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EVALUATION OF APPLICATION OF BACTERIAL INOCULA FOR RICE STRAW DURING COMPOST PROCESS UNDER AEROBIC CONDITIONS

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ABSTRACT

Aerobic composting process of rice straw , chicken manure , natural material i.e, felespar , magnetite , rock phosphate and enriched with some bacterial inocula was investigated to find out the best conditions for relatively rapid maturity ; evaluation of chemical and biological changes occurring during decomposition process was also carried out. Composting process was continued for 150 days under aerobic conditions and 90 days after enriched with various bacteria ; during composting, samples were subjected to chemical and microbiological analyses. Chemical determinations included EC, pH along with total N, P, K , available micronutrients (Fe, Mn, Zn and Cu); temperature as well as C/N ratio were also evaluated . Microbiological determinations,on the other hand ,were performed through counting of total bacteria i.e., Azotobacter chroococcum, Bacillus megatherium and Bacillus circulance. Finally, growth regulators represented by indol acetic acid (IAA) gibberellic acid (GA_3) and abscisic acid (ABA) were extrected from the studied compost to be then assayed.

Monitoring of the composting process showed that, temperature rises during the first two weeks of composting (thermophilic stag). It reached 58-62 °C starting from the third week and up the mesophilic stage appeared to be dominant towards the end of the composting process. EC and pH values were increased with increasing composting time of rice straw heaps especially after application of bacterial inoculas; total N, P, K, Fe, Mn, Zn and Cu values were also increased opposite to C/N ratio which was decreased.

Generally, the count of the studied three bacterial strains were higher at all the investigted time periods as compared to the zero time (before application of bacterial inocula). Furthermore, the nitrogen, phosphorus and potassium content increased after 90 days from application of either Azotobacter chroococcum, B. megatherium or B. circulance.

Key words: compost, rice straw, bacterial inocula, Azotobacter chroococcum, B. megatherium, B. circulance, , indol acetic acid. , gibberellic acid, abscisic acid.

INTRODUCTION

In Egypt, one of the main agricultural wastes is rice straw, which represents about 3.5 million tons annually, causing ecological problem unless it is not well disposed. Thus, bioconversion of part of such accumulated rice straw into compost could be a beneficial approach for such disposal . Composting process as a biological decomposition of wastes, consisting of organic substances of plant and/ or animal origin under controlled conditions , may be sufficiently suitable for both storage and utilization *(Diaz et al., 1993).* Composting has generally different objectives such as improvement for both biological activity of soil and hygienic conditions, reduction of germination capacity of weeds, suppression of pathogenic organisms and elimination of unpleasant odors *(Subba Rao et al., 1993)*.Different factors govern the biological reactions during the composting process ; such factors are moisture, aeration, temperature, nature of compostable materials and addition of chemical activators and biological *(Paul and Clark, 1995)*.

Composts ,depending on the degree of maturity, provide a rich medium supporting a high microbial activity *(Chen, et al., 1988)*. Plant growth promoting rhizobactria (P.G.P.R) benefit plants through different mechanisms of action including nitrogen fixation (Mbagwn and piccolo, 1990), phosphate solubilization (*Goldstein, 1986*) , Potassium solubilization.

Many microorganisms release various plant growth regulator as a secondary metabolites .Such growth regulator include auxins ,gibberellins and abscisic acid *(Nieto and Frankenberger,1990)*.Azotobacter and Bacillus are the microorganisms which are able to synthesize large amount of biologically active substances such as plant growth regulators (*Brown and Burlingham , 1968;Brown and Walker,1970 and Novikova and Irtuganova , 1966)*.On the other hand , production of plant growth regulators is influenced by substrate availability including organic matter and incubation time *(Gonzalaz et al.,1986)* .

Consequently, indicated factors should affect both quality and maturity time of compost . Therefore, the present work aims to evaluate some factors affecting the composting of rice straw as to increase their contents from available nutrients.It also involve to trials improve quality of rice straw through addition of chicken manure, natural material i.e, felespar, magnetite and rock phosphate along with enrichment of compostable materials with microorganisms. Chemical changes that may take place during composting of rice straw were also taken in consideration..In addition to evaluate of growth regulators which products by microorganisms.

MATERIALS AND METHODS

An experiment for conversion of rice straw into a suitable organic manure (compost) was carried out in Ismailia Agricultural Research Station. The experiment started on 26th November 2001 and extended of 150 days for composting process and 90 days after enriched with various bacteria .

Preparation of the composts.

Three heaps from rice straw (A, B and C), 1080 Kg of each pile, were arranged in 6 equal layers to enhance the decomposition process. To activate the decomposition process, an activator mixture of chicken manure, rock phosphate, felespar and magnetite were added to such heaps of rice straw in concentration of 8%, 4%, 4% and 1.5% respectively as sources of nitrogen, phosphorus, potassium and micronutrients i.e, Fe, Mn, Zn and cu. Some chemical properties of the used materials are shown in Table(1) the indicated mixture was also divided to 6 equal parts .The rice straw ,supplied successively with the activator mixture was placed over an area of about 1.5 x 2.0 m^2 in 6 layers heaps.;each layer was watered to about 70 % moisture content, such moisture being kept almost constant during the whole period of composting, the heaps were covered by plastic sheets, composting process being extended to 150 days. Each pile was adjusted and turned, every 15 days, from the top and sides into the center to enhance the aerobic decay process. Temperature was recorded weekly, representative samples from heaps being taken manually each 15 days. The composted samples were ground, then analyzed for EC, pH, organic carbon, total N,P, K, availble micronutrients (Fe, Mn, Zn and Cu) , C/N ratio being also estimated . After 150 days , the temperature was recorded approximately 32-38 C° ;then the bacterial inocula has been introduced to enrich the product of compost. Three different strains of associative N_2 .Fixing (Azotobacter Chroococcum) , phosphate disolving bacteria (Bacillus megatherium) and potassium disolving bacteria (Bacillus circulance) provided by the Biofertilizers unit, Cairo Mircen, Microbiological resource Center were applied as a culture inocula at the rate of two lilter / heap . The same chemical anaylsis and total count of three types of bacteria were determined each 15 days , for 90 days , after enriched with some bacteria.

METHODS OF ANALYSES

During the period of composting , the obtained samples were subjected to the following chemical analyses:-

EC and pH values in (1:10) compost water mixtures according to *Jodice et al. (1982)*. Total nitrogen and organic carbon were determined according to the standard methods of *Page et al. (1982)*.Total contents of phosphorus, potassium and micronutrients were assayed according *to Black (1982)* .

Table (1): Some chemical properties of the used activators.

Chemical properties	Chicken manure	Rock phosphate	Magnetite	feldspar
Macronutrients	**Total %**	**Available ug.g^{-1}**		
N	4.6	233.3	116	166
P	0.22	10	8.73	5.70
K	5.35	458.3	76.05	230.1
Micronutrients	**Mg-g^{-1}**	**Available ug.g^{-1}**		
Fe	3531	9.02	13.96	20.8
Mn	955	2.19	3.22	3.99
Zn	952	1.13	0.597	10.37
Cu	177	3.10	0.31	0.46

Microbiological assay .

Three representative samples from each 150 days composted heap , following each turning , were collected at 0.0,15,30,45,60,75and 90 days for microbiological assay.Counts of Azotobacter were determined using Ashby,s media as recommended by *Allen (1959)* . The viable numbers of Azotobacter were estimated using *Cochran 's Table (1950)* for estimating the most probable numbers (M.P.N) . Bacillus megatherium were counted by plated count using modified Bunt and Rovira medium *(Abdel – Hafez, 1966*) as well as Bacillus circulance were plated count using modified Aleks and Rou,s medium (*Zahra ,1969*) .

Growth regulator were extracted twice with 96% methanol as described by Sadeghian (1971), to be then assayed by Gas –liquid Chromatography (GLC) according to the method described by (*Vogel, 1975*).

RESULTS AND DISCUSSION

1- Changes occurring during composting process of rice straw.

Temperature:-

Data presented in Fig (1) show that , in generally, the temperature rose in both middle and bottom of the compost heaps and being low at the surface. The thermophillic stage started after 7 days and latred for almost a month mostly, then it gradually falls down to the ambient temperature.The early stage of rice straw composting at three piles (A,B and C); temperature was high to 40-46 C° after 3 days and reached 58-62 C° on the 12 th day. The temperature remained relatively high until the 12th week after this period, sharp decrease was recorded at the final stage (14-20 weeks) to be near the ambient temperature indicating the maturity of compost in this heaps. This could be attributed to the biological activities of microorganisms grown on the easily mineralizable organic matter available at the beginning of decomposition.

Obtained results agreement with those of *Dewes (1994)*, *Abou El-Naga et al. (1997) and Abdel - Azeem (2001)* who reported that the microorganisms present on the raw materials multiply rapidly during the first stage of composting and cause the rise of temperature.

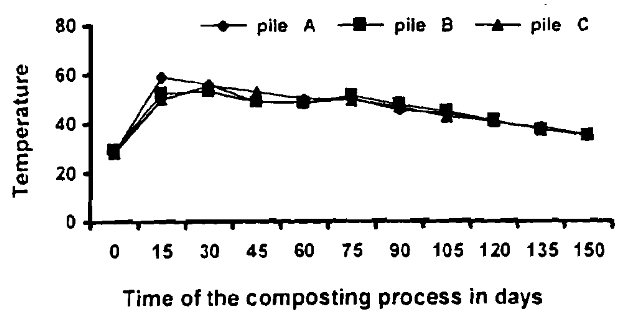


Fig.(1):- Changes of temperature during composting rice straw

EC values

The effect of decomposition period of rice straw piles, before and after inoculation with some bacteria ,on the electrical conductivity of these composts are shown in Table (2).Data revealed that EC values before enrichment with some bacterial, gradually increase with time and reached to maximum value at 135 days for B and C piles then to be decreased at the end (150 days) of composting process. Obtained data may be due to the relatively high concentrations of ammonium and other ions released during the rapid mineralization of organic matter *(laila, 2001)* and the presence of simple organic and inorganic substances resulted from decomposition process which cause an appreciable numbers in all heaps before inoculation On the other hand. electrical conductivity values decreced after enrichment with Azotobacter chroococum , B. megatherium and B.circulance. then to be continuance reduce up to the period of composting .Obtained data may be due to three microbes needed to organic and inorganic ions which used to as energy source along with stimulate the proliferation of microbes particularly Azotobacter *(Abdel -Wahab ,1999)*.

Table(2) :- EC and pH values during composting of rice straw.

a- Before inoculation

Time of composting in days	EC (1:10) dS/m			pH (1:10)		
	A	B	C	A	B	C
0	0.96	1.01	1.03	6.23	6.44	6.15
15	4.87	6.64	5.58	6.8	6.95	6.9
30	4.87	6.19	3.98	7.25	7.55	7.05
45	5.31	4.69	4.25	7.05	7.00	7.02
60	5.31	4.87	4.63	6.5	6.25	6.30
75	5.58	6.52	4.97	6.7	6.6	6.38
90	5.75	7.08	6.9	6.95	6.6	6.52
105	6.4	7.09	6.54	7.05	7.05	7.13
120	6.46	7.01	7.08	7.9	7.25	7.35
135	7.08	7.08	7.34	7.75	7.32	7.43
150	7.97	6.11	5.75	7.72	7.4	7.60

b- After inoculation

Time after added of bacteria in days	EC (1:10) dS/m			pH (1:10)		
	A*	B**	C***	A*	B**	C***
15	5.71	6.01	5.81	7.72	7.20	7.12
30	5.28	5.64	5.44	6.94	7.01	7.01
45	4.13	5.52	5.02	6.54	6.75	6.74
60	4.12	5.01	4.86	6.5	6.45	6.54
75	4.01	4.87	4.15	6.61	6.61	6.42
90	3.98	4.52	3.95	7.16	6.83	6.74

A* = rice straw pile after added of *Azotobacter chroococcum*
B = rice straw pile after added of *Bacillus megatherium***
C*= rice straw pile after added of *Bacillus circulance***

pH value:-

The changes in the pH values of the composted rice straw before and after enrichment with some bacteria are shown in Table (2) . Results of the three heaps were gradual increase as the composting period increase in spite of that slight decreased in pH values recorded at the period of 45-90 days of the composting process. Obtained data may be due to the production of organic acids, especially fulvic acids , which increased up to 30 days from composting process. After such period, the pH values were again rise then proceed at a pH around neutrality . The indicated results was agreement with obtained by Moharram et al.(1989) who found that initial values of pH at the beginning of composting ranged between 6.85 and 7.30 ; during the composting process , the pH values showed a slight decrease toward acidity as well as at the end of the composting process pH values tended to increase around neutrality.It is worthy to mention that,the aerobic composting of farm residues and urban wastes normally proceeds at a pH around neutrality ,and rarely encounters extreme pH drop or rise (*Faure and Deschamps, 1990*).

Concerning of pH values after inoculated with bacteria i. e., Azotobacter chroococcum ; Bacillus megatherium and Bacillus circulance, data show that slight decreased of pH values after application of bacteria then to be increase after 75 days from inoculation .Obtained data may be due to the metabolic degradation of organic matter, the intensive proteolysis and liberation of ammonium compounds (*Faure and Deschamps, 1990*).

2. Nutrients contents in rice straw compost.

Total nitrogen and C/N ratio:-

Data illustrated in Fig.(2) show that total nitrogen increases throughout the composting period for three rice straw piles as a result of the higher bio-oxidation of the easily decomposable carbonaceous substrates. The increase in total nitrogen during the composting processes reached to 331,302 and 311 % over initial values at the beginning of three heaps A,B,and C , respectively.Obtained data could be due to added of chicken manure to rice straw composting and gradual loss in weight of composted materials as a result of CO_2 evolute,beside the stimulation of N2 –fixers activity grown on the products of cellulose decomposition (*Kaloosh, (1994)and Liala,(2001))* .

On the other hand ,values of total nitrogen after 90 days from inoculated with bacteria were recorded an increase which reach to 63.1, 25.3 and 37.4% respectively .These results indicated that the amount of total nitrogen in rice straw pile which enriched with Azotobacter bacteria are relatively higher in total nitrogen than other heaps. Similar trend was obtained by *(Abdel – Wahab 1999)* Who reported that population of Azotobacter particularly in organic materials with high C/N ratios was greatly augmented and thus stimulate nitrogen fixation.

The decrease of organic matter content and the increase in total nitrogen content due to the increase of composting period cause a remarkable reduction in C/N ratio.Results illustrated in Fig .(3) show that the values of C/N ratio , before inoculation with some bacteria, decrease during the second month then to be sharp decrease at the period of 60 to 90 days of the composting process. After this period , the magnitude of reduction was slight until the end of the composting period.Values of C/N ratios for either A,B and C piles decrease by 81.8, 82.5 and 83.9 % respectively as compared with the initial once for rice straw. These findings agree with obtained by *Mohamed (1999) and Allam(1999).*

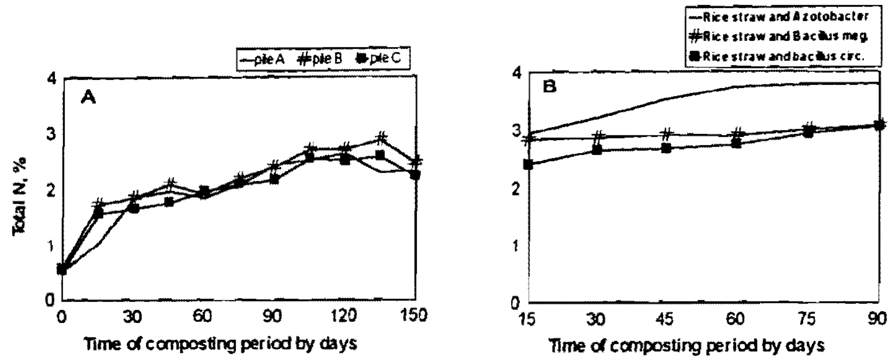


Fig. (2):- Total N values of composted rice straw as affected by composting period (A) and total N after application of bacterial inocula (B).

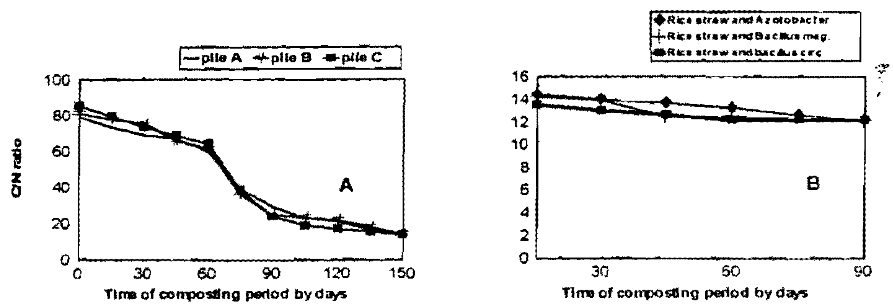


Fig.(3):- C/N ratio values of composted rice straw as affected by composting period (A) and C/Nratio after application of bacterial inocul (B).

Concerning the C/N ratio after 90 days from application of bacteria , values recorded an reduction in C/N ratios reach to 15.7, 14.8 and 11.5 % respectively as compared to C/N ratios after maturity of compost rice straw (150 days).The C/N ratio of compost can not be used as an absolute index of compost maturity, since this parameter varies greatly in the composted materials *(Hiria et al., 1983)*. For this reason, it is possible to define immature compost with a C/N ratio lower than 20 when the raw material contains high total N.

Phosphorus and potassium content.

Values of total P and K of rice straw , before and after enrichment with some bacteria, as affected by composting period illustrated in Fig. (4 and 5).

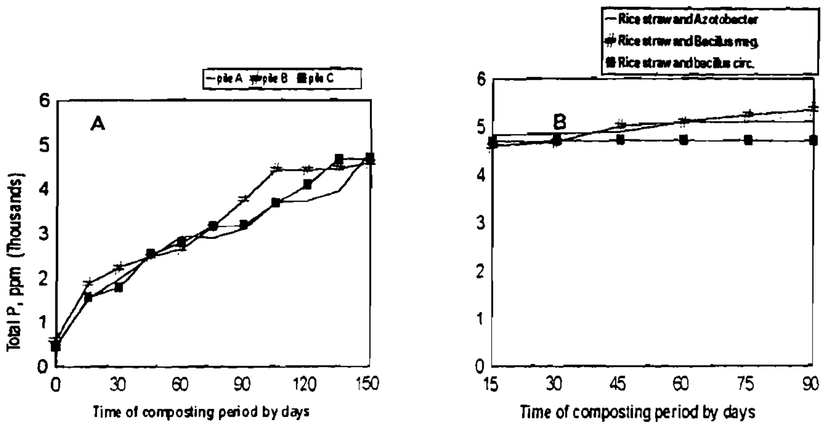


Fig. (4:- Total P content of composted rice straw as affected by composting period (A) and values of total P after inoculation with some bacteria (B).

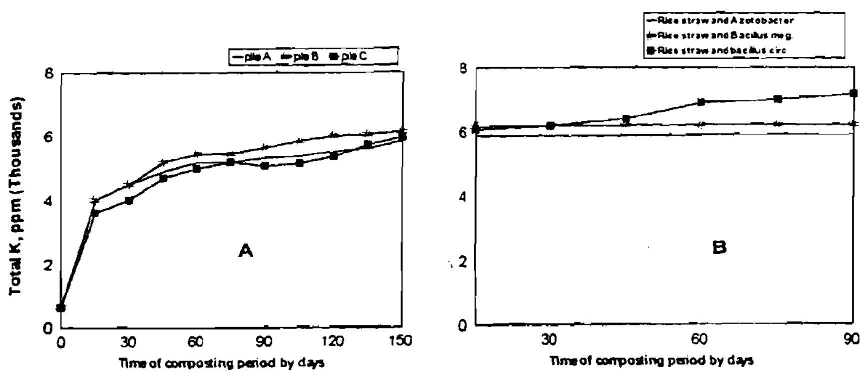


Fig. 5):-Total K values of composted rice straw as affected by composting period (A) and Total K after application of bacterial inocula (B).

Obtained data of both P and K are ,generally, increases with increasing composting period.Such increase could be related to the release of organic acids, in addition to the high temperature as well as to the microbial activity *(Mahimairaja et al .,1995).*

Furthermore,the decomposition of organic materials highly affect the solubility of insoluble phosphorus and potassium sources such as rock phosphate and feldspar, respectively, used in this investigation. In addition, composting organic waste materials with rock phosphate is also possibility for P mobilization through microbially- produced organic acids, as well as humic and fulvic acids *(Singh and Amberger, 1995).*

Concerning the changes of both P and K content after application of bacteria, Fig. (4and 5), results clearly show increase values of P and K after 90 days from added of B. megatherium and/or B. circulance ,values of phosphorus and potassium increase by about 6.13, 16.9 and 0.68 % for P and 1.09, 1.46 and 20.28 % for K, respectively as compared with before application of bacteria (150 days after composting process).

Many investigators(Assal, 1994, Balabel, 1997 and Wafaa, 2001) reported that , inoculation the compost with B. circuance led to significantly increase in the dissolution of K. The influence of microbial cell on the amenability of minerals to degradation could be occurred in terms of colloid chemistry . positively charged inorganic particles such as Al $(OH)_3$ or Fe_2O_3 tend to aggregate with microbial cells which acts colloidal particles. Some microorganisms produce polymeric compounds , which acts flocculating agents for inorganic particles.

From the previous results it can be noticed that enriched the compost with bacteria such as Azotobacter chroococcum, Bacillus megatherium and Bacillus circulance,enhanced the nutrients released such as nitrogen ,phosphorus and potassium from rich straw compost .These data indicated the importance of inoculation the compost materials with such microbes *(Gaur et al.,(1982)and Gaur (1987)).*

Correlation coefficients-:

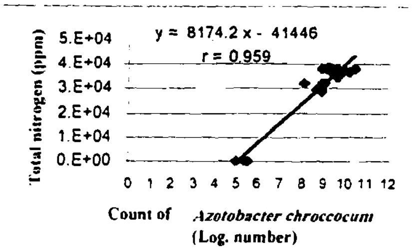
Correlation coeficient among bacterial populations count and total macronutrients (N, P and K) in rice straw compost after inoculation with some bacteria , 90 days , are show in Table (3).Obtained data revealed that correlation between Azotobacter count and total nitrogen in rice straw was computed and high significant r =0.959 (Tabulated r values at 0.05 and 0.01 levels are 0.433 and 0.549 , respectively) as well as such correlation between Bacillus count and both phosphorus and potassium were not significant and recorded a 0.167 and 0.268 respectively (Tabulated r values 0.433 at 0.05 level.

Table (3): Correlation coefficient values (r) among bacterial populations count and total nitrogen , phosphorus and potassium in rice straw during the compost period.

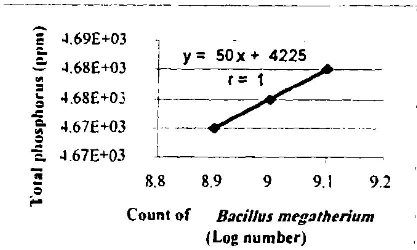
Time of composting period	Azotobacter chroccocum* Total nitrogen	Bacillus megatherum* Total phosphorus	Bacillus circulance * Total potassium
0.0	0.756	-	0.500
15	- 0.866	- 0.50	0.866
30	- 0.101	1.00 **	1.00 **
45	0.866	0.866	0.982
60	0.397	- 0.961	-
75	- 0.500	0.00	1.00**
90	-	0.00	ND

** Tabulated r values at 0.05 and 0.01 levels are 0.996 and 0.999 respectively

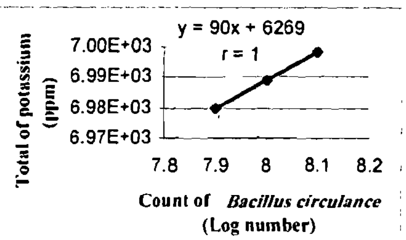
On the other hand , inoculation by Bacillus was very significant (r =1) at stationary phase (30days after inoculation, Fig. (6),) as compared to other once.This demonstrates the positive response of this period time to various inoculation treatments.



A :- Correlation coefficient s between count of Azotobacter and total nitrogen at 90 days from inoculation.



B :-Correlation coefficient s between count of Bacillus megatherium and total phosphorus at 30 days from inoculation.



C:-Correlation coefficient s between count of Bacillus circulance and total potassium at 30 days from inoculation.

Fig.(6):- Liner regression of bacterial count and total nitrogen , phosphorus and potassium content .

Available micronutrients:-

Results presented in Table (4) show that available micronutrients in rice straw composting before and/or after application of bacterial inocula.Generally, significant increases are obtained for total Fe,Mn,Zn,and Cu in three piles (A,B,C) of rice straw compost before inoculation with some bacteria (150 days).Data also indicated that content of micronutrients can be arranged as follow :Fe >Mn>Zn>Cu.

The increase of micronutrients content may be due to added magnetite to the composting materials as activator and the ability of organic acids such as humic and fulvic acids to form stable complexes with metal ions is undoubtedly because their high conent of oxygen –containing functional groups including COOH, phenolic, alcoholic and enolic - OH and C=O structures of various humic substances are effective in binding the micronutrients such as Fe, Mn, Zn and Cu (Tan ,1993).

Table (4) :- Available contents of Fe, Mn, Zn and Cu during composting rice straw.

A:- before inoculation

Time of composting in days	Available micronutients (ppm)											
	Fe			Mn			Zn			Cu		
	A	B	C	A	B	C	A	B	C	A	B	C
0	254	260	248	84	75	76	20	15	23	2	2	2
15	207	176	260	83	80	75	30	20	28	3	3	3
30	271	203	265	95	83	80	35	30	29	3	5	3
45	297	207	282	104	85	82	43	32	30	3	5	5
60	303	264	273	110	93	85	55	35	48	8	13	5
75	334	297	274	105	95	90	58	48	50	10	13	20
90	339	326	298	112	95	95	60	58	55	13	13	15
105	367	360	317	118	98	98	65	65	70	15	13	18
120	401	364	321	120	101	103	68	88	85	15	13	20
135	411	393	333	120	108	110	78	90	88	18	16	28
150	413	411	379	125	109	115	103	90	108	20	18	30

B:- After inoculation

Time afte added of bacteria i days	Available micronutients(ppm)											
	Fe			Mn			Zn			Cu		
	A*	B**	C***	A*	B**	C***	A*	B**	C***	A*	B**	C***
15	413	411	379	128	110	118	105	101	112	21	22	30
30	418	411	379	130	111	118	110	105	112	20	23	30
45	420	415	380	135	112	118	114	110	117	21	23	29
60	421	415	381	136	112	119	118	113	124	23	24	31
75	422	416	381	136	113	120	120	117	125	23	24	31
90	422	417	381	137	114	120	121	122	125	23	24	30

A* = rice straw pile after added of Azotobacter chroococcum
B = rice straw pile after added of Bacillus megatherium**
C*= rice straw pile after added of Bacillus circulance**

Concerning, the available micronutrients after 90 days from application of biological activators, data show that slightly increases for Fe, Mn,Zn and Cu .Such increases reach to 2.35, 1.34 and 0.63 % for Fe, 6.38, 6.25 and 4.25 % for Mn, 14.9, 26.2 and 13.6 % for Zn and 13.04,25.0 and zero % for Cu, respectively.The variation in the nutrients values of all piles attributed to the difference activity of microorganisms inside heaps and difference released of nutrients through decomposition of straw rice materials.

3. Production of plant growth regulators from rice straw compost which inoculated with some bacteria.

The production of plant growth as microbial metabolites in compost is often directly linked to substrate availability,such as carbon and nutrients, which realesed as a result of decomposition of rice straw. Data presented inTable (5) show that ,generally,increase of plant growth regulators after inoculation with three type of bacteria as compared to before inoculation ,in spite of that relatively decrease in IAA content as a result of added Bacillus megatherium .Results also indicated that ABA content is relatively increase when compost is enriched with Bacillus circulance.

Table (5):-Production of plant growth regulators by microorganasmis.

Plant growth	Before		After inoculation with bacteria (mg/g)	
Regulators	Inoculation (mg/g)	A*	B**	C***
IAA	1.23	2.689	0.538	1.434
GA3	0.573	1.036	0.833	2.247
ABA	0.057	0.133	0.181	1.480

A* = rice straw pile after added of Azotobacter chroococcum
B** = rice straw pile after added of Bacillus megatherium
C***= rice straw pile after added of Bacillus circulance

Obtained data agree with findings obtained by those Nieto and Frankenberger (1990) and Arshad and Frankenberger (1992) who reported that microbial production of auxins as well as Allison (1947) suggested that mechanism for the action of Azotobacter is production of plant growth regulator. Gonzalez et al. (1986) added that production of gibberelins is influenced by the growth and incubation time .On the other hand, IAA-synthesizing capacity is influrance by decomposition of carbonaceous materials (Mclaren and Peterson,1967).

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REFERENCE

Abdel – Wahab , A.F.M.(1999) . Iron-Zinc-organic wastes interactions and their Effects on diological nitrogen Fixation in newly Reclaimed soils Ph.D . Thesis ,Fac. Agric., Ain shams univ. Egypt.

Abdel- Azeem, H.M. (2001) .Some factors affecting the composting process of rice straw.Annals Agric. Sci. 46:525 -541

Abdel-Hafez ,A.H.(1966).Some studies on acid producing microorganisms in Soil and rhizosphere with special reference to phosphate dissolves. Ph.D. Thesis Fac.Agric., Ain shams univ., Cairo, Egypt ,pp.29-30.

Abou El- Naga, S.A ; M.M. El-Shinnawi ;S.A. 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 ., 37:1-14.

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. Agric., Moshtohor, Zagazig Univ.

Allen ,O.N.(1959).Experiments in soil bacteriology.3rd ed.Burgess publ .CO.

Allison,F.E.(1947).Azotobacter inoculation of crops:1.Historical .Soil Sci. 64: 413 -429.

Arshad,M. and W.T. Frankenberger (1992).Microbial biosynthesis of ethylene and its influence on plant growth: A review.Adv.Microb.Ecol.12:(in press).

Assal, M.H.(1994).The role of soil fungi in potassium release from some soils of Egypt.J.Appl.Sci.,9:335-349.

Balabel, N. M.A . (1997) .Silicate bacteria as bio fertilizer .S.M.Sc.Thesis Fac.Agric.Ain Shams Univ.,Egypt,pp.51-60,136 –143.

Black,C.A.(1982). Methods of soil analysis.Part 2 .Chemical and microbiological Properties .Second Edition .Amer .Soc. of Agron.Madison , Wisconsin, U.S.A.

Brown, M.E. and S.K. Burlingham (1968).Production of plant growth Substances by Azotobacter chroococcum.J.Gen.Microbiol.53:135-144.

Brown,M.E. and N. Walker (1970). Indolyl-3-acetic acid formation by Azotobacter chroococcum.Plant and Soil. 32:250-253.

Chen , W.; H.A.J. Hoitink ; A.F. Schmitthenner and O.H. Tuovinen. (1988). The role of microbial activity on the suppression of damping. off caused by pythium ultimum phyto pathology.Plant and soil. 78:314-322.

Cochran,W.G.(1950) . Estimation of bacteria densities by means of the "most Probable number".Biometrics,6:105-116.

Dewes,T.H.(1994).Nitrogen Leaching in Ecological Agriculture . Academic Publishers, N.Y.309-317.

Diaz,L.F.;G.M.Savage ;L.L.Eggerth and C.G.Golueke.(1993).Composting and Recycling municipal solid waste.Leuis Bocaraton, Ann.Arbor., London , Tokyo.

Faure, D. and A.M.Deschamps.(1990). Physico-chemical and microbiological Aspects in composting of grape pups. Biological Wastes.34:251-258.

Gaur ,A.C.; K.V.Sadsivam;R.S.Mathur and S.P.Magu (1982).Role of mesophilic Fungi in composting ,Agric .Wastes.,4:453-460.

Gaur,A.C.(1987).Recycling organic wastes by improved technique of composting and other methods. Resources and conservation, Elsevier Sic. Pub .B.v.. Amsterdam- printed in nether lands.13:157-174.

Goldstein, A.H.(1986). Bacterial subsidization of mineral phosphates :historical Perspective and future propects.Am.J.Altern.Agric.1:51-57.

Gonzalaz,L.j.; V. Salmeron ; M.V. Martinez-Toledo ; F. Ballesteros and A.Ramos-Cormenzana.(1986).Production of auxins,gibberellins and cytokinins by Azotobacter vinelandii ATCC 12837 in chemically – defined media and dialized soil media .Soil Biol.Biochem.18:119-120.

Hiria .M.;V. Chanyasak and H.Kubota.(1983).A standard measurement for compost Maturity.Biocycle,24:54-66.

Jodice,R.; A .Luzzati and P.Nappi.(1982).The influence of organic fertilizers, obtained from poplar bark,on the correction of iron chlorosis of luipinus albusl. Plant and Soil. 65:309-317.
Kaloosh,A.A.(1994).Changes in composition of a compost prepared from Different Organic materials and its effect on Vicia Faba yield.J.Agric.Sci., Mansoura Univ.(C.F.,Allam,E.H.1999.M.Sc.Thesis, Fac.Agric.,Moshtohor, Zagazig Univ.)
Laila,A.M.K.(2001) .Use of improved organic fertilizers as nutrients sources .Ph. D. Thesis ,Fac .Agric .,Ain Shames Univ.
Mahimairaja ,S.;N.S. Bolan and M.J. Hedley (1995).Dissolution of phosphate Rock During the composting of poultry manure : an inoculation Xperiment. Fertilizer Research 40:93-104.
Mbagwn ,J.S.C. and A . Piccolo .(1990).Carbon ,nitrogen and phosphorus Concentrations in aggregates of organic waste- amended soils .Biol. Wastes 31:97-111.
McLaren,A.D. and G.H.Peterson (1967)." Soil Biochemistry" ,Vol.1.Marcel Dekker,New York,p.509.
Mohamed,M.M.H.(1999).Organic refuses composted by micro –organisms and Their Effect on the availability of some nutrients in newly reclaimed Soil.Ph.D.Thesis,Fac.Agric., Zagazig Univ.
Moharram,T.M.M.;T.H.EL-Dahtory and M.S.A.Safwat(1989).Microbiological and chemical changes in some local organic waste materials during composting process.Minia J.Agric.and Dev.,11:403-416.
Nieto,K.F.and W.T. Frankenberger(1990).Microbial production of cytokinins .In soil Biochemistry,Vol.6,J.M.Bollag and G.Stotzky (eds.).Marcel Dekker,New York,pp.191-248.
Novikova,A.T.and L.D.Irtuganova(1966).Heteroauxin production by soil Microorganisms.Micobiologica.35:598-601.
Page,A.L.;R.H.Meller and D.R. Keeneyeds (1982). "Methods of soil Analysis", Part2.Chemical and microbiological properties .Agronomy monograph NO.9,2nd Ed.,pp.539-624.
Paul,E.A.and F.E.Clark (1995). " Soil microbiogical and Biochemistry " 2nd ed. pp .265- 287 Academic press,N.Y.
Sadeghian, E. (1971) . Einfluss von chlorchelinchlorid (CCC) auf den Gibberellingehalt (GA_3) von getreidepflanzen.Z. Pflanzenern. Bodenk 130 , 233 -241.
Singh, C.P. and A. Amberger (1995). The effect of rock phosphate−enriched Compost On the yield and phosphorus nutrition of rye grass .Am.J. Alternative Agric.82:10-87.

Subba Rao,N.S.;K.W.Hong and F.B.Metting (1993).ւ waste management in China and India .In:soil Mɪւ Application in Agricultural and Environmental Manaւ F. B.ed.) pp.562-575,Dekker,New York.

Tan, K.H. (1993). "Principles of soil chemistry " 2 nd .Ed. Marւ Lnc., New York.

Vogel ,A.I. (1975). A text Book of bractical organic chemistry . publish English Language book society and longman group limiteւ Ed.,P.969.

Wafaa, S.M.A. (2001). Biological weathering of K-bearing minerals.Ph.D Thesis,Fac.Agric., Ain shams univ., Egypt.

Zahra,M.K. (1969). Studies on silicate bacteria M.SC. Thesis ,Fac.Agric.,Cairo Univ.,Egypt, PP.44,71-73,101-111.

تقييم أضافه اللقاح البكتيري لقش الأرز أثناء عملية التخمر تحت الظروف الهوائية

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في هذا البحث تم دراسة بعض العوامل التي تؤثر على عمليــة التخمــر الــهوائي لقــش الأرز المضاف اليه سماد الدواجن والمعادن الطبيعية مثل الفلسبار والماجنتيت وصخر الفوسفات والمخصب ببعــض اللقاحات البكتيرية للوصول إلى الظروف المثلى التي تسرع من عملية النضج وتـــم كذلــك تقديــر بعــض التغيرات الكيميائية والبيولوجية أثناء عملية التحلل واستمرت عملية التخمر ١٥٠ يوم تحت الظروف الهوائيــة بالاضافة الى ٩٠ يوم اخرى بعد اجراء عملية التلقيح البكتيري حيث آخذت خلال دلك عينات لأجراء تحــاليل كيميائية تتضمن درجة الحرارة ، pH، EC ، المحتوى الكلي للنيتروجين، الفوسفور، البوتاسيوم والمحتوى الميسر من الحديد، المنجنيز، الزنك و النحاس كما تم تتبع درجة الحرارة وكذلك نسبة الكربــون :النــتروجين اثناء عملية التحلل. ومن جهة اخرى تم اجراء التلقيح البكتيري للكمبوست وتــم اجــراء بعــض التحــاليل لبيولوجيــة مثــل تقديــر أعـــــداد بكتيريــــا Bacillus ,Azotobacter chroococcum Bacillus circulance و megatherium وذلك لمدة ٩٠ يوم اخرى . واخيرا تــم اســتخلاص وتقدير بعض منظمات النمو والتى تشمل اندول استيك اسد (IAA) والجبريلك اسد (GA3) وكذلك ابسيسك اسد (ABA) من الكمبوست وذلك قبل اضافة اللقاح البكتيرى وبعد الاضافة وأوضحت النتائج مايلى:-

ارتفعت درجة الحرارة أثناء الأسبوعين الأولين حيث تبدأ مرحلة الثيرموفيليك حيث وصلت درجــة الحرارة إلى ٥٨–٦٢ م° ثم ظهرت مرحلة الميزوفيلك حيث تبدأ درجة الحرارةفى الانخفاض بعد ٦٠ يــوم من عمل الكومبوست وحتى نهاية عملية التخمر .

كما أوضحت النتائج زيادة قيم pH , EC بزيادة فترة التحلل لقش الارز فى المكمــورات الثلاثــة وخاصة بعد اضافة اللقاح البكتيرى اليها كما زاد المحتوى الكلى من العناصر الكــبرى والصغــرى تحــت الدراسة وبصفة خاصة زاد محتوى النيتروجين والفوسفور والبوتاسيوم فــي المكمــورات المخصبــة بـــــ Bacillus megatherium and Bacillus ,Azotobacter chroococcum circulance لكل منهما على الترتيب بعد ٩٠ يوم من إضافة البكتيريا كما زاد ايضا محتــوى العنــاصر الصغرى (الحديد- المنجنيز –الزنك –النحاس) كما سجلت نسبة C/N ratio انخفاض ملحوظ أثناء تحلل قش الأرز قبل وبعد إضافة اللقاحات البكتيرية.

وبصفة عامة اظهرت الدراسة زيادة اعداد البكتيريا الثلاثة خلال فترة الدراسة بعــد اجــراء عمليــة التلقيح بالمقارنة بفترة ماقبل الدراسة .