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Enhancing Black Soybean [*Glycine max* (L.) Merrill] Yield with Composts and Biofertilizers: A Comprehensive Analysis of Variety- VL Bhat 201

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted in the agriculture field of the Himalayan university, Jollang, Arunachal Pradesh to find out the effect of different composts and biofertilizers inoculations on black soybean yield. The experiment was set up in a Randomized Block Design (RBD) with three

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replications. Seven different composts and biofertilizers inoculations and one control treatment were used in the study to assess the effect of different composts and biofertilizers on black soybean yield. The findings of the study showed that vermicompost + *phosphate solubilizing bacteria* and vermicompost + *rhizobium* inoculant performed better in all aspects of yield components like number of pods per plant, number of seed per pod, seed weight, grain yield, straw yield, biological yield and harvest index etc. However, the control treatment performed lowest in every parameter. As a result of the experiment, it could be concluded that vermicompost + *phosphate solubilizing bacteria* has a significant effect on yield component of black soybean.

Keywords: Soybean; biofertilizer; Rhizobium; phosphate solubilizing bacteria; growth; production; yield.

1. INTRODUCTION

Composts and biofertilizers are gaining recognition as sustainable agricultural practices that have a significant impact on enhancing crop yield and promoting soil health. In the context of black soybeans, the utilization of composts and biofertilizers introduces a beneficial approach to cultivating this important leguminous crop. Composts, which are organic materials derived from the decomposition of plant and animal residues, are rich in essential nutrients such as nitrogen, phosphorus, and potassium. When incorporated into the soil, composts improve soil structure, increase water retention, and enhance microbial activity, all of which create a favorable environment for plant growth [1].

Similarly, biofertilizers are known for their ability to enhance nutrient availability and promote plant growth through the introduction of beneficial microorganisms. These microbial agents, such as nitrogen-fixing bacteria and phosphate-solubilizing fungi, facilitate the uptake of nutrients by plant roots, leading to improved nutrient utilization efficiency. In the case of black soybeans, which are known for their high protein and oil content, the application of composts and biofertilizers can play a crucial role in maximizing yield and quality [2].

The impact of composts and biofertilizers on the yield of black soybeans can be attributed to several factors. Firstly, the nutrient content of composts provides a readily available source of essential elements that are vital for plant growth and development. By replenishing nutrient-depleted soils, composts support the nutritional requirements of black soybeans throughout their growth stages, leading to healthier plants with increased vigor and productivity. Additionally, the organic matter present in composts improves soil structure and promotes the growth of beneficial soil organisms, further enhancing nutrient cycling and overall soil fertility [3].

Furthermore, the use of biofertilizers containing phosphate-solubilizing microorganisms can improve phosphorus availability in the soil, which is essential for root development, flowering, and seed formation in black soybeans. By enhancing nutrient uptake and utilization efficiency, biofertilizers contribute to the overall growth and productivity of black soybean plants, ultimately leading to increased yield [4].

2. MATERIALS AND METHODS

The experiment was conducted in the agriculture field of Himalayan University, Jollang from July to Nov 2024. This experiment was performed to evaluate the effects of various composts and biofertilizers on yield of black soybean. The soil of the experiment was sandy loam. The experiment was set up in a Randomized Block Design (RBD) with three replications. The crop used in the experiment was black soybean (Glycine *max*) and the variety of the crop was VL Bhat 201.

The experiment consisted of eight treatments namely T_1-control, T_2 (Coir compost at 2.5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha), T_3 (Coir compost at 5 kg/ha + Rhizobium at 2.5 kg/ha), T_4 (Vermicompost at 2.5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha), T_5 (Vermicompost at 5 kg/ha + *Rhizobium* at 2.5 kg/ha), T_6 (Biochar at 2.5 kg/ha+ Vermicompost at 5 kg/ha + *Rhizobium* at 2.5 kg/ha), T_7 (Biochar at 5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha), T_8 (Coir compost at 2.5 kg/ha + Vermicompost at 2.5 kg/ha + Biochar at 2.5 kg/ha).

Seed inoculation was done on 23 july 2023 and inoculated seeds were shown in the field on the same afternoon. The fertilizers were applied as

basal dose @ N, P, K as 20, 80, 40 kg ha^{-1} and compost 30 ton ha^{-1} at final land preparation respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil. Biofertilizers applied dose 30 g for kg^{-1} seeds. Biofertilizers were mixed with the seed before sowing. The spacing between the rows was 45 cm and between the plants was 5 to 7 cm. Intercultural operations were done for ensuring and maintaining the normal growth of the crop. The crop was harvested on 22 Nov, 2023 by observing the physiological maturity. The harvested plant materials were allowed to dry in the sun for 3 days. After drying, threshing and processing was done carefully on a plot basis. The data collection was done at different dates from different parameters and collected data were analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT- C and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of significance.

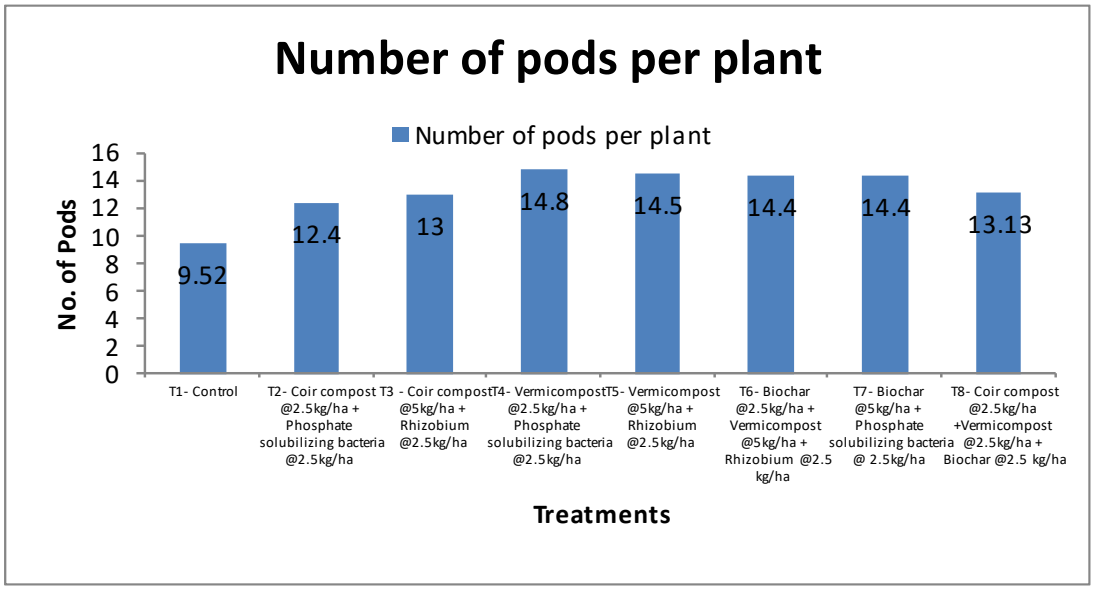
3. RESULTS AND DISCUSSION

The ultimate objective of crop production is its economic yield. Seed yield is the major concern for black soybean. The effects of composts and biofertilizers on black soybean production presented by their contributions to yield are:

Yield: Black soybean crop yield is considered by its number of seeds, and seeds weight. The result presented in Table 1 shows that the yield and yield attributes were significantly affected by the different composts and biofertilizers inoculations. The highest number of seeds, and 100 seed weights were 3.23, and 10.22 gm, respectively, which is obtained from T_4 (vermicompost at 2.5 kg/ha + *phosphate solubilizing bacteria* at 2.5 kg/ha) treatment. Similarly, the maximum seed and straw yield were also found from the T_4 (vermicompost at 2.5 kg/ha + *phosphate solubilizing bacteria* at 2.5 kg/ha). The highest seed yield and straw yield were 1.88 t/ha and 3.90 t/ha, respectively, while the minimum was 1.56 t/ha and 3.58 t/ha, which are found from the control treatment.

The highest number of pods per plant, number of seeds per pod, 100 seed weight, seed yield stove yield , biological yield and harvest index (14.8, 3.23, 10.22 g , 1.88, 3.90, 5.79, 32.56 %) was observed T_4 treatment (Vermicompost 2.5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha) (Table 1). where the lowest was measured in T_1 (control) (9.52, 2.43, 9.69 g, 1.56, 3.58, 5.14, 30.33%) (Table 1).

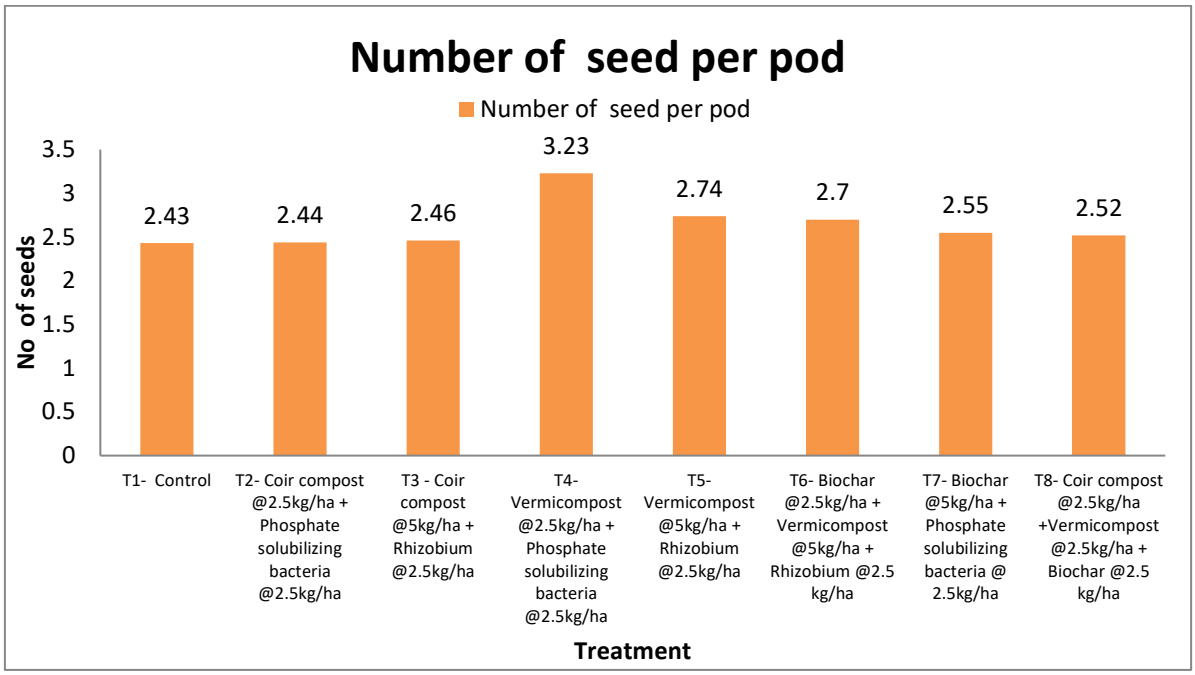
The probable reason for the higher (number of pods per plant, number of seeds per pod, seed weight, straw yield, biological yield, and harvest index) of black soybean in the T_4 treatment (vermicompost at 2.5 kg/ha + *phosphate-solubilizing bacteria* at 2.5 kg/ha) could be attributed to the enhanced nutrient availability and soil fertility resulting from the combined application of vermicompost and *phosphate-solubilizing bacteria* [5].



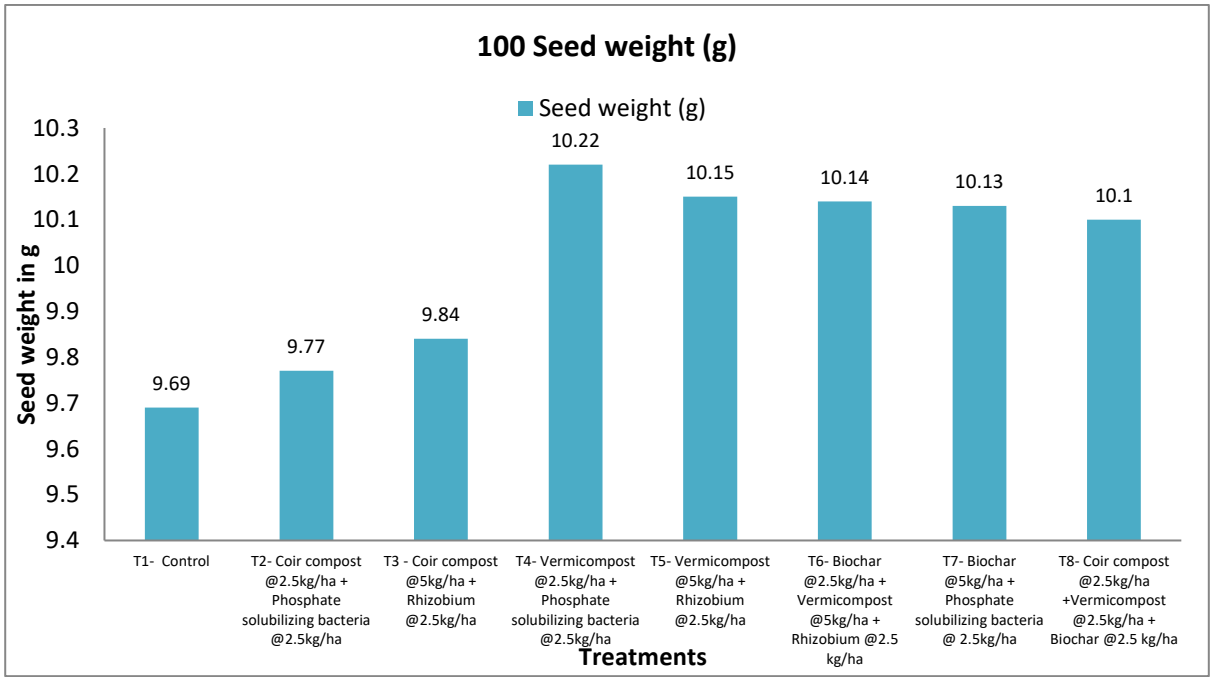
Graph 1. Effect of compost and biofertilizer on number of pods per plant of black soybean

Table 1. Yield attributes of black soybean in different treatments

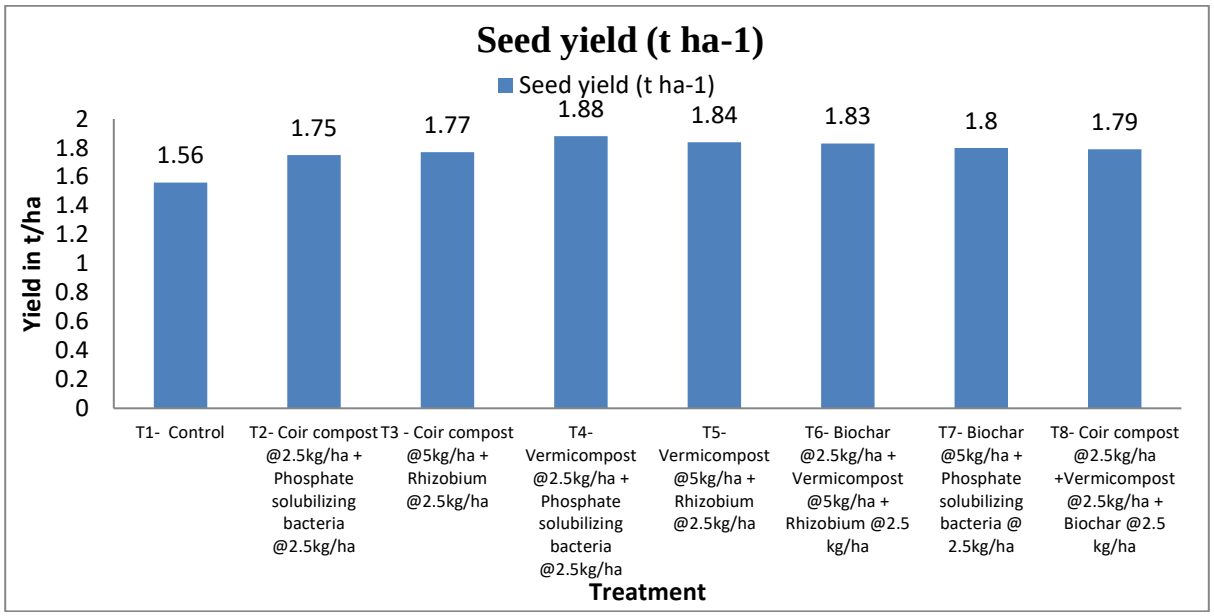
Treatments	Number of pods per plant	Number of seeds per pod	100 Seed weight (g)	Seed yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
T1-Control	9.52	2.43	9.69	1.56	3.58	5.14	30.33
T_2- Coir compost at 2.5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha	12.4	2.44	9.77	1.75	3.75	5.51	31.88
T_3 - Coir compost at 5 kg/ha + *Rhizobium* at 2.5 kg/ha	13.0	2.46	9.84	1.77	3.78	5.56	31.95
T_4-Vermicompost 2.5 kg/ha + *Phosphate solubilizing bacteria* at 2.5 kg/ha	14.8	3.23	10.22	1.88	3.90	5.79	32.56
T5-Vermicompost at 5kg/ha + *Rhizobium* at 2.5kg/ha	14.5	2.74	10.15	1.84	3.86	5.70	32.32
T_6- Biochar at 2.5 kg/ha + Vermicompost at 5 kg/ha + *Rhizobium* at 2.5 kg/ha	14.4	2.70	10.14	1.83	3.85	5.68	32.22
T7- Biochar at 5 kg/ha +*Phosphate solubilizing bacteria* at 2.5 kg/ha	14.4	2.55	10.13	1.80	3.82	5.63	32.09
T_8- Coir compost at 2.5 kg/ha + Vermicompost at 2.5 kg/ha + Biochar at 2.5 kg/ha	13.13	2.52	10.10	1.79	3.80	5.6	32.02



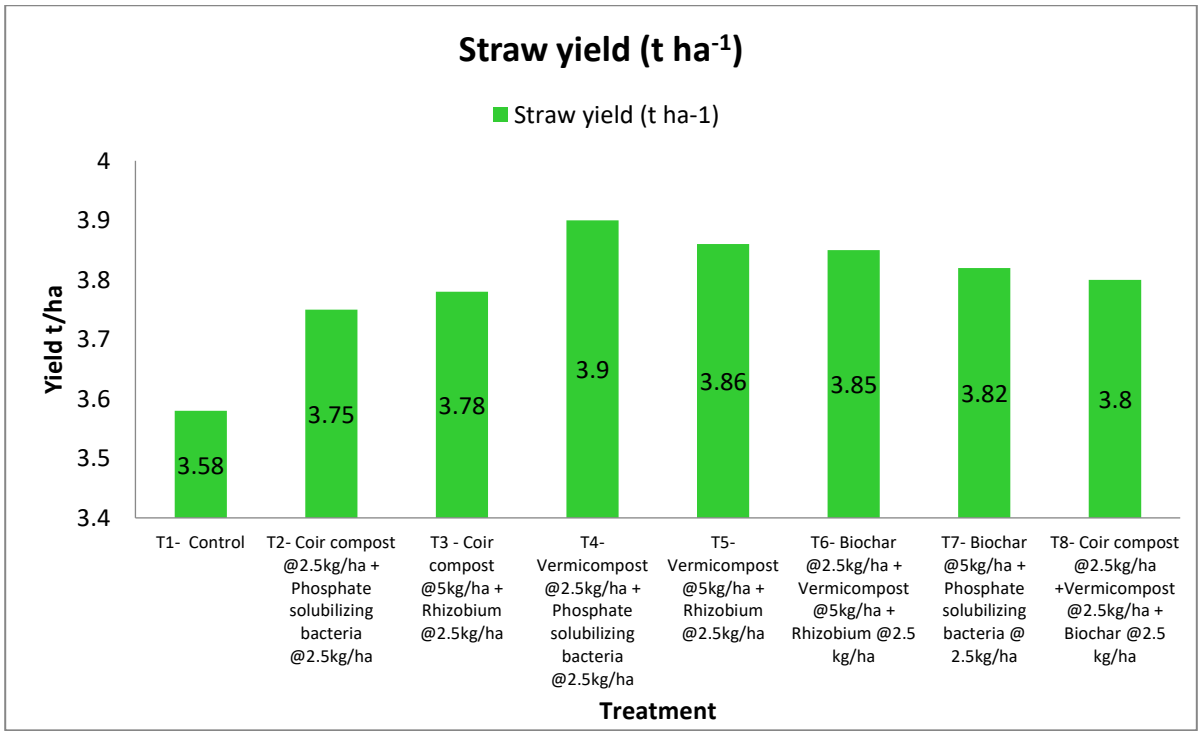
Graph 2. Effect of compost and biofertilizer on number of seeds per pod of black soybean



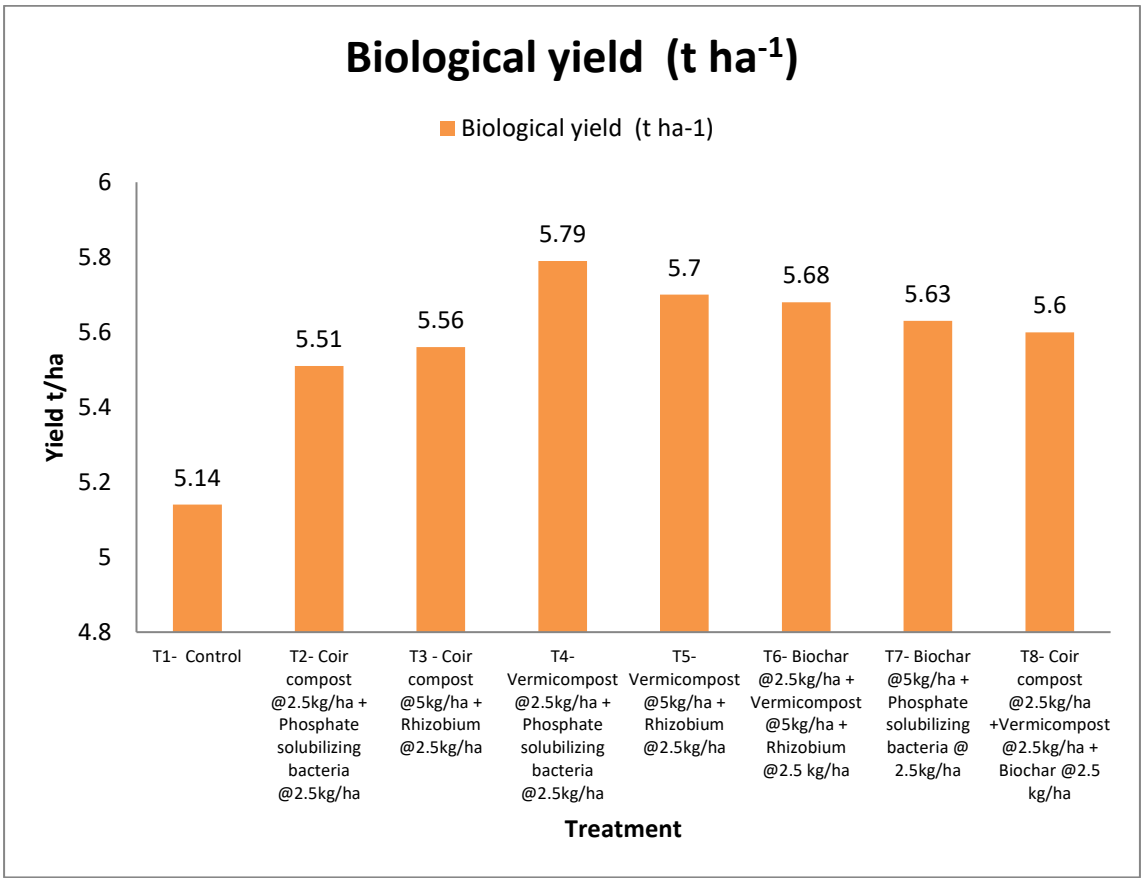
Graph 3. Effect of compost and biofertilizer on 100 seed weight of black soybean



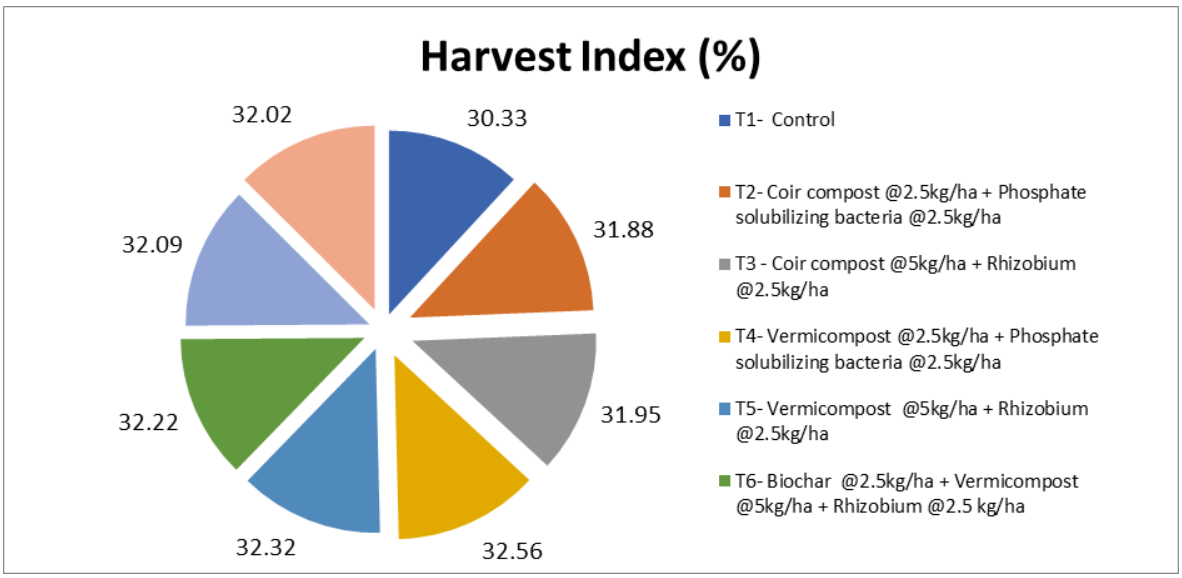
Graph 4. Effect of compost and biofertilizer on seed yield of black soybean



Graph 5. Effect of compost and biofertilizer on straw yield of black soybean



Graph 6. Effect of compost and biofertilizer on biological yield of black soybean



Graph 7. Effect of compost and biofertilizer on harvest index of black soybean

Vermicompost is known to enrich the soil with essential nutrients, organic matter, and beneficial microorganisms, promoting overall plant growth and development. The presence of *phosphate-solubilizing bacteria* further aids in the efficient utilization of phosphorus by the plants, which is crucial for flower and fruit development [6].

This synergistic effect of vermicompost and *phosphate-solubilizing bacteria* may have led to improved plant health, increased root development, and better nutrient uptake, leading to enhanced pod formation, seed set, and weight. The combination of these factors could have contributed to higher straw yield, biological yield, and ultimately, a higher harvest index in the T_4 treatment of black soybean compared to other treatments [7,8].

4. CONCLUSION

The T_4 treatment incorporating vermicompost at a rate of 2.5 kg/ha along with phosphate-solubilizing bacteria at 2.5 kg/ha has demonstrated remarkable efficacy in enhancing multiple yield parameters of black soybean. This strategic combination of organic inputs has yielded a cascade of positive effects on the growth and development of the crop.

The observed increase in the number of pods per plant can be attributed to the enriched soil fertility provided by vermicompost. The presence of essential nutrients and beneficial microorganisms in vermicompost has created a conducive environment for pod formation and development. Additionally, the phosphate-solubilizing bacteria play a crucial role in facilitating nutrient uptake, particularly phosphorus, which is known to influence flowering and fruiting in plants.

The improvement in the number of seeds per pod and the seed weight can be linked to the enhanced nutrient availability and efficient utilization of nutrients facilitated by the dual application of vermicompost and phosphate-solubilizing bacteria. These factors have likely contributed to the overall vigor and productivity of the black soybean plants, leading to higher seed set and weight.

The significant increase in both straw yield and biological yield can be attributed to the synergistic effects of vermicompost and phosphate-solubilizing bacteria on plant growth and development. The organic inputs have nourished the plants with essential nutrients, promoted root growth, and improved nutrient absorption, resulting in a substantial increase in biomass production. This, in turn, has translated into higher straw yield and overall biological yield of the black soybean crop.

Lastly, the remarkable enhancement in the harvest index of black soybean in the T_4 treatment signifies the efficiency of resource utilization and the successful conversion of inputs into harvestable yield. The combined action of vermicompost and phosphate-solubilizing bacteria has maximized the crop's potential to convert resources into valuable output, leading to a higher harvest index compared to other treatments.

In conclusion, the T_4 treatment involving vermicompost and phosphate-solubilizing bacteria at specific rates has proven to be a highly effective approach for enhancing the yield parameters of black soybean. The synergistic effects of these organic inputs have promoted plant health, nutrient availability, and productivity, ultimately leading to a significant improvement in pod formation, seed characteristics, straw yield, biological yield, and harvest index. This underlines the potential of organic farming practices in optimizing crop productivity and sustainability in agriculture.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist

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