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Full length Research paper

Production of Bioorganic Liquid Fertilizer from Food Waste and egg Shells

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Bioorganic liquid fertilizer not only increases bioorganic fertility of crops (in comparison to the control and prototype fertilizer), but also accelerates their maturation and nutrient quality. Thus, the present study was aimed to produce bioorganic liquid fertilizer from coffee ground and banana peels through aerobic fermentation in open containers. The result indicated all metallic mineral elements were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. Significance differences were also observed for carbon (C) and nitrogen (N), PH and electrical conductivity (EC). However, there were no significance differences with respect to CN ratio contents of the solutions. Comparison of mineral composition of bioorganic liquid fertilizer and compost tea solutions with the standard for major macronutrients requirement of plants indicated that the composition of both fertilizer solutions in the present study satisfies the standard with bioorganic liquid fertilizer being higher in mean values for most of the studied mineral plant nutrients. The bioorganic liquid fertilizer produced was evaluated by growing lettuce in pots in two replications. It was indicated that the performance of lettuce irrigated with bioorganic fertilizer solution was performing better than compost tea solution and soil grown plant. It can be concluded from the present study that biogranic liquid fertilizer can be produced from locally available substrates like sheep manure and banana peels. Small holder farmers can get economic relief, because by using this technology, thus, they can minimize the use of chemical fertilizer which is being expensive and not environmentally friendly.

Keywords: Compost tea, Electrical conductivity, Lettuce, Organic Fertilizers, Plant macronutrients.

INTRODUCTION

Bioorganic liquid fertilizers are advantageous over organic compost in that fermentation process can be diversified and manipulated in such a way that it can supply balanced macro- and micronutrients as well as various metabolic intermediates and as a carrier for microbial antagonistic and biofertilizers that the plants can use. Aerobic fermentation provides better breakdown opportunities for the plant nutrient source. Bioorganic liquid fertilizer is easy to process within short period of time, inexpensive & has no side effects, maintain stability of nutrient elements in the soil, reducing bad impact of chemical fertilizers, reduced environmental pollution: eutrophication, enhance resistance of the plants against disease and other stresses, improve biological quality of the crop, provide uniform application to the soil (PCT, 2013). In light of such justifications the present study has planned to produce bioorganic fertilizer through aerobic method using food waste and banana peels.

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MATERIALS AND METHODS

The experiment will be conducted in General laboratory of Haramaya University. 6kg food waste and 2kg egg shells were collected from Haramaya University Cafeteria. Fermentation solution will be prepared by mixing one liter of molasses to three liter of groundwater or dechlorinated water following the procedure used by Unnisa (2015).

Experimental Procedure and Data Collection

Aerobic Digestion:

The fermentation process was carried out under aerobic condition in two replications based on the method suggested by PCT (2013) as follow: clamps of food waste and chopped egg shells were formed in the open container covered with cotton cloth (the proportion of the food waste: egg shells = 3:1). The starting clamp components were successively arranged in layers with a height of 0.4 m each. The formed clamps were sprayed with diluted activated microbiological formulations including yeast and lactic bacteria. The microbial formulations were prepared from yeast powder and coagulated milk (as a source of lactic acid bacteria) with non-chlorinated water in the proportion of 1:50. Mixing and spraying water on the clamp was done periodically. The fermentation process was done in open container at ambient temperature for aerobic microbiological fermentation, until cycle of a fertilizer production completed (being without any flavor).

The output components of the bioorganic fertilizer was left in the open container to complete finishing of the technological process of the fertilizer production. The degree of readiness of the bioorganic fertilizer was determined according to physico-mechanical and organoleptic properties (homogeneity, looseness, lack of smell). Finally quantitative analysis for composition of macronutrients in bioorganic fertilizer was determined as per procedures below.

Determination of major plant macronutrient minerals

Nitrogen contents of fertilizer solution and compost tea (control solution) were determined by the Kjeldahl method consists of three steps: digestion, distillation, & titration.

The Phosphorus Content was determined by acid (HNO3) oxidation in the presence of vanadium ammonium molybdate. Sodium and potassium were determined by atomic absorption method.

Determination of Quality of Bioorganic Fertilizer Solution

PH measurement

PH measurement was based on procedure used by Patel and Lakdawala (2014) as follow:

Calibration Standard Preparation:

Two buffers was selected that bracket the expected sample pH. The first near the electrode isopotential point (pH 7) and the second buffer near the expected sample pH. A pH 7.00 buffer pouch was opened or a graduated cylinder was to transfer 30 mL of pH 7.00 buffer into a 50 mL beaker.

Sample Preparation:

40 mL of the sample liquid bioorganic fertilizer was measured by using a graduated cylinder into a 50 mL beaker. The beaker was covered with a watch glass. The electrode was placed in a prepared sample with the electrode tip fully immersed in the solution. The measure key was pressed on the meter. The pH icon flashed as the measurement was being made. Determination of the quality of bioorganic fertilizer solution based on PH range was based on the standard Table 1.

Electrical Conductivity (EC) Measure

A 2:1 by volume method was used to measure EC based on modified procedure used by Rhoades *et al*., (1999). Whereby a volume of mix was measured and twice as much water was added. The electrical conductivity (EC) is a measure of the total soluble salts, or the soluble nutrients (or ions) present in a growing media. The determination of electrical conductivity (EC) is made with a conductivity cell by measuring the electrical resistance of a 1:2 solute: water suspension. The determination of EC generally involves the physical measurement of the materials' electrical resistance (R), which is expressed in ohms. The reciprocal of resistance is conductance (C). It is expressed in reciprocal ohms, i.e., mhos. When the cell constant is applied, the measured conductance is converted to specific conductance (i.e., the reciprocal of the specific resistance) at the temperature of measurement.

Electrical conductivity meter & cell measures fraction of the specific resistance; this fraction is the cell constant (K = R/Rs).

Often, and herein, specific conductance is referred to as electrical conductivity, EC:

$EC = 1 / R_s = K / R$.

Procedure for conductivity:

0.746 g KCl was dissolved (previously dried at 105 °C for 2 hours) and the volume was made to 1 L with CO_2 free deionised water. This solution has an electrical conductivity of 1.413 dS/m at 25 °C. Then 1:2 biorganic fertilizer solution : water suspension was prepared by weighing 10 g air-dry bioorganic fertilizer solution (<2 mm) into a bottle. 50 mL deionised water will be added, and mechanically shaken at 15 rpm for 1 hour to dissolve soluble salts. Determination of the quality of bioorganic fertilizer solution based on EC range was as in Table 2. Electrical conductivity can be converted to estimate total dissolved solids by using the following equation (Detay, 1997):

TDS(ppm) = 0.64×EC(μS/cm) = 6.4×ECmS/cm = 640×EC(dS/m).

Pot experiment for testing bioorganic fertilizer solution

Table 1: Rating of bioorganic fertilizer solution based on pH values

Category	Range of pH value	Suggestion for remedy of bioorganic fertilizer solution
Acidic	<6.5	Requires liming for reclamation
Normal	6.5-7.8	Optimum for most crops
Alkaline	7.8-8.5	Requires application of organic manures
Alkali	>8.5	Requires gypsum for amelioration

Source: Patel and Lakdawala (2014).

Table 2: Rating of bioorganic fertilizer solution based on electrical conductivity (EC)

Range of EC	Rate of bioorganic fertilizer solution
< 0.8 ds/m	Normal
0.8-1.6 ds/m	Critical for salt sensitive crops
1.6-2.5ds/m	Critical to salt tolerant crops
2.5 ds/m	Injurious or toxicity to most crops

Source: Patel and Lakdawala (2014).

The fertilizer solution was tested by growing lettuce in pot. The experimental design was completed randomized design (CRD) in two replications. Soil sample was taken randomly from Rare field and placed in pots. Four lettuce seeds were planted in each pot. In the experimental pots half liter of bioorganic fertilizer was added during planting. However, in the control group no nutrient was applied only 500ml of water was added to each pot during planting. Then both experimental and control groups were irrigated with water as it was needed so as to prevent moisture stress. Thereafter 3 to 4 leaf stage half liter of fertilizer solution was added to experimental group. That is totally one liter of fertilizer solution was used.

Quantitative data were analyzed by using quantitative method such as frequency, percentage and mean and standard deviation using Microsoft office excel and SAS software (Version 9.2).

RESULT AND DISCUSSION

Production of Bioorganic liquid fertilizer through aerobic fermentation in Open container

6kg of chicken manure and chopped banana peels were co-fermented in open container covered with cotton cloth (so as to prevent entry of insects) for 45 days at ambient temperature.

It was found that 4 liters of bioorganic liquid fertilizer solution were produced from 6kg of co-fermented substrates. This finding was in accordance with PCT (2013) who recommended aerobic fermentation of organic wastes as an efficient process of bioorganic solution fertilizer production.

Determination of Plant Macronutrient Composition of biorganic Liquid fertilizer solution

Macronutrient composition of bioorganic fertilizer and compost tea solutions was shown in Table 3. All metalic mineral elements were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions.

It also indicated that percentage macronutrient compositions of bioorganic fertilizer solution was found to be greater than those of compost tea solution in all studied macronutrients. This finding was in accordance with Monisha and Rameshaiah (2016) who produced liquid fertilizer from vegetable waste.

Table 3: Macronutrient composition of bioorganic fertilizer solution and compost tea

Treatment	P	K	Ca	Mg	Na
Compost tea	1.44±0.33b	2.11±0.08b	2.72±0.02b	1.01±0.01b	1.19±0.08b
Biorganic	2.51±0.19a	3.74±0.88a	4.15±0.01a	2.35±0.50a	2.67±0.11a

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test).

Table 4: Quality of liquid fertilizer solutions

Treatment	PH	EC	C	N	CN
compost tea	8.45±0.35a	0.60±0.01b	29.87±1.36b	2.51±0.02b	11.89±0.62a
Bioorganic	6.15±0.50b	0.88±0..03a	41.45±1.20a	3.25±0.07a	12.76±0.65a

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test). PH: power of hydrogen; EC: electrical conductivity; C:N: carbon to nitrogen ratio.

Determination of the quality of Bioorganic liquid fertilizer

The quality of biorganic liquid fertilizer solution produced in the present study was measured with respect to PH, EC and C:N ratio as in Table 4. It was indicated that both compost tea and bioorganic liquid fertilizer solutions fulfill the basic requirements of plant macronutrients (Table 6) with respect to electrical conductivity and C:N ratio. However the PH needs adjustment to the neutral range between 6.0 to 8.0 which is optimum for most crop plants.

The carbon content of fertilizer solution in the present study, was found to be 53.85% (Table 4). The determination of natural carbon in composts serves in an indirect way as measure of accessible nitrogen. In most of the fertilizer cases the minimum carbon content or organic matter was found to be approximately 6-7% (Monisha and Rameshaiah, 2016).

Testing the bioorganic liquid fertilizer through pot experiment

The bioorganic liquid fertilizer produced was evaluated by growing Ethiopian lettuce in pot experiment in two replications. It was indicated in Table 5 that the performance of lettuce irrigated with bioorganic fertilizer solution was performing better than compost tea solution and soil grown plant. It was indicated that most of the measured parameters including above ground biomass per plant (BMW), days to maturity (DM), and head weight per plant(HWP) were found to be significant, between compost tea and biorganic fertilizer solutions, for all soil grown plant and hydroponic growth using sawdust and water solution.

However, there were no significance difference observed for number of leaves per plant (NLP). Similar study was conducted by Unnisa (2015) who conducted pot culture experiments in triplicate to test the toxicity of the organic liquid fertilizer for seed germination. Liquid fertilizer has many advantages because of easy process, inexpensive and no side effects. The resulting benefits are very likely to fertilize crops, to maintain the stability of nutrient elements in the soil and reducing the bad impacts of chemical fertilizers. In addition to a liquid fertilizer that can be sold in the market, liquid fertilizer can be used for agriculture purpose or in the premises for plantation.

Table 5: Performance of lettuce in pot

Medium	Treatment	ABM	NLP	HWP	DM
Soil	compost tea	40.11±1.54b	7.50±0.71a	34.90±0.28b	66.50±2.12a
	Bioorganic	60.71±0.58a	9.00±1.41a	51.25±3.04a	55.00±1.41b
Sawdust	compost tea	61.45±1.67b	8.00±1.41a	40.00±3.54b	61.00±1.41a
	Bioorganic	69.85±2.33a	11.00±1.41a	61.85±0.92a	51.00±1.41b

Means followed by same letter within a column were not significantly different at 0.05. Probability level based on DMRT (Duncan's Multiple Range Test). BMW: biomass weight per plant (gm); NLP: number of leaves per plant; DM: days to maturity; HWP: head weight per plant.

CONCLUSIONS

The present study has produced bioorganic liquid fertilizer solution from oil cake and banana peels through aerobic fermentation in open containers. The result indicated all metallic mineral elements were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. Significance differences were also observed for carbon (C) and nitrogen (N), PH and electrical conductivity (EC). However, there were no significance differences with respect to CN ratio contents of the solutions. Both compost tea and bioorganic liquid fertilizer solutions fulfills the basic requirements of plant macronutrients with respect to electrical conductivity and C:N ratio as a quality standard for organic fertilizers.

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