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The Added Substrates Effect On Quality Of Composting Product Through C: N And Ph

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Abstract

Waste is produced in huge quantum in urban as well as rural areas of country and its mismanagement is polluting the environment badly. There is dire need to manage wisely and convert this waste into some valuable commodity. The composting is considered a way out to control this menace and turn it into beneficial product to improve soil health resulting in enhanced crop production. A study was conducted at Soil and Water Conservation Research Institute Chakwal over the period of three years to compare various substrates i.e. sugar, gypsum, urea and rock phosphate against the control (without any substrate addition). The results revealed that the pH increased to slightly alkaline range from acidic maximum with rock phosphate followed by with urea. The C:N was significantly decreased by all substrates against control. The maximum decrease was observed with rock phosphate followed by gypsum. Conclusively, it was found effective to add substrates during composting process to enhance its quality and early production.

Introduction

Waste Management is an important and concerning issue of Pakistan. It is an important requirement of the society to manage waste in a proper way because we do not have sites for waste. In this modern era a large quantity of solid waste was produced and it will cause a serious threat to environmental, social and economic impact. (Castaldi et al. 2008). Improper way of large quantity of waste management may result in the serious issues to the residing population. So, it requires special and effective methodologies for the proper waste management (Gautam et al. 2010). The most effective, suitable and environmental friend approach towards the waste management is to utilize this waste to make compost by the process of composting. Composting is basically a method of transforming organic solid waste into environmentally friendly and beneficial soil amendments (Yu et al., 2019). As Concern to the availability of organic solid waste, the organic degradable waste includes wood, paper, agriculture waste, fruit waste, kitchen waste

etc. Composting can be done by both aerobic and anaerobic way (Cerda et al., 2019). But normally aerobic composting is preferred over anaerobic composting because during the process of anerobic composting it emits different harmful gases resulting in polluting the environment (McDougall et al., 2008). During the process of aerobic composting, organic complex degradable solid waste is converted and degraded by the presence of microorganisms into organic compost and two main byproducts heat and carbon dioxide are released during the process (Toledo et al., 2018). Compost is nutrient enriched soil amendment and it is a rich source of essential macronutrients (N, P and K) and organic matter resulting in the enhancing soil fertility and improving soil health. nutrient (Cucina et al., 2018).

Composting is considered as the best solution for recycling of organic waste. Our soils are normally deficient in nutrients and have low organic matter. So, compost as an organic soil amendment improve the soil fertility and quality of soil. According to the previous research studies, it was found that compost in addition to inorganic fertilizers improve the crop yield of rice and wheat crop and also improves the soil quality and increase the soil nutrient status of the soil (Sarwar et al., 2007)

The quality of compost is also important mater to consider. Composting is a biological process so it needs some factors to consider for the proper method of composting. The important factors for composting are temperature during the composting process, moisture percentage, pH and chemical composition of the composting material (Orrico et al., 2012). During all the process of composting degradable material, the quality of the final end product is very important to consider. A lot of studies were conducted to check the physical and chemical properties of the compost (Liu et al. 2011). The important quality parameters of the compost are compost pH, C: N of compost, Moisture percentage, organic matter, cation exchange capacity and Electrical conductivity of compost (Ryckeboer et al., 2003).

During the process of compost and the end product of compost C: N is an important parameter. It affects the composting process speed and reduce the quantity of the degradable material. The rate of composting process is highly affected by the Carbon nitrogen ration and the chemical content of the material used for decomposition. The C content in the composting material is used as energy source by the microbes involved during the process of composting whereas nitrogen is an important component of cell structure (Ameen et al., 2017).

Other than C:N ratio of the end product of compost, the other important compost parameter to consider is compost pH. It is an important parameter because it will help to check the maturity of compost that either the compost is mature or not. The soils of Pakistan are normally alkaline in nature so the pH of the end product compost should be alkaline. Lower pH of compost reduces the rate of respiration resulting in the slow process of composting (Wang et al., 2015).

Keeping in view the two challenging issues of rainfed area that are poor fertility status of soil and the management of organic farm waste because the farmers are facing serious issues regarding that. The present study was planned to develop a low-cost technology to prepare compost by using available farm waste in a better way and to evaluate the usefulness of different substrate on compost making process.

Material and Methods

The study was conducted at Soil and Water Conservation Research Institute, Chakwal (SAWCRI). Initially different farm waste was collected in both fresh (nitrogen source) and dry (carbon source). The pits were prepared having size 3 x 3 x 4 feet's. Following treatments are designed for the experiments having four replications. The experimental heaps were treated with microbial inoculants and control was without any type of inoculation. The treatment A, B and C was experimental and Treatment D was control.

T_1 = Leaves; dry matter; FYM (control)
T_2 = Leaves; dry matter; FYM (sugar)
T_3 = Leaves; dry matter; FYM (gypsum
T_4 = Leaves; dry matter; FYM (urea)
T_5 = Leaves; dry matter; FYM (Rock Phosphate)

Procedure of Decomposition

The composting material was collected from the research area of SAWCRI Chakwal. The decomposition material includes crop dry matter of straw, leaves, weeds, fruit waste and lawn cuttings. Composting material start with the three portions of dry (brown) material. Then add one portion of fresh (green) material. Add some water in each layer and add substrate according to the size of the pit in each layer. Continue to build the layer until the bin is filled. Add a layer of soil. Cover it with black sheet. Mix the material after four weeks. Check for proper moisture. Organic material will shrink as the process continues. After 3 months the finished decomposed material will be collected having uniform size, crumbly, has a pleasant earthy order and dark brown in color

Determination of C: N

Take 0.5g of compost sample in a digestion tube. Then add 1.0g of digestion mixture and 12 ml sulphuric acid in the tube containing compost. Then placed it on the digestion block and heated for about 2 hours at 400 ^{o} C. After heating the material in the tube changed its color from black to light green. Then cooled down the digestion tube. The samples were than distillated by distillation apparatus (Tandon, 2005). Carbon content was divided by nitrogen to find the ratio of C: N in the compost sample.

Determination of pH

The Ph of compost can be determined by making compost solution of adding distilled water in 1:10 and placed it for 2 hours. After that dip the Ph meter rod in the compost solution to get the pH of the compost. Record the reading when the pH value become stable. Wash the pH electrode with distilled water and dried it with the tissue paper (Monedero et al., 2001).

Statistical Analysis

The data were analyzed by using ANOVA variance (SPSS version 11). Standard deviation of the mean values was calculated for each treatment. The F test was applied to analyze the data for significant differences. The values were also compared for significant difference using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Composing is a biological and biochemical mechanism that relies on microbes and the enzymes produced by them (Zeng et al., 2010). The detail and composition of waste material is given in Table 1. The results revealed that the pH was increased from first month through to the third month from slightly acidic to light alkalinity. In the first month, maximum increase was found with rock phosphate substrate (7.15) followed by urea (7.09) and the same trend was observed in all the three months as given in Table 2. The results are in line with Bord na Mona (2003) recommending that the range of pH should be 6.9-8.3 of compost end product and all the treatments enhanced pH in this range. The pH of all treated pits was alkaline at the end and the results coincide with the findings of Sundberg et al., (2004) that the pH of the end product of compost should be in basic range (Nakasaki et al., 1993). The results of present study showed same pattern of pH during the composting process as described by several authors (Chang and Hudson, 1967; Poincelot, 1974; Inbar et al. 1993). It is considered that the decrease in pH at the initial period of composting process is expected because of the acids formed during the metabolism of readily available carbohydrates. After this initial stage, the pH is deemed to rise with release of free ammonia and to stabilize or drop slightly again to near neutral as a result of humus formation with its pH buffering capacity at the end of composting process (Poincelot, 1974; Fogarty and Tuovinen,1991).

The carbon to nitrogen (C/N) ratio is the most vital factors affecting compost quality (Michel et al. 1996). The results revealed that the C/N ratios decreased with time period from first month through to the third month. The maximum decrease was with rock phosphate (19.8) followed by gypsum (19.9) and urea (20.8) as shown in Table 3. The optimum C/N ratios for a composting process due to microbial decomposition of organic material in composting processes have been reported to be in the range of 26 to 35 (Poincelot, 1972). The results are in line with Kumar et al. 2010 reporting that initial C/N ratios of 25-30 are considered ideal for composting process to be carried out. The C/N ratio is usually considered as an index of compost maturity (Inbar et al. 1990). The findings of present study are in accordance with the previous studies reporting that the C/N ratio decreased with time in all seasons of the year. The decrease in the C/N ratio in a composting process is attributed to losses of carbon primarily as CO_2, hence, carbon content of the composting substrate lessens with time and nitrogen in the material increase resulting in lowering of C/N ratio (Goyal et al. 2005). This phenomenon is also stated by Golueke, 1981 that when a waste is undergone composting process, generally observed decrease in C/N ratio with time due to losses of carbon as CO2 which stabilizes between15-20. Often the decrease in C/N ratio is considered reliable criterion of compost maturity (Goyal et al., 2005).

Table 1. Detail and composition of organic material added

Sr.#	Material	C: N Ratio	% Moisture in material
1	Straw	100	10
2	Fruit Waste	35	80
3	Leaves	60	40
4	Weeds	19	85
5	Lawn grass cuttings	20	85

Table 2. Effect of composting process on compost pH

Treatments	1st month	2nd month	3rd month
T1: Control	6.69 D*	6.76 D	7.13 B
T2: Sugar	6.96 C	6.96 C	7.21 B
T3: Gypsum	7.05 B	7.11 B	7.46 A
T4: Urea	7.09 AB	7.16 B	7.50 A
T5: Rock phosphate	7.15 A	7.24 A	7.55 A
LSD	0.0872	0.0658	0.1104

*indicates Least Significant Difference among means at 5% level of confidence.

Variance between means of pH in 1st month

	Sum of square	df	Mean square	F	P
Between groups	0.00137	2	0.00069	45.17	0.0000
Within group	0.38756	4	0.09689		
Total	0.40609	14			

Variance between means of pH in 2nd month

	Sum of square	df	Mean square	F	P
Between groups	0.00769	**2**	0.00385	88.10	0.0000
Within group	0.43051	**4**	0.10763		
Total	0.44797	**14**			

Variance between means of pH in 3rd month

	Sum of square	df	Mean square	F	P
Between groups	0.00076	**2**	0.00038	29.83	0.0001
Within group	0.41029	**4**	0.10257		
Total	0.43856	**14**			

Table 3. Effect of composting process on C:N ratio of compost

Treatments	1st month	2nd month	3rd month
T1: Control	26.4 A*	24.9 A	22.8 A
T2: Sugar	24.8 B	22.6 B	20.8 B

T3: Gypsum	23.5 D	21.9 BC	19.9 C
T4: Urea	24.2 C	22.7 B	20.8 B
T5: Rock phosphate	23.6 CD	21.6 C	19.8 C
LSD	0.6235	0.8476	0.7717

*indicates Least Significant Difference among means at 5% level of confidence.

Variance between means of C: N in 1st month

	Sum of square	**df**	**Mean square**	**F**	**P**
Between groups	0.6493	**2**	0.32467	39.68	0.0000
Within group	17.4067	**4**	4.35167		
Total	18.9333	**14**			

Variance between means of C: N in 2nd month

	Sum of square	**df**	**Mean square**	**F**	**P**
Between groups	1.4653	**2**	0.73267	23.96	0.0002
Within group	19.4227	**4**	4.85567		
Total	22.5093	**14**			

Variance between means of C: N in 3rd month

	Sum of square	**df**	**Mean square**	**F**	**P**
Between groups	0.1493	**2**	0.07467	25.36	0.0001
Within group	17.0400	**4**	4.26000		
Total	18.5333	**14**			

Declaration

The authors have no conflict of interest.

Conclusion

It is concluded that the substrates used to enhance the quality of compost end product were found significant in lowering C:N to the optimum level instead of using organic wastes solely. Rock phosphate and urea were found better in producing quality compost product that can be applied to crops for achieving more yields under rainfed scenario of pothowar region.

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