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Effect Different Level of Organic Sources on Growth, Yield, Quality and Economic Response of Moong Bean (*Vigna radiata* L.) in Central Part of India

Mastu Patel[1], B. Gangwar[2], Prasann Kumar[1]

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ABSTRACT

Background: Excessive utilization of inorganic fertilizers and pesticides, leading to environmental, soil and water contamination and pest outbreaks, has emerged as a significant concern in recent year. In today's agricultural landscape, there is a growing trend towards organic farming, emphasizing a sift from high-volume to high-value production system.

Methods: A field experiment was conducted in Institute of Agriculture Sciences, Bundelkhand University Jhansi, Uttar Pradesh during *kharif* season of 2021. The experiment was laid out in randomized block design and replicated thrice with nine treatments combination, three different sources of organic *viz.,* farm yard manure, vermicompost and poultry manure along with Rhizobium and Phosphate solubilizing bacteria (PSB).

Result: Experimental results indicated that 1/3 through farm yard manure (16.66 q ha^{-1}) + 1/3 through poultry manure (2.77 q ha^{-1}) + through vermicompost (8.33 q ha^{-1}) + rhizobium + PSB, significantly enhancing growth parameters leaf area, leaf area index, dry matter accumulation per meter square, yield attributes like Pod weight, grain yield and quality attributes, higher net return.

Key words: Farm yard manure, Poultry manure, PSB, Root nodules, Vermicompost.

INTRODUCTION

Pulses constitute 14% of the total protein composition of the average Indian diet and are especially important as a source of protein for vegetarians. Globally, moong bean is grown on an area of about 7.3 million ha with productivity about 721 kg/ha (Anonymous, 2021). India is projected to produce 15.06 lakh tonnes of moong bean with productivity of 570 kg/ha on 5.5 million hectares (AICRPR, 2022-2023).

The excessive utilization of inorganic fertilizers and pesticide, leading to environmental, soil and water contamination and pest outbreaks, has emerged as a significant concern in recent years. In today's agricultural landscape, there is a growing trend towards organic farming, emphasizing a shift from high-volume to high-value production systems. Key management techniques focus on preserving soil health, implementing nutrient supply systems reliant on organic material rather than chemicals and adopting integrated pest management strategies. Consequently, the utilization of botanical and bio-enhancers derived from cows, when combined with organic manures, has emerged as a beneficial approach in organic farming for ensuring a dependable and cost-effective nutrient supply (Bairagi *et al.*, 2017). Organic sources such as farmyard manure, vermicompost, poultry manure and biofertilizers, serve not only as nutrient and organic matter sources but also contribute to enhancing microbial population size, diversity and activity in the soil (Ahmed *et al.*, 2023). Vermicompost, farm yard manure and poultry manure are comparatively resistant to microbial deterioration. Nonetheless, it is necessary to create and preserve the ideal physical conditions of the soil for plant growth (Agele *et al.,* 2017). It is a good supply of nitrogen for crop development that is sustainable, because it is bulky, it is still difficult to get and the high cost of inorganic fertilizer makes it unaffordable for poor farmers. Poultry manure is rich in nutrients, particularly nitrogen, which helps the crop grow faster (Muhammad *et al.*, 2020). The current study was conducted to find out the best organic nutrient sources for the profitability moong bean production.

[1]Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara-144 411, Punjab, India.
[2]Institute of Agricultural Sciences, Bundelkhand University, Jhansi-284 128, Uttar Pradesh, India.

Corresponding Author: Mastu Patel, Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara-144 411, Punjab, India. Email: mastrampatel637@gmail.com
ORCID: https://orcid.org/0009-0006-1367-3302

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MATERIALS AND MATHODS

A field experiment was conducted out at organic agriculture research farm, Karguaji, Bundelkhand University, Jhansi Uttar Pradesh, India, during *Kharif* season of 2021-22. The experimental site was located at an 25°44′98′22 North latitude and 78°61′75′96 East longitude having attitude level

of 200 m above mean sea level. The experimental soil was low in organic carbon, available phosphorus and medium available potassium

The experimental was conducted in randomized block design and replicated thrice and the experiment comprised of nine treatments *viz.,* T_0 100% RDF (25: 40: 30); T_1, 100% through FYM (50 q FYM ha^{-1}) + rhizobium; T_2, 100% through vermicompost (25 q VC ha^{-1}) + rhizobium; T_3, 100% through poultry manure (8.33 q PM ha^{-1}) + rhizobium; T_4, 50% through farm yard manure (25 q FYM ha^{-1}) + 50% through vermicompost (12.5 q VC ha^{-1}) + rhizobium; T_5, 50% through farm yard manure (25 q FYM ha^{-1}) + 50% through poultry manure (4.16 q PM ha^{-1}) + rhizobium; T_6, 50% through poultry manure (4.16 q PM ha^{-1}) + 50% through vermicompost (12.5 q VC ha^{-1}) + rhizobium; T_7, 1/3 through farm yard manure (16.66 q FYM ha^{-1}) + 1/3 through poultry manure (2.77 q PM ha^{-1}) + 1/3 through vermicompost (8.33 q VC ha^{-1}) + rhizobium; T_8, 1/3 through farm yard manure (16.66 q FYM ha^{-1}) + 1/3 through poultry manure (2.77 q PM ha^{-1}) + 1/3 through vermicompost (8.33 q VC ha^{-1}) + rhizobium + PSB (100% Phosphate solubilizing bacteria). Entire amount of organic manure was applied one week before sowing on dry weight basis. Moong bean cultivated variety 'Sikha 410-3' was sown at a spacing of 30 × 10 cm suing seed rate of 15 kg ha^{-1}. Observation with respect to growth, yield was recorded.

The soil samples were collected at the harvest of moong bean crop from 0-15 cm depth at three randomly selected spots in each replication and composite sample were prepared. The soil was gently ground, well mixed and sieved through 2 mm mesh and utilized for laboratory analysis for chemical properties. Available nitrogen, phosphorus and potassium was determined using standard methods. Protein content in moong bean of individual treatment was calculated by multiplying nitrogen content in the grain by factor 6.25. Among the economic parameters, net return per ha was calculated by deducting cost from gross return. Benefit cost ratio (B:C) was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments. Data obtained during the investigation was statistically analyzed and the difference among the treatment's means were tested their significance (5%) as per the methods outlined by Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

Growth attributing characters

Growth attributing characters were significantly influenced with organic sources of nutrients (Table 1). Experiment results revealed that significantly was recorded leaf area, leaf area index and dry shoot weight, number of nodules $plant^{-1}$ and nodule diameter through the application of 1/3 nutrient through farm yard manure + 1/3 nutrient through poultry manure + 1/3 nutrient through vermicompost + rhizobium + PSB which was found to be at par with T_7- 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost + rhizobium. This might have happened due to sufficient amount of plant nutrients for vegetative growth might have been available through the application of FYM, poultry manure, vermicompost and seed inoculated with rhizobium or PSB availability of micronutrients supporting the crop during a later growth stage favoured by the slow and continuous release of nutrients (Kumar *et al.,* 2024). Accumulation of carbohydrates in the plant timely and adequate availability of plant nutrients from organic sources resulted in significant enhancement in growth attributing characters (Tarekegn *et al.*, 2017). Results corroborate with the findings of Amipara *et al.* (2023). Significant increase in number of nodules and nodule diameter might have happened due to energy synthesized by the photosynthesis, increase stored energy and synthesize the large quantity of food materials in plant. Bacteria help in rhizosphere to developed root and uptake nutrient, resulted in significant increase in nodule count of moong bean (Argaw *et al.*, 2017**;** Makwana *et al.,* 2020).

Grain yield attributing characters

The yield attributing characters *viz.,* fresh weight of pod and grain yield of moong bean revealed significantly variation with organic sources of nutrients (Table 2). Fresh

Table 1: Effect of different organic sources on growth parameters of moong bean.

Treatments	Leaf area (cm^2 $plant^{-1}$)	Leaf area index	Dry shoot weight (g m^{-2}) at harvest	No. of nodules $plant^{-1}$	Nodule diameter (mm^2)
T_0	513.43	1.70	143.10	57.29	1.70
T_1	756.86	2.51	188.14	88.45	2.51
T_2	575.76	1.91	244.92	85.29	1.91
T_3	605.73	2.01	247.91	82.78	2.01
T_4	736.01	2.45	204.56	94.96	2.45
T_5	905.36	3.01	188.62	101.91	3.01
T_6	945.23	3.14	197.29	102.50	3.14
T_7	1,003.94	3.34	250.28	103.05	3.34
T_8	1,078.70	3.59	251.48	104.65	3.59
SE(m) ±	1.021	0.003	0.625	1.021	0.003
CD 5%	2.182	0.01	1.889	2.182	0.01

weight of pod (224.43 g m^{-2}) and grain yield (10.50 q ha^{-1}) significantly higher with (T_8) - 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost + rhizobium + PSB, which was statically at par with T_7- 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure+ 1/3 nutrients through vermicompost + rhizobium. Increased pod weight and seed yield in moong beans could have been the consequence of improved growth characteristics, which led to greater accumulation of biomass during the vegetative phase, which in turn increased the plant's bearing capacity and finally grain yield (Dkhar *et al.,* 2019) and (Verma *et al.* (2017).

Protein and N, P, K content in grains

Non-significant results were obtained with respected to nitrogen and potassium content in grains through various nutrient sources of organic (Table 2). However, significantly higher protein and phosphorus content in grain was recorded with application of T_8- 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost + rhizobium + PSB which was statically at par with application of 100% FYM + rhizobium. The increasing nutrient content, particularly protein and phosphorus, was attributed to increased biological nitrogen fixation and mineralization, which raised the percentage of protein and the phosphorus percentage. On, the other hand, application of organic sources (FYM, PM and VC) did not have a significant effect on nitrogen and potassium in moong bean, as reported by Yadav *et al.* (2022). Application of farm yard manure, vermicompost and poultry manure bio-fertilizers significantly increases the protein content and assimilation power of the plant responsible for increasing the protein content as well as phosphorus (Dhakal *et al.*, 2016). Moreover, the organic manure balances the physical, chemical and biological

Table 2: Effect of different organic sources on chemical properties of grains, yield attributes and grain yield of moong bean.

Treatments	Protein (%)	N (%)	P (%)	K %	Fresh pod weight (g m^{-2})	Yield (q ha^{-1})
T_0	19.06	3.05	0.43	0.81	132.32	7.27
T_1	21.08	3.37	0.48	0.86	174.93	9.70
T_2	20.75	3.32	0.46	1.16	181.98	8.00
T_3	20.31	3.25	0.46	1.19	175.65	7.70
T_4	20.50	3.28	0.44	1.28	151.65	7.30
T_5	19.76	3.16	0.44	1.21	168.65	8.80
T_6	20.30	3.25	0.47	1.17	151.89	7.50
T_7	19.91	3.18	0.46	1.24	186.54	9.80
T_8	21.37	3.42	0.51	1.33	224.43	10.50
SE(m) ±	0.55	0.40	0.01	0.16	0.51	0.08
CD 5%	1.651	NS	0.03	NS	1.55	0.26

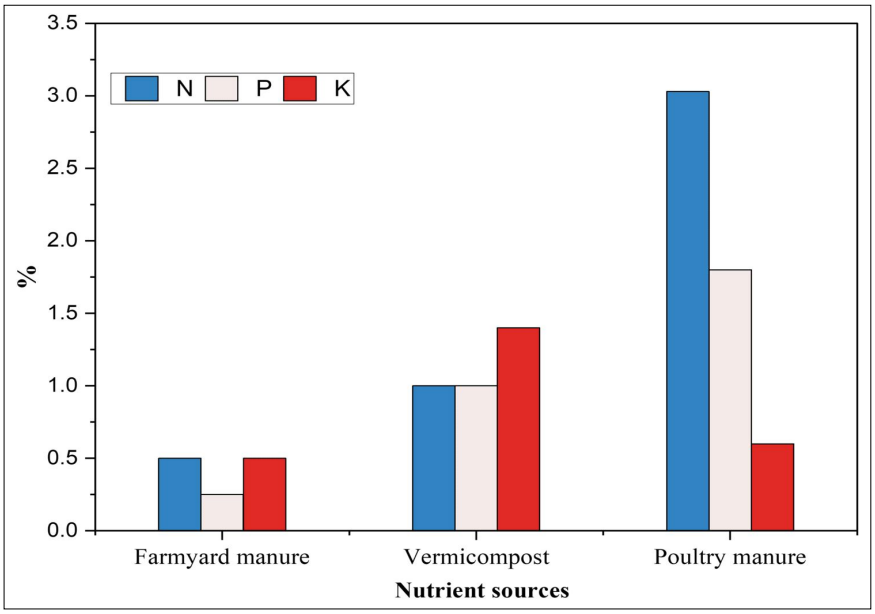


Fig 1: Nutrient content in manure.

properties of the soil, while the C:N ratio and the higher N content concentration in farm yard manure, vermicompost and poultry might have come from nitrate reductase's involvement in synthesis of protein in grain (Fig 1) (Desai *et al.,* 2020; Anwar *et al.,* 2018).

Soil properties

The details significant results Fig 2 were available NPK in soil after harvest of crop have significant increasement in the soil through various organic nutrient sources. Significantly higher available of nitrogen, phosphorus and potassium (kg ha^{-1}) was recorded with application of (T_8) 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost + rhizobium + PSB which was found to be at par with (T_2) 100% FYM. The maximum availability of nutrient in soil after harvest of moong bean is due to the balanced application of organic manure which provide slow-release nutrients and improve soil health. Rhizobium enhances nitrogen fixation, while PSB solubilizes phosphorus, increasing nutrient accessibility. This integrated approach ensures efficient nutrient utilization, minimum losses and sustains soil fertility, leaving higher residual nutrient levels post-harvest for subsequent crops (Sarkar *et al.*, 2023).

Economics

Experimental data revealed that (Table 3) maximum gross return, net return and B:C ratio was recorded with application of T_8- 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost + rhizobium + PSB as compared to other treatments. The highest cost of cultivation recorded with T_2 - 100% nutrients through vermicompost (25 q VC ha^{-1}) + rhizobium, respectively. Kolpe and Bodake, (2017); Verma *et al.* (2017), reported the economics of organic sources of nutrient application recorded higher gross and net returns

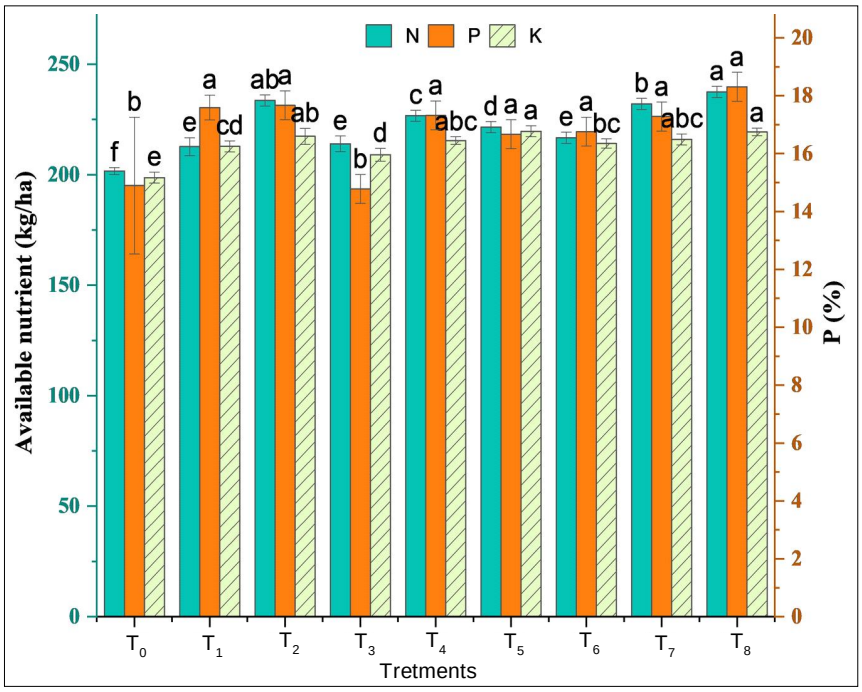


Fig 2: Available nutrient in soil after crop harvest.

Table 3: Effect of different organic sources economics of moong bean.

Treatments	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B: C ratio
T_0	22250.00	53107.50	30857.50	1.38
T_1	22450.00	72022.50	49572.50	2.20
T_2	24950.00	58927.50	33975.50	1.36
T_3	20780.00	54562.50	33780.50	1.62
T_4	23700.00	53835.00	30135.50	1.27
T_5	21615.00	64020.00	42405.00	1.96
T_6	22855.00	54562.50	31707.50	1.38
T_7	22726.65	70567.50	47840.85	2.10
T_8	23226.65	76169.25	52942.60	2.27

over control. Farmyard manure, poultry manure and vermicompost will provide all essential and beneficial nutrients for balance in soil fertility and structure. This blend will ensure a steady release of these nutrients for the crop growth cycle. The presence in this mixture of rhizobium ensures nitrogen fixation, which obviates the use of synthetic fertilizers considerably. Organic manure improves the soil microbial activity and health for better nutrient uptake and reduced disease incidence. The plants of Moong bean produce improved physiology, better quality production and increased yields. Similar results were corroborated with findings of Jha *et al.* (2015) and Gohain *et al.* (2017).

CONCLUSION

Based on investigation, it can be concluded that 1/3 nutrients through farm yard manure + 1/3 nutrients through poultry manure + 1/3 nutrients through vermicompost (8.33 q VC $ha^{-1)}$ + rhizobium + PSB, was found to suitable economical viable options for achieving higher productivity of moong bean.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare there is no competing interest.

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