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RESEARCH ARTICLE

ENHANCEMENT OF KEEPING QUALITY AND NUTRIENT CONTENT OF ORGANIC LIQUID MANURES BY AUTOCLAVING AND PGPR ADDITION

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ABSTRACT

An investigation was carried out at College of Agriculture, Vellayani, Kerala, to evaluate the keeping quality shelf life and nutrient content of organic liquid manures. The results of the study revealed that the shelf life of promising organic liquid manure could be improved by bringing the pH to slightly acidic condition (6-6.5) by the addition of lime. Autoclaving helped to remove the foul smell of liquid manures without causing any reduction in nutrient content.

INTRODUCTION

Organic manures play a key role in sustaining crop growth and productivity and the same is mainly applied through soil. Among the organic manures groundnut cake, vermi compost, neem cake, poultry manure and compost are considered to be viable choice in crop production owing to their high nutrient content. Their soil application either alone or in combination was found beneficial in enhancing the productivity of vegetables. The feasibility of developing an organic foliar formulation using these manures has not much intervened. Use of foliar formulations is gaining importance in crop production owing to its quick response in plant growth. Foliar feeding of nutrients is a viable supplement to conventional soil application and it entails the application *via* spraying of nutrients to plant leaves and stems and their absorption through those sites. Shelf life study was conducted after pH adjustment. The selected liquid manures were kept in plastic and earthen vessels both in open and refrigerated conditions with PGPR and without PGPR addition. Mould growth was first observed after three days of storage in the plastic bottles and earthen vessels kept in open condition. In the refrigerated condition mould growth was observed after seven days of storage.

The physical environment might have favoured the growth of undesirable microorganisms and thus caused the mould growth and foul odour in the liquid manures during storage and also reduced the quality of liquid manures. The autoclaving PGPR addition of liquid manures prevent the mould growth and foul odour of liquid manures and increased the nutrient content during storage.

MATERIALS AND METHODS

Three composite organic liquid manures having high nutrient content were selected for the shelf life study. Composite organic manures were prepared by mixing different proportion of various sources and these composite manures were mixed with five times water and the liquid extract was collected after seven and 15 days. The nutrient content of the organic liquid manures were analysed. The selected liquid extracts were subjected to shelf life study after bringing the pH to slightly acidic condition (6-6.5) by the addition of lime. The selected liquid manures were kept in plastic and earthen vessels both in open and refrigerated conditions with PGPR and without PGPR addition. The liquid manures kept for storage in open and refrigerated condition showed mould attack and the incidence was observed early in open condition (3DAS) and was delayed by 4 days under refrigerated condition. Storage of liquid manures in open and refrigerated condition in different

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containers had no effect on shelf life and the liquid manures had foul odour and severe mould infestation. Hence, liquid manures were subjected to autoclaving. Autoclaving removed the foul smell of the manures. Autoclaving and PGPR addition removes the foul odour and increased the nutrient content during storage. The study was undertaken with autoclaving and without autoclaving with the following treatments.

I. Shelf life study with pH adjustment and without autoclaving

Treatments

a. Liquid manures (3)

Extracts of following composite manures

L₁ – Ground nut cake +poultry manure (1:1)

L₂ - Ground nut cake + poultry manure+vermicompost (1:0.5:0.5)

L₃ - Ground nut cake +neem cake+ poultry manure (1:0.5:0.5)

b. Containers (2)

C₁ - Plastic container

C₂ - Earthen pot

c. Storage (2)

S1- Open condition

S2 - Refrigerated condition

d. Bio inoculants (2)

B₁- With PGPR mix 1 and 2 at 2% concentration

B₂- Without PGPR

II. Shelf life study with pH adjustment and with autoclaving

a. Liquid manures (3)

Extracts of following composite manures

L₁ – Ground nut cake +poultry manure (1:1)

L₂ - Ground nut cake + poultry manure +vermicompost (1:0.5:0.5)

L₃ - Ground nut cake +neem cake+ poultry manure (1:0.5:0.5)

b. Container (1)

C₁ – Glass

c. Storage (2)

S1- Open condition

S2 - Refrigerated condition

d. Bio inoculants (2)

B₁- With PGPR mix 1 and 2 at 2% concentration

B₂- Without PGPR

RESULTS AND DISCUSSION

i. Shelf life study with pH adjustment and without autoclaving

a. Nutrient content during storage

Mould growth was first observed after three days of storage in the plastic bottles and earthen vessels kept in open condition. In the refrigerated condition mould growth was observed after seven days of storage. N, P, K content of selected liquid manures kept in plastic bottles and earthen vessels were assessed in open and refrigerated condition, with and without PGPR addition at 7, 15 and 30 days of storage. The results presented in Table 1, 2, 3 revealed that the containers, PGPR addition and storage condition had no influence on the nutrient content estimated at different intervals. However, a slight increase in N content was observed with PGPR addition. In all cases nutrient content decreased with increase in storage time. The physical environment might have favored the growth of undesirable microorganisms and refrigeration slightly delayed the growth leading to four days delay on mould attack.

Storage of liquid manures in open and refrigerated condition in different containers had no effect on shelf life and the liquid manures had foul odour and severe mould infestation. Hence, liquid manures were subjected to autoclaving. Autoclaving removed the foul smell of the manures.

a. Nutrient content during storage

The nutrient content of liquid manures at different periods of storage was assessed with and without PGPR addition both under open and refrigerated condition and presented in Table 4. The results revealed that the N content varied with storage periods. PGPR addition and method of storage significantly enhanced N content of all liquid manures. PGPR have emerged as the biggest group of beneficial soil microorganisms, involved in the control of a number of plant diseases and pests by virtue of their ability to synthesize a wide range of antagonistic secondary metabolites (Malleth, 2008). At 15 DAS, L₃ with PGPR addition registered the highest N content of 0.90 % under refrigerated condition. The liquid manures kept both under open and refrigerated condition without PGPR addition showed a significant decline in N content on storage. The initial N content without PGPR addition (0.45, 0.50 and 0.62 % of L₁, L₂ and L₃) was reduced to 0.33, 0.38 and 0.51 % respectively. With PGPR addition, the N content enhanced on storage up to 60 DAS and a significant reduction was observed on 90 DAS both under open and refrigerated condition. Among the liquid manures, L₃ registered the highest N content with PGPR addition. PGPR addition might have enhanced the activity of free living *Azotobacter* and *Azospirillum* thereby increasing the N content of liquid manures on storage. The enhanced mineralization and in- vitro N fixation by microbes also contributed to high N content.

The P content of liquid manures (Table 4) analysed at different storage periods revealed that maximum P content was maintained by L₂ with and without PGPR addition up to 30 DAS.

Table 1. Nitrogen content of liquid manures on storage (%)

Treatments	Open condition				Refrigerated condition			
	Without PGPR		With PGPR		Without PGPR		With PGPR	
	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen
	7 DAS							
L ₁	0.16	0.15	0.21	0.20	0.16	0.15	0.24	0.22
L ₂	0.11	0.11	0.19	0.18	0.11	0.10	0.21	0.19
L ₃	0.18	0.16	0.24	0.22	0.18	0.16	0.25	0.22
CD	NS	NS	NS	NS	NS	NS	NS	NS
	15 DAS							
L ₁	0.13	0.13	0.18	0.16	0.13	0.12	0.19	0.18
L ₂	0.10	0.10	0.14	0.13	0.11	0.11	0.18	0.16
L ₃	0.16	0.13	0.19	0.18	0.16	0.15	0.19	0.18
CD	NS	NS	NS	NS	NS	NS	NS	NS
	30 DAS							
L ₁	0.11	0.11	0.11	0.11	0.11	0.11	0.13	0.11
L ₂	0.11	0.10	0.11	0.10	0.10	0.11	0.11	0.10
L ₃	0.12	0.11	0.13	0.11	0.11	0.15	0.13	0.11
CD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Phosphorous content of liquid manures on storage (%)

Treatments	Open condition				Refrigerated condition			
	Without PGPR		With PGPR		Without PGPR		With PGPR	
	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen
	7 DAS							
L ₁	0.01	0.01	0.04	0.04	0.02	0.02	0.04	0.04
L ₂	0.04	0.04	0.04	0.04	0.05	0.05	0.08	0.08
L ₃	0.01	0.01	0.04	0.04	0.03	0.03	0.07	0.07
CD	NS	NS	NS	NS	NS	NS	NS	NS
	15 DAS							
L ₁	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
L ₂	0.02	0.02	0.02	0.02	0.05	0.05	0.05	0.05
L ₃	0.01	0.01	0.04	0.04	0.03	0.03	0.04	0.04
CD	NS	NS	NS	NS	NS	NS	NS	NS
	30 DAS							
L ₁	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
L ₂	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04
L ₃	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
CD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Potassium content of liquid manures on storage (%)

Treatments	Open condition				Refrigerated condition			
	Without PGPR		With PGPR		Without PGPR		With PGPR	
	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen	Plastic	Earthen
	7 DAS							
L ₁	0.10	0.10	0.11	0.11	0.13	0.13	0.15	0.15
L ₂	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
L ₃	0.10	0.10	0.13	0.13	0.12	0.12	0.16	0.16
CD	NS	NS	NS	NS	NS	NS	NS	NS
	15 DAS							
L ₁	0.10	0.10	0.11	0.11	0.11	0.11	0.13	0.13
L ₂	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
L ₃	0.10	0.10	0.11	0.11	0.11	0.11	0.13	0.13
CD	NS	NS	NS	NS	NS	NS	NS	NS
	30 DAS							
L ₁	0.10	0.10	0.10	0.10	0.11	0.11	0.12	0.12
L ₂	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
L ₃	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
CD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. N, P, K content of liquid manures at different periods of storage after autoclaving

Treatments	Open condition						Refrigerated condition					
	Without PGPR			With PGPR			Without PGPR			With PGPR		
	N	P	K	N	P	K	N	P	K	N	P	K
	15 DAS											
L ₁	0.43	0.01	0.10	0.68	0.02	0.10	0.44	0.03	0.13	0.68	0.03	0.13
L ₂	0.51	0.04	0.10	0.73	0.04	0.15	0.51	0.05	0.11	0.75	0.07	0.15
L ₃	0.61	0.02	0.11	0.87	0.03	0.13	0.62	0.05	0.15	0.90	0.07	0.16
CD (0.05%)	0.027	0.009	0.016	0.027	0.009	0.016	0.027	0.009	0.016	0.027	0.009	0.016
	30 DAS											
L ₁	0.42	0.01	0.10	0.73	0.02	0.10	0.42	0.02	0.13	0.73	0.03	0.13
L ₂	0.48	0.04	0.10	0.79	0.03	0.15	0.49	0.06	0.11	0.80	0.07	0.15
L ₃	0.58	0.02	0.11	0.90	0.02	0.13	0.58	0.05	0.14	0.90	0.07	0.16
CD (0.05%)	0.021	0.012	0.047	0.021	0.012	0.047	0.021	0.012	0.047	0.021	0.012	0.047

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45 DAS												
L ₁	0.37	0.01	0.10	0.82	0.01	0.10	0.38	0.02	0.13	0.83	0.03	0.13
L ₂	0.43	0.03	0.10	0.85	0.02	0.15	0.44	0.05	0.11	0.84	0.07	0.15
L ₃	0.56	0.02	0.11	0.97	0.02	0.11	0.57	0.04	0.12	0.97	0.07	0.16
CD (0.05%)	0.031	0.011	0.048	0.031	0.011	0.048	0.031	0.011	0.048	0.031	0.011	0.048
60 DAS												
L ₁	0.35	0.01	0.10	0.89	0.01	0.10	0.35	0.02	0.11	0.91	0.02	0.12
L ₂	0.40	0.02	0.10	0.92	0.02	0.15	0.41	0.04	0.11	0.92	0.03	0.15
L ₃	0.53	0.02	0.10	0.98	0.02	0.11	0.53	0.03	0.11	0.99	0.05	0.16
CD (0.05%)	0.024	0.156	0.057	0.024	0.156	0.057	0.024	0.156	0.057	0.024	0.156	0.057
90 DAS												
L ₁	0.33	0.01	0.09	0.87	0.01	0.09	0.32	0.01	0.10	0.89	0.02	0.11
L ₂	0.38	0.01	0.09	0.89	0.01	0.12	0.38	0.04	0.09	0.90	0.03	0.12
L ₃	0.51	0.01	0.09	0.96	0.01	0.10	0.53	0.02	0.11	0.97	0.04	0.15
CD (0.05%)	0.023	0.007	0.001	0.023	0.007	0.001	0.023	0.007	0.001	0.023	0.007	0.001

Storage of liquid manure reduced the P content. Though refrigerated storage of PGPR added liquid manures decreased with increase in storage time, the decrease was more pronounced under open storage. From the initial value of 0.07 % P (with PGPR addition) for L₁ the value was reduced to 0.03 % at 15 DAS and the content was retained up to 45 DAS. Subsequently the content was reduced to 0.02 %. In the case of L₂ and L₃ the P content with PGPR addition was maintained to 0.07 % up to 45 DAS in a refrigerator and decreased subsequently.

The K content of liquid manures was estimated at 15, 30, 45, 60 and 90 DAS and results presented in Table 4. For all liquid manures addition of PGPR enhanced the K content. The treatment L₃ registered the highest K content with PGPR addition and refrigerated storage at 15, 30 and 45 DAS. The variation between open and refrigerated storage was found to be insignificant for L₂ at 15, 30 and 45 DAS. Though a slight reduction from the initial K content was observed at 15 DAS, the content was maintained up to 60 DAS and a decline was observed at 90 DAS.

Autoclaving removed the foul smell and improved the shelf life. The process might have destroyed the undesirable microflora producing foul smell and prevented mould incidence on storage which in turn promoted the shelf life of these liquid manures.

Conclusion

Autoclaving removed the foul smell and improved the shelf life. The process might have destroyed the undesirable microflora producing foul smell and prevented mould incidence on storage which in turn promoted the shelf life of these liquid manures.

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