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Chemical properties of compost as influenced by different crop residues, weed biomass, leaf litter, soil mixture and decomposing cultures

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Abstract
Composting plays a crucial role in sustainable agriculture and environmental management. It involves the natural process of decomposing organic waste, such as crop residues, into nutrient-rich humus that can be used to enrich the soil. In view of better utilizing the resources available with farmer and to prepare the utilizable compost an experiment was conducted at Centre for Organic Agriculture Research and Training (COART) farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2024. The experiment was laid out in factorial randomized block design with 12 treatment (4 main and 3 subfactors) with 3 replications. The compost was prepared with heap method.

Among crop residue mixtures, soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) recorded highest ash (%), lowest total carbon content and lowest C:N ratio at maturity among other treatment. PDKV decomposing culture recorded highest ash (%), lowest total carbon content and lowest C:N ratio at maturity among decomposing cultures. Soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) compost recorded highest enrichment of nitrogen and phosphorus whereas, compost prepared from cotton stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_2) recorded highest potassium content at maturity as compared with other treatment. Among decomposing culture, PDKV decomposing culture treated compost recorded highest nitrogen, phosphorus, potassium and micronutrient content at maturity. However, pigeonpea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_4) compost recorded highest iron, copper, manganese content at maturity among crop residue mixtures.

Keywords: Compost, decomposing culture, crop residue, chemical properties, micronutrient analysis

Introduction
India produces vast amounts of agricultural residues annually. The management of agricultural crop residues has emerged as a critical issue in sustainable farming practices. India creates an average of 500 million tonnes (mt) of crop residue per year. Cereals account for the majority of India's leftovers, accounting for 368 mt. When it comes to individual crops, rice generates the most gross residues (154 mt), followed by wheat (131 mt). These residues, if not managed properly poses serious environmental challenges (Meena *et al*, 2022) [7].

Composting is a natural process of recycling organic matter such as leaves, food scraps, weeds and crop residues into a valuable fertilizer that can enrich soil and plants. This process involves the biological decomposition of organic materials by microorganisms. The resulting product known as compost is a nutrient-rich, stable, and humus-like substance that improves soil health and fertility. Composting provides numerous benefits to soil health and agricultural productivity, making it an essential practice for sustainable farming. One of the primary advantages of compost is nutrient enrichment. It supplies essential macronutrients and micronutrients, which are vital for plant growth. Unlike synthetic fertilizers, compost releases these nutrients slowly, ensuring a steady supply to plants. Compost also significantly improves soil porosity, which allows for better air and water movement, promoting healthier root systems and boosting microbial activity.

Compost exhibits a range of chemical properties that make it an excellent soil amendment. It is rich in essential nutrients like nitrogen, phosphorus, and potassium.

The compost also contains humic substances, which improve soil structure and water retention. The pH of compost typically ranges from slightly acidic to neutral, which helps to buffer soil pH and promote plant growth. Additionally, compost contains trace micronutrients like iron, zinc, copper etc. all of which contribute to plant nutrition and growth.

Materials and Methods

An experiment entitled “Effect of different crop residues, weed biomass, leaf litter, soil mixture and decomposing culture on quality of compost” was carried out at Centre for Organic Agriculture Research and Training (COART) farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during year 2024. The present experiment was laid out in factorial randomized block design with 12 treatment combination replicated thrice. The treatment details was, (factor A-Crop Residue, weed biomass, leaf litter, soil mixture with cow dung slurry): four crop residue mixtures were used i.e. CR_1-Soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cow dung slurry (30%), CR_2-Cotton stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%), CR_3-Wheat straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%), CR_4-Pigeon pea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) and factor B (decomposing cultures): three decomposing cultures were used namely DC_1-PDKV decomposing culture, DC_2-S9 Culture, DC_3-CIRCOT Culture. Heap method of compost was used and the size of each heap was 1.0 m x 0.7 m x 0.6 m. The observations on changes in chemical properties of compost were recorded.

Table 1: Methods used to estimate chemical properties of compost

Sr. No.	Chemical property	Analytical method adopted
1	Total carbon (%)	Dry combustion method (Jackson 1973) [5]
2	Ash (%)	Dry combustion method
3	Total nitrogen (%)	Kjeldahl method (Jackson, 1973) [5]
4	Total phosphorous (%)	Vanadomolybdate phosphoric acid, yellow colour method (Jackson, 1973) [5].
5	Total potassium (%)	Neutral normal ammonium acetate using flame photometer (Jackson, 1973) [5].
6	Micronutrient Analysis (ppm)	Atomic Absorption Spectroscopy method

Result and Discussion

Chemical properties of compost

Total carbon (%), ash (%) and C:N ratio of compost

Initially, compost materials contain a high amount of organic carbon, primarily in the form of cellulose, hemicellulose, lignin, and other complex compounds. As composting progresses, microorganisms break down these carbon sources, converting them into carbon dioxide (CO_2) through microbial respiration. This results in a steady reduction in carbon content over time.

The results pertaining to total carbon content, ash content and C:N ratio initially and at maturity of compost are presented in table 2.

Crop residue mixture

During the period of composting, there was noteworthy reduction in total carbon content and increase in ash% in all treatments at maturity of compost as compared to initial content. Significantly lower total carbon content was recoded in soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) at maturity (20.58%) of compost against initial 56.12% among crop residue mixtures. Highest ash content was recorded in soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) at maturity of compost among crop residue mixtures, which recorded ash content 64.52% against initial content of 3.25%.

In case of, carbon: nitrogen ratio (C:N ratio) of matured compost, noticeable decreased from initial value in different crop residue mixtures was observed. Highest reduction in C:N ratio was recorded with soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) compost as compared with initial C:N ratio of 54.48 which reduced to 16.07 after decomposition.

The observed increase in ash content and decrease of total carbon content, C:N ratio during composting can be attributed to surge in the microbial population and increased respiratory metabolism. Microorganisms utilize carbon as their primary energy source, breaking down organic matter and converting much of the carbon into carbon dioxide (CO_2) through respiration. As microbial activity intensifies, organic materials are broken down and mineralized, while the non-degradable inorganic components remain. This results in the relative accumulation of ash over time and decrease in carbon content. Similar observations were noted by Verma *et al*. (2011) [10], Sutaria *et al*. (2016) [9] and Ghanney *et al.* (2021) [3]

Decomposing cultures

Among decomposing cultures, PDKV decomposing culture recorded significantly lower total carbon content (21.31%) and C:N ratio (17.88) at maturity as compared with other cultures. Highest ash% (63.29%) was recorded in PDKV decomposing culture at maturity followed by CIRCOT culture (62.11%) at maturity of compost. Similar observations were noted by Aye (2016) [1] and Pandule *et al.* (2019) [8].

Interaction

Interaction were found non-significant in respect of total carbon content, ash content.

Nutrient content

N, P, K content

Nitrogen, phosphorus and potash content were measured at the time of filing the compost heap and after maturation, which are presented in table 3.

Crop residue mixtures

The data presented in table 3 revealed that final nutrient content showed significant differences among crop residue mixtures and decomposing cultures as compared initially. Nitrogen, phosphorus and potassium content increased at maturity in compost prepared from crop residue mixture in all treatments.

The compost derived from soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) recorded statistically higher nitrogen content (1.28%), phosphorus content (0.57%) at maturity as compared with all other treatments. Statistically highest improvement in total potash content was recorded with cotton Stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) compost (CR_2) as against all other treatments.

The increase in nutrient content may be attributed to the high mineralization of organic matter by microbes, which results in the retention of nutrients in the mineralized form. Also, as organic matter decomposes nutrients which is primarily found in plant tissues, becomes mineralized and released in an inorganic form. Similar records of availability of nutrients were stated by Goyal and Sindhu (2011) [4], Jusoh *et al.* (2013) [6] and Pandule *et al*. (2019) [8].

Decomposing culture

Decomposing cultures noted significant increase in nutrient content in matured compost after decomposition which shows significant difference among the treatments. Among the decomposing cultures studied PDKV decomposing culture recorded significantly higher total nitrogen (1.16%), phosphorus (0.50%) and potassium content (1.04%) at maturity. CIRCOT culture recorded potash content (1.02%) at maturity which was at par with PDKV decomposing culture. Similar records of availability of nitrogen were stated by Sutaria (2016) [9] and Dhapate *et al*. (2018) [2].

Interaction

Interaction effect regarding total nitrogen, phosphorus and potash content between crop residue mixtures and decomposing cultures were found non-significant.

Micronutrient content

The data in respect of Micronutrient content recorded initially and at maturity is placed at table 4.

Micronutrients like iron, copper, zinc, manganese are often present in organic matter in their bound forms within enzymes, pigments, and other cellular structures. As composting progresses, microbial activity breaks down these organic materials, releasing the micronutrients in more available forms.

Crop residue mixtures

It is indicated that there is significant increase in micronutrient content in matured compost over initial content in all treatments.

Higher iron, copper, manganese content was recorded in pigeonpea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_4) with 252.87 ppm, 7.75 ppm, 44.15 ppm iron, copper, manganese content respectively at maturity among crop residue mixtures. Whereas higher content of zinc was noted in compost prepared with soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%) (CR_1) which recorded 37.65ppm at maturity among crop residue mixtures studied.

The increase in micronutrient content during composting might be due to mineralization of nutrients from crop residues, which makes micronutrients like zinc, copper, iron and manganese available. Microbial decomposition releases these nutrients from both plant material and microbial biomass. Similar records of availability of micronutrients were stated by Verma *et al* (2011) [10], Jusoh *et al* (2013) [6] and Sutaria *et al* (2016) [9].

Decomposing culture

Decomposing culture showed significant increase in micronutrient content of compost over initial. After comparison among the cultures, PDKV decomposing culture recorded significantly higher increase in all the micronutrients recorded i.e. iron (202.87 ppm), copper (6.46 ppm), manganese (38.87 ppm), zinc (34.51 ppm) followed by CIRCOT culture and S9 culture.

Interaction

Interaction effect regarding total micronutrient content between crop residue mixtures and decomposing cultures was not found significant.

Table 2: Total carbon (%) content, ash (%) and C:N ratio of compost as influenced by different crop residue mixtures and decomposing cultures

Treatment	Total Carbon (%)		Ash (%)		C:N ratio	
	Initial	At maturity	Initial	At maturity	Initial	At maturity
Factor A-Crop residue mixture						
CR_1-soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	56.12	20.58	3.25	64.52	54.48	16.07
CR_2-cotton stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	52.89	22.40	8.82	61.43	62.96	24.61
CR_3-wheat straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	55.34	24.43	4.60	57.91	70.05	25.18
CR_4-pigeonpea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	54.22	22.02	6.53	62.07	59.58	18.82
SE (m)±	-	0.045		0.085		
CD at 5%	-	0.133		0.249		
Factor B-Decomposing culture						
DC_1-PDKV decomposing culture	-	21.31		63.29	-	17.88
DC_2-S9 culture	-	23.77		59.04	-	22.41
DC_3-CIRCOT culture	-	22.00		62.11	-	21.47
SE (m)±	-	0.04		0.073		
CD at 5%	-	0.115		0.216		
Interaction (A×B)						
SE (m)±	-	0.096		0.18		
CD at 5%	-	NS		NS		
GM	-	22.36		61.48		

Table 3: Total nitrogen (%), phosphorus (%) and potassium (%) of compost as influenced by different crop residue mixtures and decomposing cultures

Treatment	Total nitrogen (%)		Total phosphorus (%)		Total potassium (%)	
	Initial	Final	Initial	Final	Initial	Final
Factor A-Crop residue mixtures						
CR_1-soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	1.03	1.28	0.41	0.57	0.71	1.01
CR_2-cotton Stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	0.84	0.96	0.37	0.50	0.81	1.09
CR_3-wheat straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	0.79	0.98	0.27	0.33	0.67	0.87
CR_4-pigeonpea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	0.91	1.12	0.38	0.52	0.69	0.92
SE (m)±	-	0.0083	-	0.0076	-	0.009
CD at 5%	-	0.024	-	0.0223	-	0.028
Factor B-Decomposing culture						
DC_1-PDKV decomposing culture	-	1.16	-	0.50	-	1.04
DC_2-S9 culture	-	1.09	-	0.47	-	0.97
DC_3-CIRCOT culture	-	1.13	-	0.49	-	1.02
SE (m)±	-	0.0072	-	0.0066	-	0.008
CD at 5%	-	0.021	-	NS	-	0.024
Interaction A x B						
SE (m)±	-	0.017	-	0.0161	-	0.020
CD at 5%	-	NS	-	NS	-	NS
GM	-	1.13	-	0.491	-	1.018

Table 4: Micronutrient (Iron, copper, manganese, zinc) content of compost as influenced by different crop residue mixtures and decomposing cultures

Treatment	Iron (ppm)		Copper (ppm)		Manganese (ppm)		Zinc (ppm)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Factor A-Crop residue mixture								
CR_1-soybean straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	157.11	191.22	4.41	5.64	31.47	39.76	29.14	37.65
CR_2-cotton Stalk (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	119.00	137.53	4.63	5.54	24.77	30.13	17.56	22.08
CR_3-wheat straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	132.78	148.04	3.98	4.61	30.47	35.65	21.10	25.49
CR_4-pigeonpea straw (40%) + weed biomass (20%) + leaf litter (8%) + soil (2%) + cowdung slurry (30%)	216.45	252.87	6.12	7.75	35.52	44.15	25.10	32.35
SE (m)±		1.68		0.044		0.345		0.42
CD at 5%		4.93		0.129		1.012		1.23
Factor B-Decomposing culture								
DC_1-PDKV decomposing culture	-	202.8	-	6.46	-	38.87	-	34.51
DC_2-S9 culture	-	156.3	-	5.59	-	32.36	-	27.87
DC_3-CIRCOT culture	-	179.0	-	5.91	-	36.53	-	32.05
SE (m)±		1.45		0.038		0.29		0.36
CD at 5%		4.27		0.112		0.87		1.06
Interaction A x B								
SE (m)±		3.57		0.09		0.73		0.89
CD at 5%		NS		NS		NS		NS
GM		174.42		6.215		34.92		32.14

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