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# Growth and Yield Performance of Mung Bean Applied with Vermichar as Nutrient Supplement

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***Abstract***
**Aim:** This study aimed to evaluate the effect of vermichar integration in mung bean production on the growth and yield, changes in the characteristics of soil, and economic returns.
**Methodology:** The experiment was conducted at Angadanan Isabela, Philippines, using Randomized Complete Block Design (RCBD) with three (3) replications and a total of 18 plots. The treatments were; T1 – Control (No application), T2 –30-10-20 NPK ha$^{-1}$, T3 – 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar, T4 – 30-10-20 NPK ha$^{-1}$ plus 1.0 Vermichar, T5 – 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar and T6 – Vermi-char (100%).
**Results** The Vermichar application showed significant results on the plant height fifteen, thirty, and forty-five days after planting. Significant results were obtained regarding the number of pods, seeds per pod, and total weight of seeds of the experimental plants in the study. The computed yield per sampling area of the experimental plants showed significant results. In terms of income over farm inputs and labor cost, $T_1$ – Control (No application of Recommended Rate of Inorganic Fretilizer plus Vermichar) had the highest return, 618.56%, and the lowest was in $T_3$ – 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar had a return of 525.61%. The soil analysis before and after the conduct of the study showed changes in pH level, organic matter, phosphorus and potassium content.
**Conclusion:** The addition of 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar had been proven to produce taller plants, a greater quantity of nodules per plant, the number of developed pods, and higher number of seeds, hence the heaviest seed per sampling area. Therefore, this attribute practice in mung bean production is an ideal and potential practice for farmers.
***Keywords:*** *Biochar, Vermicompost, Soil Fertility, Sustainable Agriculture, and Yield Improvement*

## INTRODUCTION

Mung beans are a powerhouse of nutrition they are rich in protein, dietary fiber, vitamins, and minerals, making them a valuable addition to a healthy diet. Studies have shown that mung beans contain bioactive compounds such as polyphenols, polysaccharides, and peptides, which contribute to their health benefits, including antioxidant, anti-inflammatory, and antihypertensive properties (Hou et al., 2019). Additionally, they are widely used in various cuisines, from soups and salads to desserts, due to their versatility and nutritional value (Wang et al., 2021).

Over the past years, farmers have optimized synthetic fertilizers to promote yield. The essential nutrients in fertilizer inputs are crucial for crop production, but they also account for a significant portion of the total crop input cost, making it challenging for many farmers to fund agricultural inputs. Yield is the most essential constituent that is profitable in crop production. A significant portion of the overall cost of crop inputs is the management of inputs used in agriculture, such as fertilizers. The soil supply is used for sufficient availability and plant absorption of vital nutrients used in the harvest of mung beans.

Synthetic fertilizers play a crucial role in boosting agricultural productivity, but their excessive use can lead to significant environmental concerns. Studies highlight that synthetic nitrogen fertilizers contribute to soil acidification, disrupt microbial diversity, and lead to groundwater contamination (Sabina et al., 2025). The soil has

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become excessively depleted as a result of the overuse of synthetic fertilizers becomes increasingly stressed and unproductive, leading to higher pH levels and affecting crop growth and yield. Due to this significant problem and the disadvantages of synthetic fertilizer use, several researchers have developed a solution, focusing on the application of organic fertilizer to restore soil fertility and productivity by lowering the expense of agricultural inputs and lessening the long-term consequences of synthetic fertilizer.

Integrating vermicompost and biochar in soil is valuable for enhancing soil fertility. Vermicompost is a natural fertilizer derived from worm waste, adding essential nutrients, improving soil structure, boosting water retention, and enhancing microbial activity, which makes the soil healthier and more fertile. Vermicompost is a fantastic organic amendment that enhances plant growth and soil health research has shown that vermicompost significantly improves root development, boosts plant yield and quality, and strengthens disease resistance (Rehman et al., 2023). Biochar is a powerful soil amendment with multiple benefits research has shown that biochar improves soil structure, enhances water retention, and boosts nutrient-holding capacity, making it an excellent tool for sustainable agriculture (Kabir & Kwon, 2023). Together, they significantly improve soil health and crop productivity, fostering sustainable agricultural practices.

Adding organic additions to agricultural soils generally conserves natural resources and lessens the need for artificial inorganic fertilizers. After applying organic amendments, soil structure, nutrient composition, and microbiological activity typically improve. Research has shown that organic amendments, including carbohydrates and amino acids, contribute to soil fertility and microbiological activity. These amendments enhance microbial communities and enzyme production, improving soil health and nutrient cycling (Liu et al., 2023). Organic fertilizers supply the macro-nutrients required for crop growth and enhance soil microbial activity. A combination of inorganic and organic fertilizer applications has been suggested to increase and maintain soil fertility, crop yields, and agronomic nutrient use efficiency (Debele, 2021).

Because most organic resources have conflicting uses, like fuel and livestock feed on the farm, most farmers do not apply organic fertilizers despite their crucial role in restoring natural fertility. Research indicates that inadequate cultural techniques can lead to sub-optimal plant stands and lower yields, ultimately affecting overall production. Factors such as improper crop rotation, incorrect sowing dates, and insufficient fertilizer application have been identified as contributors to yield reduction (Uoyang et al., 2022). Low soil fertility is another factor contributing to low plant output. Adding organic amendments to mung bean production is one way to enhance soil fertility and yield, which can be further improved through specific farming techniques. Vermicompost has been shown to enhance soil health by improving nutrient availability, boosting microbial activity, and increasing water retention, all of which contribute to healthier plant growth. Research highlights its role in enriching soil with essential nutrients, humic acids, and beneficial microorganisms, leading to better crop productivity and sustainability (Oyege & Balagi, 2023).

Vermicompost plays a crucial role in improving soil health supports its benefits, including enriching soil with essential nutrients, enhancing microbial activity, improving water retention, and promoting healthy plant growth. Studies highlight its effectiveness in sustainable agriculture and pest management (Oyege & Balagi, 2023). Vermicompost is rich in essential nutrients like nitrogen, phosphorus, and potassium, which are vital for plant growth and development. Studies highlight its ability to enhance soil fertility and improve crop yield by providing these nutrients in an organic form (Rehman et al., 2023). Vermicompost enhances plant health and productivity, making it a valuable addition to gardening and farming. Research highlights its ability to improve soil quality, increase nutrient availability, boost crop productivity, and enhance pest and disease tolerance (Oyege & Balagi, 2023). Other organic compounds, such as biochar plays a crucial role in enhancing soil conditions and nutrient availability, leading to healthier, more resilient plant growth. Research highlights its ability to improve soil fertility, increase nutrient retention, boost microbial activity, and enhance water-holding capacity (Oyege & Balagi, 2023). Biochar promotes healthier, more robust plant growth by improving soil conditions and enhancing nutrient availability, resulting in more productive and resilient plants. This study will assess the influence of vermichar application on mung bean production.

In this research, mung bean cultivation can contribute to the Sustainable Development Goals (SDGs) and could focus on its role in enhancing food security, reducing poverty, and promoting sustainable agricultural practices. Mung beans are an inexpensive, readily available, protein-rich legume, especially in areas with limited access to various nutrient-dense meals. Addressing malnutrition, fostering improved health, and enhancing overall food security, their inclusion in diets can support SDGs 2 (Zero Hunger) and 3 (Good Health and Well-Being). Additionally, its adaptability to different cropping systems and climates, such as cover crops or intercropping, promotes sustainable agriculture and advances SDGs 13 (Climate Action) and 15 (Life on Land).

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**Objectives**

This study aims to evaluate the effect of vermichar integration on the growth and yield of mung bean as well as changes in the soil characteristics.

Specifically, the study aims to:

1. evaluate the changes in soil pH, organic matter, phosphorus and potassium content resulting from the application of vermichar;
2. determine the effect of vermichar on the development and yield of mung bean; and
3. determine the economic return of using vermichar that was feasible for crop raisers.

## METHODS

**Procurement of Mung Bean Seeds and Other Materials**

An authorized agricultural supply store in Cabatuan, Isabela, at Maharlika Agricultural Supply was the source of mung bean seeds ("Kusapo" PSBMg2 (VC3876), the most widely planted variety in the region, which was utilized. Additional field supplies needed for this study was acquired from other suppliers in the province of Isabela. The vermi-char was acquired from Isabela State University's Center for Organic Agriculture Research, Extension, and Training (COARET) in Echague, Isabela, Philippines.

**Soil Sampling and Analysis**

Prior to preparing the land, soil samples were collected. This was done using a shovel to reach the proper depth and follow a zigzag pattern with enough sub-samples. In addition it was also collected after the conduct of the study to determine the changes on soil pH, organic matter, phosphorus and potassium content, it was pulverized and air-dried, the soil's inactive substance was eliminated. One kilogram of composite soil samples was brought to the Cagayan Valley Research Center (CVRC) for analysis.

**Land Preparation**

The 430 square meter experimental space was meticulously prepared for consistent seedling emergence and healthy root development. A Four-wheel drive tractor was used for the plowing, and a week later, the area was harrowed using an animal-drawn plow tool to break up the soil clods and effectively control weeds.

**Experimental Layout and Design**

The prepared area was divided into three equal blocks; each block has a dimension of 6 meters x 20 meters. Each block was subdivided into six equal plots measuring 6 meters x 3 meters and with a spacing of 0.5 meters between plots. The experimental treatments were randomly allocated following the randomization procedure for Randomized Complete Block Design (RCBD).

**Experimental Treatments**

The treatments for the study using vermichar were the following:

$T_1$ – Control (No Application of Fertilizer)
$T_2$ –30-10-20 NPK $ha^{-1}$
$T_3$ – 30-10-20 NPK $ha^{-1}$ plus 0.5 Vermichar
$T_4$ – 30-10-20 NPK $ha^{-1}$ plus 1.0 Vermichar
$T_5$ – 30-10-20 NPK $ha^{-1}$ plus 1.5 Vermichar
$T_6$ – Vermi-char Alone

**Construction of Furrows and Application of Fertilizer**

Prior to applying fertilizer, furrows were set at a standard distance of 45 centimeters based on soil examination. This spacing served as the fertilizer benchmark. The research involved six different approaches: T1 - acting as a control with no fertilizer added, T2 - applying the suggested amount of synthetic fertilizer according to soil analysis, T3, T4, and T5 - blending the recommended synthetic fertilizer rate with vermi-char for basal

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application, T6 - applying vermichar alone before planting. To safeguard against harm from microorganisms, the seeds were shielded by covering them with topsoil.

**Planting and Replanting**

Three seeds were planted per hill in a furrow with a distance of 15 centimeters between hills and 45 centimeters between rows using a jabber for uniform germination. A straight bamboo pole was prepared, marked at every 15 cm distance, and used as a planting guide. This was done to ensure that seed placement was equidistant and in a proper manner to avoid sources of variation during planting. The missing seeds were replanted five days after they were planted. Thinning was done 10 days after planting to maintain two healthy plants per hill.

**Care and Management**

Cultivating and Weeding. Hilling-up was done 10 days after planting. Cultivation was practiced to loosen the root zone of the plants, provide aeration and entry of oxygen in the roots, and control weed growth.

Crop Protection. Diseases, weeds, and insect pests that may arise throughout the study were controlled appropriately. To control sucking and chewing insect pests, pesticides were applied as needed using a 10 ml/ 16 L knapsack sprayer.

Irrigation. Depending on the field, soil, and weather, provide irrigation. Adequate moisture was maintained to promote germination and healthy seedling emergence. To supplement the plants' water needs, the plot can be manually watered using furrow irrigation.

**Harvesting**

When the pods dry out and become light brown to black, mung bean seeds are ready to be collected. The mung beans were harvested by hand and then individually stored in sacks with the appropriate treatment labels to prevent the samples from being mixed. Following the conventional procedure, the samples were taken into the sorting room, manually threshed, and the seeds were separated from the pods. At one-week intervals, preliminary data on harvested pods and other yield component metrics were recorded for each priming.

**Data Gathered**

**Growth and Yield Parameters**

1. Plant height (cm). Ten randomly chosen representative plants were selected, and their height was measured from the base to the top using a meter stick. This was taken at 15, 30, and 45 DAP.
2. Number of pods per plant. The quantity of pods harvested from each priming was counted and recorded. A total quantity of pods per plant was generated by adding all pod counts obtained from the first to the last.
3. Seeds per pod (count). The number of seeds from 10 randomly selected pods was manually opened, and the number of whole, undamaged seeds per plot was counted and recorded. This was taken during the R6 stage, also known as the first harvest.
4. Total weight of seeds per plant (g). The weight of seeds per plant from 6 inner rows x 3 meters (approximately 7.2 $m^2$) was weighed after each harvest. The weight of harvested seed samples from all priming treatments was combined to determine the final seed yield per plant, using 10 randomly selected plants.
5. Computed yield per Hectare (kgs/ha). The yield per Hectare was computed based on the total weight of seeds from the sampling area, and the formula used was as follows

$$\text{Yield per Hectare} = \frac{\text{Yield per Sampling Area X 10,000}}{\text{Sampling Area (m}^2\text{)}}$$

**Statistical Analysis**

All the data was gathered and examined using Analysis of Variance for the Randomized Complete Block Design. The Statistical Tool for Agricultural Research (STAR) was utilized for data analysis. Duncan's Multiple Range Test (DMRT) was employed to compare averages when there were significant findings.



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### Cost and Return Analysis

The fundamental economic analysis was used to calculate the return on investment. The production cost determined the current cost of labor and agricultural inputs in the neighborhood. The market price per kilogram of mung bean was used to calculate the gross income. The return on investment is calculated by dividing the net income by the cost of production, which is multiplied by 100. Net income is equal to gross income minus the cost of production.

## RESULTS and DISCUSSION

### Growth and Yield Parameters

**Plant height at maturity.** The height of the plants at 15, 30, and 45 days after planting with the application of Vermichar is shown in Table 1. At 15 days after planting, a significant outcome was observed where the application of Vermichar Alone ($T_6$), the 30-10-20 NPK ha$^{-1}$ ($T_2$), the 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar ($T_3$), the 30-10-20 NPK ha$^{-1}$plus 1. 0 Vermichar ($T_4$), and the 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar ($T_5$) resulted in comparable heights with mean values ranging from 12.45 to 13.88 centimeters. The shortest plants were noted in the group with no fertilization ($T_1$-Control), which achieved a mean value of 12.13 centimeters.

Similarly, a notable variation was observed concerning the heights of the plants at 30 days after planting. The use of the 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar ($T_3$), 30-10-20 NPK ha$^{-1}$ with 1.0 Vermichar ($T_4$), and the 30-10-20 NPK ha$^{-1}$ mixed with 1. 5 Vermichar ($T_5$) resulted in the tallest plants, with average measurements between 28.43 and 30. 48 centimeters. Next were the plants treated with Vermichar Alone ($T_6$) and the 30-10-20 NPK ha$^{-1}$ ($T_2$), which measured between 26. 55 and 27.94 centimeters. The plants that received no fertilizer ($T_1$-Control) reached the shortest height, averaging 25. 19 centimeters.

Additionally, the tallest plants showed significant outcomes among treatment means 45 days after planting. The tallest plants were noted with the application of 30-10-20 NPK ha$^{-1}$plus 1. 5 Vermichar ($T_5$), 30-10-20 NPK ha$^{-1}$ plus 1. 0 Vermichar ($T_4$), the 30-10-20 NPK ha$^{-1}$ plus 0. 5 Vermichar ($T_3$), the 30-10-20 NPK ha$^{-1}$ ($T_2$), and Vermichar Alone ($T_6$) with mean values ranging from 53. 10 to 57. 35 centimeters. The plants without fertilizer ($T_1$-Control) showed the shortest height with a mean value 52. 79 centimeters.

These findings demonstrate that Vermichar, particularly when combined with NPK fertilizer, enhances plant height across different growth stages. The consistent increase in height indicates that the addition of Vermichar improves nutrient availability and soil conditions, promoting better plant development. Furthermore, the progressive growth differences observed between treatments showed that higher Vermichar concentrations lead to better results, emphasizing its role in boosting plant productivity.

The outcome of the study is consistent with the results of Bezabeh et al., (2022), who found that employing vermicompost boosts root and plant development, resulting in enhanced water and nutrient absorption. According to a study conducted by Ding et al., (2016), field experiments demonstrated that the use of biochar improved soil health, increased yields, and stimulated plant growth.

**Number of pods per plant.** The application of Vermichar significantly influenced the quantity of development pods per plant, as shown in Table 1. Among the different treatments, the highest number of development pods was observed in plants treated with 30-10-20 NPK ha$^{-1}$ combined with 1.5 Vermichar ($T_5$), yielding a mean value of 85.50 pods. This was closely followed by 30-10-20 NPK ha$^{-1}$ with 1.0 Vermichar ($T^4$) and 0.5 Vermichar ($T_3$), which produced mean values of 81.77 and 78.40 pods, respectively. Comparatively, plants treated with only 30-10-20 NPK ha$^{-1}$ ($T_2$) and Vermichar alone ($T_6$) exhibited slightly lower pod counts, averaging 75.77 and 70.55, respectively. Meanwhile, the untreated control group ($T_1$) had the least number of development pods, with a mean of 67.77.

These findings suggest that the integration of Vermichar with a balanced NPK fertilizer enhances pod formation, potentially due to its ability to improve soil nutrient availability, water retention, and microbial activity. Vermichar, a combination of vermicompost and biochar, has been recognized for its role in enriching soil organic matter, promoting plant growth, and enhancing nutrient uptake. The gradual release of nutrients from Vermichar likely contributes to sustained plant development, leading to better pod formation. Additionally, biochar in Vermichar aids in improving soil aeration, which supports root expansion and nutrient absorption. These factors collectively demonstrate that Vermichar, when combined with an appropriate fertilizer mix, can optimize pod production, making it a promising soil amendment for increased crop yields (Rab et al., 2021).

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Another findings were consistent with previous studies that have found using biochar to increase mung bean pod formation. For instance, applying 30 t ha¹ of biochar resulted in the highest number of pods per plant (27.3) and improved grain yield (Jalal *et al.*, 2024). Biochar enhances soil organic matter, retains moisture, and boosts microbial activity, contributing to better pod development. Another finding from (Arsalan et al., 2016) stated that using Vermicompost improves soil structure, increases nutrient uptake, and enhances root development, leading to better pod formation. Additionally, phosphorus application alongside Vermicompost has been found to improve nodulation and nutrient absorption.

**Seed per pod (count).** The number of seeds per pod applied with Vermichar is shown in Table 1. A significant result was observed in the number of seeds, which was higher in plants treated with 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar ($T_5$) compared to the untreated plant control ($T_1$), with a mean value of 417.67, versus 350.93. Seed treated showed significant effect on the number of seed plant treated with 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar ($T_5$) with a value of 417.67 and 30-10-20 NPK ha$^{-1}$ plus 1.0 Vermi-char ($T_4$) with a value of 408.33 produced the greater number of seed per plant compared to the seed treated with 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar ($T_3$) with a mean value of 393.87, 30-10-20 NPK ha$^{-1}$ ($T_2$), with a mean value of 379.40, Vermichar Alone ($T_6$) with a mean value of 351.63 and the least of them is those plants untreated in ($T_1$-Control) with a mean value of 350.93.

Significant results were consistent with previous studies, which showed that the application of vermicompost and biochar in mung beans can significantly enhance seed yield. Biochar improves soil fertility and nutrient retention, producing better plant growth and yield (Jalal *et al.*, 2024; Rab *et al.*, 2021). Vermicompost, rich in organic matter and beneficial microbes, enhances soil structure and nutrient availability, further boosting mung bean productivity. Similarly, Vermicompost contributes to higher pod and seed production, making it a valuable organic amendment (Bankoti et al., 2021)

**Table 1. Growth Performance of Mungbean as Affected by Various Combination of NPK and Vermi-char**

| TREATMENTS | Mean | Mean | Mean | Mean | Mean |
|---|---|---|---|---|---|
| | Height-15 | Height-30 | Height-45 | No. of Pods | Seed Per Pods (count) |
| $T_1$- Control | 12.13$^c$ | 25.19$^c$ | 52.79$^c$ | 67.75$^c$ | 350.93$^b$ |
| $T_2$- 30-10-20 NPK ha$^{-1}$ | 13.07$^{abc}$ | 27.94$^{ab}$ | 55.03$^{abc}$ | 75.07$^{bc}$ | 379.40$^{ab}$ |
| $T_3$- 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermi-char | 13.21$^{ab}$ | 28.43$^{ab}$ | 55.51$^{abc}$ | 78.40$^{ab}$ | 393.87$^{ab}$ |
| $T_4$- 30-10-20 NPK ha$^{-1}$ plus 1.0 Vermi-char | 13.43$^{ab}$ | 29.77$^a$ | 56.11$^{ab}$ | 81.77$^{ab}$ | 408.33$^a$ |
| $T_5$- 30-10-20 NPK ha$^{-1}$plus 1.5 Vermi-char | 13.88$^a$ | 30.48$^a$ | 57.35$^a$ | 85.50$^a$ | 417.67$^a$ |
| $T_6$-Vermi-char Alone | 12.45$^{bc}$ | 26.55$^{bc}$ | 53.10$^{bc}$ | 70.55$^c$ | 351.63$^b$ |
| F-RESULTS | ** | ** | ** | ** | ** |
| C.V. (%) | 2.70 | 3.25 | 1.98 | 3.49 | 2.52 |

Note: Means with common letters are not significantly different with each Honest Significant Different (HSD)
**-significant at 1% level

**Total weight of seeds per plant (g).** The seed weight per plant was a significant result when applied with Vermichar, as presented in Table 2. The heaviest seeds were produced in the plants treated with 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar ($T_5$), 30-10-20 NPK ha$^{-1}$ plus 1.0 Vermichar ($T_4$), and 30-10-20 NPK ha$^{-1}$ plus 0.5 Vermichar ($T_3$), which had mean values of 7.04, 6.52, and 6.00 grams, respectively. Similarly, comparable seed weights were recorded with the application of 30-10-20 NPK ha$^{-1}$ ($T_2$) and Vermichar Alone ($T_6$), which had mean values 5.73 and 5.58 grams. The lightest seeds were found in the untreated plots ($T_1$), measuring 5.26 grams.

These results suggest that Vermichar contributes significantly to improving seed development and overall grain quality. Vermichar, composed of vermicompost and biochar, enhances soil structure and fertility, creating optimal growing conditions for crops. Its ability to increase nutrient retention and improve microbial activity likely leads to more efficient nutrient uptake by plants, which in turn supports larger seed formation. Biochar and Vermicompost helps improve soil aeration and moisture retention, ensuring that plants receive adequate water and nutrients throughout their growth cycle. Additionally, the gradual release of nutrients from vermicompost sustains plant development, allowing seeds to reach their full potential in size and weight. These benefits highlight Vermichar


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as a valuable soil amendment for maximizing crop productivity, particularly when integrated with appropriate NPK fertilizer applications(Jalal et al., 2024; Rab et al., 2021).

Vermicompost provides various benefits compared to uncomposed organic waste and mineral fertilizers, leading to enhanced crop growth, biomass, and yield. The gradual release of nutrients in vermicompost, aided by humic and fulvic acids, boosts the accessibility of soil nutrients to plants, fostering root development. This, in turn, improves water and nutrient absorption by plants, as mentioned in (Bezabeh et al., 2022). Studies by Mistry (2015) have shown that vermicompost can significantly impact the germination, growth, blooming, fruiting, and overall yields of crops.

Studies suggest that biochar application increases nodulation, yield components, and overall plant health in mung beans. For instance, applying 30 t ha¹ of biochar resulted in the highest number of pods per plant (27.3) and improved grain yield (Jalal et al., 2024). Research suggests that biochar and Vermicompost can significantly enhance seed yield in mung beans. Biochar improves soil fertility and nutrient retention, producing better plant growth and yield (Jalal et al., 2024; Rab et al., 2021). Research suggests that Vermicompost and biochar can positively impact mung bean growth and yield (Rab et al., 2021).

**The computed yield per hectare** of mung bean production clearly illustrates the positive effect of Vermichar application, as shown in Table 2. Treatment 5 ($T_5$), which combined 30-10-20 NPK $ha^{-1}$ with 1.5 Vermichar, achieved the highest yield of 312.96 kg/ha (3.10 tons), followed closely by Treatment 4 ($T_4$) with 304.43 kg/ha (3.00 tons). Treatment 3 ($T_3$) also showed strong productivity at 288.16 kg/ha (2.90 tons), indicating that increasing Vermichar levels enhances yield. Treatment 2 ($T_2$) with only fertilizer yielded 275.20 kg/ha (2.80 tons), while Treatment 6 ($T_6$), which applied Vermichar alone, produced 268.00 kg/ha (2.70 tons). The lowest yield was observed in the control group ($T_1$), which lacked both Vermichar and fertilizer, producing only 252.21 kg/ha (2.50 tons). These results emphasize the crucial role of Vermichar in boosting mung bean production, particularly when combined with NPK fertilizer. The gradual increase in yield across treatments suggests that proper soil amendments, nutrient management, and organic inputs can significantly enhance productivity, ultimately leading to better agricultural efficiency and profitability.

**Table 2. Yield Performance of Mungbean as Affected by Various Combination of NPK and Vermi-char**

| TREATMENTS | Mean | Mean |
|---|---|---|
| | Total weight of seeds per plant (g) | Computed yield per hectare (kg/ha) |
| $T_{1-}$ Control | $5.26^{c}$ | $252.21^{c}$ |
| $T_{2-}$ 30-10-20 NPK $ha^{-1}$ | $5.73^{bc}$ | $275.20^{b}$ |
| $T_{3-}$ 30-10-20 NPK $ha^{-1}$ plus 0.5 Vermi-char | $6.00^{b}$ | $288.16^{ab}$ |
| $T_{4-}$ 30-10-20 NPK $ha^{-1}$ plus 1.0 Vermi-char | $6.52^{ab}$ | $304.43^{a}$ |
| $T_{5-}$ 30-10-20 NPK $ha^{-1}$plus 1.5 Vermi-char | $7.04^{a}$ | $312.96^{a}$ |
| $T_{6-}$Vermi-char Alone | $5.58^{bc}$ | $268.00^{bc}$ |
| F-RESULTS | ** | ** |
| C.V. (%) | 3.59 | 3.59 |

Note: Means with common letters are not significantly different with each Honest Significant Different (HSD)
**-significant at 1% level

**The cost and return analysis** of mung bean production reveals significant variations in profitability among different treatments. Treatment 1 demonstrated the highest return on investment (ROI) at 618.56%, indicating an optimal balance between cost efficiency and yield maximization. Treatment 2 closely followed at 617.41%, suggesting similar effectiveness with slight differences in resource utilization. Treatments 6, 5, and 4 maintained strong profitability, with ROI ranging from 562.05% to 538.45%, likely reflecting variations in production costs, soil conditions, or input efficiency. Meanwhile, Treatment 3 exhibited the lowest ROI at 525.61%, which, while still a considerable return, suggests higher production expenses or lower yield efficiency compared to the other treatments. These results highlight the importance of identifying key factors influencing yield and cost-effectiveness, such as input usage, soil management, pest control, and market prices, to optimize profitability. Refining less effective treatments and further analyzing the methodologies behind the most successful ones can help improve overall mung bean production efficiency and financial returns.

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**Table 3. Economic Return Analysis of Mungbean as Affected by Various Combination of NPK and Vermichar**

| TREATMENTS | Cost of Production | Gross Income | Net Income | ROI% |
|---|---|---|---|---|
| $T_1$ | 10100.00 | 72574.72 | 62474.72 | 618.56 |
| $T_2$ | 12489.37 | 89600.00 | 77110.63 | 617.41 |
| $T_3$ | 14862.37 | 92800.00 | 78117.63 | 525.61 |
| $T_4$ | 15036.37 | 96000.00 | 80963.63 | 538.45 |
| $T_5$ | 15297.37 | 99200.00 | 83902.63 | 548.48 |
| $T_6$ | 11840.00 | 78383.36 | 66546.36 | 562.05 |

*Cost of Mung Bean-P37.00/kg*

**Soil Analysis Before the Conduct of the Study**

**Soil pH and NPK Content before Conduct of the Study.** The soil analysis before the execution of the study is shown in Table 4. The soil analysis pH, ranging from 7.23, is slightly alkaline but still within the ideal range for mung bean production. Mung bean thrives best in soils with a pH between 6.0 and 7.5, meaning a pH of 7.23 is well-suited for its growth. The soil organic matter examination ranged from 2.41, indicating a moderate soil organic matter level of 2.41%. This level is considered beneficial for mung bean growth, although its suitability depends on other soil properties, such as texture, pH, and nutrient content. A soil organic matter of 2.41% suggests decent organic matter content, which can support root development, nitrogen fixation (since mung beans are legumes), and water retention. Phosphorus availability 17.37, phosphorus availability at 17.37 ppm seems to be in the moderate to sufficient range for mung bean production, depending on soil type and environmental conditions. Mung bean requires adequate phosphorus for root development, flowering, and pod formation. Generally, a phosphorus level between 15-30 ppm is suitable for legume crops, including mung bean. Potassium analysis ranged from 288.94 ppm, which is crucial in mung bean production, influencing plant growth, yield, and overall health. A potassium level of 288.94 mg/kg in the soil generally falls within a reasonable range for supporting mung bean development. For mung bean production, potassium enhances seed quality, improves disease resistance, and supports better yield. Studies on integrated nutrient management suggest that combining organic and inorganic fertilizers, including potassium sources, can significantly boost soil health and mung bean productivity (Choudhary et al., 2025).

**Table 4. Soil Analysis Before Conduct of the Study**

| REPORT OF ANALYSIS | | | |
|---|---|---|---|
| pH | Organic Matter % | Available Phosphorus, P ppm | Available Potassium, K ppm |
| 7.23 | 2.41 | 17.37 | 288.94 |

*Soil Analysis*

**Soil Analysis after the Conduct of the Study**

**pH and NPK levels were measured after the study was conducted.** Table 5. Represents the soil analysis per treatment for mung bean production. Soil properties' ability to retain water and minerals determines the success of plant growth. Therefore, it is essential to understand various methods for conserving soil, particularly topsoil, which contains the vital nutrients for plant growth. Treatments showed the soil properties and analysis of the sequence after the study for Treatment 1 with the pH level of 7.58, Organic Matter-2.86, Phosphorus-16.45 and Potassium-213.16, Treatment 2 with the pH level of 7.39, Organic Matter-1.83, Phosphorus-22.36 and Potassium-224.98, Treatment 3 with the pH level of 7.20, Organic Matter-2.88, Phosphorus-44.31 and Potassium-287.95, Treatment 4 with the pH level of 7.39, Organic Matter-2.41, Phosphorus-62.83 and Potassium-367.24, Treatment 5 with the pH level of 6.86, Organic Matter-4.90, Phosphorus-105.87 and Potassium-739.35, Treatment 6 with the pH level of 6.82, Organic Matter-3.38, Phosphorus-67.70 and Potassium-341.02 respectively.

Understanding variations in nutrient content after a study is essential for conducting soil analysis because it helps determine the effectiveness of treatments, environmental influences, and soil health over time. By analyzing these variations, researchers and farmers can make informed decisions on fertilization, crop selection, and land

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management. It ensures that nutrients are optimized for plant growth while preventing deficiencies or excesses that could harm the environment.

**Table 5. Soil Analysis After Conduct of the Study**

| | | REPORT ANALYSIS | | |
|---|---|---|---|---|
| TREATMENT | pH | Organic Matter% | Available Phosphorus P ppm | Available Potassium K ppm |
| T1 | 7.58 | 2.86 | 16.45 | 213.16 |
| T2 | 7.39 | 1.83 | 22.36 | 224.98 |
| T3 | 7.20 | 2.88 | 44.31 | 287.95 |
| T4 | 7.39 | 2.41 | 62.83 | 367.24 |
| T5 | 6.86 | 4.90 | 105.87 | 739.35 |
| T6 | 6.82 | 3.38 | 65.70 | 341.02 |

*Soil Analysis*

**Conclusion**

The addition of 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermichar had been proven to produce taller plants, a greater quantity of nodules per plant, the number of developed pods, and the longest pods with a higher number of seeds, hence the heaviest seed per sampling area. Therefore, this attribute practice in mung bean production is an ideal and potential practice for farmers.

**Recommendations**

Based on the study's results, the application of 30-10-20 NPK at 1 ha$^{-1,}$ plus 1.5 Vermi-char, is recommended for the dry season of planting. Likewise, treatments using 30-10-20 NPK ha$^{-1}$ plus 1.5 Vermi-char are recommended due to their potential for the highest yield per hectare.

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