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SOLID WASTE MANAGEMENT: EFFECTIVENESS OF COMPOSTS ON PRODUCTIVITY OF SOILS

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Abstract: A pot experiment was conducted to study the effectiveness of aerobic compost (AC) and barrel compost (BC) on crop (*Amaranthus)* yield and soil properties in two soils (Melandaha and Dhamrai series). The soils were treated with composts and/or fertilizer (N and P). The doses of composts were 1 t ha^{-1}, 1.5 t $ha^{-1}$and 2 t ha^{-1}. The dry matter yield increased due to the treatments, showing higher yield due to the barrel compost in Melandaha soil but the best result was obtained for aerobic compost at the rate of 1.5 t ha^{-1} along with fertilizer in same soil.

Key words: *Amaranthus*, compost, availability, uptake, productivity and growth

Introduction

Agricultural, industrial and many other operations produce a large amount of waste producing a variety of pollutants. Through management practices, these wastes may be turned to a good resource in agriculture. Practices for waste collection in rural areas are negligible and in urban areas, some amount is collected everyday and the rest lie on their original place. So, these huge amounts, which are not collected properly, create numerous problems. There is some process of solid waste management and the most suitable and convenient process is composting. Aerobic and Barrel types of composting system have been introduced in Bangladesh. The objective of this study was to see the effectiveness of these two types of composts on crop yield and soil properties.

Table 1. Some physico-chemical & chemical properties of experimental soils.

Parameter		Melandaha series	Dhamrai series
Textural classes		Silt loam	Silty clay loam
Cation exchange capacity (CEC) meq/ 100g		9.77	11.63
P^H		6.13	6.72
Organic matter (OM)%		1.75	2.88
Total nitrogen (N)%		0.14	0.18
Available	N (mg kg^{-1})	30.00	43.00
	P (mg kg^{-1})	46.00	39.00
	K (mg kg^{-1})	54.00	104.00

Table 2. Compositions of composts.

Compost	Moisture (%)	% OM	pH	% N	% P	% K
Aerobic	38.75	18.82	7.5	1.66	1.38	1.40
Barrel	55.44	12.90	7.5	0.96	0.58	0.80

Materials and Methods

A pot experiment was conducted in Melandaha and Dhamrai series soils (0-15 cm depth) amended with two types of composts (aerobic compost and barrel compost). The composts were collected from *Waste Concern* which is a research based organization situated at Mirpur in Dhaka, Bangladesh. Two kg air-dried soil (that was previously prepared) was taken into each small earthen pot. The properties of the soils are presented in the Table 1. There were 14 treatment combinations (Table 3), each treatment replicated thrice. So, the total number of pots was 84 (2×14×3). To the first set of experiments, neither compost nor fertilizer was added

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(control). The second, third & forth set received 1, 1.5 and 2 t ha^{-1} composts, respectively. The fifth, sixth and seventh sets of experiment received additional (N plus P) fertilizer along with the compost. For Melandaha soil, 96.20 Kg ha^{-1}N and 28.13 Kg ha^{-1} P_2O_5 and for Dhamrai soil, 77.13 Kg ha^{-1} N and 30.75 Kg ha^{-1} P_2O_5 were added to maintain the normal plant growth, as obtained from the Fertilizer Recommendation Guide (BARC, 1997). The compost and fertilizer were well mixed with the soil. The pots were arranged in a completely randomized design. *Amaranthus* seeds were sown and after emergence 5 seedlings were kept in each pot. Water was added to bring the soil to field moisture condition. *Amaranthus* were harvested after 42 days and the dry matter weight was measured. Total N of the samples was determined by Kjeldahl method as described by Jackson (1973). Total P was determined following the ascorbic acid method after digesting it by HNO_3–$HClO_4$ mixture as described by Jackson (1962). Flame photometer determined total and available K. Available N was determined by Micro- Kjeldahl distillation method using Deverda's alloy as described by Black (1965) after extraction of soil by 1M NaCl solution (Anam *et al.*, 1977). Available P was determined colorimetrically (Page *et al.*, 1990). Depending on the pH, the extraction of soil P was made with Bray-1 (Bray and Kurtz No-1) solution as described by Jackson (1962).

Results and Discussion

***Effect of composts on N-availability*:** The experimental result shows that the availability of N increased significantly due to application of compost or compost plus fertilizer (for all treatments) in Melandaha soil. In this case, the highest value was found for BC_2F (104.16 mg kg^{-1}) treatment (Table 3). This might be due to the mineralization of added OM in the presence of chemical fertilizer. When AC or AC plus fertilizer were added to Dhamrai soil, the availability also increased significantly, but the availability decreased after addition of fertilizer along with compost as compared to compost alone (Table 3). Similar results were also obtained for BC or BC plus fertilizer treatment. For similar application rate the availability of N was relatively greater for BC plus fertilizer treatment (BC_1F, $BC_{1.5}F$, BC_2F) than the AC plus fertilizer treatments (AC_1F, $AC_{1.5}F$, AC_2F). This might be due to the fact that on application of fertilizer, microbial activity became greater in these treatments causing enhanced mineralization of OM and subsequent release of N.

Organic substances contain huge amounts of N, P, K, S and other essential trace elements in organic forms. Conversion of these organic forms to available mineral forms (NH_4^+, NO_3^-, PO_4^{3-}, SO_4^{2-}) occurs through the activity of microorganisms. The experimental results show that due to application of compost or compost plus fertilizer availability of N increased significantly.

Table 3. Changes in N, P and K in soils as influenced by compost and fertilizer.

Treatment	Melandaha Soil (mg kg^{-1})			Dhamrai Soil (mg kg^{-1})		
	N	P	K	N	P	K
Control	19.53	30.88	49.88	19.53	37.75	85.14
AC_1	32.55	30.88	52.50	110.67	42.32	97.13
$AC_{1.5}$	39.06	30.88	50.75	78.12	45.75	100.63
AC_2	39.06	34.31	52.76	91.14	43.46	90.39
AC_1F	39.06	35.46	53.38	84.63	42.32	90.39
$AC_{1.5}F$	39.06	38.03	50.75	78.12	45.75	94.50
AC_2F	32.55	37.75	55.13	84.63	43.46	92.14
BC_1	32.55	34.03	49.88	110.67	42.32	94.76
$BC_{1.5}$	39.06	32.03	51.01	84.63	43.46	97.13
BC_2	32.55	34.41	50.14	104.16	46.90	103.51
BC_1F	78.12	35.46	54.51	91.14	44.61	95.38
$BC_{1.5}F$	78.12	29.74	51.01	97.65	62.91	105.00
BC_2F	104.16	32.03	49.00	97.65	45.75	102.38
F	91.14	35.46	49.00	52.08	52.61	97.13

A = aerobic compost, C_1 = compost @ 1 t ha^{-1}, $C_{1.5}$ = compost @ 1.5 t ha^{-1}, C_2 = compost @ 2 t h^{-1}, B = barrel compost, F = fertilizer

***Effect of composts on P-availability*:** When AC was applied to Melandaha soil, the availability increased only for AC_2 (34.31 mg kg^{-1}) treatment, which was more than 11 % over control (30.88 mg kg^{-1}). After addition of fertilizer along with compost, the availability increased significantly (at 1% level) for all treatments and the highest was found for $AC_{1.5}F$ (38.03 mg kg^{-1}) treatment. When Dhamrai soil was treated with compost or compost plus fertilizer, the availability increased for all treatments over control (Table 3). The highest value was found for $BC_{1.5}F$ (62.91 mg kg^{-1}) treatment. All of these results were statistically significant at 1 % level.

From this experiment it can be said that the availability of P increased significantly which is in agreement with the observations made by Eghball and Power (1995). They showed that the availability of P increased due to application of compost. The P availability in the compost-amended soils remained higher than in the compost free soils (control). This may be due to formation of complex between P and humates, which may decrease P fixation and precipitation in soils (Stevenson, 1982). Such humates can originate from the transformation undergoing in soil-applied compost. The other probable cause may be that, organic compounds in soils increased P availability by anion replacement of $H_2PO_4^-$ on adsorption sites or by coating of Fe and Al particles by humus to form a protective cover and thus, P adsorption (Tisdale *et al.*, 1993).

***Effect of composts on K- availability*:** When AC or AC plus fertilizer were added in Melandaha soil, the availability increased for all treatments but higher values were found for compost plus fertilizer treatments as compared to compost alone. The highest value was found for AC_2F (55.13 mg kg^{-1}) treatment. For BC or BC plus fertilizer treatments the availability ranged from 49.00 (BC_2F) to 54.51 (BC_1F) mg kg^{-1} (Table 3). When Dhamrai soil was treated with compost or compost fertilizer, the availability increased for all treatments. The highest value was found for $BC_{1.5}F$ (105.00 mg kg^{-1}) treatment. All of these results were statistically significant.

It was found that for almost all the cases the availability of K slightly increased due to application of fertilizer along with compost to Melandaha soil (Table 3). This may be due to the fact that, in the presence of fertilizer, decomposition of compost was greater and luxury consumption of K might have taken place, thus, resulting available K to be less. But when compost or compost plus fertilizer was added to Dhamrai soil, the availability of K increased. This may be due to less consumption of K by plants.

Table 4. Dry matter weight ($g/_{100}$ plants) as affected by different treatments of aerobic compost along with or without fertilizer.

Treatment	Melandaha series			Dhamrai series		
	Shoot (g)	Root (g)	Total (g)	Shoot (g)	Root (g)	Total (g)
Control	11.73	1.73	13.46	15.13	2.27	17.40
AC_1	13.20	1.73	14.93	11.60	1.33	12.93
$AC_{1.5}$	16.80	2.33	19.13	14.00	1.53	15.53
AC_2	15.67	1.80	17.47	20.73	2.40	23.13
AC_1F	12.60	1.47	14.07	19.60	1.87	21.47
$AC_{1.5}F$	36.73	5.20	41.93	19.73	1.93	21.66
AC_2F	18.40	2.60	21.00	23.27	2.73	26.00
F	27.13	3.47	30.60	23.40	2.07	25.47
LSD (0.05)	0.30	0.06	0.58	0.29	0.02	0.92

A = aerobic compost, C_1 = compost @ 1 t ha^{-1}, $C_{1.5}$ = compost @ 1.5 t ha^{-1}, C_2 = compost @ 2 t h^{-1}, F = fertilizer

***Effect of composts on Amaranthus Growth*:** Application of compost to soils has often resulted in increased plant growth (Table 4 and Table 5). It was found that the growth of *Amaranthus* significantly increased (LSD at 5 % level) due to application of compost (aerobic or barrel) or compost plus fertilizer to Melandaha soil. It was also found that the average growth of *Amaranthus* was better for barrel compost (in Melandaha soil). But the individual best result was obtained for $AC_{1.5}F$ (41.93 g/100 plants) treatment in same soil. This growth exceeds the growth observed from fertilizer treated soil. From this result, it can be said that compost plus fertilizer resulted in greater *Amaranthus* growth than for either source applied alone, which is in agreement with the result of Schlegel (1992). For $AC_{1.5}F$ in Melandaha soil, it was found that addition of fertilizer along with compost has given better growth than compost or fertilizer used alone. This may be due

to the fact that, in the presence of fertilizer, the activity of microorganisms was enhanced and as a result mineralization was also enhanced and more nutrients were made available. But for Dhamrai soil, the result was different. In some cases the growth decreased due to application of compost or compost plus fertilizer. This is in agreement with the result of Clark *et al.,* (1995). They found that application of municipal solid waste compost could cause N deficiencies in plants and depress crop yield. It may be due to immobilization of nutrients or *priming effect* might have taken place (Stevenson, 1986). As a result, loss of native N may have ensued or genetic nature of plant may be responsible or other unknown cause may be involved here. In this case, some results were in agreement with the result of Schlegel (1992). For example, in Dhamrai soil, treatment AC_2F (26.00 g/100 plants) and BC_1F (30.20 g/100 plants) have given a better growth as compared to the F (25.47 g/100 plants) treatment.

Table 5. Dry matter weight ($g/_{100}$ plants) as affected by different treatments of barrel compost along with or without fertilizer

Treatment	Melandaha series			Dhamrai series		
	Shoot (g)	Root (g)	Total (g)	Shoot (g)	Root (g)	Total (g)
Control	11.73	1.73	13.46	15.13	2.27	17.40
BC_1	20.80	2.40	23.20	17.40	2.47	19.87
$BC_{1.5}$	18.40	2.87	21.27	16.07	1.67	17.74
BC_2	19.00	2.33	21.33	6.07	0.73	6.80
BC_1F	22.07	3.13	25.20	27.47	2.73	30.20
$BC_{1.5}F$	21.87	3.00	24.87	12.00	1.53	13.53
BC_2F	21.33	3.00	24.33	11.33	1.47	12.80
F	27.13	3.47	30.60	23.40	2.07	25.47
LSD (0.05)	0.42	0.15	0.58	0.29	0.02	0.87

B = barrel compost, C_1 = compost @ 1 t ha^{-1}, $C_{1.5}$ = compost @ 1.5 t ha^{-1}, C_2 = compost @ 2 t h^{-1}, F = fertilizer

From this experiment, it can be said that the best result was obtained for Melandaha soil when barrel compost was used. But the best treatment was $AC_{1.5}F$ (41.83 g/100 plants). The results indicate that the efficacy of compost is dependent on the nature of soil. Soil characteristics like pH, OM content, texture and other nutrients as well as the presence of different microorganisms have a bearing on the effectiveness of compost to a better productivity of soil.

Table 6. Uptake of N, P and K (mg/100 plants) in Melandaha soil after treating with compost or compost plus fertilizer.

Treatment	N			P			K		
	Shoot	Root	Total	Shoot	Root	Total	Shoot	Root	Total
Control	232.25	36.85	269.10	27.15	4.22	31.37	514.95	81.31	596.26
AC_1	149.16	39.10	188.26	27.5o	4.83	32.33	557.04	72.66	629.70
$AC_{1.5}$	485.52	52.89	538.41	38.89	6.50	45.39	651.84	97.86	749.70
AC_2	396.45	35.28	431.73	32.65	3.77	36.42	684.78	68.40	753.18
AC_1F	112.14	36.60	148.74	29.17	4.10	33.27	517.86	64.68	582.54
$AC_{1.5}F$	297.51	87.36	384.87	76.53	10.88	87.41	1439.82	180.96	1620.78
AC_2F	520.72	47.84	568.56	29.82	6.33	36.15	645.84	87.62	733.46
BC_1	601.12	44.16	645.28	52.97	5.86	58.83	975.52	115.92	1091.44
$BC_{1.5}$	531.76	50.80	582.56	42.60	6.01	48.61	750.72	128.58	879.30
BC_2	611.80	48.00	659.80	52.78	7.32	60.10	875.90	121.86	997.76
BC_1F	644.44	56.65	701.09	56.20	7.64	63.84	856.32	133.65	989.97
$BC_{1.5}F$	586.12	50.01	636.13	50.63	8.37	59.00	831.06	120.90	951.96
BC_2F	618.57	56.70	675.27	59.25	9.42	68.67	883.06	132.30	1015.36
F	889.86	68.36	958.22	75.37	9.68	85.05	1052.64	130.13	1182.77

A = aerobic compost, C_1 = compost @ 1 t ha^{-1}, $C_{1.5}$ = compost @ 1.5 t ha^{-1}, C_2 = compost @ 2 t ha^{-1}, B = barrel compost, F = fertilizer.

Effect of composts on N, P and K Uptake: The experimental result shows that, due to application of compost or compost plus fertilizer, the average uptake of N, P, and K were higher for almost all the treatments, as compared to control (Table 6 and Table 7). The results also shows that, the higher uptake of N, P and K has

taken place in Melandaha soil when the soil was treated with BC or BC plus fertilizer. N, P and K are required in large quantities for maximum growth. It was also observed that nutrient release from compost was greater for BC (Table 3). So, it can be said that, in almost all the cases, uptake of primary nutrients increased due to application of compost or compost plus fertilizer.

Table 7. Uptake of N, P and K (mg/100 plants) in Dhamrai soil after treating with compost or compost plus fertilizer.

Treatment	N			P			K		
	Shoot	Root	Total	Shoot	Root	Total	Shoot	Root	Total
Control	490.21	40.63	530.84	42.03	7.13	49.16	776.17	128.03	904.20
AC_1	381.94	28.86	410.80	29.54	3.25	32.79	549.84	110.92	660.76
$AC_{1.5}$	508.20	35.34	543.54	45.37	4.67	50.04	697.20	87.36	784.56
AC_2	752.50	43.68	796.18	67.19	7.53	74.72	1231.36	140.64	1372.00
AC_1F	623.28	39.27	662.55	72.60	9.13	81.73	1172.08	137.26	1309.34
$AC_{1.5}F$	662.93	40.53	703.46	50.24	5.39	55.63	903.63	90.32	993.95
AC_2F	558.48	55.69	614.17	70.03	9.52	79.55	1219.35	139.23	1358.58
BC_1	532.44	52.36	584.80	48.34	6.03	54.37	852.60	121.28	973.88
$BC_{1.5}$	485.31	38.24	523.55	48.33	5.83	54.16	853.32	91.35	944.67
BC_2	219.73	17.59	237.32	25.55	3.64	29.19	308.96	36.94	345.90
BC_1F	931.23	57.88	989.11	114.47	9.52	123.99	1678.34	194.38	1872.72
$BC_{1.5}F$	326.40	32.74	359.14	41.66	4.27	45.93	886.05	95.45	981.50
BC_2F	378.42	31.46	409.88	36.72	4.62	41.34	557.44	87.91	645.35
F	774.54	43.88	818.42	92.09	8.67	100.76	1368.90	134.55	1503.45

A= aerobic compost, C_1= compost @1 t ha^{-1}, $C_{1.5}$ = compost @1.5 t ha^{-1}, C_2 = compost @ 2 t ha^{-1}, B= barrel compost, F= fertilizer.

Conclusion

In most cases, it was found that the availability of N, P and K increased significantly ($p<0.01$) due to application of compost or compost plus fertilizer. So, it is a good sign for soil productivity. The availability of primary elements increased, plant growth also increased that is why uptake of N, P and K is also increased. The Barrel compost in Melandaha soil gives better growth but more cost is involved to prepare barrel compost. Farmer can apply aerobic compost at a rate of 1.5 t ha^{-1} along with fertilizer ($AC_{1.5}F$). Moreover, preparation of aerobic compost is more convenient and less time consuming. Using compost along with fertilizer will reduce the cost of fertilizer and thus, will help to bring down the production cost of a crop.

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