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EVALUATION OF LEAF LITTER COMPOSTS ON YIELD AND NUTRIENT UPTAKE OF SPINACH

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The aim of the present investigation was to assess the efficiency of leaf litter composts geared up by aerobic (Nadep) and anaerobic (Bangalore) pit methods on yield and nutrient contents of spinach (*Spinacia oleracea* L.). The experiment was conducted in the earthen pots with five treatments and four replications. The composts were used either independently or in amalgamation (1:1) in comparison with recommended fertilizers and reference control. The analysis of the crop was done 44 days after sowing (DAS) with one successive regrowth at 67 DAS. The litter composts (LC) improved the yield and nutrient uptake of spinach. Composting of litter by innovative technologies had optimistic effect on fertility and productivity of the soil.

Keywords: Analysis; Bangalore; Composts; Leaf litter; Nadep; Spinach; Yield.

Introduction

The soil nutrients are depleted due to incessant and intensive cropping, erosion, leaching loss etc. In addition, excess use of synthetic fertilizers worsens soil physical properties and declines the fertility status[1]. This crucial problem may be solved by supplementing organic matter to the soil from different sources[2]. Moreover, use of organic wastes viz., agricultural and garden wastes as well as cow dung as fuel has been depriving the agricultural soils from their replenishment[3]. Leaf litter acts as a nutrient source and is of great importance in the fertility of the soils[4]. The nutrient flux from trees to soil *via* litter[5]. In most instances, such organic wastes cannot be directly used because of phytotoxicity, nitrogen immobilization, high salt content and structural incompatibility. These disadvantages however can be eliminated through composting the organic wastes[6]. Composting is a system for organic matter (OM) stabilization and humification[7, 8] and compost is an organic fertilizer containing primary nutrients as well as trace minerals, humus and humic acids in a proportion that approximately matches with plant nutrient necessities which exhibit a slow release. The amount of garden waste 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 converted into useful product by making use of appropriate processing technology[9]. Recycling and reuse of the waste materials in this manner reduce volume of the waste and helps to diminish the problem of its disposal. In this investigation, attempts have been made to evaluate the effectiveness of litter composts (LC) as probable alternative sources of nutrients for the yield and nutrient uptake of spinach.

Materials and Methods

Experimental site: The experiment was conducted in the Research farm at Dr. Babasaheb Ambedkar Marathwada University's Botanical garden during the period from 2004 to 2005.

Raw materials and composting process: The freshly fallen dead leaves of trees present in the Botanical garden and Central oval garden were collected from the plantation floor and transported to experimental field for use as raw material to prepare composts during June to October 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 subsequently sprayed with 5 % urea and single super phosphate (SSP) and another lot of litter was also sprayed with 5 % dung slurry to enhance the composting process. These pretreated materials were arranged alternately along with well-composted inoculum and soil on each layer in the aerobic tanks and anaerobic pits. Sufficient water was sprinkled in order to maintain the optimal moisture (50 - 70 %) over the material. The pits were enclosed 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 one month intervals, 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. The uniformly mixed samples (100 g) of each treatment were collected immediately from the pits for analyses of nutrients.

Organic amendments and experimental plant: The experiment was performed in truncated porous earthen pots of approximately 10 liter capacity (h= 30.5 cm and d= 29.0 cm). The pots were initially filled to a 2.5 cm height with 12.5 mm nominal size chips of stone (aggregates), which were then covered with 2.0 cm thick layers of 1 - 5 mm size gravel to ensure proper drainage of excess water. A layer of local soil with 2.0 - 2.5 cm thickness was used as above the gravel bed and compost layer. The composts (3.5 kg pot^{-1}) were then top fed (18 - 20 cm thickness) either individually or in combination (1:1) into the pots with five treatments and four replications. The five treatments were: Nadep compost (AC), Bangalore compost (BC), mixture of AC + BC composts (MC), inorganic fertilizers (FE) and unfertilized pots (CO). Subsequently the experimental pots were kept in green house without any attempt to control the ambient circumstances. The spinach (*Spinacia oleracea* L. cv. All Green) seeds produced by Sungro Seeds Ltd., 207 Aradhana Bhawan, Azadpur, Delhi, were sown at a rate of 20 in each pot about 1 - 1.5 cm deep in the soil.

Fertilizer applications and plant sampling: The fertilizers were applied at the recommended levels of 40 N, 30 P and 30 K kg ha^{-1} as urea, single super phosphate and muriate of potash to FE treatment alone. Entire amount of P_2O_5 and K_2O was applied as basal dose at the time of cultivation and N was supplied 54 days after sowing (DAS). The crop received irrigations as per requirement, regularly. In order to assess the effect of treatments, analysis was done at 44 DAS and 67 DAS as a regrowth. The fresh aerial biomass yield obtained per pot was recorded and kept in oven at 70 - 80°C for 48 h. The dried samples were weighed, finely milled, sieved and stored in labelled airtight polythene bags for nutrient analysis.

Chemical analyses: Organic matter was estimated by rapid titration method of Walkley and Black[10]. Leaf chlorophyll contents (a, b and total) were determined following Yoshida *et al.*[11]. The dry matter (DM) and calcium (Ca) content was analyzed by AOAC[12]. Nitrogen (N) content was estimated by micro-Kjeldahl method according to Bailey[13] and crude protein (CP) was then calculated as N x 6.25 by AOAC[12]. Reducing sugar (RS) and phosphorus (P) was analyzed by colorimetric methods of Oser[14] and potassium (K) content was determined on a flame photometer (model Mediflame- 127) as suggested by Jackson[15].

Statistical analysis: All the results were statistically analyzed using analysis of variance (ANOVA) test and treatments means were compared using the least significant difference (CD, $P \leq 0.05$) which allowed determination of significance between different applications[16].

Results and Discussion

Yield of spinach: The application of litter composts (LC) significantly influenced the yield and dry matter of spinach in both harvestings (Table 2). During first harvesting, the yield of fresh aerial biomass was highest for MC based pots followed in order by BC, FE and AC treatments and lowest in the CO where soil obtainable nutrients were not adequate to meet the crop demand. The yield of dry matter was high in MC followed by BC and AC amendments in comparison with FE application (Table 2). In contrast to the first harvest, the highest yield of vegetation was obtained in the AC and BC amended pots followed by MC and FE applications than the unfertilized treatment for second harvesting while the maximum dry matter was generated with the fertilization of BC, AC, MC and minimum in the CO than those of fertilized pots (Table 2). The average values of MC amendment resulted in enhanced spinach production as reflected by increased spinach yield and dry matter relative to the control and other treatments during the two harvestings.

Nutrient uptake: The application of LC had significant influence on nutrient uptake by spinach with the exception of K at both harvestings. Of all the nutrients, P and RS were most abundant and N, Ca and CP were least abundant in the first harvest while interestingly, these nutrient trends were contradictory during the second harvest (Tables 3 and 4). The N and CP were maximum in MC treated pots followed in order by AC, BC and minimum in absolute CO than the FE based treatment while the P and Ca were greater in pots receiving AC followed by BC, MC and FE than that of non-fertilized treatment and the content of RS was highest in MC amendment as compared to other LC and FE treatments (Table 3). In the second harvest, the N was highest in AC manured pots followed in order by MC, FE applications and lowest in total CO than those of BC treatment. This pattern was analogous to that observed for CP content solely. The percent of P was more in pots fertilized with AC and BC amendments followed by MC and FE apart from the CO treatment. The Ca content was highest in the FE treatment in comparison with LC manured and un-manured pots where as the RS was highest in MC application followed in order by AC, BC, FE and minimum

Table 1. Nutrient contents of litter composts produced by different methods.

Composts	%						
	DM	Ash	N	P	K	OC	C:N
AC	44.35	70.35	0.83	0.21	0.12	17.19	20.71
BC	50.75	73.52	0.83	0.19	0.15	15.35	18.49
MC	49.25	72.20	0.91	0.19	0.13	16.12	17.71

§ AC= Nadep compost; BC= Bangalore compost; MC= Mixed compost; FE=Inorganic fertilizers; CO= Control; DM= Dry matter; OC= Organic carbon

$ All the values are the average of two replicates

Table 2. Yield of spinach as affected by litter composts.

Treatments	First harvest (gm pot^{-1})		Second harvest (gm pot^{-1})	
	Fresh weight	Dry weight	Fresh weight	Dry weight
AC	126.23±7.0	9.43±0.3	171.19±5.4	10.75±0.5
BC	136.14±18.3	10.17±0.9	170.45±7.8	11.22±0.4
MC	158.71±7.1	12.04±0.6	159.18±9.8	10.35±0.7
FE	127.24±21.9	8.88±0.9	158.67±7.2	8.24±0.4
CO	106.02±10.0	7.21±0.7	97.17±4.7	6.36±0.3
S.E.	7.62	0.70	12.34	0.81
C.D.	17.22	1.58	27.88	1.83

$ All the values are means of four replicates ± standard errors

Table 3. Nutrient uptake by spinach as affected by litter composts (First harvest: 44 DAS).

Treatments	%					
	N	P	K	Ca	CP	RS
AC	3.45±0.1	0.81±0.0	2.05±0.0	1.19±0.0	21.55±1.0	2.28±0.3
BC	3.43±0.1	0.79±0.0	1.78±0.1	1.15±0.0	21.45±0.9	2.71±0.2
MC	3.49±0.1	0.66±0.0	2.26±0.0	1.10±0.0	21.84±0.8	3.25±0.3
FE	2.91±0.2	0.64±0.0	2.34±0.2	1.02±0.0	18.18±1.4	2.20±0.2
CO	2.83±0.1	0.54±0.0	2.27±0.0	0.92±0.0	17.68+1.1	1.45±0.1

¶ N= Nitrogen; P= Phosphorus; K= Potassium; Ca= Calcium; CP= Crude protein; RS= Reducing sugar

Table 4. Nutrient uptake by spinach as affected by litter composts (Second harvest: 67 DAS).

Treatments	%					
	N	P	K	Ca	CP	RS
AC	4.57±0.1	0.69±0.0	1.35±0.1	1.31±0.0	28.60±1.0	1.75±0.1
BC	3.70±0.1	0.69±0.0	1.00±0.1	1.39±0.1	23.13±0.7	1.55±0.0
MC	4.24±0.1	0.60±0.0	1.57±0.0	1.40±0.0	26.52±0.9	2.14±0.2
FE	4.20±0.0	0.62±0.0	2.01±0.2	1.65±0.0	26.26±0.4	1.39±0.1
CO	3.66±0.1	0.53±0.0	2.13±0.1	1.23±0.0	22.87±0.7	1.11±0.0

$ All the values are means of four replicates ± standard errors

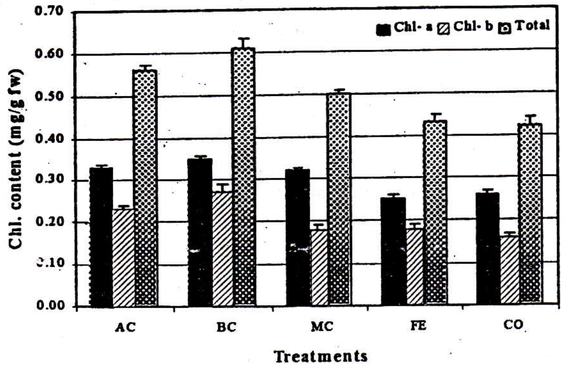

Fig. 1. Chlorophyll contents of spinach as influenced by litter composts at 44 DAS (n = 4 ± SE).

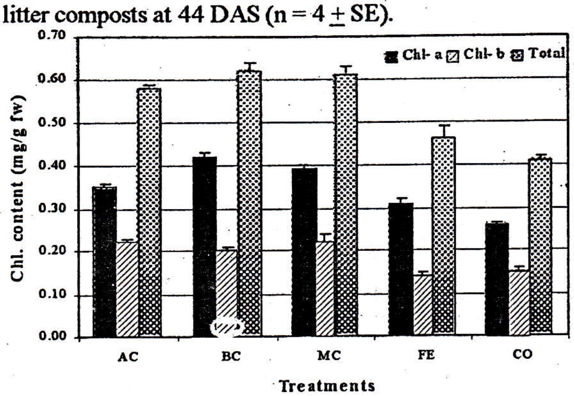

Fig. 2. Chlorophyll contents of spinach as influenced by litter composts at 67 DAS (n = 4 ± SE).

in CO (Table 4). The LC amendments enhanced nutrient uptake during the second as compared to the first harvesting.

Chlorophyll contents: The LC had significant influence on leaf chlorophyll contents (a, b and total) of spinach during both the harvests (Figs. 1 and 2). The values for chlorophyll contents ranged from 0.25 - 0.35, 0.16 - 0.27 and 0.42 - 0.61 mg g^{-1} leaf fresh weight (fw) at the first harvest (Fig. 1) and at the second harvest varied from 0.26 - 0.42, 0.14 - 0.22 and 0.41 - 0.62 mg g^{-1} fw (Fig. 2). The chlorophyll contents were highest in all LC received amendments than those of FE and reference CO treatments. Among them, chlorophyll a, b and total chlorophyll were maximum in BC treated pots (Figs. 1 and 2). Nehra *et al.*[17] also reported increased chlorophyll contents in wheat leaves due to the application of FYM.

Based on these results, it is evident that application of LC decreased the yield and nutrient contents in spinach during the first harvesting. This was attributed to the effect of less nutrients release from LC, which resulted in reduced nutrient uptake by spinach plants. Improvement in spinach yield and nutrients status were observed during second harvesting and this was ascribed to enhanced nutrient supply and availability from LC, succeeding its extended incubation in the soil resulting in the mineralization of previous immobilized nutrients. These results suggested that in order to derive short term benefits from LC amendment, it ought to be allowed to undergo some decomposition in the soil, before a crop is planted or otherwise it has to be applied in combination with mineral fertilizers. Therefore, further studies are essential to determine methods of compost application for maximum advantages and to establish the long-term effects of this amendment on the productivity of the soil.

The results of this study conclusively indicate that the LC can be effectively used as a source of nutrients for increased yield and nutrient uptake of spinach. These results are in close conformity with the findings of Whitbread *et al.*[18] and Soumare *et al.*[19]. The aerobic as well as anaerobic composting methods are promising practices to enhance the composting efficiency and quality of the product[20]. Leaf litter compost generated from the plantation floor help 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 results in the long-term enhancement of soil productivity.

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