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Response of different levels of nitrogen, potassium and PSB on growth and yield attributes of greengram (*Vigna radiata* L.)

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Abstract

The experiment was conducted during the *zaid* season of 2018 in the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad. The experiment was laid out in Randomized Block Design. The three factors are Nitrogen, Potassium and PSB. PSB has two levels *i.e.* inoculated and un inoculated, two levels of Nitrogen @ 10 kg/ha and 20 kg/ha, and two levels of Potassium 15 kg/ha and 20 kg/ha respectively comprising of nine treatment combinations each replicated thrice. Treatments were randomly arranged in each replication, divided into twenty seven plots. It is concluded that treatment T₅ [N (20Kg/ha)+K(20Kg/ha) + PSB(I)] was found to be the best treatment for obtaining higher growth and yield attributes *viz.*, plant height (46.47 cm) at 60 DAS, dry weight (16.930 g) at 60 DAS, Crop Growth Rate (9.78 g m⁻² day⁻¹) at 60 DAS, number of branches/plant (5.88) at 60 DAS, number of nodules/plant (30.89) at 45 DAS, number of pods/plant (16.33) and test weight (40.33 g) were obtained with green gram whereas, Relative Growth Rate and number of seeds/pod were found to be non-significant.

Keywords: Green gram, nitrogen, potassium and PSB

Introduction

Mungbean is one of the most important pulse crops for protein supplement in subtropical zones of the world. It is mainly grown in India, Burma, Ceylon, Pakistan, China, Fiji and Africa. It is widely grown in Indian subcontinent as a short duration catch crop between two principal crops. Mungbean contains 51% carbohydrate, 24–26% protein, 4 % mineral, and 3% vitamins. Besides providing protein in the diet, Mungbean has the remarkable quality of helping the symbiotic root rhizobia to fix atmospheric nitrogen and hence to enrich soil fertility. It has been reported that the crop produces equivalent to 22.10 kg of N ha⁻¹, which has been estimated to supplement 59 thousand tons of urea annually. In India, greengram occupies 3.44 million hectares and contributes to 1.45 million metric tons in pulse production (Directorate of Economics and Statistics, 2013-14). The important greengram growing states are Orissa, Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan and Bihar. Nitrogen requirement of pulses is very low than other crops because nitrogen is needed only for establishment of plant, later on plants have their own potentiality to fulfil their requirement through symbiotic nitrogen fixation. Nitrogen is an essential element for proper plant growth and development. It imparts green colour to leaves and stems and enables them for efficient photosynthesis. Phosphorus is an important plant nutrient which is referred to as the “Master key” element in crop production. It is associated with several vital functions like seed germination, cell division, flowering, fruiting, synthesis of fat, starch and in almost every biochemical activities. It also induces root proliferation and nodulation. Phosphorus has novel function of special importance in the process of energy storage and transfer. Most of the grain legumes have responded well due to its favorable effects on roots proliferation, nodules development, bacterial activity and nitrogen fixation.

Potassium is the third macro nutrient required for plant growth, after nitrogen and phosphorus (Abbas *et al.*, 2011) [3] and also plays a vital role as macronutrient in plant growth and sustainable crop production (Baligar *et al.*, 2001) [6]. Its adequate supply during growth period improves the water relations of plant and photosynthesis (Bukhsh *et al.*, 2011) [7], synthesizes

the protein, creates resistance against the pest attack and diseases (Arif *et al.*, 2004)^[1] and enhances the mungbean yield (Ali *et al.*, 2010)^[2]. Water deficit is frequently the primary limiting factor for crop production under arid and semi-arid conditions (Hussain *et al.*, 2011)^[10].

In recent years several strains of phosphate solubilizing bacteria (PSB) and fungi are isolated. The mechanism of action of these micro-organisms involves secretion of organic acids which lower the pH and increase the availability of sparingly soluble phosphorus sources. Inoculation of seed with PSB culture may increase the production and productivity of urdbean crops as reported by Shrivastava and Ahlawat, (1995)^[15]. The nutrient requirement of crop is met by the chemical fertilizers. However, fertilizer alone cannot sustain productivity of land in modern farming. Similarly, nutrient supply through organic manures and bio fertilizers can hardly fulfill the need of a crop. Accordingly integration of organic and inorganic sources may sustain the productivity and may improve the soil properties.

Among the various factors responsible for maximization of yield of this crop, integration of chemical and bio fertilizers is most important factor. For maximizing the yield, it is essential that green gram should not suffer due to inadequate mineral nutrient especially nitrogen and phosphorus. Since chemical fertilizers are scarce and costly, it is necessary to use them economically in combination with bio fertilizers, as green gram shows high response to bio fertilizers.

Materials and methods

A field experiment was conducted during the *zaid* season of 2018 in the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj (U.P.), which is located at 25° 57' N latitude, 87° 50' E longitude and at an altitude of 98 m above the mean sea level. The soil of experimental field was sandy loam having pH of 7.2 with 0.45% organic carbon, available nitrogen 225 kg ha⁻¹, available phosphorus 19.50 kg ha⁻¹, and available potassium 92.00 kg ha⁻¹. The experiment was laid out in randomized block design. The three factors are Nitrogen, Potassium and PSB. PSB has two levels *i.e.* inoculated and un inoculated, two levels of Nitrogen @ 10 kg/ha and 20 kg/ha, and two levels of Potassium 15 kg/ha and 20 kg/ha respectively comprising of nine treatment combinations each replicated three times. Treatments were randomly arranged in each replication, divided into twenty seven plots. Fertilizers were applied as side placement, for which 4-5 cm deep furrows were made along the seed rows with a *hand hoe*. The nutrient sources were urea and Muriate of Potash (MOP) to fulfil the requirement of N and, K₂O/ha. The recommended dose of 10, 20 kg N & 15, 20 kg K₂O per ha was applied according to the treatment details through Urea and MOP. Whole of nitrogen, and potash was applied as basal at the time of sowing.

Results and discussion

Plant height (cm)

The data pertaining to plant height is presented in Table 1. Maximum increase in plant height at 60 DAS was recorded with treatment T₅ [N (20 Kg ha⁻¹) +K (20 Kg ha⁻¹) + PSB (I)] (46.47 cm) followed by treatment T₃ N (20 Kg ha⁻¹) +K(15 Kg ha⁻¹) + PSB(I) (45.13cm). Whereas minimum increase in plant height at 60 DAS was recorded with treatment T₁: control (37.67 cm). The inoculation with PSB also significantly increased the values of growth parameters as its combination gave synergistic effect. A positive influence of PSB inoculation on plant growth parameter was observed due

to higher enzyme activities in the PSB and better nutrient availability besides the production of the plant growth regulators by bio-inoculants which stimulated plant growth. The results obtained in the investigation are in line with the findings of Vikram and Hamzehzarghani (2008)^[16], Bansal (2009)^[5].

Dry weight (g)

The data related to Dry weight is presented in Table 1. Maximum increase in dry weight accumulation per plant (g) at 60 DAS was recorded with treatment T₅ [N (20 Kg ha⁻¹) +K (20 Kg ha⁻¹) + PSB (I)] (16.93 g) followed by treatment T₃ [N (20 Kg ha⁻¹) +K (15Kg ha⁻¹) + PSB (I)] (12.42 g). Whereas minimum increase in dry weight at 60 DAS was recorded with treatment T₁ (Control) (7.74 g). Dry matter accumulation increased markedly with inoculation of PSB under the higher level of fertility. Such influence of treatment may be attributed to higher microbial population favouring more N contents (%) and its association with increased chlorophyll formation due to PSB inoculation and increased phosphate activity (that increased phosphorus supply to plants) and the beneficial effects of production of growth regulators due to PSB inoculation. The similar reasons were also proposed by Ihsan *et al.* (2013)^[11]

Crop growth rate (g m⁻² day⁻¹)

The data related to Crop growth rate is presented in the Table 1. Maximum increase in Crop Growth Rate (g m⁻²day⁻¹) at 60 DAS was recorded with treatment T₅ [N (20Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB (I)] (9.78) followed by treatment T₉ [N (20Kg ha⁻¹) + K (20Kg ha⁻¹) + PSB (UI)] (6.90). Whereas minimum increase in Crop Growth Rate (g m⁻² day⁻¹) at 60 DAS was recorded with treatment T₁ (Control) (3.998). The inoculation with PSB also significantly increased the values of growth parameters as its combination gave synergistic effect. A positive influence of PSB inoculation on plant growth parameter was observed due to higher enzyme activities in the PSB and better nutrient availability besides the production of the plant growth regulators by bio-inoculants which stimulated plant growth. The results obtained in the investigation are in line with the findings of Kumar and Chandra (2003)^[12]

Relative Growth Rate (g g⁻¹ day⁻¹)

The data related to Relative Growth Rate was presented in Table 1. Maximum increase in Relative Growth Rate (g g⁻¹ day⁻¹) at 60 DAS was recorded with treatment T₄ [N (10 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB (I)] (0.086) followed by treatment T₁ (Control) (0.076) whereas minimum increase in Relative Growth Rate (g g⁻¹ day⁻¹) at 60 DAS was recorded with treatment T₂ [N(10Kg/ha)+K(15Kg/ha) + PSB] (0.055) while the effect of treatments were non-significant. Dry matter accumulation increased markedly with inoculation of PSB under the higher level of fertility. Such influence of treatment may be attributed to higher microbial population favouring more N contents (%) and its association with increased chlorophyll formation due to PSB inoculation and increased phosphates activity (that increased phosphorus supply to plants) and the beneficial effects of production of growth regulators due to PSB inoculation. The similar reasons were also proposed by Ajay *et al.* (2014)^[4].

Number of branches per plant

The data related to Number of branches per plant was presented in Table 1. At 60 DAS the maximum number of branches (5.88) was observed by application of T₅ [N (20 Kg

ha⁻¹) + K (20 Kg ha⁻¹) + PSB] whereas the lowest value (4.11) was observed in T₁ (Control). However, T₃ [N(20 Kg ha⁻¹)+K(15 Kg ha⁻¹) + PSB] were found statistically at par with T₅ [N(20 Kg ha⁻¹)+K(20 Kg ha⁻¹) + PSB] at 60 DAS. The inoculation with PSB also significantly increased the values of growth parameters as its combination gave synergistic effect. A positive influence of PSB inoculation on plant growth parameter was observed due to higher enzyme activities in the PSB and better nutrient availability besides the production of the plant growth regulators by bio-inoculants which stimulated plant growth. The results obtained in the investigation are in line with the findings of Vanita *et al.* (2014)^[17].

Number of nodules/ plant

The data related to Number of nodules per plant was presented in Table 1. At 45 DAS there was significant difference between the treatments and maximum number of

nodules (30.89) was observed in the application of T₅ [N (20 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB], whereas the lowest value (21.00) in T₁ [N (10 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB]. However, T₃ [N (20 Kg ha⁻¹) + K (15 Kg ha⁻¹) + PSB], T₄ [N (10 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB] and T₉ [N (20 Kg ha⁻¹) + K (20 Kg ha⁻¹)] were found statistically at par with T₅ [N (20 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB]. The root nodules plant⁻¹ was observed significantly enhanced with the medium of higher fertility levels under inoculation of PSB as compared to the inoculation and control during all observation period. It was due to higher number of bacteria present under inoculated condition than un-inoculated plots. PSB inoculation showed more available phosphorus in soil, which favoured better root growth and resulted in a beneficial effect of nodulation with increased PSB bacterial activity. The results were in close conformity with the observation recorded by Kumawat *et al.* (2010)^[13].

Table 1: Response of Different levels of Nitrogen, Potassium and PSB on Growth attributes of Greengram

| Treatment | Plant height (cm) at 60 DAS | Dry weight (g) at 60 DAS | CGR (g m ⁻² day ⁻¹) 60 DAS | RGR (g g ⁻¹ day ⁻¹) 60 DAS | No. of branches/ plant at 60 DAS | No. of nodules/plant at 45 DAS |
|--|-----------------------------|--------------------------|---|---|----------------------------------|--------------------------------|
| T ₁ : control | 37.65 | 7.74 | 3.99 | 0.076 | 4.11 | 21.00 |
| T ₂ : N(10Kg/ha)+K(15Kg/ha) + PSB(I) | 40.20 | 10.18 | 4.97 | 0.055 | 4.66 | 26.88 |
| T ₃ : N(20Kg/ha)+K(15Kg/ha) + PSB(I) | 45.13 | 12.42 | 6.45 | 0.056 | 5.44 | 30.33 |
| T ₄ : N(10Kg/ha)+K(20Kg/ha) + PSB(I) | 41.40 | 12.09 | 6.82 | 0.086 | 5.11 | 28.39 |
| T ₅ : N(20Kg/ha)+K(20Kg/ha) + PSB(I) | 46.47 | 16.93 | 9.79 | 0.066 | 5.88 | 30.89 |
| T ₆ : N(10Kg/ha)+K(15Kg/ha) + PSB(UI) | 38.73 | 9.20 | 4.74 | 0.056 | 4.55 | 24.22 |
| T ₇ : N(20Kg/ha)+K(15Kg/ha) + PSB(UI) | 41.13 | 10.97 | 6.18 | 0.063 | 5.11 | 27.44 |
| T ₈ : N(10Kg/ha)+K(20Kg/ha) + PSB(UI) | 39.67 | 9.41 | 4.56 | 0.056 | 4.55 | 25.33 |
| T ₉ : N(20Kg/ha)+K(20Kg/ha) + PSB(UI) | 42.40 | 11.99 | 6.89 | 0.066 | 5.33 | 28.44 |
| F – test | S | S | S | NS | S | S |
| S. Ed. (±) | 4.06 | 3.74 | 2.49 | 0.068 | 0.77 | 1.38 |
| C. D. at 5% | 2.59 | 1.49 | 1.23 | - | 0.42 | 2.93 |

Number of pod plant⁻¹

The data related to number of pod plant⁻¹ was presented in Table 2. The results revealed that there was significant difference between the treatments and maximum number of pods (16.33) was observed by the application of T₅ [N (20 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB], whereas the lowest value (7.89 plant⁻¹) was observed in treatment T₁ Control. However, treatment, T₃ [N(20Kg ha⁻¹)+K(15Kg ha⁻¹) + PSB], T₄ [N(10Kg ha⁻¹)+K(20Kg ha⁻¹) + PSB] and T₉ [N(20Kg ha⁻¹)+K(20Kg ha⁻¹)] were found statistically at par with T₅ [N(20

Kg ha⁻¹)+K(20 Kg ha⁻¹) + PSB]. The increase in above parameters with the application of nitrogen and potassium in appropriate level might be due to its favourable effect on growth parameters. The significant increase in test weight due to the application of medium level of fertility might be on account of better removal and translocation of nutrients, especially phosphorus, resulting in hold seed formation by increasing the size and weight of grains. The results are in close accordance with findings of Kumar *et al.* (2003)^[12].

Table 2: Response of Different levels of Nitrogen, Potassium and PSB on yield attributes of Greengram

| Treatment | No. of pods/ plant 60 DAS | No. of seeds/ pod 60 DAS | Test weight (g) |
|--|---------------------------|--------------------------|-----------------|
| T ₁ : control | 7.89 | 8.67 | 29.96 |
| T ₂ : N(10Kg/ha)+K(15Kg/ha) + PSB(I) | 10.77 | 9.53 | 35.06 |
| T ₃ : N(20Kg/ha)+K(15Kg/ha) + PSB(I) | 16.11 | 10.73 | 39.22 |
| T ₄ : N(10Kg/ha)+K(20Kg/ha) + PSB(I) | 13.88 | 10.40 | 36.53 |
| T ₅ : N(20Kg/ha)+K(20Kg/ha) + PSB(I) | 16.33 | 10.80 | 40.33 |
| T ₆ : N(10Kg/ha)+K(15Kg/ha) + PSB(UI) | 9.44 | 9.07 | 32.28 |
| T ₇ : N(20Kg/ha)+K(15Kg/ha) + PSB(UI) | 11.11 | 8.33 | 37.26 |
| T ₈ : N(10Kg/ha)+K(20Kg/ha) + PSB(UI) | 10.11 | 11.64 | 33.38 |
| T ₉ : N(20Kg/ha)+K(20Kg/ha) + PSB(UI) | 15.33 | 10.40 | 38.26 |
| F – test | S | NS | S |
| S. Ed. (±) | 4.43 | 1.56 | 0.750 |
| C. D. at 5% | 3.42 | - | 0.62 |

Number of seed pod⁻¹

The data related to number of seed pod⁻¹ was presented in Table 2. The results revealed that there was non-significant difference between the treatments and maximum number of seed (11.64) was observed by the application of T₈ [N(10 Kg ha⁻¹)+K(20 Kg ha⁻¹)], whereas the lowest value number of seed (8.33) was observed in treatment T₇ [N(20 Kg ha⁻¹)+K(15 Kg ha⁻¹)]. Enhanced vegetative growth in term of dry matter production and branches/plant⁻¹ provided more sites for the translocation of photosynthetic and ultimately resulted in increased number of pods plant⁻¹, grains pod⁻¹, pod length and test weight were significantly benefitted with the availability of nutrients through PSB and fertility levels during crop growing season, which ultimately contributed towards higher yield. Choudhary *et al.* (2015).

Test weight (g)

The data related to test weight (g) was presented in Table 2. The results revealed that the difference between the treatments were significant with maximum test weight (40.33g) was observed in treatment T₅ [N (20 Kg ha⁻¹) + K (20 Kg ha⁻¹) + PSB] and minimum test weight (29.96 g) was observed in treatment T₁ Control. However, treatment, T₉ [N(20 Kg ha⁻¹)+K(20 Kg ha⁻¹)] and T₃ [N(20 Kg ha⁻¹)+K(15 Kg ha⁻¹) + PSB] was found statistically at par with T₅ [N(20 Kg ha⁻¹)+K(20 Kg ha⁻¹) + PSB]. The significant increase in test weight due to the application of medium level of fertility might be on account of better removal and translocation of nutrients, especially phosphorus, resulting in hold seed formation by increasing the size and weight of grains. The results are in close accordance with findings of Kumar *et al.* (2003)^[12].

Conclusion

Based on the findings, of this experiment it can be concluded that application of 20 kg nitrogen and 20 kg potassium through urea and MOP respectively with seed inoculation from PSB was found to be best for the farmers.

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