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RESEARCH ARTICLE

EFFECTOF ORGANIC SOURCE OF NUTRIENT ON YIELD OF TURMERIC (*CURCUMA LONGA* L.) AND BIOLOGICAL PROPERTIES OF SOIL

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ABSTRACT

Turmeric is one of the most important ancient spices of India and a traditional item of export, which is used daily by all classes of people for preparation of tasty curried dishes and as an ingredient of medicinal preparations. So, in this respect a field experiments were carried out be Influence of different source of nutrient on soil fertility and yield and quality of turmeric (*Curcuma Longa* L.), on college agriculture farm by 10 treatments and three replications with RBD. Application of different treatments of plant height (cm), Pseudo stem girth (cm), (68.47 to 94.00 cm, 7.27 to 11.00 cm) T_1 (FYM @ 40 t ha^{-1}) as compared in T_{10} (Wheat straw @ 40 t ha^{-1}), T_3 (Compost @ 40 t ha^{-1}), while in T_8 (Flower waste @ 60 t ha^{-1}). The greater soil pH varied from 7.58 to 5.62 in T_1 and T_8 with the different organic manure treatments. A small variation to decreased in pH occurred with FYM at 40 t ha^{-1} in T_8. The EC measured across different organic manure treatments ranged from 0.815 dSm^{-1} in treatment T_1 to 0.961 dSm^{-1} in treatment T_7. Bulk density 1.24 and 1.32 Mg m^{-3}. T_2 (FYM @ 60 t ha^{-1}) had the highest bulk density (1.32 Mg m^{-3}), whereas FYM @ 40 t ha^{-1} had the lowest (1.24 Mg m^{-3}). The organic carbon highest (0.96%) under compost @ 100 t ha^{-1} (T_4) and lowest (0.68%) under vermicompost @ 40 t ha^{-1} (T_7). The PSB populations greatest number (19×10^4 cfu g^{-1}) in T_9 and T_3. (flower waste @ 60 t ha^{-1}), followed by T_2 (FYM @ 60 t ha^{-1}). Greater PSB activity is associated with larger amounts of organic matter and microbial substrates. The *actinomycetes* populations greater count, 17×10^4 cfu g^{-1}, was in T_8 (vermicompost @ 60 t ha^{-1}). This was followed by T_{10} (wheat straw) and T_7 (vermicompost @ 40 t ha^{-1}) because of better organic content and aeration. The lowest count 3×10^4 cfu g^{-1} was in T_5 (poultry manure). Total Bacterial population T_1 (FYM @ 40 t ha^{-1}) recorded the greater number 135.67×10^4 cfu g^{-1}, followed by T_9 (flower waste @ 60 t ha^{-1}). Excessive T_2 (FYM @60 t ha^{-1}) lowered bacteria, possibly because of anaerobic conditions. The total Fungi population highest number (77×10^4 cfu g^{-1}) occurred in T_1 (FYM @ 40 t ha^{-1}), followed by T_5 (poultry manure) and T_4 (compost). Slight growth of fungi occurred in T_2, T_3, and T_9. Thus, organic manures play significant improvement in turmeric growth, soil properties and microbial population.

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INTRODUCTION

Turmeric (Curcuma longa L.) is an herbaceous perennial plant belong to the family. Zingiberoside originated in South East Asia. However, it is now widely cultivated in tropical and subtropical regions of the world. Turmeric is one of the most important ancient spices of India and a traditional item of export, which is used daily by all classes of people for preparation of tasty curried dishes and as an ingredient of medicinal preparations. The word Curcuma is derived from the Arabic "kurkum" and from the Hebrew "karkom" which means "yellow". The term longa refers to the elongated shape of its rhizome. It was popular even in Vedic times because of its unique properties of colour, flavour and also its importance as medicine in Ayurveda, besides its use as a cosmetic and significance in religious ceremonies and auspicious occasions. So that turmeric is also called as "Indian Saffron" (Devi and Sangamithra, 2011). As per trade practices India is the largest producer, consumer and exporter of turmeric in the world. Indian turmeric is considered the best in the world market because of its high curcumin content (Devi and Sangamithra, 2011). In India the major trading center of turmeric are Nizamabad, Dugirala of Andhra Pradesh, Sangli of Maharashtra and Coimbatore of Tamil Nadu. Turmeric rhizome contains 1.8 to 9.0 percent curcumin, crystalline substance ($C_{21}H_2O_6$) which imparts yellow colour, 2.5 to 7.2 percent of essential oil turmerol, 5.0 percent fat, 3.5 percent minerals and 69.4 percent carbohydrates (Barrero and Carreno 1999).

It is widely used in food, beverages, confectionary and medicine and because of its multifarious uses the demand for trading is increasing day by day. India being the world largest producer of turmeric, gains importance for oleoresin and curcumin having medicinal value and ample export opportunity has been created in the world trade (Selvan *et al.* 1999). Considering the worlds demand for organic source of nutrient used food, soil health productivity and the availability of local resources, it becomes essential to encourage the farmer to take the advantage of the international demand (for organically produced spice, aromatic and medicinal products). Use of organic manure for crop production is gaining momentum as the organically produce products get high economic return and they are environmentally safe compared with inorganic fertilizers. Moreover, organic manures have beneficial effects on soil health and productivity. Application of organic manure enhances the availability of native macro and micro nutrient as a consequence of which quality of produce improves (Ghuge *et al.* 2007). Therefore, the knowledge about the organic sources of nutrient to increases the turmeric growth, soil properties and microbial population. and formulate the balance manure application.

MATERIALS AND METHODS

Ballia district lies between the parallel of 25° 33' and 26° 15' N Latitude and 83° 38' and 84° 39' E longitude of mean and 213.2 feet mean sea level. The mean annual rainfall ranges from 950 mm – 1150 mm. The winter are cold and minimum temperature reached as low 5-2° December to January; frost is expected from the last week of December to the first week of February occasionally light rain was expected during the winter season in this region. Before starting the experiment, a compose sit soil sample was taken from Agriculture farm Nidharia, District Ballia. The experimental site is situated in Ballia district of U.P. located between Latitude 25.763406° and Longitude 84.142682°. The initial soil sample was collected with help of spade from 0 – 15 cm depth to determine the physical, physico – chemical and chemical Department of Agriculture chemistry and soil science of Shri Murli Manohar Town P. G. College Ballia. The organic sources such as FYM, vermicompost, compost, flower waste, poultry manure and wheat straw collected from locally available in Ballia city nearly village. For the field experiment, 270 m^2 land was selected in the agriculture farm. After that land was prepared by tillage operation used plough and cultivators, there after bed was prepared as per layout plan with their size, after preparation of field, applied required amount of manure as per treatment in each bed. Each bed was added by FYM, vermicompost, compost, flower waste, poultry manure and wheat straw. After that, turmeric was sown at proper depth and distance. Turmeric variety seed Narendra haldi – 1 was sown at proper moisture stage on 23 may 2024. The moisture contains in each bed was maintained by irrigation as per needed. First irrigation was made at 15 day (07 june 2024) of after sowing and second28 day and last at 48 days after irrigation. During the experimentation 5–6-time rainfall was occurred and that situation no need irrigation in that time. Experiment was planned in ten treatment and three replications in soil texture sandy loam, crop-mustard and variety-commander (Hyveg). Turmeric was sown in proper space at 10cm depth on 23 may 2024. Initial soil properties of experimental field were as pH-7.9, EC (dSm^{-1})-1.073, Bd (Mgm^{-3})-1.43, organic carbon (%)-0.72, respectively. The ten-treatment combination as T_1- FYM @ 40 t ha^{-1}, T_2- FYM @ 60 t ha^{-1}, T_3- Compost @ 40 t ha^{-1} T_4-Compost @ 100 t ha^{-1}, T_5- Poultry manure @ 20 t ha^{-1}, T_6-Poultry manure @ 40t ha^{-1} and T_7- Vermi Compost @ 40 t ha^{-1}, T_8- Vermi Compost @ 60 t ha^{-1}, T_9- Flower waste @ 60 t ha^{-1} and T_{10}- Wheat straw @ 20 t ha^{-1}. Observation as growth attributes -Plant height (cm) - measured at 90 DAS from base level to the apex of the longest leaf with the help of meter scale and average height was calculated. Pseudo-stem girth was recorded at 90 DAS by counting method was recorded after harvesting.

Soil analysis: Soil samples from post harvested crop field of turmeric crop well processed and analyses soil pH by glass electrode Buckman pH meter in 1:2.5 ration of soil-water suspension method as described. Electrical Conductivity of the supernatant liquid of the 1:2.5 ratio of soil-water suspension was determined by conductivity meter method as described by Jackson, (1973). Bulk density was determined by weight of soil by volume of soil and expressed method described by Kanwar and Chopra (1999). Soil organic carbon was determined by rapid titration method Walkley's and Black's (1934) as described by Singh *et al.* (2005). Microbial population- PSB followed by Murphy and Riley (1962), actinomycetes followed by Thornton (1922), Total Bacterial followed by Rao and Sinha (1963), Total Fungi followed by Katznelson and Bose (1956). Data from different treatments was statistical analyses by method described by Gomez and Gomez (1989) using RBD, significance of the treatment mean was mode with the help of critical difference.

RESULTS AND DISCUSSION

Plant height (cm): The plant height (table-1) measured 90 DAS was significantly affected by different level of organic manure treatment. The maximum plant height 94.00 cm was recorded in FYM@40 t ha^{-1} in T_1 as compared to rest of treatments, while the lowest plant height 68.47 cm was recorded in T_{10} (Wheat straw@ 40 t ha^{-1}) the maximum plant height. It has attributed plant height increased might be due to supply of nitrogen from application of FYM.

Pseudo-stem girth: The Pseudo-stem girth (table-1) as influenced by different organic manure source of 90 DAS. The maximum girth of the pseudo-stem 11.00 cm was recorded at 90 days with the application of compost@ 40 t ha^{-1} in T_3 which was significantly superior over T_5, T_6, T_2 at per T_8, T_{10}, T_1 and T_7, T_3, the minimum pseudo-stem girth 7.27cm was recorded application of to flower waste@ 60 t ha^{-1} in T_8. similarly recorded in Hore *et al.* (2003).

Soil pH: The soil pH (table-2) ranges from 7.58-5.62 (T_1 and T_8). Slight significance soil pH decrease was noted by application of FYM@ 40 t ha^{-1} in T_8 as compared to other sources. However, all the treatment of organic sources has maintained soil pH in optimum range as par most of the crop might be due to release of acidic substance.

Electrical conductivity (dSm^{-1}): The electrical conductivity values (table-2) ranged from 0.961-0.815 dSm^{-1} (T_7-T_9) in all treatment. The highest EC value (0.961) was recorded in T_7. The lowest EC value (0.815) was recorded in T_1 EC found to

Table 1. Effect of organic sources of nutrient plant height (cm) and Pseudo stem girth (cm)of turmeric

Symbol	Treatment combination	Plant height(cm)	Pseudo stem girth(cm)
T_1	FYM @ 40 t ha^{-1}	94.00	9.53
T_2	FYM @ 60 t ha^{-1}	85.07	10.87
T_3	Compost @ 40 t ha^{-1}	81.07	11.00
T_4	Compost @ 100 t ha^{-1}	79.20	8.27
T_5	Poultry manure @ 20 t ha^{-1}	70.60	8.73
T_6	Poultry manure @ 40t ha^{-1}	75.67	8.33
T_7	Vermi Compost @ 40 t ha^{-1}	76.87	8.87
T_8	Vermi Compost @ 60 t ha^{-1}	86.60	10.40
T_9	Flower waste @ 60 t ha^{-1}	82.53	7.27
T10	Wheat straw @ 20 t ha^{-1}	68.47	7.60
	C.D.(P=0.05)	19.22	3.31

Table 2. Effect of organic sources of nutrient soil Bulk density (Mgm^{-3}), pH, EC (dSm^{-1}) and Organic carbon (%) content in turmeric grown soil

Symbol	Treatment combination	Bulk density (Mgm^{-3})	pH	EC (dSm^{-1})	Organic arbon (%)
T_1	FYM @ 40 t ha^{-1}	1.24	6.17	0.86	0.75
T_2	FYM @ 60 t ha^{-1}	1.32	6.57	0.88	0.81
T_3	Compost @ 40 t ha^{-1}	1.31	7.03	0.87	0.84
T_4	Compost @ 100 t ha^{-1}	1.31	7.23	0.93	0.96
T_5	Poultry manure @ 20 t ha^{-1}	1.27	7.17	0.93	0.87
T_6	Poultry manure @ 40t ha^{-1}	1.25	7.03	0.82	0.71
T_7	Vermi Compost @ 40 t ha^{-1}	1.32	7.13	0.95	0.68
T_8	Vermi Compost @ 60 t ha^{-1}	1.32	7.33	0.96	0.96
T_9	Flower waste @ 60 t ha^{-1}	1.31	7.23	0.81	0.87
T10	Wheat straw 20t ha^{-1}	1.30	7.10	0.91	0.90
	C.D.(P=0.05)	0.044	0.161	0.004	0.151

Table 3. Effect of organic sources of nutrient on population of soil PSB (CFU g^{-1}) Actinomycetes (CFU g^{-1}) bacteria (CFU g^{-1}) and fungi (CFU g^{-1}) in turmeric grown soil

Symbol	Treatment combination	Phosphorus solubilizing bacteria (CFU g^{-1} x10^4)	Actinomycetes (CFU g^{-1} x10^4)	Bacteria (CFUg^{-1}x10^4)	Fungi (CFUg^{-1} x10^4)
T_1	FYM @ 40 t ha^{-1}	16	18	135.67	77
T_2	FYM @ 60 t ha^{-1}	21.67	20.67	33	67.67
T_3	Compost @ 40 t ha^{-1}	19.67	13.67	45	62
T_4	Compost @ 100 t ha^{-1}	11.67	17	35.33	69
T_5	Poultry manure @ 20 t ha^{-1}	14.33	14	40.67	74.33
T_6	Poultry manure @ 40t ha^{-1}	8.67	26.67	41.33	61.67
T_7	Vermi Compost @ 40 t ha^{-1}	10.33	28	34.67	44
T_8	Vermi Compost @ 60 t ha^{-1}	14.67	28.67	31.67	35
T_9	Flower waste @ 60 t ha^{-1}	25	14.67	105	54.33
T10	Wheat straw 20t ha^{-1}	14	18.35	53	47.67
	C.D.(P=0.05)	2.211	15.673	32.525	9.200

be in optimum range than in all treatment. This range confirms safe, non-saline conditions suitable for robust microbial activity and nutrient uptake, preventing root stress while supporting both vegetative and reproductive crop development stages.

Bulk density (Mgm^{-3}): The bulk density (table-2) was ranged from 1.24 to 1.32 (Mgm^{-3}) with the highest value of bulk density (1.32 Mgm^{-3}) was recorded in FYM@ 60 t ha^{-1} in T_2, while the lowest bulk density (1.24 Mgm^{-3}) was recorded in FYM@ 40 t ha^{-1} in T_1 as compared to other sources. The maximum bulk density was at attributed the height be due to supply of nitrogen from application of FYM.

Organic carbon (%): The highest value of organic carbon (0.96%) was recorded with application of compost @ 100 t ha^{-1} in T_4. Where lower soil organic carbon (0.68%) was recorded with application vermicompost @ 40 t ha^{-1} in T_7. The greater value of organic carbon dose of organic manure vermicompost, poultry manure, compost and flower waste due to buld up of organic fraction of soil with narrow C:N ratio and oxidised under the environment. The similar finding has been given by Bhamdar *et al.* (1992) and Rai and yadav (2011) also.

Microbial population

PSB: The Phosphorus solubilizing bacteria (PSB) was quite distinct across treatments (table-3). The highest number 19 × 10^4 cfu g^{-1} was recorded in T_9 where applied flower waste @ 60 t ha^{-1}, followed by T_2 (FYM @ 60 t ha^{-1}) with 11 × 10^4 cfu g^{-1}. The higher PSB activity in that treatments might be due to greater organic matter content and microbial substrates, which are conducive to microbial growth. Consistent results were also presented by Vyas and Gulati (2009), where they showed that organic amendments highly stimulate PSB activity by increasing the microbial habitat. Treatments T_5, T_6, T_7, and T_{10} had less counts 6 × 10^4 cfu g^{-1}, likely because the decomposition rate was slow or the nutrients were scarce. In general, the addition of easily decomposable organic materials such as flower residues and increased applications of FYM was successful in promoting indigenous PSB populations, which are important phosphorus mobilizers and soil fertility enhancers.

Actinomycetes

The Actinomycetes population in soil (table-3) exhibited significant difference between treatments. The maximum population 17×10^4 cfu g^{-1} was observed in T_8 (vermicompost @ 60 t ha^{-1} followed by T_{10} (wheat straw @ 40 t ha^{-1}) and T_7 (vermicompost @ 40 t ha^{-1}), which signifies that vermicompost and wheat straw favoured the growth of actinomycetes because they contain rich organic matter and an aerated texture. Gopalakrishnan *et al.* (2011) also reported similar observations, with a suggestion for the use of organic amendments to increase actinomycetes with greater substrate availability. T_5 (poultry manure @ 20 t ha^{-1}) had the lowest population 3×10^4 cfu g^{-1}, attributable to quick decomposition and less stable organic matter. In general, vermicompost and wheat straw improved actinomycetes proliferation towards improved soil and nutrient cycling health.

Total Bacterial: The population of total bacteria is presented in table-3. That application of organic manure exhibited substantial variation in bacterial populations in the soil with varying organic nutrient treatments in turmeric (Curcuma longa) grown soil. Among all the treatments, T_1 (FYM @ 40 t ha^{-1}) had the highest number of bacteria (135.67×10^4 cfu g^{-1}), which was followed by T_9 (Flower Waste @ 60 t ha^{-1}) with 105.00×10^{-4} cfu g^{-1}. So that application of well-decomposed farmyard manure in moderate amounts and flower waste increases microbial action through increasing the availability of organic carbon and promoting conditions for bacterial growth (Subba Rao, 2001; Yadav and Tripathi, 2008). In fact, interestingly, T_2 (FYM @ 60 t ha^{-1}) had a significantly lower number (33.00×10^4 cfu g^{-1}), indicated that excessive organic matter might be inhibitory to microbial growth due to anaerobic conditions or nutrient imbalances (Ramesh *et al.*, 2005). Compost and vermicompost treatments (T_3–T_8) gave moderate bacterial numbers (31.67 - 45.00×10^4 cfu g^{-1}), confirming previous research that stabilized organic matter releases nutrients slowly, favouring microbes in the long run (Gaur, 1990). Overall, the findings confirm that type and quantity of organic input have a pivotal effect on soil microbial dynamics, with FYM and Flower waste proving most useful in increasing microbial biomass, essential for the sustainable production of turmeric.

Total Fungi: The population of total fungi is presented in table-3. That application of organic manure on population of total fungi in soil. The experiment aimed to assess how different organic nutrient sources affect the fungal population in turmeric-growing soils. The data showed that T_1 (FYM @ 40 t ha^{-1}) had the highest fungal population at 77×10^4 cfu g^{-1} soil. It was followed by T_5 (Poultry Manure @ 20 t ha^{-1}) with 74.33×10^4 cfu g^{-1}, and T_4 (Compost @ 100 t ha^{-1}) with 69×10^4 cfu g^{-1}. Using farmyard manure and poultry manure in moderate amounts seems to improve fungal growth because they provide better substrate availability and a favourable microbial environment (Subba Rao, 2001; Gaur, 1990). Moderate fungal counts were found in T_2 (FYM @ 60 t ha^{-1}) and T_3 (Compost @ 40 t ha^{-1}). Similar results suggest that both amount and quality of organic matter influence fungal activity. T_7, T_8, and T_{10} had lower fungal populations, ranged from 35 to 47.67×10^4 cfu g^{-1}. This is likely due to the more stable or fibrous nature of inputs like vermicompost and wheat straw, which break down slowly (Ramesh *et al.* 2005). followed by, T_9 (Flower Waste at 60 t ha^{-1}) had a moderate fungal count of 54.33×10^4 cfu g^{-1} soil. That indicates its potential as an effective but inconsistent organic input, depending on their decomposition stage and microbial colonization. Similar findings support the idea that moderately decomposed, nutrient-rich organic manures can boost soil fungal biomass. That was important for breaking down organic matter and cycling nutrients in turmeric cultivation.

CONCLUSION

It has become clear from the above findings and results organic manures play significant improvement in turmeric growth, soil properties and microbial population. Among all treatments of organic sources, FYM@ 40 t ha^{-1} proved most effective, enhancing plant height, microbial population, and overall soil, quality. Compost and flower waste also showed also beneficial effects on pseudo-stem girth, organic carbon, and microbial dynamics. Overall, the use of well-decomposed organic manures, particularly FYM, compost, and flower waste, offer a sustainable approach to improving crop productivity and maintaining long-term soil fertility in turmeric cultivation. Therefore, further research is required on other microorganism population and their activity in turmeric grown soil.

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