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Effect of biofertilizer and liquid organic nutrient sources on growth and yield of black gram (*Vigna mungo* L.)

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Abstract

A field experiment was conducted during the *kharif* season of 2023 at SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The treatments consisted of 3 levels of *Rhizobium* – seed inoculation (0, 20, and 25 g/kg) and 3 liquid organic nutrient sources (Vermiwash 10%, Fish Amino Acid 1%, and Seaweed Extract *Kappaphycus alvarezii* 15%) along with blanket application of FYM 10 t/ha. The experiment was laid out in a Randomized Block Design with 9 treatments and replicated thrice. Application of *Rhizobium* – seed inoculation 25 g/kg + vermiwash 10% (Treatment 3) recorded highest plant height (35.26 cm), number of branches (8.86), maximum plant dry weight (18.32 g), pods per plant (25.26), seeds per pod (8.46), test weight (34.91 g), seed yield (1.57 t/ha) and stover yield (3.38 t/ha).

Keywords: *Rhizobium*, vermiwash, fish amino acid, seaweed extract, black gram, growth and yield

Introduction

Black gram (*Vigna mungo* L.) is one of the important pulse crops grown throughout India. It contains 24% protein, 60% carbohydrates, and 1.3% fat. Black gram contributes 13% of the total pulse area and 10% of the total pulse production of India. Among the soil organisms, there is a unique group of bacteria called *Rhizobium* that has a beneficial effect on the growth of legumes. The complex process by which the *Rhizobium* produces nitrogen for the legumes is called biological nitrogen fixation, or BNF. *Rhizobium* can establish an endosymbiotic association with leguminous plants and they form nodulation. Vermiwash is a liquid organic nutrient source obtained from vermicompost pits. It is the excess liquid drained from vermicompost pits and can be used as a liquid nutrient for plants. Vermiwash is rich in enzymes like amylase, phosphatase, and urease which are beneficial to the plants. (Zambare *et al.*, 2008) [26]. Application of vermiwash increases the plant growth parameters like number of twigs, leaves, length of root, and overall growth which results in higher yield. (Hatti *et al.*, 2010) [11]. Fish Amino Acid (FAA) is a liquid organic nutrient source obtained from fish waste. It is prepared by mixing equal amounts of jaggery and fish waste and by performing anaerobic decomposition in a jar for 15-20 days. After the decomposition process is completed separation of liquid from the solids should be done by using an appropriate sieve. The liquid obtained after the decomposition is Fish Amino Acid (FAA). Fish Amino Acid (FAA) is rich in various nutrients and many types of amino acids. Foliar application of Fish Amino Acid (FAA) diluted with water can increase the overall growth and yield of the crop. Seaweed extract is the liquid organic nutrient extract of red and brown algae. For this experiment red algae (*Kappaphycus alvarezii*) extract is used. It contains carbohydrates, proteins, and plant growth hormones like cytokinin, auxin and gibberellins. Foliar application of seaweed extract is beneficial for the overall crop growth and yield.

Materials and Methods

A field experiment was conducted during the *kharif* season of 2023 at SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The treatments consisted of 3 levels of *Rhizobium* – seed inoculation (no inoculation, 20, and 25 g/kg) and 3

liquid organic nutrient sources (Vermiwash 10%, Fish Amino Acid 1%, and Seaweed extract *Kappaphycus alvarezii* 15%) along with blanket application of FYM 10 t/ha. The experiment was laid out in Randomized Block Design (RBD) with 9 treatments and replicated thrice. The treatments are 1. *No inoculation* + Vermiwash – 10%, 2. *Rhizobium* – seed inoculation 20 g/kg seed + Vermiwash – 10%, 3. *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%, 4. *No inoculation* + Fish amino acid – 1%, 5. *Rhizobium* – seed inoculation 20 g/kg seed + Fish amino acid – 1%, 6. *Rhizobium* – seed inoculation 25 g/kg seed + Fish amino acid – 1%, 7. *No inoculation* + Seaweed extract (*Kappaphycus alvarezii*) – 15%, 8. *Rhizobium* – seed inoculation 20 g/kg seed + Seaweed extract (*Kappaphycus alvarezii*) – 15%, 9. *Rhizobium* – seed inoculation 25 g/kg seed + Seaweed extract (*Kappaphycus alvarezii*) – 15%. The spray of all liquid organic manures are applied once at seedling stage 20 days after sowing, second at pre flowering stage 40 days after sowing, and third at the pod development stage. Vermiwash used for this experiment is obtained from Dharavats Bio Energy Farmer Producer Company Ltd. and used in this experiment. Then the vermiwash is diluted in the same concentrations as mentioned in the treatments before application to the experimental field. Fish Amino Acid (FAA) is prepared from the fish waste and jaggery. Equal amount of fishwaste and jaggery mixed together and performed anaerobic decomposition in a jar for 15 days, then diluted in the same concentrations as mentioned in the treatments before application to the experimental field. Seaweed is prepared from fresh red algae (*Kappaphycus alvarezii*) and appropriate concentrations were made as per the treatments and used for the experiment. The growth parameters and yield was recorded at harvest from randomly selected plants in each and every plot. Data recorded in this research were analyzed using analysis of variance (ANOVA) following randomized block design. Differences were considered significant at 5% level of probability.

Results and Discussion

Growth parameters

Plant height (cm) the data revealed that, significantly higher plant height (27.60cm) was recorded in *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% at an interval of 20 DAS. However, *Rhizobium* – seed inoculation 20 g/kg seed + Seaweed extract (*Kappaphycus alvarezii*) – 15% was found to be statistically at par with treatment 3 *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%. Significant and higher plant height with application of *Rhizobium* 25 g/kg seed and vermiwash 10% might be due to foliar spray of vermiwash can increase the growth and yield response. Hatti *et al.* (2010)^[11]. No. of branches/plant the data revealed that, significantly higher no. of branches/plant (8.31) was recorded in *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% However, *Rhizobium* – seed inoculation 25 g/kg seed + Fish amino acid – 1% and *No inoculation* + Seaweed extract (*Kappaphycus alvarezii*) – 15% was found to be statistically at par with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%. Vermiwash is rich in enzymes like amylase, phosphatase, and urease which are beneficial to the plants. Zambare *et al.* (2008)^[26]. No. of nodules/plant the data revealed that, significantly highest number of nodules/plant (4.48) was recorded in *Rhizobium* – seed inoculation @ 25 g/kg seed + Vermiwash – 10% as compared to rest of the treatments. However, *Rhizobium* – seed inoculation 20 g/kg seed + Vermiwash – 10% was found to be statistically at par with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%. A significant and maximum

number of nodules with the application of *Rhizobium* 25 g/kg seed and vermiwash 10% might be due to *Rhizobium* bacteria have the remarkable ability to form an endosymbiotic relationship with leguminous plants. Through a complex signal cascade involving genes from both the bacteria and the plant, a specialized plant structure known as a nodule develops through a process called nodulation. Vermiwash, a nutrient-rich liquid derived from earthworm castings, contains a diverse array of enzymes including proteases, amylases, ureases, and phosphatases. This enzyme cocktail has been found to promote the formation of a higher number of nodules in legume plants. Plant dry weight (g) the data revealed that, significantly higher plant dry weight (14.32 g) was recorded in *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% as compared to the rest of the treatments. A significant increase was observed due to seed inoculated with *Rhizobium* 25 g/kg seed and application of vermiwash 10% with respect to plant dry weight. The improvement in plant dry weight might be due to seeds treated with *Rhizobium* bacteria and vermiwash exhibit enhanced nitrogen assimilation by the root nodules bacteria. Vermiwash is rich in a blend of enzymes including proteases, amylases, ureases, and phosphatases, which contributes to increased dry weight in plants. This combination facilitates optimal growth and development, promoting a synergistic effect on crop productivity. Bhattacharya J. *et al.* (2001)^[5]. Crop growth rate at 45-60 DAS, was significantly higher (10.41 g/m²/day) was recorded in *No inoculation* + Vermiwash – 10% as compared to the rest of the treatments and there is no significant difference between the treatments. At 45-60 DAS, the highest relative growth rate (0.0263 g/g/day) was recorded in *No inoculation*+ Vermiwash – 10% as compared to the rest of the treatments and there is no significance difference between the treatments.

Yield attributes & Yield

Number of pods/plant (No.) A significantly highest number of effective pods/plant (25.26) was recorded with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. However, *Rhizobium* – seed inoculation 25 g/kg seed + Fish amino acid – 1% was found to be statistically at par with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%. A similar result is also reported by Maya M *et al.* (2015)^[17] & Dharampal *et al.* (2016). Number of seeds/pod (No.) A significantly highest number of seeds/pod (8.46) was recorded with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. However, *Rhizobium* – seed inoculation 25 g/kg seed + Fish amino acid – 1%, *Rhizobium* – seed inoculation 20 g/kg seed + Seaweed extract (*Kappaphycus alvarezii*) – 15%, and *Rhizobium* – seed inoculation 25 g/kg seed + Seaweed extract (*Kappaphycus alvarezii*) – 15% was found to be statistically at par with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10%. Vermiwash has demonstrated a significant impact on enhancing the nutritional composition of seeds. Crops grown with vermiwash found higher percentages of fat and protein. Additionally, the application of vermiwash has led to notable improvements in the bio-chemical properties of the soil, particularly in micronutrient levels, thereby maintaining overall soil health and fertility. Ansari and Sukhraj (2010)^[11]. Test weight (g) A Significantly highest test weight (34.91 g) was recorded with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. However, *Rhizobium* – seed inoculation 25 g/kg seed + Fish amino acid – 1% was found to be statistically at par with

Rhizobium – seed inoculation 25 g/kg seed + Vermiwash – 10%. Seed yield (t/ha) A Significantly highest grain yield (1.57 t/ha) was recorded with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. However, *Rhizobium* – seed inoculation 25 g/kg seed + Seaweed extract (*Kappaphycus alvarezzi*) – 15% was found to be statistically at par with *Rhizobium* – seed inoculation @ 25 g/kg seed + Vermiwash – 10%. The remarkably higher seed yield observed can likely be attributed to the enhanced nitrogen fixation facilitated by vermiwash, leading to increased nutrient availability crucial for the efficient growth and development of plants. The augmentation in yield attributes is likely influenced by the source-sink relationship. Enhanced photosynthesis and improved carbohydrate metabolism results in greater production of photosynthates and metabolites in source tissues, which are subsequently translocated to newly formed sink tissues, such as reproductive structures. This process ultimately contributes to increased pod/plant numbers, longer pod length, and ultimately

higher grain yield in the crop. Stover yield (t/ha) A Significantly highest stover yield (3.38t/ha) was recorded with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. However, *Rhizobium* – seed inoculation 25 g/kg seed + Seaweed extract (*Kappaphycus alvarezzi*) – 15% was found to be statistically at par with *Rhizobium* – seed inoculation 25 g/kg seed + Vermiwash – 10% which was superior over all other treatments. The significantly highest stover yield might be due to The application of vermiwash found to augment the crop production potential of soil through two main mechanisms. (i) it enriches the soil by increasing its organic carbon content. (ii) it promotes the proliferation of soil microorganisms, especially those beneficial to plants, and enhances their activities. These combined effects facilitate improved nutrient uptake by plants, leading to enhanced growth and ultimately higher yields. Gopal M. *et al.* (2010)^[9].

Table 1: Influence of biofertilizer and liquid organic nutrient sources on growth attributes of black gram.

S. No.	Treatments	At 60 DAS					
		Plant height (cm)	No. of branches/plant	No. of nodules/plant	Dry weight (g/plant)	CGR (g/m ² /day) 45-60 DAS	RGR (g/g/day) 45-60 DAS
1.	No inoculation + Vermiwash – 10%	23.95	7.22	2.86	11.99	10.41	0.0263
2.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Vermiwash – 10%	25.32	6.78	3.88	12.02	9.31	0.0229
3.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Vermiwash – 10%	27.60	8.31	4.48	14.32	9.93	0.0201
4.	No inoculation + Fish amino acid – 1%	25.08	7.08	2.75	11.60	6.31	0.0151
5.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Fish amino acid – 1%	24.74	7.50	2.50	10.98	5.19	0.0133
6.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Fish amino acid – 1%	24.27	8.03	3.26	12.09	6.68	0.0155
7.	No inoculation + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	23.94	7.68	2.51	11.36	7.60	0.0191
8.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	26.20	6.78	3.01	11.84	6.68	0.0158
9.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	24.20	7.60	3.25	11.88	6.00	0.0141
	F-Test	S	S	S	S	NS	NS
	S.Em±	0.53	0.23	0.22	0.51	1.87	0.01
	CD (P=0.05)	1.58	0.68	0.66	1.53	-	-

Table 2: Influence of biofertilizer and liquid organic nutrient sources on yield attributes and yield of black gram

S. No.	Treatments	No. of pods/plant	No. of Seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.	No inoculation + Vermiwash – 10%	17.40	5.73	30.18	1.43	2.85	33.45
2.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Vermiwash – 10%	16.06	6.20	30.91	1.40	2.98	31.96
3.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Vermiwash – 10%	25.26	8.46	34.91	1.57	3.38	31.74
4.	No inoculation + Fish amino acid – 1%	18.06	6.60	31.56	1.36	2.83	32.47
5.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Fish amino acid – 1%	17.33	5.46	29.21	1.35	2.93	31.51
6.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Fish amino acid – 1%	24.66	8.20	33.19	1.38	2.88	32.51
7.	No inoculation + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	17.60	6.73	30.49	1.31	2.89	31.20
8.	<i>Rhizobium</i> – seed inoculation 20 g/kg seed + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	19.66	7.23	29.64	1.38	2.92	32.18
9.	<i>Rhizobium</i> – seed inoculation 25 g/kg seed + Seaweed extract (<i>Kappaphycus alvarezzi</i>) – 15%	18.66	7.06	31.93	1.44	3.26	30.80
	F-Test	S	S	S	S	S	NS
	S.Em±	0.84	0.47	0.93	0.04	0.10	0.98
	CD (P=0.05)	2.53	1.41	2.78	0.13	0.29	-

Summary and Conclusion

Summary

The investigation titled, “Effect of Biofertilizer and Liquid Organic Nutrient Sources on Growth and Yield of Black Gram” was conducted at SMOF (SHIATS Model Organic Farm), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And

Sciences, Prayagraj during *kharif* season of 2023. The experiment was laid out in Randomized Block Design consisting of 9 treatments and replicated thrice. Based on the objectives undertaken in the study, application of *Rhizobium* seed inoculation 25 g/kg seed + Vermiwash 10% (Treatment 3) recorded highest plant height (27.6 cm), maximum no. of branches (8.31), maximum no. of nodules (30.57), maximum

plant dry weight (14.32 g), no. of pods per plant (25.26), no. of seeds per pod (8.46), test weight (34.91 g), seed yield (1.57 t/ha) and stover yield (3.38 t/ha).

Conclusion

It is concluded that application of seed inoculation with *Rhizobium* 25 g/kg seed and foliar spray of vermiwash 10% (Treatment 3) recorded highest yield.

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