J. Cotton Res. Dev. **34** (2) 301-308 (July, 2020) **ISSN No. 0972-8619**

Storability of bio enriched compost prepared from cotton stalks

HAMID HASAN, ASHTASHILA SARDAR, N.M. ASHTAPUTRE AND V. MAGESHWARAN*
ICAR Central Institute for Research on Cotton Technology (CIRCOT), Mumbai - 400 019
**E-mail : mageshbioiari@gmail.com*

ABSTRACT: The effect of storage on total microbial population and nutritional value of bio enriched compost prepared from cotton stalks under field conditions were determined in this study. Large scale composting experiments with five tonnes of chipped cotton stalks was conducted at a farmer's field in Begu village, ICAR- CIRCOT Regional Centre, Sirsa, Haryana during the period January to March, 2015. The samples were drawn from each heap of matured compost (90 days old) at three months interval during the period June 2015 to May 2016 for its analysis. The results showed that storage of compost did not significantly affect the total microbial population. The *p*H of the compost was in the range of 7.0 to 7.3 during the storage period while total solids were in the range of 37 to 56.6 per cent. The total nitrogen, total phosphorus and total potassium content vary between 1.2 and 1.8, 0.66 and 0.85 and 0.97 and 1.25, respectively. While, the C: N ratio varied from 11.3 to 19.8. To conclude, our results showed that the storage of cotton stalks compost over one year did not affect its nutrient quality. Instead the quality was improved. Thus, the study revealed that cotton growing farmers could prepare the bio-enriched compost from chipped cotton stalks using the developed process in the field itself, store and utilize for next crop without deterioration of its quality.

Key words : CN ratio, compost, cotton stalks, microbial population, nitrogen, phosphorus, potassium

In India about 30 million tonnes of cotton stalks are generated every year (Hiloidhari *et al.,* 2014). Cotton stalks comprise about 75-82 per cent holocellulose, 24-26 per cent lignin, 12-14 per cent moisture and 6-8 per cent ether extractive. Harvested stalks stored in the field serve as storehouse for harmful insects and diseases. Sometimes cotton stalks are mulched in the soil that requires heavy machinery per cent some additional fertilizer need to be added to enhance the stalk decaying process, which further involves high energy and cost. Most of the cotton stalks are treated as waste, some are being used as fuel by rural population, while annually, and the bulk of the cotton stalk is burnt after harvest to clean the field, which then leads to nutrient losses and increased CO_2 inputs to the atmosphere. Hence the best way to bring back the nutrient into the soil is composting of cotton stalks.

Composting is the process in which complex molecules such as lignin, cellulose, hemicelluloses, lipids is converted into simpler molecules. During the composting process, besides the final product in the form of humus; heat, compounds of nitrogen, oxygen, phosphorus, CO_2, H_2O, and a significant amount of microbial biomass is created. Many factors like temperature, moisture content, oxygen concentration and nutrient availability affects the rate of decomposition of organic matter. These factors, in turn, strongly affect the

structure and diversity of the microbial community, microbial activities and the physical and chemical characteristics of the compost. Although considerable work has been done on composting of organic waste, composting of high lignin content organic material like cotton stalks within shorter period of time is still a challenge.

A rapid microbial process for preparation of bio-enriched compost from cotton stalks was developed and the prepared bio-enriched compost had three time's higher nutrient content than conventional farmyard manure (Mageshwaran *et al.,* 2015). In practice, the farmers may find difficult to use the prepared compost in the same season. Hence, the effect of storage on quality of compost for its use in next season should be understood. The present study aims to understand the effect of storage of cotton stalks compost on its quality for the period of one year.

Microbial consortia : Microbial consortia consisted of aerobic consortium, anaerobic consortium and plant growth promoting microbes. The liquid aerobic and anaerobic microbial consortia were obtained from Microbiology lab, Central Institute for Research on Cotton Technology (CIRCOT), Mumbai. The microbial strains viz., *Bacillus stearothermophilus, Pleurotus flabellatus and Phanerochaete chrysosporium* were used for the preparation of aerobic consortium. The anaerobic consortium consisted of mixture of anaerobic and facultative anaerobic microbes. The commercial solid formulations of plant growth promoting microorganism's *viz., Azosprillum, Azotobacter, Fluorescent Pseudomonas, Phospobacteria and Trichoderma viridie* were obtained from Indian Agricultural Research Institute (IARI), New Delhi.

Cotton stalks : The cotton stalks were collected and chipped to 3 - 4 cm length and 1- 2 cm thickness. The range of initial moisture in cotton stalks recorded was 30-35 per cent.

Composting trial : The large scale trials on composting of cotton stalks using five tonnes of chipped cotton stalks were conducted at a farmer's field in Begu Village, ICAR-CIRCOT unit of Sirsa, Haryana. The experimental trial was conducted during January to March, 2015. Three heaps were of each 1.7 tonnes of cotton stalks were made. The ingredients *viz.*, alkali (@ 0.2%), cattle dung (@ 10%), garden soil (@ 0.1%), Urea (@1.2%), Diammonium phosphate (@ 2%), aerobic and anaerobic culture (0.1 % each in treated heaps only) were added and mixed in sequential manner and heaps were made. The initial moisture content maintained was 50 per cent including the moisture content of raw cotton stalks. The individual heaps were covered with polythene sheets. At 30th day of composting, the plant growth promoting microorganisms (*Azosprillum, Azotobacter, Fluorescent Pseudomonas, Phospobacteria and Trichoderma viridie*) were added each @ 0.1 per cent in the treated heap only. All the heaps were turned periodically for every week for proper aeration. After ascertaining the temperature of compost reached to atmospheric temperature (90 days of composting), the compost was packed in 50 kg PP bags and stored inside a room.

Analysis of compost samples : The compost samples were taken from stored bags at periodic intervals at 0, 3, 6, 9 and 12 months

of storage, oven dried and powdered. The sampling was done during the period June 2015 to May 2016. The powdered samples were passed through 200 µ size sieve and used for analysis. Each sample was analyzed for organic carbon, Total N (TN) by micro-Kjeldhal (Humphires, 1956), Total P (TP), Total K (TK) by Flame photometer. CN ratio was determined by finding out ratio between total organic carbon and total nitrogen.

The fresh samples taken during different intervals were used for analyzing *p*H and total microbial count. The *p*H was measured using pH meter. The total microbial count including total bacterial, total fungi and total actinomycetes counts were determined using 1g of wet sample by standard serial dilution technique.

In this study, to accelerate the composting process, mixture of lignocelluloytic microorganisms including *P. chrysosporium*, *B. stearothermophilus* and *P. flabellatus* was used. In a similar study, the inoculation of lignocellulolytic microorganisms such as *P. sajor-caju*, *T. harzianum*, *A. niger* and *Azotobacter chrococcum* to enhance the composting process was reported for wheat straw composting (Singh and Sharma, 2002). The composted cotton stalks had significantly reduced hemicelluloses and lignin than cellulose when compared to raw cotton stalks (results not shown). The observed results might be due to more susceptibility of hemicelluloses towards microbial degradation than other counterparts. During the degradation, part of lignin is also degraded which results in decrease in lignin content. Similar results were found by several workers. The fungal pretreatment of cotton stalks by *P. chrysosporium* showed significant lignin and hemicelluloses degradation compared to untreated stalks (Shi *et al.,* 2009). The lignocellulosic degradation during composting process was due to composite cultures than single organism in which each organism have different specificity and thus brings faster decomposition (Gupta *et al.,* 2004).

Use of organic wastes in agriculture is known to reduce the pollution and improve soil quality. In India, about 30 million tonnes of cotton stalks are generated annually (Hiloidhari *et al.,* 2014). Farmers are burning the stalks obtained after harvesting due to its disposal problem. This causes air pollution and soil fertility deterioration in major cotton growing states of India. Cotton stalks take more time for biodegradation due to its high lignin content and broad C: N ratio. Previously, bio-enriched compost was prepared from cotton stalks using microbial consortia. Cotton growing farmers can save about Rs. 9000/ac by replacing farmyard manure with cotton stalks compost (Mageshwaran *et al.,* 2015; 2017). However, in many instances, the farmers may not able to utilize the prepared compost in the same season. It is important to understand the effect of storability of compost for a year in order to use the compost in next season. Considering this, the present study was attempted to evaluate the storage of bio enriched compost prepared from cotton stalks for the period of one year on its quality.

The composting trail was taken at a farmer's field at Begu Village, ICAR-CIRCOT unit, Sirsa, Haryana (Fig. 1). The compost was prepared from 5 tonnes of wet cotton stalks made into three heaps. The maximum temperature recorded in the compost heaps during the

thermophilic phase was 55 - 60°C. The mineralization occurs most rapidly during the thermophilic phase of composting (40 – 60° C) which lasts for several weeks or months depending on size of the system and composition of the ingredients. High temperature (60-75°C) reached in thermophilic phase of composting is a factor which completely reduces the pathogens. The bio enriched compost prepared cotton stalks are depicted in Fig. 2. The prepared compost was packed in 50 kg PP bags and stored in shade room. The initial moisture content in the compost was 63 per cent.

Effect of storage on total microbial count of compost : The total microbial count including bacteria, fungi and actinomycetes were estimated different intervals (0, 3, 6, 9 and12 months of storage). Irrespective of the storage period, the total bacterial population in the compost sample was higher followed by total actinomycetes and total fungi. The enumerated microbial count at 0, 3, 6, 9 and12 months of storage is presented in Table 1. The total bacterial count (cfu/g) was found higher during the 0th month of storage (2.6x 10^{9}) and declined to 3.0x10^{7} in 3 months and maintained 3.6 x10^{8} after 6 months of storage of compost. The total fungal count did not much differ during 12 months of storage period. The total fungal count (cfu/g) was range between 1.5x10^{5} and 4.6x10^{5}. Similarly, the total actinomycetes population did not differ much during 12 months of storage period. The actinomycetes population (cfu/g) was

Fig. 1 Composting trial taken at farmers field at Begu Village, Sirsa, Haryana

range between $1.7x10^8$ and $9.8x10^8$. Similar results were obtained by several workers. The present results showed the total microbial count in the compost did not differ during 12 months storage time however, there is a slight reduction in bacterial population in the compost was observed.

Effect of storage on physico chemical properties of compost : The physico chemical properties of cotton stalks compost analysed during different period of storage are presented in Table 2. The pH of compost was neutral and ranges between 7.0 to 7.3. The total solid in compost during 0^{th} month was 37 per cent and the total solid was increased during the storage period and it was recorded 56.6 per cent in 12^{th} month of storage. This is due to reduction in moisture content in compost over the storage time. The total organic carbon content was decreased from 23.7 to 18.7, during three months of storage period and maintained similar value during subsequent storage. The TN was increased from 1.2 to 1.8 in 9 month's storage period and subsequently reduced to 1.3 in 12 months. This might be due to volatilization of nitrogen during long storage time. The TP was increased from 0.66 (0^{th} month) to 0.85 (6^{th} month) and maintained further. While, the TK content was increased from 0.9 (0^{th} month) to 1.25 (6^{th} month) and maintained during the subsequent period of storage.

The increase in nitrogen content during composting might be a direct manifestation of mass carbon loss. Similar results were obtained by several workers that there was 27 per cent increase in nitrogen content, when mechanized compost inoculated with *Azotobacter* and rock phosphate. It is also evident from the experiments of that *Azotobacter* inoculation helps in increasing the N content of compost. Also, the phosphorus content was increased conspicuously with addition of microbial inoculants to the compost (Kavitha and

Table 1. Effect of storage on total microbial population of compost

Microbial population(cfu/g)	Months				
	0	3	6	9	12
Bacterial count	$2.6x\ 10^9$	$3.0x10^7$	$3.6x10^8$	$2.1x10^8$	$3.6x10^8$
Fungal count	$3.6x\ 10^5$	$1.5x10^5$	$4.6x10^5$	$3.5x10^5$	$4.6x10^5$
Actinomycetal count	$4.7x\ 10^8$	$9.8x10^8$	$5.4x10^8$	$1.7x10^8$	$5.4x10^8$

Table 2. Effect of storage on physico chemical parameters of compost

Physico-chemical parameters	Months				
	0	3	6	9	12
*p*H	7.1	7.1	7.3	7.0	7.3
Total solids	37	49.7	51.9	53.7	56.6
Total Organic Carbon (%)	23.7	18.7	19.1	20.3	19.5
Total Nitrogen (%)	1.2	1.5	1.4	1.8	1.3
Total Phosphorus (%)	0.66	0.72	0.85	0.85	0.8
Total Potassium (%)	0.97	1.1	1.25	1.25	1.25

Fig. 2 Bio-enriched compost from cotton stalks (A- raw cotton stalks; B- bio-enriched cotton stalks compost)

Subramanian, 2007).

The Fertilizer Control Order (FCO) recommends that the TN, TP and TK content (%) in the compost should be 1.0, 0.8 and 0.8, respectively and colour of the compost should be dark brown to black (FAI, 2007). Thus the results indicated that physico chemical properties of bio enriched compost prepared from cotton stalks stored during one year period had significant effect on NPK content. Though there is not much change in TN content in stored compost, the TP was comparatively reduced and TK was significantly increased. . The TN, TP, TK content (%) of farm yard manure (FYM) was calculated to be 0.5, 0.2, 0.5, respectively. It was noted that the TN, TP, TK level of bio-enriched compost prepared from dry cotton stalks during 12th month of storage was 1.3, 0.8 and 1.25, respectively. Hence, the cotton stalks compost is about three times nutrient rich than FYM.

Effect of storage on CN ratio of compost : CN ratio is an important indicator for composting process. As per Fertilizer Control

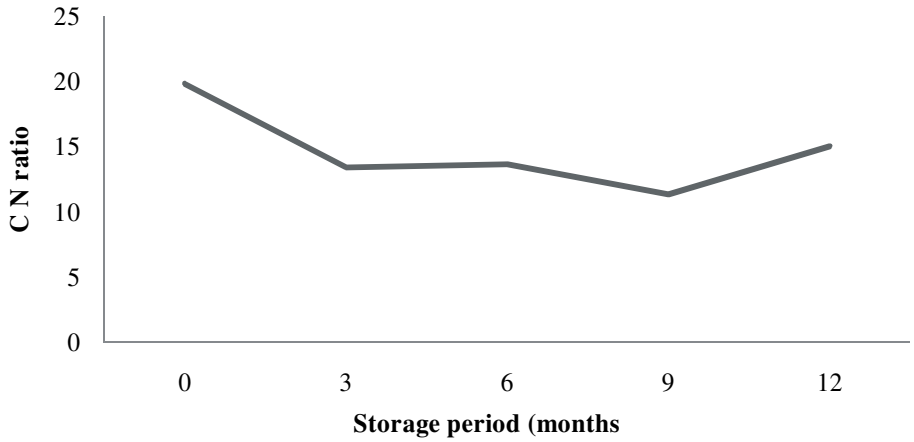

Fig. 3. Effect of storage on CN ratio of cotton stalks compost

Order (FCO), Government of India, 1985 (FAI, 2007), the CN ratio should be below 20 to effectively used for composting. In the present study, the initial CN ratio of the prepared compost was 19.8 and during the storage period, the CN ratio was declined slightly and reached to 11.3 at 9 month of storage period (Fig 3). The CN ratio was increased to 15 in 12 month due to decrease in nitrogen content (Table 2). CN ratio is an important indicator for composting process. Several workers have suggested that inoculation of fungal cultures resulted in rapid decomposition of agro residues with decreases in CN ratio.

CONCLUSION

In the present paper, the effect of storage of bio enriched compost prepared from cotton stalks on its quality was studied. During the storage period of one year, the pH of the compost was in the range of 7.0 to 7.3, total NPK was increased while CN ratio was decreased. There is no significant change in total microbial population except a slight decrease in bacterial population. Thus, the storage of compost over the period of one year is not affecting the quality of compost in turn it is improved. Thus, the cotton growers can effectively use the bio enriched compost prepared from cotton stalks over the period of one year without loss of its quality.

ACKNOWLEDGEMENT

The authors are thankful to Director, ICAR-CIRCOT, Mumbai for his guidance and support throughout the study.

REFERENCES

Arora, D.S. and Garg, K.K. 1992. Comparative degradation of lignocellulosic residues by different fungi. *Bioresource Technol.*, **1** : 279-80.

FAI.2007. The Fertilizer (Control) Order. 1985. The Fertilizer Association of India, 10, Saheed Jit Singh Marg, New Delhi, India.

Gupta, S.B., Tamraka, D.K., Tamrakar, M.P., Thakur, K., Tedia, A. T and Keshry, P.K. 2004. Effect of crop beneficial microbes on decomposition rate of different crop residues. *J. Soil Crop,* **14** : 1-4.

Hiloidhari, M., Das, D and Baruah, D.C. 2014. Bioenergy potential from crop residue biomass in India. *Renew. Sust. Energy Rev.* **32**: 504-12.

Kavitha, R. and Subramanian, P. 2007. Bioactive Compost – A value Added Compost with Microbial Inoculants and Organic Additives, *J. Appl. Sci.*, **7** : 2514-18.

Mageshwaran, V., Ashtaputre, N.M., Monga, D., Nalayani, P., Shukla, S.K and P.G. Patil. 2015. A rapid process of preparation of bio-enriched compost from cotton stalks. Symposium papers *"Future Technologies: Indian cotton in the next decade"* (Cotton Research Development Association), 469-78.

Mageshwaran, V., Satankar, V., Hasan, H., Shukla, S.K and P.G. Patil. 2017. Compost production and Oyster mushroom cultivation- A potential entrepreneurship for cotton growing farmers. *Internat. J. Forestry Crop Improv.* **8 :** 149-56.

Shi, J., Sharma-Shivappa, R.R., Chinn, M and Howell, N. 2009. Effect of microbial pretreatment on enzymatic hydrolysis and fermentation of cotton stalks for ethanol production. *Biomass Bioenerg.* **33**: 88-96.

Singh, A and Sharma, S. 2002. Composting of a crop residue through treatment with microorganisms and subsequent vermicomposting. *Bioresource Technol.* **85**: 107-111.

Received for publication : December 11, 2019
Accepted for publication : May 7, 2020