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التغيرات التي تحدث أثناء كمر المخلفات العضوية وتقييم تأثير اضافة الكمبوست علي نمو نباتات البسلة وخصائص التربة

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الملخص العربي

تم دراسة التغيرات الميكروبيولوجية والكيميائية التي تحدث خلال عمليات كمر نسب مختلفة من قش الارز مع سبلة الحيوان والكمبوست الناضج وتأثيرة علي نمو نباتات البسلة وعلى بعض خصائص التربة. وقد أوضحت النتائج زيادة في العدد الكلي للبكتيريا الميزوفيلية (المحبة لدرجة الحرارة المتوسطة) في بداية عملية الكمر (٠ – ١٥ يوم) وأيضا في النهاية (٤٥ – ٦٠ يوم) كم وجد كذلك زيادة فى العدد الكلي للبكتيريا المتجرثمة والمحبة للحرارة المرتفعة (الثرموفيلية) في الفترة من ١٥ – ٣٠ يوم من عملية الكمر. ولوحظ ايضاً إنخفاض في نسبة الكربون للنتروجين وانخفاض الكربون العضوي وزيادة في النتروجين والفوسفور والبوتاسيوم N,P,K . وبوصول الكمبوست إلي مرحلة النضج بعد ٦٠ يوم كان غني بالمادة العضوي والعناصر المعدنية التي كانت تتصف بدرجة عالية من الثبات. وعند اضافة الكمبوست الناتج من عملية الكمر بنسبة ٧٥% كمبوست + ٢٥% سماد معدني الى التربة المزروعة بنبات البسلة، وجد أن هناك زيادة معنوية في نمو وإنتاجية نباتات البسلة وتحسن في خواص التربة الكيميائية والبيولوجية التي درست .

وقد اظهرت هذة الدراسة بوضوح فائدة الكمبوست واوضحت إمكانية إستمرار تطبيقة في زراعة البسلة من خلال تدوير المواد العضوية المتاحة محلياً.

CHANGES DURING COMPOSTING OF ORGANIC WASTES AND ASSESSMENT OF COMPOST APPLICATIONS ON PEA (*PISUM SATIVUM L.*) GROWTH AND SOIL PROPERTIES

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ABSTRACT: ***This study was carried out to study the biological and chemical changes during composting process of compost consisted from different ratios of rice straw, animal manure and mature compost Also, the produced composts effects individual or in combination with mineral fertilizers at different application rates on pea growth and soil properties were studied. The results showed an increase in mesophilic bacterial counts at the beginning (0-15 days) and end (45-60 days) of composting process, and increase in spore forming and thermophilic bacteria at 15-30 days of composting. A decrease in C/N ratio, the content of organic carbon and increase in the content of total N, P, K were recorded throughout composting period. The composts that produced at 60 days, were rich in organic matter and mineral nutrients. Application of compost at a rate of 75% with 25% mineral fertilizer significantly increased growth and productivity of pea plants and improved the selected soil chemical and biological properties. The benefit of this compost demonstrated the validity and possibility of sustainable agronomic performance of pea plants using locally available recycled organic materials.***

Keywords: ***Compost; Rice straw; Pea; Growth; Productivity.***

INTRODUCTION

Rice (*Oryza sativa L.*) is an important crop in many areas of the world, and yields a large amount of rice straw residue. A major portion of this agricultural waste is disposed by burning or is mulched in rice fields. However, an alternative usage of rice straw is composting. The composting process has been defined as the biological degradation of organic constituents in wastes under controlled conditions (Golueke, 1972). The monitoring of a succession of microbial communities is important for effective management of the composting process, as microbes play key roles in this process; in particular, the appearance of certain microbes will reflect the quality of the maturing compost (Ishii *et al.,* 2000 and Ryckeboer

_et al.,_ 2003). Rice straw is rich in C and poor in N. Its C/N ratio can vary from 50 to 150, which limits the composting process. This high C/N ratio can be decreased by increasing the basal N content of rice straw by adding poultry manure, animal manure and mature compost which are readily available in Egypt. In this regard, Bustamante _et al., (_2008) found that, the mixture with the lowest C/N ratio, using exhausted grape marc and poultry manure, showed the highest initial ammonium contents, probably due to the higher and more labile N content of poultry manure.

Pedro _et al_., (2009) showed that, in general, compost application increased soil pH, mycorrhizal roots, mycelium length, and water stable aggregates. Lee _et al._, (2004) observed that a poor soil responds well to amendment with favorable micro-organisms, especially if the soil is also amended with organic materials as food for the micro-organisms. Sodhi _et al.,_ (2009) approved that the application of rice straw compost either alone or in combination with inorganic fertilizers increased the macroaggregate size fractions. The mean weight diameter was significantly higher in plots receiving rice straw compost either alone or in combination with inorganic fertilizers as compared to control. Mekail _et al.,_ (2000) found that the addition of compost from various plant residues to sandy soil increased its productivity in terms of dry matter production and increased the uptake of nutrients.

El-Etr _et al.,_ (2004) found that application of both bio-compost (rice straw compost inoculated with some microorganisms, i.e. _Azotobacter chroococcum, Bacillus megaterium_ and _B. circulans_) and compost I (rice straw compost and inoculation the soil with the same microorganisms) increased the amount of organic matter content, available N (NH_4NO_3), P (P_2O_5) and K (K_2O), and electrical conductivity and decreased the pH values in soil samples at both growth stages of pea and wheat plants (Ali _et al.,_ 2006). Othman _et al.,_ (2005) reported that compost addition at rate of 20 m^3/fed increased maize grain yield attributed this increase to the improving action of compost on the physical properties and nutrient status in the soil. They recommend applying N-fertilizer at lower doses in combination with the highest compost rate 20 m^3 fed. This will reduce both the environmental pollution and costs of maize production. EL-Desuki _et al.,_ (2010) showed the effect of levels of compost application on vegetative growth of pea plants i.e. number of leaves and branches as well as fresh and dry weight of leaves and branches. They found that all the vegetative growth parameters were significantly increased by increasing the levels of compost application from 100 up to 140 kg N/fed in a two growing seasons of pea. Awad (2002); EL-Etr _et al.,_ (2004) and Hafez and Mahmoud (2004) reported that, the vegetative growth of plant (plant height, number of leaves or branches as well as

fresh and dry weight of plant organs) were increased by using compost as organic fertilizer application.

Thus the main objective of this study is to reduce the full dependence on chemical fertilizers and keep high productivity at the same time. Also, this work is aiming at monitoring the composting process of some plant residues enriched with some organic and bio-inoculants and evaluating the effect of application of produced rice straw compost combined with different doses of mineral fertilizers on growth of pea plants grown on sandy soils.

MATERIALS AND METHODS

Raw Materials Used For Composting:

In this study two organic wastes. i.e rice straw and animal manure were used straw of rice was collected from Gharbia Governorate., animal manure was collected from Faculty of Agriculture Farm that located in, Shibin El-kom, Minufiya Governorate. Mature compost was provided by the Bio Pianta Company for Agricultural Residues Utilization (BPARU). Sadat city, Egypt. Mature compost was added to the compost heaps as an additional source of microorganisms. The chemical and physical analyses of rice straw, animal manure and mature compost were estimated according to (Cottenie, 1980 and Cottenie *et al.,* 1982). The results were shown in Table (1).

Table (1): Chemical and physical properties of the composting raw materials

Content and unit	Rice straw	Animal manure	Mature compost
Moisture (%)	11.00	29.30	25.00
Dry matter (%)	89.00	70.70	75.00
Total carbon (%)	51.04	39.54	38.57
Total nitrogen (%)	0.68	2.01	2.36
C/N ratio	75.06	19.67	16.34
Organic matter (%)	88.00	68.18	66.50
Total P (%)	0.20	5.52	5.33
C/P ratio	255.20	43.45	52.12
Total K (%)	0.90	0.91	0.74
E.C. dsm^{-1}	n.d	1.80	0.86
pH (1:10)	n.d	7.55	6.35

EC: electrical conductivity. n.d.: not detected.

Preparation of Compost Heaps:

Four heaps with 2.0 x 1.5 x 1.0 m of length, width and height were set up from shredded rice straw, animal manure and mature compost in Table (2). The heaps were composted during the period extended from beginning of July to the end of August (2008) as the following:

Table (2): Composition of heaps:

Heaps No.	Organic wastes		Mixed ratio (v/v)
	Heap composition	Heap symbol	
1	Rice straw (A) and animal manure (1).	[A1] 1	1:1
2	Rice straw (A) and mature compost (2).	[A2] 2	1:1
3	Rice straw (A) and bio-inoculants (3).	[A3] 3	30 litter/heap
4	Rice straw (A) animal manure, mature compost and (bio-inoculants) (4).	[A4] 4	1:1:1 and (10 litter/heap).

Monitoring Of Composting Process:

The heaps were mixed and turned every 15 days for the purpose of aeration. Moisture content (%) was adjusted at each turning time and maintained by addition of water to heaps during turning to maintain a moisture content level at 60-70%. Compost temperature was measured daily for the first month of composting and every 15 days in the second month at depth of 30 cm within the heaps before turning. One representative sample from each heap was collected at 0, 15, 30, 45 and 60 days for chemical and microbiological determinations. These samples were taken before each turning time from different sites of each heap and mixed thoroughly.

Microbiological determination

1- **Total count of mesophilic, thermophilic and spore forming bacteria.** **Total count of mesophilic, thermophilic and spore forming bacteria were determined by plate count on soil extract agar medium as follows: five grams of fresh compost were suspended in 45ml sterile distilled water and then shaken for 15 minutes followed by serial dilution. Counting was then accomplished by transferring one ml of an appropriate dilution into a sterile soil extract agar plate. The plates were incubated for 24h at 30 ± 2^{o}C for mesophilic, spore forming bacteria and 55 ± 2^{o}C for thermophilic ones (Clark, 1965).**

2-Total count of mesophilic fungi. Total count of mesophilic fungi were determined by plate count on potato dextrose medium (PDA) (Ahmed, 2001) with incubation for 5 days at 25 ±2^{o}C.

Chemical and physical determinatin.

1- pH. The pH was determined in 1:10 (w/v) suspension of compost: distilled water using glass electrode pH meter according to (Jackson, 1973).

2- Organic carbon. The content (%) organic carbon in raw, composted materials and composts was determined according to Walkley and Black (1934). The organic matter content was calculated by multiplying organic carbon values by 1.724.

3- Total nitrogen. Total content (%) nitrogen in organic waste and composted materials was determined using kjeldahl digestion as described by Bremmer and Mulvaney (1982).

4- Total phosphorus. Total phosphorus content (%) in organic waste and composted material was determined spectrophotometrically in an acid solution of the digested samples using ascorbic acid and mixed reagent as described by Jackson (1973).

5- Total Potassium. Total potassium content (%) in organic waste and composted material was determined in an acid solution of the digested samples using flam photometer as described by Jackson (1973).

6- Temperature. Temperature was measured in the piles at 50 cm depths using a thermometer (Mohamed, 2006).

7- Moisture content. Moisture content (%) was estimated by oven at 105 – 110 ^{o}C/24h according to Nancy and Tom (1997).

Field Experiments:

These experiments were carried out to study the effects of application rates of produced compost and chemical fertilizers individually or in together on plant and soil characteristics

These field experiments on sandy soil were conducted at Sadat city during November 2008 season. The area of each experimental plots was in 2.5m length x 5m width. Surface soil samples (0 – 20 cm) were collected before plants in from the studied soil air – dried, ground, sieved through a 2mm sieve, good mixed and analyzed for some physical properties according to Cottenie (1980) and cottenie *et al*., (1982). The obtained data were recorded in Table (4). The tested plant was peas *(pisum sativum)* (master B

variety).The composted rice straw was mixed with mineral fertilizers (ammonium sulfate (20.5% N) potassium sulfate (48% K_2O) and Super phosphate (15.5% P_2O_5) and applied with different ratios to the soil as the following.

Treatment (1): compost (A1, A2, A3 and A4) containing rice straw, animal manure, mature compost, bio-inoculants and a mixture of them were applied with the following ratio:

(a) 100% compost (A1, A2, A3 and A4) plus zero chemical fertilizers.
(b) 75% compost (A1, A2, A3 and A4) plus 25% chemical fertilizers.
(c) 50% compost (A1, A2, A3 and A4) plus 50% chemical fertilizers.

All farming processes of pea plants were carried out as recommend by Minstry of Agriculture. The experimental plots were arranged in completely randomize bloc desing with three replicates. The main factor was compost treatment where the sub factor was mineral fertilizers treatments in Table (3).

Table (3): Rates of organic and inorganic fertilizers applied to the soil for pea cultivation.

Treatment	Compost	N- Fertilizer			
		Mineral	Compost	Mineral	Compost
No.	treatment	Kg/fed.	Ton/fed.	Kg/plot	Kg/plot
1	Control-1	217.50	0.000	1.295	0.000
2	Composted rice straw and animal manure	0.000	7.580	0.000	45.120
3		54.375	5.685	0.323	33.84
4		108.75	3.790	0.648	22.56
5	Composted rice straw and mature compost.	0.000	7.016	0.000	41.762
6		54.375	5.262	0.323	31.322
7		108.75	3.508	0.648	20.881
8	Composted rice straw and bio-inoculants.	0.000	10.069	0.000	59.935
9		54.375	7.552	0.323	44.951
10		108.75	5.035	0.648	29.967
11	Composted rice straw, animal manure, mature compost and bio-inoculants.	0.000	7.323	0.000	43.589
12		54.375	5.493	0.323	32.692
13		108.75	3.662	0.648	21.795

Table (4): Physical and chemical analysis of sandy soil used for pea cultivation.

Characters and units	Values
Sand (%)	71.90
Silt(%)	21.38
Clay(%)	6.72
Total carbon(%)	0.96
Total Nitrogen (%)	0.45
C:N Ratio	2.13
Organic Matter (%)	1.67
C:P Ratio	3.56
E.C. dsm^{-1}	1.67
Total P (%)	0.27
Total K (%)	0.69
pH (1:2.5)	7.75

Plant Parameters:

Tow randomize samples of pea plants were taken after 20 and 40 days of planting. Also thired samples was taken at harvest time (60 days). These samples were subjected to the following measurements.

1- **Plant height: Plant height was measured in cm from cotyledons level to the 1st terminal bud.**

2- **Fresh and dry weight of plants: The total fresh and dry weight of whole plant at the three sampling times were recorded in g/plant. Plants were oven dried at 70^{o}C for three days until reached a constant weight.**

3- **Number of branches: Average number of branches in peas/plant was recorded after 20, 40 and 60 days of cultivation.**

Soil Parameters: After plant harvesting, surface (0 – 20 cm/ soil sample was taken separately from each plot and prepared for the following determination.

1- **Nitrogen, P and K content. Nitrogen, phosphorus and potassium content of soil were determined according to (Jackson, 1973).**

2- Rate of carbon dioxide evolution:

The rate of CO_2 evolution was determined in the rhizosphere soil according to the method described by Pramer and Schmidt, (1964) and modified by Shehata, (1972). In this procedure, 25g fresh rhizosphere soil sample which taken at 20, 40 and 60 days was placed in cylindrical polyethylene bag (which allows passage of CO_2) and tied with a thin wire. Each bag was placed in 500ml bottle containing 25ml NaOH (0.05M). Bags were hanged in the bottle by tying the other end of the wire with the rubber stopper at the top of the bottle and fixed closely to avoid any loss of CO_2. Each treatment was represented by one bottle in addition to blank (with NaOH solution, but without planting medium sample). All bottles were then incubated at 30^{o}C/24 h.

After incubation, polyethylene bags were taken out from the bottles then 3ml barium chloride solution (0.5M) and 2-3 drops of phenolphthalein indicator were added to the solution in the bottle and then titrated by HCl (0.05M) under continuous stirring until the color changed from red to colorless.

The rate of CO_2 evolution was calculated according to the following equation (Alef and Nannipieri, 1995).

$$CO_2 \text{ (mg)/sw/t} = (V^{o} - V) \times 1.1/ \text{dwt}$$

Where:

sw = The amount of planting medium dry weight in grams.
t = The incubation time in hours.
V^{o} = Volume (ml) of HCl used for the blank.
V = Volume (ml) of HCl used for planting medium sample.
dwt= The dry weight of 1g moist planting medium.
1.1 = the conversion factor (1ml 0.05M NaOH = 1.1mg CO_2).

Statistical analysis:

The obtained data were subjected to Analysis of Variance (ANOVA) and L.S.D test was used to compare the treatment means according to the procedures outlined by Snedecor and Cochran (1980) using MSTAT computer program.

RESULTS AND DISCUSSION

Physical and Chemical Changes During Composting Process:

1- Changes in temperature:

During composting, the degradable organic matter in the starting material is broken down by microorganisms. This process results in the release of heat. Temperature evolution is an indicator of microbial activity during

composting process. As this experiment conducted in the period from July to August 2008, the ambient temperature variations through this period ranged between 23 and 27°C at nights and from 30 to 39°C at lights. Changes in temperature during the composting period are illustrated in Table (5). In general, that temperature values varied during the tested time intervals. At the beginning of composting process data recorded was ranged between (zero time) 30°C and 34.8°C at 50 cm depth for all heaps. At the 15 day of the composting process the a high increase in the temperature was noticed (61.7-67.6°C) for all heaps. A slight decrease in temperature was obtained at 30 day of composting, where the temperature ranged between 56.4 -65.0°C. At 45 day, the temperature values markedly decreased and became more favorable for mesophillic microorganisms where its values ranged between 43.7 -47°C for all piles. More decreases in temperature values were occurred at the end of composting process and the piles became cool again where its temperature values ranged between 33.5 – 37.1°C at 50 cm in all piles as shown in Table (5).

Table (5): Changes in temperature degrees during the composting process in different heaps.

Compost type	Temperature c^{o}				
	Composting period (days)				
	0	15	30	45	60
A1	33.5	61.7	57.5	43.7	35.0
A2	30.4	65.9	56.4	44.1	33.5
A3	31.9	67.6	65.0	47.0	37.1
A4	34.0	66.5	61.7	45.9	34.9

It was also observed that temperature of the heaps treated with animal manure and mature compost were slightly higher than those of the piles treated with bio-inoculates at the beginning of composting. After that this previous results were reversed due to increasing of degradation of used material (rice straw) that facilitate its contact with each others. During the composting process, the temperature evaluation is considered to be a reflection of the metabolic activity of the microbial populations involved in the process and in many studies temperature has been shown to be a critical determinate of composting efficiency (Namkoong and Hwang, 1997). The results also indicated that temperatures between 30 and 45°C maximized the microbial population in the composting process, those between 45 and 55°C maximized the biodegradation rates and only the thermophilic range between 55 and 65°C is sufficient to destroy pathogens. This finding is in agreement

with the results of Venglovsky *et al.,* (2005) who stated that high and low temperature are suitable for composting where low temperature is suitable for the activity of mesophilic microorganisms which play a dominant role in biodegradation of organic compounds. Rising the temperature to exceed 65°C was desirable for killing most pathogens and maximized the sanitation. Baeta-Hall *et al.,* (2005) stated that the compost is matured enough when its temperature remains more or less constant and don't changes the turning over of the material particularly at the end of the composting process.

2- Changes in pH:

The changes in piles pH values recorded during the different time intervals of composting process are recorded in Table (6) Irrespective of treatments, generally the pH values were slightly decreased in early intervals of composting process. The pH values increased afterwards to reach to neutral value .The results set out in this table indicate that, pH values were changed toward acidity over the second week, the average of pH of all piles during this period ranged between 6.17 and 7.15, while at the third and fourth weeks of the composting process the pH values there were a slight increase.

Table (6): Changes in pH values of different heaps during composting process.

Compost type	pH values.				
	Composting period (days).				
	0	15	30	45	60
A1	7.96	7.15	7.68	7.57	7.36
A2	7.35	7.02	7.65	7.70	7.16
A3	7.67	6.61	6.76	7.41	7.32
A4	7.78	6.74	7.70	7.71	7.26

The pH values afterwards were changed to alkalinity and the average of pH values of the compost piles recorded the maximum at 45 days. This was followed by slight alkalinity in all heaps to pass the neutral phase during composting till the end of the period (60 days). The decrease in pH values at the beginning of composting process may be due to the production of organic acids causing further acidification (Rynk *et al*., 1992). Similar results were recorded by Abou El-Naga *et al*., (1997),who observed a slight decrease in the pH value of composting materials to pH 6.5 and 6.2 during the first and second week of the process. The produced acidity was followed by slight alkalinity. By the end of the process, the pH slightly increased (6.97 – 7.21). These later changes may be due to metabolic

degradation of previous organic acids or lost them by volatilization. The present study followed the typical model described by others (Beck-Friis *et al.*, 2003 and Khan *et al.,* 2009).

3-Changes in C/N ratios:

Carbon to nitrogen ratio is the most important chemical test in compost. The changes in C/N ratio during composting periods are shown in Table (7). Results showed that, the C/N ratio decreased markedly with the progress in the composting process. The C/N ratio sharply decreased from 229.06 to 57.69 during the first two weeks of composting of all heaps from. The ratio was markedly narrow and then decreased again in the last two weeks (45-60 days) to 14.95 at the 60^{th} day of composting process. The narrowing of C/N ratio with the progress of the composting process is a common features and an indicator for maturation.

As a result of high depletion of organic-C, the total nitrogen was increased hence, the C/N ratio decreased. It tended to be narrow with time in compost heaps. This may be due to the loss of carbon as CO_2, while the nitrogen remained more tightly bounded in organic combination as long as the C/N ratio is wide. These results are in agreement with those obtained by Bernal *et al*., (1999); Abdel-All, (2001) and Wong *et al.,* (2001) *,* who found that addition of some amendments such as inoculation with cellulolytic microorganisms led to decrease organic-C and result in a narrow C/N ratio of composted materials.

Table (7): Changes in C/N ratio of examined heaps during the composting process.

Compost type	C/N ratio				
	Composting period (days)				
	0	15	30	45	60
A1	136.55	80.94	38.93	25.85	16.52
A2	106.36	57.69	30.85	21.89	14.95
A3	229.06	143.66	71.50	35.79	20.36
A4	116.39	69.76	30.78	22.53	15.82

4- Changes in the content (%) of organic carbon and organic matter:

Data of changes in organic carbon (O.C) and organic matter (O.M) during the composting process are given in Tables (8 and 9). The obtained results showed a gradual decrease in O.C and consequently O.M content (%)by time of composting. The values of organic - C during the composting intervals

from the first day to the sixty day of the process fluctuated from 75.59% to 25.47%. The loss of carbon varied according to the sort and ratio of substrates which formed each heap. This loss might be due to the loss of carbon as CO_2 by microbial oxidation. Gradual decrease in organic matter during the intervals of composting process particularly from the day 15^{th} to 60^{th} were noticed, where the values of organic matter fluctuated from 130.33% to 43.91%. Generally the rate of losing in O.M. was higher in heaps inoculated by mature compost and animal manure either alone or mixed with bio-inoculants than that inoculated with bio-inoculants only. So the addition of mature compost and animal manure either alone or mixed with bio-inoculants may accelerate the rate of decomposition and decrease in O.C and consequently O.M as well as reduce the time of composting process more than that treated with bio-inoculants alone. These results were consistent with those obtained by Allam (1999) ,who found that O. M % loss were in range between 46.39 to 53.57 %. Similar findings were obtained by Abdel-Wahab (1999) and Abdel-All (2001) ,who found that there are a gradual reduction in O.C and O.M during the composting process. They also indicated that, decreasing of organic matter during the composting process may be due to the oxidation effect on the organic acids obtained under aerobic conditions. These results are also in agreement with those reported by Paredes *et al.*, (2002).

Table (8): Changes in the content (%) of organic carbon during the composting process in examined heaps.

Compost type	Organic –C %				
	Composting period (days)				
	0	15	30	45	60
A1	69.64	56.66	40.10	35.415	27.42
A2	67.01	51.35	36.72	32.63	26.47
A3	75.59	73.27	61.49	41.88	34.20
A4	67.51	52.32	32.32	29.97	25.47

Table (9): Changes in the content (%) of organic matter (%) during composting process in examined heaps.

Compost type	Organic matter %				
	Composting period (days)				
	0	15	30	45	60
A1	120.07	97.68	69.13	61.06	47.28
A2	115.53	88.53	63.30	56.25	45.64
A3	130.33	126.32	106.03	72.21	58.97
A4	116.39	90.21	55.71	51.67	43.91

5- Changes in the content (%) of total nitrogen: The periodical changes of the total nitrogen during composting process are given in Table (10). The obtained data showed an increase in the total-N during the different intervals of composting process as a result of the higher bio-oxidation of the easily decomposable carbonaceous substrates.

Table (10): Changes in the content (%) of total nitrogen (%) in different heaps during the composting process.

Compost type	Total nitrogen (%)				
	Composting period (days)				
	0	15	30	45	60
A1	0.51	0.70	1.03	1.37	1.66
A2	0.63	0.89	1.19	1.49	1.77
A3	0.33	0.51	0.86	1.17	1.68
A4	0.58	0.75	1.05	1.33	1.61

The total-N during the composting process (from zero to 60 days) was increased from 0.33% to 1.77 for all heaps. Generally, the nitrogen percentage in compost increased as a percentage of bulk composted materials gradually decreased and to the biological nitrogen fixation. Similar findings were reported by Abo-Sedera, (1995) and Abd El-Wahab *et al.*, (2003), who indicated that the increase in total nitrogen during the composting process may be due to the loss in weight of composted materials and stimulation of N_2 fixers activity grown on the products of cellulose decomposition. In addition, gathering of some raw materials varied in chemical composition, and mixing them with organic manures and biofertilizers may lead to improve the nutritional status of produced compost particularly their nitrogen content

6- Changes in the content of total phosphorus and potassium:

The changes in content (%) of total phosphorus and potassium are presented in Tables (11 and 12). The obtained data showed a gradual increase in the potassium and phosphorus percentages during composting process intervals. In addition, total-K and P were higher in heaps amended with bio-inoculants (*Trichoderma* and *Bacillus*) or mixture of mature compost, animal manure and bio-inoculants than those in the unamended ones during composting. The superiority of enriched compost by these amendments could be due to the role of such amendments, particularly phosphate dissolving bacteria, in enhancing the decomposition of composted materials and caused further narrowing in C/P and C/K ratio which resulted in gradual decrease indicating more P and K. Generally total

K and P contents were increased at the end of the composting process (60 days) with average 1.35 and 1.72 % for total-K and total-P, respectively in all heaps. These increases were relatively against the continuous reduction of organic materials and consequently the reduction in weight of composted materials. These results are in agreement with those obtained by Abdel-All (2001) , who found that the phosphorus and potassium percentages were increased gradually compared with their figures at fresh manure.

Table (11): Changes in the content (%) of total phosphorus (%) of compost material during the composting process in different heaps.

Compost type	Total phosphorus (%)				
	Composting period (days)				
	0	15	30	45	60
A1	0.52	0.83	1.18	1.60	2.17
A2	0.50	0.75	1.09	1.27	1.89
A3	0.31	0.82	0.97	1.07	1.28
A4	0.59	0.94	1.13	1.35	1.52

Table (12): Changes in the content (%) of total potassium of composted material during composting process of different heaps.

Compost type	Total potassium (%)				
	Composting period (days)				
	0	15	30	45	60
A1	0.55	0.76	0.96	1.05	1.23
A2	0.34	0.49	0.76	0.96	1.08
A3	0.49	0.84	1.14	1.38	1.39
A4	0.57	0.88	1.14	1.52	1.72

Microbial Changes During Composting Process:

1- Changes in mesophilic, sporforming and thermophilic bacterial counts:

Data presented in Tables (13, 14 and 15) showed that, the initial numbers of mesophilic bacteria were slightly higher than those of sporforming and thermophilic species. Mesophilic total numbers ranged between 153.30 x 10^6 - 262.50x 10^6 cfu (colony forming units) / g dry weight, where as the numbers of spore forming and thermophilic bacteria ranged between 97.79- 138.57 x

10^5 and 50.00x 10^5 - 67.00x 10^5 cfu/g dry weight, respectively at the beginning of composting. Subsequently, with the rise in temperature (thermophilic phase), there was a rapid reduction in the total counts of mesophilic bacteria reaching 98.00 x 10^6- 133.00x 10^6 cfu/g dry weight at the 15^{th} day of composting in all heaps. The population of sporforming and thermophilic bacteria was maximized during the period from 15^{th} to 30^{th} day of composting for all heaps. Their total numbers ranged between 186.17-266.78x 10^5 and 91.30x 10^5 and 100.00 x 10^5cfu/g dry weight, respectively.

Table (13): Changes in total count of mesophilic bacteria during composting process of different heaps

Compost type	Mesophilic bacteria population x10^6cfug^{-1}dry compost.				
	Composting period (days)				
	0	15	30	45	60
A1	247.00	115.40	200.00	258.00	295.80
A2	153.30	98.00	131.48	178.70	294.50
A3	262.50	133.00	148.30	188.80	351.78
A4	183.64	105.00	156.60	203.26	226.53

Table (14): Changes in total counts of sporforming bacteria during composting process of different heaps.

Compost type	Sporforming bacteria population x10^5cfug^{-1}dry compost.				
	Composting period (days)				
	0	15	30	45	60
A1	138.57	196.00	240.56	144.47	105.00
A2	106.00	186.17	159.56	140.00	110.00
A3	115.00	266.78	282.14	182.00	156.00
A4	97.79	211.95	206.80	161.20	121.00

Table (15): Changes in total counts of thermophilic bacteria during composting process of different heaps.

Compost type	Thermophilic bacteria population x10^5 cfu/g dry compost.				
	Composting period (days)				
	0	15	30	45	60
A1	61.42	95.94	70.00	67.74	53.40
A2	67.00	100.00	80.43	80.00	56.00
A3	66.60	100.00	83.92	88.00	69.00
A4	50.00	91.30	84.69	60.20	48.00

Thereafter the total thermophilic bacterial counts decreased gradually towards the end of the composting process. As the temperature decreased during maturation phase, the mesophilic bacteria propagated rapidly and their total numbers increased to reach 226.53x 10^6 and 351.78x 10^6 cfu/g dry weight at the end of composting process. Generally, counts of mesophilic or thermophilic bacteria were highly affected by the changes in the temperature through different periods of composting process. These results are in agreement with those obtained by El-Housseini *et al.,* (2000) , who indicated that there were a remarkable increase in the counts of thermophilic bacteria at high temperature as the heaps becomes hotter while, the mesophilic microorganisms decreased. Moreover, the obtained results showed that both mesophilic and thermophilic bacteria had higher activity during all periods of composting process if compared with fungi. These results were agreed with those reported by Mohamed, (2006) and Al-Awlaqi (2007).

2- Changes in total fungal counts:

Changes in the numbers of total fungi during the composting process of various heaps are shown in Table (16). Initially the numbers of total fungi were slightly high as they ranged between 83.90 and 123.48 x 10^4 fp/g dry weight in all heaps. Subsequently, with the rise in temperature (thermophilic phase), there was a rapid reduction in the counts of total fungi that ranged between 33.00 – 56.89 x10^4 fp/g dry weight at the 15th day of composting in all heaps under this study.

As the temperature decreased during the decline and maturation phase, the total fungi proliferated rapidly and their number increased to reach 98.40 - 136.00 x 10^4 fp/g dry weight at the end of composting process. However, counts of mesophilic fungi gave higher numbers in the early periods than later stages of composting process which declared the vital role of fungi in breakdown of hard organic materials such as cellulose and hemicellulose. These results are in harmony with those reported by El-Hammady *et al.,* (2003) and Eweda *et al.,* (2007).

Table (16): Changes in counts of total fungi during composting process of different heaps.

Compost type	Total fungi 10^4 fp/g dry compost				
	Composting period (days)				
	0	15	30	45	60
A1	83.90	35.90	52.80	77.98	105.00
A2	87.78	33.00	49.44	68.18	98.40
A3	123.48	56.89	78.56	82.00	136.00
A4	94.00	44.70	46.00	64.48	103.98

Effect Of Compost On Growth And Productivity Of Pea Plants:

1- Plant height:

The maximum plant heights obtained with treatment 1 (75% compost + 25 mineral fertilizer) were 32.50 and 76.70 cm/plant, respectively, after 20 and 60 days of sowing, while their were 44.00 and 61.67 cm/plant respectively, after 40 and 60 days of sowing with treatment2 (75% compost + 25 mineral fertilizer) (Table 17). In contrast, application of treatment3 (100% compost and 75% compost + 25% mineral fertilizer) showed a minimum plant height after 20, 40 and 60 days of sowing compared to all other treatments. Application of treatment1 (75% compost +25% mineral fertilizer) significantly increased the plant heights compared to those treated with control (mineral fertilizer or commercial compost), as well as treatment1 (100% and 50% compost).

Table (17): Effect of application of different rates of rice straw compost and mineral fertilizer on plant heights and shoot dry weights.

parameters / Treatment	Plant height (cm/ plant)			Shoot dry weight (g/plant)		
	20 days	40 days	60 days	20 days	40 days	60 days
Mineral fertilizers	21.43de	31.93d	49.33b-e	4.62 ab	10.73d	17.60cd
A1 100%	27.00bc	36.00bcd	58.33abc	4.57 ab	12.13bcd	20.00a-d
A1 75%	32.50a	36.33bcd	76.70a	4.35 ab	13.97ab	21.10abc
A1 50%	24.47cd	34.50bcd	50.00b-e	4.98ab	11.60cd	17.86cd
A2 100%	29.07abc	32.33cd	53.67bcd	6.73 a	13.53abc	17.90cd
A2 75%	29.93ab	44.00a	61.67ab	6.46a	14.37ab	19.77bcd
A2 50%	24.00cd	35.00bcd	57.67abc	3.53ab	11.03d	19.60bcd
A3 100%	17.33e	31.00d	37.33de	3.08b	10.83d	16.40d
A3 75%	19.33de	30.33d	34.33e	3.10b	10.77d	16.20d
A3 50%	20.33cd	34.67bcd	40.33cde	3.42b	12.13bcd	18.57cd
A4 100%	19.50de	39.00abc	52.00b-e	4.86ab	13.37abc	23.80ab
A4 75%	27.00bc	36.33bcd	56.00bcd	5.65ab	14.90a	24.23a
A4 50%	21.40de	37.33a-d	48.33b-e	4.52ab	12.93bcd	19.90bcd
LSD 0.05	5.45	7.06	19.22	2.67	2.31	4.31

Compost A1= rice straw and animal manure. Compost A3= rice straw and bio-inoculants. Compost A2= rice straw and mature compost. Compost A4= rice straw, animal manure, mature compost and bio-inoculants.

In this regard, Chauhan *et al.,* (2010) found that plant height and growth of pea were significantly increased by application of vermin-compost 10t/ha and NPK. 27.5 : 60 : 50 kg/ha. Reddy *et. al.,* (1998) also recorded maximum plant height at harvest, days to first flowering and branches per plant with the application of vermin-compost – 10 t/ha and recommended dose of NPK 27.5:60:50 kg/ha in garden pea.

2- Shoot dry weights:

Data in Table (17) show that, dry weights per plant was significantly increased by addition of A1, A2 and A4 treatments (75% compost + 25% mineral fertilizer) after 40 and 60 days of sowing compared to control (mineral fertilizer). The maximum dry weights obtained with A1 treatment were 13.97 and 21.10g/plant after 40 and 60 days of sowing. In addition the dry weights for A2 treatment were 14.37 and 19.77g/plant. Application of A4 treatment showed also a similar trend of dry weights as they were 14.90 and 24.23g/plant. However no significant differences in shoot dry weights were seen between A3 (rice straw + bio-inoculant) (100%, 75% and 50% compost) and control (mineral fertilizer) after 20, 40 and 60 days of sowing (table 18).This increment in vegetative growth of pea plants by adding compost fertilizers may be due to the role of compost on improving the physical properties of soil and it contains a high level of nutrient elements, which are essentially required to plant growth. These results are in harmony with those reported by Awad (2002) and EL-Etr *et al.,* (2004). They reported that the vegetative growth of plant (plant height, number of leaves or branches as well as fresh and dry weight of plant organs) were increased by using compost as organic fertilizer application. EL-Desuki *et al.,* (2010) showed that all the vegetative growth parameters of pea (*Pisum sativum L*.) were significantly increased by increasing the levels of compost application from 100 up to 140 kg N/fed in a two growing seasons.

3- Number of branches:

It is quite evident from the data in Table (18) that pea branching was remarkably positively influenced by A1, 2 and 4 treatments (75% compost + 25% mineral fertilizer) as compared with control (mineral fertilizer or commercial compost). These treatments recorded the highest number of branches / plant as reached 4.33, 3.67 and 3.67 after 60 days of sowing. However, treatment3 (100% compost) gave the lowest number of branches /plant after 20, 40 and 60 days of sowing. This may be due to the great role of this rates (75% compost with 25% inorganic N-fertilizer) in increasing available nitrogen, phosphorus and potassium in soil. In this regard, EL-Desuki *et al.,* (2010) found that vegetative growth parameters were significantly increased by increasing the levels of compost application from 100 up to 140 kg N/fed in a two growing seasons of pea.

Table (18): Effect of application of different rates of rice straw compost amended with mineral fertilizer on number of branches and pods/plant of pea plants as compared with controls.

parameters / Treatment	No. of branches/ plant			No. of pods/ plant
	20 days	40 days	60 days	60 days
Mineral ferti.	0.67bcd	1.67bc	3.00abc	13.05de
A1 100%	1.00a-d	2.33ab	3.67ab	22.53bc
A1 75%	1.67ab	2.33ab	4.33a	29.28ab
A1 50%	1.33abc	2.67ab	3.33ab	21.33bc
A2 100%	1.00a-d	1.67bc	3.33ab	23.11bc
A2 75%	2.00a	3.00a	3.67ab	31.16a
A2 50%	0.67bcd	2.00abc	2.67bc	22.64bcd
A3 100%	0.00d	1.00c	1.67c	12.67de
A3 75%	0.33cd	1.00c	1.67c	11.34e
A3 50%	0.67bcd	1.67bc	2.33bc	15.24d
A4 100%	1.33abc	2.00abc	2.67bc	25.17b
A4 75%	2.00a	3.00a	3.67ab	29.30ab
A4 50%	1.00a-d	2.00abc	3.00ab	18.32cd
LSD 0.05	1.07	1.26	1.38	3.45

4- Number of pods/plant:

Data given in Table (19) indicated that 75% compost + 25% mineral fertilizer significantly increased the number of pods per plant compared to control (mineral fertilizer) and all other treatments. The A1, 2 and 4 treatments (75% compost plus 25% mineral fertilizer) recorded the highest number of pods /plant. However, treatment3 (100% compost) were the lowest. Use of inorganic fertilizer in addition to organic-fertilizer (compost) caused a significant increase in plant growth, yield and quality. Due to the improving the vegetative growth of pea plants are in turn on increasing green pods/plant in treatments1, 2 and 4. Fernández-Luqueño *et al.,* (2010) observed that the number of flowers and pods of bean (*Phaseolus vulgaris* L.) in the vermin-compost and high-sludge treatments was higher than in the control and urea treatments. EL-Desuki *et al.,* (2010) studied the effect of compost level application on total green pods yield and found that total green pods yield and its quality were gradually and significantly increased with increasing the level of compost application. Chauhan *et al.,* (2010) reported that, vermin-compost levels also influenced the number of pods per plant. The highest pod number was obtained with vermin-compost-15 t/ha + NPK 25:60:50 kg/ha.

Table (19): physico-chemical properties of the soil samples after pea harvesting.

Treatment \ Character		Total Nitrogen %	Available P (mg|kg)	Available K(mg|kg)
Control	N.P.K	0.053	8.31	19.72
Compost A1	100%	0.071	17.48	28.94
	75%	0.101	21.52	32.86
	50%	0.068	15.41	27.81
Compost A2	100%	0.087	18.46	29.93
	75%	0.104	22.56	33.87
	50%	0.064	16.37	28.79
Compost A3	100%	0.054	8.28	17.78
	75%	0.055	7.29	17.93
	50%	0.057	9.31	19.71
Compost A4	100%	0.061	16.51	27.88
	75%	0.086	19.54	30.84
	50%	0.058	14.46	26.77

Compost A1= rice straw and animal manure. Compost A2= rice straw and mature compost.
Compost A3= rice straw and bio-inoculants. Compost A4= rice straw, animal manure, mature compost and bio-inoculants.

Effect Of Application Of Composted Rice Straw On Soil Physicochemical Properties.

1- Soil nitrogen content:

Concerning the soil content (%) ofnitrogen content, data in Table (19) show a relative increase in soil nitrogen content due to the application of deferent levels of compost mixed with inorganic N-fertilization in comparison to control treatment. It is clear from the data that soil nitrogen was considerably affected by organic amendment and level of inorganic N-fertilizer. The highest soil nitrogen contents recorded in sandy soil amended with treatments1 and 2 (75% compost) and cultivated with pea plants were 0.101 and 0.104% respectively. These values were higher than those recorded for sandy soil treated with mineral fertilizers (control), which showed 0.53 for pea plants. These increases were proportional to the increase in compost application rate, composition of organic materials and the stimulating effect on atmospheric nitrogen fixation (Al-Awlaqi 2007).

It was also noticed that compost amendment in the presence of reduced doses of inorganic N-fertilizer show an increase in soil nitrogen content more than those received the full dose of inorganic N-fertilizer (control). These

results are in line with those obtained by El-Naggar *et al.,* (2005) Soumare *et al.,* (2003); and Al-Awlaqi (2007) who found that application of different kinds of organic materials to sandy, calcareous and clay soils resulted in increasing the soil nitrogen content.

2- Soil available phosphorus:

Data in Table (19) show that the highest values of available phosphorus; 21.52, 22.56 and 19.54 mg|kg were recorded in soil amended with A1, 2 and 4 treatments (75% compost) respectively, after its cultivation with pea plants. These treatments gave higher available phosphorus values than control treatment (mineral fertilizer) and all other treatments. In addition the lowest available phosphorus content was recorded for soil treated with control (mineral fertilizer) and A3 treatment (100% and 75% compost). These results are in agreement with those obtained by Mekail and Zanouny (1998) and Badran *et al*.(2000) who found that the addition of different kinds of organic materials to sandy , calcareous and clay soils significantly increased the availability of phosphorus. They explained the increase in available P to the production of CO_2, formation of H_2CO_3 and production of organic acids during organic matter decomposition, which contributes to phosphate solubility. Similar results were obtained by El-Naggar *et al*. (2005) and Soumare *et al*. (2003), who reported that application of compost improved soil available phosphorus.

3- Soil available potassium:

Data in Table (19) show a relative increase in the soil content (mg|kg) of available potassium due to the application of different levels of compost mixed with inorganic N-fertilization in comparison to control treatment. The highest content of soil available potassium recorded in sandy soil amended with A1 and 2 treatments (75% compost) were 32.86 and 33.87 mg|kg for soil cultivated with pea plants. These values were higher than those recorded for sandy soil treated with mineral fertilizers (control), which showed 19.72 mg|kg for pea plants, respectively. Such increases were proportional to the increase in compost application rate and composition of organic materials (Al-Awlaqi 2007). These results are agreed with those obtained by Soumare *et al.,* (2003) ; Mekail and Zanouny (1998) and Badran *et al.,* (2000) , who found that, the addition of different kinds of organic materials to sandy, calcareous and clay soils significantly increased the availability of potassium.

4- Rates of CO_2 evaluation:

The trend of CO_2 evolution was similar to the recorded densities of total microbial flora at all period of study and being maximized after 40 days of sowing of pea (Table 20). Addition of the three rates of compost for pea

plants enhanced the rates of CO_2 evolution compared to mineral fertilizer (control). There were also narrow differences of CO_2 evolution between treated tested plants. The highest values of CO_2 evolution were found in A1, 2 and 4 treatments (75% compost + 25% mineral fertilizer) as they were 57.07, 67.47 and 57.04 mg/100g dry soil for pea. Carbon dioxide production is a direct indicator of microbial activity, and indirectly reflects the availability of organic material (Gomez *et al.,* 2001 and Ferreras *et al.,* 2006). Application of organic compost stimulated in general soil microbial respiration, as reported by Marinari *et al.,* (2000) , who explained their results as probably due to a synergic effect of soil and amendment microorganisms or to a stimulation of microbial growth by organic substrates added with the amendments. Despite this amendment exhibiting the highest organic carbon content in its composition, a lower soil organic carbon content were found in plots amended with A3 treatment.

Table (20) CO2 evolution rates from rhizosphere soil of pea plants as influenced by application of different rates of composted rice straw.

Treatments		Time (days)		
		20	40	60
		CO_2 mg/100g dry soil		
Control	Inorganic	12.89	40.39	25.25
Compost A1	100%	36.12	44.80	32.71
	75%	40.52	57.07	48.33
	50%	24.25	40.30	30.45
Compost A2	100%	30.95	52.04	43.20
	75%	38.16	67.47	55.40
	50%	32.33	41.61	34.25
Compost A3	100%	26.71	47.12	40.59
	75%	26.28	49.00	35.68
	50%	21.27	47.93	41.20
Compost A4	100%	37.63	51.91	41.66
	75%	38.28	57.04	46.48
	50%	25.78	51.61	37.05

Compost A1= rice straw and animal manure, Compost A2= rice straw and mature compost. Compost A3= rice straw and bio-inoculants. Compost A4= rice straw, animal manure, mature compost and bio-inoculants. C. compost*= commercial compost.

The results of this study proved that composting of agricultural wastes such as rice straw, increased its agronomic effectiveness and reduced the pollution problem associated with these wastes. Also, the compost proved to be effective agents in reclaiming sandy soils through improving soil chemical properties and reduced the reliance on chemical fertilizers and consequently decreases the cost of crops production.

REFERENCES

Abdel-All, M.H. (2001). The influence of some food industrial wastes on some soil properties and plants growth. M. Sc. Thesis, Fac. of Agric., Al-Azhar Univ., Egypt.

Abdel-Wahab, A.F.M. (1999). Iron-zinc-organic wastes interactions and their effects on biological nitrogen fixation in newly reclaimed soils. Ph.D. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

Abdel-Wahab, A.F., A.M. Biomy and W.M. Farghal (2003). Effect of some natural soil amendments on biological nitrogen fixation, growth and green yield of pea plants grown on sandy soils. Fayoum J. Agric. Res. And Environ., 17: 2, 47-54.

Abo–Sedera, S.A. (1995). Biological and chemical studies on organic wastes decomposition. Ph.D. Thesis. Fac. Agric., Al–Azhar Univ., Egypt.

Abou El-Naga, S.A.; M.M. El-Shinnawi; A.S. El-Shimi and M.A. Badawi (1997). Changes in the physico-chemical properties of biological wastes during compost processing under aerobic conditions. Egypt j. Soil Sci., 37 (1): 1-16.

Ahmed. M.A. (2001). Dictionary of the fungal terminology. Academic Book shop. 230-231.

Al-Awlaqi, M.M.S. (2007). Microbial and chemical changes during compost production from organic wastes. Ph.D. thesis, fac. Agric., Ain Shams Univ. Egypt, 88-90.

Alef, K. and P. Nannipieri (1995). Methods in applied soil microbiology and biochemistry. Academic Press. Harcourt Brace and Company Publishers, London, 214-217.

Ali, M., A.J. Griffiths, K.P. Williams and D.L. Jones (2006). Vermi-composting enhancing the quality of compost derived from green waste 21st International Conference on Solid Waste Technology and Management, Philadelphia, USA, Journal of Solid Waste Technology and Management 667-680.

Allam, E.H. (1999). Studies on production of Organic fertilizers from some sugar crops wastes and their effects on reclamation of sandy soil. M. Sc. Thesis, Fac. of Agric., Moshtohor, Banha branch, Zagazig Univ., Egypt.

Awad, E.M. (2002). Effect of compost and some bio-fertilizers on growth, yield and quality of potato crops (*Solanum tubersum,* L.). J. Agric. Sci, Mansoura, Univ., 27(8): 5525 - 5537.

Badran, Nadia M., M. E. A. Khalil and M. A. A. El-Emam (2000). Availability of N, P and K in sandy and clayey soils as affected by the addition of organic materials. Egypt. Journal of Soil Science, 40:265-283.

Baeta-Hall, L.; M.C. Sàágua; M.L. Bartolomeu and M. Anslemo (2005). Bio-degradation of olive oil husks in composting acrated piles. Bioresource Technology. 96: 69-78.

Beck-Friis, B., S. Smars, H. Jönsson, Y. Eklind and H. Kirchmann (2003). Composting of source-separated household organics at different oxygen levels: Gaining an understanding of the emission dynamics. Compost Science & Utilization, 11: 41-50.

Bernal, M.P., C. Paredes, M.A. Sunchez-Monedero and J. Cegarra (1999). Maturity and stability parameters of compost prepared with a wide range of organic wastes. Bioresource Technology, 63:91-99

Bremmer, J.M. and C.S. Mulvaney (1982). Nitrogen-total. In: Methods of soil analysis, (Eds.): A.L. Page, R.H. Miller and D.R. Keeney. Part 2. Am. Soc. Agron. Madison, WI. 9: 595-624.

Bustamante, M.A., C. Paredes, R. Moral, E. Agullo, M.D. Perez-Murcia and M. Abad (2008). Composts from distillery wastes as peat substitutes for transplant production, Resour. Conserv. Recycl. 52: 792–799.

Chauhan, H.S., S.C. Joshi and D.K. Rana (2010). Response of vermin-compost on Growth and Yield of Pea (*pisum sativum* L.) cv. Arkel. Nature and Science, 8(4): 18-21.

Clark, F.E. (1965). Agar plate Methods for Total Microbial Count in Methods of soil analysis, Part2. Agronomy, Am. Soc. Of Agron. Inc, Madison, Wis., USA., 1460-1466.

Cottenie, A. (1980). "Soil and plant testing" FAO soils Bulitin Rona.

Cottenie, A., M. Verloo, L. Kikus, G. Velghe and R. Camerlynck (1982). Analytical problems and methods in chemical plant and soil analysis. Gent. Belgium.

EL-Desuki, M., Hafez Magda M., Mahmoud Asmaa R. and Abd El-Al Faten S. (2010). Effect of organic and Bio fertilizer on the plant growth, green pod yield, quality of pea. Inte. J. Agric. Res. 2.(1): 87-92.

El-Etr, W.T., L.K.M Ali and E.I El-Khatib (2004). Comparative effects of bio-compost and compost on growth, yield and nutrients content of pea and wheat plants grown on sandy soils. Egyptian Journal of Agricultural Research., 82(2(Special Issue)): 73-94.

El-Hammady, A.M., A.F. Abo-Hadid, S. M. Selim, H.I. El-Kassas and R. Negm (2003). Production of compost from rice straw using different accelerating amendments. J. Environmnetal Science, 6(3):891-910.

El-Housseini, M., Soheir S. Fahmy and E.H. Allam (2000). Co-composting production from agricultural wastes and sewage sludge. Proceedings of the 10 th Microbiology Conference, 11-14 Nov., Cairo, Egypt, pp. 295-315.

El-Naggar, I.M., Sanaa A. Othaman, A.M. Hanna and A.M.M. Shehata (2005). Effect of bio and / or mineral nitrogenous fertilizers on maize and wheat

crops production and soil fertility. Journal of Agric. Science Mansoura Univ., 30 (20):1297-1306.

Eweda, Wedad E., Sh. M. Selim, M.I. Mostafa and D.A. Abd El-Fattah (2007). Use of *Bacillus circulans* as bio-accelerator enriching composted agricultural wastes I- Identification and utilization of microorganisms for compost production. Twelfth Conference on Microbiology, Cairo, 18-20 March 2007, In press.

Fernández-Luqueño, F., V. Reyes-Varela, C. Martínez-Suárez, G. Salomón-Hernández, J. Yáñez-Meneses, J.M. Ceballos-Ramírez and L. Dendooven (2010). Effect of different nitrogen sources on plant characteristics and yield of common bean (*Phaseolus vulgaris* L.). Bioresource Technology., 101: 396–403.

Ferreras L.E., E. Gomez, S. Toresani, I. Firpo and R. Rotondo (2006). Effect of organic amendments on some physical, chemical and biological properties in a horticultural soil. Bioresource Technology., 97:635–640.

Golueke, C.G. (1972). In: Emmaus, (Ed.), Composting: A Study of the Process and its Principles. Rodale Press, PA, p. 110.

Gomez, E., L. Ferreras, S. Toresani, A. Ausilio and V. Bisaro (2001). Changes in some soil properties in a Vertic Argiudoll under short term conservation tillage. Soil Till. Res. 61: 179-186.

Hafez, Magda and Mahmoud Asmaa R. (2004). Response of snap bean (*Phaseolus vulgaris* L.) to nitrogen fertilizer source. Annals of Agric. Sci., Mashtohor, 42(1): 261-270.

Ishii, K., M. Fukui and S. Takii (2000). Microbial succession during a composting process as evaluated by denaturing gradient gel electrophoresis analysis. J. Applied Microbiology, 89: 768– 777.

Jackson, M.L. (1973) Soil chemical analysis. Prentice-Hall, Inc., England, Cliffs, pp. 38-326.

Khan, E., S. Khaodhir and D. Ruangrote (2009). Effects of moisture content and initial pH in composting process on heavy metal removal characteristics of grass clipping compost used for storm water filtration. Bioresource Technology, 100: 4454–4461.

Lee, J.J., R.D. Park, Y.W. Kim, J.H. Shim, D.H. Chae, Y. Rim, B. Sohn, T.H. Kim and K.Y. Kim (2004). Effect of food waste compost on microbial population, soil enzyme activity and lettuce growth. Bioresource Technology, 93: 21 – 28.

Marinari, S., G. Massciandaro, B. Ceccanti and S. Grego (2000). Influence of organic and mineral fertilizers on soil biological and physical properties. Bioresource Technol., 72:9-17.

Mekail, M.M. and I. Zanouny (1998). Evaluation of some natural organic wastes as amendments for virgin coarse textured soils. II. Residual effect of filter mud (press mud) and nitrogen application on some soil properties and yield of fodder maize. Jo. Agric. Sci., Mansoura Univ., 23: 6295-6307.

Mekail, M.M., M.A. Morsy, S.M. Abdel-Aziz and M.B. Taha (2000). The effect of some composted plant residues on improving the productivity of sandy soil. Minia Journal of Agricultural Research & Development, 20(2): 377-392.

Mohamed, Dalia A.M. (2006). A study of Role of *Bcillus circulans* in bio-organic agriculture. M.Sc. Thesis. fac. Agric., Ain Shams Univ. Egypt, 68-74.

Namkoong, W. and E.Y. Hwang (1997). Operational parameters for composting night. Compost Sci., 5 (4), 46-51.

Nancy, K. and S.M. Tom (1997). Laboratory determination of compost physical parameters for modeling of airflow characteristics. Waste Manag., 28(3):660-667.

Othman, S.A., A.M.M. Shehata and I.M. El-Naggar (2005). Effect of rice straw compost and N-fertilization on maize production and some soil physical properties. Minufiya J. of Agri. Research, 30(6): 1853-1863.

Paredes, C., M.P. Bernal, J. Cegarra and A. Roig (2002): Bio-degradation of olive mill wastewater sludge by its co-composting with agricultural wastes. Bioresource Technology, 85, 1–8.

Pedro, J. V., G. Curaqueo, A. Seguel, K. Manzano, R. Rubio, P. Cornejo and F. Borie (2009). Effect of compost application on some properties of a volcanic soil from central south chile. Chilean journal of Agricultural research, 69(3):416-425.

Pramer, D. and E.L. Schmidt (1964). Experamental soil microbiology. Burgen Publishing Company, Minnesota, USA,.

Reddy, R., M.A.N. Reddy and Y.T.N. Reddy (1998). Effect of organic and inorganic sources of NPK on growth and yield of pea. Legume Res., 21 (1): 57-60.

Ryckeboer, J., J. Mergaert, J. Coosemans, K. Deprins and J. Swings (2003). Microbiological aspects of biowaste during composting in a monitored compost bin. J., Applied Microbi., 94: 127–137.

Rynk, R., M. van de Kamp, G.B. Willson, M.E. Singley, T.L. Richard, J.J. Kolega, F. Gouin, L. Laliberty, Jr.; D. Kay, D.W. Murphy, H.A.J. Hoitink and W.F. Brinton (1992). On farm composting handbook (ed.) M. Sailus, Natural Resource, Agriculture and Engineering Service, Ithaca, New York. USA. pp. 12-58.

Shehata, S.M. (1972). Evolution of some Biological Tests as Parameters for Microbial Activities Related to Soil Fertility. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt, 173.

Snedecor, G.W. and W.G. Cochran (1980). “Statistical Methods”. 7th Ed., Iowa State Univ. Press, Amr., USA, pp. 255-269.

Sodhi, G.P.S., V. Beri and D.K Benbi (2009). Soil aggregation and distribution of carbon and nitrogen in different fractions under long-term application of compost in rice-wheat system. Soil-and-Tillage-Research, 103(2): 412-418.

Soumare, M., F.M.G. Tack and M.G. Verloo (2003). Effect of municipal solid waste compost and mineral fertilization on plant growth in two tropical agricultural soils of Mali. Bioresource Technology, 86: 15-20.

Venglovsky, J., N. Sasakova, M. Vargova and Z. Pacajova (2005). Evolution of temperature and chemical parameters during composting of the pig slurry solid fraction amended with natural zeolit. Bioresources Technology, 96: 181-189.

Walkley, A. and I. R. Black (1934). An Examination of the Degtijarelf for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Sci., 29: 37.

Wong, J.W.C., K.F. Mak, N.W. Chan, A. Lam, M. Fang, L.X. Zhou, Q.T. Wu and X.D. Liao (2001). Co-composting of soybean residues and leaves in Hong Kong. Bioresource Technology.16: 99-106.

التغيرات التي تحدث أثناء كمر المخلفات العضوية وتقييم تأثير اضافة الكمبوست علي نمو نباتات البسلة وخصائص التربة

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الملخص العربي

تم دراسة التغيرات الميكروبيولوجية والكيميائية التي تحدث خلال عمليات كمر نسب مختلفة من قش الارز مع سبلة الحيوان والكمبوست الناضج وتأثيرة علي نمو نباتات البسلة وعلى بعض خصائص التربة. وقد أوضحت النتائج زيادة في العدد الكلي للبكتيريا الميزوفيلية (المحبة لدرجة الحرارة المتوسطة) في بداية عملية الكمر (٠ – ١٥ يوم) وأيضا في النهاية (٤٥ – ٦٠ يوم) كم وجد كذلك زيادة فى العدد الكلي للبكتيريا المتجرثمة والمحبة للحرارة المرتفعة (الثرموفيلية) في الفترة من ١٥ – ٣٠ يوم من عملية الكمر. ولوحظ ايضاً إنخفاض في نسبة الكربون للنتروجين وانخفاض الكربون العضوي وزيادة في النتروجين والفوسفور والبوتاسيوم N,P,K . وبوصول الكمبوست إلي مرحلة النضج بعد ٦٠ يوم كان غني بالمادة العضوي والعناصر المعدنية التي كانت تتصف بدرجة عالية من الثبات. وعند اضافة الكمبوست الناتج من عملية الكمر بنسبة ٧٥% كمبوست + ٢٥% سماد معدني الى التربة المزروعة بنبات البسلة، وجد أن هناك زيادة معنوية في نمو وإنتاجية نباتات البسلة وتحسن في خواص التربة الكيميائية والبيولوجية التي درست .

وقد اظهرت هذة الدراسة بوضوح فائدة الكمبوست واوضحت إمكانية إستمرار تطبيقة في زراعة البسلة من خلال تدوير المواد العضوية المتاحة محلياً.