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Original Research Article

Changes in Compost Physical and Chemical Properties during Aerobic Decomposition

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A B S T R A C T

Composting is a biological reduction of organic material to humus; it is made from residues of plants and/or animals that are piled, moistened and allowed to decompose.Bacteria, insects and worms in the pile help this break down.During the first semester of 2013/2014; a compost pile with about 1.7 m X 5 m X 5 m height, width and length, respectively, was prepared by piling together multi layers of 1:1 ratio of sheep manure with available plant residues (annual weeds), and some soil from the experimental field. Decompositionwas completed when the temperature in the pile drops to the temperature of the surrounding.Results obtained showed that suitable temperature, moisture and acceptable levels of EC were recorded during the compost decomposition process. Compost pH was changed to be acidic at the end of the process. O.M content, total N, available P and K was decreased during the decomposition period, but very high amounts of available K were observed at the end of the decomposition period.

Keywords

Compost, Decomposition Pile, Organic Matter

Introduction

Composting is part of the earth's biological cycle of growth and decay. When plants die, it decompose through a complex process involving microorganisms and macro-organisms. In addition, the humus remaining from this decay process provides soil with organic ingredients which can hold water and nutrients in the soil, evident by improving its structure, providing essential nutrients to soil and carbon dioxide back healthy, and productive environment for plants to grow and thrive (W. S. U., 2004).

During the preparation of composting, animal manure should be mixed with plant residuals to adjust the C: N ratio to be around 30:1 (Preusch *et al.*, 2004). Compost is ready to use when the temperature in the pile drops to the temperature of the surrounding air in addition to earthy smell.

For instance, when the pile starts to resemble dark soil, crumbly, full of manure worms and its pH is around 6-7.5. (M. O. A., 2002; Seeds, 2004).

Nutrient value of composts varies widely, depending upon the nature of feedstock composted.If the initial material contains manure, it will be richer in nitrogen and other nutrients and the chemical characteristics of most finished composts are as follows (based on percentage by weight): organic matter: 25-50, carbon: 8-50, nitrogen: 0.4-3.5, phosphorus (as P_2O_5): 0.3-3.5, potassium (as K_2O): 0.5-1.8, and calcium (as CaO): 1.5-7.0, according to W. S. U. (2004).

Compost means to put together the correct amounts of compostable materials to make a great soil amendment. It is the biological reduction of organic material to humus; it is made from residues of plants and/or animals that are piled, moistened and allowed to decompose, and bacteria, insects and worms in the pile (Raabe, 2004) help this break down.

Thousands of years are required for the earth to build good soil.We can help do this in 5 – 10 years by adding compost—which adds humus to the soil that maintain soil productivity, supply plant nutrients, and help in combination with biological pest control to destroy insects, weeds, and other pests (Ames and Kuepper, 2000, and Ames *et al*., 2003). Compost contains valuable nutrients that could replace and/or supplement use of commercial fertilizers by homeowners (Bot and Benites, 2005). Composting is very suitable for drier areas where crop residues decompose very slowly in the field, in this situation composting provides greater yields for the farmer (Palm and Sanchez, 1990). This study aiming to follow and understand the changes in the chemical properties of the compost during aerobic decomposition.

Materials and Methods

Description of the study area

Al-Balqa' Applied University is a government-supported university located in Salt, Jordan. Salt is famed in Jordan for its fertile soil and the quality of its fruit and vegetable harvests, particularly olives, tomatoes, grapesandpeaches. It is on the old main highway leading from Amman to Jerusalem. Situated in the Balqa highland, about 790–1,100 meters above sea level, the town is built in the crook of three hills, close to the Jordan Valley. One of the three hills, (Jebal Al Qala'a), is the site of a 13th-century ruined fortress. It is the capital of the Balqa Governorate, Figure 1.

The Salt area has a predominantly Mediterranean type climate, characterized by hot dry summers and cool to cold wet winters. As in most semi-arid areas, temperatures exhibit large seasonal and diurnal variations, with absolute daily temperatures ranging from a maximum of around 45 °C in August to –5 °C in January. The average maximum temperature ranges from 12 °C in January to about 33 °C in August.Annual precipitation decreases westwards from over 600 mm to less than 150 mm in the extreme west, Figure 2 (a and b)while the average monthly rain fall ranges from less than 20 mm in May to more than 55 mm in January. Towards the end of winter season, thunderstorms are often associated with unstable air at higher altitudes.

Compost preparation

During the first semester of 2013/2014a compost pile with about 1.7 m X 5 m X 5 m height, width and length, respectively, was prepared according to Preusch *et al*. (2004) recommendations. This work is carried out at Al-Balqa Applied University-As-

Salt/Jordan location, by piling together multi layers of 1:1 ratio of sheep manure with available plant residues (annual weeds), and some soil from the experimental field; soil was used between layers to aid the earthworms and humus formationas recommended by Seeds (2004).

Water was added to moisten the layers (which were maintained at around 50 % relative humidity), and then the pile was covered with clear plastic mulch to avoid heat and moisture loss, and to prevent flies from laying eggs (Inckel *et al.*, 2005).

To maintain aerobic decomposition of the organic matter to stable humus, the pile was turned every 10 days to supply oxygen, which is required for microorganism's respiration, and water was added to the pile when necessary.Decompositionwas completed by the end of the semester (after 50 days).When the temperature in the pile drops to the temperature of the surrounding air in addition to earthy smell and when the pile starts to resemble dark soil,the plastic mulch was then removed and the pile turned and exposed to sun and air for five days, in order to reduce moistureaccording to Seeds (2004) recommendations.

Parameters measured:

Every ten days during compost decomposition; a three organic matter samples were taken from different sites and depths for chemical analysis or measurements. The samples were air dried or oven dried, depending upon the analysis requirements, grinded by Wiley Mill and passed through a 2-mm mesh size screen prior to their use in the laboratory as recommended by Preusch *et al*. (2004), and the average readings were recorded for the three samples each time of analysis. The following parameters were measured or analysed for the compost:

pH: Was measured in 1: 5 (w/v) compost-water suspension, using a Glass Electrode pH-Meter (Inolab pH level, D-82362, Weilheim, Germany) as recommended by Mc Lean (1982).

Total soluble salts: Were measured for compost in 1:5 (w/v) compost-water suspensions, by using Electrical Conductivity (EC) Meter (Jenway, Conductivity Meter 4310, Italy) to obtain EC in mille Siemens per centimetre (mS/cm) (Rhoades, 1982).

Total nitrogen (N) percentage: Was determined by using micro Kjeldahl method (Kjeldahl Digestion: Tector, Digestion system 40 1016, Germany, and Kjeldahl Distillation: Gerhardt, Vapodest-Germany) (Bremner and Mulvaney, 1982).

Available phosphorus (P): Was extracted by 0.5 N $NaHCO_3$ with pH of 8.5 with Spectrophotometer (Varian, Carry 100 Conc, CaryWinsoftware, Australia) (Olsen and Sommers, 1982).

Available potassium (K): Was extracted by 1 N ammonium acetate determined by Flame Photometercally (Corning Flame Photometer 410, serial No.2124, U. K.) (Knudsen *et al*., 1982)**.**

Total organic matter (O.M.) percentage: Was determined by using potassium dichromate wet digestionmethod (Schnitzer, 1982).

Temperature: Was measured each time for the pile, directly after removing the plastic cover and removing about 20 cm of the upper part of the pile, using a thermometer.

Humidity: Compost samples below 20 cm depth were taken, and weighed using a digital scale balance, then placed into Petri dishes to facilitate and fasten their drying to a constant weight at 105 °C for 48 hours, and then the percentage of humidity was calculated using the following equation:
Humidity % =[(fresh weight – dry weight) ⁄ fresh weight] X 100

Experimental design and statistical analysis:

A completely randomized design (CRD), with six treatments (days) and three replicates were used. All data obtained were statistically analysed by variance, according to the procedure outlined by Steel and Torrie (1980). The differences between means of the different treatments were compared by the Least Significant Difference (LSD) test using SAS software, and differences with probability value at $P = 0.05$ were considered significant.

Results and Discussion

Temperature

During the decomposition period; it's observed that temperature was initially startedfrom 25 ºC at zero time, then started to increase and reached the maximum (30 ºC) after 30 days from the start of the decomposition period (Table 1), after that a decline in temperature was recorded and ended with 24 ºC after 50 days of the start of decomposition.It means that, once the temperature started to increase, compost decomposition was started and the pile reached the peck of the decomposition after 30 days of starting the experiment, then a decline in decomposition occurred once temperature started to decrease and ended after 50 days which recorded the lowest temperature (24 ºC).

Moisture

Moisture was decreased after 10 days of the start of decomposition (Table 1). This is due to the consumption by the microorganisms.But once that observed, a lot of water will be added, because the optimum moisture should be around 50 % for decomposition, then water percentage was observed around 40 % during the decomposition period and reached the lowest at the end of the decomposition period (50 days).

pH.

An alkaline compost was recorded with 8.38 pH (Table 2), then during the decomposition period, it starts to decrease and the pile become acidic (6) once the decomposition was ended.

Electrical Conductivity (EC)

The highest "EC"was measured at the initial time of decomposition, but with an acceptable medium soluble amount(Table 2); also during the decomposition period the EC was observed to decrease and reached the lowest (0.75 mS/cm) at the end of the experiment.

Organic Matter (O.M.)

High amounts of organic materials was measured with 29 % at the beginning of the experiment (Table 2), then during the decomposition it starts to decrease due to the consumption by the microorganisms, and become lower than 12 % at the end of the decomposition period.

Nitrogen (N)

The highest total"N"percentagewas observed at the beginning of the decomposition period with about 2.6 % (Table 3), once the decomposition started; nitrogen was started to decrease due to the consumption by the decomposers, and the lowest available “N” amount (0.65 %) was measured at the end of the experiment(50 days).

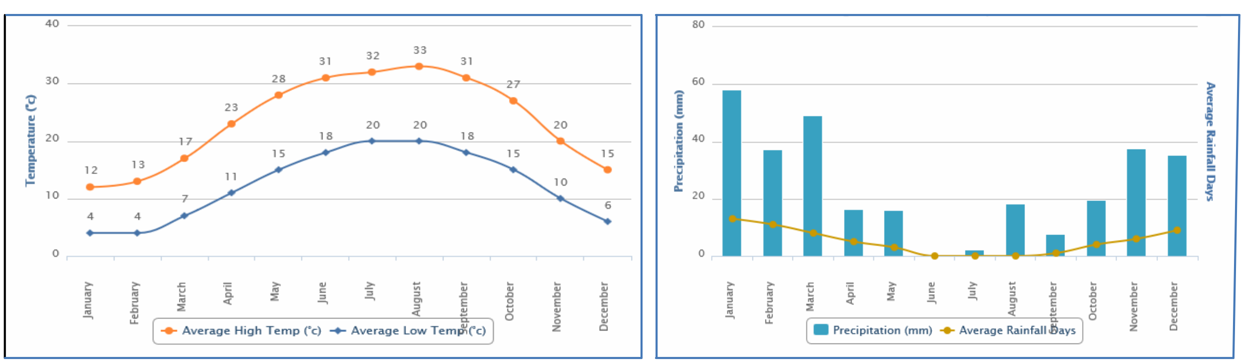
Phosphorus (P)

A low amount of available “P” was determined at zero time (67 ppm) (Table 3), that stats to decrease with time during the decomposition process, and reached the lowest significant amount at the end of the decomposition, due to the feeding by the microorganisms.

Potassium (K)

A very high significant amounts of available “K” was measured at the beginning of the treatments (Table 3), then it starts to decrease during the decomposition process, but it remains very high at the end of the decomposition period with 3640 ppm.

Figure.1 Location Map of the Study Area



(a) **(b)**

Figure.2 Average Maximum and Minimum **(a)** and Average Rainfall and Average Rainfall Days at Salt Station **(b)**

Table.1 Results of compost temperature and moisture measurements during the decomposition period*

Treatments (days)	Temperature (Cº)	Moisture (%)
0	25.1 bc**	45.9 b
10	28.2 ab	23.7 d
20	30.2 a	53.3 a
30	27.3 abc	42.8 bc
40	26.2 bc	40.0 bc
50	24.1 c	37.3 c
$LSD_{0.05}$	3.24	5.94

*: Values are the mean of three replicates.
**: Means followed by the same letter are not significantly different at 0.05 probability level.

Table.2 Results of compost pH and EC measurements, and organic matter percentage during the decomposition period*

Treatments (days)	pH	EC (mS/cm)	O. M. (%)
0	8.38 a**	2.54 a	29.5 a
10	8.34 a	1.65 b	26.6 a
20	8.01 a	1.48 b	16.3 b
30	7.18 b	0.85 c	12.6 b
40	7.2633 b	0.8800 c	12.6 b
50	6.0200 c	0.7500 c	11.4 b
$LSD_{0.05}$	0.7	0.25	5.3

*: Values are the mean of three replicates.
**: Means followed by the same letter are not significantly different at 0.05 probability level.

Table.3 Results of compost total N, available P and K analysis during the decomposition period*

Treatments (days)	N (%)	P (ppm)	K (ppm)
0	2.57 a**	67.3 a	5187 a
10	2.33 a	57.3 b	4840 ab
20	1.67 b	40.7 c	4700 bc
30	1.35 bc	33.7 cd	4360 c
40	1.15 c	29.4 d	3887 d
50	0.65 d	29.5 d	3640 d
$LSD_{0.05}$	0.34	7.3	360

*: Values are the mean of three replicates.
**: Means followed by the same letter are not significantly different at 0.05 probability level.

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References

Ames, G.K., Kuepper, G. 2000. Overview of organic fruit production. NCAT agriculture specialists, ATTRA. http://attra.ncat.org/attra-pub/PDF/fruitover.pdf

Ames, G., Born, H., Guerena, M. 2003. Strawberries: Organic and IPM options. NCAT agriculture specialists, ATTRA. http://attra.ncat.org/attra-pub/PDF/strawberry.pdf

Bot, A., Benites, J. 2005. The Importance of Soil Organic Matter, Key to Drought-Resistant Soil and Sustained Food Production. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/009/a0100e/a0100e.pdf

Bremner, J.M., Mulvaney, C.S. 1982. Nitrogen-total. In: Miller, R.H., Keeney, D.R. (Eds), Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, (2nd Edn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin, USA.

Inckel, M., Smet, P., Tersmette, T., Veldkamp, T. 2005. The Preparation and Use of Compost. Agromisa Foundation, Wageningen, Netherlands.

Knudsen, D., Peterson, G.A., Pratt, P.F. 1982. Lithium, sodium, and potassium. In: Miller, R.H., Keeney, D.R. (Eds), Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties (2nd Edn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin, USA.

M. O. A. (2002). Biological compost activator product. Microtack Organic Aquaculture and Wastewater Treatment Supplies. Retrieved September 15th, 2004, from: http//:www.microtack.com/html/compost_evaluating.html

Mc Lean, E.O. 1982. Soil pH and lime requirement. In: Miller, R. H., and Keeney, D. R. Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. (2nd Edn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin, USA.

Olsen, S.R., Sommers, L.E. 1982. Phosphorus. In: Miller, R. H., and Keeney, D. R. Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. (2nd Edn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin, USA.

Palm, C.A., Sanchez, P.A. 1990. Decomposition and nutrient release patterns of the leaves of three tropical legumes. *Biotropica,* 22: 330–338.

Preusch, P.L., Takeda, F., Tworkoski, T.J. 2004. N and P uptake by strawberry plants grown with composted poultry litter. *Sci. Hort.,* 102: 91–103. www. elsevier. Com /locate/scihorti

Raabe, R. 2004. The rapid composting method. Vegetable Research and Information Center. University of California. http://vric.ucdavis.edu/pdf/compost_rapidcompost.pdf

Rhoades, J.D. 1982. Soluble salts. In: Miller, R.H., Keeney, D.R. (Eds) Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. (2ndEdn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin, USA.

Schnitzer, M. 1982. Organic matter characterization. In: Miller, R. H., and Keeney, D. R. Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, (2ndEdn). American Society of Agronomy, Inc., Publisher, Madison, Wisconsin.

Seeds, p. 2004. Compost making. Retrieved September 15th, 2004, http//:www.primalseeds. org/compost.htm

Steel, R.G.D., Torrie, J.H. 1980. Principles and Procedures of Statistics, 2nd edn. McGraw-Hill, New York.

W. S. U. 2004. Compost fundamentals. Washington State University (WSU) Whatcom County Extension. Retrieved September 15th, 2004, from:http//:whatcom.wsu.edu/ag/co mpost/fundamentals.