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Composting Technology and Impact of Compost on Arid Soil Biochemical Properties

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Author's contribution

This whole work was carried out by author RAAA.

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ABSTRACT

Organic farming is one of several approaches to sustainable agriculture. Properly managed, organic farming reduces or eliminates environmental pollution and helps conserve water and soil on the farm. Organic farming system requires significantly greater amount of organic fertilizers input than conventional system. Because of the shortage of organic fertilizers in the arid areas, composting is a way to transform the waste materials left over from agricultural production and processing into a useful resource. Mature compost is an excellent organic fertilizer and desert soil amendment. The potential of composting to turn on-farm waste material into farm resources makes it an attractive proposition. Composting offers several benefits such as enhance soil fertility and soil health, thereby increase agricultural productivity, improve soil biodiversity, reduce ecological risks and improve environment. Aerobic composting of some agricultural wastes (peanut, wheat straw and palm tree wastes) was carried out to raise its fertilizing value compared with widely used organic fertilizer, farmyard manure. The influence of composted and non-composted agricultural wastes on availability of nitrogen, phosphorus and potassium (NPK) in desert sandy soil as well as uptake of these elements by corn plants was also studied. Results indicated rapid degradation of palm tree and wheat straw wastes as compared with peanut one. The composting process raised fertilizing value of agricultural wastes as indicated by increase of nutrients availability. Application of the composted wastes as organic fertilizers to desert sandy soil increased content of available N, P and K. Results showed that application of different composted organic materials increased the dry weight and NPK uptake by corn plants.

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Keywords: Agricultural waste; palm trees waste; composting technology; arid region; fertilizing value.

1. INTRODUCTION

Egypt is one of the oldest agricultural countries known in the history. Up to now, the Egyptian economy is based mainly on the agriculture. The total amount of the agricultural waste produced annually is in the range of 30-35 million tons a year. Only 11 million tons of the agricultural wastes are utilizing as 7 million tons animal feed and 4 million tons as organic manure [1]. One feature of sustainable agriculture is its lower dependence on chemical fertilizers and recycling of on-farm residues to maintain and /or improve soil fertility. Compost produced from agricultural waste can be used for fertilizing the soil and to improve the growth of cultivated plants [2]. Other important advantages of composting are the reduction of the wastes, the destruction of weed seeds and of pathogenic microorganisms [3]. Additional benefits of composting as mechanism for waste management are production of valuable soil amendments, low operation costs, easy to be applied in most of developing countries, and encouragement of environmentally friendly practices such as reduction of the emission of greenhouse gases, promote the efficiency of fertilizer application [4].

Microbial technologies for agriculture and waste management are receiving significant attention to meet the special need of developing countries. Therefore, this work aims at raising the fertilizing value of some agricultural wastes through the composting process. Effects of composted materials on the mineralization rate of nitrogen, phosphorus, and potassium in Sinai sandy soil (arid region) as well as the uptake of these elements by corn plants were also studied.

2. MATERIALS AND METHODS

2.1 Composting of Agricultural Wastes

Three agricultural wastes; peanut, wheat straw and palm tree wastes were composted aerobically in windrows (25 x 3 x 1.5 m) with aeration through turning [5,6]. Two tons of each of chopped material were prepared and divided into 10 parts. An activator mixture (50 kg $(NH_4)_2\ SO_4$ + 10 kg superphosphate +50 kg of commercial calcium carbonate) was well mixed and divided also into 10 parts. A portion of the chopped material was scattered over the area; then, a portion of the activator mixture was spreaded over it and moistened. The first layer was then built. The other nine layers were built over the first layer, in the same manner. Water was added if necessary to keep the moisture content inside the heap at 60% of the weight through the experiment. Ten PVC cylinders with a length of 2 m and a diameter of 10 cm were inserted in each heap to allow aeration for the microorganisms. After 45 days, the materials in each heap were turned using a tractor equipped with a backhoe. The temperature of the heaps was daily recorded at 10 and 50 cm below surface. The heaps were left 6 months for composting. Samples from the surface area and the central parts of the heap were taken manually after 0, 7, 14, 21, 30, 60, 90, 120, 150 and 180 days, mixed thoroughly and four replicates were examined microbiologically for total count of mesophillic, thermophillic bacteria and aerobic cellulose- decomposing bacteria. The serial dilution plate count procedure was used to estimate the total count of mesophillic and thermophillic bacteria [7]. Dobus's cellulose medium [8] was used for the counting of aerobic cellulose-decomposing bacteria. At the beginning and the end of composting, pH, EC, organic carbon, total nitrogen, phosphorus and potassium were determined according to [9].

2.2 Influence of Composted and Non-composted Agricultural Wastes on Availability of Nutrients in Sinai Sandy Soil

Surface soil samples (0 – 30 cm depth) were collected from Al-Areesh area, Sinai, Egypt. The soil samples were air dried and sieved through 2 mm mesh sieve and water holding capacity was determined. The soil was sandy in texture with pH 8.15, EC 0.85 dS/cm, organic matter 0.26% and Ca CO_3 6.77%. Two hundred gram portions of the soil were packed in plastic pots and supplemented with 2% of each composted, non-composted agricultural wastes or farmyard manure (chemical properties of farmyard manure used are given in Table 1. Control pots of soil samples without addition of organic manures were prepared. Therefore, the treatments were

1- Untreated soil (T1)
2- Farmyard manure treated sample (T2)
3- Wheat straw treated sample (T3)
4- Composted wheat straw treated sample (T4)
5- Peanut wastes treated sample (T5)
6- Composted peanut wastes treated sample (T6)
7- Palm tree wastes treated sample (T7)
8- Composted palm tree wastes treated sample (T8)

Different organic manures were added to soil samples and thoroughly mixed. Each treatment was repeated 6 times at the same time. Water was added to maintain the soil moisture to 60% of its water holding capacity. The pots were incubated at 28°C for six weeks. The soil moisture content was kept nearly constant throughout the experiment. Soil samples from each treatment were taken after 0, 7, 15, 30, 45 and 60 days to determine available N, P and K according to the method described by [9]. Some important soil microorganisms were followed up during the experiment. Total bacterial count [7], aerobic cellulose - decomposing bacteria [8], *Azotobacter* [10] and phosphate- dissolving bacteria [11] modified by [12] were estimated using the serial dilution method.

2.3 Effect of Composted and Non-Composted Agricultural Waste on Nutrients Uptake by Zea Maize

A greenhouse experiment was carried out to study the effect of composted, non-composted and farmyard manure application to agricultural soil on the nutrients uptake by corn (*Zea maize* L.). Cylinders of 25 cm diameter and 30 cm in depth were filled with 50 kg of the same soil used in the second experiment. Soil samples were mixed with 0.5, 1.0 and 2.0 % of each organic manures (composted, non-composted and farmyard manure) and mixed thoroughly. Soil without organic manure was used as control. The treatments were moistened to near field capacity and left for two weeks. Each treatment was replicated 6 times. Five seeds of corn were sown in each cylinder, which thinned out to two on germination. After 7 weeks, plants were harvested, dried on $70^{o}C$ and ground in a still steel mill. Nitrogen, phosphorus and potassium were determined in the plant samples according to [9].

Table 1. Chemical properties of used farmyard manure

Chemical properties	Value
pH	7.75
EC (dS / m)	2.90
Organic matter %	23.30
Organic carbon %	13.51
Available nitrogen (mg/kg soil)	462
Total nitrogen %	0.63
Available phosphorus (mg/kg soil)	207
Total phosphorus %	0.143
Available potassium (mg/kg soil)	689
Total potassium %	0.173
C / N ratio	21.45

2.4 Statistical Analyses

Data were statistically analyzed using Tukey method according to [13].

3. RESULTS AND DISCUSSION

3.1 Microbiological and Chemical Changes during Composting of Agricultural Wastes

Temperature is the most important indicator of efficient composting process and depends on aeration rate [14]. Changes in temperature inside different agricultural wastes heaps are presented in Table, 2. Composting process exhibited classical temperature pattern. Three periods were distinguished: a phase of latency which correlates to microbial population adapted in the compost conditions, a phase of sudden rise in temperature up to 65 and a phase of cooling in which the temperature decreased progressively and returned to its starting values. Table, 2 indicates that temperature inside heaps of different agricultural wastes rose to reach about 65°C after 7 days. This high temperature inside the heaps is necessary to destroy pathogens. The rising of temperature during composting is mainly due to the activity of microorganisms in the degradation of agricultural wastes. The results were in agreement with the findings of [15,16,17]. After 20 days the temperature inside the heaps reached about 50 and 62°C at 10 cm and 100 cm below surface, respectively (mean is 56°C) and this temperature was maintained for the maximum biodegradation. In this respect, temperature should not exceed 65°C, as this would kill almost all microorganisms and cause the process to cease. After the first 30 days, temperature gradually decreased to around 35°C although, it rose up due to the turning of heaps after 45 days from starting time. The temperature attained by a compost heaps is influenced by the amount of oxygen available to the microorganisms in the compost, and hence the aerobic nature of the composting process. The rise in temperature inside the heaps of the different agricultural wastes was due to the promoting effectiveness of turning (more oxygen) and water addition, which enhanced the microbial activity. The temperature inside the heaps of the different agricultural wastes thereafter, became more or less constant around 30ºC until the end of composting period.

Table 2. Mean of temperature variations during composting process of three different agricultural wastes

Time (day)	Temperature ºC	
	At 10 cm below surface	At 50 cm below surface
0	32	31
7	58	65
21	50	62
30	50	64
45	40	55
60	35	49
75	32	40
90	35	42
120	30	32
150	30	31

3.1.1 Microbiological changes

Data in Table, 3 show a decrease in counts of mesophilic bacteria during the first two weeks of composting followed by increases till the end of the composting period (180, 90 and 120 days for peanut, wheat straw and palm tree wastes, respectively). These results indicated the importance of mesophilic bacteria at the beginning of composting as they attack readily decomposable constituents of organic wastes. Production of excessive heat creates suitable environment for the thermophilic flora. These results were in harmony with those of [18,19,16].

Table 3. Microbiological changes during composting of wheat straw, peanut and palm tree wastes (Counts/g dry material)

Organisms	Time in days									
	0	7	14	21	30	60	90	120	150	180
					Peanut wastes					
Mesophillic bacteria x 10^6	578	217	182	392	534	612	715	662	617	559
Thermophillic bacteria x 10^5	3	112	157	87	69	54	47	33	29	17
Aerobic cellulose decomposer x10^4	56	7	3	12	142	188	112	73	78	64
					Wheat straw					
Mesophillic bacteria x 10^6	317	89	67	139	417	489	515	-	-	-
Thermophillic bacteria x 10^5	9	323	412	290	112	34	45	-	-	-
Aerobic cellulose decomposer x10^4	13	7	3	12	141	157	97	-	-	-
					Palm tree wastes					
Mesophillic bacteria x 10^6	432	113	108	215	477	514	642	492	-	-
Thermophillic bacteria x 10^5	7	182	246	273	163	105	87	56	-	-
Aerobic cellulose decomposer x10^4	37	19	16	22	129	157	195	60	-	-

Counts of thermophilic bacteria in the composted materials showed a marked increase after 14 days of composting (Table, 3). This was mainly due to the high temperature of the heap during this period of composting. Thermophilic bacteria, thereafter, decreased with the fall of temperature until the end of the composting period but the final counts were much higher than the initial one. These results indicated that changes in temperature of the composted heaps govern the types and development of microorganisms concerned in the decomposition process [20,19,16].

Aerobic cellulose decomposing bacteria showed a decrease during the first 21 days, and then a progressive increase in their counts was observed reaching to the maximum after 2 month. This might have been due to the reduction in the population of cellulose decomposers during the high temperature phase followed by increase due to the subsequent lower temperature and / or the degradation of the easily decomposable material at the first period of composting leaving the cellulytic-materials which are hardly decomposable to degrade at later stage of composting. These results are in line with those of [19,21,16].

3.1.2 Chemical changes

Data in Table 4 shows that pH values of the three agricultural wastes at initial time of composting were slightly alkaline. During composting, pH values gradually decreased with production of organic acids. The final pH of peanut, wheat straw and palm tree wastes were 7.71, 7.55 and 6.8, respectively. This decreasing in pH values mostly occurred at the high temperature periods due to the increase in the decomposition rate particularly by thermophilic organisms. The salinity level (EC) was increased at the end of composting process because of organic materials mineralization. These results were in agreement with those of [22].

Dry matter content of the agricultural wastes decreased gradually during the whole period of composting (Table 4). Total loss of dry matter content amounted to 25.3, 33.7 and 36.5% from the initial amount of peanut, wheat straw and palm tree wastes, respectively. These results are in line with those of [23]. The present results clearly indicate the rapid degradation of palm tree wastes and wheat straw as compared to peanut wastes. It seems that the highest rate of decomposition took place at high temperature and the rate was decreased during the subsequent low temperature period.

Changes in the figures of organic matter and carbon contents during composting of peanut, wheat straw and palm tree wastes found to be in line with those recorded for the dry matter content (Table 4). The most active period of decomposition was at the high temperature periods. This indicates the important role of the thermophilic organisms in the decomposition process [18,19,16]. The loss in organic matter content during the decomposition period amounted to be 14.5, 23.2 and 23.05% of the initial amount of peanut, wheat straw and palm tree wastes, in respective order. This indicates that the rate of decomposition was high in wheat straw and palm tree wastes as compared to peanut one. This could be due to the high content of wheat straw and palm tree wastes of easily decomposable substances than that of peanut materials.

As the result of decomposition process, percentage of inorganic nitrogen decreased, while the percentage of total and organic nitrogen increased in the three agricultural composted materials (Table, 4). Composted materials contain significant amounts of N in organic form that, whilst not easily available to plants, are also less leachable [24]. The increase in total nitrogen percent may be due to the higher oxidation of non- nitrogenous organic materials and partially to the N_2-fixation by non-symbiotic nitrogen fixers as indexed by the increase in organic nitrogen. This indicates that the immobilization of nitrogen taken place during composting and conserved the nitrogen from loss.

Changes in the ratio of organic carbon to nitrogen during composting of the agricultural wastes are recorded in Table 4. The C/N ratios were first 61.5, 98.4 and 87.7 for peanut, wheat straw and palm tree wastes, respectively. As the result of the changes in the amount of nitrogen and the loss of organic carbon during composting process, a progressive narrowing in the C/N ratios of the composted materials was observed reaching to 25.4, 23.9 and 18.3, in respective order for peanut, wheat straw and palm tree wastes. The changes in C/N ratio could be taken as evidence of the degradation rate of the organic materials and the maturity of compost. These results are in line with those of [25,26,16].

Table 4. Chemical properties of peanut, wheat straw and palm tree wastes at the beginning and end of composting process

Chemical properties	**Peanut wastes**		**Wheat straw**		**Palm tree wastes**		**L.S.D At 5%**
	Raw material	**Compost**	**Raw material**	**Compost**	**Raw material**	**Compost**	
pH	8.35	7.71	8.20	7.55	8.12	6.8	0.358
EC (dS m^{-1})	0.85	1.40	1.25	4.05	0.92	2.12	1.356
Dry matter %	100	74.7	100	66.27	100	63.50	23.676
Organic matter %	94.1	79.6	94.7	71.5	90.7	67.75	13.825
Organic carbon %	54.71	46.28	55.10	41.57	52.63	39.29	7.682
Available - N %	0.241	0.11	0.102	0.315	0.02	0.09	0.054
Organic - N %	0.649	1.71	0.46	1.425	0.60	2.15	0.943
Total - N %	0.890	1.82	0.56	1.74	0.62	2.24	0.971
Available - P(ppm)	168	583	297	630	167	432	238
Total - P %	0.15	0.35	0.21	0.44	0.07	0.52	0.172
Available – K (ppm)	782	1328	991	2017	823	1362	457
Total - K %	0.11	0.16	0.18	0.31	0.16	0.87	0.032
C/N ratio	61.47	25.43	98.39	23.89	87.71	18.27	33.569

3.2 The Influence of Composted and Non-Composted Agricultural Wastes on Microbiological Properties of Sinai Sandy Soil

Compost is known to improve the biological properties of the soil [27]. Data in Table 5 shows that the addition of composted and non-composted agricultural wastes to the sandy soil builds up its microbial population. The counts of total bacteria were increased gradually in all treatments reached their maximum level after 30 days of incubation period. The counts, thereafter, decreased but not reached to the control level at the end of the experiment. The stimulating effect of the composted or non-composted agricultural wastes was higher as compared with untreated soil due to the richness of the wastes with energy sources. Composted materials were the most effective in this regard as compared with non-composted ones. The addition of compost to the sandy soil inevitably provides a substrate for microbial growth and, as this improves, so does the fertility and health of the soil. These results are in harmony with the finding of [28] who found that microbial counts exhibited a periodical behavior. They were significantly affected by the addition of organic materials, but the effect of compost was greater.

Table 5. Effect of composted and non-composted organic materials on microbiological changes in Sinai sandy soil

Treatments	Time in days					
	0	7	15	30	45	60
	Total bacterial counts x 10^6					
Untreated soil	5	18	23	37	21	16
Peanut wastes	35	43	67	79	56	49
Composted peanut wastes	74	82	99	128	102	85
Wheat straw	43	67	73	82	76	65
Composted wheat straw	95	119	132	157	125	103
Palm tree wastes	55	76	88	95	82	71
Composted Palm tree wastes	112	147	156	179	143	119
Farmyard manure	82	97	117	139	120	92
	Aerobic cellulose decomposers x 10^4					
Untreated soil	3	6	11	18	14	12
Peanut wastes	52	65	79	95	112	37
Composted peanut wastes	14	22	39	84	58	42
Wheat straw	78	84	107	134	92	80
Composted wheat straw	26	47	65	113	78	52
Palm tree wastes	84	96	116	148	110	91
Composted Palm tree wastes	38	58	77	131	87	67
Farmyard manure	61	74	83	98	52	39
	***Azotobacter* x 10^4**					
Untreated soil	2	3	7	19	13	9
Peanut wastes	6	9	22	37	30	18
Composted peanut wastes	13	21	34	79	62	51
Wheat straw	8	13	29	42	37	21
Composted wheat straw	21	35	66	102	85	72
Palm tree wastes	23	39	53	74	66	41
Composted Palm tree wastes	62	89	105	141	128	96
Farmyard manure	17	29	49	91	71	48
	Phosphate dissolving bacteria x 10^3					
Untreated soil	2	9	12	27	19	13
Peanut wastes	14	17	29	44	36	25
Composted peanut wastes	29	35	44	57	50	32
Wheat straw	16	19	27	35	26	21
Composted wheat straw	36	48	56	84	72	53
Palm tree wastes	21	39	42	58	51	46
Composted Palm tree wastes	47	73	88	106	93	67
Farmyard manure	32	37	48	70	60	45

As regards the physiological groups of soil microorganisms, aerobic cellulose decomposers, *Azotobacter* and phosphate dissolving bacteria followed the same trend as total bacterial counts (Table 5). The non-composted materials enriched the sandy soil with more cellulose decomposers at the beginning of incubation as compared with the composted ones. Its counts were gradually increased reached its maximum after one month and then decreased due to the low content of cellulytic materials because of the degradation of the agricultural wastes. The lower numbers of cellulose decomposers in compost-treated soil than in non-composted agricultural wastes supplemented ones could be explained by the fact that a great portion of cellulytic materials was degraded during the composting process that done before.

Counts of *Azotobacter* as one of the most important non-symbiotic N_2-fixers in soils and phosphate dissolving bacteria were followed up during the experiment. Counts of both *Azotobacter* and phosphate dissolving bacteria were increased gradually in all treatments reached their maximum after 30 days and then decreased but still higher than the initial numbers (Table 5). Organic materials incorporated in the soil markedly increased the counts of *Azotobacter* and phosphate dissolving bacteria. Compost was superior in this respect as compared with the non-composted materials. The lower counts of both organisms in non-composted agricultural wastes supplemented soil may be due to the low pH because of the production of organic acids during the degradation of the agricultural wastes whereas the compost was reached the maturity state before adding to the soils.

3.3 Influence of Composted and Non -Composted Agricultural Wastes on Availability of Nitrogen, Phosphorus and Potassium Nutrients in Sinai Sandy Soil

Compost is known to improve the physical, and chemical properties of the soil [27]. The addition of composted or non-composted agricultural wastes to the sandy soil increased its available nitrogen content at the beginning of the experiment (Fig. 1). These increases were differed according to the available nitrogen of the added organic wastes. The different nitrogen transformations are the result of various microbial activities in soil, namely N_2-fixation, assimilation and denitrification. Increase in mineral nitrogen caused by mineralization of organic nitrogen whereas a decrease points to mineral nitrogen assimilation or losses through denitrification or volatilization. Data clearly show that, the available nitrogen decreased gradually during the first month of non-composted materials application and thereafter, it increased again. This is mainly due to immobilization by microorganisms and partially to nitrogen loss. Immobilization was occurred due to the wide C/N ratio of the added non-composted agricultural wastes [29]. However, mineralization rates were higher in compost-treated soil as compared with non-compost-treated one, indicating the high content of available nitrogen in these treatments. Inorganic N release depended on the availability of C and N and the C/N ratio [26]. Higher mineralization rate was also taken place due to richness in phosphates in addition to the narrow C/N ratio of the composted materials. The mineralization rate was higher during the first month of the experiment and then slightly decreased. Thus, mineralization rate of nitrogen in the different organic wastes treatments decreased in the following order: composted wheat straw > composted peanut > composted palm tree wastes > farmyard manure, respectively.

These results are in harmony with the findings of [30,31,26]. The application of agricultural wastes to the soil tended to accelerate the assimilation of nitrogen for a long period (45 days after application) in contrast to the incorporation of composted materials, which had a beneficial effect on the availability of nitrogen during the first period of application. These results clearly indicate the importance of composting process to the different agricultural wastes before its application to the soil. Therefore, the important factor related to the organic matter incorporated in the soil is the kind and maturity of the organic material added [32,5].

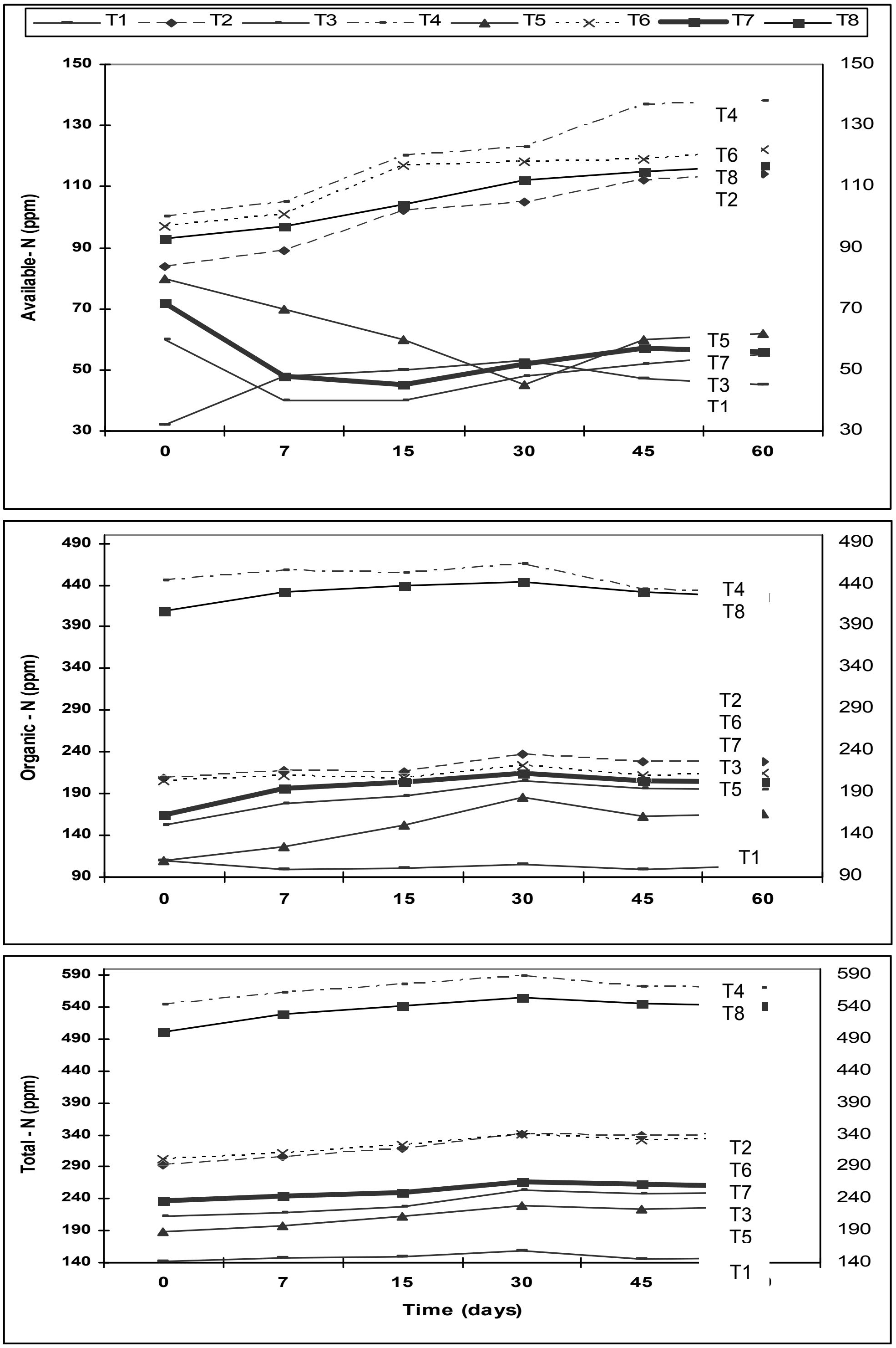

Fig. 1. Effect of composted and non-composted agricultural wastes on different nitrogen forms in Sinai sandy soil

Changes in total and organic nitrogen contents of the soil are shown in Fig. 1. Application of composted or non-composted agricultural wastes raised the total nitrogen level in the soil. Composted materials, as expected, were more effective in this respect than non-composted ones. Total nitrogen showed definite increases in the control as well as soil supplemented with organic materials during the first month, followed by decrease within the second month but still higher than the initial. The behavior of organic nitrogen was about the same as total nitrogen. During the first month of incubation, an increase in total and organic nitrogen contents occurred in all treatments, indicating active N_2 - fixation by non-symbiotic nitrogen fixers. Organic material incorporated in soil markedly accelerated the nitrogen fixation process, and the effect of compost surpassed that of non-composted wastes in stimulating the non-symbiotic nitrogen fixation because of its richness in phosphates in addition to the presence of some available sources.

Changes that took place for mobilization of the mineral phosphorus released by degradation of the various organic materials applied to the sandy soil are shown in Fig.2. The control soil (untreated) revealed slight increases in the available P within the first 15 days of incubation, thereafter, rate of mobilization had become more or less constant. This situation is reflection of the activity of soil microbial population, in rendering the soil P available via dephosphorylation of its original organic fraction, during their rapid growth phase. Application of the organic materials resulted generally in augmenting the contents of available P, which followed the same trend of phosphate dissolving bacteria (Table, 5). Orders of mineral P availability rates obtained for the different organic materials were: composted wheat straw> farmyard manure > composted peanut > composted palm tree wastes > non-composted wheat straw > non-composted palm tree wastes > non-composted peanut, respectively. These results indicate the higher increases of available P in the compost-treated soil. These results could be attributed to narrow C/N and C/P ratios of composted materials, which promote the rate of P availability. This is a reflection of stimulated decomposition of composted materials resulting in production of carbonic acid and chelating metabolites mainly as organic acids [33,34].

Considerable increases of available potassium were observed with application of different organic materials used (Fig. 2). This effect was more pronounced under composted than non-composted materials. This reflects again the importance of composting maturity, which is an important factor affecting successful application in agriculture [31,5,34].

Composting of organic wastes does not appear to affect K availability but, application may affect both soil K [35,36] and plant K uptake [37]. Compost made from grass and straw has been shown to contain approximately twice the K content of chicken manure [38]. This type of material might therefore be beneficial in stockless organic systems.

The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide. Compost plays a vital role in sustaining forming by providing plant N-supply [39]. The addition of mature compost at reasonable rates increases available soil nutrient level [40,41].

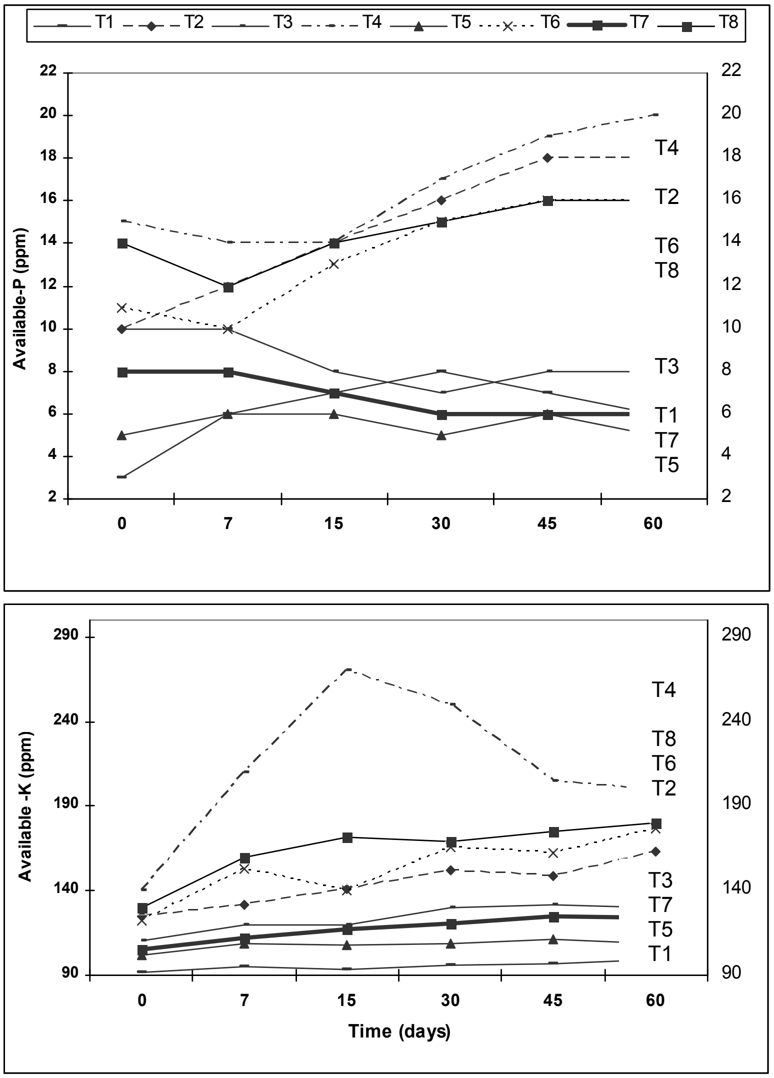

Fig. 2. Effect of composted and non-composted agricultural wastes on phosphorus and potassium availability in Sinai sandy soil

3.4 Effect of Composted and Non-Composted Agricultural Wastes on the Nutrients uptake of Zea Maize Plants

The application of agricultural wastes either composted or non-composted induced significant increase in maize dry weight (Table 6). These increases were parallel to the increase of application rate. The dry weight of maize plants was lower in soil treated with non-composted wastes than those grown in compost-treated ones. This could be explained by the lower decomposition rate of non-composted wastes when incorporated into the soils compared with composted materials. The addition of matured compost at reasonable rates, enhance the plant growth, [40,41]. These results are also in harmony with those of [42]. A composted palm tree waste was superior in increasing plant dry weight followed by the composted wheat straw, peanut wastes and farmyard manure, respectively.

Table 6. Effect of composted and non-composted agricultural wastes on dry matter, N, P and K uptake of corn plants grown in sandy soil

Treatments	Application rate (%)	Dry weight (g/ plant)	Uptake (mg/ plant)		
			Nitrogen	Phosphorus	Potassium
Untreated soil	-	2.24	64.9	4.75	23.7
	0.5	2.42	75.0	5.40	27.6
Peanut wastes	1.0	2.62	78.2	6.41	33.4
	2.0	2.93	84.5	6.74	39.5
	Mean	2.66	79.2	6.18	33.5
	0.5	2.66	91.5	6.94	30.6
Composted peanut wastes	1.0	2.91	115.8	7.94	42.2
	2.0	3.15	134.0	8.73	50.7
	Mean	2.91	113.7	7.87	41.2
	0.5	2.48	71.0	5.95	26.6
Wheat straw	1.0	2.65	90.7	6.52	35.1
	2.0	2.88	98.2	6.74	41.9
	Mean	2.67	86.6	6.40	34.5
	0.5	2.61	114.1	7.25	32.1
Composted wheat straw	1.0	2.95	125.4	8.61	52.8
	2.0	3.78	176.9	11.9	82.8
	Mean	3.11	138.8	9.25	55.9
	0.5	2.64	78.1	6.1	29.1
Palm tree wastes	1.0	2.73	84.6	6.5	32.8
	2.0	3.09	100.1	8.0	43.3
	Mean	2.82	87.6	6.87	35.1
	0.5	2.92	119.9	8.2	43.8
Composted Palm tree wastes	1.0	3.51	129.3	10.2	56.2
	2.0	3.83	146.4	11.9	65.1
	Mean	3.42	131.9	10.1	55.1
	0.5	2.89	105.8	6.76	39.3
Farmyard manure	1.0	2.90	111.1	7.05	40.3
	2.0	3.39	135.6	8.41	52.5
	Mean	3.06	117.5	7.41	44.0
L.S.D. at 5% for:					
Treatments		0.43	19.20	2.35	9.14
Application rate		0.35	7.90	1.15	6.34
Interactions		0.62	23.80	3.87	11.89

Data recorded in Table, 6 indicate that adding agricultural wastes (composted or non-composted materials) led to generally significant positive increase in maize contents of N, P and K. Such response may be due to decomposition of organic wastes and subsequently release of nutrient elements. Other possibilities could be: i) effect of organic materials in chelating and formation of organic complexes relatively available for plant especially in the compost treatments, ii) production of humate which could exchange for adsorbed anions such as phosphate led to increase the movement of phosphate resulting in availability for plant uptake [43,44].

Results given in Table, 6 also showed that composted materials gave the highest N, P, and K contents of maize plants as compared with treatments supplemented with non-composted ones. This may be due to the high mineralization rate of composted materials, which liberated sufficient amount of available nutrients for plant uptake. These results indicated again the importance of composting process before adding the agricultural wastes to soils. Results also showed that the application of different forms of composted organic materials increased the dry weight and NPK uptake by corn plants.

4. CONCLUSIONS

Results obtained showed that composted agricultural wastes increased the availability of NPK in soil. These results indicated the importance of composting to different agricultural wastes before its application to soils in general and arid sandy soil in particular. Therefore, the important factor related to the organic matter incorporated in the soil is the kind and maturity of the organic material added. Results also showed that the application of different forms of composted organic materials increased the dry weight and NPK uptake by corn plants.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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