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Recycling of cotton stalks with rice straw to compost as friendly technology to the environment

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ABSTRACT

Two aerobic trapezoidal heaps of compost were practiced to investigate the value of bio-enrichment of chopped plants residues (cotton stalks and rice straw) through inoculation the mixture of these residues and some organic and mineral amendments with lignocellulytic fungi during the active composting in relation to their capacity to accelerate lignocellulose degradation. Also, some plant growth promoting rhizobactria were applied to the composted materials at maturity stage to study their ability to improve the biological and nutritional quality of the produced compost. Results of monitoring the composting process exerted that the physico-chemicals and microbiological properties of the composted materials were developed with progressing of the process until 90 days. However, bio-enriched heap exhibited more acceleration than unenriched one with regard to reduce the organic carbon and C/N ratio. In addition, the maturity indices exerted acceptable values for generation index, CO_2 – evolution, dehydrogenase activity and ratio of NH^{+}_{4}/NO^{-}_{3} as an indicator to nitrification process.

INTRODUCTION

Cotton is one of the important strategic crops in Egypt and plays a major role in the Egyptian economy, as it is an important source of raw material in the manufacture of cotton textiles exported to the entire world, as well as being a source for the production of plant oil. Cotton stalks produced as a by product of post-harvest with large quantities of tens of thousands of tons annually, causing many problems such as: the farmer storing it on the roofs of the houses, causing fires when the wind coming or disposed from it by burning, causing significant environmental problems, which lead to spread of many diseases, on the other hand, cotton stalks contain eggs and larvae of pink boll worm, which remain dormant until cultivating the next crop, causing serious damage on the cotton crop.

Composting is one of the technologies of integrated waste management strategies used for the recycling of organic materials into useful product. Composting is defined as biological decomposition and stabilization of organic substrates under conditions, which allow development of thermophilic temperature as a result of biologically produced heat, with a final product sufficiently stable for storage and application to land without adverse environmental effects (Haug, 1993). This highly complex biological process includes many species of bacteria, fungi and actinomycetes, which convert a low value of bio-wastes such as materials generated by agriculture, food processing, wood processing, and sewage treatment industrial and municipal wastes into highly value products.

Lignocelluloses, the most abundant compound in agricultural wastes, are recalcitrant macromolecule, which can produce phytotoxic metabolites as they are slowly decomposed (Requena *et al*., 1996). On the other hand, the humification process is fed by the intermediate compounds coming from the degradation of lignocellulose (Perez *et al*., 2002). Although the microbial community naturally present in composted raw materials usually carries out the process satisfactorily, the inoculation of agricultural residues with efficient lignocellulolytic microorganisms is a strategy that could potentially lead to accelerate the decomposition process and improving the properties of the final product (Vargas-Garcia *et al*., 2005). In this concern, application of lignocellulolytic microorganisms such as *Trichoderma, Phanerochaete* and *Pleurotus* are capable of efficiently metabolizing cellulose and lignin in a variety of lignocellulosic materials resulting in hastening their decomposition rate (Vargas-Garcia *et al*., 2005; Kavitha and Subramanian, 2007; Shi *et al*., 2008 and Raut *et al*., 2008). Additionally, the microbial enrichment technique of the final compost product with nitrogen fixers, P-solubilizer and cellulose decomposers are considered one of the possible ways for increasing the nutrient contents of the compost (Kavitha and Subramanian, 2007).

Thus, in the light on high cost of mineral fertilizer and direction of State Policy to Rationalize the use of mineral fertilizers and for environmental considerations, the main objectives of this study is the recycling of cotton stalks with rice straw as lignocellulosic materials by bio-conversion approach through successive inoculation with lignocellulotic fungi and plant growth promoting rhizobacteria (PGPR) as friendly technology.

MATERIALS AND METHODS

Two compost piles were made from different crops residues chopped to particle size less than 5 mm by using a shredder mill, 250 kg cotton stalks and 500 kg rice straw, and supplemented with the following amendments: 200 kg farmyard manure, 100 kg bentonite, 50 kg rock phosphate, 50 kg feldspar and 25 kg urea. The main characteristics of the raw materials and amendments used are presented in Table (1) according to (Page *et al*., 1982).

The plant residues mixture was well incorporated with the amendments at equal portions in successive layers to make the heaps at dimensions of 2x3x1.8 m. for width, length and height, respectively. At construction and after 30 days of composting the first heap was inoculated with legnocellulolytic inoculum composed of Trichoderma *harzianum, Trichoderma viridi* and *Phanerochaete chresosporum* cultured on commercial liquid medium at rate of 1 liter/ton composted materials. After 75 days of composting process (maturity stage) the first heap re-constructed at dimensions 1.5 x 2.7 x 0.75 m for width, length and height, respectively, then it inoculated with one liter from a mixture of rhizobacteria inoculants, which contains *Bacillus polymyxa*, *Azospirillum braselinse*, *Serrattia* sp. and *Pseudomonas fluorescens*. Afterword, vinass solution 1% was broadcasted on the heap to activate the applied microorganisms. The heap was then left to cure for 15 days. In synchronism, second heap was completely practiced and cured likewise as the first one without received any microbial inoculants.

Table (1): Some characteristics of the raw materials used for preparing the compost

Parameters	Rice straw	Cotton stalks	Farmyard Manure	Rock Phosphate	Feldspar	Bentonite
pH	5.89	5.09	7.93	7.75	7.80	8.1
EC(ds/m)	4.93	4.11	3.25	3.10	0.52	6.2
Organic -C%	48.91	53.81	13.17	0.45	0.39	0.1
Total- N%	0.53	0.42	0.92	0.036	ND	0.0
C/N ratio	92.28	128.12	14.32	12.5	ND	5.3
Total-P%	0.091	0.16	0.55	10.20	0.035	0.4
Total- K%	1.28	1.41	1.79	0.38	8.72	1.4
Total soluble- N(ppm)	111.8	93.8	185.7	ND	ND	ND
Total – Fe(ppm)	793.2	953.2	169.5	4800	1379.3	593
Total – Mn(ppm)	23.5	19.9	42.5	360	64.6	150
Total – Zn (pm)	18.3	17.8	27.9	82	22.7	73

Legnocellulolytic inoculants:

Used inoculants are composed of local isolates of *Trichoderma harzianum, Trichoderma viridi* and *Phanerochaet,chresosporum*, which cultured in potato dextrose media (Martin, 1950).

Rhizobacteria Inoculant:

Pure cultures of local isolates of *Bacillus polymyxa, Serratia* sp*., Pseudomonas fluorescens* and *Azospirillum brasilense* were grown separately on king's medium (Atlas,1995), excluding *Azospirillum*, which was cultured in N-free semi-solid media (Bashan *et al*., 1993). Afterwards, each culture was injected into the sterilized carrier that prepared by mixing vermiculite with 4% Irish peat and packed in polyethylene bags (300 g carrier per /bag), then sealed and sterilized by gamma irradiation (5.0 x10^6)

All microorganisms used were kindly provided by Biofertilizers Production Unit, Soils, Water and Environment Research Inst., ARC, Giza, Egypt.

The chemical composition of the cotton stalks and rice straw were determined according to A.O.A.C. (2000) and are shown in Table (2).

Table (2): Chemical composition of the cotton stalks and rice straw

Component (%)	Cotton stalks	Rice straw
Crude cellulose	31.95	38.21
Pentosan	13.1	19.3
Ash	4.3	24.3
Moisture content	10.6	7.9
Lignin and other materials	25.0	10.0

Both compost heaps were assessed for some physico-chemical and microbiological properties,.i.e., dehydrogenase activity (Casida *et al*., 1964) and CO_2 evolution (Pramer and Schmidt, 1964), at 30, 60, 75 and 90 days of compost process as well as they were monitored for some maturity and stability indices. Physico-chemical and microbiological characteristics of raw materials and composts as well as the maturity indices were determined as described by Page *et al*. (1982) and Iglesias-Jimenez and Perez-Garcia (1989).

During the composting process the temperature profile was measured after few days, 3 days until 103 days, as a good indicator of the heat generated by the microbial metabolism and biochemical activity during the composting process.

The obtained data was subjected to analysis of variance outlined by SAS program (SAS, 1991), LSD 0.05 % test was used for comparing the different means.

RESULTS AND DISCUSSION

Temperature change during the composting process:

The temperature increased in compost heaps immediately after few days (2-3 day), which reached after 15 days of the process to maximum degrees, and then it is gradually declined after 60 days to reach near the ambient temperature after 90 days of the process. These results are in agreement with those obtained by Mostafa (2004), Goyal *et al*. (2005), Raut *et al*. (2008) and Kato and Miura (2008). The prolonged duration of thermophilic stage (temperature was ranged between 50˚C – 60 ˚C for 60 days) might be an indicative for relevant conditions to accelerate the degradation of organic materials. In addition, the gradual decline in temperature in both studied heaps is an indicative for reducing the microbial activity and dominancy of the recalcitrant compounds (the remained legnocellulosic materials). These mean that composting process coming to competition and the compost may be considered mature. Changes in temperature during different stages of composting process are shown in Fig. (1).

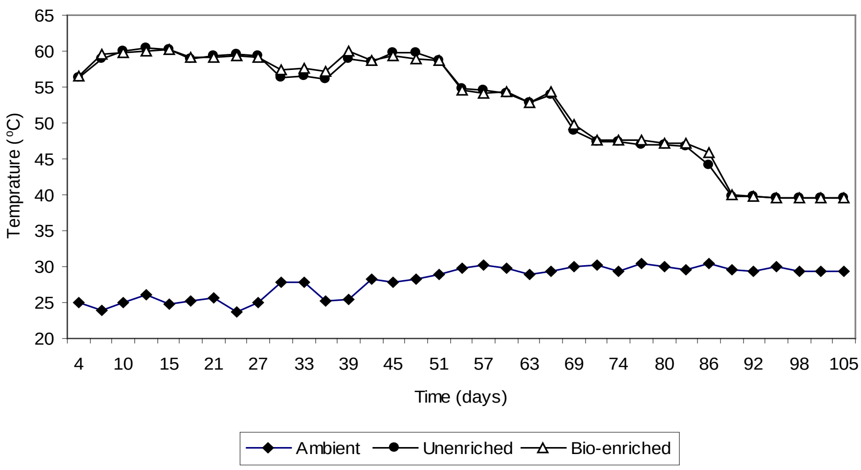

Fig. (1): Temperature change during the composting process as affected by bio-additives.

Physico -chemical properties of the composted materials during the composting process:

Table (3) represents the changes in some physico-chemical properties of compost during the composting process. The values of bulk density (kg/m^3) and water holding capacity increased with increasing the decomposition period, which is an indicative of progressing the degradation of composted materials and reducing their volume (Rynk *et al*., 1992) .There was no significant differences in the values of bulk density and water holding capacity between the bio-enriched heap and unenriched one.

The values of pH and electric conductivity (EC), (dSm^{-1}) exhibited gradual increases during the progressing of composting time in both studied heaps. The rising of pH and EC values during composting process might be elucidated by the degradation and mineralization of organic compounds through biological activity, particularly ammonification process, which is mainly responsible for rising pH as consequence of ammonia liberation. There were significant differences in pH values due to bio-enrichment, while the increases occurred in EC values of bio-enriched heaps were significantly higher than that of unenriched one, these results are in agreement with Wang *et al*. (2004) and Raut *et al*. (2008).

The percentage of total organic carbon (organic-C) declined with increasing the composting time, while in reverse total – N% increased. The greatest reduction in organic –C occurred during thermophilic stage then the reduction slowed down at later stage (maturity stage). The greatest increasing in total –N attained after 60 days of the composting process, then these increases continued until 90 days of the composting process. Therefore, C/N ratio of both tested heaps decreased as a composting process progressed. Similar results were found by Bentio *et al*. (2003), Goyal *et al*. (2005) and Hellal (2007). The reduction of carbon caused by degradation of organic materials and loosing of carbon mainly as carbon dioxide during the composting process leading to increase the total-N by concentration effect. On the other hand, bio-enrichment of composted materials led to a significant decrease in the organic-C and C/N ratio, whereas it increased significant total – N. These results may be explained by the ability of the applied microorganisms to accelerate the degradation of composting materials. Similar findings were obtained by Bader El- Din and Abo Sdera (2001) and Mostafa (2004).

Regarding the soluble nitrogen forms, results exerted that the concentration of NH^+_4-N increased initially until 60 days of the composting process, then it decreased, while NO^-_3–N concentration was gradually increased a composting time progressed. The initial increases in NH^+_4- N may be due to mineralization of organic-N compounds, whereas the depression of its concentration after there was occurred as a result, of volatilization as NH_3 and conversion of NH^+_4 to NO^-_3 *via* nitrification process (Bernal *et al*., 1998 and Bentio *et al*., 2003) .

In relation to availability of the plant nutrients during the composting process (Table 3), results exhibited that progressing of decomposition time associated with gradual increasing in dissolution of the plant nutrition, namely P, K, Fe, Mn and Zn in both investigated heaps. With respect to bio-enrichment treatment, inoculation of composted materials with celluloytic fungi and rhizobacteria increased significantly the availability of P and K, while they had no significant effect on micronutrients as compared to unenriched treatment. These results are an indicator of the remarkable role of decomposable organic substances with regard to affecting the availability of macro and micronutrients originated from the applied mineral amendments such as rock phosphate and feldspar during the composting process through the effects of heat, organic acids and products of humic substance. These results are in agreement with those obtained by Abdel- Wahab (1999), Singh and Sharma (2002) and Zayed and Abdel-Motaal (2005), who reported that there was a significant increases in macro and micronutrient concentrations during the composting of the plant residues combined with natural minerals as consequence of mineralization of organic materials. In this concern, Singh and Amberger (1990) demonstrated that humic substances specially fulvic acid that adsorbs a significant amount of Ca^{+2} and release H^{+} ions, which help in rock phosphate solubilization. Also, humic substances produced during composting may check the re-precipitation of solubilized P and Ca by complexion both ions and creating a sink in the system for further dissolution of rock phosphate.

Cation exchange capacity (CEC) in the composted materials increased as a result of progressing the composting process. Increasing of CEC during composting process might be explained by the progressing of humification process, which resulted in formation of functional groups such as carboxyl and phenolic groups leading to raise CEC (Manna *et al*. 2003 and Vargas – Gareia *et al*., 2007). On the other hand, there were no significant differences in CEC values between bio-enriched heap and unenriched one.

Microbial activity during composting process was evaluated by measuring dehydrogenase activity (DHA-ase), which involved in the respiratory chains of all organisms and it refers to groups of most endocellular enzymes, which catalyze the oxidation of organic matter (Foster *et al*., 1993). Thus, DHA-ase activity and CO_2 evolution were used as parameters to evaluate the overall microbial activity during composting process. As seen in Table (3) DHA-ase and CO_2 evolution were high at bio-oxidative stages then they dramatically depressed until the end of composting process. The behavior of both parameters was the same in both investigated heaps. It could be deduced from these results that there is a close relationship between the high microbial activity and degradation of organic materials at active composting. These findings are in accordance with those of Serra-Wittling *et al*. (1995), Vuorinen and Saharien (1997) and Goyal *et al*. (2005) who showed that DHA-ase activity decreased with composting time for different organic feed stocks then remained stable after 2-3 months. In this context, Bentio *et al*. (2003) added that the highest decrease in the potential metabolic index (the ratio between DHA-ase activity and water soluble carbon) occurred during the most active phase of composting process (bio-oxidative phase), then after day 81, this index remained stable until the end of composting process (Maturation phase).

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Thus, the obtained results emphasized the using of DHA-ase activity and CO_2 evolution as microbial activity indices during the composting process (Bentio *et al*., 2003) and as indices of maturity and stability of compost (Wang *et al*., 2004).

Some maturity and stability indices of the produced compost:

Some maturity and stability indices of the produced composts are presented in Table (4). Results revealed that color, bulk density and water holding capacity of both studied composts are nearly the same and its referred to reasonable physical traits as described by Iglesias-Jimenez and Perez-Garcia (1989).

C/N ratio of the produced composts considered in acceptable level for compost maturity according to Vuorinen and Saharinen (1997) who suggested a C/N ratio between 15 and 20 is ideal for ready use compost without any restrictions. The final C/N ratio to initial C/N ratio reached to 0.34 and 0.41 for bio-enriched and unenriched composts, respectively, which is indicator of the produced composts is ready to use (Van-Heerden *et al*., 2002 and Abdel-Wahab, 2008).

Table (4): Monitoring of some maturity and stability indices of the compost product as affected by bio-enrichment

Parameters	Bio-enriched compost	Unenriched compost
Color	Dark brown	Dark brown
Bulk density (kg/m^3)	0.63 ± 0.07	0.62 ± 0.04
WHC (%)	130.07 ± 1.70	129.13 ± 1.70
C/N ratio	12.82 ± 0.60	15.54 ± 0.67
Final C/N / initial C/N	0.34 ± 0.02	0.41 ± 0.02
pH at 55 °C	7.31 ± 0.04	7.18 ± 0.02
CEC / organic-C	5.46 ± 0.06	4.87 ± 0.24
E_4/E_6 in aqueous - extract	3.80 ± 0.30	3.77 ± 0.21
E_4/E_6 in alkaline - extract	3.10 ± 0.20	3.33 ± 0.42
* SGI % :		
For cress seeds	75.07 ± 3.41	72.70 ± 2.71
For barley seeds	85.17 ± 3.36	84.50 ± 4.46
For bean seeds	76.76 ± 3.98	75.53 ± 3.36
For cotton seeds	85.60 ± 3.34	84.85 ± 3.21
Accumulative CO_2:		
After 1 st day	2.13 ± 0.32	2.50 ± 0.20
After 2^{nd} day	2.43 ± 0.15	2.20 ± 0.30
After 3^{rd} day	2.27 ± 0.21	1.86 ± 0.21
After 4^{th} day	1.73 ± 0.25	2.00 ± 0.26
After 5^{th} day	1.63 ± 0.32	1.70 ± 0.30
** N_2-ase activity	78.66 ± 4.53	73.18 ± 3.69
NH^+_4 / NO^-_3 ratio	0.89 ± 0.06	0.92 ± 0.05
*** PDB 10g number	7.61 ± 0.30	6.92 ± 0.19

***SGI: Seed germination index, ** N_2-ase: Nitrogenase activity (mmol C_2H_4/ g/hr),**
*****PDB: Phosphate dissolving bacteria**

Soil reaction value (pH) of saturated compost samples which incubated at 55 °C tended to remain neutral or near alkaline, indicating that the produced composts may considered mature (Abdel-Wahab, 2008).

Values of E_4/E_6 of the two compost samples were moderate either in aqueous or in alkaline extract, which is an indicative of causing the humification process. These findings could be confirmed by the ratio of CEC / organic – C, which it has a high values indicating that these composts were well mummified (Manna *et al*., 2003 and Abdel-Wahab, 2008).

Mature compost could be safely be used with plants without occurring phytotoxicity, which may be resulted from raw materials or produced during the early period of composting where its degraded during the process giving mature compost (Bernal et al., 1998). The two compost samples taken after 90 days of the composting process were attained values higher than 50 % (value suggested by Zucconi *et al*., 1981). For the germination index of the three tested plants, which is indicative of these composts are free phytotoxins.

For the biological properties of the studied composts as maturity and stability indices data in Table (4) demonstrated that accumulative CO_2 evolution after five days did not give clear trend and its values are reasonable for compost stability without reducing the desirable microbiological trait such as N_2-fixation, P-solubilization and nitification, which was evident from reasonable values given by N_2-ase activity, count of P-dissolving bacteria and NH^+_4 – N / NO^-_3 – N ratio (as indication of nitrification process), (Hoitink and Boehm, 1999). It is evident that inoculation of composted materials at curing stage with rhizobacteria could be increased the performance of N_2-fixation and P-solubilization as compared to unenriched compost.

CONCLUSION

In conclusion, the present study could lead to that the cotton stalks and rise straw can be of beneficial agricultural waste, if it used in manufacturing of compost. This phenomenon ,can be accomplishing by inoculating the compost heaps, that is constructed by using cotton stalks and rice straw with some degradable microorganisms (bacteria and fungi).However, the bacterial inoculation for pre-composting materials (cotton stalks and rice straw) positively can accelerate the compost ripping along with getting a compost product rich in its nutrient content . Thus, this work should be repeated to reach the level of the recommendation of compost bacterial inoculation.

REFERENCES

A. O. A. C. (2000). Analysis Association of Official Agriculture Chemists (Official Method, 17th Ed. PUB. AOAC International, Maryland, U.S.A.

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. Agric. Ain Shams Univ. Cairo, Egypt.

Abdel-Wahab, A .F. M. (2008). Evaluation of enriched compost and its role in synergy with rhizobacteria and N- fertilization for improving maize productivity in sandy soil Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo. 16: 319-334.

Atlas, R.M.(1995).Handbook of midia for Environment Microbiology. CRC. Press, Boca Raton,F.

Bader El-Din, S. M. S. and S. A. Abo – Sdera (2001). Acceleration of composting of sugar beet humus using two highly effective cellulose decomposing microorganisms. Egypt. J. Microbiol., 36:161-174.

Bashan,Y., G. Holguin and R. Lifshitz (1993).Isolation and characterization of plant growth promoting rhizobacteria .In Methods in Plant Molecular Biology and Biotechnology. Eds: B.R. Glick and J.E. Thompson. CRC Press, Boca Raton. Pp.331-345.

Bentio, M.; A. Masguer and A. Moliner (2003). Chemical and microbiological parameters for the characterization of the stability and maturity of burning waste compost. Biol. Fertil. Soil. 37:184-189.

Bernal, M. P.; C. Paredes; M. A. Sanchez-Monero and J. Cegarra (1998). Maturity and stability parameters of composts prepared with a wide range of organic wastes. Bioresource Technol., 63:91-99.

Casida, L. E., D. A. Klein and T. Santoro (1964). Soil dehyderogenase activity. Soil Sci., 98: 371-376.

Foster, J.C., W. Zeeh and E. Wardinger (1993). Comparison of chemical and microbiological methods for characterization of the maturity of composts from contrasting sources. Biol. Fertil. Soils. 16:93-99.

Goyal , S. ; S. K. Dhull and K. K. Kapoor (2005). Chemical and biological changes during composting of different organic wastes and assessment of compost maturity Bioresource Technol., 96:1584-1591.

Haug, R.T. (1993). The Practical Handbook of Compost Engineering, Lewis Publishers; Boca Raton, Florida, USA. 717p.

Hellal, F. A. (2007). Composting of rice straw and its influences on iron availability in calcareous soil . Res. J. Agric. Biol. Sci., 3:105-114.

Hoitink, H. A. J. and M. J. Boehm (1999). Biocontrol within the context of soil microbial communities: A. substrate dependent phenomenon. Annal. Res. Phytopathol., 37:427-446.

Iglesias-Jimenez, E. and V. Perez-Garcia (1989). Evaluation of city refuse compost maturity. A Review, Biological Wastes. 27:115-142.

Kato, K. and N. Miura (2008). Effect of matured compost as a bulking and inoculating agent on the microbial community and maturity of cattle manure compost. Bioresource Technol., 99:3372-3380.

Kavitha, R. and P. Subramanian (2007). Bioactive compost- A value added compost with microbial inoculants and organic additives. J. Appl. Sci., 7: 2514-2518.

Manna, M. C.; P. K. Ghosh and T. K. Ganguly (2003). Comparative performance of four sources of enriched phosphocompost and inorganic fertilizer application on yield. Food, Agric. Environ., 1:203-208.

Martin, J. P. (1950). Use acid rose Bengal and streptomycin in plate method for estimating soil fungi. Soil Biol. Biochem., 17: 245-248.

Mostafa, M. H. (2004). Enhancement of cotton stalks composting using certain microbial inoculants. Egypt. J. Appl. Sci., 19:795-805.

Page, A. L.; R. H. Miller and D. R. Keeney (1982). Methods of Soil Analysis. II Chemical and Microbiological Properties. 2nd Ed. Madison, Wisconsin, USA.

Perez, J.; J. Munoz-Dorado; T. de la Rubia and J. Martinez (2002). Biodegradation and biological treatments of cellulose, hemicellulose and lignin: an overview. International Microbiol., 5: 53-63.

Pramer, D. and E. L. Schmidt (1964). Experimental soil microbiology. Burgess Publisher Company. Minnesota, U. S. A.

Raut, M. P.; S. P. M. P. William; J. K. Battacharyya; T. Chakrabarti and S. Devotta (2008). Microbial dynamic and enzyme activites during rapid composting of municipal solid waste-A compost maturity analysis perspective. Bioresources Technol., 99:6512-6519.

Requena, N.; R. Azcon and M. T. Baco (1996). Chemical changes from compost due to incubation with lignocellulolytic micronutrients and effects on lettuce growth. Appl. Microiol. Biotechnol., 45: 857-863.

Rynk, R. (1992). On Farm Composting Handbook. Pp. 23-35 Northeast Reginoal Agricultural Engineering. Service, Cooperative Extension. Ithaca, NY., USA.

SAS Institute Inc. 1991-1996. SAS User's Guide: Statistics Version 4.1. Cary, NC 27513-2414, USA.

Serra- Wittling, C.; S. Houot and E. Barriuso (1995). Soil enzymatic response to addition of municipal solid waste compost. Boil. Fertil. Soils. 20: 226-236.

Shi, J.; M. S. Chinn and R. R. Sharma-Shivappa (2008). Microbial pretreatment of cotton stalks by solid state cultivation of *Phanerochaete chresosporium*. Bioresource Technol., 99:6556-6564.

Singh, A. and S. Sharma (2002). Composting of a crop residue through treatment with microorganisms and subsequent verm in composting. Bioresource Technol., 85: 107-111.

Singh, C. P. and A. Amberger (1990). Humic substances in straw compost with rock phosphate . Biological Wastes. 31:165-174.

Van – Heerden, I.; C. Cronie; S. H. Swort and J.M. Kotze (2002). Microbial, chemical and physical aspects of citrus waste composting. Biolresources Technol., 81: 71-76.

Vargas-Garcia, M. C.; M. J. Lopez; F. Suarez- Estrella and J. Moreno (2005). Laboratory study of inocula production for composting processes: Modifications in ligicellulosic fraction. Waste Management. 27: 1099- 1107.

Vuorinen, A. H. and M. H. Saharinen (1997). Evaluation of microbiological and chemical parameter during manure and straw co-composting in drum composting system. Agric. Ecosys Environ., 66: 19- 29.

Wang, P.; C. M. Change; M. E. Watson; W. A. Dick; Y. Chen and H. A. J. Hoitink (2004). Maturity indices for composted dairy and pig manure. Soil Boil. Biochem., 36:767-776.

Zayed, G. and Heba Abdel-Motaal (2005). Bio-active composts from rice straw enriched with rock phosphate and their effect on the phosphorus nutrition and microbial community in rhizosphere of cowpea. Bioresource Technol., 96: 959-935.

Zucconi, F.; M. Forte; A. Monoc and M. Beritodi (1981). Biological evaluation of compost maturity. Biocycle. 22: 27- 29.

إعادة تدوير حطب القطن مع قش الارز إلى كمبوست *كتقنية صديقة للبيئة*

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**** معهد بحوث الاراضى و المياة والبيئة - مركز البحوث الزراعية – جيزه – مصر**

تم عمل كومتين من الكمبوست لدراسة تأثير إضافة بعض المخلفات النباتية (حطب القطن و قش الارز) مع بعض المحسنات العضوية و المعدنية واثرائها ببعض الفطريات المحللة للمواد اللجنوسليلوزية خلال المرحلة النشطة للتحلل. أيضا تم تلقيح هذة المواد ببعض الريزوبكتيريا المنشطة للنمو أثناء فترة النضج و ذلك بغرض الاسراع من معدل التحلل وأخصاب الكمبوست الناتج لتحسين خواصة البيولوجيه و الغذائية. وقد أوضحت النتائج أن الخواص الفيزيوكيميائية و الميكروبيولوجية قد تطورت مع تقدم فترات التحلل حتى 90 يوم، وقد أدت اضافة اللقاحات الميكروبية الى الاسراع فى عمليات التحلل مقارنة بالكومة غير الملقحة حيث أعطت قيم أقل فيما يتعلق بنسبة الكربون العضوى و نسبة الكربون الى النتروجين، بالاضافة الى ذلك فقد أعطت بعض مظاهر النضج قيما مقبولة بالنسبة لدليل الانبات ، و انطلاق ثانى اكسيد الكربون ونشاط انزيم الديهيدروجينيز و نسبة الأمونيوم إلى النترات كمؤشر لقياس عملية النترتة.

قام بتحكيم البحث

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Table (3) : Phsyco-chemical properties of the composted materials at different periods of composting and maturing as affected by bio-enrichment inoculation

Parameters	Bio-enriched compost					Un-enriched compost					LSD values at 0.05		
	Composting periods (days)					Composting periods (days)					Compost (C)	Period (P)	CxP
	30d	60d	75d	90d	Overall means	30d	60d	75d	90d	Overall means			
Bulk density (kg/m^3)	0.36	0.47	0.54	0.63	0.50	0.36	0.46	0.53	0.62	0.49	N.S	N.S	N.S
WHC(%)[a]	78.60	102.13	112.80	130.06	105.90	78.23	102.10	111.16	129.13	105.17	N.S	4.551	N.S
pH	7.06	7.14	7.38	7.65	7.31	7.20	7.23	7.27	7.70	7.36	N.S	0.117	N.S
EC (dS/m)	3.10	4.00	4.13	4.67	3.98	3.19	3.31	4.11	4.34	3.74	0.225	0.320	N.S
Organic-C (%)	34.87	27.65	22.96	21.05	26.64	35.70	30.05	25.95	22.61	29.33	1.537	2.173	N.S
Total-N (%)	1.07	1.41	1.56	1.64	1.42	1.07	1.36	1.50	1.46	1.35	0.061	0.087	N.S
C/N ratio	32.40	19.67	14.72	12.82	19.91	33.38	22.05	17.35	15.54	22.08	0.662	0.937	N.S
N-NH^+_4 (ppm)	310.93	332.40	270.26	190.43	276.02	307.63	330.06	262.10	180.00	269.95	4.213	5.958	N.S
N-NO^-_3 (ppm)	21.63	56.77	113.53	213.50	101.36	22.07	55.77	107.80	195.10	94.93	5.182	7.329	N.S
NH^+_4 /NO^-_3 ratio	14.43	5.86	2.38	0.89	5.90	14.05	6.03	2.43	0.92	5.78	N.S	1.021	N.S
Total soluble-N (ppm)	332.60	389.16	383.80	403.93	377.38	329.56	384.83	269.90	375.10	364.89	7.119	10.068	N.S
Available - P (ppm)	247.50	290.23	330.30	361.73	307.44	247.53	283.80	328.40	349.63	302.34	3.413	4.827	N.S
Available - K (ppm)	341.10	506.30	606.70	698.43	538.13	338.96	502.00	593.06	673.30	526.83	7.210	10.197	N.S
DTPA-extract Fe (ppm)	119.30	206.23	254.66	274.93	213.78	118.36	188.73	252.63	267.47	210.97	N.S	6.953	N.S
DTPA-extract Mn (ppm)	29.70	45.43	63.26	76.90	53.83	26.56	44.70	63.13	71.67	52.52	N.S	3.901	N.S
DTPA-extract Zn (ppm)	16.87	28.13	42.53	54.50	35.51	16.36	27.96	42.56	53.17	35.07	N.S	3.589	N.S
CEC(e mol/kg) [b]	53.33	77.76	93.10	117.63	85.46	53.23	78.10	92.56	114.73	84.69	N.S	4.258	N.S
DHA-ase[c]	763.07	652.27	401.23	280.06	524.16	759.36	652.23	400.10	284.33	524.00	N.S	21.197	N.S
CO_2 evolution (mg/gcompost/day)	5.73	4.00	2.73	1.76	3.56	5.50	4.00	2.73	1.87	3.53	N.S	0.523	N.S

a- WHC: Water holding capacity.

b- CEC: Cation exchangeable capacity.

c- **DHA-ase: Dehydrogenase activity (mg TPF/100g compost/day)**