



CHEMICAL AND BIOCHEMICAL PROPERTIES OF PARTHENIUM AND CHROMOLAENA COMPOST

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ABSTRACT

Parthenium (*Parthenium hysterophorus*) and chromolaena (*Chromolaena odorata*) are fast growing weeds which come up in abundance in fallow lands, road sides, gomal (range) lands, the biomasses can be used for composting. The organic additive was cow dung at the rate of 20 per cent; inorganic additives were rock phosphate, zinc and boron. The microbial inoculum used was a mixture of *Pleurotus sajorcaju*, *Phanerochaete chrysosporium*, *Trichoderma harzianum*, ZnSO₄ @ 400 ppm Zn and borax @ 200 ppm was added 30 day before termination of composting. Both composts recorded near neutral pH are due to the natural buffering of humus. The EC of chromolaena compost recorded higher value than that of the parthenium compost. However, pH and EC values are within the acceptable limits and hence they are ideal for application to all types of soils under different cropping system. The organic carbon and nitrogen recorded were more in chromolaena compost compared to parthenium compost which was due to their high OC and N contents in the raw materials. The enrichment of parthenium and chromolaena with rock phosphate has yielded higher P content in composts. The K, Ca, Mg and S content did not show much difference in both the composts. The rock phosphate enrichment has increased the Ca and Mg content in the compost. The enrichment of zinc recorded higher zinc value.

KEY WORDS: Parthenium, chromolaena, compost, rock phosphate, micronutrients.

INTRODUCTION

Chemical fertilizers are the most basic needs of present day agriculture and it has shown marked cost escalation in recent years. On the other hand, many waste plants are growing menacingly threatening agriculture and environment and they are having abundant biomass which can be exploited for soil improvement and economic crop production. Among these parthenium (*Parthenium hysterophorus*) and chromolaena (*Chromolaena odorata*) are fast growing which come up in abundance in fallow lands, road sides, gomal (range) lands. Besides having high content of N and P, they have succulent biomass and could be used to help substantially in N and P economy of crops if incorporated in the soil. Keeping this in view parthenium and chromolaena compost evaluated.

MATERIALS AND METHODS

Compost preparation

For the preparation of composts, cement cisterns of dimension 90 cm height 90 cm diameter were used. Holes of three cm diameter were made at height of 15 cm above the bottom on the four sides of the cistern. Chopped chromolaena and parthenium plants were added uniformly in separate tanks. Over this, rock phosphate was sprinkled along with cow dung slurry and microbial culture (*Pleurotus sajorcaju*, *Phanerochaete chrysosporium*, *Trichoderma harzianum* mixture) uniformly. Over this layer another layer of chromolaena / parthenium was added over it uniformly. This procedure was repeated to finish 100 kg of chromolaena/parthenium and finally the top of the cistern was covered with soil slurry to prevent exchange of gases and loss of heat. Throughout the com

posting process the moisture was maintained around 60 per cent of maximum water holding capacity of the material. The details of treatment combination are C₁: Parthenium + Cow dung slurry @ 20 per cent + Microbial culture (20 g) + Rock phosphate at 5 %. C₂: Chromolaena + Cow dung slurry @ 20 per cent + Microbial culture (20 g) + Rock phosphate at 5 %. ZnSO₄ @ 400 ppm Zn and borax @ 200 ppm was added 30 day before termination of composting.

Biochemical composition namely, cellulose, hemicellulose, lignin, labile fraction were determined by the method proposed by Van Soest (1968). Carbon (Amato, 1983) and total N content was determined following the micro kjeldahl method as outlined by Jackson (1973). Phosphorus by vanadomolybdic yellow colour and potassium by Flame Photometer method (Piper 1966). Calcium, magnesium and sulphur (Piper, 1966) and zinc, copper, iron and manganese (Lindsay and Norwell, 1978) were estimated. Humic acid and fulvic acid fraction (Schnitzer 1982), Invertase and cellulase (Schinner and Van Mersi, 1990), urease (Zantuva and Bremner, 1975) and acid phosphatase (Eivazi and Tabatabai, 1977) of compost were estimated.

RESULTS AND DISCUSSION

Data on chemical composition of parthenium and chromolaena used in the experiments are presented in Table 1. Highest carbon and nitrogen content was noticed in chromolaena followed by parthenium. Phosphorus content ranged from 0.63 to 1.93 per cent; lowest in parthenium and highest in chromolaena compost.

Maximum K content was noticed in chromolaena compost (1.89 %) followed by parthenium compost (1.46 %). The C: N ratio showed wide variation among organic materials. It ranged from 15.50 (chromolaena compost) to 23.95 (parthenium).

Cellulose content was found to vary in the organic materials. Highest cellulose content was observed in

chromolaena (18.76 %) followed by parthenium (12.04 %). Lignin content of the materials ranged from 5.20 per cent in chromolaena compost to 26.63 per cent in parthenium (Table 1). Lignin: N ratio was observed to be in between 3.93 to 14.02.

Table 1. Biochemical composition of the organic manures

Parameters	Chromolaena	Chromolaena Compost	Parthenium	Parthenium Compost
Carbon (%)	39.30	20.47	38.32	19.32
Nitrogen (%)	1.90	1.32	1.60	0.99
Phosphorus (%)	0.69	1.93	0.63	1.03
Potassium (%)	1.08	1.89	0.98	1.46
C:N ratio	20.68	15.50	23.95	19.15
Cellulose (%)	18.76	11.92	12.04	6.79
Lignin (%)	11.36	5.20	26.63	6.63
Lignin : N ratio	7.04	3.93	14.02	6.69

The pH of the decomposing materials decreased gradually up to 90 days. This may be due to the production of organic acids and phenolic substances during decomposition (Table.2). The findings in this study concurred with the results of Poincelot (1974) and Verdonck (1988) who indicated that during biological conversion of wastes in to humus, the acid forming bacteria resulted in initial drop of pH followed by an increase to alkaline condition due to ammonia formation which finally stabilized to near neutral or slightly alkaline condition.

The EC of the decomposing materials was highest at 30 days and then decreased up to 90 days (Table 2). Due to high initial microbial activity and mineralization, soluble salt contents will be high and hence high EC was recorded in the initial stages. In the later stages, as humification proceeds the humic fraction might have complexed the soluble salts and thus decreases the amount of mobile free ions.

Irrespective of the organic materials, per cent organic carbon decreased during composting in both treatments. The lowest organic carbon content was recorded in C₁ treatment (parthenium compost) which was due to low organic carbon in raw material itself. Even though the organic carbon content was more in raw materials, it decreased during composting; this may be due to faster loss of organic carbon. The results in the present study are concurred with observation of Mathur *et al.* (1980) who reported that the organic carbon content in the raw materials was high in the beginning of composting, which reduced considerably during composting.

Per cent N shows increasing trend during composting. The increase in N content during composting may be due to direct manifestation of mass loss due to mineralization of organic fraction. Higher N values were recorded in C₂ treatment (chromolaena compost), and it is due to higher initial N content in raw material itself.

The C: N ratio of the compost materials decreased with progress in decomposition in both treatments. Bhanawase *et al.* (1994) reported that the addition of rock phosphate

reduced the organic carbon content of the compost. They also found that the C: N ratio of compost narrowed down from 33.7 to 15.0 in inoculated treatments. Chanayasad and Kubota (1981) pointed out that the C: N ratio of well decomposed materials vary widely from 5 to 20, depending on the type of raw materials used.

In general, the per cent total P increased during composting in both treatments. Chromolaena compost registered higher P content over parthenium compost due to initial high P content in raw material. The increase in P content may be due to mass loss during decomposition. The composting of agricultural waste with low grade rock phosphate was known to increase the solubility of insoluble rock phosphate (Singh *et al.*, 1983; Mey *et al.*, 1986). The incorporation of N either in organic or inorganic form would enhance the microbial activity and helps in solubilization of inorganic P in RP, thereby increasing the soluble P fractions in the composts.

The K and S content of both treatments increased during composting, this increase may be due to mass loss during composting. Potassium and sulphur content was higher in chromolaena compost treatment, which was due to their high contents in chromolaena itself.

The Ca and Mg content of compost treatments increased during composting. This may be due to enrichment of composts with RP. Calcium being a constituent of apatite structure, it might have resulted in higher Ca content. The increase may also be attributed to mass loss during composting.

An increase in the micronutrients content (Zn, Cu, Fe and Mn) of compost materials during composting was observed in both the treatments. This may be due to loss of mass during composting. The enrichment of zinc as zinc sulphate enhanced the higher value of zinc in compost. Incorporation of micronutrients to compost can yield high value composts with high level of micronutrients (Bhargavi, 2001).

The CEC of both compost treatments had increased during composting, which was directly related to the degree of humification. The humification process produces

functional group that increases the CEC (Allison, 1973). Molecules and radicals are oxidized and create acid groups that contribute to CEC. The lignin as such has high CEC due to more functional groups and chromolaena compost treatment which is higher lignin content.

The biochemical properties monitored over the period of decomposition were lignin, cellulose and total phenols. These biochemicals undergo decomposition and their contents decreased as the compost get matured. Similar results were reported by Surya Rao Pampana (2000) and Bhargavi (2001) wherein they reported that there was a drastic reduction in lignin and cellulose content during composting.

The lignin content decreased gradually in both treatments during composting of chromolaena and parthenium as organic manures. The degradation of lignin which may be due to the weakening of lignin structure is attributed to the activity of lignin degrading microorganisms which were inoculated during composting.

The changes in cellulose content during composting of organic manures followed similar trend to that of lignin content. When compared to lignin and cellulose, degradation of cellulose is rapid than lignin. This observation confirms the report by Cortez *et al.* (1996). According to them cellulose will be decomposed faster than lignin in decomposing system, which were rich in cellulose and lignin.

The urease, cellulase, acid phosphatase and alkaline phosphatase activity recorded highest values at 30 days and then decreased up to 90 days and later got stabilized. This may be due to availability of easily degradable substances and hence there was a spurt in microbial activity in the initial stages. The production of metabolic intermediates including inorganic radicals might have changed the biology of the system. The initial stage of active decomposition is followed by a second stage of synthesis during composting. During this stage a change in the spectrum of the enzyme activities is expected. The mechanism behind the decreased enzyme activity in the later stages may be due to lack of suitable carbon compounds for microorganisms which leads to decline in microbial biomass (Adani *et al.*, 1995 and Nohrstedt *et al.*, 1989). It is also possible that other enzymes may dominate during the synthetic phase.

Urease activity was higher in chromolaena compost, which may be due to high availability of easily degradable substances along with higher N and narrow C: N ratio when compared to that of parthenium compost. Cellulase activity was higher in parthenium compost due to high availability of substrate cellulose in them. Optimum pH for activity of cellulase was around 6.0 according to Stutzenberger *et al.* (1970). Acid phosphatase and alkaline phosphatase decreased during composting due to lack of suitable carbon compounds for microorganisms.

Humic acid (HA) production increased with decomposition time while fulvic acid (FA) initially increased up to 60 days and then decreased. This suggests that low molecular weight FA fraction is produced initially in high quantities and then, they might have been converted to humic acid with the maturation of the compost. According to Kononova (1966) HA and FA are linked by a sequence of single interconvertible chain.

Singh and Amberger (1990) observed an increase in humic acid with time while FA decreased after 30 days of composting of wheat straw. Similar results were observed by Chefetz *et al.* (1996) while composting municipal solid waste. According to him increasing levels of HA represents the degree of humification of maturity of compost.

Both HA and FA contents were lower in chromolaena compost treatment which may be due to lesser lignin content, which obviously resulted in lesser humification. Hence humification is dependent on the biochemical compositions of raw material Kadalli (1999) observed similar results.

Matured compost

Both parthenium and chromolaena based composts recorded near neutral pH (Table 3). This may be due to the natural buffering of humus. The EC of chromolaena compost recorded higher value than that of the parthenium compost. However, pH and EC values are within the acceptable limits and hence they are ideal for application to all types of soils under different cropping system.

The organic carbon and nitrogen recorded were more in chromolaena based compost compared to parthenium based compost which was due to their high OC and N contents in the raw materials.

The enrichment of parthenium and chromolaena with rock phosphate (RP) has yielded higher P content in composts. The K, Ca, Mg and S content did not show much difference in both the composts. The RP enrichment has considerably increased the Ca and Mg content in the compost.

The enrichment of zinc recorded higher zinc value. Hence incorporation of micronutrient to compost can yield high value compost with high levels of available micronutrients.

The enrichment of compost with additives increased the decomposition rate, which may be due to availability of essential nutrients for the increased biological activity. From this investigation it can be stated that enrichment of parthenium and chromolaena plant materials with cow dung, rock phosphate, mixed microbial culture, zinc and borax resulted in value added composts. According to Radhakrishna *et al.* (1995) enrichment of composts with nutrients like P in the form of rock phosphate resulted in high value composts due to higher degree of decomposition.

Lignin and cellulose content decreased considerably on composting. This may be due to the action of lignin degrading microorganisms which could have hastened degradation. The highest lignin content was recorded in chromolaena compost. The cellulose content was high in chromolaena compost compared to parthenium compost. This may be due to faster degradation by cellulolytic microorganisms or it may be due to low cellulose content in the initial material itself.

The lignin to N ratio (L/N), lignin + cellulose to N (L+C/N), lignin + cellulose to N (L+C / N) and lignin + total phenols to N ratio (L+P/N) of both the compost decreased considerably on composting of parthenium and chromolaena. This was due to decrease in lignin, cellulose and total phenols and increase in N content during composting. Melitto *et al.* (1982) suggested that L/N ratio

is a good predictor of decomposition rate. Taylor *et al.* (1989) reported that L/N ratio is a good index of substrate quality for litters of high to medium lignin content. They

also reported that lignin is one of the most resistant components and an inverse relationship has been found between lignin concentration and rate of decomposition.

Table 2. Changes in the chemical properties of parthenium and chromolaena compost materials at different intervals (days) of composting

Parameters	Parthenium			Chromolaena		
	30	60	90	30	60	90
pH (1:10 in distilled water)	8.77	7.81	7.04	8.08	7.90	7.26
EC (dSm ⁻¹)	1.20	0.96	0.46	1.28	0.94	0.52
Organic Carbon (%)	37.12	35.96	23.06	31.32	29.00	26.68
Nitrogen (%)	1.72	1.81	1.99	1.96	2.01	2.37
C: N ratio	21.58	19.88	16.61	15.97	14.42	11.26
Phosphorus (%)	0.64	0.98	1.02	1.69	1.56	1.97
Potassium (%)	0.79	0.84	0.98	1.14	1.23	1.51
Sulphur (%)	0.14	0.20	0.28	0.16	0.26	0.31
Calcium (%)	0.70	0.81	1.02	1.00	1.13	1.21
Magnesium (%)	1.04	1.11	1.20	0.91	0.98	1.13
Zinc (ppm)	169	265	340	103	273	357
Copper (ppm)	135	158	164	149	163	171
Iron (ppm)	6040	6371	7100	4010	4573	5190
Manganese (ppm)	364	414	549	474	563	620
CEC (c mol (P ⁺) kg ⁻¹)	31.73	36.86	41.99	32.42	38.30	46.71
Lignin (%)	9.81	7.32	6.49	22.12	19.39	15.32
Cellulose (%)	10.36	8.93	6.84	16.34	14.49	12.04
Total phenols (mg 100 g ⁻¹)	80.20	68.81	62.30	73.60	59.40	54.20
Urease (µg NH ₄ ⁺ - N g ⁻¹ hr ⁻¹)	263.40	178.10	123.15	287.10	166.90	101.73
Cellulase (µg TPF g ⁻¹ hr ⁻¹)	579.80	430.70	329.64	482.60	396.70	287.14
Acid phosphatase (µg PNP g ⁻¹ hr ⁻¹)	72.80	63.70	59.00	96.40	83.20	74.00
Alkaline phosphatase (µg PNP g ⁻¹ hr ⁻¹)	85.40	71.30	63.00	94.60	81.40	78.00
Humic acid (%)	9.90	9.70	12.50	8.70	8.80	13.60
Fulvic acid (%)	2.90	3.00	2.49	2.87	3.02	2.47

So the decreased L/N, L+C/N and L+P/N ratios of composts indicate higher substrate quality and thus are found suitable to field application.

Higher urease activity was recorded in chromolaena compost treatment compared to parthenium compost treatment. This may be due to high microbial activity, which resulted from high nutrient availability in this compost. Parthenium compost revealed higher cellulase activity due to high cellulose content in parthenium. Acid and alkaline phosphatase activities were higher in chromolaena compost which may be due to high nutrient availability in this compost.

The humic and fulvic acid contents increased during composting. The HA content was highest in chromolaena compost, which was due to release of higher polyphenols which is a precursor of HA. Parthenium compost registered lower HA, which may be due to low lignin content in parthenium. The humification index (HI) which is a ratio of HA to FA was believed to be a good maturity and stability index (Jimenez and Garcia, 1992). Highest humification index was recorded in chromolaena compost treatment.

The C and N contents of humic acid was found to be higher than that of fulvic acid in both composts. According to Stevenson (1982), the C content of humic

acid was more than that of fulvic acid and per cent N varies from 2 to 6 and < 1 to 3 for humic acid and FA respectively. Schnitzer (1991) also reported similar results. Kadalli (1999) while studying the nature and functional groups of HA from coir dust compost reported similar results.

The E₄/E₆ ratios of FA recorded higher values than that of HA. The E₄/E₆ ratio of HA or FA is a measure of aromaticity or aliphaticity (Table 3). The E₄/E₆ ratio is inversely related to the molecular weight or size of the molecule (Chen *et al.*, 1977). According to Schnitzer (1991) E₄/E₆ ratio of FA is considerably higher than that of HA, which means that FA has a lower particle or molecular weight than that of HA. Parthenium compost recorded lower E₄/E₆ ratios for both HA and FA, which may be due to higher humification and resulted in increase in aromaticity of HA.

The total acidity of FA was found higher than that of HA. According to Schnitzer (1991), FA is rich in phenolic OH, alcoholic OH, ketonic C=O groups when compared to HA. The hypothetical structure of FA reveals more functional groups and free carboxyl groups (Stevenson, 1982). Chromolaena composts recorded highest total acidity which may be due to release of phenolic derivatives in condensed lignin exposing more dissociable groups.

Table 3. Composition of matured parthenium and chromolaena compost

Parameters	Parthenium compost	Chromolaena compost
pH (1:10 in distilled water)	7.07	7.35
EC (dSm ⁻¹)	0.40	0.52
Organic carbon (%)	19.52	20.47
Total N (%)	0.94	1.32
C:N ratio	20.76	15.50
Total P (%)	1.03	1.93
Total K (%)	1.46	1.89
Calcium (%)	1.22	1.76
Magnesium (%)	1.19	1.54
Sulphur (%)	0.34	0.32
Iron (ppm)	7100	5190
Manganese (ppm)	549	620
Copper (ppm)	164	171
Zinc (ppm)	540	385
CEC (c mol (P ⁺) kg ⁻¹)	34.99	36.71
Lignin (%)	6.32	15.20
Cellulose (%)	6.79	11.92
Total phenols (mg 100 g ⁻¹)	13.96	17.81
L/N	6.72	11.52
L+ C/N	27.49	27.02
L+P/N	21.57	25.01
Urease (µg NH ₄ ⁺ - N g ⁻¹ hr ⁻¹)	101.73	123.15
Cellulase (µg TPF g ⁻¹ hr ⁻¹)	329.64	287.14
Acid phosphatase (µg PNP g ⁻¹ hr ⁻¹)	59.00	74.00
Alkaline phosphatase (µg PNP g ⁻¹ hr ⁻¹)	63.00	78.00
Humic acid (%)	12.50	13.60
Fulvic acid (%)	2.49	2.47
Humic Acid Index (HI)	5.02	5.51

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