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Application of Biomass Technology in Sustainable Agriculture

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Abstract: Enhancing soil nutrient level using biomass technology was carried out by use of bio-fertilizer (a by-product of anaerobic digestion of wastes). The effect of the use of bio-fertilizer obtained by anaerobic digestion of piggery wastes for different retention time of one, two, three and four week period was investigated against non digested natural and non application of bio-fertilizer. Nsukka yellow pepper (*Capsicum annuum* L.) was used as test plants. Both the plants and bio-fertilizer (manure) were placed randomly in bags. The results showed that the application of bio-fertilizers increased the pepper yield in terms of plant height, number of fruits, branches and mass of fruit against plants planted without the bio-fertilizer. Among bio-fertilizer treatments, the 21-day (3 weeks) retention (RT) bio-fertilizer application yielded more than the rest in terms of the parameters above followed by the undigested raw waste.

Key words: Bio-fertilizer, digested waste, Nsukka Yellow pepper, plant height, number of fruits, branches, fresh fruit weight

INTRODUCTION

Increase in human population has led to increase in the demand for available agricultural land for other socio-economic development activities. To this end, the available land has been subjected to constant use since farming activities must go on. This has reduced the length of time required for the used land to regain its lost nutrient during previous agricultural practices. In order to maintain or improve the soil nutrient, farmers have resorted to use of inorganic fertilizers, some of which have resulted to permanent damages to soil structure and have left long-lasting effects on the micro-organisms in the soil.

Biomass Technology (BT) has got wide application in different aspects of socio economic life of the people. It yields biogas (a combustible gas rich in methane) and bio-fertilizer, rich in plant and animal nutrients. The biogas burns with minimal sooth when it burns well while the bio-fertilizer is a good source of soil conditioner.

The technology of Biomass has application in sustainable agricultural development. Most advanced farms utilize the biogas from anaerobic digestion of animal and plant wastes for electricity generation, heating and drying purposes (Nelson and Lamb, 2002; Taignides *et al*., 1963). The spent slurry is a very good biofertilizer rich in plant nutrients. According to Roberts (2005), the residual slurry of biogas fermentation is a good source of organic nutrients for plant development because the process of methane formation removes CO_2 and CH_4 from biomass. Due to the selective removal of these elements from the biomass, the other constituents such as N, P, K, Ca, Fe etc get concentrated in the residual slurry (Roberts, 2005). Cattle manure has been used to grow corn by Silva *et al*. (2006)

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in which the yield was monitored and reported. Similarly, El - Sirafy *et al*. (2006) also have investigated the effect of biofertilizer and nutrient uptake in the yield of Egyptian winter wheat. The effect of different application rates of biogas sludge from poultry waste on Nsukka Yellow Pepper (NYP) has been investigated and reported by Oparaku (2006). Biofertilizer from pig waste was used to grow Nsukka yellow pepper seedlings (*Capsicum annuum* L.). *Capsicum annuum* is the major specie involved in food flavoring Nsukka yellow pepper belongs to this pepper and has good potential for use on commercial scale. It is characterized by its distinctive aroma which is the selling of the cultivar that makes it to be very much cherished by house wives and hoteliers and caterers. It has high content of ascorbic acid. According to Uzoma (1984), Nsukka yellow pepper is characterized by its low yield. Hence, the use of additive to improve its yield.

Biofertilizer has useful properties. Beside its richness in plant nutrient, it is readily available to plants and improves microbial activities. Its high caption exchange (Eze *et al*., 1998) capacity could enhance soil erosion resistance, acid buffering capacity, water availability, soil nutrient availability and microbial activity much needed in our high acid rainfall soil generally low in soil fertility. The objectives of this study include investigation of the effect of bio-fertilizer application on the crop yield against Non application (NM); determination of the performance of the biofertilizer digestion period on crop yield; and to compare between the effect result from undigested waste (T0) and digested wastes (T1-T4).

MATERIALS AND METHODS

Materials

The materials used in the test of the effect of bio-fertilizer application to soil include Nsukka yellow pepper (*Capsicum annuum*, L.), soil sample from uncultivated farm, bio-fertilizer (waste digested different days), raw Hog waste, cellophane bags, five goat brand weighing balance model Z051599 and metre rule, Ohaus Adventurer analytical balance among other minor instruments.

Methods

The experiment was set up using young pepper seedlings. All the soil samples were collected from the same spot and weighed into cellophane bags after sieving to remove plant roots and stones. This controls rate of weed growth and soil nutrient depletion. A total of 15 kg soil was used in each bag. The experiment was carried out at the National Centre for Energy research and Development, University of Nigeria, Nsukka campus. Nsukka is located (Latitude 6.8°N longitude 7.29°E). There are two major seasons in the year- rainy and dry. The rainy season starts about March and spans to October while the dry season starts at the end of October through March.

The seedlings were planted randomly in the soil samples and all kept under the same climatic condition. The pig waste was collected from veterinary farm of university of Nigeria, Nsukka. Equal masses of water and waste were used in the digestion of the waste using four biodigesters. All the digesters had the same slurry after mixing in an open ended cylindrical tank. The manure was obtained after digesting the waste for 1, 2, 3 and 4 weeks, respectively for each of the digesters. After two weeks of planting, the bio-fertilizer was applied to the plants the same day. One kilogram of the bio-fertilizer was weighed out using the weighing balance and applied to each of the plants randomly too. Some plants were not manured so as to serve as control between planting on natural soil and manured soil. Another treatment was raw waste to serve as control between digested and undigested bio-fertilizers. A total of six replicates of each treatment were used i.e., Not Manured (NM) plants were 6, undigested manure (T_0) -6, 1st, 2nd, 3rd and 4th week- digestions periods -T1, T2, T3 and T4,

respectively were 6 each. A total of 36 plants were used in the study. The following data were measured and recorded: the plant height, the number of fruits, fresh fruit weight and the number of branches.

Plants height was measured using metre rule on weekly intervals after manuring, up to 9 weeks when the fruits started ripening. The fruits were harvested and counted as they ripen. The fresh fruit weight of the harvested fruits was determined using the Ohaus Adventurer analytical weighing balance. The branches were counted when the plants had outlived their life and all leaves shaded. The plants were grown between 15th July and 6th November, 2006. Nsukka Yellow Pepper (NYP) is grown during the early rains of April to June but can be grown at other times under controlled condition such as under irrigation. The period of the experiment was the part of the growing season. A total of 9 weeks (63 days) were used for the experiment.

RESULTS AND DISCUSSION

From the Table 1-4, there is a clear indication that bio-fertilizer has effect on the parameters that indicate plant yield. The plants in the soil No Manure (NM) performed poorly from the ones with manure either with undigested (T0) or digested wastes T1, T2, T3, or T4.

Table 1: Effect of the bio-fertilizers on maximum plant height (cm) attained

		Treatments				
r	NM	T0	T1	T2	T3	T4
1	21.00	18.50	29.20	34.30	21.50	35.50
2	12.50	29.50	21.50	22.00	23.00	12.50
3	17.50	35.30	17.00	32.50	31.00	19.50
4	14.00	31.00	23.50	26.70	24.50	35.50
5	25.00	31.00	31.70	21.50	33.50	21.50
6	18.50	31.50	27.50	16.00	35.40	22.50
Total	108.50	176.80	130.40	153.00	169.20	147.00
Average	18.08	29.47	21.73	25.50	28.20	24.50

Table 2: Effect of the bio-fertilizers on No. of fruits harvested from the plants

		Treatments				
r	NM	T0	T1	T2	T3	T4
1	2	7	0	25	0	3
2	0	30	1	14	45	4
3	0	29	0	13	12	0
4	0	12	2	5	1	24
5	5	6	22	0	26	8
6	2	0	11	5	11	3
Total	9	84	36	62	95	42
Average	1.5	14.0	6.0	10.33	15.83	7.0

Table 3: Effect of the bio-fertilizers on fresh fruit weight in grams

		Treatments				
r	NM	T0	T1	T2	T3	T4
1	4.528	16.974	0.000	46.821	0.000	2.369
2	0.000	74.509	5.219	31.199	145.577	2.609
3	0.000	50.584	0.000	32.974	18.417	0.000
4	0.000	34.867	1.999	11.389	1.272	95.965
5	8.126	16.742	46.543	0.000	61.968	10.513
6	3.283	0.000	17.082	10.924	26.836	5.040
Total	15.937	193.676	70.843	133.307	254.070	116.496
Average	2.660	32.280	11.810	22.220	42.325	19.420

Table 4: Effect of the bio-fertilizers on number of branches of the pepper plants

		Treatments				
r	NM	T0	T1	T2	T3	T4
1	4	8	20	18	11	10
2	0	45	7	18	17	4
3	4	38	0	30	22	8
4	3	12	6	16	13	18
5	5	16	16	7	43	19
6	2	11	9	6	23	4
Sum	18	130	58	95	129	63
Average	3.0	21.60	9.67	15.83	21.50	10.50

r = No. replications per treatment, NM = No Manure, T0 = Undigested (raw) waste, T1 = Digestion at 1 week (7 days), T2 = Digestion at 2 weeks (14 days), T3 = Digestion at 3 weeks (21 days), T4 = Digestion at 4 weeks (28 days)

Anaerobic digestion of wastes results in better plant and soil nutrient than the undigested waste. This agrees with Roberts (2005) report in which he showed that there was N, P, K, Ca and Fe concentration in residual slurry of Anaerobic Digestion (AD). This could be responsible for the higher average number of fruits from T3 plants than T0 (Table 2). This agrees with Eze *et al*. (1998) where tomatoes yield was increased by application of slurry from AD.

The effect of digestion of waste was noticed in the fresh fruit weight as shown in Table 3 where average weight of 42.3 g were recorded by T3 plants against 32.3 g observed in T0 plants. Anaerobic Digestion (AD) removes harmful gas component of the waste to improve its quality, hence the increase in the yields. Nsukka Yellow Pepper (NYP) is not known for growing very tall in one year. The application of bio-fertilizer generally improved the soil condition for effective plant growth as can be showen Table 1 and 4. The plants in NM soil had stunted growth with average height of 18.08 cm and very few branches against plants in soils with bio-fertilizer treatments. The height of pepper is a measure of nutrient content of the soil. This makes it easy for plants to be better exposed to sunlight for photosynthetic processes. According to Eboatu *et al*. (2005), Okra plants showed differences in height on application of bio-fertilizer over the ones without bio-fertilizer and similarly, plants with digested slurry were taller than ones with undigested slurry. Even though, in terms of height and branches, T0 plants had higher average performance, the T3 plants showed close competition to them.

The number of branches determines the exposure of plant leaves to photosynthetic processes. This is a major factor in the overall performance of plants with different number of branches when exposed to the same amount of sun radiation. The least of 3.0 mean branches was recorded on the NM plants. From this the effect of biofertilizer application can be vividly observed. There is no doubt that the biofertilizer application contributed to the performance of the plants in terms of number of branches developed by the plants.

CONCLUSION

From the results, plant improvement can be achieved by use of bio-fertilizers. Similarly, better result comes when the bio-fertilizer is digested slurry from anaerobic digestion of wastes. Even though the undigested manure gave a good and close range result to the 3 week digestion, the advantage of use of digested slurry over undigested waste cannot be overemphasized. It is pathogen and odour free, richer in plant nutrient and maintains environmental friendliness. Optimum of 21 days digestion period is recommended for agricultural application. When anaerobically treated, the benefits from wastes are enormous. It is a major source of energy for cooking, heating, lighting and fuel for co-generators for electricity production. Investment on anaerobic digestion of animal wastes is a welcome development as the project has high rate of Return on Investment (ROI). Further investigation is suggested using annual crops such as corn or a cereal other than a perennial crop. It is also suggested that further work on this will employ direct field work where the plants roots are not confined unlike in potted plants system.

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