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Full length Research paper

Production of Bioorganic Liquid Fertilizer from Cow Manure and Groundnut Husk

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The bioorganic fertilizer obtained through anaerobic fermentation comprises number of growth substances, vitamins, antibiotics, amino acids and useful micro-organisms. 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 cow manure and groundnut husks through aerobic fermentation in open containers. The result indicated that macronutrient composition of bioorganic fertilizer and compost tea solutions indicated that Potassium (K), 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 with respect to PH, EC and C:N ratio 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. However the PH needs adjustment to the neutral range between 6.0 to 8.0 which is optimum for most crop plants. It was indicated that the performance of lettuce irrigated with bioorganic fertilizer solution was performing better than compost tea solution and without any fertilizer (control) plant. Above ground biomass per plant (BMW) and Head weight per plant (HWP) was found to be significant among all treatments: lettuce irrigated with bioorganic liquid fertilizer; with compost tea, and without any fertilizer. It can be concluded from the present study that biogranic liquid fertilizer can be produced from locally available substrates like cow manure and groundnut husks.

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

INTRODUCTION

Natural organic fertilizers used in plant cultivation are characterized by low efficiency and therefore in order to obtain high yield they are soil-applied in large quantities about 7 - 30 t/ha. On the other hand, intensive use of mineral or chemical fertilizers leads to significant mineralization of the soil and to a loss of fertility, and has been brought about pollution of water bodies since the era of green revolution (Mishra and Jain, 2013). Thus, for sustainable and organic agriculture searching for new forms of ecologically clean bioorganic fertilizers and liquid utility formulations are useful in organic farming and ensuring the optimization of absorption of mineral nutrients of cultivated plants, obtaining high yields, reduction of chemical load of agricultural land and soil restoration. There are drastic shortages of such highly efficient bioorganic fertilizers, obtained by microbiological processing of poultry manure and animal husbandry and also their liquid utility forms (Sharafzadeh and Ordookhani, 2011).

The bioorganic fertilizer obtained through anaerobic fermentation comprises number of growth substances, vitamins, antibiotics, 18 amino acids and useful micro-organisms. However, the disadvantages include lack of finished product of effective micro-organisms balanced according to the generic composition comprising the following dominant genera: lactic fermentation bacteria *Lactobacillus spp,* photosynthetic bacteria and yeast *Spp;* presence in the finished product undesired foreign bacterial microflora, insignificant speed of microbial fermentation in anaerobic conditions; seasonal restrictions on the use of prototype fertilizer depended on

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the domination of anaerobic cellulose-degrading micro-organisms; constant proportion and a limited set of starting components, making it impossible to get a finished product, balanced for specific crops taking into account their biological characteristics and physiological needs; not very high physical-mechanical parameters and the quality of the finished product: high humidity, viscosity, heterogeneity; insignificant content of mineral nutrients and biologically active substances in the finished products (PCT, 2013). In light of such justifications the present study has planned to produce bioorganic fertilizer through aerobic method from cow manure and groundnut husks.

MATERIALS AND METHODS

The experiment was conducted in Central laboratory, Haramaya University. 6kg cow manure was collected from Haramaya university dairy Farm, and 6kg milled groundnut husk was obtained from traditional processors in Harar city. 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 crunched groundnut husk were formed using distilled water in the open container covered with cotton cloth (the proportion of the cake: 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 60days. 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×EC(μS/cm) = 6.4×ECmS/cm = 640×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

Sample bioorganic liquid fertilizer solution produced from mixture of cow manure and groundnut husk in two replications. 3kgs of cow manure and crunched groundnut husks 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 6kgs of co-fermented substrates. The present fertilizer was produced as 4L per 6kgms of substrate (4L/6kgms). Further dilution can be conducted depending on the economy of the user and performance evaluation. This finding was in accordance with PCT (2013) who recommended aerobic fermentation of organic wastes as an efficient process of bioorganic solution fertilizer production. The rising prices of fertilizer in market looking for an idea to force someone else to meet the needs of the crops they planted (Food Waste to Energy and Fertilizer, 2010). In addition, chemical fertilizer if used continuously can made microorganism in the soil becomes dead and causing the soil to be infertile (Mason *et al*., 2011). Utilization of organic food waste as a liquid fertilizer is expected to solve these problems and can help increasing the economy by farmers and housewives in the village (Unnisa, 2015).

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 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 to Carbon(C), Nitrogen (N), and phosphorus contents of the solutions.

It also indicated that percentage macro nutrient 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	1.59±0.59a	2.40±0.22b	2.74±0.02b	1.49±0.02b	1.40±0.05b
Bioorganic	3.67±0.42a	4.50±0.25a	3.91±0.64a	3.66±0.60a	2.45±0.14a

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 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 4) 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.

Table 4: Quality of liquid fertilizer solution

Treatment	PH	EC	C	N	CN
Compost	5.06±0.06b	0.72±0.10b	36.99±1.62b	3.57±0.45a	10.49±1.76b
Bioorganic	8.52±0.03a	1.18±0.23a	47.73±2.02a	2.61±0.36a	18.44±1.78a

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.

The carbon content of fertilizer solution in the present study, was found to be 47.73 % (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 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 without any fertilizer (control) plant. Above ground biomass per plant (BMW) and Head weight per plant (HWP) was found to be significant among all treatments: lettuce irrigated with bioorganic liquid fertilizer; with compost tea, and without any fertilizer. There was also significance difference between control and treatment groups for number of leaves per plant (NLP). However, no significance difference between treatments with respect to 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

Table 5: Performance of lettuce in greenhouse

Treatment	ABM	NLP	HWP
Soil	42.95±3.78c	5.50±0.71b	35.40±1.27c
Compost tea	54.27±1.46b	8.50±0.71a	43.40±1.27b
Bioorganic	75.00±0.57a	10.50±0.71a	57.65±2.19a

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.

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 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 devastating effect on the environment. The present study that bioogranic liquid fertilizer can be produced from locally available substrates. Small holder farmers can get economic relief, because by using this technology, they can minimize the use of chemical fertilizer which is being expensive and not environmentally friendly.

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