

# Performance Assessment of Rice Straw-Derived Compost for Use as Biomanure in Crop Production

Isha Hasija<sup>1\*</sup>, Sridevi Tallapragada<sup>2</sup>

<sup>\*1</sup> Assistant professor, Department of Botany, Dyal Singh College, Karnal, India

<sup>2</sup> Professor, Department of Botany and Plant Physiology College of Basic Science, CCSHAU. Hisar, India

## Corresponding Author: Isha Hasija

Assistant professor, Department of Botany, Dyal Singh College, Karnal, India

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**Abstract:** Rice straw, an abundant agricultural residue, presents a valuable resource for sustainable agriculture when converted into compost. This study evaluates the performance of rice straw-derived compost as an effective biomanure in enhancing soil fertility and crop productivity. The compost was prepared through controlled aerobic decomposition and characterized for nutrient content, pH, and organic matter. Field trials were conducted to assess its impact on soil health parameters and crop yield compared to conventional fertilizers. Results demonstrated significant improvements in soil nutrient availability, moisture retention, and microbial activity, leading to increased crop growth and yield. The findings suggest that rice straw compost is a viable, eco-friendly alternative to synthetic fertilizers, promoting circular agriculture by recycling crop residues and reducing environmental pollution.

**Keywords:** Biomanure, Soil fertility, Crop productivity, compost, Sustainable agriculture.

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## Introduction

India, as an agrarian nation, has achieved self-sufficiency in food production primarily due to the Green Revolution. However, meeting the increasing food grain demand of a growing population has led to intensive cropping practices and heavy reliance on chemical fertilizers. While this approach ensured short-term productivity, it has also caused long-term deterioration of soil health, manifested in declining fertility, nutrient imbalances, and degradation of soil structure.

Among the world's staple cereals, rice (*Oryza sativa* L.) holds particular significance in India, serving as the principal *kharif* crop and a dietary staple for the majority of the population. India ranks as the second-largest rice producer globally, contributing nearly 24% of total global rice output, with an annual production of approximately 170 million tonnes of paddy. However, this scale of production generates vast amounts of agricultural residues, especially rice straw, which pose major challenges for sustainable waste management. Rice straw alone contributes to the 740–1,100 million tonnes of annual global production of crop residues, with India and China accounting for nearly half of the total. In India, open-field burning remains the predominant disposal practice, particularly in Punjab, Haryana, and Uttar Pradesh, owing to its cost-effectiveness and speed. Nevertheless, residue burning emits methane (CH<sub>4</sub>), carbon monoxide (CO), nitrous oxides (NO<sub>x</sub>), and particulate matter, resulting in severe air pollution, greenhouse gas emissions, soil nutrient losses, and public health hazards.

From a sustainability perspective, rice straw holds significant potential as a raw material for composting. Its high lignin and silica content, however, restricts rapid decomposition, making conventional methods less effective. Microbial composting, using ligninolytic and cellulolytic consortia such as *Aspergillus* spp., *Trichoderma viride*, *Bacillus* spp., and actinobacteria, has emerged as an eco-friendly alternative to

accelerate the breakdown of lignocellulosic biomass. In addition, biofertilizers play a crucial role in improving root development, nutrient uptake, and plant growth, thereby enhancing the overall efficiency of composting-based systems (Yaseen et al. 2020). The resulting compost is a nutrient-rich biomanure that improves soil organic matter, enhances nutrient availability, increases microbial activity, and promotes better soil structure and water retention. These benefits are particularly relevant for nutrient-demanding crops such as tomato (*Solanum lycopersicum* L.), one of the world's most important vegetables in both dietary and economic terms.

A growing body of research has demonstrated the effectiveness of compost and organic amendments in enhancing soil fertility and crop productivity while reducing reliance on chemical fertilizers. Sheoran et al. (2015) reported that wheat yield and nutrient uptake increased significantly with the combined application of vermicompost and nitrogen fertilizer. Mukta et al. (2015) observed that vermicompost, applied at 10 t ha<sup>-1</sup> with 50% chemical fertilizer, improved tomato yield and soil nutrient status. Similarly, Han et al. (2016) demonstrated the positive influence of organic manure on seedling growth and soil properties in forestry systems, while Zhang et al. (2016) showed long-term compost application improved maize yield and nutrient use efficiency, alongside reduced nitrogen leaching and enhanced soil organic carbon, phosphorus, and potassium. Long-term studies, such as Xin et al. (2017), further confirmed that organic manure could effectively replace mineral phosphorus fertilizers, improving uptake and use efficiency in cereal-based systems.

Recent investigations reinforce these findings. Geng et al. (2019) showed that partial substitution of chemical fertilizer with livestock manures improved maize yield and dry matter accumulation. Djajadi et al. (2019) demonstrated that integrating biofertilizers and green manure enhanced nutrient uptake and



sugarcane performance, while Sofyan et al. (2019) reported increased sweet corn yields with combined organic and inorganic inputs. Erana et al. (2019) observed that agro-waste compost improved onion productivity through better soil structure and microbial activity. Likewise, Adekiya et al. (2020) highlighted that poultry and pig manure outperformed NPK fertilizers in okra cultivation by increasing yield and nutrient density.

Collectively, these studies establish compost as a reliable biomanure that not only sustains soil fertility but also improves crop yield, nutrient-use efficiency, and ecological balance. When applied alone or in synergy with reduced doses of chemical fertilizers, composted rice straw provides an effective pathway toward sustainable agriculture, offering a dual solution to residue management and soil degradation while reducing the environmental footprint of intensive farming.

## Materials and Methods

Rice straw-derived compost was prepared through aerobic decomposition over a 60-day period, using microbial inoculants to accelerate the breakdown of lignocellulosic material. The mature compost was air-dried, sieved (2 mm), and analyzed for key nutrient parameters using standard protocols.

Organic carbon was estimated via the dry combustion method (Nelson and Sommers, 1982), where 500 mg of compost

was ashed at 500 °C. Organic carbon and organic matter were calculated based on ash content.

Total nitrogen was determined using the Kjeldahl digestion method (Bremner, 1982). Samples were digested with a catalyst mixture and concentrated sulfuric acid, then distilled with NaOH. Ammonia was trapped in boric acid and titrated with 0.1 N HCl to estimate nitrogen content.

Total phosphorus was analyzed following the ascorbic acid method (John, 1970). Samples were digested in a nitric-perchloric acid mixture, and phosphorus concentration was determined colorimetrically at 882 nm using a UV-Vis spectrophotometer.

Total potassium was measured using flame photometry after acid digestion. Potassium concentration was quantified by comparing readings to a standard curve prepared from known KCl solutions.

All analyses were conducted in triplicate, and results were expressed on a dry weight basis.

## Result

### Initial chemical analysis of soil

Table 23. shows the initial analysis of soil which was used for pot experiment. The soil was sandy, its organic carbon was 0.15%, total N, P and K was respectively.

**Table 1 : Analysis of soil used for pot experiment**

Component	Quantity
Soil type	Sand
Organic carbon	0.15%
Total N	0.12%
Total P	0.21%
Total K	0.22%

Based upon the quality parameters two composts were selected and were used under pot house condition. These selected composts were having neutral pH and were dark brown in colour.

- **RICE STRAW COMPOST 1 (RSC1) :** PS+ PD + *L. casei* + *A. chroococcum* + *P. florescens* + *P. chrysosporium* + *T. asperillum (viride)* + *A. awamori*
- **RICE STRAW COMPOST 2 (RSC2) :** PS+ PD + *L. casei* + *A. chroococcum* + *P. florescens* + *P. chrysosporium* + *T. asperillum (viride)* + *A. awamori* + *Eisenia foetida*

### N, P, K content in tomato fruit and soil after plant harvest

Paddy straw compost and chemical fertilizers significantly influenced N, P and K content of tomato (Table). In this study, the highest nutrient contents of fruit were recorded from T 18 (Soil + RSC 2 + 100% RDF) treatment followed by T17 (Soil + RSC 2 + 80% RDF) treatment. Nitrogen content in tomato fruits was significantly affected by the use of vermicompost and chemical fertilizers. The content of N in fruits was from 0.21 to 0.49%. The highest N content (0.49%) in fruits was obtained in T18 treatment

and the lowest N content (0.21%) was recorded in T1 (control) treatment, which was significantly inferior to all treatments.

The content of P in tomato fruits varied from 0.16 to 0.41%. The highest P content (0.41%) was observed in T18 (Soil + RSC 2 + 100% RDF) treatment and the lowest P content (0.16%) in fruits was found in T1 (control) treatment.

Potassium content in tomato fruits varied from 0.53 to 0.94%. Maximum K content (0.94%) of fruit was obtained in T18 (Soil + RSC 2 + 100% RDF) treatment and minimum K content (0.53%) was observed in T1 (control) treatment. The result showed that K content was increased with the application of paddy straw compost and chemical fertilizers.

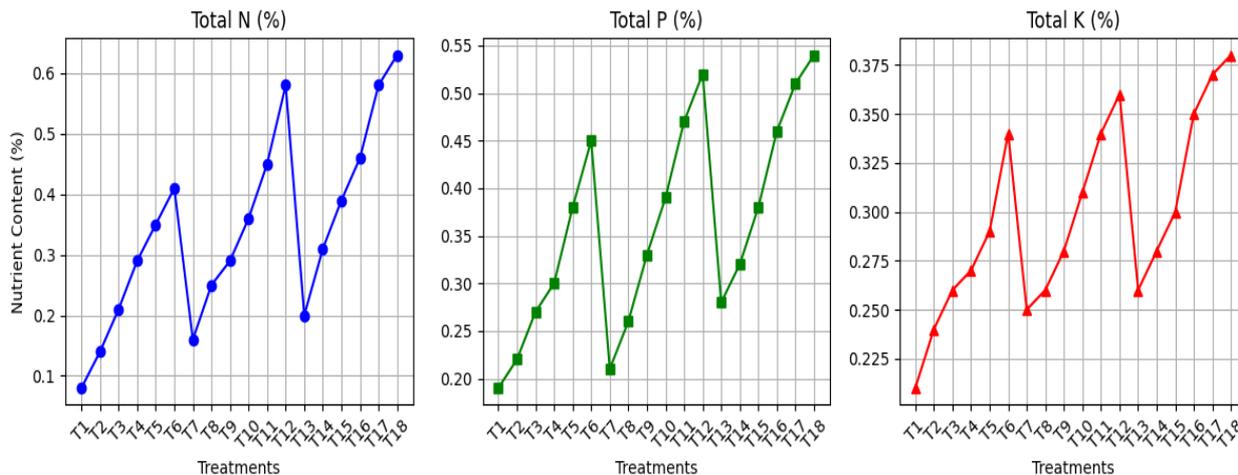
Total N, P and K content in tomato fruit of T6 where only inorganic fertilizers were used (Soil + 100% NPK) were 0.38%,0.29% and 0.79% which are similar to great extent with treatment T16 (Soil + RSC 2 +60% RDF) and in case of RSC 1, T11 (Soil + RSC 1 + 80% RDF) values are quite similar. So, it has been observed that paddy straw compost of treatment T11 and T16 matches the 100% dose of inorganic fertilizer.

**Yield of tomato**

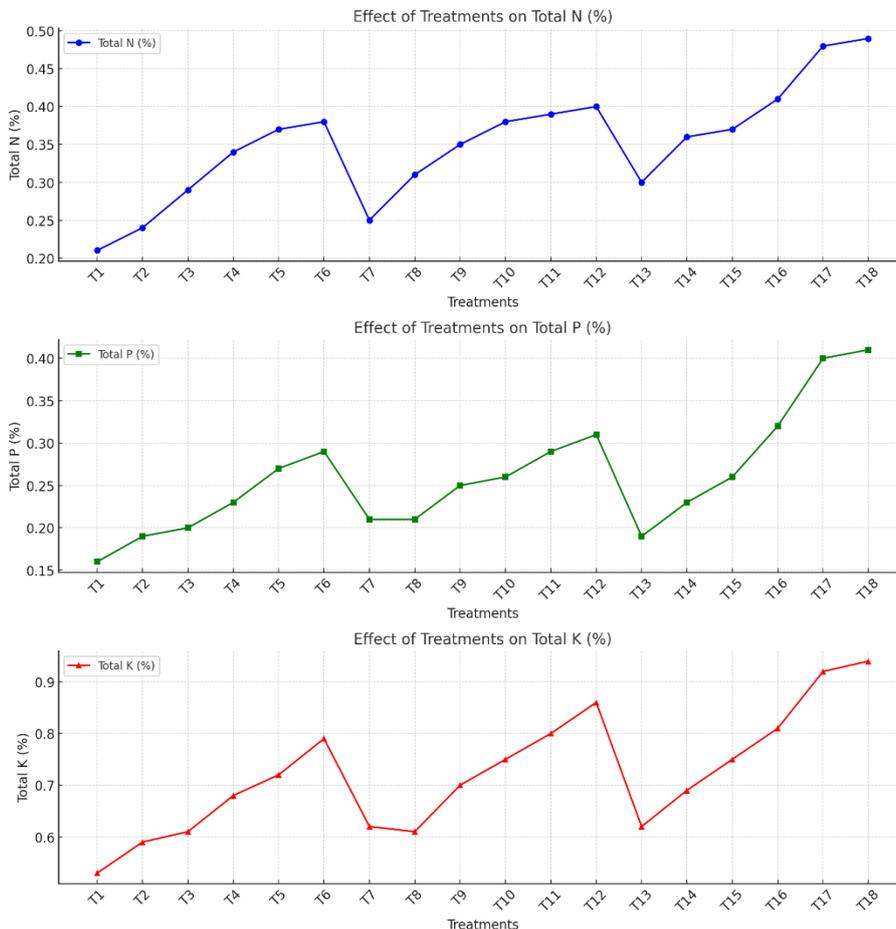
The yield was found to be maximum in treatment having Soil + RSC 2 + 100% RDF, T18 (1.62 kg plant<sup>-1</sup>) and T17 having Soil + RSC 2 + 80% RDF (1.58 kg plant<sup>-1</sup>) and lowest in control having only soil. The yield in T6 in which 100% RDF was given to soil was equivalent to T16 where 60% RDF was provided to soil with paddy straw compost. But in treatment T16, the yield was significantly more as compared to T6 in which 100% recommended dose of inorganic fertilizer was provided. Treatment T11 (Soil + RSC 1 + 80% RDF) in which paddy straw compost 1 was used also shows more yield than T6.

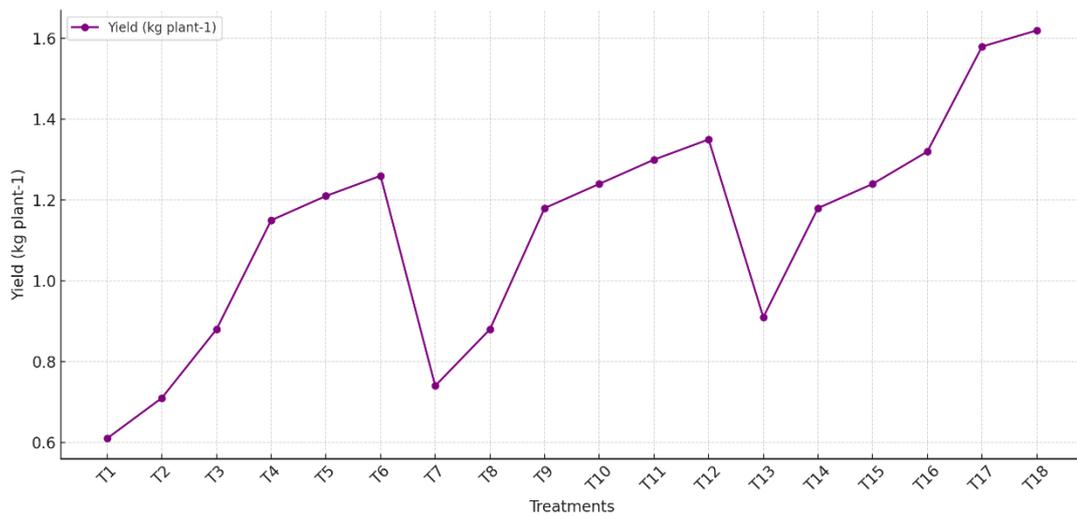
**RSC= Paddy straw compost, CD= Critical difference**

After harvesting of tomato, soil was analyzed for total N, P and K. In control the amount of total N, P and K was found to be decreased as compared to initial content while in all other treatment total N, P and K increased significantly. Maximum total N, P and K were reported in paddy straw compost 2 in treatment T18 (Soil + RSC 2 + 100% RDF) 0.63%, 0.54, 0.38% followed by T17 (Soil + RSC 2 + 80% RDF) 0.58%, 0.51, 0.37% (Table).



**Figure 1 : Total N, P, and K content in soil after plant harvest**





**Figure 2. Total N, P, and K content and yield response of tomato plant to chemical fertilizer accompanied by application of paddy straw compost**

Biofertilizers have beneficial effects in improving plant growth as they provide nitrogen, phosphorous and potassium nutrition. They also help the plant establish a greatly organized root system, thus increasing nutrient uptake and improving plant growth (Yaseen *et al.* 2020). In this investigation paddy straw compost and chemical fertilizers significantly influenced N, P and K content of tomato. The highest N and P content (0.68%, 0.41%) in fruits was obtained in T18 and K was high in T17 (0.96%) and the lowest N, P, K content (0.21%, 0.16% 0.53%) was recorded in T1 (control) treatment, which was significantly inferior to all treatments. The compost 2 (PS+ PD + *L. casei* + *A. chroococcum* + *P. florescens* + *P. chrysosporium* + *T. viride* + *A. awamori* + *Eisenia foetida*) was found to be superior over compost 1 having only microbial consortia with no earthworms. N, P, K content in Treatment 6 having 100% RDF was similar to T16 (soil + RSC 2 + 60 % NPK) and T11 (soil + RSC1 + 80% NPK). It shows that combination of RSC2 and 40% NPK, RSC1 and 60 % NPK can substitute 100% recommended dose of fertilizer.

## Conclusion

The study clearly demonstrates that rice straw-derived compost is an effective biomanure for enhancing soil fertility and crop productivity. Both compost formulations improved nutrient availability, organic matter content, and tomato yield, with RSC2 (enriched with *Eisenia foetida*) showing superior performance. Treatments combining RSC2 with 60–80% RDF achieved yields comparable to or higher than 100% RDF, indicating that compost can partly substitute chemical fertilizers. This integration reduces dependency on synthetic inputs while maintaining high productivity.

In addition to improving crop yield, compost application enhanced soil nutrient retention, microbial activity, and long-term soil health. The approach also addresses the environmental issue of rice straw burning by recycling residues into a valuable resource. Thus, rice straw compost provides dual benefits of waste management and sustainable crop production. Future research focusing on large-scale application and economic feasibility will further strengthen its adoption in farming systems.

## References

1. Adekiya, A. O., Agbede, T. M., Aboyeji, C. M., Dunsin, O. & Simeon, V. T. 2020. Effects of biochar and poultry manure on soil characteristics and the yield of tomato (*Lycopersicon esculentum* Mill) on a degraded soil in Southwestern Nigeria. *Scientific African* 9: e00492.
2. Bremner, J. M. 1982. Total nitrogen. In: Page, A. L., Miller, R. H. & Keeney, D. R. (eds). *Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties*. Madison, WI: American Society of Agronomy. p. 594–624.
3. Djajadi, D., Martono, B., Indradewa, D. & Shiddiq, D. 2019. The potential of biochar for improving nutrient use efficiency and crop productivity on marginal soils. *IOP Conference Series: Earth and Environmental Science* 393: 012063.
4. Erana, H., Assefa, A. & Meseret, A. 2019. Effect of organic and inorganic fertilizers on the yield and yield components of maize (*Zea mays* L.) in Western Ethiopia. *International Journal of Agronomy* 2019: 1–7.
5. Geng, Y., Cao, G., Wang, L., Wang, S. & Chen, X. 2019. Effects of organic manure input on soil chemical properties and soil heavy metal pollution. *Environmental Science and Pollution Research* 26: 16858–16866.
6. Han, S. H., An, J. Y., Hwang, J., Kim, S. B. & Park, B. B. 2016. The effects of organic manure and chemical fertilizer on the growth and nutrient concentrations of yellow poplar (*Liriodendron tulipifera* Lin.) in a nursery system. *Forest Science and Technology* 12(3): 137–143.
7. John, M. K. 1970. Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. *Soil Science* 109: 214–220.
8. Mukta, S., Rahman, M. M. & Mortuza, M. G. 2015. Yield and nutrient content of tomato as influenced by the application of vermicompost and chemical fertilizers. *Journal of Environmental Science and Natural Resources* 8(2): 115–122.
9. Nelson, D. W. & Sommers, L. E. 1982. Total carbon, organic carbon, and organic matter. In: Page, A. L., Miller, R. H. & Keeney, D. R. (eds). *Methods of Soil Analysis, Part 2: Chemical and Microbiological*

- Properties*. Madison, WI: American Society of Agronomy. p. 539–580.
10. Sheoran, H. S., Duhan, B. S., Grewal, K. S. & Sheoran, S. 2015. Grain yield and NPK uptake of wheat (*Triticum aestivum* L.) as influenced by nitrogen, vermicompost and herbicide (Clodinafop propargyl). *African Journal of Agricultural Research* 10(42): 3952–3961.
  11. Sofyan, E. T., Sara, D. S. & Machfud, Y. 2019. The effect of organic and inorganic fertilizer applications on N, P-uptake, K-uptake and yield of sweet corn (*Zea mays saccharata* Sturt). *IOP Conference Series: Earth and Environmental Science* 393: 1–6.
  12. Xin, X., Qin, S., Zhang, J., Zhu, A., Yang, W. & Zhang, X. 2017. Yield, phosphorus use efficiency and balance response to substituting long-term chemical fertilizer use with organic manure in a wheat-maize system. *Field Crops Research* 208: 27–33.
  13. Yaseen, R., Hegab, R., Kenawey, M. K. & Eissa, D. 2020. Effect of super absorbent polymer and bio fertilization on maize productivity and soil fertility under drought stress conditions. *Egyptian Journal of Soil Science* 60(4): 377–395.
  14. Zhang, Y., Li, C., Wang, Y., Hu, Y., Christie, P., Zhang, J. & Li, X. 2016. Maize yield and soil fertility with combined use of compost and inorganic fertilizers on a calcareous soil on the North China Plain. *Soil and Tillage Research* 155: 85–94.