted in increased protein yield. Similar results were reported by Gadhavi *et al.*, (2005), Madane *et al.*, (2014) and Dongare *et al.*, (2016)

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