The Pharma Innovation Journal 2023; 12(7): 3018-3020

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 3018-3020

www.thepharmajournal.com
Received: 02-05-2023
Accepted: 08-06-2023

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Influence of phosohorus levels and phosphorus solublizing bacteria inoculation on yeild of black gram (*Vigna mungo* L.)

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Abstract
During the summer of 2022, the current experiment was set up at Kakhli Research Farm of Dr. KSG Akal College of Agriculture, Eternal University, Baru Sahib (HP). The experiment comprises of two factors: PSB (with and without inoculation) and phosphorus levels (0, 20, 40, and 60 kg P/ha), which were combined to create eight treatment combinations that were laid out in FRBD and replicated three times. Phosphorus concentrations and PSB inoculation had a positive impact on the yield characteristics of black gram. Grain and straw yields both improved with the application of 60 kg P/ha+ PSB. Furthermore, grain and straw production increased when seeds were treated with PSB compared to the control (untreated). Conclusion: When compared to lower levels and the control, the usage of 60 kg P/ha in conjunction with PSB was statistically superior in terms of yield attributes of black gram.

Keywords: Black gram, inoculation, legume, phosphorus, phosphorous solublizing bacteria, and yield

Introduction
In India, where the majority of the population is vegetarian, pulses constitute the primary source of protein. Important legumes like the urad bean are grown all over India. In India, urad bean (*Vigna mungo* L.) is the most important crop of legumes. With chromosome number 22, Mash belongs to the family "Leguminosae" and the genus "Vigna". It is a significant cultivar that is grown alongside the green gram. This culture is also referred to as mush, purée, and urd in India. This crop is a costly legume that self-pollinates, has 24% protein, and is high in phosphoric acid. The urd bean is a good source of calcium and iron. The black gram has a brief harvesting season. Black gram originated primarily in India and primarily in Central Asia. It can grow in both light and heavy soils. It favors dense soils with moisture retention. In heavy soils with a pH range of 5.0 to 7.5, it drains efficiently. It cannot survive in alkaline or saline environments. After the pods are removed, the plant can be used as high-quality dry or green food. It is suitable for a range of cross-crop and multi-crop systems. As a primary, medium, cover crop, green manure, and intermediate crop, pulses occupy a special place in the farming system. Because they are poorly managed and farmed without sufficient resources, the average production of urdu beans continues to be low.

By using thorough management techniques, the outstanding potential output of black gram can be achieved. In order to achieve simultaneous maturation and high yield of urd bean, proper variety, planting period, and plant density are crucial non-financial elements. Basically, black gram is a crop that enjoys the heat. grows up to 1800 mm high at sea level and occurs in regions with 600 to 1000 mm of yearly rainfall. Black gram can be grown year-round in both irrigated and rain-fed crops. It is mostly produced on bare ground in a monoculture mixed system without any fertilizers under wet circumstances, which results in relatively low yield differentials that can be handled by providing plants with a complete and balanced supply of nutrients (Rathore *et al*., 2010) [11]. Continued usage of conventional cultivars with limited potential, low seeding rates, and subpar agronomic techniques are the main causes of the low yields in farmer fields. The amount of personality is the most significant constraint on plant growth, and it helps to pave the path for the release of the black gram seed.

The most crucial nutrient for optimum plant development and growth is phosphorus. The typical soil contains 0.5% of P, however only 0.1% of this P is usable by crops (Zhu *et al*., 2011) [12]. Due to its large impact on root growth and subsequent involvement in fixing atmospheric nitrogen, it plays a crucial part in the production of pulses (Nair, 1985) [13].

Phosphorus aids in healthy root development, boosts nodules, aids in nitrogen fixation, and is crucial for photosynthesis, cell division, the formation of meristems in living tissues, seed quality, and the majority of physicochemical processes. P stimulates the symbiotic fixation of nitrogen. It is a requirement that causes bacterial cells to move to the node's roots because as the bacterial cells become mobile, so does it (Charel, 2006) [14]. The ratio of starch and sucrose in the original leaves and reproductive parts can be regulated by adding additional phosphorus and promoting crop growth. Increased grain yields may be related to the beneficial effects of phosphorus on plant fruiting and better delivery of the necessary metabolites to the harvesting sections of plants. Rice, millet, oilseeds, legumes, and vegetables are just a few of the crops that can be treated with PSB (Phosphorus Solubilizing Bacteria).

These are helpful microorganisms that can turn insoluble phosphorus into soluble molecules. PSB is a new phosphate biofertilizer that has been introduced to agriculture. It is important in making soil phosphorus available to plants by solubilizing it during the course of numerous organic acids (Gaur, 1991) [15]. Additionally, PSB usage lessens the harm that excessive fertilizer use does to the environment. The application of phosphorus in PSB increased plant output and phosphorus uptake. This demonstrates how PSB may breakdown phosphorus and move it to crops. The requirement for crop phosphate fertilizers can be decreased by around 5% when PSB is combined with rock phosphate. Phosphates can be broken down by PSB with phosphatase catalysis potential. In agriculture, PSB is a significant source of plant nutrition and can be useful in supplying soluble phosphorus to plants (Khan *et al*., 2001) [16].

Material and Method

The present study, "Growth and yield of black gram (*Vigna mungo* L.) as influenced by levels of phosphorus and phosphorus solubilizing bacteria inoculation" was conducted at Experimental Research Farm of Dr. Khem Singh Gill Akal College of Agriculture at Kakhli during the summer season. The detail of material method and methods used during the research trail were as follows. The experimental was conducting in a FRBD with eight treatments combination and each treatment was replicated 3 times. The experiment comprises of two factors: PSB (with and without inoculation) and phosphorus levels (0, 20, 40, and 60 kg P/ha).

Result and Discussion

Effect of phosphorous levels on yield

The pod/plant, pod length, seed/pod, weight of thousands of seeds was significantly influenced due to P levels. The yield attributes were noted maximum under P_3 (60 kg P/ha) and smallest were noted with the use of P_0 (0 kg P/ha). The enhancement is due to greater vegetative growth of plant resulted in the growing reproductive part. The results were found similar by Kadam *et al*. (2014) [3], Kant *et al*. (2016) [4], Jangir *et al*. (2016) [2], Singh *et al*. (2018) [9], Singh *et al*. (2020) [8].

Grain and straw yield were statically differed due to several rates of phosphorus. The significantly maximum seed and straw yield were noted with P_3 (60 kg P/ha) and minimum were recorded with P_0 (0 kg P/ha), this is due to the application of phosphorus helped in an increase in carbohydrates accumulation and their remobilization, presence into the reproductive part thus flowering, fruiting, and an increase in seed set formation. These results were similar with the finding of Niraj and Ved (2015) [5], Kant *et al*. (2016) [4], Singh *et al*. (2020) [8].

HI was statically improved due to the different level of P. Harvest index was reported maximum under the treatment P_4 (60 kg P/ha) and smallest value was noted under P_0 (0 kg/ha). Parashar *et al*. (2020) [6] and Veer *et al*. (2021) [10] also noted the similar findings.

Effect of PSB on yield

Total pods/plants, seeds/pod, pod length and weight of thousands of seeds were significantly differed due to PSB inoculation. The maximum yield attributes were found under the treatment B_1. The minimum value was found in B_0.This was in line with the result noted by Hussain *et al*. (2011) [1], Kant *et al*. (2016) [4], Jangir *et al*. (2016) [2] and Singh *et al*. (2018) [9].

Yield suggestively affected due to seed inoculation with PSB. The maximum yields were recorded in the treatment B_1while the minimum recorded in treatment B_0. It is due to inoculation with PSB statically improved the availability of P in soil and helps release native phosphorus as well as additional phosphorus fixation protection. Jangir *et al*. (2016) [2] and Rabari *et al*. (2022) [7] noted similar results in black gram. The enhanced straw production could be attributable to a faster start to the season and stronger straw yield from the use of phosphorus. Single Super Phosphate also supplies S to the plant and soil, which promotes vegetative growth of crop, protein and enzyme constituents, and aids in the lowering of the oxidation mechanism in metabolism, as well as increasing root-growth. High seed yield may be attributable to abundance of photosynthates to the generative portion during the pods filling stage when varied P levels and biofertilizers were used. Plant cells contain P, which is important for the transportation and utilization of solar energy into energy and simple sugars molecules like ADP and ATP.

PSB inoculation was significantly affected harvest index. The harvest index was found higher with B_1. The minimum was found under the treatment B_0. These consequences were also recorded by Kadam *et al*. (2014) [3].

Table 1: Effect of P levels and PSB inoculation on number of pods/plants and pod length

Sr. No	Treatment	Pods/Plant	Pod Length (cm)
A	**Phosphorus levels**		
	P_0- 0 kg P/ha	13.39	7.51
	P_1- 20 kg P/ha	14.41	7.91
	P_2- 40 kg P/ha	15.47	8.00
	P_3- 60 kg P/ha	16.63	8.60
	S. Em±	0.04	0.031
	$CD_{0.05}$	0.13	0.09
B	**PSB inoculation**		
	B_0	14.74	7.88
	B_1	15.21	8.13
	S. Em±	0.03	0.02
	$CD_{0.05}$	0.09	0.07

Table 2: Effect of P levels and PSB inoculation on seed/podand weight of 1000 seeds (g).

Sr. No	Treatment	Seed/pod	Weight of 1000 seeds (g)
A	**Phosphorus Levels**		
	P_0- 0 kg P/ha	7.75	46.33
	P_1- 20 kg P/ha	8.26	47.24
	P_2- 40 kg P/ha	8.84	48.39
	P_3- 60 kg P/ha	9.47	49.99
	S. Em±	0.05	0.04
	$CD_{0.05}$	0.17	0.12
B	**PSB Inoculation**		
	B_0	8.44	47.78
	B_1	8.72	48.19
	S. Em±	0.04	0.02
	$CD_{0.05}$	0.12	0.09

Table 3: Effect of P levels and PSB inoculation on grain, straw yield and HI.

Sr. No	Treatments	Yield q/ha		Harvest Index (%)
		Seed	Stover	
A	**Phosphorus levels**			
	P_0- 0 kg P/ha	11.24	22.38	29.48
	P_1- 20 kg P/ha	11.58	22.64	30.36
	P_2- 40 kg P/ha	12.31	22.99	30.68
	P_3- 60 kg P/ha	12.96	23.49	30.79
	S. Em±	0.03	0.02	0.03
	$CD_{0.05}$	0.10	0.07	0.09
B	**PSB inoculation**			
	B_0	11.87	22.76	30.23
	B_1	12.17	22.99	30.43
	S. Em±	0.02	0.01	0.02
	$CD_{0.05}$	0.07	0.05	0.06

Conclusion

It was inferred from this trial that application of 60 kg P/ha with PSB inoculation resulted in maximum yield along with highest net return and B/C ratio of black gram (Himachal mash 1).

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