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EVALUATION OF TOWN REFUSE COMPOSTS PRODUCED BY DIFFERENT TECHNOLOGICAL METHODS BY MEASURING THEIR EFFECTS ON CHEMICAL AND BIOLOGICAL ACTIVITIES OF SANDY SOILS

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ABSTRACT

A laboratory experiment was carried out to evaluate the manurial value of different composts, produced by different technological methods, by measuring their effects on some chemical and biological changes in newly reclaimed sandy soil. These changes included: pH, organic carbon, total nitrogen and available-p, as well as, the CO_2 evolution and enzymatic activities of invertase, phosphatase and dehydrogenase. The soil samples were taken periodically (initially and after 2, 4, 8 and 12 weeks of added composts.

The obtained results showed that amending the soil with the different types of composts prepared by different additives slightly decrease the soil pH. The organic carbon and total nitrogen increased in treated soil due to the higher C and N content of the added composts. The C/N ratio narrowed in all treatments as a result of organic carbon mineralization and the slightly increasing of total nitrogen in soil. Addition of compost also increased the available phosphorus as a result of organo-phosphorus compounds mineralization.

Generally, the composts added in soil, increased the CO_2 evolved as a result of stimulation of micro organisms in soil and induced the enzymes studied, improving their activities in soil, especially, in the organic accelerated composts followed by the chemical accelerated one.

INTRODUCTION

In recent years, composted urban wastes have been added to agricultural soils for both waste disposal and to improve their fertility. Compost is rich in organic matter and important source of nutrients for plants (Gallardo-Lara and Nogales, 1987).

Town refuse is considered as one of the most valuable resources for organic manure production and is acceptable as feedstuff for livestock (El Boushy and Vander Poel, 1994). In Egypt, town refuse is characterized by its high content of organic materials reaching about 58% (Saber *et al.*, 1997). The disposal of organic fraction of town refuse throughout composting is considered one of the most safe and environmentally sound practices. The produced manure might partially fulfill the gap in organic fertilizers required for enriching the desert soils and fertilizing the old ones. Composting of town refuse (TR) has proven to be useful techniques for different purposes such as horticulture (Fitz Patrich and Carter, 1983), bioorganic farming system (Lampkin 1990) and reforestation (Bengtson and Cornette, 1973).

The aerobic bioconversion of organic waste makes it potential renewable raw material for efficient plant nutrition. Organic fertilizer as an end product of town refuse organic fraction composting, can give similar or even higher yields than a number of inorganic fertilizers (Gajdos, 1997 and Saber, 2000). The composting of presorted town refuse is a simple wide used technology by using the traditional method of wind rows (Donhue *et al.*, 1998) to get benefit from all forms of organic residues for production of organic fertilizers. This technique is the very common wide spreading practice particularly in many developing countries through the world (Amon and Vinkovic, 1998; Goldstein, 1999 and Abdel Maksoud *et al.*, 2000).

The aim of this work is to improve the practices used in the preparation of compost followed in garbage recycling factories to produce good final products by evolution of their manurial values in treated soils.

MATERIAL AND METHODS

Construction of compost heaps:

The collected raw town refuses (RTR) at Abou Rawash organic fertilizer factory-Giza Governorate, were sorted to fractionate their different components. The organic fraction of RTR was used to construct the heaps for composting. Three types of heaps, two tons each, were built up in windrows system. The first heap was treated with chemicals to accelerate the compost heap: 60 kg ammonium sulfate, 14 kg super phosphate and 50 kg $CaCO_3$. The second heap was treated with 800 liters sewage effluent (60%) as an organic accelerator. The last heap did not receive any accelerator. Each heap was built up in ten layers, moistened to the proper level (60-70%) for initiating microbial proliferation. The surfaces of the heaps were covered with thin layer of sand and left for 90 days. During this period, the heaps were turned over 3 times after 30, 45 and 60 days from construction date, to homogenate the constituents of the heaps and to maintain a good biodegradation. The temperature of the heaps was frequently measured to control the bioconversion of organic fraction, moisture content was determined and water was added to adjust the level at (60-70%) until the heaps mature.

A composite sample was taken from the previous heaps at three levels along the wind raw: at the top, in the middle and near the bottom (30cm over the baseline), mixed all together to be homogenized, then a representative composite samples were taken for chemical analysis at the end of 90 days of composting.

Evaluation of Chemical and biological activities of prepared composts:

A laboratory experiment was carried out to evaluate the effects of addition of these three types of TR-composts to a newly reclaimed sandy soil on its chemical and biological properties.

The used soil was collected from EL Nobaria region; Behera Governorate. It was sandy in texture; water holding capacity 19.1%; E.C. 0.38 mmohs/cm; pH 7.3; organic carbon 0.073%; total nitrogen 0.207%; available phosphorus 4.0 ppm and C/N ratio 3.5.

Jars were filled with the collected soil (200g/Jar). The following

treatments were used:

1-Untreated soil (control),

2-Soil + NPK (2: 1: 0.5) using NH_4SO_4, super phosphate and K_2SO_4 respectively.

3-Soil + 2.0% composted town refuse naturally fermented without any additives (compost 1).

4-Soil + 2.0% composted town refuse chemically accelerated with NPK + $CaCO_3$ (compost 2).

5-Soil + 2.0% composted town refuse accelerated with sewage effluent (compost 3).

The chemical analysis of the different types of prepared composts with the different accelerators are shown in Table (1).

Table (1): The Chemical analysis of different composts

Characters	Compost 1	Compost 2	Compost 3
PH	7.4	7.9	7.4
E.c. (ds/ml)	4.9	5.4	5.5
O.M.%	40.9	38.9	38.2
T.N.%	1.84	1.94	2.14
T.P.%	0.21	0.22	0.25
T.Potassium%	0.09	0.09	0.14
Total Fe (ppm)	4250	4522	4810
Total M (ppm)	318	322	322
Total Zn (ppm)	600	615	604
C/N ratio	12.9	11.6	10.4

All jars were moistened by tap water adjusted to 60% of WHC of the soil, by compensating the loss of moisture all over the experimental time.

Soil samples were taken from all previous treatments at zero time and after 2, 4, 8 and 12 weeks, for the following chemical and biological analyses comprised: pH, organic carbon, total nitrogen and available-P (Black *et al.*, 1965).

The biological activities included the CO_2 evolved from the soil (Monib *et al.*, 1981) and enzymatic activities of invertase (Balasubramanyan *et al.*, 1970), phosphatase (Khaziev, 1968) and dehydrogenase (Skujins, 1973) were also determined.

RESULTS AND DISCUSSION

1. Effect of different composts on some soil chemical properties :

The effect of different town refuses composts, prepared either naturally or by accelerating additives on the chemical properties of treated soil are shown in Table (2).The obtained results showed that the pH values of the treated soils were slightly fluctuated compared to the untreated soil, except in amended with composted TR accelerated organically (compost 3), showed a slight decrease in pH at the end of incubation period (12 weeks). This slight fluctuation occurred might be due to the nature of prepared composts, their degree of biodegradation and the intermediate products.

Table (2): Effect of different town refuses composts on some chemical properties of treated sandy soil.

Treatments Time (weeks)	Untreated soil (control)	Soil + NPK	Soil + Comp. 1	Soil + Comp 2	Soil + Comp. 3
(1) PH (1: 2.5)					
0	7.04	7.84	7.84	7.90	7.82
2	7.14	7.86	7.88	7.85	7.41
4	7.30	7.68	7.77	7.76	7.35
8	7.48	7.50	7.48	7.55	7.26
12	7.40	7.44	7.40	7.42	7.20
(2) Organic Carbon (mg/ kg Soil)					
0	734	734	5468	5250	5170
2	692	680	5147	5056	4329
4	607	580	4542	4361	3633
8	570	550	4300	3473	2040
12	543	507	3058	2651	1814
(3) Total. N (mg/ kg Soil)					
0	249	260	617	637	677
2	251	288	632	655	707
4	253	310	662	682	742
8	260	366	680	702	774
12	265	391	700	730	805
(4) C/N ratio					
0	2.95	2.82	8.86	8.24	7.64
2	2.76	2.36	8.14	7.72	6.12
4	2.40	1.87	6.86	6.39	4.90
8	2.19	1.50	6.32	4.95	2.64
12	2.05	1.30	4.37	3.63	2.25
(5) Available- P (P_2O_5) mg/ kg Soil					
0	2.04	2.86	2.76	2.57	2.77
2	1.64	7.97	7.33	10.31	12.88
4	3.31	8.46	10.22	12.81	14.11
8	3.67	10.92	11.07	13.11	16.22
12	4.04	12.08	14.32	15.70	18.35

As a general trend, incorporation of organic matter into the sandy soil increases the organic carbon content throughout the aerobic decomposition of these composts by the heterotrophic microorganisms. The variations occurred in carbon percentages between the different treatments could be deduced to the different accelerators used either minerally (NPK + $CaCO_3$) or organically (sewage effluent). The mineralization rate of soil organic carbon was the higher in organically accelerated compost (64.9%) more than in chemically accelerated one (49.5%) over the control. These results are in line with Saber, 2000.

Nitrogen content of soil amended with different composts is a valuable factor in the evaluation of compost decomposition, as it considered as an essential element for plant nutrition. The data showed that initially, a high increases in soil nitrogen amended with the different types of compost, especially in the organically accelerated compost treatment, which contain increased due to the nitrogen fixation by the microorganisms as a result of enriching the soil with a source of energy for these microorganisms (Lampkin, 1990 and Halvin *et al.*, 1999).

Concerning to C/N ratio, it depends on the both ratios of C and N in the different composted town refuses added. Initially, these composts raised this ratio in soil as a result of their high content of C and N. During the compost decomposition, these ratios narrowed a cause to the organic carbon degradation and nitrogen increasing in the soil due to the microbial activities (Table 2) (Halvin *et al.*, 1999).

In general, the results showed that the studied composts added to the soil differ in their effect on the availability of phosphorus depending on their composition. Therefore, the sewage-accelerated compost was the most effective in the availability of phosphorus (compost 3) over the control. This increase in available phosphorus is a result of application of sewage effluent in composts that add more organisms that contain phosphate solubilizers and their higher content of phosphorus (El Sherif and El-Sherif, 1973).

2. Effect of different composts on soil biological activities :

Studies of CO_2 evolution and enzymatic activities provide information on the biochemical processes occurring in the soil and there is growing evidence that soil biological parameters may have a potential as early and sensitive indicators of soil ecological stress and restoration (Dick and Tabatabai, 1992).

The effects of different composts on soil biological activities were shown in Table (3).

The data showed that the highest quantities of CO_2 evolved from the soil amended with the different composts, whereas the mineral fertilizer treatment had intermediate proportion compared to the untreated soil. Generally, the degradation process of organic matter added as composts increased the CO_2 evolved from the soil as a result of degradation process of these materials and the stimulating of microbial activities in presence of these easily decomposable materials as a labile source of organic C for soil biota (Diaz *et al.*, 1994 and Garcia *et al.*, 1998).

Enzymatic activities (Table 3) varied widely among the studied treatments The results showed that the sewage effluent accelerated compost stimulated the activity of enzymes studied and it was the most effective on these activities followed by the compost accelerated chemically and the naturally composted (without additives), whereas the mineral fertilizers treatment was the least effective.

Generally, the highest values of the three enzymes studied were found (Table 3) in the soil received the sewage effluent accelerator compost followed by the chemical accelerator and natural composts (without additives)

The additions of organic residues increased the invertase phosphatase activities in soil due to the available metabolites in the fresh organic matter. Dehydrogenase is an intracellular enzyme that involved in microbial oxidoreductase metabolism, as it correlated with microbial respiration, therefore, this enzyme could be a good indicator of soil microbial activity (Garcia et al., 1994b).

As conclusion, soils amended with different composts can improve soil quality, increasing the organic matter content of degraded soils and improving soil biological and biochemical properties.

Table (3): Effect of different types of town refuses composts on the biological activities of treated sandy soil.

Treatments Time (weeks)	Untreated soil (control)	Soil + NPK	Soil + Comp. 1	Soil + Comp. 2	Soil + Comp. 3
(1) CO_2 (mg CO_2 / 100 g soil / day)					
0	0.00	0.00	0.00	0.00	0.00
2	7.61	8.84	11.13	15.25	15.36
4	8.04	18.93	22.36	29.01	37.18
8	11.13	21.41	28.15	25.27	30.58
12	13.51	19.40	20.85	22.53	25.89
(2) Invertase activity (mg Glucose/ 100 g soil/ 24 hours)					
0	50.12	50.12	50.65	50.46	50.28
2	55.12	60.41	78.46	88.82	95.81
4	60.91	68.49	88.65	100.43	120.63
8	68.01	75.18	91.85	110.44	150.30
12	53.69	58.40	68.44	80.10	115.47
(3) Phosphatase activity (mg P_2O_5/100 soil / 24 hours)					
0	5.42	5.92	5.86	5.12	5.40
2	11.99	15.82	24.04	31.75	40.81
4	17.12	24.83	32.08	38.71	53.65
8	15.05	20.29	26.41	28.51	42.36
12	13.71	15.18	18.52	21.15	31.81
(4) Dehydrogenase activity (□lH_2 / g soil / 24 hours)					
0	0.58	0.58	0.58	0.58	0.58
2	1.19	1.78	5.41	7.20	9.10
4	1.78	3.01	7.93	9.89	15.89
8	0.99	1.21	6.84	6.42	11.78
12	0.59	4.28	3.62	3.62	7.31

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تقبيم القيمة السمادية للسماد العضوى الصناعى الناتج عن الكمر البيولوجى لقمامة المدن بتكنولوجيات مختلفة بقياس النشاط الكيميائى والحيوى للتربة المعاملة به

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أجريت تجربة معملية لتقييم السماد العضوى الناتج بالكمر البيولوجى لقمامة المدن باستخدام تكنولوجيات مختلفة (اضافات معدنية وعضوية للمكون العضوى لقمامة المدن) لتنشيط عملية التحلل – بقياس التغييرات فى الخواص الكيميائية والحيوية لتربة رملية مستصلحة حديثا معاملة بهذه الأسمدة (٢٠طن/الفدان).

هذه التغييرات شملت الاس الايدروجينى لمستخلص التربة ، الكربون العضوى ، النتروجين الكلى وكذلك النسبة ك/ن والفوسفور الذائب – هذا بجانب تقدير كمية ثانى اكسيد الكربون المنطلقة من التربة والنشاط الإنزيمى لكل من الانفرتيز والفوسفاتيز والديهيدروجنيز .وقد قدرت هذه التغييرات فى عينات التربة دوريا (بعد ٢ ، ٤ ، ٨ ، ١٢ أسبوع من الإضافة).

أوضحت النتائج أن اضافة الأسمدة العضوية الصناعية الناتجة عن المعاملات المختلفة أدت إلى انخفاض طفيف فى الأس الايدروجينى للتربة وزيادة الكربون العضوى والنيتروجين الكلى فى التربة نتيجة لاحتواء هذه الأسمدة على نسبة عالية من المادة العضوية وبالتالى إلى ارتفاع نسبة ك/ن فى بداية التجربة ثم انخفاضها أثناء تحلل هذه الأسمدة .

كذلك أدت هذه الإضافة إلى زيادة الفوسفور الذائب فى التربة المعاملة نتيجة لمعدنه المركبات الفوسفورية العضوية لهذه الأسمدة. إضافة هذه الأسمدة (المعالجة كيماويا أو عضويا) أدى إلى زيادة كمية ثانى اكسيد الكربون المنطلق من التربة المعاملة نتيجة لزيادة النشاط الميكروبى للتربة بعد الإضافة.

كذلك نتيجة لزيادة النشاط الحيوى لتربة زاد النشاط الانزيمى للنزيمات تحت الدراسة زيادة كبيرة نتيجة لاضافة هذه الأسمدة.

هذه التغييرات ظهرت فى التربة المعاملة بالسماد العضوى المعالج عضويا (اضافة مياه المجارى) بصورة واضحة عن التربة المعاملة بالسماد المعالج كيميائيا (اضافات معدنية).