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EVALUATING THE EFFICACY OF CONSORTIA-BASED BIOCOMPOST ON MAIZE PRODUCTIVITY AND SOIL FERTILITY

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ABSTRACT

Maize (*Zea mays* L.) is a critical crop for global food security, but its productivity is often limited by soil fertility and nutrient availability. This field trial evaluated the efficacy of biocompost on maize growth, yield, and nutrient uptake. The results showed that biocompost application at 10 MT/ha + recommended dose of fertilizers (RDF) significantly increased maize plant height (202.37 cm), cob length (20.67 cm), and grain yield (71.37 q ha-1) compared to the control treatment. Importantly, biocompost application enhanced maize nutrient uptake, with the highest nitrogen, phosphorus, and potassium uptake observed in the 10 MT/ha + RDF treatment. Soil microbial analysis revealed a significant increase in fungal, bacterial, and actinomycetes populations in the rhizosphere of treated plants. These findings highlight the potential of biocompost to improve maize productivity, soil fertility, and sustainability.
Keyword : Efficacy, biocompost, nutrient uptake.

Introduction

Maize (*Zea mays* L.) is a nutrient-demanding crop that necessitates balanced fertilization to optimize growth and productivity. As a staple crop, maize plays a pivotal role in global food security, sustainable agriculture, and rural development, providing sustenance for approximately 900 million people worldwide (FAO, 2020). Maize production is heavily reliant on external inputs, including synthetic fertilizers, pesticides, and irrigation, which can lead to soil degradation, reduced fertility, and environmental pollution (Tilman *et al.*, 2011). Prolonged and indiscriminate application of inorganic fertilizers has been reported to adversely impact soil health, leading to deterioration in its physical and chemical properties, as well as disruption of biological activities (Mahajan *et al.,* 2008). Various strategies are being employed to manage organic waste, but there is a growing need for environmentally safe and sustainable approaches that prioritize nutrient conservation (Prakash *et al.*, 2019).

The integration of biocompost prepared from sugarcane trash into maize cultivation has emerged as a promising strategy to mitigate these negative impacts and promote sustainable farming practices. Biocompost is a specialized type of compost produced through the action of microorganisms with targeted functional capabilities, utilizing organic waste materials such as straw as substrates (Corato, 2020). Extensive research has consistently shown that the application of biocompost in various crops has numerous benefits, including enhanced plant growth, increased yield, and improved nutritional quality (Sindhu *et al.*, 2020). Biocomposting offers an effective strategy for mitigating the accumulation of organic waste in landfills and the attendant greenhouse gas emissions (Osman *et al.*, 2022).

This study aims to investigate the efficacy of consortia-based biocompost prepared from sugarcane trash in improving maize productivity, with a specific focus on its impact on soil fertility, microbial communities, and crop yields. The slow release of nutrients from biocompost ensures a sustained supply of essential elements, such as nitrogen, phosphorus, and potassium, to plants throughout the growing season, thereby reducing reliance on chemical fertilizers (Sindhu *et al*., 2020). By exploring the potential of biocompost to enhance maize production sustainability, this research seeks to contribute to the development of more environmentally friendly and socially responsible agricultural practices.

Materials and Methods

A field experiment was conducted during *Rabi*, at Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra to study the efficacy of biocompost prepared from sugarcane trash on growth and yield of maize (cv. *Phule Rajarshi*). The experiment was carried out in a randomized block design (RBD) with three replications. The seeds were spaced at 20 cm in 60 cm wide rows. Biocompost was prepared using a consortium of microorganisms, including fungi, bacteria, and actinomycetes. The reference compost was obtained from the Research cum Development Project (RCDP), Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The treatment details comprised seven different combinations. Biocompost was applied at three varying rates: 5.5 MT/ha (T1), 7.5 MT/ha (T2), and 10 MT/ha (T3), all in combination with the recommended dose of fertilizer (RDF). Reference compost was also applied at the same three rates: 5.5 MT/ha (T4), 7.5 MT/ha (T5), and 10 MT/ha (T6), along with RDF. The seventh treatment (T7) consisted of the application of only the recommended dose of N, P, and K fertilizers (GRDF) at the rate of 120:60:40 NPK kg/ha. The data collected from various parameters were subjected to statistical analysis using the standard method of analysis of variance (ANOVA) as described by Panse and Sukhatme (1985). The standard error (SE) for treatment combinations and critical difference (CD) at 5% level of significance were calculated and used for comparing treatment means.

Nutrient Uptake Analysis

Maize plant samples were collected from each treatment plot at the harvesting stage to determine nitrogen (N), phosphorus (P), and potassium (K) uptake. The samples were dried in paper bags in a hot air oven at 70°C for 48 hours, then finely ground in a mixer, and again dried in an oven at 60°C for a couple of hours. The total N, P, and K content in the plant samples were determined using modified Kjeldahl's method (Jackson, 1967), Vandomolybdate phosphoric yellow color colorimetric method (Jackson, 1973), and flame photometry (Jackson, 1973), respectively, and expressed as a percentage on a dry weight basis.

Microbial Population Analysis of Rhizospheric Soil

Soil samples from each plot were collected before sowing and after harvesting, and analyzed for fungal, bacterial, and actinomycetes populations. Serial dilution and plate count techniques were employed to determine microbial counts (Jackie Reynolds 2016). Potato Dextrose Agar (PDA), Nutrient Agar (NA), and Starch Casein Agar (SCA) media were used for plating dilutions under in vitro conditions. Plates were incubated at 28±2°C for 4-5 days, and colony-forming units (cfu) were counted and expressed as cfu g^{-1} soil.

Results and Discussion

A comprehensive analysis was conducted to investigate the effects of different compost treatments on maize plant height, with measurements taken at tasseling and harvesting stages (Table 1 and Fig. 1). The results revealed significant variations in maize plant height among the different treatment combinations, attributed to varying compost doses and recommended fertilizer applications. Notably, Treatment T3 (Biocompost @ 10 MT/ha + RDF) exhibited the highest plant height at both tasseling (189.90 cm) and harvesting stages (202.37 cm), demonstrating statistical superiority. These findings are consistent with Sifolo Coulibaly *et al.* (2020), who reported increased maize plant height with compost application before sowing, with heights of 177.65±30.17 cm at 60 days and 178.95 cm at 75 days after sowing. The results revealed significant variations in maize cob length, width, and number of cobs per plant among the different treatment combinations (Table 1 and Fig 2). Treatment T3 (Biocompost @ 10 MT/ha + RDF) recorded the highest cob length (20.67 cm), cob width (5.43 cm), and number of cobs per plant (3.00), demonstrating statistical superiority over other treatments, while being on par with Treatment T2 (Biocompost @ 7.5 MT/ha + RDF) for cob length (19.63 cm) and cob width (4.50 cm), and Treatment T6 (Reference compost @ 10 MT/ha + RDF) for cob length (18.47 cm). Raman and Suganya (2018) reported similar results, where integrating pressmud compost with 100% Recommended Dose of Fertilizers (RDF) significantly enhanced cob length, with a maximum length of 22.68 cm achieved with 5 t ha^{-1} pressmud compost application. In contrast, the lowest cob length (13.92 cm) was recorded with 100% RDF application alone.

The nitrogen, phosphorus, and potassium uptake by maize varied significantly among the treatment combinations (Table 2 and Fig. 3). Treatment T3

(Biocompost @ 10 MT/ha + RDF) recorded the highest nutrient uptake, with values of 164.77 kg ha^{-1} for nitrogen, 43.85 kg ha^{-1} for phosphorus, and 96.08 kg ha^{-1} for potassium, demonstrating statistical superiority over other treatments. These findings are consistent with Korai *et al*. (2014), who reported increased nitrogen uptake in maize with the application of biocompost and mineral fertilizers. The 1000 grain weight and grain yield were significantly influenced by the compost quantity and recommended doses of fertilizers (Table 2 and Fig 4). Treatment T3 (Biocompost @ 10 MT/ha + RDF) recorded the highest 1000 grain weight (259.70 g) and grain yield (71.37 q ha^{-1}), demonstrating statistical superiority over other treatments. These findings are in line with Admas *et al.* (2015), who reported increased 1000 seed weight with combined application of nitrogen, compost, and sulfur fertilizers.

The application of biocompost derived from sugarcane trash positively impacted soil microbial populations, influencing crop productivity (Table 3 and Fig 5). The initial soil microbial counts were 10.2 x 10^7 cfu g^{-1} for bacteria, 8.9 x 10^5 cfu g^{-1} for fungi, and 7.69 x 10^4 cfu g^{-1} for actinomycetes. Treatment T3 (biocompost @ 10 MT/ha + RDF) showed the highest microbial populations at harvest: 19.40 x 10^7 cfu g^{-1} for bacteria, 17.43 x 10^5 cfu g^{-1} for fungi, and 16.54 x 10^4 cfu g^{-1} for actinomycetes. These findings are in agreement with Meena *et al.* (2015), who reported that leaf compost application resulted in increased microbial populations, with values of 26.11 x 10^5 cfu g^{-1} for bacteria, 21.13 x 10^2 cfu g^{-1} for fungi, and 11.61 x 10^2 cfu g^{-1} for actinomycetes.

Conclusion

The findings of this study unequivocally demonstrate the efficacy of biocompost in augmenting maize plant growth, nutrient uptake, and soil microbial populations. Among the treatments, Biocompost @ 10 MT/ha + RDF (T3) consistently exhibited superior performance, recording significant enhancements in plant height, cob dimensions, nutrient uptake, 1000 grain weight, and grain yield. Moreover, T3 also showed a substantial increase in soil and root rhizosphere microbial populations. These results underscore the potential of biocompost as a sustainable and eco-friendly approach for improving crop productivity and soil health. Therefore, the application of biocompost at 10 MT/ha in conjunction with RDF is recommended as a viable strategy for enhancing maize productivity while promoting environmental sustainability.

Table 1 : Effects of sugarcane trash biocompost on plant height and cob characteristics in maize (*Zea mays* L.)

Tr. No.	Treatments	Plant height (cm)		Cob characteristics		
		At tasseling stage	At harvesting stage	Cob length (cm)	Cob width (cm)	Number of cobs/ plant
T_1	Biocompost @ 5.5 MT/ha + RDF	177.80	192.10	15.50	3.70	1.67
T_2	Biocompost @ 7.5 MT/ha + RDF	185.10	198.80	19.63	4.50	2.67
T_3	Biocompost @ 10 MT/ha + RDF	189.90	202.37	20.67	5.43	3.00
T_4	Reference compost @ 5.5 MT/ha + RDF	176.97	190.30	15.17	3.47	1.33
T_5	Reference compost @ 7.5 MT/ha + RDF	180.10	195.43	16.80	3.83	2.00
T_6	Reference compost @ 10 MT/ha + RDF	182.20	197.03	18.47	4.23	2.33
T_7	RDF (120:60:40 $N:P_2O_5:K_2O$ kg ha^{-1})	171.63	185.20	13.47	2.93	1.00
	S.E m.±	1.17	1.06	0.75	0.38	0.28
	CD at 5%	3.61	3.27	2.31	1.18	0.87

Table 2 : Effects of sugarcane trash biocompost on nutrient uptake and yield attributes of maize (*Zea mays* L.)

Tr. No.	Treatments	Nitrogen Uptake (kg ha^{-1})	Phosphorus Uptake (kg ha^{-1})	Potassium Uptake (kg ha^{-1})	1000 grain weight (g)	Yield (q ha^{-1})
T_1	Biocompost @ 5.5 MT/ha + RDF	139.97	27.52	68.98	251.50	63.53
T_2	Biocompost @ 7.5 MT/ha + RDF	155.17	39.43	85.99	257.03	69.30
T_3	Biocompost @ 10 MT/ha + RDF	164.77	43.85	96.08	259.70	71.37
T_4	Reference compost @ 5.5 MT/ha + RDF	132.63	22.29	60.95	250.67	62.97
T_5	Reference compost @ 7.5 MT/ha + RDF	144.90	33.33	75.56	254.70	66.13
T_6	Reference compost @ 10 MT/ha + RDF	153.30	35.38	83.73	256.27	68.50
T_7	RDF (120:60:40 $N:P_2O_5:K_2O$ kg ha^{-1})	123.10	19.49	54.49	242.83	58.20
	S.E m.±	1.45	1.05	1.30	0.91	0.62
	CD at 5%	4.48	3.24	3.99	2.81	1.91

Table 3 : Effect of sugarcane trash biocompost on microbial populations of bacteria, fungi, and actinomycetes in maize (*Zea mays* L.)

Tr. No.	**Treatments**	**Bacteria x 10^7 cfu g^{-1} soil**	**Fungi x 10^5 cfu g^{-1} soil**	**Actinomycetes x 10^4 cfu g^{-1} soil**
T_1	Biocompost @ 5.5 MT/ha + RDF	15.90	14.90	13.89
T_2	Biocompost @ 7.5 MT/ha + RDF	17.67	16.35	14.76
T_3	Biocompost @ 10 MT/ha + RDF	19.40	17.43	16.54
T_4	Reference compost @ 5.5 MT/ha + RDF	15.19	14.31	13.35
T_5	Reference compost @ 7.5 MT/ha + RDF	16.26	15.26	14.31
T_6	Reference compost @ 10 MT/ha + RDF	18.13	16.82	15.28
T_7	RDF (120:60:40 N:P_2O_5:K_2O kg ha^{-1})	11.61	9.24	8.37
	S.E m.±	0.51	0.99	0.70
	CD at 5%	1.58	3.05	2.15

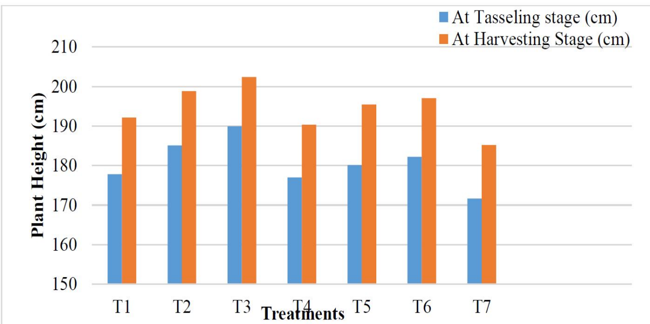

Fig. 1 : Effects of sugarcane trash biocompost on plant height in maize (*Zea mays* L.)

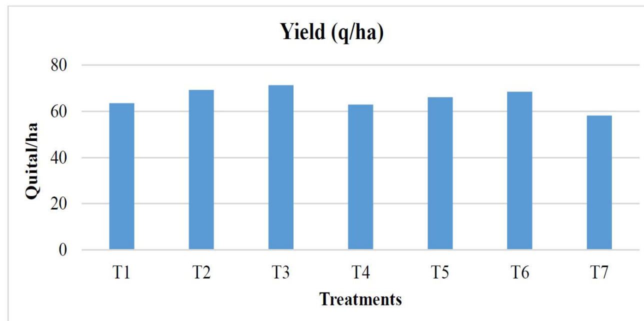

Fig. 4 : Effects of sugarcane trash biocompost on grain yield on maize (*Zea mays* L.)

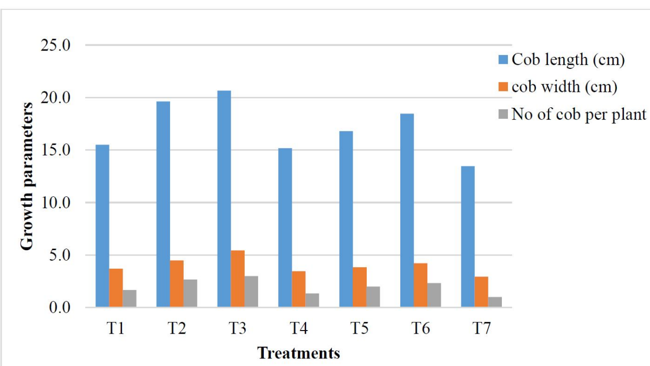

Fig. 2 : Effects of sugarcane trash biocompost on cob characteristics in maize (*Zea mays* L.)

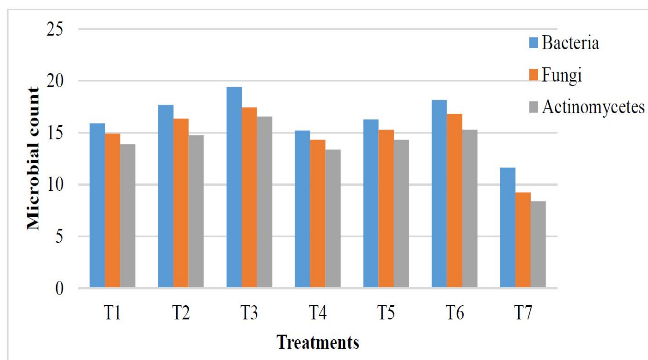

Fig. 5 : Effects of sugarcane trash biocompost on microbial populations in maize (*Zea mays* L.) rhizoshpere

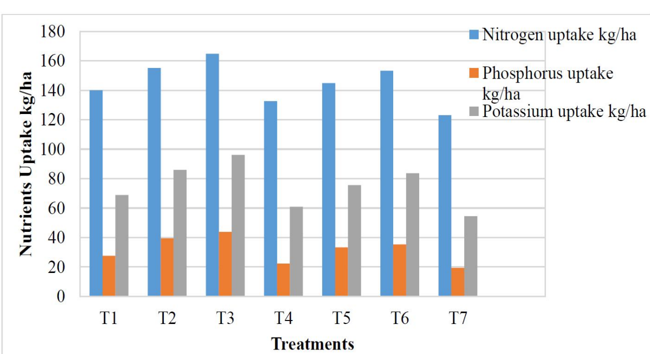

Fig. 3 : Effects of sugarcane trash biocompost on nutrient uptake by maize (*Zea mays* L.)

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