

Evaluation of Quality and Nutrient Status of Enriched Compost

Manjunatha Chari K, Ravi M. V,

Department of Soil Science and Agricultural Chemistry University of Agricultural Sciences, Raichur

Abstract: The disposal of these wastes has been a major concern for the farmers as well as economist. However these wastes contain bio degradable organic and mineral constituents which are of plant origin which can be better utilized for composting. Composting was prepared by chaffed cotton stalks and farm wastes, enrichment with other additives. Enriched compost was prepared using additives like urea, single super phosphate and during the termination of compost zinc, iron, copper and manganese were used. The result revealed that there was a reduction in C:N ratio, reduction in lignin content and total phenol during the composting period compare to original raw material and with increase in other nutrients during the period of composting period.

Key words: cotton stalk, enriched, crop residues

I. Introduction

India is the largest producer of cotton in the world cultivated in an area of 9.5 million hectare with a production of 30.79 million tonnes of cotton stalks. In Karnataka, it is cultivated in an area of 0.38 million hectare with production of 0.74 million tonnes. Even if 50% of these residues are utilized as animal feed or fuel, the rest can be mobilized for recycling of plant nutrients and to avoid the dependence on chemical fertilizers to certain extent. The direct addition of crop residues to soil leads to immobilization of plant nutrients which may have adverse effects on the growth of crops. So, prior to this decomposition of organic residues it is essential to avoid immobilization of nitrogen by microorganisms.

Cotton stalks are low in nutritive value and contain higher amount of lignin and cellulose. Though nitrogen and phosphorus is the accepted technology for synthesis of high value composts, incorporation of trace elements in compost preparation not widely attempted. Scientific method of composting using decomposition technique and enrichment can render this waste fit for agricultural use. Because of wider C: N, ratio there will be slow rate of decomposition. Further, inoculation of cellular organism into plant residues will hasten the biodegradation process. To get better quality compost, there is need to enrich cotton stalks with nutrient additives and also by use of microbial culture for proper decomposition.

Enrichment of compost using nitrogen source as urea and crop residues and phosphorus source as single super phosphate and quality of compost was enhanced using micronutrients is less explored so far. It is also possible to use of microbial culture lignin decomposer *Phaerochaete chrysosporium* for faster degradation of the resistant material by making use of cow dung. Therefore one should know ideal maturity of compost before application of enriched compost. Various parameters have been proposed to establish the degree of stability and quality of composts. The true maturity assessed by measuring maturity indices such as C:N ratio, lignin, phenol content and quantity of secondary and micronutrients during the period of composting.

II. Materials and methods

The basic raw materials used for composting were cotton stalks and organic additives were garden weeds, cow dung @ 20% and urea @ 0.2%. The inorganic additives were single superphosphate @ (P₂O₅) 1% and micronutrients (Zn, Fe, Mn and Cu @ 400, 200, 20 and 20 ppm respectively 15 days before termination of composting). *Phanerochaete chrysosporium* was used as microbial inoculum @ 1kg/ton in compost treatments. The samples were collected in four places at different intervals (30th, 60th, 90th and 120th days of composting) in each pit and analyzed statistically using CRD. As per the treatments, cotton stalk was spread and compacted well at the bottom of the pit and cultural materials, garden weeds and cow dung slurry were spread over the layer. Over these, mineral additives were added. This procedure was repeated till complete fill up of pit. Turnings were given at a monthly interval up to end of composting (120th days), moisture was maintained around 60-65%. Pre sampling of residues used for this study was done for analysis of chemical properties. Upto 120th days of decomposition, monthly turning of compost samples were collected intermittently, dried and ground to pass through a 1 mm sieve and used for chemical analysis. Super phosphate with 16% P and urea 46 % N and micronutrients sulphates of Zn, Fe, Mn and Cu were used. Organic carbon (OC) content was determined by dry combustion method by Walkley and Black as described by Jackson (1973), calcium, magnesium and sulphur as described by Jackson (1973), Micro nutrients like zinc, copper, iron and manganese were determined by diacid digestion method (Piper, 1966) and analysed by the standard methods and were

analyzed using AAS and lignin and phenol content estimated by using standard procedure as outlined by Goering and Vansoest. (1975).

Compost treatments involves C₀: Cotton stalk; C₁: Cotton stalk + Cow dung; C₂: Cotton stalk + Cow dung + Microbial culture; C₃: Cotton stalk + Cow dung + Garden weeds; C₄: Cotton stalk + Cow dung + Microbial culture + Garden weeds; C₅: Cotton stalk + Cow dung + Microbial culture + Garden weeds + Superphosphate + urea; C₆: Cotton stalk + Cow dung + Microbial culture + Superphosphate + urea+ Micronutrients.

Chemical changes during composting

C: N

Irrespective of composting period, there was a significant effect of treatments on C: N ratio. All the compost treatments showed decrease in C: N ratio with time of decomposition. Lowest C: N ratio was recorded in C₆ (12.62%) and highest in C₀ (63.44%). However, addition of organic and inorganic additives during composting in C₆ recorded lowest C: N ratio of 15.97% and 9.46% and highest C: N ratio of 74.00% and 51.69% in C₀: Cotton stalk on 30th and 120th day of decomposition respectively. The decrease in C: N ratio was due to higher N content and faster rate of decomposition due to the activity of introduced fungal strain. Several workers have suggested that inoculation of fungal cultures resulted in rapid decomposition with decreases in C: N ratio (Jagadeesh *et al.*, 1996). It attributed to fungi produce more of cellulase than bacteria.

Calcium and Magnesium

The significant difference was found in calcium content of the compost treatment at different intervals (Table 2). Higher calcium content of 2.77 per cent recorded in C₆ and least in C₀ (0.76%). However, calcium content of all compost treatments were less at 30th day and there will be no much higher content of calcium recorded at the end of composting period (120th day). There was no significant difference between C₅ and C₆ mineral enriched treatments but superior over (C₀, C₁, C₂, C₃ and C₄) treatments. The microbial and organic enriched composts along with cotton stalk shows less percent of calcium compared to combination of mineral, microbial and organic enriched compost treatments C₅ and C₆ (3.18% and 3.31% of calcium at 120th day).

Increase in magnesium content with increase in period of composting. However, higher (1.89 %) magnesium content was noticed in C₆ and least (0.37%) in C₀. Irrespective of composting period there will be significant effect of treatment on magnesium content. Mineral enriched compost treatments C₅ and C₆ recorded non significant differences and which is superior over C₀, C₁, C₂, C₃ and C₄ treatments. Enrichment with superphosphate resulted in higher calcium content. Calcium, sulphur and phosphorus being a constituent of superphosphate and it might have resulted in higher calcium content in mineral enriched compost as compared to C₀: Cotton stalk. Similar trend was observed with respect to magnesium. Higher magnesium content was recorded in C₆ (2.44%) and C₅ (2.36%) and least in case of C₀ (0.39%) at 120th day of composting. Enrichment enhanced the status of these nutrients compared to C₀: Cotton stalk and microbial enriched treatments. Similar results were obtained by Gundappa (1999) and Preethu *et al.* (2007).

Sulphur

Sulphur content of cotton stalk residues during the composting period indicates (Table 2) that all the compost treatments were found to have marked influence. Among all the treatments, C₅ and C₆ recorded highest values (1.13 % and 1.18% of sulphur at 120th day of composting) and significantly superior over other treatment combinations. Mineral enrichment (C₆) resulted in higher sulphur content. This was due to sulphur content in super phosphate and also enrichment with micronutrients (Preethu *et al.*, 2007), as these are salts of sulphur resulted in significantly higher sulphur content compared to other treatment combination.

Micronutrients

With increase in period of composting there will be increase in micronutrient like zinc, iron and manganese content of the compost treatment (Fig.2). Among the compost treatments, the treatment with mineral enrichment shows maximum content followed by other treatment combinations. Among the composts treatment zinc content was high in C₆ followed by C₅ and least in C₀. The treatment C₆ recorded highest (0.044 % and 0.088 % at 30th and 120th day) zinc content which is significantly superior over C₅ and other treatment combinations. Iron and manganese content of compost increases with increase in period of composting and at 120th days of maturity C₆ (3.94% and 0.268%) and C₅ (3.86% and 0.256%) respectively, composts significantly superior over other treatments from C₀ to C₄.

The changes in the content of lignin, cellulose and hemicelluloses and phenol during composting decreased with composting. This may be due to positive effect of these additives on decomposition by way of increased availability of N, P and essential nutrients for microorganisms involved during the decomposition

process. Microbial succession ensures the breaking down of such compounds over a period of time. The results clearly show that microbial inoculation enhances the degradation of cellulose, lignin and phenols over a period of time. This observation was confirmed by the report of Cortz *et al.* (1996). According to them cellulose will be decomposed faster than lignin in decomposition system which were rich in cellulose and lignin. Barder and Crowford (1981) reported lignin degradation was greatest in presence of high levels of nitrogen. Further enhancement of lignin degradation occurred in medium containing organic supplemented with low levels of nitrate; this may be reason for high rates of decomposition in C₅ and C₆. Enrichment through micronutrients showed significant increase in the availability of the compost due to the chelating effect of organic materials. Similar results obtained by Dakshinamurthy and Upendra, 2008 who reported enrichment of zinc and Boron showed increase in availability Zn and B content of composting materials this due to organically chelated micronutrients. This is also due to micronutrient enrichment before termination of composting to the compost resulted in increased availability of micronutrients and also due to chelating effect of organic molecules.

Biochemical changes during composting

Phenol

The data on changes in total phenols at different intervals the total phenol content in all the composts decreased with period of decomposition (Fig. 3). Phenol content ranges from 8.00 mg 100 gm⁻¹ in C₀ to 26.00 mg 100 gm⁻¹ in C₁ at the 120th days of decomposition. C₅ and C₆ recorded 16.00 and 16.12 mg 100 gm⁻¹ respectively. Among composts treatment, enrichment with no additives C₀ resulted in lower total phenol content compared to organic, mineral and microbial enriched treatments C₁ to C₆. The highest phenol content was recorded in treatment with all additives viz., garden weeds, superphosphate, urea and microbial culture (C₅ and C₆). This may be due to higher humification in presence of adequate nutrients and all additives in enriched composts treatment result in weakening the lignin structure and release of poly phenols. However, amount of humic substances formed during decomposition was higher due to presence of *Phanerochaete chrysosporium* during decomposition, humic and fulvic acids formed during decomposition of higher lignin containing residues in presence of lignin degrading fungi (Bhattacharya *et al.*, 1999).

Lignin

The data changes in per cent lignin content in composting material at different intervals that lignin content of decomposing materials decreased with period of decomposing in all the treatments. Among all the treatments, microbial and mineral enriched composts treatment C₆ and C₅ recorded significantly higher lignin reduction over other treatments (8.03% and 8.35% respectively) at 120th as compared to 30th days of composting (12.15% and 12.28% respectively) and least lignin degradation was recorded in C₀ (18.72% at 30th and 15.73% at 120th day) compost treatments (Fig.4). The lignin percent decreased considerably when cotton stalk was taken for composting as compared to their initial status. Among different composts, enriched composts C₅ and C₆ which received all additives registered lower lignin as compared to other treatments. This might be due to higher decomposition in presence of adequate nutrients and residues undergo biological decomposition. This observation was confirmed by the report of Cortz *et al.* (1996) which states that cellulose will be decomposed faster than lignin in decomposition system which were rich in cellulose and lignin. Barder and Crowford (1981) reported that lignin degradation was greatest in presence of high levels of nitrogen. Further enhancement of lignin degradation occurred in medium organic supplement with low levels of nitrate; this may be the reason for high rates of decomposition in C₅ and C₆.

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Table 1. Physico-chemical properties of cotton stalk residues used in the study

Sl No.	Properties	Value
1.	pH (1:10 Compost: water)	5.71
2.	EC (dsm ⁻¹) (1:10 Compost: water)	1.43
3.	Organic carbon (%)	38.50
4.	Nitrogen (%)	0.45
5.	Phosphorus (%)	0.20
6.	Potassium (%)	0.60
7.	Calcium (%)	0.21
8.	Magnesium (%)	0.13
9.	Sulphur (%)	0.01
10.	Zinc (%)	0.012
11.	Iron (%)	0.121
12.	Manganese (%)	0.038
13.	Lignin (%)	19
14.	Cellulose (%)	38
15.	Hemicelluloses (%)	21

Fig 1: C:N ratio (%) of different composts at different intervals

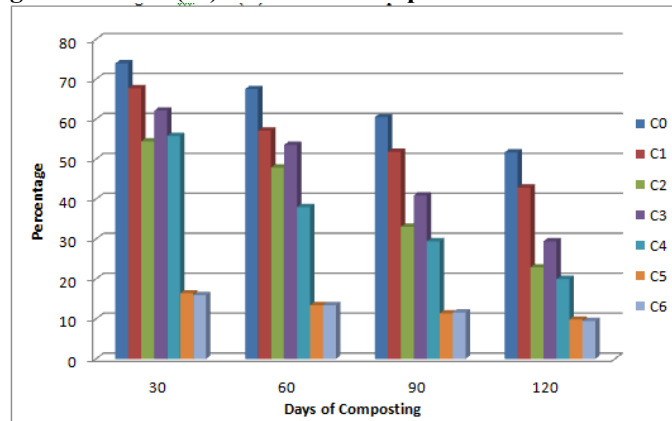


Fig 2: Micronutrient status of different composts at different intervals

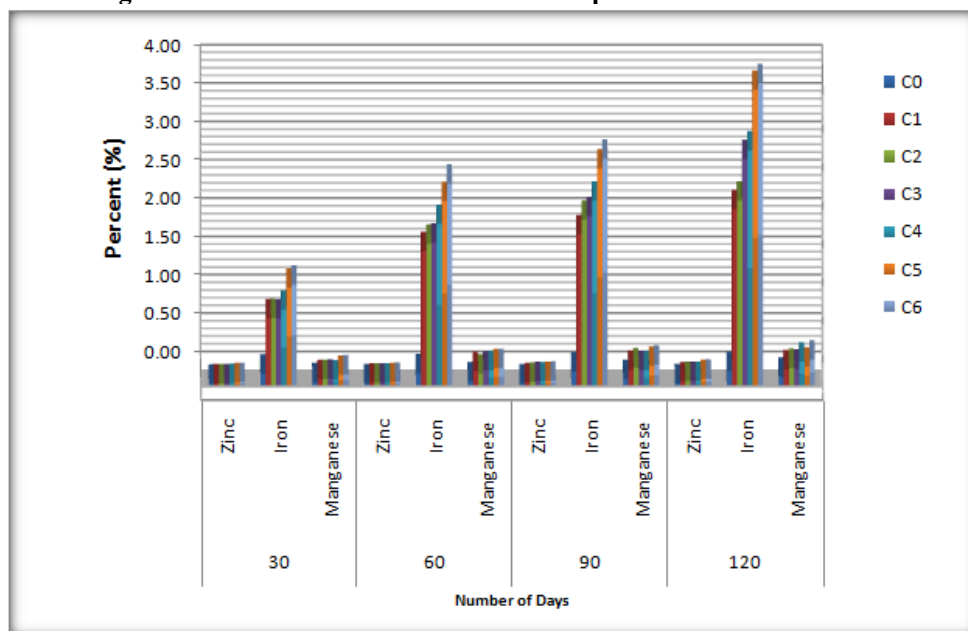


Table 2: Nutrient status (%) of different composts at different intervals of Calcium, Magnesium and Sulphur

Intervals	30 th day			60 th day			90 th day			120 th day		
Treatments	Ca	Mg	S	Ca	Mg	S	Ca	Mg	S	Ca	Mg	S
C0	0.37	0.34	0.03	0.69	0.37	0.04	0.93	0.37	0.06	1.03	0.39	0.06
C1	1.41	0.8	0.09	2.15	1.36	0.18	2.89	1.5	0.24	2.97	1.61	0.35
C2	1.53	0.96	0.12	2.3	1.52	0.16	2.9	1.7	0.24	3.08	1.7	0.26
C3	1.83	1.06	0.27	2.32	1.6	0.32	2.62	1.71	0.34	2.84	1.8	0.54
C4	1.5	1.24	0.25	2.34	1.68	0.34	2.44	1.75	0.35	2.79	1.86	0.71
C5	2.27	1.35	0.86	2.57	1.84	0.94	3.1	1.92	1.35	3.18	2.36	1.4
C6	2.27	1.36	0.86	2.65	1.79	0.99	3.17	1.95	1.41	3.31	2.44	1.48
S.Em ±	0.04	0.03	0.01	0.05	0.04	0.01	0.07	0.04	0.01	0.07	0.05	0.02
CD at 5%	0.13	0.09	0.03	0.16	0.12	0.03	0.21	0.12	0.04	0.22	0.16	0.06

Fig 3: Phenol (mg 100 gm⁻¹) at different intervals of composting

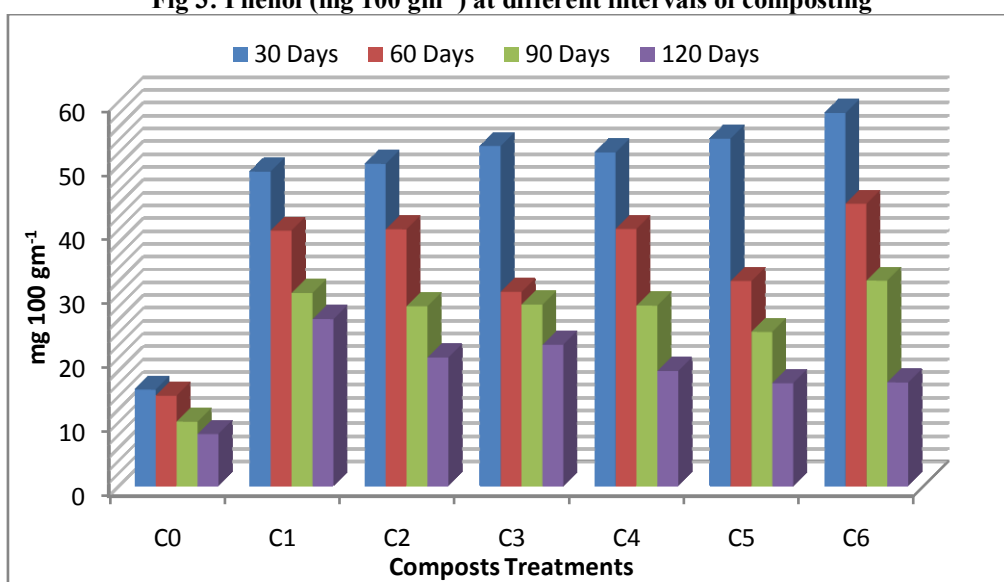


Fig 4: Lignin content (%) at 30th and 120th days of composting

