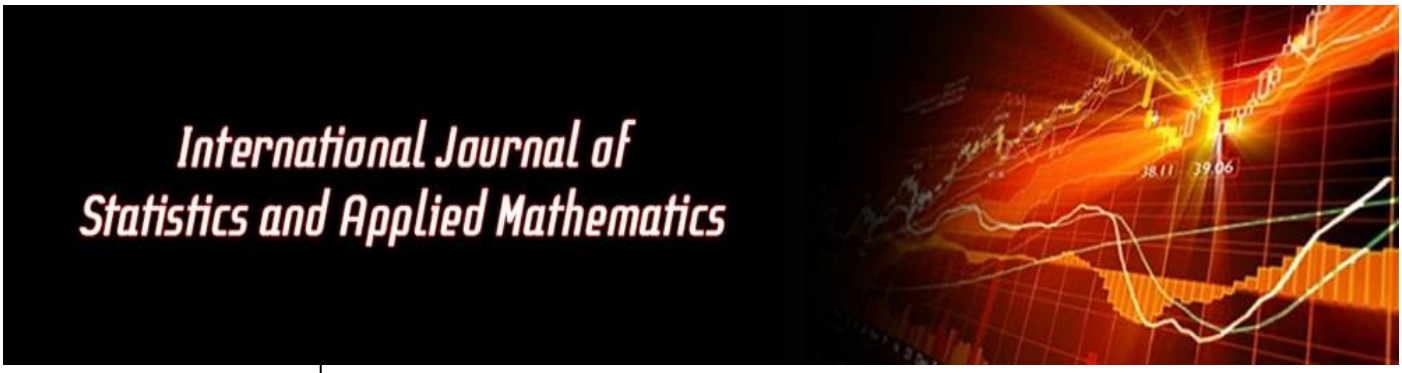

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The response of bio-fertilizers (Rhizobium and phosphate solubilizing bacteria) and inorganic fertilizer application on yield and yield contributing attributes of black gram (*Vigna mungo*) under rain fed condition of Chitrakoot region

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Abstract
A field experiment was conducted at the Nanaji agricultural research farm, faculty of agriculture, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.) to study the response of rhizobium and Phosphate solubilizing bacteria along with inorganic fertilizers on yield and yield contributing attributes of "IPU-243" variety of black gram (Vigna mungo) crop. The experiment was conducted during the kharif season of the session 2021-22 in the dryland area of Chitrakoot. The experiment was consisted of three replications along with thirteen treatments laid out in randomized block design (RBD). The treatment was composed of bio-fertilizers incorporated with inorganic fertilizers to see the difference between absolute control and combined treatments. The seed treatment was done with rhizobium and phosphate solubilizing bacteria (PSB) was given along with soil by mixing it with finely powdered farmyard manure. The yield contributing factors that were taken into account for the purpose of study was number of pods per plant, number of seed per pod, test weight, grain yield per plot and grain yield per hectare. The results indicated that treatment with 100% RDF + rhizobium + PSB showed the best results amongst all the treatment was statistically significant over control and rest all other treatments.

Keywords: Bio-fertilizers, rhizobium, phosphate solubilizing bacteria, black gram, yield

Introduction
Vigna mungo, also known as black gram, urad bean, urid bean, matimah, matikolai, mash kalai, uzhunnu parippu, ulundu paruppu, minapa pappu, uddu, or black matpe, is a bean grown in South Asia. Like its relative, the mung bean, it has been reclassified from the Phaseolus to the Vigna genus. The product sold as black lentil is usually the whole urad bean, whereas the split bean (the interior being white) is called white lentil. It should not be confused with the much smaller true black lentil (Lens culinaris). Black gram originated in South Asia, where it has been in cultivation from ancient times and is one of the most highly prized pulses of India. It is very widely used in Indian cuisine. In India the black gram is one of the important pulses grown in both Kharif and Rabi seasons. This crop is extensively grown in southern part of India, northern part of Bangladesh and Nepal. (Wikipedia, n.d.) Pulses contain carbohydrates mainly starch (55-65%), proteins including essential amino acids (18-25%) and fats less than 4%. Legume plants are notable for their ability to fix atmospheric nitrogen due to their symbiotic relationship with certain bacteria known as Rhizobium found in root nodules of these plants. The ability to form this symbiotic relationship reduces fertilizer costs for farmers and allows legumes to be used in crop rotation to replenish soil that has been depleted of nitrogen. The nitrogen fixing ability of legumes is enhanced by the availability of calcium in the soil and diminished by the presence of ample nitrogen (Kumar, 2011) [1]. The role of PSB is very important, as it helps in de-phosphorylation of phosphorus bearing organic compounds. Release of phosphorus by PSB from insoluble and fixed/adsorbed forms is an important aspect regarding phosphorus availability in soils (Pathania, 2019) [5].

By keeping all the above given statements in minds the experiment was carried out.

Materials and Methods

The field experiment was conducted at the Nanaji agricultural research farm, faculty of agriculture, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.), to study the response of rhizobium and PSB on yield and other yield attributes of black gram (Vigna mungo) crop. The Chitrakoot region belongs to Central Plateau & Hills Region (Bundelkhand) agro-climatic zone (KVK, N.D.). The soil of the experimental site was light textured sandy loam. The experiment was composed of thirteen treatments with three replications laid out in randomized block design (RBD) and the data that was collected was subjected to statistical analysis by analysis of variance (ANOVA), the treatment details are mentioned in Table 1. The variety "IPU-243" of black gram crop was used along with it the seed was treated with rhizobium and soil application of PSB was done along with farmyard manure. The net plot size was 5 m x 3 m. The readings for the data was taken at harvest stage. The standard error of mean and critical difference only for significant cases were calculated at 5% levels of probability.

Table 1: Treatment Combinations

S. No	Symbol	Treatments
1.	T_0	0% RDF + No Bio-fertilizers
2.	T_1	100% RDF + No Bio-fertilizers
3.	T_2	75% RDF + No- Bio-fertilizers
4.	T_3	50% RDF + No Bio-fertilizers
5.	T_4	0% RDF + PSB (Soil application)
6.	T_5	100% RDF + PSB (Soil application)
7.	T_6	75% RDF + PSB (Soil application)
8.	T_7	50% RDF + PSB (Soil application)
9.	T_8	0% RDF + Rhizobium
10.	T_9	100% RDF + Rhizobium
11.	T_{10}	75% RDF + Rhizobium
12.	T_{11}	50% RDF + Rhizobium
13.	T_{12}	100% RDF + Rhizobium +PSB

Results and Discussion

In this experiment the, yield is expressed in terms of pods per plant, seed per pod, test weight of seed, grain yield per plot and grain yield per hectare and the results of treatment combinations is mentioned in Table 2.

Effect of rhizobium and PSB on Number of pods per plant

The number of pods per plant is the most important yield attribute which decides the ultimate yield of the crop. From the data obtained here it is evident that the highest number of pods per plant was present in treatment T_{12}- 100% RDF + Rhizobium + PSB that is 25.40 which is significantly higher over the absolute control treatment with the least number of pods which was 8.80. Application of Rhizobium increased the dry weight of plants, number of grains per pod, number of pods per plant, pod length, 1000 grain weight, straw yield and number of nodules per plant and their dry weight in black gram as compared to control reported by (Kumar, 2011) [1].

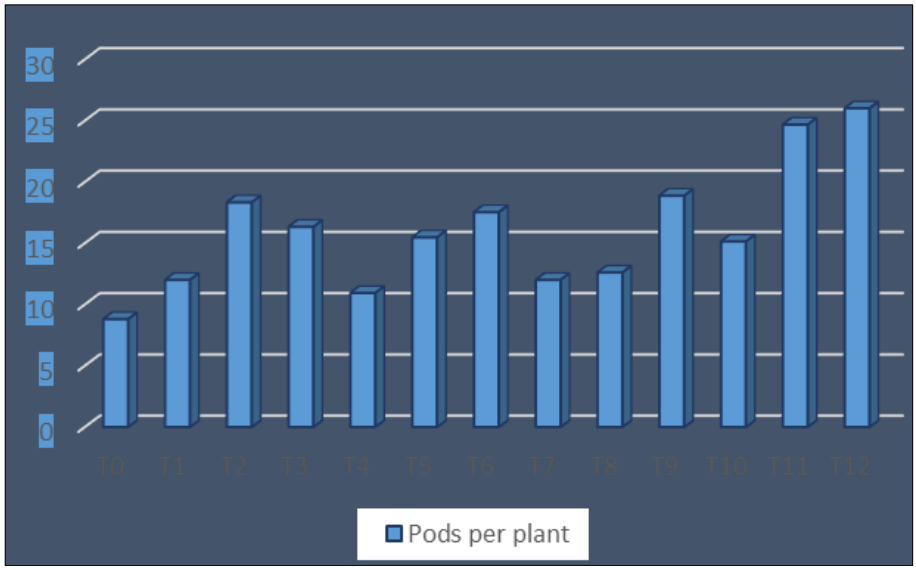

Fig 1: Number of pods per plant

Effect of Rhizobium and PSB on Seed per pod

The number of seeds per pod reflects the amount of nutrients available to the plant and thus leading to formation of seeds in pods, and hence the number of seeds found in pods directly influence the yield of the crop. The results obtained here indicated that the maximum number of seed per pod was present in T_{12}- 100% RDF + Rhizobium + PSB that is 14.47. Similar results were obtained by (Singh, 2011) [7].

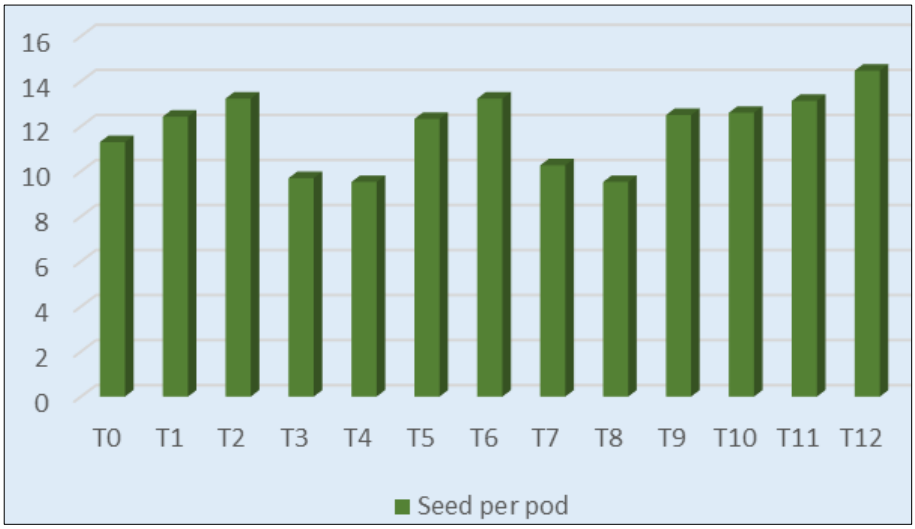

Fig 2: Number of seed per pod

Effect of Rhizobium and PSB on Test weight (1000 seed weight)

Seed test weight is the weight of seeds per unit volume and is usually expressed in kg per hectare. Test weight in terms of weight is an important parameter as it gives an indication of seed chemical composition, seed dampness, insects' infestation, and maturation, therefore it is an important yield attributing factor. The results indicated that the treatment T_{12} - 100% RDF + rhizobium + PSB showed the maximum test weight with 43.33gm. The results were found in conformity with (Singh, 2011) [7], (Ripudaman, 2017) [6].

Fig 3: Test weight

Effect of Rhizobium and PSB on grain yield per plot

The data obtained for grain yield per plot indicated that the treatment T_{12}- 100% RDF + Rhizobium + PSB was the best performing treatment with a grain yield per plot of 2.62 Kg. the results were in conformity with (Kumar, 2011) [1] (Pankaj, 2005) [4] and (P, 2018).

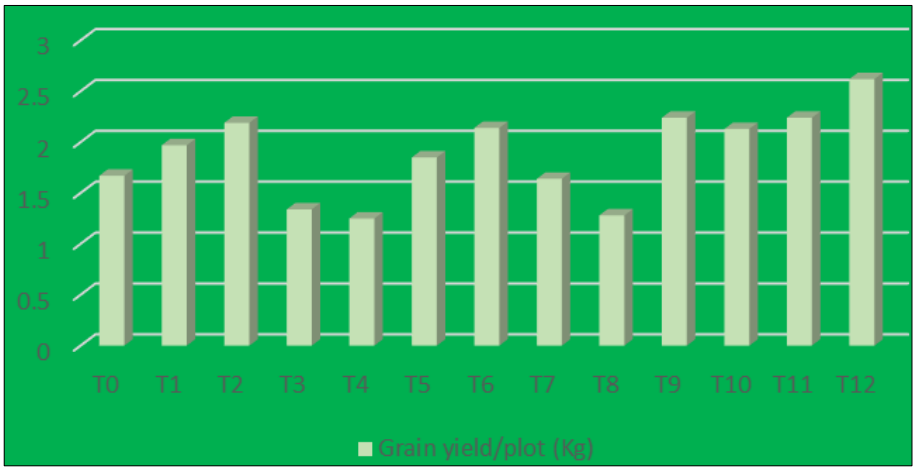

Fig 4: Grain yield per plot

Effect of Rhizobium and PSB on Grain yield per hectare

By the means of the data obtained in this experiment, it can be concluded that the grain yield per hectare was highest in treatment T_{12}-100% RDF + Rhizobium + PSB that is 1741.33 kg. Similar results were obtained by (Kumar, 2011) [1] (Singh, 2011) [7] (Pankaj, 2005) [4] in their experiments too.

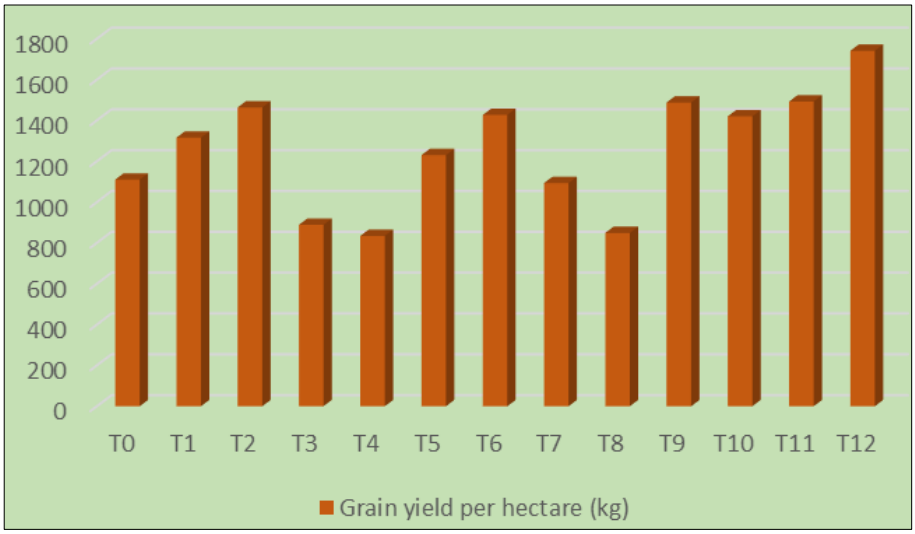

Fig 5: Grain yield per hectare (kg)

Table 2: Effect of rhizobium and PSB along with inorganic fertilizers on yield and yield attributing parameters of Black gram (*Vigna mungo*)

S. No.	Treatment	Pod per plant	Seed per pod	Test weight	Grain yield/plot (kg)	Grain yield /hectare (kg)
1.	T_0	8.80	11.30	35.50	1.67	1110.00
2.	T_1	12.00	12.43	41.30	1.97	1315.67
3.	T_2	18.33	13.23	42.50	2.19	1463.67
4.	T_3	16.33	9.70	38.57	1.34	888.67
5.	T_4	10.93	9.53	40.47	1.25	834.33
6.	T_5	15.47	12.33	42.43	1.85	1230.33
7.	T_6	17.53	13.23	37.27	2.14	1427.00
8.	T_7	12.00	10.27	36.57	1.64	1093.33
9.	T_8	12.60	9.53	39.70	1.28	849.00
10.	T_9	18.87	12.50	37.50	2.24	1487.67
11.	T_{10}	15.13	12.60	38.03	2.13	1420.00
12.	T_{11}	24.67	13.13	37.57	2.24	1492.67
13.	T_{12}	26.00	14.47	43.33	2.62	1741.33
	$S.E_{(m)\pm}$	0.92	0.15	0.10	0.03	42.51
	$C.D._{5\%}$	2.69	0.43	0.29	0.09	124.08

Conclusion

By the virtue of all the data, it can be concluded that rhizobium and PSB along with inorganic fertilizers are suggested to give to the black gram crop in Chitrakoot region in order to obtain high yield.

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