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EFFECT OF ORGANIC FORMULATIONS ON MICROBIAL ACTIVITY AND NUTRIENT UPTAKE ON TORIA (*BRASSICA CAMPESTRIS* L.)

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ABSTRACT

A field experiment was conducted to know the effect of different organic inputs such as FYM, Biochar, Biochar enriched FYM along with Beejamrutha and Jeevamrutha on microbial population of toria field during *rabi* season 2023-24. Among treatments, organic inputs FYM 2 t ha^{-1}, Bamboo biochar 0.6 t ha^{-1} and Biochar enriched FYM 2 t ha^{-1} as applied into the soil. Beejamrutha is used as seed treatment @ 50 % and 100 % whereas Jeevamrutha is applied as foliar spray @ 5 % at every 15 days interval. The mean microbial count (CFU g^{-1} of soil) with three serial dilutions at 10^4, 10^5 and 10^6 were also calculated. Among the different organic inputs, Biochar enriched FYM @ 2 t/ha+ 100 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_{10}) recorded highest mean microbial population at 10^4 dilution 64.33 (CFU x 10^4 g^{-1} soil), 10^5 dilution 57.66 (CFU x 10^5 g^{-1} soil) and 10^6 dilution 53.66 (CFU x 10^6 g^{-1} soil) and were significantly superior over all other treatments except in Biochar enriched FYM @ 2 t/ha+ 50 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_9). Thus, it can be concluded that the application of enriched biochar along with Beejamrutha and Jeevamrutha are better to increase microbial population as well as yield attributes of toria in the field.

Keywords **:** Organic formulations, microbial activity, nutrient uptake, toria (*Brassica campestris* L.)

Introduction

Natural farming is a sustainable agricultural practice that relies on natural inputs and minimizes external interventions, creating a balanced ecosystem that enhances soil microbial health. Microorganisms play a crucial role in nutrient cycling, contributing to the sustainability of soil productivity by acting as both sources and sinks for mineral nutrients. They drive key biochemical transformations, facilitating processes such as nitrogen fixation, phosphorus solubilization, and organic matter decomposition, which enhance nutrient availability and support plant growth (Umadevi *et al.*, 2018). The use of organic formulations such as Jeevamrutha are fermented bio-inputs enriched with beneficial microorganisms that promote plant growth, enhance vegetative development and improve yield quality. The increased microbial activity leads to disease suppression, improving soil structure and soil fertility (Bharucha *et al.*, 2020). Naturally occurring beneficial microorganisms, including predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria, and certain fungi, have been identified in cow dung (Swaminathan, 2005). Overall, natural farming enhances soil microbial health by creating a thriving microbial ecosystem, improving soil resilience, fertility, and long-term sustainability.

Organic formulations can improve soil fertility, plant health, and pest and disease control (Sathya *et al.*, 2020). Microorganisms, which include bacteria, fungus, and protozoa, interact with plants and the soil microbiome in a variety of ways, helping to maintain

ecosystem balance and promote sustainable agriculture (Hartmann *et al*., 2017). These formulations serve as critical supplements, providing essential nutrients necessary for numerous physiological processes in plants.

The application of organic inputs is a crucial practice for enhancing soil microbial activity, as reported by Edesi *et al*. (2013). Liquid organic formulations play a significant role in natural farming by supporting beneficial microflora, which acts as a key driver for nutrient availability and crop growth improvement (Devakumar *et al*., 2014). Considering these aspects, the present study was conducted to evaluate the effect of organic inputs on soil microbial populations in toria crops.

Materials and Methods

The experiment was carried out in the Natural Farming Block, Biswanath College of Agricultural Farm, AAU, Biswanath Chariali, Assam during *Rabi* season 2023-24. The experiment was laid out in a randomized block design and replicated thrice with ten treatments *viz.*, T_1-Absolute control, T_2-FYM @ 2 t/ha, T_3-Bamboo Biochar @ 0.6 t/ha, T_4-Biochar enriched FYM (1:9 :: Biochar: FYM) @ 2 t/ha, T_5-FYM @ 2 t/ha + 50% beejamrutha + 5% jeevamrutha spray at 15 days interval, T_6-FYM @ 2 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval, T_7-Biochar @ 0.6 t/ha + 50% beejamrutha + 5% jeevamrutha spray at 15 days interval, T_8 -Biochar @ 0.6 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval, T_9-Biochar enriched FYM @ 2 t/ha + 50% beejamrutha + 5% jeevamrutha spray at 15 days interval, T_{10}-Biochar enriched FYM @ 2 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval. Beejamrutha was applied as a seed treatment.

Microbial population studies were carried out by using serial dilution and standard plate count methods (Johnson and Curl, 1972) for isolation of microbes. Petri dishes were prepared by pouring Potato Dextrose Agar solid medium. Then 1 g of soil sample in each treatment was diluted with 9 ml sterile water and that was considered being 10^1 dilution factors. Transferring of 1 ml of 10^1 dilution to 9 ml sterilized water with the help of a sterilized pipettes yielded 10^2 dilution factors. In this way, a series of up to 10^6 dilutions were prepared under aseptic condition. 0.1 ml of the suspension from required dilution (e.g. 10^6) was taken and poured into the Potato Dextrose Agar media on Petri dish and spread with L-spreader. Then plates were incubated at 25 ± 2°C for 3-5 days and the colony counts were recorded. Initial microbial population at 10^4, 10^5 and 10^6 dilutions were 25.6 CFU/g, 18.3 CFU/g and 11.4 CFU/g, respectively.

Results and Discussion

Soil microbial population

The application of organic inputs significantly influenced the soil microbial population across all dilution levels (10^4, 10^5, and 10^6 CFU/g of soil), with notable variation among treatments.

The highest microbial count at 10^4 dilution was observed in T_{10}-Biochar enriched FYM @ 2 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval (64.33 CFU/g), followed by T_9- Biochar enriched FYM @ 2 t/ha + 50% beejamrutha + 5% jeevamrutha spray at 15 days interval (61.66 CFU/g) and T_8- Biochar @ 0.6 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval (57.33 CFU/g). The lowest count was recorded in the Absolute control (T_1) at 33.33 CFU/g. At 10^5 and 10^6 dilutions also microbial populations remained significantly higher in the T_{10}- Biochar enriched FYM @ 2 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval (57.66 CFU/g & 53.66 CFU/g), followed closely by T_9- Biochar enriched FYM @ 2 t/ha + 50% beejamrutha + 5% jeevamrutha spray at 15 days interval (55.33 CFU/g & 50.33 CFU/g) and T_8- Biochar @ 0.6 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15 days interval (53.33 CFU/g & 49.33 CFU/g). The lowest population was observed in T_1-Absolute control (28.33 CFU/g & 21.33 CFU/g). Treatments incorporating Biochar-enriched FYM with Beejamrutha and Jeevamrutha (T_{10} and T_9) exhibited significantly higher microbial activity, likely due to the combined effects of biochar providing microbial habitat and the organic formulations enhancing microbial proliferation.

This may be due to the presence of beneficial microorganisms in Beejamrutha and Jeevamrutha due to their nutrient-rich ingredients like cow dung, cow urine, pulse flour, and jaggery, which supply essential nutrients and growth hormones that significantly enhance microbial diversity in soil by promoting the growth of beneficial native microbes like nitrogen-fixers, actinomycetes and phosphorus-solubilizers (Sreenivasa *et al*., 2010). The addition of native soil during Jeevamrutha preparation enhances microbial diversity (Devakumar *et al*., 2014). These microorganisms secrete bioactive compounds such as proteins, organic acids, and antioxidants, which facilitate the decomposition of organic matter. This catalytic microbial activity improves soil health, nutrient availability, and suppresses pathogens, contributing to sustainable crop production and

enhanced ecosystem functioning (Kasbe *et al.*, 2015). The lowest microbial population was recorded in absolute control under all three dilutions.

The application of organic inputs like FYM, biochar and organic formulations enhances soil organic carbon content, which improves soil organisms. Porous structure of Biochar provides a stable habitat for microbial communities by enhancing water retention, aeration, and nutrient availability (Pandian *et al.*, 2016). This improved micro environment fosters microbial growth, leading to enhanced nutrient cycling and soil health (Ogawa 1994).

Table 1: Soil microbial populations as influenced by organic inputs

Treatment	Microbial count (CFU/ g of soil)		
	10^4	10^5	10^6
T_1: Absolute control	33.33	28.33	21.33
T_2: FYM @ 2 t/ha	39.66	33.33	29.66
T_3: Bamboo Biochar @ 0.6 t/ha	40.33	35.66	30.66
T_4: Biochar enriched FYM (1:9 :: Biochar: FYM) @ 2 t/ha	43.66	39.33	35.66
T_5: FYM @ 2 t/ha 100% beejamrutha + 5% jeevamrutha *	50.33	44.33	38.33
T_6: FYM @ 2 t/ha 50% beejamrutha + 5% jeevamrutha *	52.33	48.66	43.33
T_7: Bamboo Biochar @ 0.6 t/ha 100% beejamrutha + 5% jeevamrutha *	55.66	52.66	48.66
T_8: Bamboo Biochar @ 0.6 t/ha 50% beejamrutha + 5% jeevamrutha *	57.33	53.33	49.33
T_9: Biochar enriched FYM @ 2 t/ha 100% beejamrutha + 5% jeevamrutha *	61.66	55.33	50.33
T_{10}: Biochar enriched FYM @ 2 t/ha 50% beejamrutha + 5% jeevamrutha *	64.33	57.66	53.66
SEm (±)	**1.86**	**2.01**	**1.81**
CD=P (0.05)	**5.51**	**5.99**	**5.39**
CV (%)	**7.159**	**7.01**	**7.83**

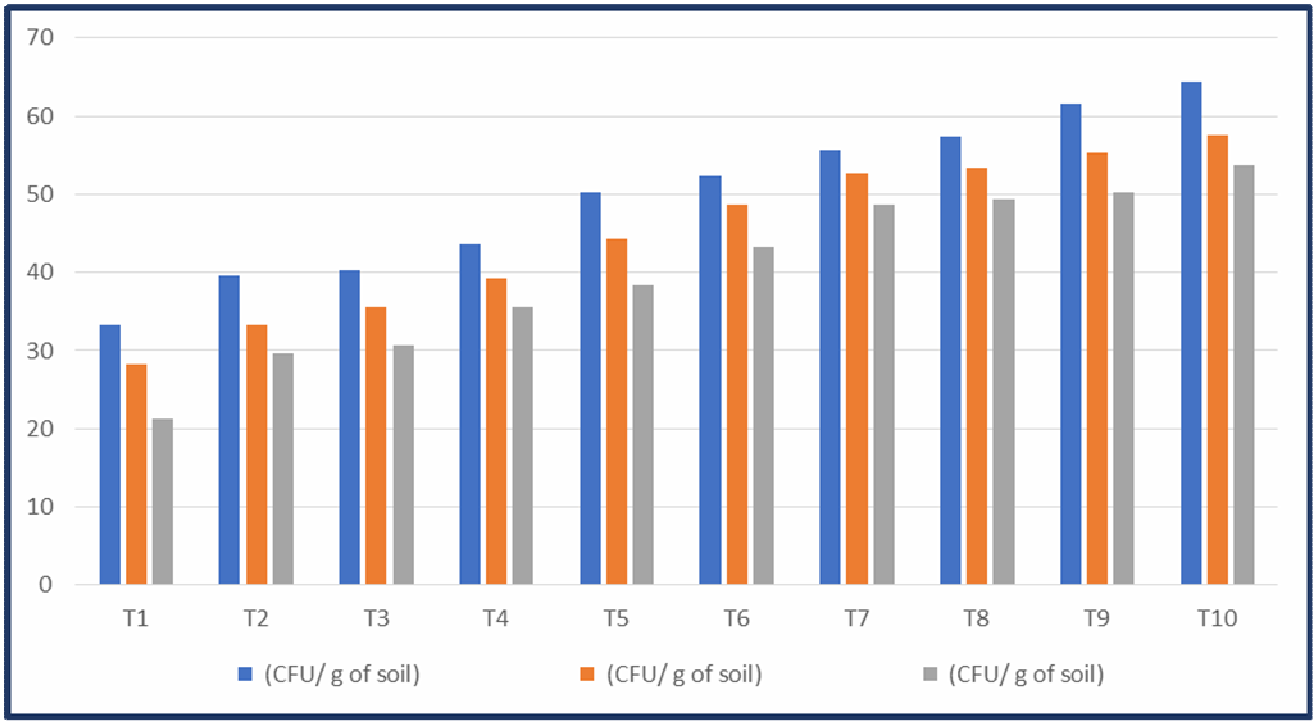

Fig. 1 : Soil microbial populations as influenced by organic inputs.

Plate 1: Media preparation at laminar flow

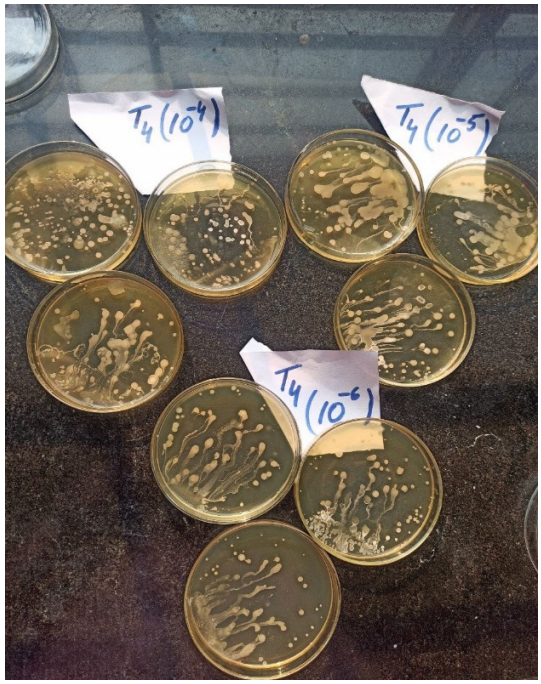

Plate 2: Microbial colony forming units

Nutrient uptake as influenced by Microbial activity on toria

The application of different organic nutrient sources significantly improved nitrogen, phosphorus, and potassium (N, P, and K) uptake as compared to the absolute control. The highest N uptake (27.39 kg ha^{-1}), P uptake (4.01 kg ha^{-1}) and K uptake (20.15 kg ha^{-1}) was recorded with Biochar enriched FYM @ 2 t/ha+ 100 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_{10}) followed by Biochar enriched FYM @ 2 t/ha+ 50 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_9) and FYM @ 2 t/ha+ 100 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_6). Absolute control (T_1) recorded significantly lowest nutrient uptake among the tested treatments. The increased nutrient uptake can be attributed to soil application of organic inputs, along with increased microbial activity. The complementary effect of organic formulations after fermentation further supported better nutrient uptake, crop growth, resulting in higher grain yield. the gradual release of nutrients during organic matter decomposition of FYM, ensuring prolonged availability of nitrogen, phosphorus, potassium, and micronutrients to meet crop demands and enhance growth characteristics.

Grain yield as influenced by Microbial activity

Significantly higher grain yield (6.54 q ha^{-1}) and stover yield (17.03 q ha^{-1}) of toria were observed with application of Biochar enriched FYM @ 2 t/ha+ 100 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval followed by Biochar enriched FYM @ 2 t/ha+ 50 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval (T_9) also attributed to produce significantly higher uptake of nutrients. significantly lower grain yield (3.03 q ha^{-1}) and stover yield (10.41 q ha^{-1}) were recorded with absolute control (T_1). The increased nutrient uptake can be attributed to the gradual release of nutrients during organic matter decomposition of FYM, ensuring prolonged availability of nitrogen, phosphorus, potassium, and micronutrients to meet crop demands and enhance growth characteristics. Microbial activity on nutrient mobility and plant nutrient uptake is a key activity in crop production.

The highest nutrient uptake and grain yield was observed in Biochar enriched FYM @ 2 t/ha+ 100 % beejamrutha+ 5 % jeevamrutha spray at 15 days interval, because the maximum microbial activity is observed in this treatment.

Table 2: Nutrient uptake and yield as influenced by organic inputs

Treatment	Total nutrient uptake kg/ha			Grain yield q/ha	Stover yield q/ha
	N	P	K		
T_1: Absolute control	13.16	1.79	10.87	3.03	10.41
T_2: FYM @ 2 t/ha	19.78	2.8	15.36	4.65	14.36
T_3: Bamboo Biochar @ 0.6 t/ha	19.22	2.7	15.14	4.53	14.19
T_4: Biochar enriched FYM (1:9 :: Biochar: FYM) @ 2 t/ha	20.75	2.97	15.89	4.89	14.74
T_5: FYM @ 2 t/ha 100% beejamrutha + 5% jeevamrutha *	23.77	3.45	17.73	5.63	15.99
T_6: FYM @ 2 t/ha 50% beejamrutha + 5% jeevamrutha *	24.95	3.66	18.48	5.97	16.43
T_7: Bamboo Biochar @ 0.6 t/ha 100% beejamrutha + 5% jeevamrutha *	22.64	3.25	16.91	5.35	15.51
T_8: Bamboo Biochar @ 0.6 t/ha 50% beejamrutha + 5% jeevamrutha *	23.3	3.37	17.33	5.52	15.74
T_9: Biochar enriched FYM @ 2 t/ha 100% beejamrutha + 5% jeevamrutha *	26.16	3.85	19.2	6.25	16.86
T_{10}: Biochar enriched FYM @ 2 t/ha 50% beejamrutha + 5% jeevamrutha *	27.39	4.01	20.15	6.54	17.03
SEm (±)	**1.07**	**9.16**	**0.88**	**0.30**	**0.43**
CD=P (0.05)	**3.18**	**0.46**	**2.62**	**0.88**	**1.27**
CV (%)	**8.38**	**8.46**	**9.16**	**9.82**	**4.90**

Correlation between microbial activity, nutrient uptake and crop yield

The correlation matrix shows a strong positive relationship between grain yield, straw yield, nutrient uptake (N, P, K), and microbial counts. Grain yield was highly correlated with total N, P, and K uptake (values close to 1), indicating that increased nutrient uptake directly contributes to higher yields (Kasbe *et al*., 2015 & Mousavi *et al*., 2022). Microbial population at different stages (10^4, 10^5 & 10^6) also showed a positive correlation with nutrient uptake and grain yield, suggesting that microbial activity enhances nutrient availability and uptake, ultimately enhancing crop performance (Devakumar *et al*., 2018). The consistent high correlation values across parameters enhancing soil health and crop productivity.

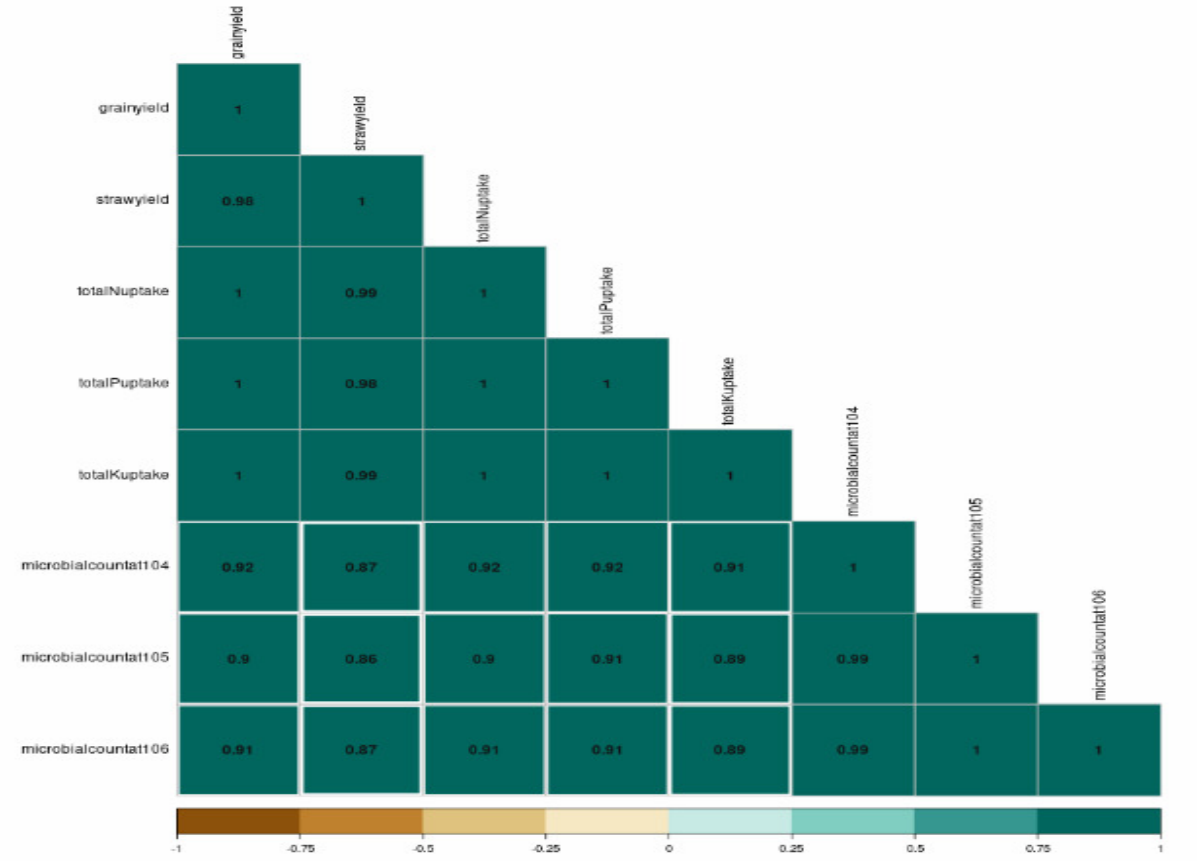

Fig. 2 : Correlation matrix

Conclusion

The application of organic inputs, particularly the integration of biochar-enriched FYM combined with beejamrutha and jeevamrutha sprays, significantly enhanced soil microbial populations, nutrient uptake, and crop yields. Among the treatments, T_{10} (Biochar enriched FYM @ 2 t/ha + 100% beejamrutha + 5% jeevamrutha spray at 15-day intervals) consistently recorded the highest microbial counts across all dilution levels, nitrogen, phosphorus, and potassium uptake, and the maximum grain and stover yield of toria. The gradual nutrient release from FYM decomposition and the enhanced microbial activity contributed to sustain nutrient supply throughout the crop growth period. Therefore, the combined use of biochar-enriched FYM with organic bio-stimulants like beejamrutha and jeevamrutha proves to be a promising practice for improving soil health, nutrient availability, and crop yield in natural farming systems.

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