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Changes in biological properties during decomposition of various crop residues

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Abstract
The present investigation was conducted during 2017-18 to study the changes in biological properties during decomposition of crop residues at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The various crop residues viz; wheat straw, shredded cotton stalks, sorghum stubbles and glyricidia leaves along with rock phosphate, urea, elemental sulphur, cow dung slurry and PDKV decomposing culture were decomposed upto 120 days by pit method. The experiment was laid in completely randomized design with four replication. The microbial count significantly increased initially during first sixty days and thereafter decreased as decomposition progressed. The pH, organic carbon and C: N ratio decreased with increased in decomposition**.** The CO_2 evolution increased initially during first sixty days and thereafter decreased as decomposition progressed**.** The temperature increased initially during first seventy days and thereafter decreased as decomposition progressed. However, the CO_2 evolution and microbial count i.e. fungal, bacterial and actinomycte was higher in mixure of 25% wheat straw +25% shredded cotton stalks +25% glyricidia leaves +25% sorghum stubbles. The changes in E4/E6 ratio also recorded below 5 in all the treatments except treatment 100% wheat straw at 120 days stage of composting. At 120 days of decomposition E4/E6 ratio was lower due to low degree of aromatic carbon and low-molecular weight.

Keywords: crop residues, CO_2 evolution, c: n ratio, e4/e6 ratio, glyricidia leaves

Introduction
Agriculture built a bridge between humans and nature. During thousands of years of agricultural history, agricultural practices changed as civilization developed. After the industrial revolution, farmers began to use chemical fertilizers and pesticides to increase the productivity of land in response to exponential growth of world population. The dependence on non-renewable fossil fuels increased stress on the agroecosystem. Land degradation, global warming and food security problems indicate that the conventional farming system cannot be sustainable for the long-term organic agriculture developed as an effective way to decrease environmental damage from farming activities and ensure long term food security. Proper composting stabilizes organics destroys pathogens and provide significant drying of the substrates. These unique conditions are achieved when optimum moisture and proper aeration are maintained. Soil microbial population, a living phase of soil is predominantly influenced by the magnitude of soil organic matter in soil and hence quantification of their abundance and the species prevailing determines the overall biological processes and soil health at large. Soil microbial activity during the process of decomposition of residues is dependent on the availability of easily degradable carbon rather than mineral nitrogen (Das, 2004) [1]. Being a microbial mediated process decomposition of crop residues is accompanied by the changes in enzymes responsible for most of this transformation. The diversity and population of soil microorganism and the enzymes produced will depend on the chemical composition of crop residues. (Sajjad *et al*. 2002) [3]. Composting process of rice, wheat straw enriched with rock phosphate decrease the concentration of total carbon, NH_4-N, C: N ratio, biomolecules and increase the total nitrogen, soluble phosphorus, and organic acid (formic, citric, lactic and acetic acids). Detection of these organic acids may indicate their role in P solubility. The phospho-composted produced with FYM enrichment can be considered a rich P fertilizer for increasing P solubility and crop production. Phosphorus is an element that is widely distributed in nature and occurs together with nitrogen and potassium, as a primary constituent of life. Phosphorus plays a series of functions in the plant metabolism and is of the essential nutrients required for plant growth and development. It has functions of a structural nature in macromolecules, such as nucleic acids and energy transfer in metabolic pathways of biosynthesis and degradation. Under continuous cultivation, P inputs, in particular water soluble fertilizers, must be added to either maintain the soil P status of fertile soils or increase that of soil with inherent lower P fertility. Therefore soil, crop, water, P-fertilizer management

practices, climate conditions, etc. are important factors to be considered when attempting to formulate sound P-fertilizer recommendations and obtain adequate crop yield responses. In order to optimize the benefits of plant residue on soil quality improvement, it is critical to synchronize the release of nutrients from residue decomposition with patterns of plant nutrient uptake, which may minimizethe loss of available nutrients via leaching, runoff and erosion.

Material and method

Experiment was conducted at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2017-18. The compost was prepared by decomposing various crop residues (wheat straw, shredded cotton stalks, glyricidia leaves, sorghum stubbles), cow dung slurry with rock phosphate, urea, elemental sulphur and PDKV, decomposer. The enriched compost were prepared by mixing various crop residues and rock phosphate. The treatment combinations are given below. T_1-100% Wheat Straw, T_2-100% Shredded Cotton Stalk T_3-50% Wheat Straw +50% Shredded Cotton Stalks,T_4-40% Wheat Straw +40% Shredded Cotton Stalks +20% Glyricidia Leaves,T_5-30% Wheat Straw +30% Shredded Cotton Stalks +20% Glyricidia Leaves +20% Sorghum Stubbles and T_6-25% Wheat Straw +25% Shredded Cotton Stalks +25% Glyricidia Leaves +25% Sorghum Stubbles.

The compost were prepared by pit method. Turnings were given at 15 days interval up to 90 days of decomposing. After 90 days of decomposing, heaps of compost were collected at one place and allowed to cure for another 30 days. Temperature were recorded at 7 days of interval. Compost were watered regularly at 5-7 days of interval, so as to maintain moisture content up to 60-70%.

The microbial count comprising bacteria, fungi and acinomycetes at 15,30,60,90 and 120 days of decomposition was enumerated by serial dilution technique as described by Dhingra and Sinclair (1993) [4]. E4/E6 ratio was determined at 90 and 120 days after decomposition of compost as described by Schnitzer (1982). The data generated were subjected to statistical analysis as per Gomez and Gomez (1984).

Result and discussion

Bacteria

The data pertaining to microbial count during decomposition of crop residues are presented in Table 1. The bacterial count was increased upto 60 days, however, in the subsequent stage of composting, the microbial count was narrow down. The high temperature rise in composting system might have destroyed the microbial population. In the initial stages of composting the microbial population was comparatively lower than succeeding stages of composting. The higher bacteria count was observed in the range of 24 to 30 (cfu x 10^6 g^{-1}). The significantly highest microbial population during 15 days (30 cfu x 10^6 g^{-1}) was noted in (T_2) i.e.100% SCS. These treatments was found significant over the all other treatments. The higher bacterial count was found in treatments 100% WS (T_1) and 40% WS + 40% SCS + 20% glyricidia leaves. By and large almost similar trend was observed in bacterial count at remaining days of decomposition. The results are in agreement with Thakur and Sharma, (1998) [5].

Table 1: Changes in bacteria as influenced by various crop residues during periodic decomposition

Treatments		Bacteria (cfu x 10^6 g^{-1})				
		Days after decomposition				
		15	30	60	90	120
T_1	100% WS	24	30	48	34	31
T_2	100% SCS	30	33	38	32	30
T_3	50% WS +50% SCS	27	31	44	37	34
T_4	40% WS +40% SCS +20% Glyricidia Leaves	24	28	45	34	30
T_5	30% WS +30% SCS +20% Glyricidia Leaves +20% Sorghum Stubbles	25	30	49	33	31
T_6	25% WS +25% SCS +25% Glyricidia Leaves +25% Sorghum Stubbles	26	34	53	38	35
SE(m)±		0.84	0.67	0.84	0.74	0.62
CD at 5%		2.54	2.01	2.55	2.23	1.86

Table 2: Changes in fungi as influenced by various crop residues during periodic decomposition

Treatments		Fungi (cfu x 10^4 g^{-1})				
		Days after decomposition				
		15	30	60	90	120
T_1	100% WS	16	20	33	28	26
T_2	100% SCS	15	18	36	30	25
T_3	50% WS +50% SCS	17	19	35	28	24
T_4	40% WS +40% SCS +20% Glyricidia Leaves	14	20	32	29	28
T_5	30% WS +30% SCS +20% Glyricidia Leaves +20% Sorghum Stubbles	16	21	34	27	25
T_6	25% WS +25% SCS +25% Glyricidia Leaves +25% Sorghum Stubbles	17	24	39	31	25
SE(m)±		0.52	0.86	0.93	0.60	0.57
CD at 5%		1.57	2.59	2.80	1.80	1.72

Fungi

The fungi population were ranged between 14 to 17 (cfu x 10^4 g^{-1}). The significantly higher population was recorded during 15 days (17 cfu x 10^4 g^{-1}) in treatment of 50% WS +50% SCS and 25% WS +25% SCS +25% glyricidia leaves +25% sorghum stubbles. These treatment found significant over all other treatments. The lowest fungi population are found in treatment 100% WS (T_1). The fungi population of compost varied from 18 to 24 (cfu x 10^4 g^{-1}). The significantly higher fungal population during 30 days (24 cfu x 10^4 g^{-1}) was recorded in treatment of 25% WS +25% SCS +25% glyricidia leaves +25% sorghum stubbles. The lowest fungal count are found in treatment 100% SCS (T_2). The fungi population was decreased during 90 days as compared to 15, 30 and 60 days of decomposition. The lowest fungi count was found in treatment 30% WS +30% SCS +20% glyricidia leaves +20% sorghum stubbles at 90 days.

Actinomycetes

The data in relation to actinomycetes count are presented in Table 3 and were ranged between 10 to 16 (cfu x 10^4 g^{-1}). The significantly highest actinomycetes population was observed during 15 days (16 cfu x 10^4 g^{-1}) in treatment 25% WS +25% SCS +25% glyricidia leaves +25% sorghum stubbles. The lowest actinomycetes count were recorded in 100% WS. The significantly highest actinomycetes population during 30 days (18 cfu x 10^4 g^{-1}) was recorded in treatment 25% WS +25% SCS +25% glyricidia leaves +25% sorghum stubble. The lowest actinomycetes counts were found in treatment 100% WS. The highest count of actinomycetes during 60 days (34 cfu x 10^4 g^{-1}) was noted in treatment of 25% WS +25% SCS +25% glyricidia leaves +25% sorghum stubbles (T_6). The lowest actinomycetes population was recorded during decomposition in treatment of 100% SCS. At 120 days of decomposition the actinomycetes population was noted similar trend.

Table 3: Changes in actinomycetes as influenced by various crop residues during periodic decomposition

Treatments		Actinomycetes (cfu x 10^4 g^{-1})				
		Days after decomposition				
		15	30	60	90	120
T_1	100% WS	10	13	29	25	21
T_2	100% SCS	12	16	28	24	20
T_3	50% WS +50% SCS	11	14	30	26	19
T_4	40% WS +40% SCS +20% Glyricidia Leaves	13	17	32	28	23
T_5	30% WS +30% SCS +20% Glyricidia Leaves +20% Sorghum Stubbles	14	16	30	29	22
T_6	25% WS +25% SCS +25% Glyricidia Leaves +25% Sorghum Stubbles	16	18	34	30	24
SE(m)±		0.69	0.51	0.82	0.78	0.40
CD at 5%		2.08	1.52	2.47	2.34	1.22

Table 4: Changes in E4/E6 ratio as influenced by various crop residues during 90 and 120 days after decomposition

Treatments		E4/E6 ratio	
		Days after decomposition	
		90	120
T_1	100% WS	8.22	5.48
T_2	100% SCS	7.20	4.39
T_3	50% WS +50% SCS	7.61	4.68
T_4	40% WS +40% SCS +20% Glyricidia Leaves	6.80	4.11
T_5	30% WS +30% SCS +20% Glyricidia Leaves +20%Sorghum Stubbles	7.32	4.37
T_6	25% WS +25% SCS +25% Glyricidia Leaves +25% Sorghum Stubbles	7.14	4.04
SE(m)±		0.262	0.298
CD at 5%		0.775	0.884

E4/E6 ratio

Formation of humic substance is important parameter of the mature compost; therefore, to study the changes in humification parameter, E4/E6 ratio is widely adopted. It provides the quality of humic acid and aromatization level of compost. If the E4/E6 ratio is below five then the sample is characterized as humic acid, whereas if the ratio is above five then the sample is characterized as fulvic acid (Zorpas *et al.* 2008) [6].

Conclusion

From the study it can be concluded that, the compost prepared from 25% wheat straw +25% shredded cotton stalks +25% glyricidia leaves +25% sorghum stubbles was found beneficial to increase the highest microbial count during stages of composting. The E4/E6 ratio was found significantly below 5 in all treatments except treatment 100% wheat straw at 120 days of composting. Below 5 because low degree of aromatic carbon and low-molecular weight. Since, this E4/E6 ratio should decrease with time; the same can be achieved if time allowed for compost maturity is increased.

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