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Full length Research paper

Production of Bioorganic Liquid Fertilizer from Chicken Manure and Onion Peels

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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 chicken manure and groundnut husks through aerobic fermentation in open containers. The result indicated that Potassium (K), calcium (Ca), Magnesium (Mg) and sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. However, there were no significance differences with respect to Carbon(C), Nitrogen (N), and phosphorus (P) 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

Inorganic chemical fertilizers have contributed a lot to agricultural production since 1960s era of green revolution. However, continuous/excessive use of inorganic/chemical fertilizers has resulted in depletion in soil fertility & pollution in surface water bodies, rapid rate of nutrients loss in different forms & increases the soil acidity with nitrification, emission of ammonia, methane, nitrous oxide & elemental nitrogen from the soil system as a result of denitrification, incomplete nutrient supply of macronutrients. Even though organic fertilizers supply all materials required by the crop plants, they are not without limitations as: low efficiency: since required in large amount, take long time (more than 3 months to decompose), may carry some toxic substances, pathogenic microbes, & harbor pests, the composition may not be uniform : excess of some nutrients and/or shortage of some other nutrients.

Bioorganic fertilizers are microbial preparations which on application to soil help in augmenting sustainable agricultural production. Bioorganic liquid fertilizer not only increases bioorganic fertility of crops (in comparison to the control and prototype fertilizer), but also accelerates their maturation. At the same time the biological value of products is increasing: the content of vitamins and carotene in vegetables is increased and the nitrate content is significantly reduced. The doses of applying fertilizer are reduced 2.0-2.2 times (PCT, 2013). In light of such justifications the present study has planned to produce bioorganic fertilizer through aerobic fermentation using the groundnut husks and banana peels.

MATERIALS AND METHODS

The experiment was conducted in Central laboratory of Haramaya University. 6kg groundnut husk was obtained from Harar city, and 6kg banana peels was obtained from

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collection at home. Compost tea that used as a control was obtained from Bate district, Haramaya. Fermentation solution was prepared by mixing 500g sorghum flour to one liter of groundwater 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 Groundnut Husks and chopped banana peels were formed in the open container covered with cotton cloth (the proportion of the Groundnut husks: banana peels = 1:1). 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 were 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). When the above conditions are observed the duration of a complete technology cycle was taken around 40 to 50days. Finally quantitative analysis for composition of macronutrients in bioorganic fertilizer was determined as per procedures below.

Determination of major plant macronutrient minerals

Determination of Total Nitrogen Content

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

The percentage nitrogen was calculated according the equation:

$$\%N = ([(\text{ml standard acid x N of acid}) - (\text{ml blank x N of base})] - (\text{ml std base x N of base}) \text{ x } 1.4007) / (\text{weight of sample in grams})$$

Where "N" represents normality of acid or base "ml blank" refers to the milliliters of base needed to back titrate a reagent blank if standard acid is the receiving solution, or refers to milliliters of standard acid needed to titrate a reagent blank if boric acid is the receiving solution. When standard acid is used as the receiving solution.

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.

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).

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.

The conductivity meter was calibrated according to the manufacturer's instructions using the KCl reference solution to obtain the cell constant. The cell was rinsed thoroughly. The electrical conductivity of the 0.01M KCl was measured at the same temperature as the soil suspensions.

The conductivity cell was rinsed with the sample biorganic fertilizer suspension. The conductivity cell was refilled without disturbing the settled solute. The value indicated on the conductivity meter was recorded. The cell was rinsed with deionised water between samples. For EC, researchers adopted the term “mho”-“ohm” written backwards. 1dS/m = 1mmho/cm = 1000μmho/cm. Units used for measuring electrical conductivity of water are MicroSiemens per centimeter μS/cm, millisiemens per centimeter (mS/cm) and DeciSiemens per meter dS/m. 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):
$TDS(ppm) = 0.64 \times EC(\mu S/cm) = 6.4 \times EC mS/cm = 640 \times EC(dS/m)$.

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).

Pot experiment for testing bioorganic fertilizer solution

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 the 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

Sample bioorganic liquid fertilizer solution produced from mixture of groundnut husks and banana peels as indicated in Figure 1. 6kg groundnut husks of and chopped banana peels were co-fermented in open container covered with cotton cloth (so as to prevent entry of insects) for 60 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.

Figure 1: Sample bioorganic liquid fertilizer produced from mixture of Groundnut husk and banana peels.

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

Treatment	P	K	Ca	Mg	Na
Compost tea	0.81±0.10a	2.17±0.46b	1.27±0.08b	3.29±0.30b	1.25±0.14b
Bioorganic solution	1.32±0.14a	3.92±0.05a	3.24±±0.03a	4.52±0.32a	1.74±0.05a

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).

Determination of Plant Macronutrient Composition of biorganic Liquid fertilizer solution

Macronutrient composition of bioorganic fertilizer and compost tea solutions was shown in Table 3. Potassium (K), calcium (Ca), Magnesium (Mg) and sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. However, there were no significance differences with respect to Carbon(C), Nitrogen (N), phosphorus (P) and sodium (Na) contents of the 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.

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. The carbon content of

Table 4: Quality of liquid fertilizer solutions

Treatment	PH	EC	C	N	CN
compost tea	10.65±0.77a	0.65±0.06a	17.87±2.78b	2.61±0.02b	6.86±1.13b
Bioorganic	7.05±0.35b	0.80±0.02a	49.45±1.63a	3.62±0.30a	13.71±0.70a

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.

fertilizer solution in the present study, was found to be 53.85%. 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 and Figure 2&3 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 all measured parameters including above ground biomass per plant (BMW), days to maturity (DM, number of leaves per plant (NLP) 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. 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 experiment

Medium	Treatment	ABM	NLP	HWP	DM
Soil	compost tea	66.61±1.27b	8.50±0.71a	53.40±1.84b	81.00±1.41a
	Bioorganic	81.71±1.94a	11.50±0.71a	66.25±1.20a	66.50±2.12b
Sawdust	compost tea	84.45±1.66b	9.50±0.71a	64.90±2.26b	85.50±2.12a
	Bioorganic	106.35±2.62a	12.50±0.71a	86.35±1.63a	61.00±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.

Figure 2: Growth of lettuce on soil and sawdust treated with bioorganic fertilizer

Figure 3: Hydroponic growth of lettuce soil and sawdust treated with compost tea

CONCLUSION

The commercially available chemical fertilizer supplies not only limited number of macronutrients but also expensive. Thus, the present study has produced quality organic fertilizers from locally available substrates having diverse composition of minerals. Small holder farmers can easily produce it locally and use it so as to reduce dependence on chemical fertilizers and their devastatingeffect on the environment. However, further studies are required to optimize fermentation durations and condition.

The present study has checked the quality of the fertilizer by its mineral composition and pot experiment. Further studies are required to conduct field evaluation of the fertilizer solution and its impact on the quality of the nutrients. The bioorganic fertilizer solution produced in the present study will be helpful for hydroponic farming. Thus, studies are required to evaluate the fertilizer solution in hydroponic experiment. Further studies are also required to conduct cost and benefit analysis (economic study) fertilizer solution.

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