Developing an effective method for composting of rice straw

As a part of the requirement for the partial fulfilment of the course work of

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Declaration:– I, Neeraj Pal, hereby certify that the work presented in this Report entitled 'Developing an effective method for composting of rice straw" in partial fulfillment of the course requirement for the award of the Degree of Ph.D., being submitted to CSIR-HARIT Unit, CSIR-Indian Institute of Petroleum, Dehradun, is an authentic record of Project Research work carried out by me at CSIR-IIP during the period of my Ph.D. course work and under the supervision of Dr. A.K. Sinha.

Date: 29-9-2020

Signature of the Student

Purpose of the study

Indian Institute of Petroleum is one of the constituent laboratories of the Council of Scientific and Industrial Research, India, which work on developing different techniques for the sake of society and the environment. Every year in late September and October, farmers mainly in Punjab and Haryana burn an estimated 35 million tons of crop waste from their paddy fields after harvesting as a low-cost straw-disposal practice to reduce the turnaround time between harvesting and sowing for the second (winter) crop. Smoke from this burning produces a cloud of particulates visible from space and has produced what has been described as a "toxic cloud" in New Delhi, resulting in declarations of an air-pollution emergency.

While reading news daily about the rising of particulate matter, smoke, harmful gases emission like CO_2, CO, N_2O, and CH_4. It degrades air quality and human health. I was thinking of doing something to give my contribution to resolve this problem to some extent from my side at any basic level. Since lots of people have already done a lot of work by using it in many ways but still it isn't able to solve the major problem. As the amount of rice straw that produced needs to have a simple and easy way to use it to produce something which is beneficial and easy for conversion.

Figure 1. Burning of rice straw.

The present study was conducted to compost a small volume of rice straw and find out that the idea is working or not. The purpose was to convert the amount of rice straw into compost using only animal waste and water only. Natural aerobic microorganisms help the process under controlled conditions for obtaining the product, which is compost that can be utilized as fertilizer. It acts as a catalyst or decomposer. Also, to investigate how much amount of compost is the yield on the basis of raw material used is also considered, which affect the progress and

outcome of the composting process. The rice straw was collected from the home of a farmer. The experiment was carried out in the area available in front of my quarter in CSIR-IIP.

Introduction

Crop residue burning in Punjab, Haryana, and western Uttar Pradesh has been well known, but nowadays, it's spreading more frequently in other parts of the country. Wheat stubble burning is a relatively new issue that started with mechanized harvesting using combine harvesters. The state government has not implemented the National Policy for Management of Crop residues to protect the *parali* (crop residue). On December 10, 2015, the National Green Tribunal (NGT) had banned crop residue burning in the states of Rajasthan, Uttar Pradesh, Haryana, and Punjab.

Rice is the primary staple food for more than 40% of the world's population. Globally about 155 million ha of rice is harvested annually with a production of about 596 million tons (IRRI 2001). More than 90% of this is produced and consumed in Asia. India, with 42.25 million ha of land under rice, produces about 110 million tons of rice and 170 million tons of rice straw[1] every year (FAI 2001). The disposal of such a huge amount of rice straw is a major concern, particularly in northwest India, where the rice-wheat cropping system is extensively followed. Rice straw[1] is not used as animal feed due to its low digestibility, low protein, high lignin, and high silica contents. It is also not recycled in soil due to limited time (20–25 days) left before the sowing of succeeding wheat crop. Within this short period of 20–25 days, rice straw cannot be completely decomposed in soil. Moreover, due to the addition of a large amount of organic carbon through rice straw [8], a net immobilization of nitrogen occurs in soil, and the wheat crop suffers from nitrogen deficiency resulting in lower yield. Farmers in northwest India, therefore, dispose of a large part of rice straw by burning it in situ. In a recent survey, it was observed that 60 and 82% of rice straw produced in the north-western states of Haryana and Punjab, respectively, are burned in the field (Punjab Agricultural University, unpublished).

The burning of rice straw is environmentally unacceptable as it leads to

(1) Release of soot particles and smoke causing human health problems such as asthma or other respiratory problems[2].

(2) Emission of greenhouse gases such as carbon dioxide, methane, and nitrous oxide (N_2O) causing global warming.

(3) Loss of plant nutrients such as N, P, K, and S.

Almost entire amounts of C and N, 25% of P, 50% of S, and 20% of K present in straw are lost due to burning (Dobermann and Fairhurst 2000). The gaseous emissions from the burning of rice straw were 70% CO_2, 7% CO, 0.7% CH_4, and 2.1% N_2O (Yoshinori and Kanno 1997). Therefore, the burning of crop residues should be avoided, and alternate measures of disposal of residues should be found out.

Relevancy of the Study

In the present scenario, increasing population growth, industrialization, urbanization leads to an increasing number of municipal solid. Adequate waste management is a serious problem faced by all developing countries. Hence, waste management like agriculture waste, household waste, municipal waste etc. cannot be ignored. There has been a growing emphasis on the three **R's: Reduce, Reuse, and Recycle**. Composting provides a way of accomplishing all three of the R's. Composting allows to reduced landfill, the organic matter, i.e., compost is reused and recycled rather than dumped. The compost was used for soil amendments.

Composting is a method for saddling the common procedure of decomposition to accelerate the decay of waste. Recent concern about waste management in an environmentally friendly manner has prompted recharged enthusiasm in small-scale garden composting as well as an interest in developing large-scale, commercial, and crop residue/ waste composting systems. The study of waste production and management provides awareness among individuals for waste production and waste reduction. Thus solve the real-world problem using the composting approach.

Experimental procedure

The experiment was performed in IIP Colony in the area, which was in front of my quarter. For composting, I have used rice straw 30 kg and 15 kg of cow dung and water total of around 10 liters. Whereas in the previous method of composting rice straw that various people has been used is time consuming, laborious, and required a large quantity of water. In one of the similar work of composting of rice straw was done by International Crops research Institute for the Semi-Arid Tropics (ICRISAT), they have processed 1 ton of rice straw and uses 3000 liter of water along with they have used additional microbes and urea also rock phosphate.

Figure 2. Rice straw used for composting grouped into a pile.

Thus used lot of water for processing and other ingredients too. Hence, after understanding the basics of manure formation and composting usually, people have directly used long straws for compost as shown in figure 2. Which takes more time to convert into compost so rather the using it as it is like long straw it will be more helpful to shred it into small pieces. Whereas I have first chopped the rice straw in small pieces of approx. one-inch size by a grass cutting machine that is shown in figure 3 and then used for compost.

Figure 3. Cutting of rice straw into smaller fragments.

The method that I used is to use rice straw, cow dung, and water in layering it in such a way so that the process of composting can be accelerated. A systematic diagram is shown in Figure 4, in which the bottom layer was made from rice straw, and that layer is 10cm in height, 10cm of width, and 10 cm of height. Similarly, the next layer of cow dung is placed over it after watered

it for maintaining appropriate moisture. Once again, rice straw was spread over the cow dung layer, maintaining the 10cm of height after sprinkling the water on the cow dung layer. After finishing each layer, water was sprinkled for adequate moisture. Repetition of the layer formation was continued up to 2 ft. of height, 2ft. of length, and 2 ft. of width and finally cover it completely with rice straw.

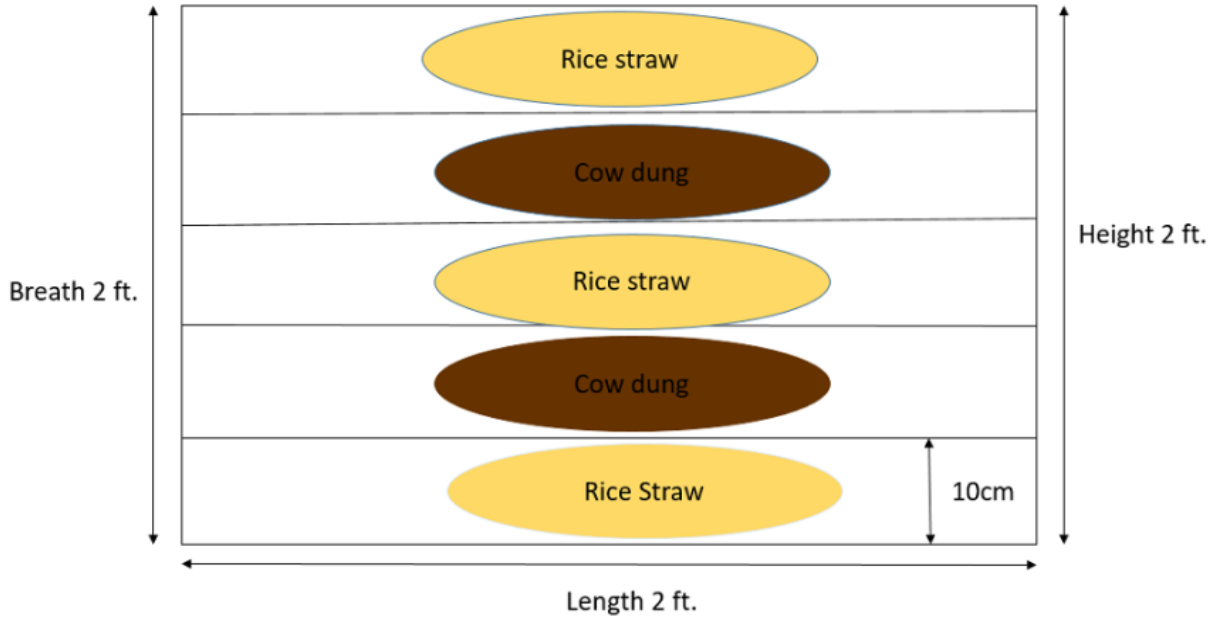

Figure 4. The systematic arrangement of rice straw and cow dung and water for fast composting.

The pile is first turned over after 15 days then maintained with proper moisture. After that, again, the pile was labeled. This practice was continued after 15 days over the pile was regularly flick through and watered for 90 days after turned up the pile for the first time the turning of the pile followed by every seven days and also maintain the proper moisture that is water does not flow from the pile and it does not look dry by appearance like 50% of moisture is maintain by sprinkling the water.

Result and Discussion

The pile made up of rice straw and cow dung was monitored and the pile was turned after an interval of 15 days, we observed that the pile of rice straw and cow dung gradually started to decay and transformed into compost. Initially, layer of rice straw and cow dung is covered with the rice straw to encapsulate the natural heat generated by the decaying and microbial influence.

Figure 5.Initial pile formation by using systematic diagram 4 for composting

It has been observed that the average temperature inside the pile was around 30˚C - 40˚C some variation is natural due to surrounding environmental condition like temperature, moisture and humidity. The pile is formed by implementing the setup, as shown in Figure 4. The left, center, and right image of the pile formed is shown in figure 5(a), 5(b), and 5(c), respectively. In figure 5 the three images refer to the shape of the pile as transformed into narrowing when the height of the pile is increased. After that pile was left in the atmospheric condition, the natural decomposers and microbes help the process of converting into compost. After 15 days' completion pile needs to turn for air circulation and microbial multiplication, after first turn up turning of the pile was continued after every seven days' for fast composting. which maintain the nutrient of the compost and are required to improve the biodiversity of the soil. We can also add *effective microbes 1(EM1)* for fast microbial growth. Microorganisms are responsible for a large part of biological activity (60-80%)[3], which is associated with processes regulating nutrient cycles and decomposition of organic residues. During the turning time of the pile, some earthworms are naturally found there is a good sign of composting.

Figure 6. Pile after turning over after 15 days.

Layering helps to provide a suitable condition for microbial growth like aspergillus awamori (fungus)[4], which is naturally found in nature. Microbes are especially important components for soil biodiversity[5] and growth of crops which helps to maintain the essential nutrients in the soil. Particularly fungi and bacteria are crucial, as they change and release many nutrients playing important roles in nutrient cycling and sustain vegetation. These micro-organisms use organic matter as their energy source. This will heat up the windrow and as a result a considerable part of the organic matter will be lost as CO_2, which is emitted into the environment. Cow dung contains a high level of ammonia and pathogen, and it contains about 3 percent nitrogen, 2 percent phosphorus, and 1 percent potassium (3-2-1 NPK). Thus using it with rice straw helps to generate high nutritious organic manure. After 15 days, when the pile was turned whitish color was found in between the layers of cow dung and rice straw, it was the fungus was found over it, and moistures were also reduced in the pile as appeared from the appearance of the pile, so after mixing it with sufficient required amount of water by sprinkling the water on the pile, the condition of the pile is shown in Figure 6, after 15 days.

Figure 7. Compost obtain after completion of around 90 days

The final product from rice straw and cow dung after composting is shown in figure 7. The CHNS analysis of raw rice straw and compost is shown in Table 1. It has been observed that the component in the compost is suitable to use as manure in the soil and maintaining the soil biodiversity[5]. The factors that are responsible for accelerating the composting time are temperature, moisture, oxygen (Air), microbes, etc.

Table 1. CHNS analysis, C/N ratio and moisture of rice straw and compost.

Component	Rice straw (%)	Compost (%)
Total Organic Carbon	48.7	41.7
Hydrogen	10.9	7.7
Nitrogen	1.1	0.98
Oxygen	42.5	48.2
Sulfur	0.14	1.1
C/N	44.2	40.8
Moisture	16	37.1
Organic matter	88.4*	-

*[9] S. Hosseini, H. Aziz, C. Syafalni et.al reorted.

Turning of the pile is also an important factor in proper air circulation and making a pile is helps in increasing the pressure and natural fungus for the growth of earthworm and other decomposers. The yield obtained suffers the environmental effect that is rain, wind, sun, animals, etc.

Conclusions

The method of using the rice straw and cow dung in layering form is to reduce the time of composting. From our result, we have obtained the compost after completion of around 90 days. Whereas only cow dung takes around 6 to 9 months to convert it into compost and only rice straw is not on its own able to decompose into compost. Many people have used both of these ingredients for composting but in a different manner and got different yields with different C/N ratios. In our compost, C/N ratio 44.83, 48.7:1.1 is obtained, which we can use to as compost, but it can be improved by increasing more improvement in the method as the ideal C/N ratio is considered 30/1. Moisture present in compost is increased because of the rainwater and weather conditions. The amount at last obtained by compost after considering and balancing it with raw material used is 28 kg as some amount is flow in the rain. Thus rather than burning rice straw polluting the air quality, we can use this waste material for composting and increase the soil quality, biodiversity, and heredity of the land.

Reference

[1] R. Bakker, W. Elbersen, R. Poppens, and P. Lesschen, "Rice straw and Wheat straw," no. June, 2013.

[2] G. Engling *et al.*, "Size-Resolved Anhydrosugar Composition in Smoke Aerosol from Controlled Field Burning of Rice Straw Size-Resolved Anhydrosugar Composition in Smoke Aerosol from Controlled Field Burning of Rice Straw," vol. 6826, no. May, 2009.

[3] M. Lokman, C. Jusoh, L. A. Manaf, and P. A. Latiff, "ENVIRONMENTAL HEALTH Composting of rice straw with effective microorganisms (EM) and its influence on compost quality," pp. 1–9, 2013.

[4] N. N. Joshi, "' Production and Utilizati on strategies of Organic Fertilizer for Organic Farming : An eco- friendly approach ,'" vol. 8, no. 8, pp. 58–61, 2015.

[5] A. M. Breure, "SOIL BIODIVERSITY : MEASUREMENTS , INDICATORS , THREATS AND SOIL FUNCTIONS," pp. 83–96, 2004.

[6] J. J. Cheng, Z. Liu, J. Gontupil, and O. Kwon, "Anaerobic co-digestion of rice straw and digested swine manure with different total solid concentration for methane production," no. December 2014, 2015.

[7] Dickson, N., T. Richard, and R. Kozlowski. 1991, Composting to Reduce the Waste Stream: A Guide to Small Scale Food and Yard Waste Composting, 1991.

[8] M. S. Zayed, M. K. Hassanein, and A. M. A. El-satar, "Evaluation of compost , vermicompost and their teas produced from rice straw as affected by addition of different supplements," *Ann. Agric. Sci.*, vol. 59, no. 2, pp. 243–251, 2014.

[9] S. Hosseini, H. Aziz, C. Syafalni, and M. Kiamahalleh, "Optimization of NaOH thermo-chemical pre-treatment for enhancing solubilisation of rice straw by Response Surface Methodology HAL Id : hal-00607962," no. June, 2011.