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Research Article

Studies on the influence of different organic manures on soil microbial activity, growth and yield performance of Blackgram (*Vigna mungo* L.)

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ABSTRACT

The core principle of organic farming revolves around utilizing naturally occurring resources, such as organic waste, along with natural processes like decomposition, biological nitrogen fixation, and resistance, to fulfill the requirements of crop production. By employing organic manures to promote crop growth, the organic matter content of the soil is enhanced. Organic manures not only provide nutrients but also serve as a food source for microorganisms, fostering their population growth. This, in turn, enhances nutrient mineralization in the soil, improving soil fertility and productivity. Experiment was conducted to explore the impact of different organic manures on soil microbial activity, as well as the growth and yield of black gram (*Vigna mungo* L.). The study consisted of seven treatments and three replications, following a Completely Randomized Design (CRD). The treatment involving a combination of FYM (25%), Vermicompost (25%), Cow dung (25%), and Bone meal (25%) exhibited the highest abundance of various microorganisms, including Bacteria, Fungi, Actinomycetes, PO_4-solubilizing microorganisms, and *Rhizobium*, whereas the control group had the lowest abundance. Several plant parameters, such as plant height, number of branches per plant, number of leaves per plant, dry matter production, test weight and plant yield, were measured. Application of recommended dose of fertilizer (RDF) (100%) resulted in significantly higher values for these parameters, whereas the control group yielded the lowest results.

KEY WORDS: Blackgram; *Rhizobium*; Biofertilizers; *Vigna mungo*; Rhizosphere

1. Introduction

The increasing awareness of environmental conservation, health risks associated with agrochemicals and consumers' preference for safe and hazard-free food are significant factors driving the growing interest in organic agriculture. The fundamental objective of organic farming is to achieve sustainable agricultural production while preserving natural resources and ensuring the production of high-quality agricultural goods. The advent of high-tech modern agriculture, heavily reliant on fertilizers and chemicals since the mid-1960s, helped bridge the gap between food demand and supply for a rapidly growing population. However, by the late 1980s, signs of soil exhaustion and declining overall productivity per unit area began to emerge, despite the use of modern technologies. This trend has persisted until today.

In agriculture, organic manures play a crucial role by adding essential organic and mineral matter to the soil. Organic systems prioritize the management of organic matter to enhance soil fertility and productivity. Organic matter exerts a significant influence on nearly all soil properties, and it is considered a valuable repository of nutrients. The presence of soil fauna and microorganisms is indispensable for the

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mineralization of organic matter. The soil is home to a dynamic population of microorganisms, arthropods, and other soil biota.

Black gram (*Vigna mungo* L.) holds the position of being the third most significant pulse crop in India. This annual pulse crop originated in central Asia and is also extensively cultivated in regions such as West Indies, Japan, and other tropical/subtropical countries. The seeds of black gram are highly nutritious, containing a substantial amount of protein (24-26%) as well as potassium, phosphorus, and calcium, with good sodium content. Additionally, it is known for its richness in vitamins A, B_1, B_3, along with nutritionally valuable proteins, essential minerals, and vitamins. Black gram is associated with medicinal properties, including the treatment of diabetes, sexual dysfunction, nervous disorders, hair disorders, digestive system disorders, and rheumatic afflictions (Anonymous, 2010). As a summer pulse crop, it has a relatively short duration of 90-120 days (Delic *et al.*, 2009). Notably, black gram is valued for its high digestibility and the absence of flatulence effects (Fary, 2002). In order to reduce production costs associated with mineral fertilization and promote environmental protection, application organic manures can be employed to increase pulse production. With this objective experiment was conducted to assess the different organic manures on the growth and yield of blackgram.

2. Materials and Methods

The treatments used in the experiment were as follows: T_1 represented the control group, T_2 received the recommended dose of fertilizer (RDF) at 100%, T_3 was treated with 100% Farmyard Manure (FYM), T_4 received 100% Vermicompost, T_5 was treated with 100% Cow dung, T_6 received 100% Bone meal, and T_7 was a combination of FYM (25%) + Vermicompost (25%) + Cow dung (25%) + Bone meal (25%).

For the experiment, recommended dose of organic manures per ha was taken into consideration and calculated as per the kg of soils required for the pot experiment, each treatment was replicated three times to ensure reliable results. The variety of blackgram used in the pot experiment was LBG 17. Data collected on various soil microbial populations, blackgram growth, and yield parameters were subjected to statistical analysis using Fisher's method of analysis of variance, with the interpretation guidelines outlined by Gomez and Gomez (1984).

To enumerate the microbial populations, soil samples were collected from the pot experiment site. Bacteria, fungi, actinomycetes, as well as physiological groups such as *Rhizobium* and Phosphorus Solubilizing Microorganisms (PSM), were assessed using the serial dilution agar plate method. During different stages of blackgram growth 30 days after sowing (DAS) and At harvest, random plant selections were made from each treatment to record observations on various growth and yield parameters. These observations were integral to assessing the impact of the different treatments. Overall, this experiment aimed to investigate the effects of various organic manures on soil microbial activity, blackgram growth, and yield parameters in order to gain insights into sustainable agricultural practices.

3. Results and Discussion

3.1 Assessment of Microbial Population in the Study Site

At 30 days after sowing (DAS), the combined application of FYM (25%) + vermicompost (25%)

+ cow dung (25%) + bone meal (25%) resulted in a significantly higher bacterial population (cfu × 10^7 g^{-1} of dry soil) compared to other treatments. The next best treatments were cow dung (100%), vermicompost (100%), FYM (100%), and RDF (100%). The control treatment exhibited a significantly lower number of bacterial colonies. Similar trend was also noticed at harvest stage for bacterial population.

Regarding fungal population (cfu × 10^4 g^{-1} of dry soil), at 30 DAS, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) showed a significantly higher fungal population compared to other treatments. The control treatment exhibited a significantly lower number of fungal colonies, which was comparable to the other treatments except vermicompost (100%), FYM (100%), RDF (100%), and cow dung. At harvest, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) resulted in a significantly higher fungal population compared to all other treatments. The control treatment exhibited a significantly lower number of fungal colonies, which was comparable to the other treatments except FYM and RDF. Similar results were also obtained by Santoshagowda *et al.*, 2015 and recorded combined application of organic manures showed the significant increase the growth and yield attributes of blackgram.

Actinomycetes population significantly influenced by the application of different combination of organic manures. At 30 days after sowing (DAS), the application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) resulted in a significantly higher actinomycetes population (cfu × 10^3 g^{-1} of dry soil) compared to other treatments. The control treatment exhibited a significantly lower number of actinomycetes colonies, which was comparable to the other treatments except vermicompost (100%), FYM (100%), RDF (100%), and cow dung. At harvest, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) showed a higher actinomycetes population compared to all other treatments. The control treatment exhibited a significantly lower number of actinomycetes colonies, which was comparable to the other treatments except RDF, cow dung, and bone meal. These findings highlight the positive impact of specific treatments, particularly the combined application of organic amendments, on the actinomycetes population in the soil. The presence of higher actinomycetes populations can contribute to enhanced soil health and nutrient cycling, thus promoting overall crop productivity and sustainability.

With respect to Phosphate Solubilizing Microbial (PSM) population, At 30 days after sowing (DAS), the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) resulted in a significantly higher population of phosphate solubilizing microbes (PSM) (cfu × 10^3 g^{-1} of dry soil) compared to all treatments. The control treatment exhibited a significantly lower number of PSM colonies, which was comparable to the other treatments. At harvest, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) showed a significantly higher population of phosphate solubilizing microbes compared to all other treatment. The control treatment exhibited a significantly lower number of PSM colonies. These results indicate that the application of specific treatments, particularly the combined use of organic amendments, can significantly enhance the population of phosphate solubilizing microbes in the soil (Ananth *et al.*, 2015). This is beneficial for nutrient availability and uptake by plants, ultimately contributing to improved crop growth and productivity.

The population of nitrogen-fixing microbes, specifically *Rhizobium*, was evaluated at 30 days after sowing (DAS) and At harvest stage in blackgram under different treatments. Among the treatments, the application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) resulted in a significantly higher population of nitrogen-fixing microbes at 30 DAS compared to all treatments. The control treatment exhibited a significantly lower number of nitrogen-fixing microbial colonies. Similarly, At harvest, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) showed a significantly higher population of nitrogen-fixing microbes compared to all other treatments. The control treatment exhibited a significantly lower number of nitrogen-fixing microbial colonies, while the remaining treatments showed similar results to each other. These findings emphasize the positive impact of incorporating organic amendments, particularly the combined use of FYM, vermicompost, cow dung, and bone meal, in promoting the population of nitrogen-fixing microbes like *Rhizobium*, which can enhance nitrogen fixation in the soil and contribute to improved blackgram growth and development.

In the current study, a noticeable enhancement in the population of various soil microorganisms, including bacteria, fungi, actinomycetes, *Rhizobium*, and phosphate solubilizers, was observed at different stages of blackgram growth (30 DAS and At harvest). This increase can be attributed to the availability of easily metabolizable compounds early in the growth stage, as well as the active growth phase of the crop, resulting in higher root exudate production and providing favorable conditions for diverse microbial communities. The combined application of different organic manures, such as FYM, cow dung and bone meal, resulted in a significant increase in microbial population, particularly with the treatment of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%). In contrast, the control treatment showed lower microbial population, indicating minimal impact on the soil microbial community. These findings highlight the positive influence of organic manure additions on the abundance of beneficial soil microorganisms. Consistent with previous studies conducted by Sreenivasa (2007), Deshpande *et al*. (2010), and Dhok and Ghodpage (2011), the present results also demonstrate that the combined application of organic substances leads to higher soil microbial populations compared to individual organic inputs or the control treatment. These findings further support the notion that organic amendments have a positive impact on soil microorganisms. Moreover, the effects of these microbial populations on plant growth parameters were also investigated (Table 1).

At 30 days after sowing (DAS), the application of recommended dose of fertilizer (RDF) resulted in significantly higher plant height of blackgram (29.00 cm) compared to all other treatments. The control treatment exhibited significantly lower plant height (13.33 cm), the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) recorded (26.33 cm), FYM (100%) (24.67 cm), cow dung (100%) (22.33 cm) and vermicompost (100%) (21.00 cm),. At harvest, the application of RDF (100%) continued to yield significantly taller plants (38.33 cm) compared to all other treatments. The treatments with combined application of FYM

(25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) (54.00 cm) and vermicompost (100%) alone (49.67 cm) followed as the next best options. The control treatment displayed significantly lower plant height (38.33 cm), which was similar to the remaining treatments.

At harvest, the application of recommended dose of fertilizer (RDF) resulted in a significantly higher number of branches per plant of blackgram (8.67), which was followed combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) (7.33) and vermicompost (100%) (5.0). The control treatment exhibited a significantly lower number of branches per plant (3.00).

The number of leaves per blackgram plant was assessed at two different stages of growth. At 30 days after sowing (DAS), the application of RDF resulted in a significantly higher number of leaves per plant (5.33) followed by the treatment which received combination FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) where (4.00) leaves were observed. The control treatment exhibited a significantly lower number of leaves per plant (1.67). Moving At harvest stage, the application of RDF (100%) showed a significant increase in the number of leaves per plant (13.67) compared to all other treatments, the combined application of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) (11.33), FYM (100%) (10.67), cow dung (100%) (9.00) and vermicompost (100%) (8.33). Once again, the control treatment displayed a significantly lower number of leaves per plant (5.00).

Significant variations were observed in the dry matter production per plant of blackgram at different stages of growth. At 30 DAS, the application of RDF (100%) demonstrated a significantly higher dry matter production per plant (3.67 g plant^{-1}) compared to other treatments, the next best treatment was FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) (2.33 g plant^{-1}). Conversely, the control treatment exhibited a significantly lower dry matter production per plant (0.93 g plant^{-1}). Moving forward to At harvest stage, RDF (100%) continued to exhibit a significant impact on dry matter production per plant, recording the highest value (9.33 g plant^{-1}) among all treatments. In contrast, the control treatment resulted in a significantly lower dry matter production per plant (3.67 g plant^{-1}). The treatment which received combination of FYM (25%) + vermicompost (25%) + cow dung (25%) + bone meal (25%) recorded (6.67 g plant^{-1}) which was followed farmyard manure (100%) recorded (6.00 g plant^{-1}), cow dung (100%) (5.67 g plant^{-1}) and vermicompost (100%) (5.00 g plant^{-1}). Furthermore, blackgram plants treated with RDF (100%) showcased a substantial increase in grain yield (952 kg/ha) compared to all other treatments, while the control treatment yielded significantly lower results (387 kg/ha).

The present study revealed that plant height, number of branches, number of leaves, dry matter production, and yield exhibited an increasing trend as the plants matured. The application of inorganic fertilizer resulted in higher plant yield, as it is readily absorbed by plants, while organic manures require microbial decomposition, leading to a slower release of nutrients. The growth and yield of blackgram were significantly higher when treated with recommended dose of fertilizer (RDF) throughout the growth stages, in contrast to the significantly lower plant growth and yield observed in the control group without organic manure supplementation (compared to RDF) (Table 2). Previous studies have also reported enhanced crop growth and yields with the combined application of organic manures (Thomas and Lal, 2003; Patil *et al*., 2012; Dakshayini *et al*., 2020).

4. Conclusion

These findings highlight the positive impact of specific treatments, particularly the combined application of organic amendments, on the bacterial and fungal populations in the soil. Such treatments can play a crucial role in enhancing soil microbiota and promoting beneficial microbial activity for improved agricultural outcomes.

5. Reference

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Table 1: Represents the population of bacteria, fungi, actinomycetes, phosphate solubilizing microbes (PSM), and *Rhizobium* at various growth stages of blackgram, influenced by nutrient management practices using organic materials in pot experiments.

Treatments	Bacteria (CFU × 10^7)		Fungi (CFU × 10^4)		Actinomycetes (CFU × 10^3)		PSM (CFU × 10^3)		*Rhizobium* (CFU × 10^3)	
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
T_1 - Control	25.00	58.00	14.67	26.00	18.33	30.67	22.33	31.00	29.33	54.33
T_2 - Recommended Dose of Fertilizer (RDF)-100%	31.33	75.33	18.00	32.67	22.67	35.33	27.00	37.67	39.00	61.33
T_3 - Farmyard Manure (FYM) - 100%	38.00	87.67	28.00	41.33	32.67	44.00	33.67	45.00	52.33	77.67
T_4 - Vermicompost - 100%	36.33	81.00	22.00	34.00	28.67	39.67	29.67	40.33	45.00	71.00
T_5 - Cow dung - 100%	37.00	84.00	27.33	38.67	31.00	41.33	30.00	42.00	48.67	73.00
T_6 - Bone meal - 100%	27.67	72.67	17.00	29.00	20.33	34.67	32.33	43.67	41.33	68.67
T_7 - T_3 (25%) + T_4 (25%) + T_5 (25%) + T_6 (25%)	42.67	93.33	31.33	45.67	38.00	49.67	37.00	48.33	58.00	81.33
S.Em	0.94	1.36	1.02	1.23	1.48	1.29	1.13	1.21	1.76	1.07
CD (p=0.05%)	2.80	4.08	3.04	3.66	4.42	3.85	3.38	3.63	5.28	3.20

Note: Values are mean of three replications

Table 2: Represents the growth and yield parameters of blackgram at various growth stages, influenced by nutrient management practices using organic materials in pot experiments.

Treatments	Plant height (cm)		No. of Branches/plant		No. of Leaves/plant		Plant Dry Weight (gm)		Yield (kg/ha)
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	
T_1 - Control	13.33	38.33	1.33	3.00	1.67	5.00	0.93	3.67	387
T_2 - Recommended Dose of Fertilizer (RDF)- 100%	29.00	58.67	6.33	8.67	5.33	13.67	3.67	9.33	952
T_3 - Farmyard Manure (FYM) - 100%	24.67	51.33	4.67	6.00	3.67	10.67	2.00	6.00	746
T_4 - Vermicompost - 100%	21.00	49.67	3.67	5.00	3.00	8.33	1.00	5.00	715
T_5 - Cow dung - 100%	22.33	50.00	4.00	5.33	3.00	9.00	1.67	5.67	723
T_6 - Bone meal - 100%	17.00	48.67	3.00	4.67	2.33	7.00	1.00	4.00	654
T_7 - T_3 (25%) + T_4 (25%) + T_5 (25%) + T_6 (25%)	26.33	54.00	5.00	7.33	4.00	11.33	2.33	6.67	897
S.Em	0.81	1.04	0.36	0.31	0.22	0.64	0.28	0.32	8.76
CD (p=0.05%)	2.43	3.12	1.07	0.92	0.65	1.92	0.83	0.95	26.28

Note: Values are mean of three replications