EFFICIENCY OF NITROGEN SOURCES AS COMPOSTING STARTER AND DECOMPOSITION OF PARTHENIUM WEED INTO A QUALITY COMPOST

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ABSTRACT

Nitrogen starter is an essential component of successful composting. Parthenium weed, being high nutrient accumulator from agricultural soils, was composted under different sources of nitrogen viz chiken manure, blood meal, soybean meal, cotton seed meal, urea, and a control to evaluate their relative effectiveness for composting starter and decomposition into a a quality mature compost. Composts treatments were evaluated after each month for physico-chemical properties and the results indicated the highest pH (8.33) and mineral N (10.68 g kg^{-1}) and the lowest bulk density (1.03 g cm^{-3}) for soybean meal whilst the maximum total N (27.68 g kg^{-1}) and P (3.04 g kg^{-1}) for cotton seed meal treated composts. Chicken manure treated compost indicated the highest electrical conductivity (EC; 2.14 dS m^{-1}) and total K (201.3 mg kg^{-1}). Micro-nutrients Fe (639.15 mg kg^{-1}) and Mn (558.7 mg kg^{-1}) were maximum in the compost treated with Urea as N starter. Water holding capacity (47.9 %) was maximum in the compost treated with blood meal. The experiment concluded that use of N from organic sources and urea were equally effective as N starter in composting with the maximum favorable effect on compost quality, however, Soybean meal and Cotton seed meal were distinct with respect to improved physico-chemical properties of the mature compost. [1]

Keywords: Chicken manure, cotton seed meal, nitrogen sources, parthenium weed compost, physico-chemical properties.

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INTRODUCTION

World population at current growth rate would be 10 billion by 2050 while resources lack chances of expansion acordingly. On the other hand, due to economic compulsions and changes in consumption patterns, exhaustive use of natural resources make their future health doubtful. Continuous non-judicious management has degraded the soil, water and environment quality and resulted in failure of their safe hand over to the future generations. Reduction in soil fertility and nutrient imbalances, deterioration of soil physico-chemical properties and a considerable decrease in soil organic matter are the clear markers of jeopardizing this natural resource. This situation warrants more suitable tactics and committed research activities for improving the fertility and to safeguard our natural resource base (Omotayo and Chukwoka, 2009) for future generations.

Currently, organic farming has been advocated for quality production as well as improved soil health. Organic farming allows the use of inorganic nutrients, yet their uses are minimized to provide a starter dose for soil organisms to carry out decomposition of the organic amendments efficiently and timely. In the absence of the starter inorganic N, microorganisms may immobilize the available nutrients during decomposition process which may result in failure of the crop. The breakdown of organic matter by micro-organisms is a natural process that takes place within a specific range of temperature and moisture called composting (Van Elsas et al., 2007). Considerable high temperature during the decomposition process is sufficient to kill pathogens and weeds seed. The final product is less bulky and well concentrated with respect to nutrient content compared to its raw form. Composting also allows a mixture of organic material of variable sources and the final product is, therefore, more nutrient rich organic soil amendment. Compost, therefore, possesses vital significance to plant growth that can be used to increase soil humus (Ayuba, 2005). All biodegradable products can be composted but they should have a reasonable nutrient concentration (Sunar et al., 2009). Higher C/N value would limit the growth of microorganisms, slowing down the composting process. Lower C/N would lead to excess available nitrogen and higher losses as ammonia (de Guardia et al., 2008).

Recently, parthenium weed has emerged as a clear threat to local biota. It is also responsible for decreasing crop yield as well as increased cost of production (Anil, 2014). Its seeds are lighter that are easily dispersed by wind and quickly cover an uncovered area (Tamado, 2001). Attempts to eradicate parthenium weed was not successful due to its fast reproduction (Tamado, 2004). Channapogodar et al. (2015) has reported very high NPK content for parthenium weed, which can be used for composting. The idea also represents a unique environment friendly way of this noxious weed management in a profitable manner. However, it should be investigated that under which starter N source its compost is more successful and effective with respect to its physico-chemical properties. This research was carried out with the hypothesis whether different N sources can be favorable compost starter. This research will identify amongst a number of N sources, the most suitable combination of the starter N source for making parthenium weed compost.

MATERIALS AND METHODS

The experiment was conducted during 2015 at the University of Agriculture, Peshawar, AMK Campus, Mardan, Pakistan. Based on their N content (Table-1), chicken manure, blood meal, soybean meal, cotton seed meal and urea were tested against a control as compost starter to prepare compost. Farmyard manure, kitchen waste and chopped parthenium weeds were used at the rate of 75, 45 and 30 kg, respectively (50, 30 and 20% on weight basis respectively) as per treatment compost ingredients.

Parthenium weed was collected from the University Research Farm before flowering stage, farmyard manure from a local dairy farm at Mardan whilst

Kitchen wastes were collected from local vegetable market and hotels. Six pits ($4*2*2$ ft^3) were dug on a raised leveled bed. Side walls and base were covered with polythene plastic. Materials were spread in 4 inch layers from bottom up order; parthenium weed-kitchen waste-farmyard manure-N source-water till the pit was full. A thin soil layer was spread at the top to minimize gaseous losses. The material were also covered with polythene plastic sheet to further minimize the gaseous losses, rain water infiltration and allowed to decompose for 90 days. Moisture content (40%) and temperature (35-40 C^o) were maintained with the help of an automatic moisture meter and thermocouple, respectively. Mixing was carried out after thirty days and samples were collected from each treatment analysis for the following physco-chemical properties.

Bulk density of the compost was determined using cores (Blake and Hartge, 1984) of 100 cm^{-3} volume where composts samples were uniformly compressed with uniform pressure to the brim of the core, oven dried at 70 C^o for 48 hours and weighed. Bulk density was calculated as BD = m/v where m is oven dry mass and v is volume of the compost taken in the core. Saturation percentage was determined by the procedure of Gardner (1986). The core samples were re-saturated and weighed. Saturation percentage was determined as; (saturated weight-oven dry weight)/oven dry weight * 100. Available water holding capacity was determined for each compost sample by using pressure membrane apparatus (Raza et al., 2003). Total volatile solids were determined procedure reported by Peces et al. (2014). For determination of pH, EC, Total and mineral N, total P, K and micronutrient content were determined according to procedures mentioned in Ryan et al. (2013).

The data were statistically analyzed by Analysis of Variance procedure (Gomez and Gomez, 1984) using Statistix 8.1 software. For identifying the difference among the treatments, the least significant difference (LSD) test was used (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Results revealed that, except electrical conductivity, all the observed physico-chemical properties of the parthenium weed compost significantly ($p \leq 0.05$) varied amongst treatments of different N sources applied as composting starter. Except compost pH, time allowed to decomposition significantly ($p<0.05$) affected all the observed physic-chemical properties of the compost. Sources with organic N, except soybean meal, were mostly ineffective with respect to changes in compost pH. Soybean meal, however, showed significantly ($p<0.05$) increased compost pH. Inorganic N (Urea) significantly ($p<0.05$) reduced compost pH of the mature compost over the control (Table-2). Variation in the effect of organic and inorganic sources on compost pH might be due to difference in the release of weak acid or salts during the course of decomposition. . Time effect on compost pH was non-significant, a non-significant drop in pH (0.5%) was, however, noted during mid composting stage (Table-1). Costa et al. (2002) reported initial drop in pH when different nitrogen sources were used. EC significantly ($p<0.05$) varied with time and was maximum at 90 days (16 and 7% higher over 60 and 30 days, respectively) (Table-2). Compost reduced volume at maturity per unit weight might contain greater salt content. Variation in compost pH and EC due to interaction between N sources and time was non-significant.

Nitrogen sources, though statistically similar among themselves, recorded significantly ($p \leq 0.05$) higher total volatile solid (TVS) of the compost (28-29%) compared to the control (26.4%). Increase in TVS for different N sources over the control was 6-9% (Table-2). This indicated the role of N in particular and the equivalent importance of different N sources in general in the decomposition of carbonaceous material and the resultant liberation of volatile compounds. Greater the amount of nitrogen, greater will be the release of volatile solids (Chattergee et al., 2013).

The data in Table-2 showed highest TVS in the compost (28.8%)

after 30 days of decomposition indicating the liberation of TVS from the easily decomposable material at early stage of decomposition. At 60th day, the compost TVS decreased to 27.3% indicating exhaustion of easily decomposable material at the mid composting stage. However, at 90th day, TVS content in the compost (28.1%) increased by 2.9% over the 60th day indicated the liberation of intricately bound volatile compounds at the advanced stage of decomposition. Interaction (Table-2, Fig. 1) between N sources and decomposition time for TVS in the compost showed significantly higher TVS (31.2%) in urea treated compost after 30 days and chicken manure (30.2%) after 60 days of composting indicate their relative efficiencies for composting at different decomposition stages. The lowest TVS (25.1%) in Urea after 60 days of composting shows urea efficiency at early decomposition stage only.

The data (Table-2) revealed the significantly ($p<0.05$) lower bulk density (BD) of the compost treated with urea (1.17 g cm^{-3}). Significantly higher BD of the mature compost treated with chicken manure, cotton seed meal and soybean meal (1.3, 1.28 and 1.26 g cm^{-3}, respectively) than the control (1.22 g cm^{-3}) The maximum available water content was found with blood meal (47.6%) that correlates well with its lowest bulk density. Water holding capacity at 60th and 90th day was 9 and 13% higher than 30th day, respectively. In interaction (Fig. 1), water holding capacity of the compost with blood meal increased significantly but this N source performance was, especially, superior at maturity of the compost. Moisture content along with C:N ratio determines maturity of compost. It shows availability of compost for use as organic amendment to soil.

Mineral N (Table-2)and total N (Table-3) content in the compost showed significantly ($p\leq0.05$) higher concentrations for soybean meal amongst the N sources. Amongst the decomposition time interval, mineral and total N was significantly ($p<0.05$) higher for 90 days (Tables 2 and 3). Interactions between the decomposition time and N source (Fig. 1) showed significantly higher mineral and total N for soybean meal at 90 days followed by 60 days. Reduction in volume of the compost due to decomposition with time resulted in higher concentration per unit weight of the compost. Benito et al. (2005) also recorded differences in total nitrogen content of the compost made by using different nitrogen sources. Data on C/N ratio (Table-3) showing significant reduction with proceeding maturity of the compost support this statement. These results confirmed that N addition as compost starter from various sources also improve compost quality. Himanen and Hanninen (2011) observed variations in mineral nitrogen contents of composts prepared using different N sources. Regarding decomposition time and N source interaction on C/N ratio (Fig. 1), C/N ratio of the compost improved with time for all sources except chicken manure. Sanmanne et al. (2011) also reported decline in C:N ratio of different composts with the passage of time.

Significantly ($p<0.05$) higher total P in the compost was observed in the soybean mean and cotton seed meal (26 and 24% higher over the control, respectively) followed by chicken manure (18% higher over the control) whilst total K content in the compost was maximum in chicken manure treated compost (10% higher over the control) followed by soybean meal (9% higher over the control) (Table-3). The P and K fraction of the N source and the possible difference in their decomposition efficiency for the carbonaceous material might be supportive for difference in P and K content of the compost. The P and K content of the compost were 10 and 12% higher at 60th day and 30 and 20% higher at 90th day, respectively, compared to their contents at 30th day. This might be due to reduction in volume per unit mass of the compost. Performance of all N sources with respect to P and K contents improved significantly ($p<0.05$) uniformly in interaction with time and was highest at maturity (90th day). However, some N sources like urea at 30th and cotton seed meal at 60th day for P and chicken manure at 30th day for K were very poor, however, their performance were significantly higher over the other sources at maturity for their respective nutrients (Fig. 1). Pan et al. (2012) reported different P and total K contents.

All N sources were significantly ($p<0.05$) higher in Fe (from 5 to 13%) and Mn (from 21 to 42%) over the control (Table-3). Amongst the N sources, urea and blood meal proved to be superior in case of Fe followed by similar effect of the chicken manure, soybean meal and cotton seed meal whilst in case of Mn, urea proved to be solely superior followed by blood meal and other organic N sources. Better performance of the urea in both cases directly points towards better decomposition to decrease volume per unit mass and hence increase micronutrients concentration per unit mass of the compost. However, the close follow up by other N sources challenge its sole position with respect to compost starter. Data (Table-3) showed improvement in Fe and Mn concentration increased with decomposition time. Micronutrient Fe and Mn were 4 and 13% higher at mid composting (60th day) and 12 and 39% higher at maturity over the initial compost stage (30th day). . Azeem et al. (2014) also observed different iron concentrations in compost with the passage of time. Interaction between the N sources and decomposition time (Fig. 1) showed some sources like chicken manure and cotton seed meal efficiencies were very low at initial decomposition stage (30th day) but improved drastically at mid composting (60th day) and at maturity (90th day) stages.

CONCLUSION

It is concluded that use of the organic N sources as the compost starter were equally effective in the composting. However, soybean meal and cotton seed meal had displayed distinctive physico-chemical improvement in the mature compost properties and the same can effectively be substituted as alternate N sources for preparation of the parthenium weed compost.

Table-1. N sources with their N content and the total amount calculated for composting.

Source	N Content (%)	Total required amount (kg)
Urea	46	0.463
Blood meal	12	2.5
Manure	4	7.4
Cotton seed meal	6	4.9 kg
Soya bean meal	6	4.9 kg

Pit Volume = 4×2×2= 16 ft = 0.592 yd^3, Compost N starter application rate (Fredrick et al., 2012) = 500 g $yard^{-3}$

Table-2. Physico-chemical properties of the Parthenium weed compost pH as affected by different nitrogen sources and Time.

N Source	pH	EC	TVS	Bulk Density	AWHC	Mineral N
		dS m^{-1}	g $10g^{-1}$	g cm^{-3}	%	g kg^{-1}
Chicken Manure	8.23 bc	2.19	2.89 a	1.30 a	42.01 b	7.43 b
Blood meal	8.27 ab	2.17	2.82 a	1.19 cd	47.59 a	7.10 c
Soybean meal	8.33 a	2.31	2.86 a	1.26 b	46.16 a	8.05 a
cotton seed meal	8.27 ab	2.29	2.79 a	1.28 ab	41.70 b	6.69 d
Urea	8.18 c	2.31	2.85 a	1.17 d	39.02 b	6.69 d
Control (Cont.)	8.26 b	2.16	2.64 b	1.22 c	40.13 b	5.61 e
$LSD_{0.05}$	0.067	ns	0.098	0.03	3.21	0.31
Time						
30 days	8.27	2.25	2.88 a	1.25 a	39.84 b	5.82 c
60 days	8.23	2.06	2.73 b	1.22 b	43.34 a	6.79 b
90 days	8.27	2.41	2.81 a	1.25 a	45.13 a	8.17 a
$LSD_{0.05}$	Ns	0.13	0.07	0.02	2.27	0.22
N * Time	Ns	ns	*(Fig.1)	*(Fig. 1)	*(Fig. 1)	*(Fig.1)

EC: Electrical conductivity, TVS: Total volatile solids. AWHC: Available water holding capacity. Values with different letters in the same column are significantly different at the $p \leq 0.05$.

Table-3. Physico-chemical properties of the parthenium weed compost as affected by different nitrogen sources and time.

N Source	Total N	C/N ratio	Total P	Total K	Total Fe	Total Mn
	$g\ kg^{-1}$		………$g\ kg^{-1}$………		……$mg\ kg^{-1}$………	
Chicken Manure	24.43 b	29.16 c	2.51 b	185.68 a	571.07 b	415.7 c
Blood meal	24.10 b	29.86 b	2.10 d	174.14 cd	599.67 a	447.0 b
Soybean meal	25.05 a	28.67 c	2.67 a	182.78 b	564.53 b	421.1 c
cotton seed meal	23.69 c	30.46 b	2.62 a	172.43 d	561.27 b	395.8 d
Urea	23.69 c	30.20 b	2.44 c	176.36 c	601.85 a	463.8 a
Control (Cont.)	22.61 e	32.62 a	2.11 d	168.16 e	533.84 c	326.4 e
$LSD_{0.05}$	0.06	0.60	0.064	2.22	13.83	16.43
Time						
30 days	22.82 c	31.25 a	2.12 c	159.26 c	537.33 c	341.2 c
60 days	23.79 b	30.59 b	2.34 b	178.80 b	576.53 b	419.2 b
90 days	25.17 a	28.64 c	2.76 a	191.72 a	602.25 a	474.5 a
$LSD_{0.05}$	0.047	0.43	0.046	1.57	9.78	11.62
N * Time	*(Fig.1)	*(Fig.1)	*(Fig.1)	* (Fig.1)	*(Fig.1)	*(Fig.1)

Values with different letters in the same column are significantly different at the $p \leq 0.05$.

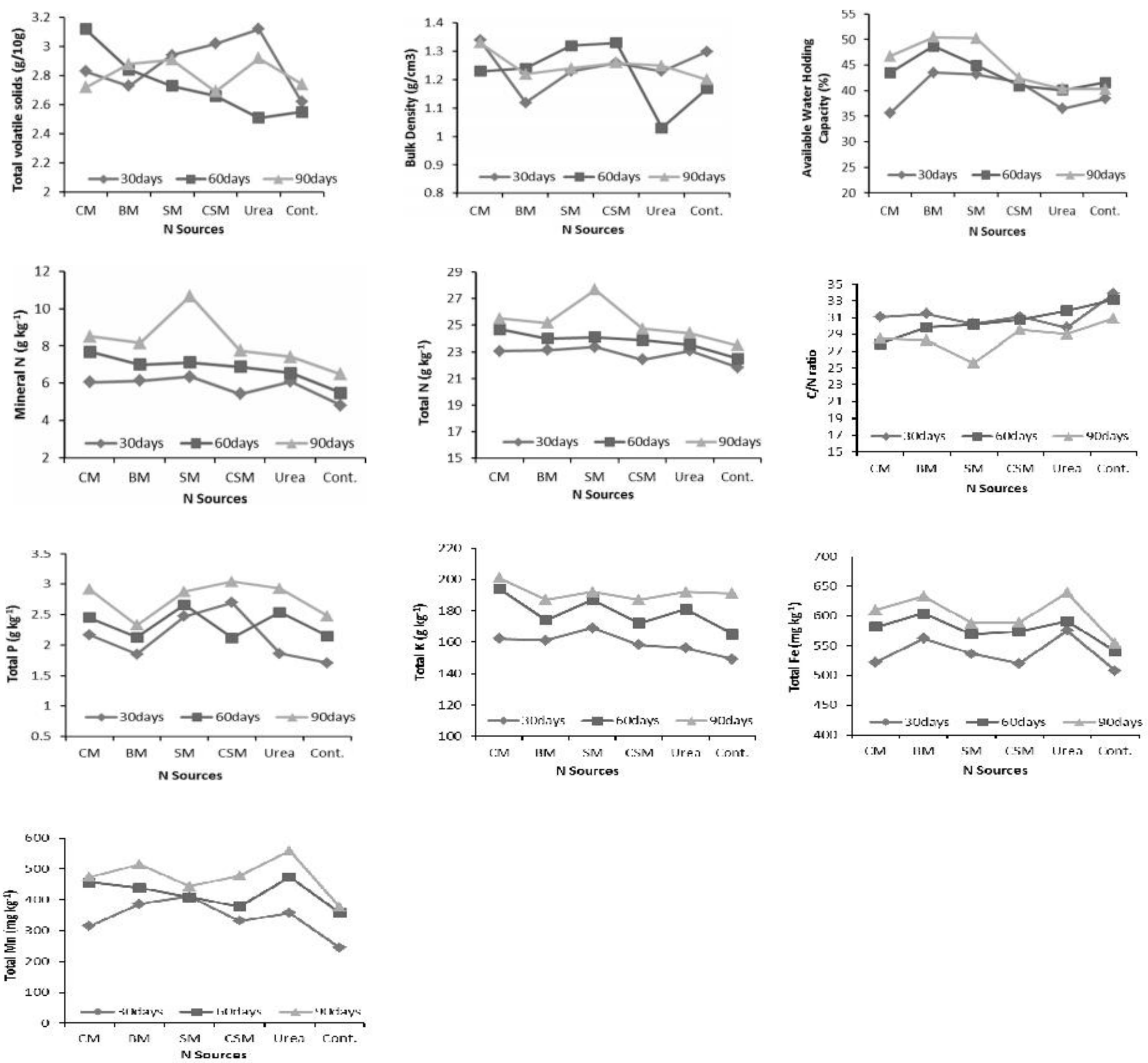

Fig. 1. Interaction between time and N sources on Physico-chemical properties of mature parthenium weed compost.

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