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Chemical properties and microbial population of soil as influenced by different organic nutrient sources in turmeric

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Abstract
The experiment was conducted at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2015-16 and 2016-17 in Randomized Block Design replicated thrice with twelve treatments consisting of different organic manures, recommended dose of fertilizers and different biofertilizers. The highest organic carbon content was recorded with application of Neem cake @ 4 t ha^{-1} + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}). However, different organic nutrient management treatments imparted changes in pH and EC of soil but differences were non-significant. All treatments of organic nutrient management practice i.e. organic manures alone and in combination with biofertilizers increased the microbial population of soil. The maximum fungi, bacteria and actinomycetes population was observed with application of Fermented cow dung slurry @ 12500 l ha^{-1} in three equal split doses at 30, 60 and 90 DAP + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}).

Keywords: Organic carbon, microbial population, nutrient management, turmeric

Introduction
Turmeric (*Curcuma longa* L.), is important spice crop of tropical and sub-tropical regions belonging to family Zingiberaceae. It is one of the most precious spices globally and is cultivated in the India since ancient times. India is the largest producer of turmeric having lion share of about 75 per cent in world production and 60 per cent in world export (Anonymous, 2018) [1]. Turmeric being a long duration (8-9 months) and exhaustive crop, responds well to nutrition. Hence, optimum dose of nutrients is essential to get good yield. During Agriculture Census carried out in year 2011-12, the consumption of fertilizers, chemicals and organic manures for turmeric was reported which revealed that, in India most of the area i.e. about 62920 hectare under cultivation was treated with chemical fertilizers and about 53800 hectare was treated with pesticides (Anonymous, 2017) [2]. Though the chemical fertilizers are being used on large scale but it's injudicious use in agriculture for increasing yield and production can contaminate the water, air and food. It also decrease soil fertility, inhibits growth of soil microorganisms and hazard human health (Parr *et al*., 1991) [10]. This negative effect of agricultural practices could be reversed by the correct utilization of manures and/ or crop residues within cropping system either alone or in combination with organic fertilizer (Mandal *et al.*, 2007) [7]. The role of organic manures and biofertilizers in improving soil structure and fertility is well understood. Organic manures have positive influence on soil texture and structure, microbial population, better water holding capacity and drainage which in turn help for better growth and development of rhizomatous crop like turmeric.
Soil organic carbon is the basis of soil fertility and indicator of soil health. It releases nutrients for plant growth, promotes the structure, biological and physical health of soil also serve as buffer against harmful substances. Soil pH is a master variable as it regulates many chemical and biochemical processes within the soil. It is a measure of the acidity or alkalinity of a soil. Electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics. Also analysis of microbial communities in soils offers an important opportunity for exploring the relationships between soil biotic and abiotic factors. Different soil and crop management systems can result in different substrate availabilities that will ultimately determined by promoting or inhibiting them the establishment of different microbial groups. Due to due to number and activity of microorganisms present in soil, several changes takes place which are generally helpful to the plants while a few of them are harmful. The application of organics favorably help in augmentation of beneficial microbial population and their activities such as organic matter

decomposition, biological nitrogen fixation, phosphorus solublization and availability of plant nutrients through mineralization. In view of this background, the study is aimed to evaluate the effect of organic nutrient management chemical properties and microbial population of soil in turmeric.

Material and Methods

The experiment was carried out during year 2015-16 and 2016-17 at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola located in subtropical region between 22.42º N latitude and 77.02º E longitude at an altitude of 307.42 m above the mean sea level. The experimental plot was having very loose soil with uniform texture and structure with good drainage. The soil of experimental plots was slightly alkaline in reaction (pH 8.23), EC (0.62 dSm^{-1}), low in organic carbon (3.50 g kg^{-1}), available N (168.72 kg ha^{-1}), available P (16.72 kg ha^{-1}) high in available K (318.24 kg ha^{-1}). The experiment was laid out in Randomized Block design with twelve treatments *viz.*, T_1 - Recommended Dose of Fertilizers (200:100:100 NPK kg ha^{-1}), T_2 – Farm Yard Manure @ 20 t ha^{-1}, T_3 – Vermicompost @ 13.2 t ha^{-1}, T_4 – Neem cake @ 4 t ha^{-1}, T_5 – Farm Yard Manure @ 20 t ha^{-1} + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}), T_6 – Vermicompost @ 13.2 t ha^{-1} + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}), T_7 – Neem cake @ 4 t ha^{-1} + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}), T_8 – *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}), T_9 - Recommended Dose of Fertilizers (200:100:100 NPK kg ha^{-1}) + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}), T_{10} - Fermented cow dung slurry @ 12500 l ha^{-1} in three equal split doses at 30, 60 and 90 DAP , T_{11} - Fermented cow dung slurry @ 12500 l ha^{-1} in three equal split doses at 30, 60 and 90 DAP + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}) and T_{12} - Absolute control which were replicated thrice. The planting was done in *Kharif* season of 2015-16 and 2016-17 on broad bed furrow at spacing of 30 X 22.5 cm. Recommended package of practices was followed. The high curcumin containing cultivar "PDKV Waigon" developed by Dr. PDKV, Akola, Maharashtra was used. The organic carbon content of soil samples was analyzed by Walkley and Black rapid titration method (Black, 1965) [3]. The pH of soil samples was determined by using glass electrode pH meter (Jackson, 1973) [5]. The electrical conductivity of soil samples was determined by using conductivity meter (Richards, 1954) [12] and was expressed in dsm^{-1}. The soil microbial count was analyzed by standard serial dilution plate count technique using soil extract agar (Bunt and Rovira, 1955) [4] for bacteria count, Martin's Rose Bengal agar for fungi (Martin, 1950) [8] and Kusters ager for actinomycetes (Kuster and Williams, 1964) [6]. The statistical analysis of data for Randomized Block on observations recorded was done as suggested by Panse and Sukhatme (1967) [9].

Results and Discussion

Organic carbon, pH and Electrical conductivity

It was observed that, during year 2015-16 and 2016-17 highest organic carbon content (3.73 and 3.78 g kg^{-1}) was recorded in treatment T_7 i.e. application of Neem cake @ 4 t ha^{-1} + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}) being statistically at par with T_6 during 2015-16 and with T_6, T_4, T_5, T_3, T_2, T_{11} and T_{10} during 2016-17 (Table 1). The application of organic manures with biofertilizers recorded increase in organic carbon content over initial value (3.50 g kg^{-1}) during both the years of experimentation. The very minute change was observed with application of chemical fertilizers. Also the absolute control plots have not shown any increase in organic carbon content. The slight variation in these properties are evident that continuous use of organic manures along with the biofertilizers may impart conducive change and thereby productivity of soil along with elevated organic carbon content of soil from initial value. The built up of organic carbon content of the plots treated with organic manures and biofertilizers inoculants was due to additive effect of carbonaceous compounds of organic manures and also the microbial biomass. However, there was non-significant effect on the pH and EC during both the years of experimentation as it remained rigid with very tiny change over the initial values (8.23 and 0.62 dsm^{-1}). This might be due to the buffering action of organic matter in the soil. Also the EC was not affected which might be due to leaching of salts to the lower layers with frequent irrigations to the crop, apart from organo metal complexes. The results are in agreement with Sadanadan and Iyer (1986) [14] and Roy and Hore (2012) [13].

Table 1: Effect of organic nutrient management through different sources on organic carbon, pH and EC content of soil at harvest

Treatment	OC (g kg^{-1})		pH		EC (dsm^{-1})	
	2015 - 16	2016 - 17	2015 - 16	2016 - 17	2015 - 16	2016 - 17
T_1	3.53	3.54	8.26	8.28	0.64	0.67
T_2	3.53	3.77	8.23	8.25	0.65	0.69
T_3	3.53	3.78	8.23	8.26	0.66	0.70
T_4	3.62	3.82	8.25	8.27	0.66	0.70
T_5	3.57	3.80	8.26	8.28	0.65	0.68
T_6	3.70	3.84	8.27	8.29	0.65	0.68
T_7	3.73	3.85	8.26	8.29	0.65	0.69
T_8	3.53	3.64	8.25	8.28	0.65	0.68
T_9	3.55	3.55	8.26	8.28	0.68	0.71
T_{10}	3.53	3.73	8.26	8.29	0.65	0.69
T_{11}	3.53	3.74	8.26	8.28	0.66	0.69
T_{12}	3.50	3.50	8.25	8.27	0.63	0.67
'F' test	Sig.	Sig.	NS	NS	NS	NS
SE (m) $\pm$	0.03	0.05	0.02	0.02	0.02	0.02
CD at 5 %	0.09	0.15	-	-	-	-

Microbial population (Fungi, Bacteria and Actinomycetes)

In case of microbial population of the soil, maximum fungi (28.92×10^{-4} and 29.07×10^{-6}), bacteria (44.25×10^{-6} and 44.41×10^{-6}) and actinomycetes (26.21×10^{-4} and 26.33×10^{-6}) was observed in treatment T_{11} i.e. Fermented cow dung slurry + *Azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}) for year 2015-16 and 2016-17, respectively (Fig 1 to 3 and Plate 1). The minimum microbial population was observed in absolute control. It was observed that, all the organic nutrient treatments increased the microbial population of soil comparing to absolute control as the best treatment T_{11} was at par with all treatments under experimentation except T_1 i.e. Recommended Dose of Fertilizers (200:100:100 NPK kg ha^{-1}) for population of fungi while with T_9 and T_1 for bacterial population. Also the treatments applied with organic manures and biofertilizers were at par with T_{11} excluding T_9, T_8 and T_1 for actinomycytes population during both the years. However, treatment T_{12} i.e. absolute control recoded minimum population of fungi, bacteria and actinomycetes during both the years of experimentation.

Microbial population in soil rhizosphere was improved after application of different treatments. Particularly higher numbers of microbial population was observed in plots treated with fermented cow dung slurry alone and in combination of biofertilizers which may be attributed to the presence of flush of easily metabolizable compounds at the beginning and the crop was also under active growth phase releasing higher amount of root exudates, supporting numerous and diverse microflora. Their larger number is indicative movement towards better soil health and improved nutrient availability to the plant. Thus, utilization of organic manures with different biofertilizers could be better preposition for improving biological attributes of soil, which in turn may increase quality productivity potential of the crop. The attributed reason could be the enhanced organic carbon content of the soil as a result of organic manure application. The carbon acts as a source of energy for microbes and ferments organics that results in quick build up of microflora and fauna. This results into activation of soil microflora *viz.* bacteria, actinomycetes and fungi that are present in soil. Besides this, the organic manure addition it would have resulted in increased secondary and micronutrients in the soil which might have helped to increase the microbial population. The results are analogous with findings of Reddy *et al.* (2000), Roy and Hore (2012) and Srinivasan *et al.* (2016) [11, 13, 15] in turmeric.

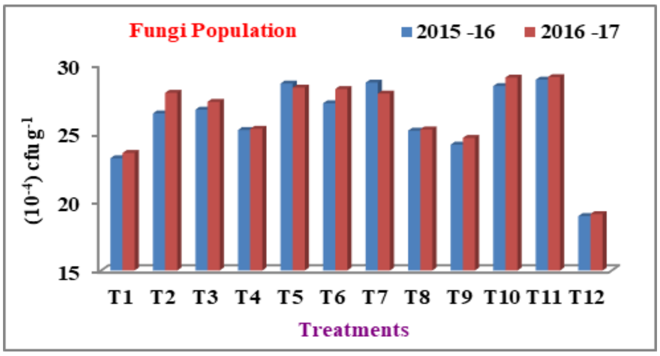

Fig 1: Effect of organic nutrient management through different sources on fungi population in soil at harvest

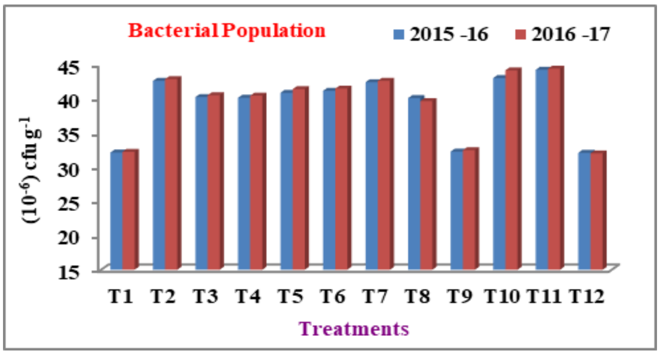

Fig 2: Effect of organic nutrient management through different sources on bacterial population in soil at harvest

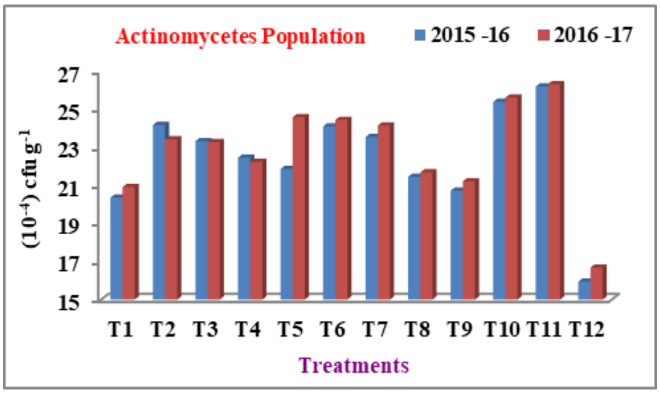

Fig 3: Effect of organic nutrient management through different sources on actinomycetes population in soil at harvest

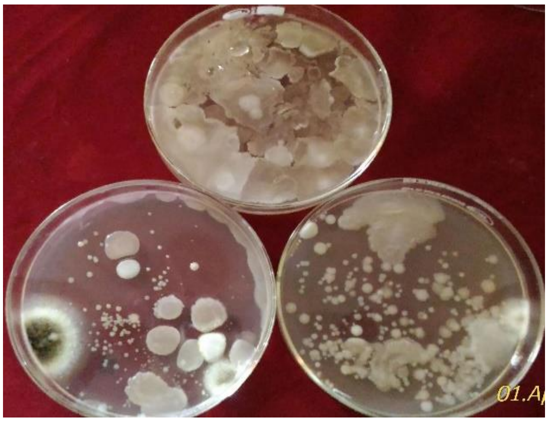

Plate 1: Mircobial Growth as influenced by different organic nutrient management treatments in turmeric

Conclusion

On the basis of findings from present investigation, the effect of organic nutrient management in turmeric on soil health determining properties *viz.* organic carbon status, microbial population was found to be promising. The continuous use of organic manures in combination with different biofertilizers will improve the soil health and elevate the soil fertility and productivity in turmeric.

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