



# **Influence of Biofertilizers and Gibberellic Acid on Growth and Yield of Blackgram (*Vigna mungo* L.)**

**Charles Wesley J. <sup>a++\*</sup> and Joy Dawson <sup>a#</sup>**

<sup>a</sup> Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India.

## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/IJECC/2023/v13i92235

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/101961>

**Original Research Article**

**Received: 20/04/2023**

**Accepted: 22/06/2023**

**Published: 01/07/2023**

## **ABSTRACT**

A field experiment was conducted during *Zaid* season 2023 at CRF, (Crop Research Farm), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *Zaid* season of 2023. The purpose of this research is to study the Influence of Biofertilizers and Gibberellic acid on growth and yield of Blackgram. The soil of experimental plot was sandy loam in texture, Basic in soil reaction (pH 7.19), low in organic carbon (0.54%), available N (286.93 kg/ha), available P (21.67 kg/ha), available K (157.12 kg/ha). The treatments included PSB seed inoculation at 10 and 20g/1kg seeds, Rhizobium seed inoculation at 10 and 20g/1kg seeds and three levels of Gibberellic acid foliar application (50,100 and 150ppm) and control (20:40:20 NPK kg/ha) were used. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. As a result, Maximum plant height (36.03 cm), plant dry weight (6.72 g/plant), Crop growth rate (7.08 g/m<sup>2</sup>/day), Relative growth rate (0.056 g/g/day), Maximum Pod/plants (21.85), Seeds/pod (4.42), Seed yield (1.12 t/ha), Stover yield (2.03 t/ha) Test weight (34.89 g) and Harvest index (35.63 %) were recorded. Higher Gross

<sup>++</sup> M.Sc. Scholar;

<sup>#</sup> Professor and Head;

\*Corresponding author: E-mail: [jcharleswesley@gmail.com](mailto:jcharleswesley@gmail.com);

returns (84179.17 Rs./ha), Net returns (57761.07 Rs./ha) and Benefit Cost Ratio (2.19) were obtained with application of (PSB 10g/1kg seeds, Rhizobium 10g/1kg seeds and Gibberellic acid at 150ppm).

**Keywords:** Black gram; gibberellic acid; PSB; rhizobium; growth and yield.

## 1. INTRODUCTION

“Blackgram (*Vigna mungo*) is one of important pulse crop. The food legumes, particularly the grain or pulses are important food stuff in all tropical and subtropical countries. It is grown throughout India”. [1] Black gram is widely grown grain legume and belongs to the family “leguminosae” and genus “vigna” and assumes considerable importance from the point of food and nutritional security in the world. “It is also known as urdbean, udad dal, urad dal or urad. It also acts as cover crop and its deep root system protects the soil from erosion. The crop also improves soil fertility by symbiotic fixation of atmospheric nitrogen in root nodules” [1].

“Black gram is the cheapest source of protein for the poor and is called the poor men’s meat. It contains approximately 25-28 per cent protein, 4.5-5.5 per cent ash, 0.5-1.5 per cent oil, 3.5-4.5 per cent fibre and 62-65 percent carbohydrate on dry weight basis. Pulses are commonly grown in soils with low fertility status or with application of low quantities of organic and inorganic sources of plant nutrients, which in turn resulted in deterioration of soil health and productivity” [2].

“Pulse can fix atmospheric nitrogen through the symbiotic relationship between the host black gram roots and soil bacteria and thus improves soil fertility. In general, pulses do not require to be provided with external N application. But slow rate of dry matter accumulation during pre-flowering phase, leaf senescence during the period of pod development and low partitioning efficiency of assimilates to grain, which is identified as the main physiological constraints for increasing yield. But, these are also attributed in black gram for as key factors highly responsive to nitrogen. For the pulse crops, nitrogen is most useful because it is the main component of protein. The management of fertilizer greatly affects the growth, development and yield of this crop” [3].

Biofertilizers like (PSB) create plant development ingredients in the soil by saturating insoluble soil phosphates like tri-calcium phosphate. Rhizobium is among the different bio- fertilizers of utmost significance. With the help of legumes,

rhizobium fixes atmospheric nitrogen symbiosis. More phosphorus was readily accessible in the soil after PSB inoculation, which encouraged improved root development and produced a positive nodulation effect with higher PSB bacterial activity. Increased nitrogen fixation might increase output if a productive strain of Rhizobium is introduced to a nitrogen-deficient soil. As inoculants in the root zone of crop plants, phosphorus-solubilizing bacteria partially solubilize the insoluble phosphate and increase phosphorus usage productivity. “Gibberellic acid (GA3) is an important PGR that affects plant growth and development by inducing metabolic activities and regulating nitrogen

Utilization” (Sure et al. 2012). “It also plays a significant role in seed germination, endosperm mobilization, stem elongation, leaf expansion, reducing the maturation time and increasing flower and fruit set and their composition” (Roy & Nasiruddin 2011). “GA3 delays senescence, improves growth and development of chloroplasts, and intensifies photosynthetic efficiency which could lead to increased yield” [4]. The applications of gibberellins increase the seed germination percentage by attributing the fact that they increase the amino acid content in embryo and cause release of hydrolytic enzyme required for digestion of endospermic starch when seeds renew growth at germination. Keeping these considerations in mind, the current study, “Influence of Biofertilizers and Gibberellic acid on growth and yield of blackgram (*vigna mungo* L.)”, During the Zaid season 2023, Naini Agriculture Institute will be a part of Sam Higginbottom University of Agriculture, Technology and Sciences in Prayagraj, Uttarpradesh.

## 2. MATERIALS AND METHODS

The experiment was conducted during the Zaid season 2023, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25.4089724 North latitude, 81.8535686 East longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right

**Table 1. Treatment combinations**

SI No.	Treatment combinations
1	PSB (20g/1kg seeds) + Gibberellic acid - (50ppm)
2	PSB (20g/1kg seeds) + Gibberellic acid - (100ppm)
3	PSB (20g/1kg seeds) + Gibberellic acid - (150ppm)
4	Rhizobium (20g/1kg seeds) + Gibberellic acid -(50ppm)
5	Rhizobium (20g/1kg seeds) + Gibberellic acid -(100ppm)
6	Rhizobium (20g/1kg seeds) + Gibberellic acid -(150ppm)
7	PSB (10g/1kg seeds) + Rhizobium (10g/1kg seeds) + Gibberellic acid - (50ppm)
8	PSB (10g/1kg seeds) + Rhizobium (10g/1kg seeds) + Gibberellic acid - (100ppm)
9	PSB (10g/1kg seeds) + Rhizobium (10g/1kg seeds) + Gibberellic acid - (150ppm)
10	Control (NPK-20:40:20 kg/ha)

side of the Yamuna River of Prayagraj - Rewa road about 12 km from the city. The soil of experimental plot was sandy loam in texture, Basic in soil reaction (pH 7.19), low in organic carbon (0.54%), available N (283.93 kg/ha), available P (21.67 kg/ha), available K (157.12 kg/ha). The weekly minimum and maximum temperature ranged from 23.10 to 38.61°C and Relative humidity ranged 26.42 to 43.26 % The treatments included PSB seed inoculation at 10 and 20g/1kg seeds, Rhizobium seeds inoculation at 10 and 20g/1kg seeds and three levels of Gibberellic acid foliar application (50,100 and 150ppm) and control (20:40:20 NPK kg/ha) were used. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The plots were set up with dimensions of 3 m x 3 m, and seeds of the Shekar-II variety were planted with 30 cm x 10 cm spacing. In determining growth characteristics, the following formulas were used: plant height (cm), dry weight per plant (g), crop growth rate (g/m<sup>2</sup>/day), and relative growth rate (g/g/day). The crop was completely harvested at the point of physiological maturity, and observations were made, including the number of pods per plant, the number of seeds per pod, the test weight in (g) of 1,000 seeds, the seed yield in tonnes per hectare (t/ha), and the stover yield in tonnes per hectare (t/ha). The growth parameters of the plants were recorded at frequent intervals from Sowing until 60 DAS and finally, the yield parameters were recorded after harvest.

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameters

##### 3.1.1 Plant height (cm)

At 60 DAS, the highest plant height (36.03 cm) was recorded with treatment 9 (PSB 10g/1kg

seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 5 (Rhizobium 20g/1kg seeds + Gibberellic acid at 100ppm) and treatment 6 (Rhizobium 20g/1kg seeds + Gibberellic acid at 150ppm) and treatment 8 (PSB at 10g/1kg seeds + 10g/1kg seeds Rhizobium and Gibberellic acid at 100ppm), While the minimum was recorded in treatment 10 (31.25 cm) with (Control NPK 20:40:20 kg/ha).

Significant and higher plant height was observed with the application of biofertilizer PSB and Rhizobium might be due to better uptake and translocation of plant nutrients. Similar results were reported by Yadav et al, [5].

Foliar application of GA3 resulted in significantly higher plant height, number of leaves plant- 1, branches plant-1, length of root, total dry matter plant-1, pod length, grains pod-1 and test weight in mungbean [6].

##### 3.1.2 Dry weight (g/plant)

At 60 DAS, the highest plant dry weight (6.72 g) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm). There are no statistically at par values in the treatment combination. While the minimum was recorded in treatment 10 (4.72 g) with (Control NPK-20:40:20 kg/ha).

The fact that the plant's dry weight rose after PSB treatment may be attributable to the strains' enhanced availability of P, which allowed the plant to absorb more P and improve its development characteristics. A comparable outcome was noted by Kachave et al. [7].

Plant growth regulators (GA3 and Salicylic acid) applied to black gram plants had significantly increased the plant height, days to maturity and dry weight per plant than control [8].

### 3.1.3 Crop growth rate (g/m<sup>2</sup>/day) and relative growth rate (g/g/day)

At 45-60 DAS, the highest Crop growth rate (7.08 g/m<sup>2</sup>/day) was recorded with treatment 9 with PSB (10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20 g/1kg seeds + Gibberellic acid at 150ppm) and treatment 7 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 50ppm). While the minimum was recorded in treatment 1 (4.15 g/m<sup>2</sup>/day) with (PSB 20 g/1kg seeds + Gibberellic acid at 50ppm).

At 45-60 DAS, the highest relative growth rate (0.056 g/g/day) was recorded with treatment 7 (PSB 10g/1kg + Rhizobium 10g/1kg + Gibberellic acid at 50ppm) which was statistically at par to treatment 5 (Rhizobium 20g/1kg seeds + Gibberellic acid at 100ppm), treatment 8 (PSB 10g/1kg + Rhizobium 10g/1kg + Gibberellic acid at 100ppm) and treatment 9 (PSB 10g/1kg + Rhizobium 10g/1kg + Gibberellic acid at 150ppm). While the minimum was recorded in treatment 4 (0.035 g/g/day) with (Rhizobium 20g/1kg seeds + Gibberellic acid at 50ppm).

The significant and higher crop growth rate noticed with the application of PSB may be attributable to better dry matter accumulation throughout the vegetative and reproductive phases of the plant. This improves physiological and metabolic activity and growth by assimilation of nutrients that are accessible at a greater extent of growth parameters and facilitating more photosynthesis, ultimately resulting in higher crop growth rate. A similar outcome was noted by might all be contributing factors. Similar results lined with by Hussain et al [9].

## 3.2 Yield Parameters

### 3.2.1 Number of pods/plant

From the observations maximum number of pods per plant (21.85) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20g/1kg seeds+ Gibberellic acid at 150ppm) and treatment 8 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 100ppm). While the minimum was recorded in treatment 10 (18.59) with (Control NPK 20:40:20 kg/ha).

The significant and higher number of pods/plant were observed with the application of rhizobium,

this might be due to enhanced nitrogen fixation, thereby increasing the availability of plant efficient growth and development, particularly number of pods/plant. A similar result was concluded by Kumar et al., [10].

The effect of seed treatment and foliar application of Gibberellic acid on mungbean crop. They reported that application of Gibberellic acid had greater number of pods, higher fresh and dry weight of pod [11].

### 3.2.2 Number of seeds/pod

From the observations maximum number of seeds per pod (4.42) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20g/1kg seeds + Gibberellic acid at 150ppm). While minimum was recorded in treatment 10 (3.20) with (Control NPK-20:40:20 kg/ha).

The significant and higher number of seeds/pod were observed with application of rhizobium Due to increased nodulation, an extensive root system, and increased metabolite production and translocation to various sinks, particularly the fruiting structures (pods and seeds), the number of pods for each plant may have increased in furtherance to the plant's overall growth [12].

### 3.2.3 Test Weight (g)

From the observations maximum test weight (34.89 g) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 8 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 100ppm). While the minimum was recorded in treatment 10 (28.98 g) with (Control NPK 20:40:20 kg/ha).

Because of PSB application, beneficial effects on the development of extensive root systems that can extract more water and nutrients from the soil and improve plant growth and yield attributes, significant and maximum test weight was seen with PSB application. Similar outcomes were seen by Pramanik & Singh [13].

“Seed or soil inoculation with bio-fertilizers (PSB, VAM and PSB + VAM) significantly enhanced the number of pods/plant, number of grains pod-1, test weight as well as grain and straw yield of

urdbean over no inoculation and no significant effect on harvest index” [14].

### 3.2.4 Seed yield (t/ha)

From the observations maximum seed yield (1.12 t/ha) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20g/1kg seeds + Gibberellic acid at 150ppm).

While the minimum was recorded in treatment 10 (0.57 t/ha) with (Control NPK 20:40:20 kg/ha).

The bio-fertilizer Rhizobium has been linked to the supply of more plant hormones (auxin, cytokinin, gibberellin, etc.) by the microorganisms injected or by the root as a result of reaction to microbial population, which may be the cause of the increase in seed production with Rhizobium treatment. similar outcomes had been conformity to Umamaheswari et al., [15].

GA3 delays senescence, improves growth and development of chloroplasts, and intensifies photosynthetic efficiency which could lead to increased yield [4].

### 3.2.5 Stover yield (t/ha)

From the observations maximum stover yield (2.03 t/ha) was recorded with treatment 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds +

Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20g/1kg seeds + Gibberellic acid at 150ppm). While the minimum was recorded in treatment 10 (1.45 t/ha) with (Control NPK-20:40:20 kg/ha).

“Possibly as a result of the improved nutritional environment of the rhizosphere and plant system leading to better plant metabolism and photosynthetic activity, plants have grown and developed more in terms of height, branches, and dry matter”. [5].

The increased dry matter buildup and improved root growth brought about by the treatment of PSB and Rhizobium may have contributed to the higher stover output by allowing for maximal nutrient and moisture absorption. The same outcomes were reported by Rajesh et al. [16].

### 3.3 Harvest Index (%)

From the observations Harvest Index (35.63 %) was recorded with treatments 9 (PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm) which was statistically at par to treatment 6 (Rhizobium 20g/1kg seeds + Gibberellic acid at 150ppm). While the minimum was recorded in treatment 10 (28.35 %) with (Control NPK 20:40:20 kg/ha).

“The combined inoculation of IARI Rhizobium+ IARI PSB with proved one of the most efficient approaches to in increasing in harvest index, nutrient content and uptake” [17].

**Table 2. Influence of biofertilizers and gibberellic acid on growth attributes of blackgram**

Treatments	60 DAS		45-60 DAS	
	Plant height (cm)	Dry weight (g/plant)	Crop growth rate (g/m <sup>2</sup> /day)	Relative growth rate (g/g/day)
1. PSB-20g/1kg + GA3-50ppm	31.77	5.09	4.15	0.039
2. PSB-20g/1kg + GA3-100ppm	32.26	5.22	6.58	0.044
3. PSB-20g/1kg + GA3-150ppm	33.31	5.70	4.92	0.037
4. Rhizobium 20g/1kg + GA3-50ppm	32.88	5.39	5.59	0.035
5. Rhizobium 20g/1kg + GA3-100ppm	34.76	6.09	7.01	0.054
6. Rhizobium 20g/1kg + GA3-150ppm	35.21	6.24	6.77	0.041
7. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-50ppm	34.29	5.76	6.69	0.056
8. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-100ppm	35.73	6.44	5.77	0.049
9. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-150ppm	36.03	6.72	7.08	0.044
10. Control NPK-20:40:20 kg/ha	31.25	4.72	5.03	0.039
F test	S	S	S	S
S. Em (±)	0.53	0.05	0.49	0.004
CD (P=0.05)	1.57	0.16	1.45	0.012

**Table 3. Influence of biofertilizers and gibberellic acid on yield attributes of blackgram**

Treatments	No. of Pods /plant	No. of seeds /pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1. PSB-20g/1kg + GA3-50ppm	18.78	3.30	29.50	0.61	1.51	28.67
2. PSB-20g/1kg + GA3-100ppm	18.89	3.35	31.28	0.66	1.52	30.30
3. PSB-20g/1kg + GA3-150ppm	19.11	3.41	32.02	0.69	1.56	30.85
4. Rhizobium 20g/1kg + GA3-50ppm	20.45	3.52	30.66	0.73	1.78	29.23
5. Rhizobium 20g/1kg + GA3-100ppm	21.00	3.97	33.01	0.92	1.89	32.65
6. Rhizobium 20g/1kg + GA3-150ppm	21.78	4.30	32.70	1.02	1.95	34.35
7. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-50ppm	20.67	3.75	33.01	0.85	1.75	32.66
8. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-100ppm	21.33	3.86	33.96	0.93	1.85	33.47
9. PSB 10g/1kg + Rhizobium 10g/1kg + GA3-150ppm	21.85	4.42	34.89	1.12	2.03	35.63
10. Control NPK-20:40:20 kg/ha	18.59	3.20	28.98	0.57	1.45	28.35
F test	S	S	S	S	S	S
S. Em ( $\pm$ )	0.23	0.06	0.59	0.03	0.03	0.51
CD (P=0.05)	0.69	0.18	1.75	0.10	0.09	1.52

#### 4. CONCLUSION

The results show that the treatment combination PSB 10g/1kg seeds + Rhizobium 10g/1kg seeds + Gibberellic acid at 150ppm were found more productive (1.12 t/ha) and significantly increased plant height (36.03 cm), dry weight (6.72 g/plant), pods (21.85), seed yield (1.12 t/ha), stover yield (2.03 t/ha) and harvest index (35.63%).

#### ACKNOWLEDGEMENT

The Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj- 211007, Uttar Pradesh, India, provided the field, necessary facilities, and assistance in conducting this research. The author also expresses gratitude to advisor Dr. Joy Dawson.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

- Ahmad W, Niaz A, Kanwal S, Rahmatullah, Rashed MK. Role of boron in plant growth. A review. J. Agriculture Research. 2009;47(3):329-338.
- Kumpawat BS. Integrated nutrient management in black gram (*Vigna mungo*) and its residual effect on succeeding mustard (*Brassica juncea*) crop. Indian Journal Agricultural Sciences. 2010;80(1): 76-79.
- Kulsum MU, Baque MA, Karim MA. Effects of different nitrogen level on the morphology and yield of blackgram. Journal of Agronomy. 2007;6: 125-130.
- Yuan L, Xu DQ. Stimulation effect of gibberellic acid short-term treatment on the photosynthesis re-lated to the increase in Rubisco content in broad bean and soybean. Photosynthesis Research 2001;68:39-47. DOI: 10.1023/A:1011894912421
- Yadav M, Yadav SS, Kumar S, Yadav T, Yadav HK. Effect of phosphorus and biofertilizers on growth and yield, of urdbean (*Vigna mungo* (L.) Hepper). International Journal of Plant & Soil Science. 2017;18(5):1-7.
- Rahman MM, Khan A, Hasan MM, Banu LA, Howlader MHK. Effect of foliar application of gibberellic acid on different growth contributing characters of mungbean. Progressive Agriculture. 2018;29(3):233.
- Kachave RR, Indulkar BS, Vaidya PH, Ingole AJ, Patil NM. Effect of phosphorus and PSB on growth, yield and quality of blackgram [*Vigna mungo* (L.) inceptisol. International Journal of Current Microbiology and Applied Sciences. 2018;7(07):3359-3365.

8. Manjari A, Singh SD, Gupta R, Bahadur, Singh AK. Responses of black gram to foliar applied plant growth regulators. International Journal of Current and Microbiology and Applied Sciences. 2018;(Special Issue 7):4058-4064.
9. Hussain N, Mehdi M, Dar SNR, Hussain M, Fatima N. Effect of rhizobium and PSB on growth and yield attributes of blackgram (*Vigna mungo* L.). Ecology, Environment and Conservation. 2015;21(3):1231-1233.
10. Kumar A, Singh SS, Rakesh Kumar, Narendra Kumawat and Singh AK. Response of rhizobium and different levels of molybdenum on growth nodulation and yield of black gram (*Vigna mungo* L.). Environment and Ecology. 2010;28(3A):1728— 1730.
11. Hoque MM, Haque MS. Effect of Gibberellic acid (GA3) on physiological contributing characters of mungbean (*Vigna radiata* L.). Pakistan Journal of Biological Sciences. 2002;5;401-403.
12. Ghanshyam, Rakesh Kumar, Jat RK. Productivity and soil fertility as affected by organic manures and inorganic fertilizers in green gram (*Vigna radiata*) wheat (*Triticum aestivum*) system. Indian Journal of Agronomy. 2010;55(1);16-21.
13. Pramanik K, Singh RK. Effect of levels and mode of phosphorus and bio-fertilizers on chickpea under dryland conditions. Indian Journal of Agronomy. 2003;48:294-96.
14. Maya Yadav, Yadav SS, Sunil Kumar, Hansa Kumari Yadav, Pradip Tripura. Effect of phosphorus and bio-fertilizers on yield, nutrient content and uptake of urban [*Vigna mungo* (L.) Hepper]. International Journal of Current and Microbiology and Applied Sciences. 2017;6(5):2144-2151.
15. Umamaheswari P, Padmalatha Y, Murali Rao. Evaluation of different sources of bio- fertilizers in association with inorganic and organic manures in groundnut. Agriculture Science Digest. 2001;21:250-252.
16. Rajesh M, Kaliyamoorthy Jayakumar TM, Sathees Kannan. Effect of biofertilizers application on growth and yield parameters of green gram (*Vigna radiata* L.). International Journal Fertilizer, Tillage Practices and Weed Control Methods. 2013;3(7):254-256.
17. Sharma P, Gupta RP, Khanna V. Evaluation of liquid rhizobium inoculants in mungbean, urdbean and pigeonpea under field conditions. Indian Journal of Pules Research. 2006;19:208-209.

© 2023 Charles and Joy; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<https://www.sdiarticle5.com/review-history/101961>