Arab Gulf Journal of Scientific Research, 23 (2), pp 80-91 (2005)

Original Paper Ref. No 2349

Composting Technology and the Impact of *Compost* on Soil Biochemical Properties

إنتاج سماد الكمبوست من المخلفات الزراعية وتأثيره على تيسير العناصر الغذائية فى التربة الرملية

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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 systems require significantly greater amounts of organic fertilizers input than conventional systems. Because of the shortage of organic fertilizers in arid areas, composting is a way to transform waste materials left over from agricultural production and processing into a useful resource. Mature compost is an excellent organic fertilizer and 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 to enhance soil fertility and soil health, thereby increasing agricultural productivity, improving soil biodiversity, reducing ecological risks and improving the environment. Aerobic composting of some agricultural wastes (peanut, wheat straw and palm tree wastes) was carried out to raise its fertilizing value compared with the widely used organic fertilizer, farmyard manure. The influence of composted and non-composted agricultural wastes on the availability of nitrogen, phosphorus and potassium (NPK) in sandy soil, as well as the uptake of these elements by corn plants, was also studied. Results indicated a rapid degradation of palm tree and wheat straw wastes as compared with peanut wastes. The composting process raised the fertilizing value of agricultural wastes as indicated by an increase in nutrient availability. The application of the composted wastes as organic fertilizers to sandy soil increased the content of available N, P and K. Results showed that the application of different composted organic materials increased the dry weight and NPK uptake by corn plants .

Keywords: Organic farming, sustainable agriculture, composting technology, impact of compost, fertilizing

المستخلص: تعتبر الزراعة العضوية أحد المحاور الرئيسية للتنمية الزراعية المستدامة، ويؤدى إستخدامها الى الحد من تلوث البيئة والمساعدة فى ترشيد استخدام المياه، وزيادة خصوبة التربة. وبسبب إفتقار البلاد النامية الى الكميات المناسبة من الأسمدة العضوية، مع رغبتها الملحة فى استخدام الزراعة العضوية، لجأت الى إستخدام تكنولوجيا التكمير الهوائى كوسيلة فاعلة فى تحويل المخلفات الزراعية الى أسمدة عضوية صناعية (أسمدة الكمبوست). والتى تعتبر من أجود الأسمدة العضوية المستخدمة فى المزارع العضوية لما لها من خصائص جودة متميزة. في هذه الدراسة تم إجراء تجربة حقلية لتكمير ثلاث أنواع من المخلفات الزراعية هى الفول السودانى وتبن القمح وسعف النخيل، تحت الظروف الهوائية لإنتاج سماد الكمبوست ومقارنة خواصة بخواص السماد البلدى (سماد المزرعة)، كما تم دراسة أثر إضافة المخلفات الزراعية الثلاثة بدون عملية التكمير وأسمدة الكمبوست الناتجة منها بعد عملية التكمير الهوائى على تيسير العناصر الغذائية الرئيسية (النيتروجين – الفوسفور – البوتاسيوم) فى تربة رملية. وكذلك أثر الإضافة على إمتصاص تلك العناصر بواسطة نباتات الذرة الشامية فى تجربة أصص. وقد أوضحت النتائج سرعة تحلل سعف النخيل وتبن القمح مقارنة بمخلفات الفول السودانى؛ كما أدت عملية التكمير الهوائى للمخلفات الزراعية الى رفع قيمتها السمادية. مما إنعكس على زيادة محتوى التربة الرملية المستخدمة من العناصر الغذائية الرئيسية (النيتروجين والفوسفور والبوتاسيوم). وزيادة الوزن الجاف وكمية العناصر الغذائية الرئيسية الممتصة بواسطة نباتات الذرة الشامية. وتؤكد هذه النتائج على أهمية إجراء عملية التكمير للمخلفات الزراعية لتحويلها الى أسمدة عضوية (أسمدة الكمبوست)، والتى يمكن أن تساهم فى التوسع فى استخدام الزراعة العضوية.

كلمات مدخلية: الزراعة العضوية، الزراعة المستدامة، تكنولوجيا التكمير، أسمدة الكمبوست، خصوبة التربة.

Introduction

Organic matter is of the utmost importance for soil fertility as it improves the biological, physical and chemical properties of soils. Saudi Arabian soils are poor in their organic matter content because of their rapid oxidation and insufficient amounts of added organic amendments. In the last decade, farmers have had to add huge amounts of chemical fertilizers to overcome shortages of organic fertilizers, and to increase crop production. Such fertilizers have had an adverse effect on the environment.

One feature of sustainable agriculture is its lower dependence on chemical fertilizers and the recycling of on-farm residues to maintain and /or improve soil fertility. The recycling of agricultural wastes is worthwhile in that it provides high quality organic fertilizers that can be used in the fertilization of agricultural lands. Managing residues plays an important role in system nutrient recycling and in the dynamics of plant pathogens. The microorganisms play a significant role in the recycling process due to powerful enzymatic mechanisms involved in their biological system, and the challenge is to enhance the value of plant residues at the expense of the negative value through the composting process (Blaine Metting, 1993).

Microbial technologies for agriculture and waste management are receiving significant attention to meet the special needs 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 sandy soil, as well as the uptake of these elements by corn plants, were also studied.

Materials and Methods

A survey of agricultural and animal wastes throughout the Kingdom of Saudi Arabia was first carried out to asses their average annual production.

(I) Composting of agricultural wastes:

The Department of Soil Science, Food Science and the Agricultural College extended composting of agricultural wastes to (Al-Kharj) farmers. 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 (Baca *et al.*, 1995) and (Suhaimi and Ong, 2001). 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 spread over it, and moistened. The first layer was then built. The other (9) layers were built over the first layer in the same manner. Water was added, when necessary, to keep the moisture content inside the heap at 60% of the weight throughout the experiment. (10) PVC cylinders with a length of (2m) 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 recorded daily at (10 and 100 cm) below the surface. The heaps were left for (6) months to break down into compost. 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 (4) replicates were examined microbiologically for a total count of mesophillic and 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 (Difco, 1966). Dobus's cellulose medium (Allen, 1982) was used for the count 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 (Cottenie *et al.*, 1982).

(II) The Influence of composted and non-composted agricultural wastes on the availability of nutrients in sandy soil:

Surface soil samples (0 - 30 cm depth) were collected from the (Al-Kharj) area. The soil samples were air dried and sieved through a 2 mm mesh sieve. Thus the 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 $CO3$ 6.77%. (200 gram) portions of the soil were packed in plastic pots and supplemented with 2% of each of composted agricultural wastes, non-composted agricultural wastes or farmyard manure. (The chemical properties of farmyard manure used are given in Table, 1). Control pots of soil samples without the addition of organic manures were also 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)

Table 1: Chemical properties of farmyard manure used.

Chemical properties	Value
pH	7.750
EC (dS / m)	2.900
Organic matter %	23.300
Organic carbon %	13.510
Available nitrogen (mg/kg soil)	462.000
Total nitrogen %	0.630
Available phosphorus (mg/kg soil)	207.000
Total phosphorus %	0.143
Available potassium (mg/kg soil)	689.000
Total potassium %	0.173
C / N ratio	21.450

Different organic manures were added to the soil samples and thoroughly mixed. Each treatment was repeated (6) times simoultaneously. Water was added to maintain the soil moisture at 60% of its water holding capacity. The pots were incubated at 28°C for (6) 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 (Cottenie *et al.*, 1982). Some important soil micro-organisms were investigated during the experiment. The total bacterial count (Difco, 1966), aerobic cellulose, decomposing bacteria (Allen, 1982), Azotobacter (Abdel - Malek and Ishac, 1968) and phosphate, dissolving bacteria (Bunt and Rovira, 1955) modified by (Louw and Webley, 1959) were estimated using the serial dilution method.

(III) 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 nutrient uptake by corn (Zea maize L.). Cylinders of (25 cm) in 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 manure type (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 were subsequently thinned out to two on germination. After (7) weeks, plants were harvested, dried at 70°C, and ground in a still steel mill. Nitrogen, phosphorus and potassium were determined in the plant samples according to (Cottenie *et al.*, 1982).

(IV) Statistical analysis:

Data were statistically analyzed using the Tukey method according to (Neter *et al.*, 1985).

Results and Discussion

(1) Survey of the agricultural and animal wastes:

A survey of the annual production of agricultural and animal wastes in Saudi Arabia (Table, 2) showed that total production ranged between 3,139484 to 3,683895 tons. The largest quantities of wastes were produced from field crops, followed by vegetables. Most quantities of fruit wastes came from palm trees, which exceeded twenty million trees. The production of animal wastes was between 3,020656 and 3,297187 tons, most of which came from sheep.

Table 2: Survey of annual production of agricultural and animal wastes in Saudi Arabia

Sources	Quantity
Agricultural wastes produced (Ton)	
Field Crops	1827951 - 2102144
Vegetables	901854 - 1037132
Fruits	409679 - 544619
Total	3139484 - 3683895
Animal Wastes produced (Ton)	
Camels	381836 - 402357
Cows	473900 - 532782
Sheep	1589692 - 1723468
Goats	490345 - 543268
Poultry	84883 - 95312
Total	3020656 - 3297187

(2) Microbiological and chemical changes during the composting of agricultural wastes:

(2:1) Temperature changes:

Temperature is the most important indicator of the efficiency of the composting process, and depends on the aeration rate (Lau *et al.*, 1993). Changes in temperature inside different agricultural waste heaps are presented in (Table 3).

Table 3: Mean of temperature variations during the composting process of three different agricultural wastes

Time (day)	**Temperature (°C)**	
	At 10 cm below surface	At 100 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

The composting process exhibited a classical temperature pattern. Three periods were distinguished: a phase of latency, which correlates to a microbial population adapted to the compost conditions, a phase of a sudden rise in temperatures up to 65°C, and a phase of cooling, in which the temperature decreased progressively and returned to its starting value. (Table 3) indicates that the 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 rise in 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 (Stentiford 1996) and (El-Meniawy 2003). After 20 days, the temperature inside the heaps reached about 50°C and (62°C at 10 cm and 100 cm below the surface, respectively (the mean is 56°C), and this temperature was maintained for 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, the temperature gradually decreased to around 35°C, although it rose due to the turning of heaps after 45 days after the starting time. The temperature attained by a compost heap 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 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 at around 30°C until the end of composting period.

(2:2) Microbiological changes:

The data in (Table 4) shows a decrease in the count of mesophilic bacteria during the first two weeks of composting, followed by increases until 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

Table 4: Microbiological changes during the 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 106	578	217	182	392	534	612	715	662	617	559
Thermophillic bacteria x 105	3	112	157	87	69	54	47	33	29	17
Aerobic cellulose decomposer x104	56	7	3	12	142	188	112	73	78	64
					Wheat straw					
Mesophillic bacteria x 106	317	89	67	139	417	489	515	-	-	-
Thermophillic bacteria x 105	9	323	412	290	112	34	45	-	-	-
Aerobic cellulose decomposer x104	13	7	3	12	141	157	97	-	-	-
					Palm tree wastes					
Mesophillic bacteria x 106	432	113	108	215	477	514	642	492	-	-
Thermophillic bacteria x 105	7	182	246	273	163	105	87	56	-	-
Aerobic cellulose decomposer x104	37	19	16	22	129	157	195	60	-	-

composting as they readily attack decomposable constituents of organic wastes. The production of excessive heat creates a suitable environment for thermophilic flora. These results were in harmony with those of (Taha *et al.*, 1968, (Abo-Sedera, 1995) and (El-Meniawy, 2003).

Counts of thermophilic bacteria in the composted materials showed a marked increase after 14 days of composting (See, Table 4). 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 (Abdel-Malek *et al.*, 1961); (Blaine Metting, 1993); (Abo-Sedera, 1995) and (El-Meniawy, 2003).

Aerobic cellulose decomposing bacteria showed a decrease during the first 21 days, followed by a progressive increase in their counts, reaching their maximum after two month. This might have been due to the reduction in the population of cellulose decomposers during the high temperature phase, followed by an increase due to the subsequent lower temperature and / or the degradation of the easily decomposable material during the first period of composting, leaving the cellulytic-materials which are hardly decomposable to degrade at a later stage of composting. These results are in line with those of (Abo-Sedera, 1995); (Hage, 1999) and (El-Meniawy, 2003).

(2:3) Chemical changes:

Data in (Table 5) shows that pH values of the three agricultural wastes during the initial phase of composting were slightly alkaline. During composting, pH values gradually decreased with the 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 decrease in pH values mostly occurred during 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 the composting process because of organic materials' mineralization. These results were in agreement with those of (Blaine Metting, 1993) and (Sylvia, Fuhrmann *et al.* 1999).

The dry matter content of the agricultural wastes decreased gradually during the whole period of composting (Table 5). The 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 (Wallace, 2003). 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

Table 5: Chemical properties of peanut, wheat straw and palm tree wastes at the beginning and end of the composting process.

Chemical properties	Peanut wastes		Wheat straw		Palm tree wastes	
	Raw material	Compost	Raw material	Compost	Raw material	Compost
pH	8.35	7.71	8.20	7.55	8.12	6.80
EC (dS m-1)	0.85	1.40	1.25	4.05	0.92	2.12
Dry matter %	100.00	74.70	100.00	66.27	100.00	63.50
Organic matter %	94.10	79.60	94.70	71.50	90.7	67.75
Organic carbon %	54.71	46.28	55.10	41.57	52.63	39.29
Available - N %	0.241	0.11	0.102	0.315	0.02	0.09
Organic - N %	0.649	1.71	0.46	1.425	0.60	2.15
Total - N %	0.89	1.82	0.56	1.74	0.62	2.24
Available - P (ppm)	168.00	583.00	297.00	630.00	167.00	432.00
Total - P %	0.15	0.35	0.21	0.44	0.07	0.52
Available - K (ppm)	782.00	1328.00	991.00	2017.00	823.00	1362.00
Total - K %	0.11	0.16	0.18	0.31	0.16	0.87
C/N ratio	61.47	25.43	98.39	23.89	87.71	18.27

decomposition took place at high temperatures, and the rate decreased during the subsequent low temperature period.

Changes in the figures of organic matter and carbon contents during the composting of peanut, wheat straw and palm tree wastes were found to be in line with those recorded for the dry matter content (See, Table 5). The most active period of decomposition was during the high temperature periods. This indicates the important role of the thermophilic organisms in the decomposition process (Taha *et al*, 1968) and (Abo-Sedera, 1995) and (El-Meniawy, 2003). 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, respectively. This indicates that the rate of decomposition was high in wheat straw and palm tree wastes as compared to peanut waste. 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 a result of the decomposition process, the percentage of inorganic nitrogen decreased, while the percentage of total and organic nitrogen increased in the three agricultural composted materials (See, table 5). Composted materials contain significant amounts of (N) in organic form that, whilst not easily available to plants, are also less leachable (Mamo, Rosen *et al.* 1999). The increase in total nitrogen percentages may be due to the higher oxidation of non-nitrogenous organic materials and partially to the N2-fixation by non-symbiotic nitrogen fixers as indexed by the increase in organic nitrogen. This indicates that the immobilization of nitrogen took place during composting and conserved the nitrogen from loss.

Changes in the ratio of organic carbon to nitrogen during the composting of the agricultural wastes are recorded in (Table 5). The C/N ratios were first 61.5, 98.4 and 87.7 for peanut, wheat straw and palm tree wastes, respectively. As a result of the changes in the amount of nitrogen and the loss of organic carbon during the 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 respectively 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 (Blaine Metting, 1993), (Canet & Pomares, 1995); (Amlinger, Bettina *et al.* 2002) and (El-Meniawy, 2003).

(3) The Influence of composted and non-composted agricultural wastes on the microbiological properties of sandy soil:

Data in (Table 6) 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, reaching their maximum level after 30 days incubation. The counts thereafter decreased, but did not reach 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 soil inevitably provides a substrate for microbial growth and, as this improves, so does the fertility and health of the soil.

As regards the physiological groups of soil microorganisms, aerobic cellulose decomposers, Azotobacter and phosphate dissolving bacteria followed the same trend as the total bacterial counts (Table 6). The non-composted materials enriched the sandy soil with more cellulose decomposers at the beginning of incubation as compared with the composted materials. Its counts gradually increased and 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 soil could be explained by the fact that a great portion of cellulytic materials was degraded during the composting process done before.

Counts of Azotobacter as one of the most important non-symbiotic N2-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 and reached their maximum after 30 days, and then decreased but were still higher than the initial numbers (Table 6). 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 waste-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 reached maturity, adding to the soils.

Table. 6: Effect of composted and non-composted organic materials on microbiological changes in 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

(4) The Influence of composted and non-composted agricultural wastes on availability of nitrogen, phosphorus and potassium nutrients in sandy soil:

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 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. Increases in mineral nitrogen is caused by the 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 increased again. This is mainly due to immobilization by microorganisms and partially to nitrogen loss. Immobilization occurred due to the wide C/N ratio of the added non-composted agricultural wastes (Alexander, 1978). However, mineralization rates were higher in compost-treated soil as compared with non-compost-treated soils, 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 (Amlinger, Bettina *et al.* 2002). A higher mineralization rate also took 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, the mineralization rate of nitrogen in the different organic wastes treatments decreased respectively 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 (Abdel-Malek *et al.*, 1972), (Inbar *et al.*, 1990), and (Amlinger, Bettina *et al.* 2002).

The application of agricultural wastes to the soil tended to accelerate the assimilation of nitrogen over 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 the 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 (Xin Toa He *et al.*, 1992) and (Baca *et al.*, 1995).

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 amounts of nitrogen showed definite increases in the control, as well as soil supplemented with organic materials during the first month. This was followed by a decrease within the second month, but still higher than the initial phase. The behavior of organic nitrogen was approximately 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 the mobilization of mineral phosphorus released by degrad-ation of the

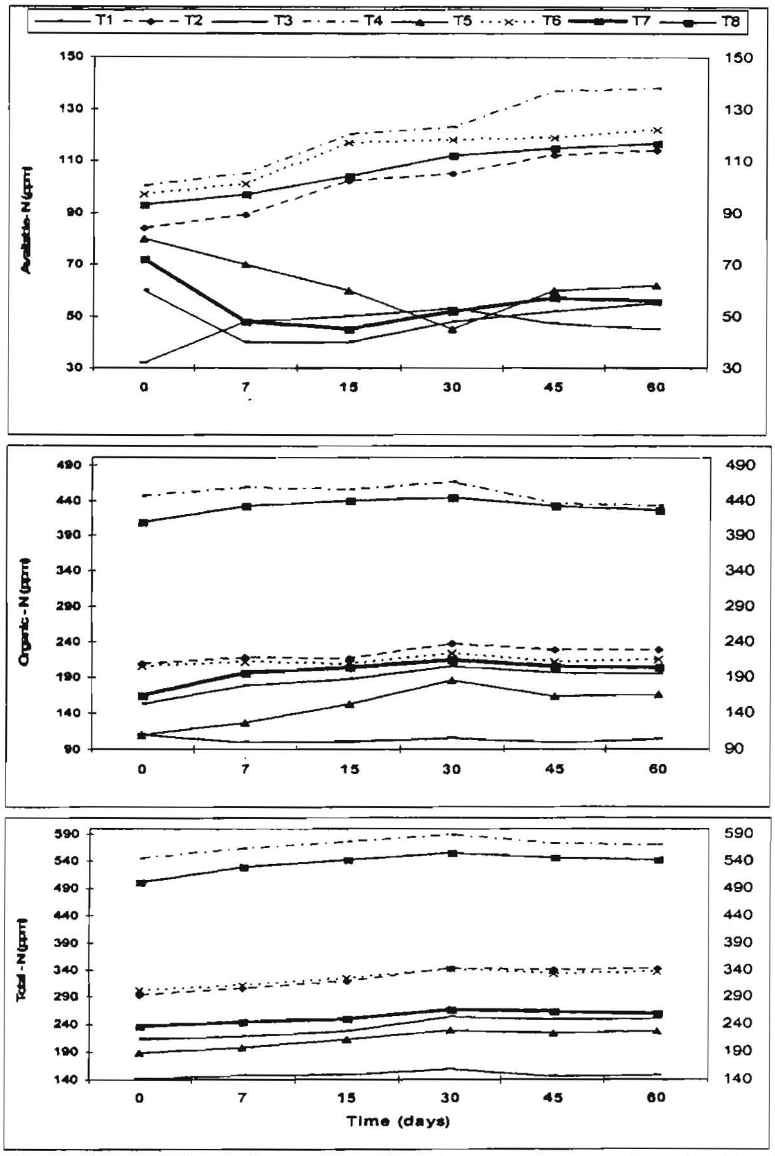

Fig. 1: The Effect of composted and non-composted agricultural wastes on different nitrogen forms in sandy soil

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, the rate of mobilization became more or less constant. This situation is a reflection of the activity of soil's microbial population in rendering the soil (P) available via (d) the ephosphorylation 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 (See, table 6). Orders of mineral (P) availability rates obtained for the different organic materials respectively were:

- Composted wheat straw
- Farmyard manure
- Composted peanut
- Composted palm tree wastes
- Non-Composted wheat straw
- Non-Composted palm tree wastes
- Non-Composted peanut

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 the stimulated decomposition of composted materials resulting in the production of carbonic acid and chelating metabolites mainly as organic acids (Somani, 1983) and (El-Shinnawi *et al.*, 1991).

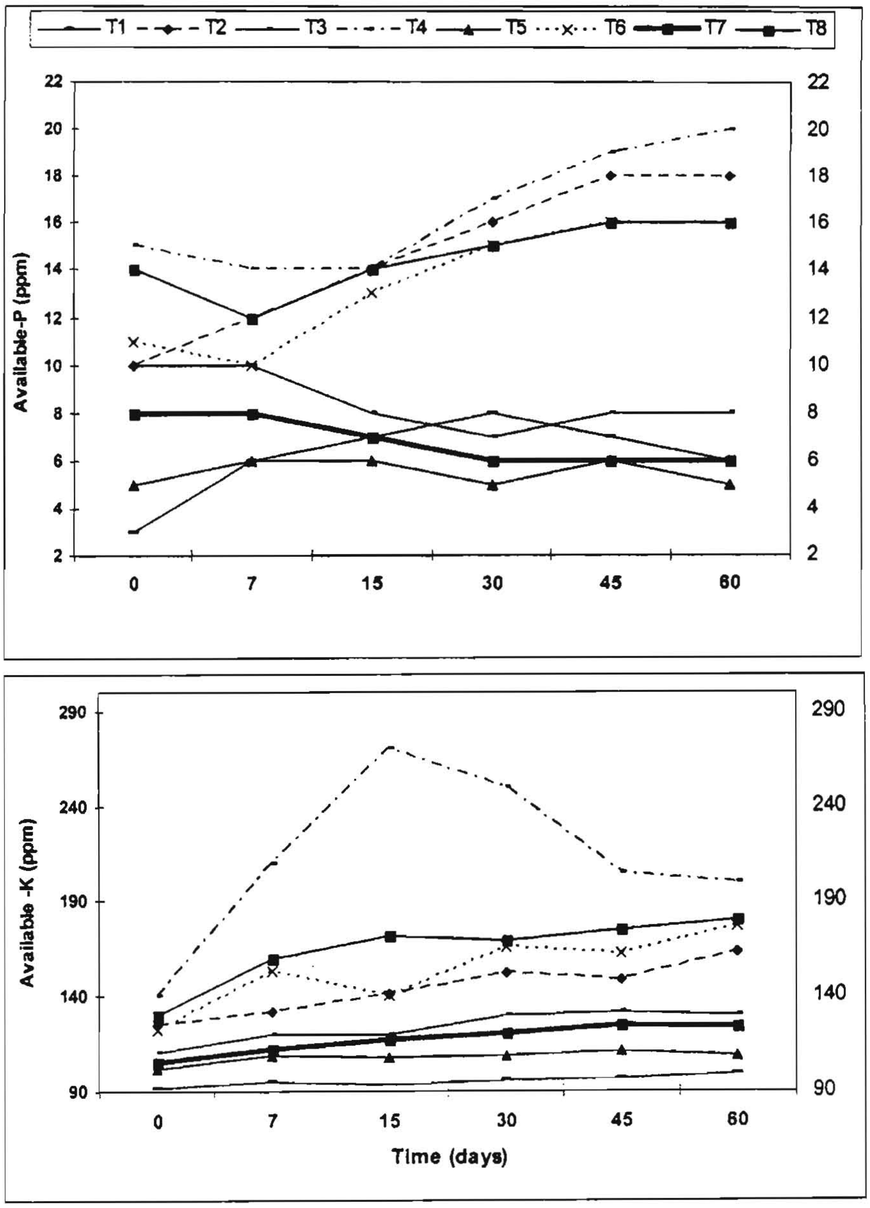

Fig. 2: Effect of composted and non-composted agricultural wastes on phosphorus and potassium availability in sandy soil

Considerable increases of available potassium were observed with the application of different organic materials (Fig. 2). This effect was more pronounced under composted rather than non-composted materials. This reflects again the importance of composting maturity, which is an important factor affecting successful application in agriculture (Xin Tao He *et al.*, 1992), (Baca *et al.*1995) and (Parkinson, Fuller *et al.* 1999).

(5) The Effect of composted and non-composted agricultural wastes on the nutrient uptake of Zea maize plants:

The application of agricultural wastes, either composted or non-composted, induced a significant increase in the dry weight of maize (Table, 7). 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. These results are in harmony with those of (Girma and Endale, 1995). Composted palm tree waste was superior in increasing plant dry weight, followed by the composted wheat straw, peanut wastes and farmyard manure, respectively.

Data recorded in (Table 7) indicates that adding agricultural wastes (composted or non-composted materials) led to generally significant positive increases in maize of (N), (P) and (K). Such a response may be due to the decomposition of organic wastes and subsequent release of nutrient elements. Other possibilities could be:

(i) The effect of organic materials in chelating, and formation of organic complexes relatively available for plants, especially in the compost treatments.

(ii) Production of humate, which could be exchanged for adsorbed anions such as phosphate, led to increase the movement of phosphate resulting in availability for plant uptake.
(Meak *et al.*, 1979 & El-Leboudy *et al.*, 1988).

Results given in Table, 7 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.

Table, 7: 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
Peanut wastes	0.5	2.42	75.0	5.40	27.6
	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
Composted peanut wastes	0.5	2.66	91.5	6.94	30.6
	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
Wheat straw	0.5	2.48	71.0	5.95	26.6
	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
Composted wheat straw	0.5	2.61	114.1	7.25	32.1
	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
Palm tree wastes	0.5	2.64	78.1	6.1	29.1
	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
Composted Palm tree wastes	0.5	2.92	119.9	8.2	43.8
	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
Farmyard manure	0.5	2.89	105.8	6.76	39.3
	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

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 agricultural wastes to soils.

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 their application to soils. Therefore, the important factor related to the organic matter incorporated in the soil is the kind and maturity of the organic material added.

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Ref: 2349
Received : 03/08/2004
In revised form: 30/03/2005