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Full length Research paper

Production of Bioorganic Liquid Fertilizer from Cow Manure and Banana Peels

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Bioorganic liquid fertilizer not only increases bioorganic fertility of crops, but also accelerates their maturation and nutrient quality. Thus, the present study was aimed to produce bioorganic liquid fertilizer from Cow manure and banana through aerobic fermentation in open containers. The bioorganic liquid fertilizer solution was produced from mixture of cow manure and banana peels. Clumps of cow manure and chopped banana peels (3kgs each) were co-fermented in open container covered with cotton cloth (so as to prevent entry of insects) for 50 days at room temperature. The experiment was laid in two replications. It was found that 4 liters of bioorganic liquid fertilizer solution were produced from 6kgs of co-fermented substrates. Macronutrient composition of bioorganic fertilizer and compost tea solutions were shown that phosphorus (P), Calcium (Ca), Magnesium (Mg) and also sodium (Na) were found to be significant between bioorganic liquid fertilizer and compost tea (used as a control) solutions. The quality of biorganic liquid fertilizer solution produced in the present study was indicated that both compost tea and bioorganic liquid fertilizer solutions fulfill the basic requirements of plant macronutrients with respect to electrical conductivity and C:N ratio. The performance of lettuce irrigated with bioorganic fertilizer solution was performing better than compost tea solution and soil grown plant. All the three parameters including above ground biomass per plant (ABM), number of leaves per plant (NLP) and Head weight per plant (HWP) were found to be significant between bioorganic liquid fertilizer and compost tea solutions. It can be concluded from the present study that biogranic liquid fertilizer can be produced from locally available substrates like Cow manure and banana peels. Small holder farmers can get economic relief, by using this technology

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

INTRODUCTION

Organic fertilizers refer to the nutrients contained in the product that are derived solely from the remains or by-products of a once-living organism. Urea is a synthetic organic fertilizer, an organic substance manufactured from inorganic materials. Cottonseed meal, blood meal, bone meal, hoof and horn meal, and all manures are examples of organic fertilizers (Cogger, 2013). Synthetic fertilizers act more quickly than organic types, though some organic materials release their nutrients quite rapidly. It isn't possible, therefore, to make a blanket statement about the long-term effects of fertilizers, except that organic materials such as manures and plant waste do usually help improve the soil structure while adding nutrients while chemical fertilizers do not affect soil structure. General-purpose synthetic fertilizers have the advantage of being readily available to the gardener and relatively inexpensive (Chandra, 2005).

Fertilizers come in many shapes and sizes. Different formulations are made to facilitate types of situations in which fertilizer is needed. Packaging for all formulations must show the amount of nutrients contained, or the analysis, and sometimes it tells how quickly a nutrient is available. Some of the formulations available are: granular solids, water-soluble powders, slow-release spikes, liquids, and tablets. In most fertilizers, a "filler" is added to bulk up the fertilizer. This is done to lower the analysis, allowing a more even spreading pattern as compared to trying to spread a small amount of a high analysis over an area. A filler is generally an inert material

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such as sand, lime, ground corn cobs, etc (Cogger, 2013). Some fillers are used to enhance the fertilizer's handling qualities. Not all types of formulations are commonly used by for vegetable gardens. The most common and readily available formulations are: dry/granulated Fertilizers. This is the most common type of fertilizer applied to the garden. The manufacturer treats the material so that it has large more evenly sized grains. Granules spread more evenly and easily. Sometimes granules are coated to prevent moisture absorption (Miles *et al.,* 2013). In light of such justifications the present study has planned to produce bioorganic fertilizer through aerobic method using cow manure and banana peels.

MATERIALS AND METHODS

The experiment was conducted in Central laboratory of Haramaya University. Six kilogram cow manure was collected from Haramaya university Dairy Farm, and 6kg banana peels was obtained from 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 cow manure and chopped banana peels were formed in the open container covered with cotton cloth (the proportion of the Cow manure: 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 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). 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

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

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 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):
$TDS(ppm) = 0.64 \times EC(\mu S/cm) = 6.4 \times EC mS/cm = 640 \times EC(dS/m)$.

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 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

The amount of fertilizer to apply to a garden depends on the natural fertility of the soil, the amount of organic matter present, the type of fertilizer used, and the crop being grown. The best way to determine fertilizer needs is to have the soil tested.

Accordingly, in the present study bioorganic liquid fertilizer solution was produced from mixture of cow manure and banana peels. Clumps of cow manure and chopped banana peels (3kgs each) were co-fermented in open container covered with cotton cloth (so as to prevent entry of insects) for 50 days at room temperature.

The experiment was laid in two replications. It was found that 4 liters of bioorganic liquid fertilizer solution were produced from 6kgs of co-fermented substrates.

Further dilution can be conducted depending on the economy of the user and performance evaluation. Similar study was reported by PCT (2013) who recommended aerobic fermentation of organic wastes as an efficient process of bioorganic solution fertilizer production.

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

Treatment	P	K	Ca	Mg	Na
Compost tea	0.98±0.06b	2.60±0.06a	1.14±0.17a	1.22±0.02b	1.29±0.05b
Bioorganic	3.14±0.06a	3.23±0.23a	3.31±0.41b	2.54±0.35a	2.47±0.17a

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 solution

Treatment	PH	EC	C	N	CN
Compost	6.35±0.35b	0.57±0.02b	23.49±0.91b	3.57±0.45a	6.67±1.09a
Bioorganic	6.52±0.03b	0.96±0.03a	40.73±0.60a	2.61±0.36a	15.77±1.95a

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 Plant Macronutrient Composition of biorganic Liquid fertilizer solution

Macronutrient composition of bioorganic fertilizer and compost tea solutions was shown in Table 3. It was found that phosphorus (P), Calcium (Ca), Magnesium (Mg) and also 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 potassium (K). It was 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 Unnisa (2015) 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. It was indicated that both compost tea and bioorganic liquid fertilizer solutions fulfill the basic requirements of plant macronutrients with respect to electrical conductivity and C:N ratio. The carbon content of fertilizer solution in the present study, was found to be 40.73% (Table 6). Monisha and Rameshaiah (2016) 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%.

In this study, the PH needs adjustment to the neutral range between 6.0 to 8.0 which is optimum for most crop plants. However, further evaluation of fertilizer should have to be done by conducting field experiments for various crop plants. Since fertilizer requirement depends on nature of the soil, crop plant types and other environmental factors.

Testing the bioorganic liquid fertilizer through pot experiment

The liquid fertilizer produced was evaluated by growing lettuce in pot experiment in two replications.

Table 5: Growth of lettuce in pot

Treatment	ABM	NLP	HWP
Soil	22.45±3.08c	8.50±0.71ab	15.90±0.58c
Compost tea	37.77±3.59b	6.50±0.71b	24.90±0.85b
Bioorganic	60.50±2.69a	9.50±0.71a	37.90±2.55a

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; HWP: head weight per plant.

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. All the three parameters including above ground biomass per plant (ABM), number of leaves per plant (NLP) and Head weight per plant (HWP) were found to be significant between bioorganic liquid fertilizer and compost tea solutions. This finding was in accordance with Monisha and Rameshaiah, (2016) who conducted pot culture experiment to 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.

CONCLUSIONS

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 devastating effect on the environment. However, further studies are required to optimize fermentation durations and conditions. 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.

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