The International Journal of Engineering and Science (IJES)
|| Volume || 9 || Issue || 12 || Series I || Pages || PP 21-26 || 2020 ||
ISSN (e): 2319-1813 ISSN (p): 20-24-1805

Phyto – Toxicity Evaluation of Agro – Waste Formulated Compost on Five Different Plant Seeds

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----------***ABSTRACT***----------

Phytotoxicity is one of the most important criteria for evaluating the suitability and maturity of compost foragricultural purposes and to avoid environmental risks before these composts can be recycled back toagricultural land. Application on soil of no stabilized organic materials could affect both crops and theenvironment because of the presence of phyto-toxic compounds. This work is aimed at evaluating the phyto toxicity of three agro-waste compost on the seeds of tomatoes, maize, millet, soya bean and cucumber for seven weeks with the objectives of ascertaining the degree of suitability and maturity of the compost through germination index analysis. Standard methods were used. The results reveal an increase in the germination index(GI) from the start up to the seventh week. These increase have shown that the composts are suitable and mature for agricultural purposes.

Key words; Germination index, Compost, Phyto-toxicity

Date of Submission: 01-12-2020 Date of Acceptance: 15-12-2020

I. INTRODUCTION

Wastes that are produced from agricultural activities can be described as agricultural wastes. Composting is a sustainable waste management practice that converts any volume of accumulated organic waste into a usable product. When organic wastes are broken down by microorganisms in a heat-generating environment, waste volume is reduced, many harmful organisms are destroyed, and a useful, potentially marketable, product is produced. Organic wastes may include manure from livestock operations, animal bedding, yard wastes, such as leaves and grass clippings, and even kitchen scraps.Composting is a process by which organic wastes are broken down by microorganisms, generally bacteria and fungi, into simpler forms. The microorganisms use the carbon in the waste as an energy source. The degradation of the nitrogencontaining materials results in the breakdown of the original materials into a much more uniform product which can be used as a soil amendment. Heat generated during the process kills many unwanted organisms such as weed seeds and pathogens. Advantages of composting include reduction of waste volume, elimination of heat-killed pests, and the generation of a beneficial and marketable material. Adding compost to soil increases organic matter content. This, in turn, improves many soil characteristics and allows for the slow release of nutrients for crop use in subsequent years.Phytotoxicity is one of the most importantcriteria for evaluating the suitability of compost foragricultural purposes and to avoid environmental risksbefore these composts can be recycled back toagricultural land (Tiquia*et al.,* 1996; Brewer &Sullivan, 2003 and Cooperband*et al.,* 2003). Immature compost also introducesphyto-toxic compounds such as heavy metals (Tam andTiquia, 1994), phenolic compounds (Wong, 1985),ethylene and ammonia (Tam and Tiquia, 1994), excessaccumulation of salts (Tam and Tiquia, 1994), andorganic acids (Manios*et al.,* 1989)which could retardseed germination and plant growth.The germination index is a maturity test basedon seed germination and initial plant growth using aliquid extract from the compost (Zucconi, *et al.,* 1981).The germination index, which combinesmeasures of relative seed germination and relative root elongation has been used to evaluate the toxicityof compost(Tam and Tiquia, 1994, Tiquia*et al.,* 1996and Wong *et al.,* 2001)**.**

Phytotoxicity is often best evaluated by conductinggermination or growth tests (Gariglio*et al.,* 2002 andBrewer and Sullivan, 2003).Germination Index (GI) is the best way to test the phytotoxicity of compost to plant growth because theresults of it are quite straightforward and reliable. Germination bioassays are widely used to test for salinity, soil pathogens, toxic substances and some other physicaland chemical properties of compost (Zucconi*et al.,* 1985)

STATEMENT OF PROBLEM Some research works and certain claims have demonstrated that application of immature compost onto the soil causes negative effects on seed germination, plant growth and development. These effects occur because immature compost induces high microbial activity, which reduce oxygen concentration in the soil, blocks the existing soil available nitrogen.Immature compost also introducesphytotoxic compounds.

OBJECTIVES OF THE STUDY

To evaluate the maturity and sustainability of three agro waste prepared compost in order to ascertain the degree of maturity throughphyto-toxicity study using germination index bioassay.

MATERIALS AND METHODS Sample Collection

The rabbit droppings were collected from a local animal farm in Nnobi town, Idemili – South Local Government Area, Anambra State. The sheep and goat manures were collected at Central Animal Market, Owerri, Imo State. Mature compost was obtained from Anambra State Government Compost Factory Awka.

Cultivar

The millet, maize, tomatoes, soya beans and cucumber seeds were purchased from NkwoOgbe Market Ihiala L.G.A Anambra State.

COMPOST PREPARATION

All the non-compostable materials contained in the waste were sorted out and not included in the compost preparation. The waste materials were shredded to 5mm in size with the shredder. 3kg dried weight each were prepared from air dried and shredded wastes. The compost was prepared according to the method described by Selim*et al.* (2012).

SEED GERMINATION TECHNIQUE This was carried out by the modified method of Selim*et al*. (2012) and Gopinathan and Thirumurthy,(2012). The compost extracts was evaluated by the seed germination technique in which water extract of each compost was prepared by shaking the samples with distilled water at 1:10 w/v ratio for 1 hr, and then filtered. Seeds of cabbage, onions, cucumber, soyabeans, tomato, maize, sorghum, millet, rice and wheat were surface sterilized byimmersion in 75 % alcohol for three minutes and finally thoroughly washed with sterilized distilled water to get rid of the ethanol**.** 10 ml of water compost extract was applied to filter paper in a Petri dish and 10 seeds were then placed on the filter paper.

PHYTOTOXICITY EVALUATION

The phytotoxicity of compost extracts was evaluated by the seed germination technique [Zucconi*et al.*1981, Tam and Tiquia, 1994 and Tiquia*et al*., 1996]. The seedswere surface sterilized byimmersion in 75% alcohol for three minutes followed bytransferring in 0.001 $HgCl_2$solution for two minutes withperiodical agitation and finally thoroughly washed withsterilized distilled water to get rid of toxic chemicals[Rovira, 1956]. 10 ml of water compost extract wasapplied to filter paper in a Petri dish and 20 seeds were thenplaced on the filter paper. All experiments were run intriplicate. The Petri dishes were sealed with tape tominimize water loss while allowing air penetration and thenwere incubated in the dark for 72 hours at roomtemperature, the seed germination percentage and rootlength of the plants in the extracts were determined.

GERMINATION INDEX (GI)

The germination index(G I) can be calculated as:

$$\textbf{Germination Index} = \frac{(\%\ \text{Germination}\ )\text{X}\ (\%\ \text{Root lenght}\ )}{100}$$

$$\textbf{\% Germination} = \frac{Averagenumberofgerminationseedintestsample}{Averagenumber\ \ ofgerminationseedincontrolsample}\ \text{X}\ 100$$

$$\textbf{\% Root Length} = \frac{Averagenumberofrootintestsample}{Averagenumberofrootsincontrolsample}\ \text{X}\ 100$$

II. RESULTS AND DISCUSIONS

Table 1	Sheep compost	Rabbit compost	Goat compost	Control compost
Tomatoes	-	-	-	-
Maize	173.70	152	160	125.30
Millet	57.14	57.10	32.57	82.20
Soyabean	224.30	88.42	94.87	96.10
Cucumber	59.50	31.49	30.22	31.53

Table 1: Germination Index of the compost at the

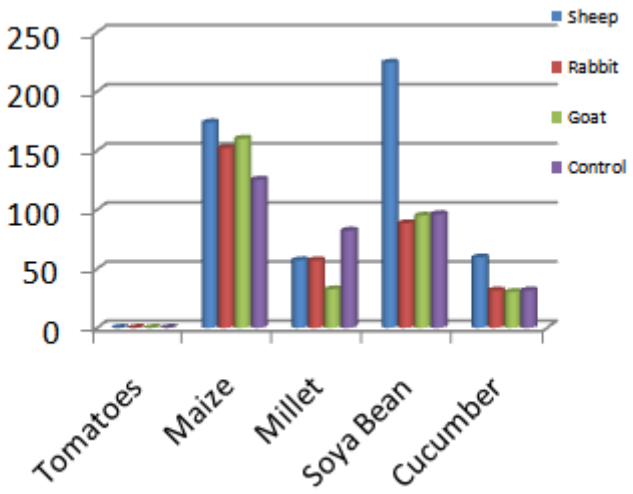

Figure 1: Germination index of the compost at theStart up.

Table 1 shows the results of the germination index of sheep compost, rabbit compost, goat compost and the control on tomatoes, maize, millet, soya bean and cucumber seeds at the start up. From the result, maize seed showed higher values of the three compost all above the control.

On the millet seed, the values were all lower than that of the control. For soya bean seed and cucumber, except in sheep compost, others showed a value lower than the control. Figure 1 showed that the highest value of germination index is seen on sheep compost on soya bean seed while tomatoes has no values.

Table 2	Sheep compost	Rabbit compost	Goat compost	Control compost
Tomatoes	375	91.50	328	280.50
Maize	176.80	42.18	67.20	100
Millet	165	78.90	142.76	132
Soyabean	64.10	21.20	159	143
Cucumber	43.7	235.45	102	176.88

Table 2: Germination Index of the compost after OneWeek.

Table 2 shows the results of the germination index of sheep compost, rabbit compost, goat compost and the control on tomatoes, maize, millet, soya bean and cucumber seeds after one week. From the results, tomatoes and maize showed higher value of germination index on sheep compost, while only cucumber showed higher value on rabbit compost. Then tomatoes and soya beans showed higher values on goat compost.

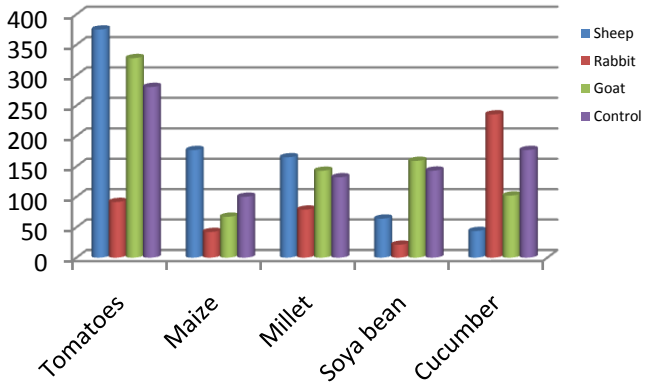

Figure 2: Germination Index of the compost afterOne Week

From the results, tomatoes and maize showed higher value of germination index on sheep compost, while only cucumber showed higher value on rabbit compost. Then tomatoes and soya beans showed Figure 2 shows that the highest value of germination index after one week was seen on sheep compost on tomatoes seed.

Table 3	Sheep compost	Rabbit compost	Goat compost	Control compost
Tomatoes	92	-	-	-
Maize	162	70.11	35.2	83.16
Millet	167	57	112.30	200.80
Soyabean	200	84.60	189.70	148.5
Cucumber	82.20	118.45	129	138.3

Table 3: Germination Index of the compost after Three Weeks.

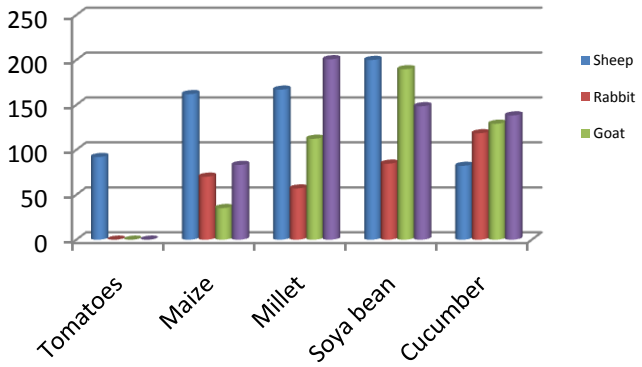

Figure 3: Germination index of the compost after Three Weeks

Table 3 shows the results of the germination index of sheep compost, rabbit compost, goat compost and the control on tomatoes, maize, millet, soya bean and cucumber seeds after three weeks. From the results, goat compost showed a high value of 200 on soya bean, rabbit compost showed a high value of 118.45 on cucumber and goat compost showed a high value of 189.7 on soya bean. Figure 3 reveals that sheep compost has the highest value of 200 on soya bean.

Table 4	Sheep compost	Rabbit compost	Goat compost	Control Compost
Tomatoes	52	191.10	113.95	109.40
Maize	104.20	68.50	110.90	97.56
Millet	25.30	16	11.64	18.28

Soyabean	144.20	274.30	294.80	134.50
Cucumber	72.10	77.40	101	89.80

Table 4: Germination Index of the compost after Five Weeks.

Table 4 shows the results of the germination index of sheep compost, rabbit compost, goat compost and the control on tomatoes, maize, millet, soya bean and cucumber seeds after five weeks. The results shows that soya bean has a high germination index on rabbit compost and goat compost of a value of 274.30 and 294.80 respectively.

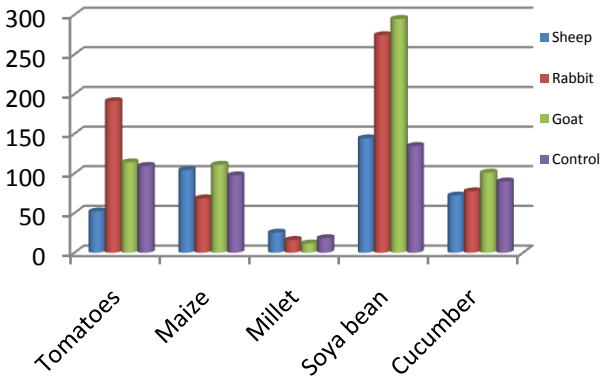

Figure 4: Germination index of the compostafterFive Weeks.

Figure 4 shows that soya bean on goat compost had the highest value of germination index. Small value of germination index was seen on millet with all the compost.

Table 5	Sheep compost	Rabbit compost	Goat compost	Control compost
Tomatoes	244	138.00	81	-
Maize	548	212.80	209	132.8
Millet	244.80	288	150	208
Soyabean	239.70	800	435	1200
Cucumber	114.60	76.5	114.84	96.22

Table 5: Germination Index of the compost after Seven Weeks.

Table 5 shows the results of the germination index of sheep compost, rabbit compost, goat compost and the control on tomatoes, maize, millet, soya bean and cucumber seeds after seven weeks. From the results all the seeds showed a very significant high value of germination index with all the agro waste compost.

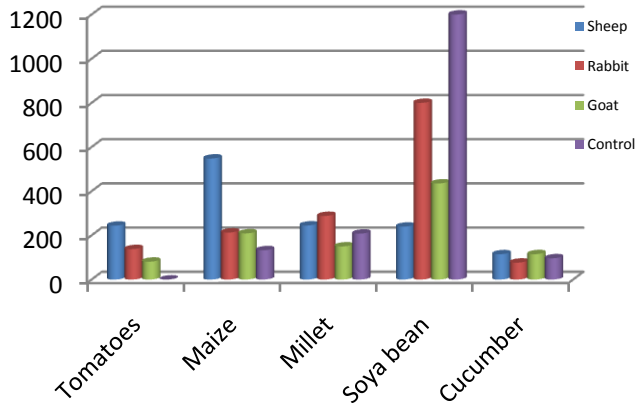

Figure 5: Germination index of the compost after Seven Weeks.

Figure 5 shows that apart from the control, rabbit compost showed the highest value of 800 with so800 with soya bean seed.

III. SUMMARY AND CONCLUSION

This whole research work reveals that there is a staggering rise in the germination index (GI) in all the compost treatments of all the five seeds used during the 7 weeks period of composting. The results clearly proved that there were disappearances of phytotoxins initially present in all the treatment set up at the end of this composting.Wei *et al.*, (2000)reported an increased GI is indicative of decreasedphytotoxicity and thus of a more mature product. It has been noted thatwhen a germination index value is more than 80 %, compost is consideredmature and practically free of phytotoxic substances.(Bernal *et al*., 1998, Zucconi*et al.*, 1981). The facts that there were increased GI values of more than 80 % in all the treatments is an indication of decline in phytotoxicity and hence our final compost products could be considered mature and safe for agricultural and environmental purposes.

REFERENCES

[1]. Azim, K., Faissal, Y., Soudi, B., Perissol, C. and Roussos, S and Alamis, I.T. (2017).Elucidation of functional chemical groups responsible of compost phytotoxicity using solid-state ^{13}C NMR spectroscopy under different initial *C/N* ratios.*Environmental Science and Pollution Research.*llttps:// doi.org/10.1 007/s11356-017-0704 – 9.

[2]. Bernal, M. P.; M. A. Paredes; M. A. Sanchez-Monedero and J. Cegarra (1998). Maturity andstability parameters of composts prepared with a wide range of organic wastes. Bioresource Technology,63:91-99.

[3]. Brewer, L. J. and D. M. Sullivan (2003). Maturityand stability evaluation of composted yard trimmings.Compost Science & Utilization, 11(2):96–112.

[4]. Cambardella, C. A.; T. L. Richard and A. Russell (2003). Compost Mineralization in soil as a function of composting process conditions.*European Journal of Soil Biology*, **39**: 117-127.

[5]. Cooperband, L. R.; A. G. Stone; M. R. Fryda andJ. L. Ravet (2003). Relating compost measures ofstability and maturity to plant growth. CompostScience and Utilization, 11: 113–124.

[6]. Gao, M., Liang, F., Yu, A., Li, B and Yang, L. (2010). Evaluation of stability and maturity during forced-aeration composting of chicken manure and sawdust at different C/N ratios.*Chemosphere*,**78**: 614 – 619.

[7]. Gopinathan, M. and Thirumurthy, M. (2012). Evaluation of phytotoxicity for compost from organic fraction of municipal solid waste and paper and pulp mill sludge.*Environmental Research, Engineering and Management*, **1** (59): 47 – 51.

[8]. Iwegbue, C.M.A., Egun, A.C., Emuh, F.N. and Isirimah, N.O. (2006). Compost maturity evaluation and its significance to agriculture.*Pakistan Journal of Biological Sciences*, **9**: 2933-2944.

[9]. Manios, V. I.; P. E. Tsikalas and H. I. Siminis(1989). Phytotoxicity of olive tree in relation toorganic acid concentration. Biological Waste, 27: 307-317.

[10]. Meunchang S., Panichsakptana S. and Weaver, R. W. (2005). Co-composting of filter cake and baggasse; by products from a sugar mill. *Bioresource Technology*, **96**: 437- 442.

[11]. Selim, S. M., Zayed, M. S. and Atta, H. M. (2012). Evaluation of phytotoxicity of compost during composting process.*Nature and Science*, **10** (2): 69 - 77.

[12]. Tam, N. F. Y. and S. M. Tiquia (1994). Assessingtoxicity of spent sawdust pig-litter using seedgermination technique. Resources, Conservation andRecycling ,11: 261-274.

[13]. Tiquia, S. M. and Tam, N. F. Y. (1998). Elimination of phytotoxicity during co-composting of spent pig manure sawdust litter and pig sludge.*Bioresource Technology*, **65**: 43 – 49.

[14]. Wei, Y. S.; Y. B Fan; M. G. Wang and J. S. Wang(2000). Composting and compost application in China.Resources Conservation and Recycling, 30: 277-300.

[15]. Wong, M. H. (1985). Phytotoxicity of refuse compostduring the process of maturation. EnvironmentalPollution, 37: 159-174

[16]. Zucconi, F.; A. Pera; M. Forte and M. de Bertoldi(1981).Evaluating toxicity of immature compost.BioCycle, 22 (4): 54-57.

AnukamN. Basil, et. al. "Phyto – Toxicity Evaluation of Agro – Waste Formulated Compost on Five Different Plant Seeds." *The International Journal of Engineering and Science (IJES)*, 9(12), (2020): pp. 21-26.