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Dynamics of free living N_2 -fixing and P-solubilizing microorganisms during composting and phospho composting of Urban solid waste

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ABSTRACT

An experiment was conducted to study the population dynamics of N_2-fixers and P-Solubilizers during composting and phosphocomposting of urban solid waste. The results indicate that the populations were initially very low up to 30th day and increased thereafter. The population of both the microorganisms was high in phosphocomposting system during last stage compared to ordinary composting. There was significant difference in pH during composting of urban solid waste. Initially pH was acidic (6.61), later on there was increase in pH noticed up to 21st day and there after pH started decreasing. In ordinary composting system 21st day registered highest reducing sugar (8.64 mg /g dry weight) but phosphocompost registered highest reducing sugar on 7th day (9.86mg/ g dry weight) .In phosphocomposting system there was considerable reduction in the reducing sugar content noticed.

Key words: Composting, Phosphocomposting, N_2-fixers, P-Solubilizers.

INTRODUCTION

Composting is a method of stabilizing organic matter and it involves microbial degradation of organic matter carried out by dynamic and quick succession of microorganisms[1]. The maturity of compost critically affects their successful utilization in agriculture. The use of incompletely decomposed immature compost for crop production leads to reduction in crop yield due to immobilization of plant nutrients and phytotoxicity[2].

The development of sustainable agriculture requires a strong reduction in agrochemical inputs and their replacement by more ecological, efficient and cheap natural products[3]. The N_2 - fixers and P-solublizers are important natural inputs which can reduce environmental pollution and cost of agricultural production. Some heterotrophic and free living nitrogen fixers and P-solubilizers are naturally present in decaying organic matter. The population of microorganisms in any ecosystem is influenced by condition existing in that ecosystem. In this view an experiment was conducted to know the influence of stage of decomposition on population of beneficial microflora such as N_2 - fixers and P-solubilizers. The knowledge of population dynamics of these microflora during different stages of composting also helps us to know the importance of compost maturity.

MATERIAL AND METHODS

Composting process

In case of ordinary composting, substrate comprising of 20 tones of municipal solid waste and cow dung slurry @ 5per cent (W/W), were mixed properly using poklane machine and allowed it for decomposition in windrow method. In phosphocomposting, substrate comprising of 20tones of municipal solid waste, cow dung slrry @ 5 per cent, Udaipur rock phosphate @ 5 per cent and lignite based P-solubilizing microflora *Aspergillus awamori* @ 1Kg per tone of waste were

mixed using Pokelane machine and allowed for decomposition in windrow method. Regular turnings were given at weekly intervals. Samples were drown at random from three different places during 0, 7, 15, 21, 30, and 45th days of composting from both ordinary and phosphocomposting systems and analyzed for pH, temperature, reducing sugar content, population counts of free living Nitrogen fixing and P-solubilizing microorganisms.

Measurement of pH

About 10 g of sample was stirred with 25 ml of distill water for 30 minute and pH of the suspension was measured potentiometrically using pH meter [4]

Measurement of temperature

The measurement of temperature was done at three places of heap by inserting hand thermometer.

Reducing sugar

Reducing sugar content of compost samples were analyzed as per Prussian blue method [5].

Enumeration

The enumeration of free living Nitrogen fixing and P-solubilizing microorganisms was done by standard dilution plate count method using Norris N-free medium [6] and Sperber's medium[7] 10 g of compost sample was transferred into 90 ml of sterile water blank and serially diluted .The one ml aliquot from appropriate dilutions were transferred aseptically into sterile plates and molten lukewarm agar were poured to respective plates. The plates were gently rotated to uniformly distribute the inoculums before the medium was solidified. The plates were then incubated at 30±1°C temperature for 3-7 days and colony counts were recorded. In case of P- solubilising microorganisms only clear zone forming colony counts were taken.

RESULTS

The population of Nitrogen fixers was highest in phosphor composting than in ordinary composting (Table 1) .The 45th day old compost showed maximum population followed by 35th day old compost. The minimum population of free living Nitrogen fixers recorded during 21st day in both ordinary (3×10^5 CFU/g dry weight) and phosphocomposting ($1.75X10^5$ CFU/ g dry weight). The 45th day old phosphocompost recorded maximum population of N_2-fixers (30.26×10^5 CFU/g dry weight)

The population of P-solubilizers was highest in phosphocompost than ordinary compost. The population of P- solubilizers was highest in 45th day old phosphocompost ($37.02X10^5$ CFU/ g dry weight) but lowest population was documented in ordinary compost during 21st day ($7.25X10^5$ CFU/ g dry weight).

Table 1: Population dynamics of N2 –fixers and P-solubilizers during composting

Days	Population of N2-Fixers(CFUX10^5)			Population of P-solubilizers(CFUX10^5)		
	Ordinary composting	Phospho composting	Mean	Ordinary composting	Phospho composting	Mean
0	9.80	9.80	9.80	16.55	16.55	16.55
7	8.85	5.95	7.40	13.15	6.28	9.71
15	5.05	2.69	3.87	7.15	7.43	7.29
20	3.15	1.55	2.35	3.55	18.63	11.09
30	9.50	12.11	10.80	13.60	20.76	17.18
35	15.45	28.98	22.21	15.50	24.92	20.21
45	16.45	30.26	23.35	15.65	37.02	26.33
Mean	9.75	13.04		12.16	18.79	

Table 2: Temperature and pH during different stages of composting

Days	Temperature (°C)			pH		
	Ordinary composting	Phospho composting	Mean	Ordinary composting	Phospho composting	Mean
0	30.66	30.66	30.66	6.78	6.78	6.78
7	49.33	54.33	51.83	8.45	7.80	8.12
15	52.66	67.33	60.00	8.14	8.49	8.31
20	57.33	62.33	54.83	8.24	8.56	8.40
30	58.00	66.00	62.00	8.58	8.17	8.37
35	50.66	61.00	55.83	8.14	8.12	8.13
45	41.33	51.00	46.16	7.84	7.72	7.78
Mean	48.57	54.66		8.02	7.94	
Source	**SEm±**	**CD (5%)**	**Source**	**SEm±**	**CD**	
A(Stages)	1.03	2.99	A(Stages)	0.89	**(5%)**	
B(System)	0.55	1.59	B(System)	0.048	0.24	
AxB	1.46	4.23	AxB	0.126	NS +0.34	

+Non significant

The data pertaining to dynamics of temperature during composting and phosphocomposting reveals that the temperature attained in phosphor composting was significantly higher than ordinary composting (Table 2). On 15th day and 30th day the phosphocomposting system documented highest temperature (of 67.33°C and 66.00°C respectively).A highest temperature of 58° was noticed in ordinary composting system during 30th day.

There was significant difference in pH during composting of urban solid waste. Initially pH was acidic (6.61), later on there was increase in pH noticed up to 21st day and there after pH started decreasing (Table 2). Between composting systems there was no significant changes noticed with respect to pH. The 30th day ordinary compost registered maximum pH (8.58) followed by phosphocomposting on 30th day (8.56).

Table 3 represents the reducing sugar content of compost sample at different stages of composting.In general there was decrease of reducing sugar content during composting upto 30th day and there onwards increasing trend was noticed. In ordinary composting system 21st day registered highest reducing sugar (8.64 mg /g dry weight) but phosphocompost registered highest reducing sugar on 7th day (9.86mg/g dry weight). In phosphocomposting system there was considerable reduction in the reducing sugar content noticed.

Table 3: Changes in reducing sugar content during composting

Days	Reducing sugar content (mg/ g dry weight)		
	Ordinary composting	Phospho composting	Mean
0	11.83	11.83	11.83
7	7.60	9.86	8.73
15	8.06	4.56	6.31
20	8.64	5.22	6.93
30	6.33	3.33	4.83
35	6.68	5.32	6.00
45	7.55	6.17	6.86
Mean	8.09	6.61	
Source	**SEm±**	**CD (5%)**	
A(Stages)	0.34	0.98	
B(System)	0.18	0.53	
AxB	0.49	1.41	

DISCUSSION

The natural carbon cycle involving soil-plant-animal-air-soil systems plays significant role in soil improvement and maintenance of environmental quality.It is due to this basic necessity that the organic materials of the plant and animal origin have been considered as immense practical value to the soil fertility and productivity from the historic times [8] .The organic matter availability is substantial it cannot be directly used as plant nutrient because it can cause serious damage to plant growth[2].

So it should be stabilized before application. Composting is one such method of stabilization of organic solid (non aqueous) materials that involves aerobic respiration and it yields stabilized end product called compost. The quality of compost developed by ordinary means is very poor so variety of methods are used for the improving it. One such method is phosphocompost. In this study an effort is made to study the influence of application of rock phosphate on population of Nitrogen fixers and P-solubilizers.

The population of N_2-fixers and P-solubilizers was highest in phosphocompost than ordinary compost. The phosphorus is a constituent of nucleic acid, phospholipids and coenzymes.Thus it is of great importance in microbial nutrition. It is also a constituent of ATP, phosphorylated sugars and phosphorylated organic acids. Thereby it plays an integral role in energy metabolism [9]. In the light of these observations the increased population of the organisms observed in phosphocompost may be due to the increased P availability to N_2-fixing and p-solubilizing microorganisms. In both the composting systems the minimum population of N_2 fixing and P-solubilizing microorganisms was noticed during initial stages (up to 30th day). In those stages temperature and pH of the samples were very high and that might have created an uncongenial environment resulting in decreased population of microbes.In the initial stages of composting pH was acidic and lateron there was significant increase upto 21st day and thereafter there was decreasing trend noticed. The urban waste contains very high amount of moisture and it will lead to anaerobic condition initially. Under anaerobic condition incompletely oxidized products such as organic acids are produced which reduces the pH of the sample.as the composting processes there will be loss of moisture resulting in shift from anaerobic metabolism to aerobic metabolism. The breakdown of proteins associated with release of ammonia is responsible for increase pH[10]. So the increased pH noticed in the present study may be due to release of ammonia due to decomposition of proteins. During composting raise temperature is due to evolution and conservation of metabolic heat [10].In the present study among composting systems higher temperature was attained during phosphocomposting. Addition of rock phosphate during composting enhances microbial activity[11]. Higher temperature attainment in phosphocomposting may be due to higher microbial acivity. In two types of composting systems, during 45th day the population of both the beneficial isolates were very high compared to other stages. The reducing sugar content was also high during 45th day.

The high reducing sugar content coupled with favourable pH and temperature may be the possible reason for increased population. In phosphocomposting system 45th day old sample recorded low amount of sugar compared to same day old ordinary compost but the population of beneficial organisms recorded during that stage was more. The reduction of reducing sugar may be due to increased microbial activity and there by increased microbial utilization. In ordinary composting system 21st day registered highest reducing sugar (8.64 mg /g dry weight) but phosphocompost registered highest reducing sugar on 7th day (9.86mg/g dry weight),even then the population of beneficial microbes was less which may be due to increased temperature and pH during those stages.

CONCLUSION

Composting is an organic matter stabilization method. Organic matter is applied to improve soil property and there by soil health. This study gives an idea the importance of compost

maturity in maintaining the soil health. The results of this study clearly indicates that the immature compost is a poor supporter of natural beneficial microflora and other hand the complete stabilization of organic matter creates a congenial environment for the growth of microorganisms. It also proves that phosphocomposting in addition to improving nutrient content of compost developed also increases the population of beneficial microflora.

REFERENCES

1. Viel,M.,Sayag,D.Peyare,A. and Andre,L., Optimization of in vessel composting through heat Recovery..*Biol.Wastes.*, **20**:167 (1987).
2. Zucconi, F. and Bertoldi,M., Compost specification for production and characterization of composts from municipal solid wastes.InCompost production quality and usecompost production quality and use, Elsevier pub. London, 2 (1987)
3. Macias, F.A., Marin, D., Oliveros-Bastidas, A., Varela, R.M. Simonet, A.M., Carrera, C. and Molinillo, J.M.G., Allelopathy as a new strategy for sustainable ecosystems development, *Biol. Sci. Space*, **17**: 18 (2003)
4. Baruah,T.C.and Barthakur,H.P.,Atext book of soil analysis,Vikas publishing house Pvt.Ltd.,New Delhi, 106 (1997)
5. Schinner,F. and Von Mersi,W.,Xylanase, CM-cellulose and invertase activity in soil: an improved method, *Soil Biol.Biochem*, **22**: 511 (1990)
6. Norris , J.R., Isolation and identification of *Azotobacter*, *Lab practice,* **8**: 239 (1959)
7. Sperber, J.I., Solubilization of mineral phosphate by soil bacteria, *Nature,* **180**: 994 (1957)
8. Bharadwaj, K.K.R. and Gaur, A.C., Recycling of organic wastes.IARI, New Delhi,3 (1985)
9. Stanier, R.Y., Ingraham, J.L., Wheelis, M. L. and Painter. P. R., Microbial World, Prenice Hall, New Jersey, 221 (1986)
10. Miller, Ecological process of composting In: Soil microbial ecology ,Marcel dekkerInc. New York, 215 (1993)
11. Manna, M.C. and Ganguly, T.K., Rock phosphate and pyrite in composting technology. *Fert,* **45**(7): 41(2000).