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Mustard Straw Composting and Its Evaluation for Quality Parameters

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Abstract

The mustard straw compost, prepared by using two different inocula (cattle dung+ consortium of three fungi and cattle dung alone) was evaluated for various maturity and quality parameters. The C/N ratio of compostable material dropped down from 82.41 to 17.01 and 82.60 to 21.06 after using consortium of fungi + cattle dung and cattle dung alone respectively for 90 days. Total humic substances in finished product were 260 and 239 mg/g compost with consortium of fungi + cattle dung and cattle dung alone respectively. Carbon dioxide evolution in finished product with cattle dung and consortium of fungi as inoculum was 142mg/100g and 168mg/100g in compost with cattle dung alone. About 84% seeds of wheat and 74% seeds of mustard showed germination in compost water extract under laboratory conditions. The study shows that out of two inocula used, consortium of three fungi + cattle dung was better than using cattle dung alone for carrying out mustard straw composting.

Keywords: Composting, Fungal Inoculants, Cattle Dung, Mustard Straw, Compost Quality.

Introduction

Maintenance of soil organic matter is crucial for long-term productivity and fertility of soil. Continuous use of inorganic fertilizers has brought down the level of soil organic matter in many parts of Haryana (India).There is a great need to maintain soil health in terms of soil organic matter and productivity to sustain the increasing population. A variety of agro wastes which are generated can be reutilized to provide important plant nutrients. In India, about 400 million tons of crop residues are produced annually, from which about 7.3 million tons of N and P can be harnessed if they are directly incorporated into the field or composted. Mustard straw is the byproduct of an oilseed crop, Which is the major rabi crop of North-west India. Although mustard straw sticks are used as fuel inhousehold and in cline for making bricks. Burning of mustard straw is known to induce environmental and health problems (Reinhardt *et al*. 2001) so, burning of mustard straw is not ecofriendly and causes environmental problems.

To evaluate compost maturity various parameters are based upon its physical and chemical parameters like C:N ratio, organic matter and nutrient contents, cation exchange capacity and evolution of CO_2 in finished product. The respiratory activities, nitrification potential, ATP content, enzyme activities and microbial counts have also been successfully used to assess compost maturity. Most of these studies have been restricted to monitoring the changes in microbial activities during composting (Goyal *et al*.2005).

Humification is widely considered as an important process during composting of organic materials, where humic substances are formed and non humic substance decompose (Baddi *et al*. 2004). As composting progresses, the percentage of humic substances is expected to increase relative to the total dry mass of the total organic matter. As a result, humification-related parameters have been examined to represent compost stability and maturity (Provenzano *et al*. 2001). Mustard straw is still and hard, so if it is directly incorporated it will not be completely degraded in soil and may lead to various environmental problems.Therefore, during the present investigation, we tried to utilize the mustard straw through composting and have tested the quality of compost and studied the phytotoxic effect on seed germination.

Aim of the Study

The main aim of this study was to prepare compost from mustard straw and evaluate its different parameters to ensure its quality. Findings show promising results and can be used by farmers in their farms.

Material and Methods

Collection of Material

Mustard straw and cattle dung were collected from the fields of Regional Rice Research Station at Bawal of CCSHAU Hisar, India, and analyzed for C, N, P and K contents. A consortium of three fungi *Aspergillus awamorii, Paecilomyces fusisporous and Trichoderma viride* which were isolated from our previous experiment were used as inoculum during this study (Goyal et al. 2005). Mustard straw contained 53.67 % organic C, 0.58 % nitrogen, 0.35 % phosphorus and 0.76% potassium while cattle dung contained 48.14% organic C, 1.42% total N, 0.4% total P and 0.90% K. The initial C/N ratio of mustard straw and cattle dung was 92.5 and 33.9 respectively.

Composting of mustard straw was carried out in pits of 10 X 4 X 2.5 ft size using two different inocula:

T1- Mustard straw + Cattle dung 10%

T2- Mustard straw + cattle dung (10%) + Consortium of fungi

Preparation of the Compost

Mustard straw compost was prepared by using two different inocula, cattle dung alone and cattle dung with fungal consortium. The inoculum of cattle dung and cattle dung + consortium of fungi was prepared by mixing it into water and then added to the compostable material. Cattle dung was added @ 10.0% on dry weight basis to the mustard straw whereas, one gram of charcoal based consortium of three fungi containing 10^9 spores ml^{-1} was suspended in 10 litre of water. After analyzing the moisture content regularly, moisture was maintained to 60% water holding capacity (WHC) at different intervals of composting. The material decomposed for three months and in between two turnings were given after 15 and 30 days of composting. Sample was observed at 0,15,30,60 and 90 days interval. The compost samples were dried, ground to pass through 2 mm sieve for chemical analysis such as C, N, P and K. The quality of mustard straw compost was determined by measuring humic and fulvic acid contents, water soluble carbon, CO_2 evolution in finished compost and germination index of wheat and mustard seeds under laboratory conditions.

Chemical Analysis

Total organic C was measured by the method described by Nelson and Sommers in 1982. Kjeldahl digestion method described by Bremner and Mulvaney in 1982 was used to determine total N. The total phosphorus content was calculated by the method given by John (1970). Flame photometer was used to calculate the potassium content in the compost digest.

Five gram of oven dried and sieved compost (2mm particle size) was suspended in 50 ml distilled water and shaken for 30 minutes at 160 rpm. It was then filtered through Whatman no. 1 filter paper and was used to measure water soluble C.

Kalembassa and Jenkinson in 1973 described the titration method to calculate total C in compost water extract. Carbon dioxide evolution in the final product was determined by the method given by Pramer and Schmidt in 1964. Humic substances in compost were measured according to the protocol outlined by Kononova in 1961.

Seed Germination

Wheat and mustard seeds' germination index was determined by taking 30 seeds each on a sterile petri plate with a base of sterilized ordinary filter paper disc. Compost water extract was prepared by dissolving 10g finished compost in 90 ml distilled water and then filtered through Whatman no 1 filter paper after shaking for half hour. From this, 8 ml water extract from each treatment was added to the petri plates containing seeds and incubated at 30^oC. The germination index was calculated by comparing the number of seeds germinated in compost water extract of different treatments to that of seeds germinated in sterilized distilled water.

Statistical Analysis

Analysis was done in a set of triplicate and significant differences between treatment means was determined using LSD values at P=0.05.

Results and Discussion

C/N Ratio

Carbon, Nitrogen and C/N ratio of composting at different time intervals are presented in table 1. Carbon content of mustard straw compost decreased from 32.8 to 11.6% with time in different treatments. Minimum amount of organic Carbon was found in mustard straw inoculated with consortium of fungi + cattle dung in comparison to cattle dung alone inoculated mustard straw after 90 days of decomposition. The complex organic matter is degraded into simple ones with evolution of gases and energy as the composting progressed. Lowering of organic carbon at initial stages of mustard straw decomposition is more than rest of the composting period. Vuorinen and Saharinen (1997) have also reported that approximately 11–27% of the total C is lost during initial stages of active composting and about 62–66% during the whole composting time.

Nitrogen content per unit of composting material increased from 0.391 to 0.682%. Inoculation of mustard straw with consortium of fungi + cattle dung led to 8.7% more N in comparison to cattle dung inoculated mustard straw after 90 days of composting. During decomposition, decrease in carbon content of compostable material resulted in an increased N content per unit material in the system.

To estimate compost maturity and stability, low C/N ratio is considered as one of the parameter. The compost having C/N ratio below 20 is considered as mature and stable. At the start of mustard straw composting the C/N ratio was 82.60 which dropped down to 17.01 after 90 days. The C/N ratio of compostable material after 30 days of composting came down from 82.60 to 52.88 showing thereby that

microorganisms developed during the composting process were decomposing the material efficiently. Compost inoculated with consortium of fungi + cattle dung had lower C/N ratio in comparison to compost with cattle dung alone. Similar results have been obtained by Brito *et al*.(2008), who observed that the C/N ratio declined from over 36 to a value of 14 towards the end of composting, indicating an advanced degree of organic matter stabilization.

N, P and K Content

Changes in nutrient contents in the form of N, P and K in the compost prepared from mustard straw at different intervals of time is shown in table 2. The total N, P and K content increased from 0.391 to 0.682, 0.033 to 0.061 and 0.266 to 0.804% respectively.Compost inoculated with fungal consortium + cattle dung had 8.7, 3.2 and 3.7% more N, P and K than cattle dung inoculated compost.

Humic Acid and Fulvic Acid C

Table 3 shows total amount of humic substances present in finished compost. Amount of humic substances present in compost prepared from mustard straw using consortium of fungi + cattle dung as inoculum was 215 mg/g compost which was more than compost prepared from mustard straw + cattle dung alone. Mustard straw compost prepared using fungal consortium + cattle dung showed 8.1% more total humic substances carbon in finished product as compared to the compost prepared using cattle dung alone.

During composting, the complex organic material is broken down into simple substances such as carbon dioxide and side by side humic substances are formed mainly from lignin. Due to the humification process lignin is polymerized into fulvic acid and humic acid which are degraded slowly. The maturity of compost is related with the presence of humic substance in the compost which are produced at later stages of composting. These humic substances are stable fraction of soil organic matter and acts as a permanent source of energy for the growth of microorganisms. Veekens *et al*. (2000) found that humic substances are produced at later stages of composting and they are stable fraction of carbon which regulates the carbon cycle and release important nutrients like nitrogen and phosphorus. Lopez *et al*. (2005) have evaluated the degradation of lignin in the mixtures of horticultural plant residue with different C/N ratio by different lignocellulolytic fungi. Inoculation of waste with *Coriolus versicolor, Phanerochaete flavido-alba and Trichoderma koningii* enhanced the formation of humic substances showing thereby that lignin was degraded by all these three fungi.

Lesser amount of water soluble C (2.69%) was observed with the consortium of fungi + cattle dung inoculated mustard straw compost. (Table 3). This led to the production of compost with low amount of water soluble carbon, suggesting that these fungi were efficient in decomposition of organic matter present in mustard straw to the level that finished product had lower amount of water soluble carbon and higher amount of humic substances. Pullicinio *et al*. (2007) have reported that the ratio of hydrophobic to hydrophilic carbon increased to a value greater than unity is an indicator of stabilized compost. Castaldi *et al*. (2005) found that water-soluble organic C concentration rapidly increased to maximum at day 18 and declined thereafter during 122 days of composting.

Carbon Dioxide Evolution in Finished Compost

During the present investigation the CO_2–C evolved from 90 days old compost with consortium of three fungi + cattle dung inoculation had 15.5% lesser amount of CO_2–C evolution than compost prepared from cattle dung alone. The evolution of CO_2–C is from the degradation of undecomposed organic matter present in the final product and in as table compost it should be less. It has been suggested that a good quality compost should have carbon dioxide evolution less than 500 mg $100g^{-1}$ of total organic C to be of good quality (Garcia *et al*. 1992). The higher amount of CO_2 evolution suggests that material is not yet stabilized and needs further decomposition. During the present investigation the evolution of CO_2–C in 90 days old compost was less than above limit indicating that these compost were very well stabilized after the 90 days of decomposition.

Germination Index

The application of unstable and immature compost in soil can lead to the reduction of oxygen concentration and also can immobilize important plant nutrients. To find out the phytotoxic effect of the compost prepared by using different inocula, % germination of wheat and mustard seeds were tested under laboratory conditions taking germination with sterilized water as control (Table 3).The mustard straw compost prepared with cattle dung and consortium of three fungal inocula showed higher % germination of seeds. However, no significant difference was found between % germination within cattle dung or fungal consortium + cattle dung inoculated mustard straw compost. Gaind et al. (2009) carried out the composting of wheat straw aerobically in presence of fungal consortium of *Aspergillus awamori, Aspergillus nidulans, Trichoderma viride and Phanerochaete chrysosporium.* Poultry droppings, neem cake, castor cake, jatropha cake and grass clippings were used separately as organic nitrogen additives to decrease the high C/N ratio of wheat straw. Evaluation of compost maturity showed that mixture of wheat straw, poultry dropping and jatropha cake had the lowest C/N ratio of 10:1, and a germination index exceeding 80% in 60 days of decomposition. Inoculated and grass clipping amended wheat straw-poultry dropping mixture resulted in compost with C/N ratio of 13.5, and germination index of 59.66%.

Table 1
Changes in Organic Carbon, Total Nitrogen and C/N Ratio at Different Time Intervals of Mustard Straw Composting

Treatments	Organic C (%)Days				Total N (%) Days				C/N ratio Days			
	0	30	60	90	0	30	60	90	0	30	60	90
Mustard straw + 10% dung	32.3	27.6	16.6	13.1	0.391	0.463	0.464	0.622	82.6	59.6	35.7	21.1
Mustard straw + 10% Fungal consortium	32.8	25.7	14.4	11.6	0.398	0.486	0.659	0.682	82.4	52.9	21.9	17.0
CD at 5%	0.04	0.01	1.2	1.1	0.052	0.047	0.063	0.024	1.5	2.4	4.3	3.7

Table 2
Plant Nutrient Contents (N, P, K) of Mustard Straw Compost after 90 Days of Mustard Straw Composting

Treatments	Total N (%) Days				Total P (%) Days				Total K (%)Days			
	0	30	60	90	0	30	60	90	0	30	60	90
Mustard straw + 10% dung	0.391	0.463	0.464	0.622	0.038	0.042	0.053	0.059	0.266	0.262	0.672	0.774
Mustard straw + 10 % Fungal Culture	0.398	0.486	0.659	0.682	0.033	0.044	0.055	0.061	0.339	0.351	0.718	0.804
CD at 5%	0.052	0.047	0.063	0.024	0.004	0.002	0.001	0.003	0.004	0.015	0.068	0.042

Table 3
Quality Parameters in Mustard Straw Compost after 90 Days of Mustard Straw Composting

Treatments	Humic Acid C (mg/g compost)	Fulvic acid C (mg/g compost)	TotalHumic substances C (mg/g Compost)	Water soluble C as % of total C	CO_2-C evolution in 4 weeks (mg100 g^{-1} compost)	Wheat (%)	Mustard (%)
Mustard straw + 10% dung	193	46	239	3.9	168	84	74
Mustard straw + 10% Fungal Culture	215	45	260	2.6	142	86	79
CD at 5%	5	2	4	0.9	7	4	6

Conclusion

The result of the present study shows that use of consortium of three fungi along with cattle dung as inoculum in preparation of mustard straw compost in three months is better than cattle dung alone. The resulting product is stable and mature and does not have any phytotoxic effect on seed germination of wheat and mustard.

References

1. Baddi, G.A., Hafidi, M., Cegarra, J., Alburquerque, J.A., Gonzalvez, J., Gilard, V., Revel, J.C. (2004). Characterization of fulvic acids by elemental and spectroscopic (FTIR and C-NMR) analyses during composting of olive mill wastes plus straw. Bioresour. Technol. 93:285–290.
2. Bremner, J.M., Mulvaney, C.S. (1982). Nitrogen total. In: Miller RH, Keeney DR (ed) Methods of soil analysis, Part 2. Am SocAggron, Madison, pp 371-378.
3. Brito, L.M., Coutinho, J., Smith, S.R. (2008) .Methods to improve the composting process of the solid fraction of dairy cattle slurry. Bioresour. Technol. 99:8955-8960.
4. Castaldi, P., Alberti, G., Merella, R., Melis, P. (2005).Study of the organic matter evolution during municipal solid waste composting aimed at identifying suitable parameters for the evaluation of compost maturity. Waste Management25:209-213.
5. Gaind, S., Nain, L., Patel, V.B. (2009).Quality evaluation of co-composted wheat straw, poultry droppings and oil seed cakes.Biodegradation. 20:307-317.
6. Garcia, C., Hernandez, T., Costa, F., Ayuso, M. (1992). Evaluation of the maturity of municipal waste compost using simple chemical parameters. Commun. Soil Sci. Pl. Anal.23:1501-1512.
7. Goyal, S., Dhull, S.K., Kapoor, K.K. (2005). Chemical and biological changes during composting of different organic wastes and assessment of compost maturity. Bioresour. Technol. 96:1584-1591.
8. John, M.K. (1970). Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. Soil Sci.109:214-220.
9. Kalembassa, S.J., Jenkinson, D.S. (1973). A comparative study of titrimetric and gravimetric methods for the determination of organic carbon in soil. J. Sci. Food Agric.24:1085-1090.

10. Kononova MM (1961) Soil organic matter. Peragmon Press, Oxford
11. Lopez, M.J., García, M.D.C.V., Estrella, F.S., Moreno, J. (2005).Biodelignification and humification of horticultural plant residues by fungi. Int.BiodeteriorationBiodegrad.57:24-30.
12. Nahum, S.Z., Markovitch, O., Tarchitzky, J., Chen, Y. (2005). Dissolved organic carbon (DOC) as a parameter of compost maturity. Soil Biol.Biochem.371:2109-2116.
13. Nelson, D.W., Sommers, L.E. (1982). Total carbon, organic carbon and organic matter. In: Page AL (ed) Methods of soil analysis part 2. Am. SocAgron, Madison, pp 539-579.
14. Pramer, C., Schmidt, A. (1984). Organic matter. In: Methods of Soil Analysis, Part 2, Black CA (ed). Am. Soc. Agron, Madison, USA.
15. Provenzano MR, De Oliveira SC, Silva MRS, Senesi N (2001) Assessment of maturity degree of compost from domestic solid wastes by fluorescence and Fourier transform infrared spectroscopy. J. Agric. Food Chem.49:5874–5879
16. Pullicino, D.S., Kaiser, K., Guggenberger, G., Gigliotti, G. (2007). Changes in the chemical composition of water-extractable organic matter during composting: Distribution between stable and labile organic matter pools. Chemosphere 66:2166-2176.
17. Reinhardt, T.E., Ottmar, R.D., Castilla, C. (2001). Smoke impacts from agricultural burning in a rural Brazilian town. J. Air Waste Manag. Assoc. 51:443-450.
18. Veeken, A., Nierop, K., De Wilde, V., Hamelers, B. (2000).Characterization of NaOH-extracted humic acids during compostingof a biowaste. Bioresour. Technol. 72:33–41.
19. Vuorinen, A.H., Saharinen, M.H. (1997).Evolution of microbiological and chemical parameters during manure and straw co-composting in a drum composting system.Agric. Eco. Environ. 66:19-29.