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EFFECTS OF VERMICOMPOST AND COMPOST ON SOIL PROPERTIES AND GROWTH AND YIELD OF KALMI (*IPOMOEA AQUATICA* FORSK.) IN MIXED SOIL

AFROJA NASRIN, SAYMA KHANOM* AND SHAHID AKHTAR HOSSAIN

Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

Key words: vermicompost, compost, *Ipomoea aquatica*, mixed soil

Abstract

An incubation study was conducted to find out the best mixing ratio of acid and calcareous soil (maintaining 70% moisture) for pot experiment. Depending on various physico-chemical properties mixed soil 1 : 1 (i.e. acid : calcareous) was selected for pot experiment. The pot experiment was carried out to observe the effects of vermicompost and compost on soil properties and growth and yield of Kalmi (*Ipomoea aquatica* Forsk.). This experiment included seven treatments with three replications including control. Treatment variables were T_0 (control), T_1 (4 t/ha vermicompost), T_2 (8 t/ha vermicompost), T_3 (12 t/ha vermicompost), T_4 (4 t/ha compost), T_5 (8 t/ha compost) and T_6 (12 t/ha compost). All the treatments had significant positive effects over control on growth and yield of kalmi. The highest growth and yield were recorded with T_3 (12 t/ha vermicompost) treatment. In case of, macro and micronutrient uptake treatment T_3 (12 t/ha vermicompost) performed best followed by T_6 (12 t/ha compost) over T_0 (control). However, in post-harvest soil except soil reaction (pH); electrical conductivity (EC), organic carbon (OC), available N, P, K, S, Ca, Mg, Na, Fe and Zn significantly increased for T_3 (12 t ha^{-1} vermicompost) than T_1, T_2, T_4, T_5, T_6 and T_0.

Introduction

Bangladesh is a developing country where agriculture plays a vital role. About 85% of the total population in the country depends on agriculture directly or indirectly for their livelihood. Most of the soils of Bangladesh are low to medium acidic in nature; due to predominance of high rainfall areas and leaching of basic cations(1). Acid soil possesses high concentration of Al^{3+}, Fe^{3+}, Mn^{2+} and low concentration of P, low availability of bases and in calcareous soil there is abundance of Ca, Mg but lack of Fe, Mn, Zn, B and phosphate and nitrate(2). Mitigation measures to reclaim acid and calcareous soils are very much expensive and intricate to local farmers. So, mixing of these two kinds of soils to get a reasonable soil pH which is finally termed mixed soil may give adequate supply of the nutrient elements.

*Author for correspondence: <sayma_swedu@yahoo.com>.

Moreover, the soils of Bangladesh are basically very low in organic matter, deficient in plant nutrients, especially nitrogen and phosphorus. Due to poor management practices and unbalanced use of chemical fertilizers, organic matter content is getting reduced day by day that ultimately reduces microbial activity and causes macro and micro nutrient deficiencies(3). Therefore, organic farming systems with the aid of various nutrients of biological origin like vermicompost and compost are thought to be the answer to sustain soil fertility and crop productivity.

Vermicompost is a potential input and nutritive organic fertilizer rich in humus, macro and micro nutrients, growth hormones (auxines, gibberlins and cytokinins) and beneficial for soil microbes. It is an excellent soil amendment and conditioner(4). With the continued application of vermicompost the 'organic nitrogen' and other nutrients tends to be released at a constant rate from the accumulated 'humus'. The net overall efficiency of NPK over a period of years is considerably greater than that of chemical fertilizers. It is a new solution in sustainable agriculture that not only promotes excellent growth of crops but also protects them from pests and diseases(5). On the other hand, compost is an aerobically decomposed product of organic wastes that contains beneficial soil microbes which help in soil regeneration. It supplies balanced nutrients and improves the physical and chemical properties of the soil. Matured composts are stable and have pleasant smell, but if the composting process is ended prematurely, the resulting immatured compost may have negative effects on soils and plants(6). The current research was undertaken to examine effects of vermicompost and compost on the growth and yield of kalmi (*Ipomoea aquatica*Forsk.) grown in mixed soil and also to determine changes in soil properties due to application of vermicompost and compost.

Materials and Methods

The study area for sample collection was chosen depending on high and low pH of soil. For low pH, acid soils were collected from Binnapara, a village of Chehelgazi Union of Dinajpur Sadar Upazilla in Dinajpur district. For high pH, calcareous soils were collected from West Gongabordi, a village of Krishnanagar union of Faridpur Sadar Upazilla in Faridpur district.

The soils were collected at 0 - 15 cm depth from both sampling sites. The collected soil samples were air-dried for 3 days. Visible roots and debris were removed. After air-drying, the larger aggregates were broken by a wooden hammer. Then an incubation study was run by mixing acid and calcareous soils at different ratios like 1 : 1, 2 : 1, 5 : 3, 7 : 1, 0 : 4, and 4 : 0 maintaining 70% moisture. Depending on physico-chemical properties, 1:1 ratio was selected for pot experiment (Table 1). Approximately 500 g of each sample was taken for physico-chemical analysis which was screened to pass through a 2 mm stainless steel sieve.

Table 1. Physico-chemical properties of acid, calcareous and mixed soil.

Physico-chemical properties	Acid Soil	Calcareous soil	Mixed (1 : 1)	Mixed (2 : 1)	Mixed (5 : 3)	Mixed (7 : 1)	Mixed (0 : 4)	Mixed (4 : 0)
Texture	Silt-loam	Loam	Loam	Loam	Loam	Silt -loam	Loam	Silt-loam
pH	4.50	8.30	6.50	6.83	6.23	4.00	8.30	4.50
EC (μS/cm)	447	176	340	236	311	550	176	447
Organic carbon (%)	1.08	0.89	0.98	0.50	0.95	1.09	0.89	1.08
C.E.C (C mol/kg)	4.15	23.25	15.95	9.42	9.55	4.20	23.25	4.15
Total N (mg/kg)	960	1080	1019	992	1124	970	1080	960
Available N (mg/kg)	192.50	108	164	145	162.92	193.45	108	192.50
Available P (mg/kg)	5.50	18.80	28.76	25	27.52	5.75	18.80	5.50
Available K (mg/kg)	58.53	103.28	90.93	80.2	86.73	58.75	103.28	58.53
Available S (mg/kg)	30.95	15.83	27.75	24.9	24.70	30	15.83	30.95
Available Ca (mg/kg)	300.50	3615	1755	1742	1247	299.65	3615	300.50
Available Mg (mg/kg)	97.50	508	300.80	287.2	195.45	93.75	508	97.50
Available Na (mg/kg)	25	62.50	20.50	65.13	66.92	29.45	62.50	25
Available Fe (mg/kg)	103.10	15.38	60.35	25.52	28.86	104	15.38	103.10
Available Mn (mg/kg)	37.52	15.70	29.73	28.55	27.32	38.25	15.70	37.52
Available Zn (mg/kg)	1.73	2.44	2.05	1.40	1.65	1.60	2.44	1.73

Vermicompost and compost were used as organic fertilizers. Vermicompost was collected from a farm situated in Keraniganj and compost was collected from a farm house at Sreepur area in Gazipur. Collected vermicompost and compost were passed through a 0.5 mm stainless steel sieve and different physical, chemical and physico-chemical properties were determined following standard method as described by Jackson[7] (Table 2).

Table 2. Properties of Vermicompost and Compost.

Properties	Vermicompost	Compost
Colour	Dark grey to black	Dark grey
Physical condition	Non- granular form	Non- granular form
Odour	Absence of foul odour	Presence of foul odour
pH	8.50	8.16
EC (dS/m)	5.63	3.47
OC (%)	24.54	19.40
Total N (%)	2.40	1.69
Total P (%)	0.93	0.81
Total K (%)	0.54	0.34
Total S (%)	0.25	0.12
Total Ca (%)	1.90	1.45
Total Mg (%)	0.92	0.79
Total Na (%)	1.15	1.06
Total Fe (%)	0.16	0.12
Total Mn (mg/kg)	220	140
Total Zn (mg/kg)	110	90

The experiment was laid out in Completely Randomized Design (CRD) with three replications. To set up the experiment all plastic pots were filled up with 3 kg of air-dried mixed soil (1 : 1). Before seeding, recommended doses of fertilizers (RDF) were mixed according to fertilizer recommendation guide[8].

Seeds of Kalmi (*Ipomoea aquatica* Forsk.)were collected from BADC and aboutten seeds were sown in each pot on June, 2016. After 3-4 days of germination, thinning was done and four plants were allowed to grow. Cultural operations were done when necessary. After 42 days, kalmi plants were collected from each pot and plant height and fresh weight were taken. After harvesting of plants, soils from each pot were collected using a hoe and processed as described earlier and various physico-chemical properties were analyzed using standard procedure as described by Jackson[7].

Results and Discussions

Effects on growth parameters and yield: Application of different rates of vermicompost and compost showed significant positive effects on plant height, fresh weight and yieldof kalmi (Table 3).

Growth parameters: Plant height (PH) is an important morphological character. The highest plant height (64 cm) was found with T_3 (12 t/ha vermicompost) treatment, which was 28% higher over T_0 (control) and the second highest plant height (62.7 cm) was found with treatment T_6 (12 t/ha compost) which was 25.34% higher over T_0 (control). Similarly, the maximum plant fresh weight (35.09 t/ha) was recorded with T_3 (12 t/ha vermicompost) which was 60.74% higher over control (Table 3).

Table 3. Growth and yield of kalmi in response to different treatments.

Treatment	Plant height (cm)	Fresh weight (t/ha)	Yield (t/ha)
T_0 (Control)	50.0	21.83	2.98
T_1 (4 t/ha vermicompost)	52.7	29.15	3.87
T_2 (8 t/ha vermicompost)	58.8	31.49	4.46
T_3 (12 t/ha vermicompost)	64.0	35.09	5.13
T_4 (4 t/ha compost)	50.5	27.91	3.79
T_5 (8 t/ha compost)	55.0	30.33	4.29
T_6 (12 t/ha compost)	62.7	33.19	5.02
LSD at 5%	4.12	4.37	1.07

Yield: Statistically significant positive effects of all the treatments on yield of kalmi were found in the experiment. The maximum yield of kalmi (5.13 t/ha) was obtained in T_3 (12 t/ha vermicompost) which was 72.15% higher over control (Table 3). Yield of kalmi ranked in the order of $T_3>T_6> T_2>T_5>T_1> T_4> T_0$. It appeared that maximum plant height, green weight and dry weight were attained with the highest dose of vermicompost application which was similar to the result reported by Atarzadeh *et al.*(9) and Karmakar *et al.*(10).

Effects on nutrient uptake in plant: Application of different rates of vermicompost and compost showed significant positive effects on macro and micronutrient uptake of kalmi (Table 4).

Macronutrient uptake: Application of different treatments showed statistically significant positive effects on macronutrient uptake of kalmi. The highest amount of N uptake (84.65 kg ha^{-1}), P uptake (41.78 kg/ha), K uptake (218.10 kg/ha), S uptake (34.40 kg/ha), Ca uptake (90.29 kg/ha) and Mg uptake (18.47 kg/ha) was found with treatment T_3 (12 t/ha vermicompost) which were 82.09, 138.47, 400.34, 209.1, 103.35 and 377.3%, respectively higher over control. Similarly, the second highest amount of N uptake (81.83

kg/ha), P uptake (38.43 kg/ha), K uptake (190.51 kg/ha), S uptake (30.62 kg/ha), Ca uptake (85.80 kg/ha) and Mg uptake (15.13 kg/ha) was found with T_6 (12 t/ha compost) which were 76.02, 119.35, 337.05, 175.1, 93.24 and 290.96%, respectively higher over T_0 (Table 4) which was similar to the findings of Akhter *et al.*(11).

Table 4. Uptake of macro and micronutrients by kalmi in different treatments.

Treatment	Macro and Micronutrient uptake (kg/ha)									
	N	P	K	S	Ca	Mg	Na	Fe	Mn	Zn
T_0 (Control)	46.49	17.52	43.59	11.13	44.40	3.87	30.99	1.48	0.156	0.180
T_1 (4 t/ha vermicompost)	61.15	25.15	94.83	18.59	60.73	8.13	46.03	2.32	0.215	0.290
T_2 (8 t/ha vermicompost)	72.25	32.21	132.28	25.50	74.93	12.49	105.70	3.39	0.262	0.389
T_3 (12 t/ha vermicompost)	84.65	41.78	218.10	34.40	90.29	18.47	151.85	4.77	0.354	0.491
T_4 (4 t/ha compost)	59.50	23.50	86.47	16.30	57.47	6.82	42.36	2.04	0.203	0.277
T_5 (8 t/ha compost)	68.64	29.63	117.72	23.60	69.50	10.55	100.20	3.01	0.250	0.351
T_6 (12 t/ha compost)	81.83	38.43	190.51	30.62	85.80	15.13	141.53	4.23	0.317	0.450
LSD at 5%	0.749	0.814	0.574	0.287	0.206	0.226	0.237	0.049	0.016	0.036

Micronutrient uptake: The highest uptake of Na (151.85 kg/ha), Fe (4.77 kg/ha), Mn (0.354 kg/ha) and Zn (0.491 kg/ha) was recorded for treatment T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) which were 390, 222.3, 126.9 and 172.8%, respectively higher over control (Table. 4).

Effect on physico-chemical properties of post harvested soil samples: Application of different treatments of vermicompost and compost showed significant positive effects on physico-chemical changes of the post-harvest soil.

In different treatments,soil pH of post-harvest soil samples significantly decreased from controlexcept T_4 (4 t/ha compost). The minimum soil pH (7.42) was recorded in T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) and the maximum soil pH (7.69) was obtained in control (Table 5) which was similar to the findings of Atiyeh *et al.*(12) and Butler *et al.*(13). Electrical conductivity (EC) of post-harvest soil samples significantly increased with all treatments over control. The highest EC (290 µS/cm) was observed in treatment T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) over control (Table 5) which was similar to the results of Azarmi *et al.*(14). The maximum organic carbon (OC) (1.30%) was found for treatment T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) and the minimum organic carbon (OC) (0.95%) was obtained with control (Table 5). Similar results were obtained by Whalen *et al.*(15).

The highest available N content (138 mg/kg), P content (15.45 mg/kg), K content (79.85 mg/kg), S content (28.50 mg/kg), Ca content (2043 mg/kg) and Mg content (335.3 mg/kg) were recorded with T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) over control (Table 5). Similar results were reported by Renato *et al.*(16) and Nardi(17).

Table 5. Changes in physico-chemical properties and available nutrient elements of post-harvest soil under different treatments.

Treatment	Physico-chemicalproperties			Available nutrient elements (mg/kg)									
	pH	EC (μS/cm)	OC (%)	N	P	K	S	Ca	Mg	Na	Fe	Mn	Zn
T_0 (Control)	7.69	210	0.95	121	11.06	68.87	19.20	1540	297.2	35.6	48.5	21.2	1.98
T_1 (4 t/ha vermicompost)	7.60	220	1.07	126	12.08	70.50	22.60	1627	300.4	36.5	51.7	22.4	2.06
T_2 (8 t/ha vermicompost)	7.54	254	1.22	131	13.29	75.35	25.70	1704	315.8	38.7	55.7	24.2	2.13
T_3 (12 t/ha vermicompost)	7.42	290	1.30	138	15.45	79.85	28.50	2043	335.3	41.8	60.2	26.3	2.20
T_4 (4 t/ha compost)	7.62	215	1.02	122	11.93	69.12	19.95	1553	299.2	35.8	50.1	21.8	2.00
T_5 (8 t/ha compost)	7.58	249	1.18	127	12.73	74.31	22.85	1635	310.5	37.5	54.3	23.4	2.08
T_6 (12 t/ha compost)	7.50	279	1.27	134	13.82	78.76	26.58	1839	327.6	40.5	59.2	25.2	2.16
LSD at 5%	0.065	1.75	0.053	0.092	0.138	0.565	0.771	0.038	0.799	0.197	0.544	0.610	0.084

Similarly, the highest available Na content (41.8 mg/kg), Fe content (60.2 mg/kg), Mn content (26.3 mg/kg) and Zn content (2.20 mg/kg) were found with T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) and the lowest available Na content (35.6 mg/kg), Fe content (48.5 mg/kg), Mn content (21.2 mg/kg) and Zn content (1.98 mg/kg) were found with control (Table 5) which was similar to the findings ofChoudhary and Jat[18].

From the study it is revealed that due to mixing of acid and calcareous soil at 1 : 1 ratio, soil pH became neutral and other physico-chemical properties were at optimum level. All the treatments had significant positive effects over control in respect of growth parameters and yield of kalmi. The highest plant height (64 cm), fresh weight (35.09 t/ha) and yield (5.13 t/ha) were recorded with treatment T_3 (12 t/ha vermicompost) followed by T_6 (12 t/ha compost) over control. Themaximum macro and micro nutrient uptake were obtained for T_3 (12 t/ha vermicompost) treatment. Application of different rates of treatments showed statistically significant positive effects on physico-chemical properties of post-harvest soil. Except soil reaction (pH); electrical conductivity (EC), organic carbon (OC), available N, P, K, S, Ca, Mg, Na, Fe, Mn and Zn increased for treatment T_3 (12 t/ha vermicompost) over control. Considering all the points, it is found that vermicompost appeared to be the most efficient organic fertilizer to increase growth, yield and make changes in soil properties.

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