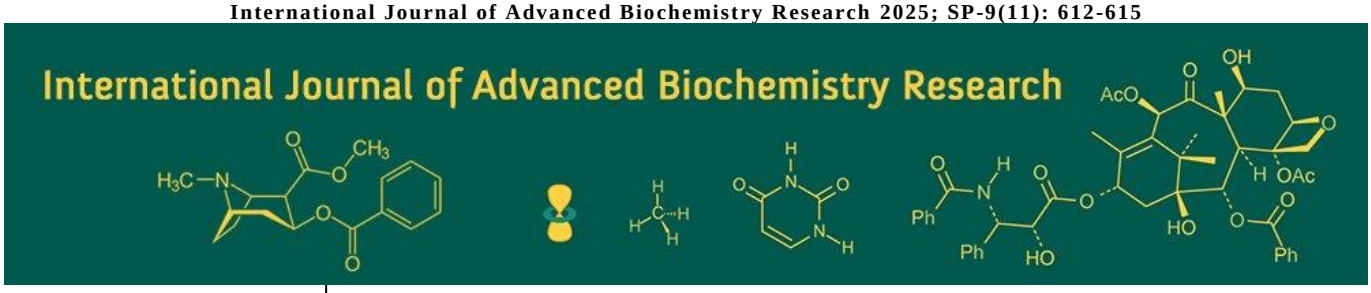

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Patil Rahul Vikram
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj Uttar Pradesh, India

Shikha Singh
Assistant Professor, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj Uttar Pradesh, India

Corresponding Author:
Patil Rahul Vikram
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj Uttar Pradesh, India

Effect of biofertilizer and cow urine on the growth and yield of blackgram (*Vigna mungo* L.)

Patil Rahul Vikram and Shikha Singh

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Abstract
A field experiment was conducted at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). it was carried out during the Karif season of 2024. Low in organic carbon (0.458), low in available nitrogen (186.50), high in available phosphorus (27.4), medium in available potassium (243.8), and medium in electrical conductivity (0.375 dsm-1) were the characteristics of the sandy loam experimental plot. The treatments consisted of 3 different Biofertilizer (*Trichoderma, PSB, Rhizobium*) and levels of Cow urine spray at (*0.5%, 1.0%, 1.5%*). Recommended fertilizer doses of nitrogen, phosphorus, and potassium (20:40:20 N:P:K kg/ha) were uniformly applied across all plots. The experiment carried out in a Randomized Block Design and replicated thrice. The result revealed that inoculation of Rhizobium 20gm/kg along with foliar spray of 1% Cow urine (T_8) at 15 and 30 DAS recorded maximum plant height (15.11cm), dry weight (10.16g), CGR (9.70g/m^2/day), RGR (0.0354g/g/day), number of pods per plant (26.47), number of seeds per pods (6.27), test weight (39.33g), seed yield (1064.1kg), stover yield (3054.43kg) and harvest index (25.78). It also recorded maximum gross returns (80599.39 INR/ha), net returns (53037.84 INR/ha), and B:C ratio (1.92) in Blackgram.

Keywords: Blackgram, *Trichoderma*, Phosphate-Solubilizing Bacteria (PSB), Rhizobium, Cow urine

1. Introduction
Blackgram (*Vigna mungo* Lis) one of the most widely grown pulse crops in India. As a fodder crop, it is grown in the United States and Australia. This annual herb grows hairily and can be either erect, sub-erect, or trailing. The crop can be grown as a sole crop with residual moisture or as a catch crop, mixed crop, or sequential crop in cropping systems. Green manure, catch, cover, and main crops are all grown with blackgram. It is utilized as livestock feed. Through symbiotic nitrogen fixation with Rhizobium bacteria, it fixes atmospheric nitrogen. Since it has deep roots, it helps to prevent drought and manage soil erosion. It is rich source of nutrients Per 100 g of seed, it has high levels of protein (24%), fat (1.4%), carbohydrates (59.6%), calcium (154 mg), phosphorus (385 mg), iron (9.1 mg), beta carotene (38 mg), thiamine (0.4 mg), riboflavin (0.37 mg), and niacin (2 mg). High levels of folate are also found in black grams (628 µg/100 g raw, 216 µg/100 g cooked). The total area used for pulse production worldwide is 959.68 lakh hectares. 973.92 lakh tonnes of pulses are produced overall, with an average productivity of 1015 kg/ha (FAO, 2022). Presently, India is the world's top producer of black gram, contributing over 70% of the total production. Blackgram is planted in 48.38 lakh hectares of land in India, yielding 27.28 lakh tonnes and 564 kg/ha of productivity. One of the main Indian states that produces blackgram is Uttar Pradesh. Blackgram is produced in Uttar Pradesh on an area of 5.72 lakh hectares, with an average yield of 522 kg/ha and a production of 2.99 lakh tonnes (GOI, 2022).
There are few studies that highlight the use of *Trichoderma* spp. spores on seeds and foliage to lower disease incidence. Although the direct administration of *Trichoderma* spp. spores has not been well studied, plants develop systemic resistance against pathogen infection as a result of the activation of several antioxidants that can lower disease incidence. There are few studies that reveal the function of antioxidant systems in assessing the effectiveness of *Trichoderma* spores against Alternaria and Fusarium in legumes (Surekha and others, 2013) [21].

By aiding in the solubilization of insoluble phosphorus and promoting growth by supplying hormones, vitamins, and other growth factors, phosphorus-solubilizing bacteria contribute to increased agricultural output (Bhattacharya and Jain, 2000) [1]. By releasing different organic acids like butyric acid and formic acid, among others, phosphate solubilizing bacteria are essential microorganisms that aid in the solubilization of fixed phosphorus and make it accessible to plants (Gaur, 1991) [3].

The quantity, efficacy, and nodulation of these microorganisms vary. Despite being a fantastic source of symbiotic nitrogen fixation, nodulation and nitrogen fixation can occasionally go wrong because of a lack of Rhizobia or inadequate native Rhizobia. Rhizobia are added to soil from the outside in the form of biofertilizers to guarantee an effective population in the soil. Applying biofertilizer involves both soil application and seed treatment. Using organic sources to apply biofertilizer could be another strategy. (Tripathi and others, 2021) [17].

A good source of nitrogen, phosphorus, potassium, calcium, magnesium, chlorine, and sulphur in its sulphate form is cattle urine. 95% of it is water, 2.5% is urea, and 2.5% is other material (enzymes, hormones, and mineral salts). Cow urine is a valuable resource for increasing crop quality, productivity, and soil fertility. The possibility of fertigation, which is increasingly prevalent in most crops, may also exist here (Pradhan *et al*. 2018) [12].

Materials and Methods

An experiment was conducted During *Kharif* season 2024, an experiment was carried out at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experimental plot's soil had a sandy loam texture, a pH of 7.3, a medium electrical conductivity of 0.375 dsm-1, a medium organic carbon content of 0.458%, low nitrogen levels of 186.50 kg/ha, high phosphorus levels of 27.4 kg/ha, and medium potassium levels of 243.8 kg/ha. With ten treatments and three replications, the experiment was set up using a Randomized Block Design. Application of *Trichoderma* + Cow Urine 0.5%, *Trichoderma* + Cow Urine 1.0%, *Trichoderma* + Cow Urine 1.5%, T4 + PSB + Cow Urine 0.5%, T5 + PSB + Cow Urine 1.0%, T6 + PSB + Cow Urine 1.5%, T7 + Rhizobium + Cow Urine 0.5%, T8 + Rhizobium + Cow Urine 1.0%, T9 + Rhizobium + Cow Urine 1.5%, and T10-Control RDF N:P:K 20:40:20 (No inoculation + water spray) are the treatments. After ten days of sowing, the gaps were closed by transplanting following germination. Where necessary, seedlings were thinned out to maintain a 30 cm x 10 cm spacing. To reduce crop weed competition, khurpi was used to assist in manual weeding at 15 and 30 days following sowing. Harvesting took place at 60 DAS. Pods/plant, seeds/pod, test weight (g), seed yield (kg/ha), stover yield (kg/ha), and harvest index (%) were measured at harvest, while plant growth parameters, such as plant height (cm), dry weight (g/plant), number of nodules/plant, and number of branches, were measured at regular intervals from germination until harvest. Analysis of variance (ANOVA), which is relevant to randomized block design, was used to statistically examine the observed data.

3. Results and Discussion

3.1 Growth Attributes

1.1 Plant height (cm)

At 60 days after sowing (DAS), the maximum plant height (15.11 cm) was observed in (T_8) Rhizobium along with foliar spray of Cow urine 1.0%. which was statistically similar to all other treatments except the control. Plant height was significantly influenced by the application of IARI Rhizobium and IARI PSB, both individually and in combination with seed inoculants. These treatments positively impacted growth parameters of mung bean. The improvement in plant height may be attributed to better nutrient availability, uptake efficiency, and microbial activity. Similar findings were reported by Pandey (2023) [8].

1.2 Dry weight (g/plant)

At 60 DAS, the highest plant dry weight (10.60 g) was recorded in (T_8) Rhizobium along with foliar spray of Cow urine 1.0% which was statistically at par with T_7 and T_9. The increase in dry matter accumulation could be attributed to the synergistic effects of biofertilizers and organic inputs, which enhanced soil microbial activity, nitrogen fixation, and nutrient availability. Rhizobium and PSB likely contributed to phytohormone production and phosphate solubilization, supporting continuous nutrient supply throughout crop growth. These results are supported by earlier studies (Kumhar *et al.*, 2012; Reddy *et al.*, 2014; Singh *et al.*, 2014; Singh & Kumar, 2016) [7, 14, 18, 19].

1.3 Number of nodules/plant

At 60 DAS, no significant differences were observed among treatments for nodule number, although the highest mean value (38.00 nodules/plant) was recorded in (T_5) PSB along with foliar spray of Cow urine 1.0%, while the lowest (32.17) was in (T_1) *Trichoderma* along with foliar spray of Cow urine 0.5%. Foliar application of liquid organic manures at flowering and 15 days after flowering (DAF) notably improved root nodule formation. Cow urine spray, in particular, showed a positive effect on nodule development, likely due to its nutrient content and bio-stimulatory properties. These results align with findings reported by Patil *et al.* (2010) [10] and Saranraj *et al*. (2011) [16].

3.2 Yield Attributes

3.2.1. Number of pods per plant

At 60 DAS, a significant and highest number of pods per plant (26.47) was recorded in (T_8) Rhizobium along with foliar spray of Cow urine 1.0%, which was statistically at par with T_3, T_5 and T_7. The increase in pod number may be attributed to the synergistic effect of biofertilizers like Rhizobium, PSB, and KSM in combination with organic inputs, which enhanced nutrient availability and solubilization of micronutrients in the rhizosphere. These factors collectively supported better pod formation and development. Similar findings were reported by Rathore *et al.* (2007) [13], Reddy *et al*. (2014) [14], and Patel *et al*. (2018) [14].

3.2.2. Number of seeds per pods

A significant and maximum number of seeds per pod (6.27) was recorded in (T_8) Rhizobium along with foliar spray of Cow urine 1.0%, which was statistically at par with (T_1, T_2, T_3) *Trichoderma* along with foliar spray of Cow urine at 0.5%, 1.0%, and 1.5% respectively, T_5 and T_7. The number of seeds per pod showed limited response to foliar application of cow urine, as this trait is primarily governed by genetic factors. Similar findings were also reported by Kumar *et al.* (2020) [6].

3.2.3. Test weight

However, (T8) had the highest test weight (39.33 g), this result was not deemed statistically significant. Rhizobium inoculation with a 1% cow urine foliar spray applied at 15 and 30 DAS had a major impact on important sesame growth and yield metrics, especially the number of pods per plant and seeds per pod. Regarding the factors that contribute to yield, Treatment 8 performed the best.

3.3 Seed Yield (kg/ha)

The significant difference was found among all the treatments. Statistically highest seed yield summarized in Table 2. showed that significantly highest grain yield (1103.29 kg/ha) was observed in (T_8) Rhizobium along with Cow urine 1.0%. However, T_3, T_5, T_6, T_7 and T_9 was found to be statistically at par with the treatment 8. The best grain yield was achieved by foliar spraying cow urine rather than water (Patil *et al*. 2009) [9]. It is possible that the enhanced yield and yield-attributing characteristics result from the balanced and combined application of Rhizobium inoculation, which increases the photosynthetic activity of leaves and the translocation of photosynthates from source to sink, improving nutrient uptake, improving metabolism, and increasing the efficiency of other nutrients. The findings of Dudeja and Duhan (2005) [2], Sahu and Singh (2009) [15], Kachhave *et al*. (2009) [5], and Sardar *et al*. (2016) [20] are consistent with our work.

3.4 Stover Yield (kg/ha)

The data on stover yield is summarized in Table 2, showed that a significantly maximum stover yield (3054.29 kg/ha) was observed in (T_8) Rhizobium along with foliar spray of Cow urine 1.0%. However, T_1 and T_7 and T_9 it was found to be statistically at par with T_8. This improvement may be attributed to the combined effect of biofertilizers and organic inputs, as no single nutrient source alone can fulfill the crop's total nutrient demand. The application of organic manures enhances soil aeration, nutrient availability, and microbial activity, contributing to increased biomass production. Similar findings were reported by Kumhar *et al*. (2012) [7].

3.5 Harvest Index (%)

At harvest, no significant differences were observed among the treatments for harvest index is summarized in Table 2. However, the highest value (25.78%) was recorded in (T_8) Rhizobium along with foliar spray of Cow urine 1.0%, while the lowest (17.68%) was noted in (T_5) PSB along with Cow urine 1.0%. The higher harvest index with Rhizobium may be attributed to its nitrogen-fixing ability, enhancing vegetative growth and seed development. In contrast, the lower value with PSB might be due to its role in phosphorus solubilization and root efficiency, which may not directly influence partitioning towards seed yield. Similar observations were reported by Rathore *et al*. (2007) [13] and Kumhar *et al*. (2012) [7].

3.6 Economics

The data on the economics of different treatments summarized in Table 3. Showed that the significantly higher Gross returns (80599.39 INR/ha), Net return (53037.84 INR/ha) and B:C (1.92) ratio was recorded with the inoculation of Rhizobium along with foliar spray of Cow urine 1.0 % in T_8.

Table 1: Influence of Biofertilizer and Cow urine on growth attributes of Blackgram

S. No.	Treatments	At 60 DAS			At 45-60 DAS	
		Plant height (cm)	Number of nodules/plant	Dry weight (g)	Crop Growth rate (CGR) (g/m^2/day)	Relative growth rate (RGR) (g/g/day)
1.	*Trichoderma* + Cow urine 0.5%	14.73	32.17	8.97	7.33	0.0314
2.	*Trichoderma* + Cow urine 1.0%	14.93	36.00	8.83	6.30	0.0261
3.	*Trichoderma* + Cow urine 1.5%	14.14	36.00	8.57	5.56	0.0232
4.	PSB + Cow urine 1.0%	14.94	34.17	8.32	5.74	0.0256
5.	PSB + Cow urine 1.0%	14.48	38.00	8.27	7.44	0.0321
6.	PSB + Cow urine 1.0%	14.84	33.83	8.52	6.26	0.0268
7.	Rhizobium + Cow urine 0.5%	14.69	35.17	9.13	5.33	0.0202
8.	Rhizobium + Cow urine 0.5%	15.11	35.50	10.60	9.70	0.0354
9.	Rhizobium + Cow urine 0.5%	14.05	35.00	9.32	6.43	0.0261
10.	Control (RDF) 20:40:20 N: P: K kg/ha	14.18	37.33	7.07	2.07	0.0097
	F-Test	S	NS	S	S	NS
	SEm±	0.54	1.85	0.51	1.16	0.00
	CD (P=0.05)	2.25	-	1.92	3.44	-

Table 2: Influence of Biofertilizer and Cow urine on yield attributes of Blackgram

S. No.	Treatment Combinations	No. of Pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
1.	*Trichoderma* + Cow urine 0.5%	21.80	5.93	36.87	951.18	2951.47	24.59
2.	*Trichoderma* + Cow urine 1.0%	21.47	6.00	36.87	970.23	2929.16	24.87
3.	*Trichoderma* + Cow urine 1.5%	24.33	6.00	36.33	968.45	2932.14	22.82
4.	PSB + Cow urine 0.5%	23.93	5.80	37.20	963.09	2918.45	22.54
5.	PSB + Cow urine 1.0%	22.47	5.87	36.33	969.04	2930.95	17.68
6.	PSB + Cow urine 1.5%	22.40	5.80	36.33	973.81	2926.19	24.96
7.	Rhizobium + Cow urine 0.5%	24.13	6.13	37.30	1025.00	2990.47	25.52
8.	Rhizobium + Cow urine 1.0%	26.47	6.27	39.33	1103.29	3054.43	25.78
9.	Rhizobium + Cow urine 1.5%	22.60	5.47	38.67	1029.16	3018.45	25.42
10.	Control (RDF) 20:40:20 N: P: K kg/ha	17.87	5.60	35.67	954.35	2844.04	24.48
	F test	S	S	NS	S	S	NS
	SEm(±)	0.99	0.14	1.17	46.04	37.11	2.43
	CD (p=0.05)	2.95	0.43	-	136.78	110.25	-

Table 3: Influence of Biofertilizer and Cow urine on economics of Blackgram

S. No.	Treatment Combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	*Trichoderma* + Cow urine 0.5%	27466.55	72413.78	44947.23	1.64
2.	*Trichoderma* + Cow urine 1.0%	27471.55	73774.66	46303.11	1.65
3.	*Trichoderma* + Cow urine 1.5%	27476.55	73655.55	46179.00	1.68
4.	PSB + Cow urine 0.5%	27556.55	73253.43	45696.88	1.66
5.	PSB + Cow urine 1.0%	27561.55	73694.93	46133.38	1.67
6.	PSB + Cow urine 1.5%	27566.55	74018.84	46452.29	1.69
7.	Rhizobium + Cow urine 0.5%	27556.55	77730.71	50174.16	1.82
8.	Rhizobium + Cow urine 1.0%	27561.55	80599.39	53037.84	1.92
9.	Rhizobium + Cow urine 1.5%	27566.55	78078.33	50511.78	1.83
10.	Control (RDF) 20:40:20 N: P: K kg/ha	27431.55	72492.82	45061.27	1.64

Conclusion

It is concluded that inoculation of Rhizobium 20gm/kg along with foliar spray of 1% Cow urine at 15 and 30 DAS (T_8) in Blackgram recorded highest seed yield and benefit cost ratio.

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