International Journal of Research Studies in Biosciences (IJRSB)
Volume 1, Issue 1(July 2013), PP 23-28
www.arcjournals.org

Assessing the Effect of Ecosan Compost on Growth and Yield Characteristics of Maize

Jothimani.P, R.Sangeetha, B.Kavitha and K.Senthilraja
Department of Environmental Sciences,
Tamil Nadu Agricultural University,
Coimbatore-3, Tamil Nadu, India.
kavithaphd2008@gmail.com

Abstract: *Humanure (human manure) is human fecal material and urine. It is a major source of environmental pollution around the world. It is also a source of major diseases. When it is diffused into the environment as a waste material, it creates pollution and threatens public health. If it is recycled, the pollution and health threats can be eliminated. Humanure also contains valuable soil nutrients that can enhance plant growth and should be recycled whenever possible. For these reasons, a field experiment was conducted at Musiri (TK), Trichy (Dt.) to determine the effect of human manure (ecosan compost) on maize. Among the treatments T_5 (50 % RDF + NS compost @ 7.5 tonnes/ha) recorded the maximum of grain yield compared to the other treatments.*

Keywords:

1. INTRODUCTION

Human waste disposal in an innocuous form in highly populated and developing countries, Such as India and so it is an ever growing problem. The improper disposal of waste causes a serious threat of organic pollution to the environment and so several infectious diseases are bound to occur in epidemic proportions due to the contamination of drinking water resources [1]. Human faeces are rich in phosphorus and potassium, which are important plant nutrients, and they also contain carbon, which can increase the fraction of organic matter in soils. More organic matter in soils is especially important to improve the soil structure in tropical countries so that it becomes more resistant to droughts and to erosion from heavy rains and floods. It is also known that an increase in organic matter through the use of compost can make plants more salt-tolerant as shown in Swiss chard and common beans and apple trees [2].

Before using human waste as a fertilizer, they must be made safe because the number of enteric bacteria, viruses, protozoa and helminthes eggs in faeces can be high. Composting is the best way for doing so. Composting is also a method to balance the relation of carbon and nitrogen and if there is excess nitrogen its portion will be reduced [3]. Human wastes are considered to be a valuable nutrient source in a number of countries. Hence considering these benefits of human waste, a field experiment was conducted to determine the effect on growth and yield of maize.

2. MATERIALS AND METHODS

Human waste compost used for the cultivation of maize was obtained from the ECOSAN compost chambers constructed by SCOPE (NGO) at Musiri, Trichy (Dt). To study the effect of Ecosan compost on maize, the field experiment was conducted in the SCOPE, The NGO Field at Musiri during 2009. Maize seeds (Hybrid NK 6240) were planted during 2009 and applied the Ecosan compost and Municipal Solid Waste compost (obtained from Musiri Town Panchayat)

individually and in combination as per the treatment details given below. The Design of the experiment is RBD. It includes seven treatments and three replications.

Treatments

T_1 - Control
T_2 - 75% RDF + NS Compost @ 5 t/ha
T_3 - 75% RDF + VC compost @ 5 t/ha
T_4 - 75% RDF + MSW compost @ 5 t/ha
T_5 - 50 % RDF + NS compost @ 7.5 t/ha
T_6 - 50 % RDF + VC compost @ 7.5 t/ha
T_7 - 50 % RDF + MSW compost @ 7.5 t/ha
NS : Night soil compost / Human waste compost VC : Vermicompost
MSW : Municipal Solid Waste compost of Musiri Selection Grade Town Panchayat
RDF : Recommended Dose of Fertilizers

3. RESULTS AND DISCUSSION

3.1 Ecosan compost on soil properties

The data on soil reaction has revealed that it is higher under the treatment that has received Ecosan compost than those treatments that have received Vermicompost and MSW compost (Table 1). Among the treatments, T_5 has recorded the highest mean pH, EC and organic carbon value of 8.31, 1.62 dS m^{-1} and 1.22 %, respectively. The least value is observed in T_1 (8.16, 1.30 dS m^{-1} and 0.82%, respectively) (Control). All the stages and treatments are found to be significantly different from one another. This might be due to the organic acids released through microbial decomposition of organic matter [4]. This is in accordance with the findings of [5] who reported an increase in soil EC, due to the application of compost, which dissolves the salts from fertilizers. This reduction in salt concentration may be due to nutrient removal by crops and leaching of salts from surface to subsurface soil.

As the composts underwent mineralization, the organic carbon content of soil also could have increased. In soil, significant reduction in organic carbon content was noted at the post harvest stage. The organic carbon content of soil was found to be decreased at the end of the post harvest stage, which could be due to the rapid decomposition of organic matter and loss of carbon as CO_2 from soil [6].

3.2 Macronutrients

The available nitrogen content of soil ranges from 234 to 319 kg ha^{-1} (Table 2). The available nitrogen, phosphorus and potassium content is higher under application of Ecosan compost than that of Vermicompost and MSW compost. The mean soil available N, P and K is the highest in T_5 (50 % RDF + NS compost @ 7.5 tonnes/ha) (319, 43 and 347 kg ha^{-1}) followed by T_6 (50 % RDF + VC compost @ 7.5 tonnes/ha) (308, 40 and 340 kg ha^{-1}). Application of the Ecosan compost invariably increases the soil available NPK content of soil and the NPK availability decreases with progress of the cropping period. Reduction in nutrient availability towards the maturity of crop might be due to higher uptake by plant. In general, Ecosan compost, Vermicompost and MSW compost are found to increase the soil fertility status. Among these, the performance of Ecosan compost @ 7.5 t/ha is found to be superior to the rest of the composts in terms of enhancing the soil available NPK status. A marked decline in available nitrogen in soil is observed with the advancement of crop growth, which might be due to the continuous removal of nitrogen by the crop, losses due to volatilization and leaching [7].

3.3 Soil microbial dynamics and enzyme activities

Among the treatments, T_5 (50 % RDF + NS compost @ 7.5 tonnes / ha) has recorded the highest bacterial, fungal and actinomycetes population of 72 x 10^6 g^{-1}, 13 x 10^3 g^{-1} and 20 x 10^4 g^{-1} followed by T_6 (Table 3). The lowest number is observed in T_1 (24 x 10^6 g^{-1}, 7 x 10^3 g^{-1} and 6x 10^4 g^{-1}). The microbial load decreases from flowering to vegetative stage and then decreased due to the variation in the crop growth stages and the action of root exudates. Humic substances in compost will contribute to increased levels of soil microflora and one of the important contributions of

compost is its high organic matter fraction, which improves the physical condition of poor soils [8].

The mean cellulase and phosphatase activity range between 52.3 and 74 mg of glucose released g^{-1} of soil and 18.3 to 48.6 µg PNP released g^{-1} of soil, respectively. The lowest activity is noticed in T_1 (Control). All the stages are significantly different from one another. Application of Ecosan compost, MSW compost and Vermicompost increase the soil organic carbon and microbial population which in terms responsible for the enzyme activity and it varies according to the dose of the manures applied. It may be due to the easily biodegradable organic matter in compost, since the biological activity is correlated with organic carbon content.

3.4 Growth and yield of maize

Plant height of maize is increased from vegetative to harvesting stage. Application of 50 % RDF + NS compost @ 7.5 tonnes/ha (T_5) has produced plant height, LAI and dry matter production of 180.93 cm, 4.67 and 7798 kg ha^{-1}. The highest cob length, number of cobs per plant, hundred grain weight, grain yield and straw yield is recorded in the treatment that applied with 50 % RDF + NS compost @ 7.5 tonnes/ha (T_5) 19.0 cm, 210.56, 42.43, 32 g, 6735 kg/ha and 10989 kg/ha followed by the T_6 (50 % RDF + VC compost @ 7.5 tonnes / ha (18.35cm, 40.0, 206.75, 31.65, 6585 kg/ha and 10763 kg/ha). Highest starch content (70.70 mg/g) and Crude protein (12.35 %) is observed in the treatment which has received 50 % RDF + NS compost @ 7.5 tonnes / ha (T_5) which is followed by T_6. Ferrara et al.[9] reported that the humic acid present in compost is the most active components of soil organic matter and have been shown to have an hormone like activity which stimulates plant growth.

Table 1. *Ecosan compost on Soil pH, EC and Organic carbon content- Maize hybrid –NK 6240*

Treatments	pH				EC (dS m^{-1})				Organic carbon (%)			
	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
T_1	8.15	8.17	8.16	**8.16**	1.32	1.30	1.30	**1.30**	0.88	0.82	0.78	**0.82**
T_2	8.22	8.25	8.23	**8.23**	1.55	1.52	1.50	**1.52**	1.20	1.14	1.10	**1.14**
T_3	8.20	8.23	8.21	**8.21**	1.52	1.50	1.48	**1.50**	1.15	1.10	1.05	**1.10**
T_4	8.18	8.21	8.19	**8.19**	1.50	1.48	1.46	**1.48**	1.10	1.02	0.97	**1.03**
T_5	8.30	8.33	8.31	**8.31**	1.64	1.62	1.60	**1.62**	1.38	1.32	1.27	**1.32**
T_6	8.27	8.30	8.28	**8.28**	1.61	1.59	1.57	**1.59**	1.30	1.21	1.15	**1.22**
T_7	8.24	8.27	8.25	**8.25**	1.58	1.55	1.52	**1.55**	1.25	1.19	1.12	**1.18**
Mean	**8.22**	**8.25**	**8.23**	**8.23**	**1.53**	**1.50**	**1.49**	**1.51**	**1.18**	**1.11**	**1.06**	**1.11**
SE.d	**0.01**	**0.01**	**0.01**		**0.01**	**0.01**	**0.01**		**0.011**	**0.012**	**0.012**	
C.D(0.05)	**NS**	**NS**	**NS**		**NS**	**NS**	**NS**		**0.022**	**0.024**	**0.024**	

Table 2. *Ecosan compost on Soil available N, P and K content - Maize hybrid –NK 6240*

Treatments	Available Nitrogen (kg ha^{-1})				Available Phosphorus (kg ha^{-1})				Available Potassium (kg ha^{-1})			
	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
T_1	240	238	225	**234**	32	30	28	**30**	290	283	273	**282**
T_2	285	279	270	**278**	33	40	35	**36**	342	329	302	**324**
T_3	260	258	250	**256**	37	34	30	**33**	334	318	297	**316**
T_4	254	250	241	**248**	33	30	29	**30**	329	306	293	**309**
T_5	325	320	312	**319**	48	42	40	**43**	360	345	336	**347**
T_6	315	310	301	**308**	45	41	36	**40**	354	340	328	**340**
T_7	303	296	284	**294**	40	36	32	**36**	348	330	310	**329**
Mean	**283**	**278**	**269**	**276**	**38**	**36**	**32**	**35**	**336**	**321**	**305**	**321**
SE.d	**4.21**	**4.10**	**3.50**		**1.05**	**0.75**	**0.70**		**3.20**	**2.10**	**1.40**	
C.D (0.05)	**8.42**	**8.20**	**7.00**		**2.10**	**1.50**	**1.40**		**6.40**	**4.20**	**2.80**	

Table 3. *Ecosan compost on Soil microbial dynamics - Maize hybrid – NK 6240*

Treatments	N Fixing Bacteria (x 10^6 g^{-1})				Fungi (x 10^3 g^{-1})				Actinomycetes (x 10^4 g^{-1})			
	S1	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**
T_1	20	28	24	**24**	8	7	7	**7**	5	7	8	**6**
T_2	45	65	53	**54**	12	10	10	**10**	13	14	19	**15**
T_3	40	58	45	**47**	10	9	9	**9**	11	12	18	**13**
T_4	36	51	40	**42**	9	8	8	**8**	10	11	15	**12**
T_5	61	82	73	**72**	14	13	12	**13**	18	20	24	**20**
T_6	53	78	69	**66**	13	12	11	**12**	17	18	22	**19**
T_7	48	70	57	**58**	12	11	11	**11**	15	16	21	**17**
Mean	**43**	**61**	**51**	**52**	**11**	**10**	**9**	**10**	**12**	**14**	**18**	**14**
SE.d	**1.01**	**0.9**	**0.7**		**0.05**	**0.04**	**0.02**		**0.41**	**0.31**	**0.45**	
C.D (0.05)	**2.02**	**1.8**	**1.4**		**0.10**	**0.08**	**0.04**		**0.82**	**0.62**	**0.90**	

Table 4. *Ecosan compost on soil enzyme activity - Maize hybrid – NK 6240*

Treatments	Cellulose activity (mg glucose g^{-1} soil)				Phosphates activity (µg PNP release g^{-1} of soil)			
	S1	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**
T_1	54	51	52	**52.3**	17	20	18	**18.3**
T_2	64	61	70	**65.0**	30	41	38	**36.3**
T_3	59	56	65	**60.0**	27	37	29	**31.0**
T_4	57	54	63	**58.0**	25	30	22	**25.6**
T_5	73	70	79	**74.0**	40	55	51	**48.6**
T_6	68	65	74	**69.0**	38	49	48	**45.0**
T_7	61	58	66	**61.6**	35	45	43	**41.0**
Mean	**62.2**	**59.2**	**67.0**	**62.8**	**30.2**	**39.5**	**35.5**	**35.1**
SE.d	**1.50**	**1.01**	**1.52**		**1.21**	**1.35**	**1.25**	
C.D (0.05)	**3.00**	**2.02**	**3.10**		**2.40**	**2.70**	**2.50**	

Table 5. *Ecosan compost on Growth attributes of Maize hybrid – NK 6240*

Treatments	Plant height (cm)				Leaf Area Index				Dry Matter production (kg ha^{-1})			
	S1	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**
T_1	96.0	195.1	205.3	**165.47**	2.58	5.20	3.78	**3.85**	862	6630	13462	**6984**
T_2	99.2	207.6	218.5	**175.10**	3.00	5.45	4.85	**4.43**	894	7035	14026	**7318**
T_3	98.5	205.4	213.6	**172.50**	2.79	5.32	4.37	**4.16**	890	6832	13832	**7184**
T_4	97.0	200.3	208.5	**168.60**	2.67	5.25	3.98	**3.97**	876	6713	13645	**7078**
T_5	103.4	215.4	224.0	**180.93**	3.20	5.61	5.20	**4.67**	948	7580	14867	**7798**
T_6	102.0	213.7	220.0	**178.57**	3.15	5.58	5.12	**4.62**	927	7328	14635	**7630**
T_7	100.8	210.0	215.8	**175.53**	3.08	5.50	5.00	**4.53**	908	7116	14230	**7418**
Mean	**99.56**	**206.79**	**215.10**	**173.81**	**2.92**	**5.42**	**4.61**	**4.32**	**900**	**7033**	**14099**	**7344**
SE.d	**1.01**	**1.50**	**1.61**		**0.15**	**0.21**	**0.21**		**2.10**	**11.75**	**47.00**	
C.D (0.05)	**2.02**	**3.00**	**3.20**		**0.30**	**0.40**	**0.39**		**4.20**	**23.00**	**96.00**	

Table 6. *Ecosan compost on yield attributes and yield of Maize hybrid – NK 6240*

Treatments	Cob length (cm)	No of grains rows/ cob	Weight of individual cob (g)	100 grain weight (g)	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Starch content (mg g^{-1})	Crude protein (%)
T_1	17.45	30.63	190.53	28.91	5437	9893	60.03	9.15
T_2	18.15	37.75	203.49	30.98	6125	10326	67.15	11.05
T_3	18.00	35.28	200.12	30.58	5863	10117	63.21	10.75
T_4	17.85	32.90	196.67	29.53	5780	9927	61.10	9.95
T_5	19.00	42.43	210.56	32.00	6735	10989	70.70	12.35
T_6	18.85	40.00	206.75	31.65	6585	10763	68.25	11.65
T_7	18.35	38.85	204.00	31.02	6433	10444	65.13	10.53
Mean	**18.24**	**36.83**	**201.73**	**30.67**	**6136**	**10351**	**65.08**	**10.77**
SE.d	**0.150**	**0.50**	**0.80**	**0.30**	**41.20**	**75.50**	**1.00**	**0.230**
C.D (0.05)	**0.30**	**1.00**	**1.60**	**0.60**	**82.41**	**150.10**	**2.10**	**0.460**

4. CONCLUSION

The Environmental impacts of the Ecosan Project in the village are improvement of health by minimizing the introduction of pathogens from human community waste into the water cycle; safe, hygienic recovery and use of nutrients; organics; trace elements; water and energy; resource conservation; through lower water consumption, substitution of chemical fertilizers and minimization of water pollution. Human excreta is a valuable source of nutrients. Their use should be promoted in order to replace some of the artificial fertilizers used in agriculture. For the time being, there are many unanswered questions which need to be researched before human waste compost can be widely used in plant production. Quality control has to be strict to assure the consumer that the use of a composted product will not cause problems.

ACKNOWLEDGEMENT

The authors are thankful to the authorities of Department of Drinking Water Supply, Ministry of Rural Development, GOI for funding to undertake this study.

REFERENCES

[1] Olsen J.E and Larsen H.Y.E. Bacterial decimation times in anaerobic digestion of animal slurries. Biological Wastes, 1987, 21, 153-68.

[2] Smith D.C., Beharee V. and Hughes. 2001. The effects of composts produced by a simple composting procedure on the yields of Swiss chard (Beta vulgaris L. var. flavescens) and common bean (Phaseolis vulgaris L. var. nanus). Scientia Horticulture., 91: 394 -406.

[3] Tanski H.H. and Sijbesma C.W. 2005. Human excreta for plant in human urine and food refuse. Use of municipal organic waste. Proceedings of NJF seminar no. 292, November 23–25, 1998 Agricultural Research Centre, Jokioinen, Finland. DIAS report Plant Production no. 13, June 1999. 2nd volume, p. 125–130.

[4] Yaduvanshi N.P.S. 2001. Effect of five years of rice-wheat cropping and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. J. Indian Soc. Soil Sci., 49(4): 714-719.

[5] Zhe Y.G., Chen S.B. and Yang J.C. 2004. Effect of soil amendments on lead uptake by two vegetable crops from a lead contaminated soil from Anhui, China Environ. Int., 30: 351-356.

[6] Wei X., Hao M., Shao M. and Gale W.J. 2006. Changes in soil properties and the availability of soil micronutrients after 18 years of cropping and fertilization. Soil Till. Res., 91: 120-130.

[7] Mylavarapu R.S. and Zinati G.M. 2009. Improvement of soil properties using compost for optimum parsley production in sandy soils. Sci. Hortic, 120: 426-430.

[8] Dinesh R., Dubey R.P., Ganesamurthy A.N. and Shyam Prasad G. 2000. Organic manuring in rice-based croppingsystem: Effects on soil microbial biomass and selected enzyme activity. Curr. Sci., 79: 1716-1720.

[9] Ferrara G. and Brunetti G. 2010. Effects of the times of application of soil humic acid on berry quality of table grape (Vitis vinifera L.) cv Italia. Spanish J. Agric. Res., 8(3):