Australian Journal of Basic and Applied Sciences, 3(4): 4591-4600, 2009
ISSN 1991-8178
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Applcation of Sewage Sludge in Composting Technology for Eradication of Pathogenic Bacteria

Heba M.A. Khalil and Sanaa, S.H. Sabana

Microbiol. Dept. Soils, Water and Environment Inst. Agric. Res. Center, Giza, Egypt.

Abstract: The conducted work included , eradication of pathogenic bacteria by the recycling of some organic residues through compost processing, and investigation on the impacts of using such produced composts for inducing the safe agricultural production. The organic residues were mixed at ratios to attain comparable initial C/N ratio of about 30:1 through all the tested heaps before composting. The composting process was conducted for 10 weeks whereas the final C/N ratios were 13.2 and 14.39 For the two types sewage sludge and cow dung of produced compost, respectively. No significant difference between the type of pile in Physical and chemical analysis were determined during the composting process including bulk density, moisture content dry matter, organic matter, total nitrogen ammoniacal nitrogen (NH_4^+ - N), nitrate (NO_3^- N), pH, EC, temperature and C/N ratio, at periods of 0, 7, 14, 21, 28, 56, 84 an 110 days. As well as the change with increasing in the microbial population in sewage sludge than bagasse. On the other hand change with reducing in pathogenic bacteria [total fecal Coliform, salmonella and Shigella]. The effect of application compost (two types) cow dung and sewage sludge, compared with inorganic on barley plants were grown in pots in sandy soil for 110 days. Dry weight and N, P, K for barley plant in grain yield and straw cultivated in organic manure. As well as increasing in the count of soil microflora (bacteria, actinomycetes and fungi) at the periods of 0, 1, 3, 7, 15, 30, 45, 60, 90 and 110 days from barley seeding and also in increasing the microbial activity by CO_2 and dehydrogenase activity in that period time. In addition to reduction in total pathogenic bacteria especially in sewage sludge pale.

Key words: Sewage sludge, Composting technology, Pathogenic bacteria, Eradication, Bagasse.

INTRODUCTION

Composting is a method for stabilization of organic waste products. Other methods include aerobic digestion, anaerobic digestion, time stabilization and heat treatment (Bitton, 1999). Composting is based on the decomposition of organic matter by microorganisms under aerobic conditions. The types of waste materials most commonly used for production of compost are yard water, sewage sludge, municipal solid waste, household waste, industrial and agricultural wastes (animal droppings, crop residues, forest wood wastes, etc.).

Composting is regarded as a fully sustainable practice, since it aims at both conservation of the environment, human safety and economically convenient production (Sequi, 1996). The use of compost contributes to conservation of the environment by reducing both utilization of non-renewable resources and consumption of energy for waste treatment and production of chemical fertilizers. Composting indirectly also contributes to human safety by avoiding an improper fate or disposal of organic wastes. Furthermore, due its low cost, compost is convenient to the farmer, but even more to the society by avoiding the use of expensive solutions for waste disposal (Bitton, 1999).

In this study comparing between the plant residues with cow dung and sewage sludge. Microbial, chemical analysis and efficiency test in organic fertilizers.

MATERIALS AND METHODS

Materials:

The different raw materials used for this study, whole main physical and chemical characteristics were determined according to Black *et al.* (1965) and Jakson (1973).

Corresponding Author: Heba M.A. Khalil, Microbiol. Dept. Soils, Water and Environment Inst. Agric. Res. Center, Giza, Egypt.

The sewage sludge was collected from the stacked area of El-Berka. El-Salam City, Cairo Governorate. Raw sewage sludge (2-3% total solids) is pumped to some drying beds and allowed to dry for a period of 3 to 4 months.

Shopped Bagasse, Cow dung, barley grains and soil sample were collected from El-Nobaria, Research Station Farm.

Compost was prepared from mixing of raw materials, to give a C/N ratio about 30:1. The mixture was left about 110 days. Two different heaps were mix 1 and mix 2 (mix I.= Bagasse + sewage sludge and mix 2= Bagasse + cow dung).

Greenhouse experiments:

The effect of these composts on plant yield as well as the microbiological properties of the tested soils were evaluated using Barley (*Hordeum vulgare*) as an indicator plant.

Air dried soil samples were placed in pots of 30 cm height where each pot received 8 kg soil. The recommended doses of 200 kg super phosphate and 180 kg ammonium nitrate/feddan were applied The fertilization was divided to 3 doses 20% at cultivation, 40% at 1^{st} irrigation and 40% at 2^{nd} irrigation, while potassium sulphate (50 kg/fed.) was added during soil preparation.

Methods of Analysis:

Physical and Chemical Characteristics:

Plant and soil samples were dried, to constant weights (Black, *et al.* 1965). The moisture content which was calculated as a percentage for each material.

Temperature, bulk density; pH values; Electric conductivity (EC).

Organic carbon (OC) and organic matter (OM) were determined by Walkley and Black method according to Black *et al.* (1965).

The extraction of soil available P was determined according to (Olsen *et al.*,1954). The concentration of phosphorus in the soil extract was determined colorimetrically.

Total available potassium in soils was extracted by leaching the samples with 1N ammonium acetate solution (pH 7) at a ratio of 1:25 as described by Chapman and Pratt (1961).

Micronutrients:

The contents of available Fe, Mn, Zn and Cu in soil and plant samples were determined by using an atomic absorption spectrophotometer Perkin Elemer Model 3300 as described by Hesse (1971).

Cation Exchangeable Capacity (CEC):

Cation exchange capacity (CEC) of soil was determined by using sodium acetate of pH 8.2 for saturation and ammonium acetate of pH 7.0 for elution (Richards, 1954), while the CEC of compost was determined according to (Harada and Inoko, 1980).

Microbiological Determinations:

Total viable bacteria were determined using Gensen's medium (Allen, 1959): Total counts of actinomycetes using Martin's medium (Allen, 1959):

Total counts of fungi using Mac-Conkey's bile salt agar medium (Difco Manual, 1977): Total and fecal coliform bacteria using *Salmonella* and *Shigella* (SS) agar medium (Difco Manual, 1977):

The total counts of the previous microorganisms groups were calculated on dry weight basis of the tested materials.

RESULTS AND DISCUSSION

Physical and chemical properties of raw materials and soil used in this study were recorded in Tables (1, 2 and 3).]

The raw materials and soil used in this study were analyzed according to Black *et al*, (1965) and Jakson (1973) as recorded in tables 1,2 and 3.

Physical Changes:

Temperature assessment changes in temperature during the composting period for the two piles at depth of 20, 40 and 60 cm were measured throughout the composting period [August to November]. The atmosphere temperatures variations through this period were between 22 and 25ºC at night and form 30 and 35ºC. While,

Table 1: Physical and chemical characteristics of the used raw materials.

Characters	Raw materials		
	Sewage sludge	Bagasse	Cow dung
Physical characteristics			
(1.5) pH	6.15	4.2	7.08
(1:10) (Ec dS/m)	2.71	1.3	
Bulk density (kg cm^2)	421	103.3	
Moisture content	4.40	4.9	70-80
Dry matter %	95.60	95.1	20-30
Chemical characteristics			
T.N %	3.14	0.38	1.402
T.P %	1.046	0.232	701-409
T.K %	0.43	0.52	1.4-1.5
O.N %	64.97	96.20	73.26
O.C %	37.70	55.8	31.68
C/N ratio	12.1	149.84	22.546.:1
Ash	35.03	3.8	25.54-26.74
Micronutrients (ppm)			
Zn	3235	244	430
Mn	326	85	60
Fe	10330	420	1160
Cu	466	9	230

Table 2: Physical and chemical analysis of tested soil.

		Soluble anions in saturation extract (meq/L)	
Coarse sand %	23.0		
Fine sand %	45.5		
Silt %	15.0		
Clay %	12.9		
CaCO%	26.1		
Textural class-sandy loam		CO_3	0.0
pH (1:2.5)	7.9	Cl^-	1.89
E.C (1:5 dSm^{-1} 25ºC	1.29	SO_4^{--}	3.82
O.C %	0.57	HCO_3^-	0.68
O.M % 0.98	0.98	Ca^{++}	2.60
T.N % 0.06	0.06	Mg^{++}	1.30
T.K % 0.54	0.54	Na^+	2.10
T.P % 0.061	0.06	K^+	0.39

Table 3: Microbial characteristics of soil, dung sewage sludge and bagasse.

	Soil	Cow-dung	Sewage sludge	Bagasse
Total viable bacteria count/g	1.9×10^9	189×10^7	216×10^6	15×10^2
Total coliform count/g	760×10^7	83×10^4	3.0×10^4	< 10
Total actinomycetes count/g	$1,34 \times 10^4$	23.6×10^3	3.4×10^3	5×10^5
E. coli count/g	Absent	Absent	5.6×10^3	>10
Salmonella	Absent	Absent	21×10^4	Absent
Shigella	Absent	Absent	Present	Absent
Fecal streptococcus	Absent	Absent	1.0×10^3	Absent
Aspergillus	Absent	Absent	Present 54%	Absent
Penicillium	Absent	Absent	150	Absent
Or/ha parasites			6.2×10^4	Absent
T. fungi				19×10^6

Microbiological analysis (per gram)

at day light the initial mesophilic stage (up to 45ºC) has very short duration at 12 hours (less than one day). After 24 hrs of composting, temperatures of 45, 25ºC and 46, 57ºC have been measured for pile mix 1and 2 at depths of 40 and 60 cm, respectively. A progressive temperature increase has been measured at a depth of 60 cm to stabilize above 70ºC few days (2-5 days) before cooling down gradually and slowly to a stationary thermophilic period with an optimum temperature range (45-55ºC), which is favorable to thermophilic microbial activities. Slowly decreasing the load to a stabilize thermophilic period after 4-6 weeks at 60 cm and 40 cm, respectively, with an optimum temperature of 55 for 4^{th} weeks, from 1 to 5 weeks which is favorable to the thermophilic microbial activities. The thermophilic phase was continued for 42 days of the composting process and it reached the maturation phase at the end of the experimental period (Tables 4& 5).

Table 4: Changes in analogical parameter during composting of organic wastes for (1) Compost mix = bagasse + sewage sludge.
(1) Bagasse + sewage sludge :

Period days	Bulk density (Kg/m^3)	Moisture content (%)	Dry matter (%)	Organic matter (%)	Ash (%)	Total N (%)	Soluble Mg/g NH_4	N63	Organic carbon (%)	C/N ratio	p.H 1:10.	E.C (1:5) dSm^{-1} 1:10
0	428.3	54.4	46.6	77.56	22.44	1.49	329	75	44.99	30.2	7.1	2.20
7	434.5	57.9	43.1	79.86	20.14	1.57	422	26	46.32	29.5	6.82	2.60
14	470.1	60.9	39.77	77.31	22.69	1.59	812	23	44.87	28.2	6.81	3.08
21	509.5	59.5	41.5	68.40	31.6	1.66	985	30	39.67	23.9	6.90	3.75
28	539.1	55.7	43.7	65.80	34.18	1.72	855	37	38.18	22.2	7.14	4.77
56	560.2	58.1	42.5	61.10	38.9	1.98	220	171	35.44	17.9	7.39	4.11
84	587.0	55.9	44.7	55.65	44.35	2.29	25	261	32.28	14.1	7.15	4.76
110	644.4	51.5	47.9	53.70	46.3	2.36	17	311	31.15	13.2	7.05	4.50

Table 5: Changes in analogical parameter during composting of organic wastes for (2) Compost mix = bagasse + cow dung.

Periods days	C/N ratio	(1:10) pH	% O.M	% O.C	% Ash	% T.N	Kg/m^3 Bulk densely	% moist content	% dry matter	EC 1:10 dSm^{-1}
0	29.9	7.75	80.1	46.458	19.9	1.55	333.6	60	71.2	7.1
7	28.3	7.14	78.6	45.588	21.4	1.61	359.8	61.8	39.9	7.9
14	28.3	6.84	76.1	44.138	23.19	0.8	400.9	58.6	42.4	8.3
21	27.3	6.99	72.1	41.818	27.9	153	430.1	53.1	47.5	8.6
28	25.45	6.44	69.4	40.25	30.6	1.58	480.1	55.0	44.9	8.9
56	21.02	5.96	63.2	36.656	36.8	1.73	520.1	51.1	50.1	8.33
84	17.01	5.93	55.62	32.259	44.38	1.886	549.9	51.2	51.2	8.5
110	14.39	5.94	53.2	30.856	46.8	2.10	583.1	48.5	51.9	8.7

pH Value:

pH value of the heap materials was changed from 7.1 to 6.81 in heap 1 and 7.7 to 6.84 in heap 2 during the two weeks, more acidity was observed in the second week of the compost (Tables 4& 5). Decreasing in the pH values may be due to the production of organic acid causing further acidification or hydrolyzed polysaccharides during bio-oxidation phase. The produced acidity was followed by a slight alkalinity in the heap, then passed to the neutrality phase during composting process till the end of the experiment. These changes may be due to the metabolic degradation of the previous organic and fatty acids or lost then by volatilization (El-Housseini *et al.* 2000 and Afify, 2002).

Change in Compost Bulk Density:

Data of bulk density for compost piles presented in Tables (4& 5) bulk density values for the compost piles showed a gradual increase. However, as composting proceeded, the bulk densities increased from 428.3 to 644.4 kg/m^3 and 333.6 to 583.1 kg/m for piles mix 1 and 2. The variations in the initial bulk density values could be attributed to physical characteristics and weights of the organic wastes and to the additive conditions used for making the composting mixtures at initial time before heaping partial sizes of the wastes and there capacities for holding water and porosity percentages might have an important influence on the bulk densities throughout the composting period . The increase of compost weight per unit of volume as the composting process proceeded, reflects the high percentage of fine particles in the particle size distribution and may give some indication about compost maturity (Allam, 2005).

Biodegradation of Organic Matter:

Changes in the percentages of moisture content, organic matter, ash and total nitrogen are shown in Tables (4& 5), which were used for calculation the weight after 0, 7, 14, 21, 25, 50, 84 and 110 days of composting. The degradation period of organic matter during the composting process was expressed as percentage loss on dry basis and organic matter weights. Organic matter started to degrade slowly during the first 7 days of composting, then rapidly increased after 21 days. The total loss of dry matter after 21 days of composition was 68.40% and 72.1 for piles 1, 2, while Jimerez and Garcia (1991) reported losses of 74.8% and when domestic refuse sewage sludge for 165 days. Allam (1999) found that the organic matter losses percentage in relation to compost dry and organic matter weight ranged from 52.2% to 61.1% and from 70.5 to 74.5% when some agriculture wastes and sewage sludge were composted for 16 weeks. These results are in accordance with those obtained by (Ouedraogo *et al.*, 2001).

5. Total Nitrogen:

Total nitrogen percentage increased gradually throughout the composting process as a result of high biodegradation of carbon aqueous substances, the increase was from 1.49, 1.55 to 2.36, 2.10% for both piles (1, 2) at the end of the experimental period Tables (4& 5). In spite of these increases, the decrease in the total nitrogen content could be attributed to its volatilization as ammonia and/or to leaching as nitrate after moistening the pile (Camilia *et al*., 2006).

6. Carbon to Nitrogen Ratio (C/N ratio):

The ratio of carbon to nitrogen Tables(4& 5) were calculated using available results. During the bio-oxidative phase, C/N ratio was narrowed and slightly stabilized without appreciable variation towards the 56 days. The C/N ratio showed high reduction towards the end of composting period. Therefore, ratio narrowed initially from 30.2:1, 29.9:1 to 13.2:1, 14.69:1 for both piles after 110 days.

The stabilization of C/N ratio could be considered as a valid index for compost maturity. This parameter could be considered as an excellent index for the evaluation of compost maturity (Afify 2002 and Allam 2005).

7. Electrical Conductivity (EC):

The electrical conductivity value of heap began with 2.20 and 7.1 dS/m and increased gradually till 28 days to reach 4.77, 8.9 dS/m for two piles, then fluctuated during the 56 days and lightly changed till the end of the experiment to reach 4.50, 8.7 dS/m during 110 days (Tables 4 & 5).

The increase in the conductivity of the three composted materials could be related to high concentrations of ammonia and other ions released during rapid mineralization of organic matter. This may be due to the original characteristics of the banana compounds. The relative fluctuation observed at the end period of composting period could also be attributed to ions release, and/or fixation throughout changes in proliferation of the aerobic microbial production, (Afify, 2002 and Allam, 2005).

Total Viable Bacteria (TVB count):

Change in the mesophilic (TVB) throughout the composting period are shown in Table (6). The number of mesophilic (TVB) at initial time for both piles were between 1.5 x 10^6 and 7 x 10^6 cfu/g dry weight. The number increased during 8 first days of composting to be in range from 100 x 10^6 cfu/g dry weight to 330 x 10^6 cfu/g dry weight as the temperature decreased during the decline and maturation phases. During the first 28 days of composting in which the temperature degree was 45ºC. Jimenez and Garcia (1991) reported that the thermal inactivation of microorganisms can be produced if the temperatures exceed 70ºC for a long period. In this study, the maximal temperatures were between 68 and 71ºC only for one to 7 days. Therefore, the microbial inactivation was not appearing in all piles under study during incurring and maturation phases (Table 6).

Table 6: Changes in count of total bacteria, total fungi and Actinomycetes during composting process in two compost mix.

Time	Compost mix (I) bagasse + sewage sludge			Compost mix (2) bagasse + FYM		
	T.C. of bacterial 10^7 cfu/g dwt.	Fungi (10^5) cfu/g dwt.	Actinomycetes 10^6 cfu/g dwt.	T.C of bacteria 10^6 cfu/g dwt.	Fungi (10^5) cfu/g dwt.	Actinomycetes (10^6) cfu/g dwt.
0	0.15	19.5	1.6	100	10	5
7	129.4	115	1.58	330	26	30
14	130.4	250	1.55	330	26	40
21	125.1	213	1.47	330	20	105
28	116.4	60.10	1.6	310	16	100
56	93.3	4.50	1.71	150	11	90
84	0.75	0.9	1.66	9	10	35
110	0.7	0.6	1.70	6	9	20

T.C. = Total count.

Total Fungi:

Changes in the numbers of mesophilic fungi throughout the composting course of two different mixtures or agricultural wastes are shown in Table (6). The counts of mesophilic fungi ranged between 10 x 10^6 cfu/g, 19 x 10^5 cfu/g dry weight to 60.1 x 10^6, 16 x 10^5 cfu/g dry weight at 28 days of composting for two piles under this study. After 28 days, as the temperature start to drop towards the maturation phase, the mesophilic fungi counts began to increase and reached maximum 4.5 x 10^5 to mix 1 and 1 x 10^5 to mix 2 at the 28 days of composting in piles (Table 6).

Actinomycetes:

The count of actinomycetes was 1.6 x 10^6 cfu/g, 5 x 10^5 cfu/g fresh weight at initial time of composting. The number of actinomycetes increased and changed to 07 x 10^6 cfu/g, 2 x 10^6 cfu/g (Table 6).

Biological Activity in Soils as Affected by Organic and Inorganic Fertilization:

Total Viable Count Bacteria (TVCB):

Data of TVCB are presented in Table (7) both tested soil, significantly increased the numbers of TVCB, the positive effect on (TVCB) values due to soil manuring was increased in the order compost mix I < compost II. As for the rate of change in microbial activity, general trend could be observed of the microbial activity enhancement due to compost application instead of the inorganic source, was maximized after (30 or 15) days from barley seeding i.e., after 37 or 22 days from soil treatment. Afterwards, the gap in microbial activity between manured and unmanured due to compost application instead of the inorganic source, was maximized after 30 or 15 days from soil treatment. Afterwards, the gap in microbial activity between manured and unmanured soil tended to be progressively limited with prolonging the growth period particularly in soil at 110 days growth period, probably due to the exhaustion of available nutrition sources according to the above mentioned results it may be stated that, substituting the addition of the organic N sources for mineral one (ammonium nitrate) to mineral treatment, at the same rate, seriously increased microbial activity in soil. The microbial activity was progressively enhanced with increasing the rate of substitution of the organic 'N' source to reach maximum counts (55 days to 178 days) and (134 days to 108 days) cfu/g (dry w. soil) after 30 days to 45 days from treating the soil with compost (mix I and mix II) and in completely absence of the mineral N source for the mineral test (inorganic).

Table 7: Changes in analogical parameters in soil cultivated with barley plants.

Treatment Time-days	Organic (control)			Organic					
				Compost (mix I) seawage + bagasse			Compost (mix II) co dung + bagasse		
	Total count of bacteria 10_7 x cfu/g dry weight	Total fungi x10^3 on dry weight	Actinomycetes cfux10^5/g dry weight	T.C. bacteria cfux10^7	T. fungi cfux10^5	Actinomycetes cfu x 10^5	T.C. bacteria cfux10^7	T. fungi cfux10^5	Actinomycetes cfu x 10^5
0	10.33	2.9	10.33	52.33	15	43.33	53	12.97	43.13
7	18	4.97	12.6	68.33	23.93	48.03	63.33	18.02	45.93
15	25	7.8	18.83	72.33	27	66.77	70.33	20.97	63
30	34.67	10.9	24.3	154.67	65.63	88.97	134	24.97	78.97
45	45.33	13.87	35.33	178	56.07	94.9	108	78.73	85.13
60	20	6.1	28	87	49.03	72.67	83.33	43	69.8
90	14	7.07	20.63	39.33	78.73	50.87	38	35	49.1
110	13.33	6	16.97	38	27.87	42.97	30	23.07	38.73
		5	12.97		24.8	29.13		18.17	24.77

The effect of organic matter on the soil microflora was studied by many investigators. Saber 1966 observed that application of raw sewage effluent, decanted sewage effluent or dried sludge increased total bacterial count and increase in the dried sludge treatment was more pronounced in the sandy soil. Badran, Nadia (1983) found that the addition of form sewage sludge and town refuse to alluvial soils slightly increased the total count of bacteria, while sewage sludge caused higher bacterial counts than those of control. Mostafa (1994) and Abd El-Hakem (1995) reported that addition of kg biogas manure or compost to sandy soil enhanced bacterial counts over control in all treatment. Badr and Fahmy (1997) reported that the addition of organic manures alone or in combination with mineral-N significantly increased the TVB.

Total Count of Fungi:

Results presented in Table (7) for fungi counts in soil under barley plant showed a trend almost similar to that of bacteria and actinomycetes but more obvious in magnitude than that of bacteria and in trend than that of actinomycetes.

The compost mix I and mix II was more effective in increasing fungus activity in soil than inorganic treatment. The gradual increase in the degree of substituting the organic nitrogen sources for the mineral ones, progressively enhanced the number of fungi in soils to reach maximum values (88.97 and 78.97 x 10^3 cfu/g dry weight soil) after 30 days from barley cultivation with compost mix I and compost mix II. Number of fungi were affect by the addition of different kinds of organic materials. Saber (1966) found that the application of raw sewage effluent, decanted sewage effluent or dried sludge increased the number of fungi.

Almost these similar results were obtained by (Mahmoud *et al*., 1992 and Ahmed, 1993) who reported that the effect of the application of organic matter to soil increased the number of fungal and activity.

Actinomycetes:

Data in Table (7) for actinomycetes count in the soil under barley growth reveal a general trend almost resembling to that observed with the microbial count, the obtained results can be briefly summarized in the following.

Progressive substitution of the organic N source instead of the mineral N source, steadily induced the counts of actinomycetes under barley growth. This including effect on actinomycetes counts was progressively increased after soil manuring (composts) to reach maximum values with complete substitution of the different compost types in soil after 30 days from cultivation .

The maximum actinomycetes count amounted about 35 x 10^5 (cfu/g dry weight soil) for inorganic and 95 x 10^5 and 85 x 10^5 for compost mix I and mix II, respectively. Badran (1983) found that the application of organic manures slightly increased the actinomycetes. The superiority of the digested organic manures in increasing actinomycetes count was assured by (Filip and Muller, 1984).

Total Count of Coliform:

Results presented in Table (8) revealed the enhancement of the total count of coliform groups in soil under barley. This inducing effect was maximized after 15 days growth (i.e 21 days from application to soils). There was a sudden and acute reduction after 90days of growth period compost mix I was the most efficient in soil, in respect to the numbers of coliform group in soil. The number of coliform group were increased with compost application to the soils, it is well known that the source of this bacteria in the human and animal excretes contained in sewage sludge, which is in turn constitute compost mixtures, hence the initial samples of treated with organic manures showed higher counts than corresponding controls, the highest counts that occurred over the different growth periods and different treatments were 350 and 460 (cfu/g dry weight soil) instead of corresponding control numbers of 80 for the soil.

Table 8: Total count of *Salmonella* and *Shigella*.

Time days	Inorganic		Organic			
			Compost mix I		Compost mix II	
	Total count Salmonella and Shigella	Total count coliform groups	Total count Salmonella and Shigella	Total count coliform groups	Total count Salmonella and Shigella	Total count coliform groups
0	nd	1	nd	20	nd	10
7	n	3	1	46	n	55
15	nd	1	3	30	nd	11
30	nd	nd	nd	9	nd	1
45	nd	nd	nd	1	nd	nd
60	nd	nd	n	nd	nd	nd
90	nd	nd	nd	nd	nd	n
110	nd	nd	nd	nd	nd	nd

ndnd = not detected

These high counts were due to entire substitution of organic N source (compost mix I). Badra and Fahmy (1997) found at 10^{-1} dilution in most manure treated soil samples after second cut of sorghum., faecal coliform bacteria numbers ranged between 3 x 10^2 to 37 x 10^2 cfu/g soil.

Total Count of Salmonella and Shigella:

Results in Table (8) revealed that the occurrence of pathogenic bacteria i.e. *Salmonella* and *Shigella* in the tested soils which were observed only during growth and initial growth periods i.e. 15 days after soil seeding with barley grains.

However, the observed numbers of *Salmonlla* and *Shigella* bacteria did not exceed 70 colonies, being more pronounced when increasing the rate of applied compost(sewage sludge) with the application of mineral fertilizer only growth compost mixtures of both types of such pathogenic bacteria were entirely undetectable.

Microbial Activity Tests:

1. CO_2 :

As the aerobic composting process progresses the microbial activity declines, so that with time less O_2

in consumed and less CO_2 produced the respiration rate in a mature compost is significantly lower than that in starting row mix (Ribalda *et al*., 1987). Many such comparisons have been made, based on the amount of oxygen consumed or CO_2 produced per unit weight of compost. Because compost vary in their organic contents and activity at maturation stage, no single value can be used for all types of composts. The data show in Table (7). Some what similar losses percentage were 33.6% for dry matter and 56.1% for organic matter when a mixture of..? refuse and sewage sludge was compost for 16 week [Hanafy, *et al*., 1990], while (Kujnebez and Garcia, 1991) reported lasses of 74.8% when domestic refuse sewage sludge for 165 days.

2. Dehyrogenase Activity:

During composting the starting material is transformed through a variety of biological and biochemical processes in which enzymes play a role (Vuarinen, 2000). Characterizing and quantifying the enzymatic activity during composting can reflect the dynamics of composting process in terms of the decomposition of organic matter (De La Horra *et al*., 2005 and Gayal *et al*., 2005) and may provide in formation about maturity of composted product (Tiquia, 2002 and Mondini *et al*., 2004). In respect of dehydrogenase activity (DHA) which concerns with the overall biological activity in soil, date in Table (9) showed that addition of PGPR resulted in great increases in DHA as compared with the absolute control. These findings one in accordance with Mervill an Mckeen, 2001 and Abdel-Wahab *et al.* (2004).

Table 9: Effect of treatments on soil CO_2.

Time (days)	Inorganic	Organic	
		Compost	Compost II
0	0.012	0.237	0.223
1	0.223	1.75	0.58
3	0.695	1.18	1.135
7	0.98	1.62	1.513
15	0.81	1.41	1.38
30	0.77	1.187	1.11
45	0.55	1.077	1.023
60	0.47	0.98	0.88
90	0.413	0.56	0.75
110	0.34	0.63	0.59

Table 10: Effect of treatments on dehydrogenase activity (µl/g soil)

Time(days)	Inorganic	Organic	
		Compost	Compost II
0	311	920.3	610
7	339	950.7	654.3
15	530	1001.3	532
30	619	1319.7	1119
45	490	1732.7	1070.7
60	434.7	1685.7	969.3
90	299.3	1495	878.3
110	255.3	1151	690

Table 11: NPK content and uptake in barley plant using different (fertilizer treatments)

Treatment		Straw yield g/pot D.W.	N		P		K	
			%	N-uptake mg/pot	%	N-uptake mg/pot	%	N-uptake mg/pot
Inorganic		40.96	1.36	55.71	0.31	12.69	0.73	29.90
Organic	Compost I	37.87	1.57	59.46	1.12	42.41	1.87	70.82
	Compost II	37.24	1.54	58.35	1.12	41.71	1.85	68.89
		Grain yield g/pot D.W.						
Inorganic	20.45	3.24	66.36	1.11	22.73	0.30	6.144	
Organic	Compost I	24.03	3.51	84.35	2.73	5.60	2.31	55.51
	Compost II	23.05	3.5	80.68	2.70	62.24	2.30	53.02

Greenhouse Experiment:

Effect of organic and inorganic fertilizers on dry matter yield of barley plants. As mentioned before, this greenhouse experiment was conducted to study the effect of the combination between mineral and organic N sources as well as the solely application of each on the yield and nutrients uptake of barley plants, in this trial mineral N was NH_4NO_3 and organic N was represented by two different types of Co-compost, at compost mixtures namely compost Mix I and II.

Dry matter contents of barley (grain and straw) as well as the concentration and total uptake of N, P and K were determined.

For straw yield (g/pot)and grain yield the inorganic treatment produced lower dry matter yield of straw as compared with that two organic treatments (compost I, compost II) the effect of compost types on straw yield was not pronounced, since the average values were very close, Table (10)., In Table (11), the organic treatment produced higher N, P and K in yield of straw or grain yield such results were in agreement with those obtained by Mostafa (1994), Abdel-Wahab *et al.* (2004).

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