Comparative study of aerobic and anaerobic composts prepared from autumn leaves on *Zea mays* L.

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ABSTRACT

A field experiment was carried out in the Research farm located in the Botanical garden of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad to evaluate the effects of aerobic (NADEP tank) and anaerobic (Bangalore pit) leaf composts on growth and nutrient contents of fodder maize. These treatments were compared with fertilizer alone (FER) and absolute control (CO) with four replicates each. The mineral fertilizers N, P_2O_5 and K_2O (120:80:40 kg/ha) were applied through urea, single super phosphate and muriate of potash for comparison. The growth analysis of maize crop was noted at 64 and 110 DAS as plant height, diameter, number of leaves per plant, plant fresh weight, 4th upper leaf length, its width, weight and leaf area. Chlorophyll a, chlorophyll b and total chlorophyll content was also determined. NADEP compost was found to be more effective than Bangalore pit compost in increasing the growth and productivity of maize. The average yield of fresh aerial biomass (Kg/ha) of maize was highest in the plots received with AC amendment.

Key words: aerobic, anaerobic, chlorophyll, compost, leaves, maize.

INTRODUCTION

Composting is a natural biological process which results in the degradation of organic waste to a stable end product, commonly referred to as compost, which can be utilized for various agricultural purposes. Increasing landfill costs and regulations which limit many types of waste accepted at landfills has increased interest in composting as a component of waste management (Goldstein, 1995). Composting may be divided into two categories by the nature of the decomposition process – aerobic and anaerobic.

Sir Albert Howard made the first major advance in the history of modern composting (Howard, 1933, 1935). Sir Howard, in collaboration with other workers, developed the composting procedures into a method known as the "Indore process" (Brunt 1949). Later, the Indian Council of Agricultural Research at Bangalore improved the Indore method and named it the Bangalore process (Acharya 1950). Bangalore method is anaerobic method of composting. In anaerobic composting, decomposition occurs where oxygen (O_2) is absent or in limited supply. Under this method, anaerobic micro-organisms dominate and develop intermediate compounds including methane, organic acids, hydrogen sulphide and other substances.

Aerobic composting takes place in the presence of ample Oxygen. In this process, aerobic micro-organisms break down organic matter and produce carbon dioxide, ammonia, water, heat and humus, the relatively stable organic end product. Although more nutrients are lost from the materials by aerobic composting, it is considered more efficient and useful than anaerobic composting for agricultural production (Chamle 2007). NADEP method is aerobic method of composting. The NADEP method of making miracle compost was first invented by N.D. Pandharipande living at Yevatmal in Maharashtra (India). The method, which has become quite popular among the farmers in India, now bears his name.

The amount of garden waste (autumn leaves) is quite higher in almost all Indian cities and therefore its utilization will be useful. Organic waste is a valuable raw material located at wrong place which can be rehabilitated into useful product by making use of appropriate processing technology (Sharma and Verma 2001).

Taking this in view, the present investigation was carried to study comparative effect of aerobic compost (NADEP method), anaerobic compost (pit method), prepared from garden leaf litter on growth and productivity of maize.

MATERIALS AND METHODS

Experimental site:

The field experiment was conducted in the Research farm of Dr. Babasaheb Ambedkar Marathwada University's Botanical garden.

Raw material and composting process:

The freshly fallen dead leaves of trees present in the Botanical garden Aurangabad were collected from the plantation floor and transported to experimental field for use as raw material to prepare composts by NADEP tank (aerobic) and Bangalore pit (anaerobic) methods. Each pit used for composting was 105 x 75 x 90 cm (l x w x h).

The leaf litter was spread on the hygienic floor and sprayed with 5 % dung slurry to enhance the composting process. This pretreated material was arranged alternately along with well-composted inoculums and soil on each layer in the aerobic tanks and anaerobic pits. The pits were closed with dung-mud paste to prevent loss of moisture or heat and allowed to decompose. The trenches were watered whenever the dampness was less than 50 percent. After every month interval, turning the whole material upside down was employed for airing and achieving uniform homogenous decomposition of the organic wastes. The pits were again irrigated and closed by dung-mud mixture. Finally, amorphous, dark brown, well-fermented composts were obtained.

Experiment design and treatments

The Experimental design was a randomized block design (RBD) with four treatments and four replications. The four treatments were (i) NADEP compost (AC); (ii) Banglore pit compost (BC); (iii) Fertilizer (FER) and (iv) Control (CON). Composts were transferred to the experimental area and incorporated into the top of soil (15 - 20 cm) by disking at the rate of 12 kg/plot (13333 kg/ha). Samples (100 g) of each application were collected for nutrient analyses. The fodder maize (*Zea mays* L.) var. 'African Tall' (Mahalaxmi) produced by Mahendra Hybrid Seeds Co. Ltd., Jalna was cultivated at the rate of 100 kg/ha. A plot with the size 9 m^2 and nine rows spaced 30 cm apart was adopted to keep the uniform population density.

Fertilizer applications and plant sampling

The mineral fertilizers N, P_2O_5 and K_2O (120:80:40 kg/ha) were applied through urea, single super phosphate and muriate of potash. Whole quantity of phosphorus (P) and potassium (K) was applied as basal dose for all the treatments except CON at the time of sowing and the two equal doses of nitrogen were applied at 42 and 75 DAS to FER treatment alone in split doses. The crop was harvested during the early hours of the day at 10 - 20 % flowering stage. At the time of harvest, total yield of maize crop per plot was recorded.

Growth and chemical analysis The growth analysis of maize crop was noted at 64 and 110 DAS as plant height, diameter, number of leaves per plant, plant fresh weight, 4^{th} upper leaf length, its width, weight and leaf area per plant was determined by gravimetric method (Shahane and Mungikar 1984).

The leaf chlorophyll contents (a, b and total) were estimated following Arnon (1961), using 80 % acetone as a solvent for extraction of pigments. Ash values were obtained by burning the moisture-free samples in a muffle furnace at 600°C for 2 hours and calcium (Ca) Content was analyzed by titrating the acid soluble ash solution against 0.01 N $KMnO_4$ solution using methyl red as indicator (AOAC, 1995). Nitrogen (N) was estimated by micro-Kjeldahl method after digesting the sample with Conc. H_2SO_4 (Bailey 1967). The amount of phosphorus was measured following Fiske and Subba Rao (1972) as described by Oser (1979). Potassium (K) Content was determined on a flame photometer (model Mediflame- 127) as suggested by Jackson (1973).

All the results were statistically analyzed using analysis of variance (ANOVA) test and treatments means were compared using the least significant difference (C.D., p = 0.05) which allowed determination of significance between different applications (Mungikar 1997).

RESULTS AND DISCUSSION

Analysis of compost amendments

The fresh weight (Kg/ha) was in same quantity in both the treatments i.e. AC and BC however dry matter (Kg/ha) was found more in the treatment of AC (Table 1). The nitrogen content, total ash content and percent of carbon, calcium, phosphorus and potassium was more in AC and less in BC. One of the most important aspects of the total nutrient balance is the ratio of organic carbon to total nitrogen (C/N). If compost has a high C/N ratio and decomposes rapidly in the soil, it can rob the nitrogen from the soil needed to support plant growth. If the compost has too low C/N ratio, the ammonia released can be phytotoxic to plant roots (Zucconi *et al*. 1981a). A C/N ratio about 25–30 is optimum for most types of composts (Zucconi *et al*. 1981b). In this experiment also C/N ratio is within the range of 25–30. AC showed high C/N ratio as 29.80 while less in BC with C/N ratio 26.28.

Growth analyses

First Growth Analysis (64 DAS)

First growth analysis of maize crop was done at 64 DAS (Table 2). The tallest plant was observed in the plots amended with NADEP compost (AC) followed by Bangalore pit compost (BC), fertilizer (FER) treatments over the control (CON). The diameter of plant, number of leaves was more in BC treatment than in AC and FER applications and CON applied plots. The fresh weight of root was higher with the AC followed in order by BC, FER and CON. Same trend of results was observed in case of fresh weight of stem and fresh weight of leaves and ultimately for fresh weight of total plant. The length, width and weight of 4^{th} upper leaf were found more in compost treatments as compared with CON. The maximum leaf area was found in the treatment of AC, followed in order by BC and FER, while it was found minimum in CON.

Table 1. Analysis of leaf litter composts produced by different methods

Compost	Fresh wt.	DM		N		%					C:N
	(kg/ha)	%	kg/ha	%	kg/ha	Ash	C	Ca	P	K	ratio
AC	13333	49.45	6593	0.92	60	42.8	24..82	2.04	0.21	0.16	29.80
BC	13333	45.40	6053	0.83	50	41.53	24.08	1.92	0.19	0.15	26.28

AC- NADEP compost, BC- Banglore compost, DM-Dry Matter.

Table 2. Growth analysis of maize plant (Age of plant: 64 and 110 DAS)

				Plant fresh weight(g)				4th upper leaf			
Treatment	Plant height (cm)	Diameter (cm)	No of leaves /plant	Root	Stem	Leaves	Total	Length (cm)	Width (cm)	Weight (g)	Leaf area (cm)
First Harvesting (64 DAS)											
AC	147.4	1.3	10.75	7.41	82.27	62.21	151.89	66.5	5.2	6.33	392.16
BC	144.1	1.4	11	7.06	81.86	56.17	145.09	70.9	5.1	5.51	357.08
FER	125.8	1.2	10	6.45	66.92	44.68	118.05	69.4	5.6	5.13	324.62
CON	62.9	0.6	8.75	4.27	43.26	18	65.53	51.0	3.0	1.83	176.02
S.E.	**19.63**	**0.17**	**0.51**	**0.70**	**9.16**	**9.79**	**19.61**	**4.57**	**0.58**	**0.99**	**47.53**
C.D.	**44.36**	**0.38**	**1.15**	**1.58**	**20.7**	**22.13**	**44.32**	**10.33**	**1.31**	**2.24**	**107.42**
Second Harvesting (110DAS)											
AC	243.3	1.8	13	9.46	185.81	48.03	243.30	76.9	7.3	6.72	407.75
BC	267.7	1.7	12.75	8.69	207.6	51.45	267.74	77.9	7.1	5.75	377.25
FER	201.8	1.4	12.25	8.04	153.86	39.91	201.81	69.5	6.8	5.74	367.5
CON	83.3	0.7	11	6.93	55.15	21.24	83.32	61.6	3.8	2.56	207.25
S.E.	**40.9**	**0.24**	**0.44**	**0.54**	**33.68**	**6.75**	**40.9**	**3.79**	**0.83**	**0.91**	**45.05**
C.D.	**92.43**	**0.54**	**1.41**	**0.99**	**76.11**	**15.26**	**92.43**	**8.57**	**1.88**	**2.06**	**101.81**

AC- NADEP compost, BC- Banglore compost, FER-Chemical fertilizer, CON- absolute control, S.E.-Standard error, C.D.-Critical difference at p=0.05.

Table 3: Chlorophyll contents of maize leaf as influenced by leaf litter compost at 64 and 110 DAS

Sr. No.	Treatment	Chlorophyll A	Chlorophyll B	Total. Chlorophyll
	First harvesting (64 DAS)			
1	AC	0.96	0.67	1.63
2	BC	0.97	0.68	1.65
3	FER	0.91	0.48	1.39
4	CON	0.43	0.28	0.70
	S.E.	**0.13**	**0.10**	**0.22**
	C.D.	**0.41**	**0.30**	**0.70**
	Second harvesting (110 DAS)			
1	AC	1.34	0.70	2.04
2	BC	1.16	0.67	1.83
3	FER	1.06	0.58	1.64
4	CON	0.48	0.28	0.75
	S.E.	**0.19**	**0.10**	**0.28**
	C.D.	**0.60**	**0.31**	**0.90**

Table 4: Total yield of fodder maize

	Fresh wt.		Dry matter	
Treatment	(g)/plot	Kg/ha	%	Kg/ha
AC	38.25	42500	18.66	7930
BC	35.88	39861	19.35	7713
FER	35.63	39583	18.63	7372
CON	22.50	25000	18.57	4642
S.E.		**3967**		**766**
C.D.		**8965**		**1731**

Second Growth Analysis

During the second growth analysis, the maximum height of plant was found in the treatment of BC followed in order by AC and FER amendments over the CON plots. The diameter, number of leaves of plant was more in AC treatment than in BC, FER, while it was minimum in CON applied plots. Same trend was observed in case of fresh weight of root. The fresh weight of stem and fresh weight of leaves was more in BC followed in order by AC, FER while it was less in the CON. Similar trend was observed lastly for fresh weight of total plant. The length, width, weight and leaf area of 4^{th} upper leaf was found maximum in the treatment of BC, followed in order by AC and FER, while it was found minimum in CON.

The application of different organic manures showed a significant increase in plant height and number of fruits plant of chilli (Dileep 2005). The significant influence on growth characters might have been due to the enhancement of uptake of nutrients favored by the addition of organic manures.

Chlorophyll Analysis:

Chlorophyll contents were determined from fresh leaves. Chlorophyll a, chlorophyll b and total chlorophyll contents varied from 0.43-0.97, 0.28-0.68 and 0.70-1.65 mg g^{-1} leaf fresh weight at first growth analysis (64 DAS)(Table 3) and 0.48-1.34, 0.28-0.70 and 0.75-2.04 mg g^{-1} fresh weight for second growth analysis (110 DAS). The chlorophyll contents were more in BC followed by AC and FER, while minimum in CON for the first growth analysis. Whereas in the second growth analysis the chlorophyll a, b and total chlorophyll were maximum in the AC amended plots and minimum in the CON plots.

Low chlorophyll synthesis can directly limit photosynthetic potential and primary and hence primary production (Curan *et al*. 1990). The chlorophyll content in the leaves might have been significantly improved with the application of organic source of nutrients. The application leaf compost might have helped in chlorophyll synthesis which in turn increased the rate of photosynthesis. The results are in agreement with the findings of Sanwal *et al*. (2007).

Analysis of yield of fodder maize crop:

At final harvesting (110 DAS), average yield of fresh aerial biomass (Kg/ha) of maize was highest in the plots received with AC amendment followed in order by BC, FER and lowest in CON (Table 4). Same trend was observed in case of dry matter of maize. Application of organic manures thus would have helped in the plant metabolic activity through the supply of such important micro nutrients in the early vigorous growth (Anburani and Manivannan 2002).

Based on the results it reveals that the growth and yield of maize increased significantly due to application of organic manures as a result of better uptake of nutrients from the soil.

The results of this study conclusively indicate that the leaf litter compost can be effectively used as a source of nutrients for crop as reflected by improved performance of maize. NADEP compost not only has better nutrient content but also succeeded in increasing the growth and productivity of maize as compared to Bangalore pit compost. Both treatments are excellent, active and cheapest source of plant nutrients working with high efficiency as compared to chemical fertilizer treatment.

These results are in agreement with the findings of Dad (1992) who carried out experiment on relative performance of NADEP and Bangalore system of composting in relation to time of maturity and quality compost showed that, although the time required to prepare compost by NADEP as well as Bangalore method is almost same, quality of final compost prepared in NADEP pit was found to be better as compared to Bangalore pit. The leaf litter compost improved the yield of spinach (Chamle and Jadhav 2007).

Leaf litter compost generated from the plantation floor assist to compensate the deficiency of organic matter content along with nutrients in the soil and acts as an ideal substitute against inorganic fertilizers. Its regular use in agriculture may results in the long term enhancement on soil productivity.

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