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Effect of bio-fertilizers and organic manures on growth and yield of greengram (*Vigna radiata* L.)

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Abstract

A field experiment was conducted during *Kharif* 2021 at SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T1: Rhizobium 10 g/kg + FYM 5 t/ha, T2: Rhizobium 10 g/kg + Vermicompost 4 t/ha, T3: Rhizobium 10 g/kg + Poultry manure 3 t/ha, T4: PSB 10 g/kg + FYM 5 t/ha, T5: PSB 10 g/kg + Vermicompost 4 t/ha, T6: PSB 10 g/kg + Poultry manure 3 t/ha, T7: Rhizobium + PSB (5+5 g/kg) + FYM 5 t/ha, T8: Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha, T9: Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha used. The results showed that application of Rhizobium + PSB (5+5g/kg) + Poultry manure 3 t/ha was recorded significantly higher plant height (29.40 cm), Plant dry weight (16.66 g/plant), nodules/plant (7.63), No. of Branches/plant (9.80), pods/plant (26.67), Seeds/pod (10.67), Test weight (38.20 g) whereas maximum crop growth rate (9.66 g/m²/day) was recorded with Rhizobium 10g/kg + Poultry manure 3 t/ha. However, higher Seed yield (1172.90 kg/ha), gross returns (Rs. 82,103.00/ha), net return (Rs. 51,953.00/ha) and benefit cost ratio (1.72) were obtained with application of Rhizobium + PSB (5+5g/kg) + Poultry manure 3 t/ha as compared to other treatments.

Keywords: Rhizobium, PSB, vermicompost, FYM, poultry manure, yield

Introduction

Green gram (*Vigna radiata* L.), also known as mungbean, is one of the most important pulse crops and an excellent source of high quality protein (Patel *et al.*, 2016; Mahalingam *et al.*, 2018) ^[10, 7]. It is also used as sprout salad, vegetable and some Indian dishes like curry, sevpuri, panipuri or Indian chat sprout salad. In India, green gram is cultivated since olden times and is native to the Indian sub-continent and central Asia and is grown in these regions over a long decade. It is also widely cultivated all over Asia, including India, Pakistan, Bangladesh, Sri-Lanka, Thailand, Cambodia, Vietnam, Indonesia, Malaysia, South China and Formosa. (Patel *et al.*, 2013) ^[11] recorded that the production of green gram was cultivated in an area of 3.44 million hectares with the total production of about 1.4 million tonnes and productivity of 406.98 kg/ha. Fertilizer only cannot maintain productivity of land in modern farming.

Among various biofertilizers, rhizobium inoculation is a cheapest, easiest and safest way of supplying nitrogen to green gram through well-known symbiotic nitrogen fixation process. Phosphate Solubilizing Bacteria (PSB) have the consistent capacity to increase the availability of phosphate to plant by mineralizing organic phosphorus compounds (Beg and Singh 2009) ^[2]. Vermicompost for enhancing crop productivity and improving soil health is gaining popularity among the farming community. The possibility of utilizing different plant biomass (weed biomass, crop residue etc.) into quality organic manure. Improvement in soil health and crop productivity, following vermicompost application, have been earlier reported by many workers (Karmakar *et al.*, 2013; Rajkhowa *et al.*, 2003; Rajkhowa *et al.*, 2000) ^[6, 12-13]. Vermicompost enhances soil biodiversity by promoting beneficial microbes, which in turn enhances plant growth directly by production of plant growth regulating substances (hormones and enzymes) and indirectly by controlling plant pathogens, nematodes and other pests. Farmyard manure is known to play an important role in improving the fertility and capacity of soils through its positive effects on soil physical, volatility and biological properties and level of plant nutrition.

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Poultry manure can be efficiently used for the crops after composting the same to save the nutrients. (Amanullah *et al.*, 2003) [1]. Plants that collect poultry manure grew taller than other plants possibly more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development (Enujeke, 2013) [4].

Materials and Methods

The present Experiment was carried out during *Kharif* 2021 at SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25°30' 42" N latitude, 81° 60' 56" E longitude and 98 m altitude above the mean sea level (MSL). The experiment laid out in Randomized Block Design which consisting of nine treatments with T₁: Rhizobium 10 g/kg + FYM 5 t/ha, T₂: Rhizobium 10 g/kg + Vermicompost 4 t/ha, T₃: Rhizobium 10 g/kg + Poultry manure 3 t/ha, T₄: PSB 10 g/kg + FYM 5 t/ha, T₅: PSB 10 g/kg + Vermicompost 4 t/ha, T₆: PSB 10 g/kg + Poultry manure 3 t/ha, T₇: Rhizobium + PSB (5+5 g/kg) + FYM 5 t/ha, T₈: Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha, T₉: Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha⁻¹), higher available P (19.50 kg ha⁻¹) and medium available K (213.7 kg ha⁻¹). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, no. of nodules per plant, no. of nodules branches per plant and plant dry weight are recorded. The yield parameters like pods per plant, seeds per pod, test weight, seed yield (kg/ha) were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height: Significantly Higher plant height (29.40 cm) was observed in the treatment with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha over all the other treatments. However, the treatments with application of Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (29.30 cm) which were found to be statistically at par with treatment Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. The application of Poultry manure might have favoured better root proliferation, more solubility of phosphorous which consequently favoured higher biological nitrogen fixation and uptake of nutrients and availability of all plant nutrients during the crop growth period. Which resulted in the higher plant height. These results are in close in close conformity with the findings of Pandey *et al.* (2019) [8].

Plant dry weight

The treatment with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha was recorded with significantly maximum dry weight (16.66 g/plant) over all the treatments. However, the treatments with Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (16.56 g/plant) which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. Inoculation of PSB solubilization of inorganic insoluble phosphates by microorganisms to the production of organic acids, chelating oxoacids from sugars, and exchange reactions in growth environment, and rhizobium inoculation helped in nitrogen fixation which helped in higher biomass accumulation in greengram plants. The results were found to similar with Vijayakumar *et al.* (2004). The increase in the total dry matter production may be due to better source and sink capacity developed due to better dry matter production with the application of PM and its accumulation in assimilatory surface area and increase in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry accumulation. The results were found to be similar with Patil (2000) [9].

Nodules/Plant

The Maximum nodules per plant (7.63) was observed in the treatment with application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha, which was significantly higher over rest of the treatments. However, the treatments with Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (7.53) which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. The application of biofertilizers like rhizobium and PSB helped in higher nitrogen fixation and phosphorous solubilization respectively which helped in higher root growth and nodules development and also application of poultry manure helped in availability of nutrients which helped in higher nodule formation. The results were in accordance with Sharma *et al.* (2006) [15] and Ghansyam *et al.* (2010) [5].

No. of Branches/Plant

The maximum number of Branches per plant (9.80) was observed in the treatment with application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha, which was significantly higher over rest of the treatments. However, the treatments with Rhizobium 10 g/kg + Poultry manure 3 t/ha (9.67) and Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (9.77) which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. The higher number of branches due to the application of poultry manure might be due to the availability of desired and required quantity of nutrients for longer period in root zone of growing plants which helped plant cells to divide. The results were found to in correspondence with Jat *et al.* (2012) [5].

Table 1: Effect of bio-fertilizers and organic manures on growth attributes of greengram

Treatments	Plant height (cm)	Dry weight (g/plant)	Branches/plant	Nodules/plant
Rhizobium 10 g/kg + FYM 5 t/ha	28.43	15.74	9.00	6.67
Rhizobium 10 g/kg + Vermicompost 4 t/ha	28.87	16.33	9.50	7.17
Rhizobium 10 g/kg + Poultry manure 3 t/ha	29.17	16.45	9.67	7.27
PSB 10 g/kg + FYM 5 t/ha	28.07	15.36	8.60	6.37
PSB 10 g/kg + Vermicompost 4 t/ha	28.27	15.64	8.73	6.57
PSB 10 g/kg + Poultry manure 3 t/ha	28.60	15.92	9.17	6.87

Rhizobium + PSB (5+5 g/kg) + FYM 5 t/ha	28.70	16.11	9.37	6.97
Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha	29.30	16.56	9.77	7.53
Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha	29.40	16.66	9.80	7.63
F- test	S	S	S	S
S. EM (\pm)	0.05	0.06	0.07	0.11
C. D. (P = 0.05)	0.17	0.17	0.21	0.31

Yield attributes and Yield

Pods/plant

Significantly Maximum Pods/plant (26.67) was recorded with the treatment of application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha over all the treatments. However, the treatments Rhizobium 10 g/kg + Poultry manure 3 t/ha (26.00) and Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (26.33) which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. Significant increase in number of pods/plant is due to increase in the availability of Nitrogen and Phosphorous through bio fertilizer inoculation (rhizobium and PSB) by which more pods are produced due to increased rates of primordial production, similar results were found Kothiyari *et al.* (2017).

Seeds/pod

Significantly highest Seeds/Pod (10.67) was recorded with the treatment of application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha over all the treatments. However, the treatments Rhizobium 10 g/kg + Poultry manure 3 t/ha (10.00) and Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha (10.33) which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. The greater photosynthesis production of metabolites and enzymatic activities due to the seed treatment of biofertilizers and Poultry manure application might have influenced into increased nodulation and extensive root system and the greater production of metabolites and their translocation to various sinks especially the productive structures (pods and seeds) could have helped to increase into the number of pods per plant besides increasing the overall growth. The results were found to be similar with Kothiyari *et al.* (2017) and Ghansyam *et al.* (2010)^[5].

Test weight (g)

Significantly highest Test weight (38.20 g) was recorded with

the treatment application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha over all the treatments. However, the treatments with (37.72 g) in Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. The beneficial response of poultry manure to yield attributes might also be attributed to the availability of sufficient amounts of easily utilizable from of plant nutrients throughout the growth period and especially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes. The results were found to be similar with Dhaliwal *et al.* (2007)^[3].

Seed yield (q/ha)

Significantly highest Seed yield (1172.90 kg/ha) was recorded with the treatment application of Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha over all the treatments. However, the treatments with (1100.09 kg/ha) in Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha which were found to be statistically at par with Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha. Increase in yield attributes and yield through bio-fertilizer might be attributed to supply of more plant hormones (auxin, cytokinin, gibberellin etc.) by the microorganisms inoculated or by the root resulting from reaction to microbial population similar results were obtained by Umamaheswari *et al.* (2001)^[16]. The higher increase in the yield has been reported to be associated with the release of macro and micro nutrients during the course of microbial decomposition. Organic matter also functions as source of energy for soil micro flora which brings about the transformation of other nutrients held in soil or applied through other means, in a form that is readily utilized by growing plants which helped in increase of seed yield. The results were in accordance with Sharma and Abraham (2010)^[14].

Table 2: Effect of bio-fertilizers and organic manures on yield attributes and yield of greengram

Treatments	Pods/Plant	Seeds/pod	Test weight (g)	Seed Yield (kg/ha)
Rhizobium 10 g/kg + FYM 5 t/ha	24.33	8.67	35.23	812.41
Rhizobium 10 g/kg + Vermicompost 4 t/ha	25.33	9.67	36.76	952.18
Rhizobium 10 g/kg + Poultry manure 3 t/ha	26.00	10.00	37.18	1011.33
PSB 10 g/kg + FYM 5 t/ha	23.33	8.00	34.60	726.61
PSB 10 g/kg + Vermicompost 4 t/ha	23.67	8.33	34.84	766.23
PSB 10 g/kg + Poultry manure 3 t/ha	25.67	9.00	35.51	870.70
Rhizobium + PSB (5+5 g/kg) + FYM 5 t/ha	25.00	9.33	36.19	903.59
Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha	26.33	10.33	37.72	1100.09
Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha	26.67	10.67	38.20	1172.90
F test	S	S	S	S
S. EM (\pm)	0.37	0.28	0.17	24.76
CD (P = 0.05)	1.11	0.84	0.51	74.23

Economics

Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments.

Gross returns

Higher Gross returns have been recorded with the Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha (Rs. 82,103.00/ha)

over rest of the treatments, whereas minimum gross return was recorded with PSB 10 g/kg + FYM 5 t/ha (Rs. 50,862.70/ha).

Net returns: Higher Net returns have been recorded with the treatment Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha (Rs. 51,953.00/ha) over rest of the treatments, whereas minimum Net returns was recorded with PSB 10 g/kg + FYM

5 t/ha (Rs. 23,412.70/ha).

Benefit Cost ratio

Higher Benefit cost ratio have been recorded with the treatment Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha (1.72) over rest of the treatments, whereas lower Benefit cost ratio was recorded with PSB 10 g/kg + FYM 5 t/ha (0.85).

Table 3: Effect of bio-fertilizers and organic manures on economics of greengram

Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
Rhizobium 10 g/kg + FYM 5 t/ha	27,550.00	56,868.70	29,318.70	1.06
Rhizobium 10 g/kg + Vermicompost 4 t/ha	28,750.00	66,652.60	37,902.60	1.31
Rhizobium 10 g/kg + Poultry manure 3 t/ha	30,000.00	70,793.10	40,793.10	1.35
PSB 10 g/kg + FYM 5 t/ha	27,450.00	50,862.70	23,412.70	0.85
PSB 10 g/kg + Vermicompost 4 t/ha	28,650.00	53,636.10	24,986.10	0.87
PSB 10 g/kg + Poultry manure 3 t/ha	29,900.00	60,949.00	31,049.00	1.03
Rhizobium + PSB (5+5 g/kg) + FYM 5 t/ha	27,700.00	63,251.30	35,551.30	1.28
Rhizobium + PSB (5+5 g/kg) + Vermicompost 4 t/ha	28,900.00	77,006.30	48,106.30	1.66
Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha	30,150.00	82,103.00	51,953.00	1.72

Conclusion

It is concluded that application of treatment Rhizobium + PSB (5+5 g/kg) + Poultry manure 3 t/ha was recorded significantly higher Seed yield (1172.90 kg/ha), higher gross returns (Rs. 82103/ha), net returns (Rs. 51953/ha) and benefit cost ratio (1.72) as compared to other treatments. Since, the findings based on the research done in one season.

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