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PRODUCTION OF BIO FERTILIZER FROM TUBER CROPS WASTE - AN REVIEW

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Abstract: Biofertilizers are the product of fermentation process, constituting efficient living soil microorganisms. They improve plant growth and productivity through supply of easily utilizable nutrients. They are cost-effective and eco-friendly bioinoculants having great potential to enhance agricultural production in sustainable way. Biofertilizers are grouped into different types based on their functions such as nitrogen-fixing, phosphate-solubilizing, phosphate mobilizing, and other plant growth-promoting biofertilizers promoting plant growth by different mechanisms. Agricultural products such as tuber crops produce huge amounts of waste when processed into consumable goods. The waste generated is generally considered to contribute largely to environmental pollution. Tuber crop wastes can be processed and converted into value-added components such as fertilizer, methane (biogas), pig meat, ethanol, and surfactant etc. The study therefore recommends the proper waste management of tuber crops waste to minimize environmental pollution

Key words: Biofertilizer Production, Bioinoculants, Environmental Pollution, Fermentation, Tuber crops waste.

1 INTRODUCTION

Biofertilizers are defined as preparation of living cells or efficient microorganism which helps to uptake the nutrients for the growth of plants (Abdullahi et. al., 2012). Biofertilizers are used to improve the soil fertility contain toxic materials, hence the living microorganism present in the soil are able to enrich the fertility of the land (Dumitrescus et.al., 2009). Thus Biofertilizers can increase the output and improve the quality of the soil. Use of such natural products like biofertilizers in crop cultivation will help in safeguarding the soil health and also the quality of crop products(Ajay Kumar Singh et.al., 2013) using the biological wastes.

Globally, 60% of the tuber crops produced is mostly used for consumption in numerous forms by humans, while the animal food industry uses about 33% of the world production. The remaining 7% is used by industries to produce products such as textiles, paper, organic acids, flavor and aroma compounds.

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conversion into vermicompost, whereas all other biomass and byproducts needed more time (43–65 days). The rate of increase of earthworm weight and population was higher in vermicompost made from cassava and sweet potato thippi. The tuber crop-wastes can be used in the production of Biofertilizer using fermentation method such as: Solid State Fermentation (SSF) which is a simple

Three main types of residues are generated during the industrial processing of tuber crops: peels, solids, and wastewater. These wastes are poor in protein content, but their residues are very rich in carbohydrate and are generated in large amounts during the production. The cost associated with the handling and disposal of these wastes constitutes a huge financial burden to the tuber crops-processing industries in most rural regions of the country.

In the past century, the farmers were eager in the usage of chemical fertilizer as it yielded great number of crops. But eventually, they realized that chemical fertilizer affects the soil fertility and kills the beneficial microbes which enhance the growth of crops. The major issue they faced using chemical fertilizers were affecting not only the soil but also human beings who eat these farm products (Shah Alam and Rajendra Kumar Seth, 2012).

1.1 Tuber crop waste

The study revealed that the vermicompost prepared from biomass and byproducts of tuber crops had fairly higher levels of nitrogen (1.12–2.23%), phosphorus (0.26–0.88%), and potassium (0.33–1.29%) compared to initial status. The vermicompost prepared from sweet potato dry leaves had the highest nitrogen (2.23% and 2.03%), phosphorus (0.88% and 0.69%), and potassium (1.29% and 0.84%) content during both the years of study. Cassava thippi (tuber residue) required 40–43 days for the complete
these minerals promote plant nutrition.

2 MATERIALS AND METHODS

2.1 Materials required

and cost effective method (Soh-Fong Lim and Sylvester Usan Matu, 2015).

1.2 Solid state fermentation

Solid State Fermentation has been defined as a fermentation process which is used in cultivation of microorganisms under controlled conditions in the absence or near absence of free water. It is a potential technology that is used in the production of microbial products such as feed, fuel, food, chemical and pharmaceutical products. Solid substrate generally provides a good environment to the microbial flora containing bacteria, and micronutrients as these minerals promote plant nutrition.

1.3 Plant nutrition

Plant requires 80 – 90% of water. Essential elements required for the plant growth are classified into Macronutrients and Micronutrients. Macronutrients can be broken into two or more groups of primary and secondary nutrients. The primary nutrients present in the soil are Nitrogen (N), Phosphorous (P) and Potassium (K). These major nutrients are usually lacking in the soil plants use large amounts of them for their growth and survival (Bákonyi et. al., 2013). The secondary nutrients present in the soil are Calcium (Ca), Magnesium (Mg) and Sulphur (S). Also, large amounts of Calcium and Magnesium are added when lime is applied to acidic soils (Moola Ram1 et. al., 2014). Sulphur is usually found in sufficient amounts from the slow decomposition of soil organic matter. Micronutrients are those elements essential for plant growth which are need in only very small quantities. These elements are sometimes called minor or trace elements. The micronutrients are Boron (B), Copper (Cu), Iron (Fe), Chloride (Cl), Manganese (Mn), Molybdenum (Mb) and Zinc (Zn) (Aher et. al.,2015). A fertile soil should possess all the macro and micronutrients as

2.3.1 BATCH – I

Thousand grams of tuber crop wastes was placed in a polythene bottle which has a capacity of 5 L. Two hundred milliliters of water was added to it. The bottle was kept undisturbed for 30 -40 days until the soluble product was formed. This soluble product was filtered with a fabricated filter. The fermented solution is the first batch biofertilizers produced.

2.3.2 BATCH – II

Hundred milliliters of this filtered solution was used as inoculums precursor to the next SSF process. 500 g of new tuber crop wastes were placed in a polythene bottle. The precursor increases the rate of fermentation and minimizes the duration of SSF process. The bottle was kept undisturbed for 20-30 days at room temperature until the soluble product was formed. This soluble product was filtered with a fabricated filter. This filtered solution is called second batch biofertilizer.

2.4 Soil fertility analysis

1. Polythene bottle
2. Tuber crop wastes
3. Distilled water

2.2 Collection of samples

Tuber – wastes were collected from the market. The five different tubers waste used for the present study are cassava, potato, sweet potato, beet root and carrot **(Figure 1)**. outer skin of tuber crops peeled and smashed. They were used for Solid-State Fermentation (SSF). The soil samples were collected from nearby area.

Figure 1 Collection of Tuber crop waste

2.3 Methodology

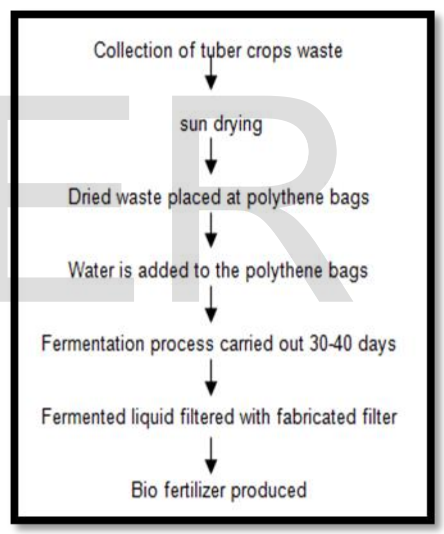

Figure 2 Process flow chart of Biofertilizer

2.5.2 Need of Biofertilizers for Crop Production

The blanket use of inorganic chemical fertilizers has led to soil and water pollution and affected the population and diversity of beneficial microorganism in soil. This results to crops more prone to attack of insect pest and drastic decline of the crop yield (Dotaniya et al. 2016). The toxic level of one plant nutrient affected the availability of another nutrient in soil, mainly micronutrients (Mahajan et al. 2003). Fertilizer demand for agricultural crop production is much higher than the availability in global market. It is expected that by 2020, to achieve the targeted production of 280 MT of food grain, the requirement of plant nutrients will be 28.8 MT, whereas their availability will be only 21.6 MT being deficit of 7.2 MT.

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Soil Fertility Analysis was carried out by estimating the Soil pH, Electric Conductivity, Calcium, Magnesium, Sulphate, Chloride, Phosphorous, Total Organic Carbon, Nitrogen, Sodium, Potassium, Iron, Zinc, Manganese and Copper.

2.5 Experimental study

1 kg of soil was taken in empty box which has a capacity of 500gm. 50 g of groundnut seeds were taken. 10 ml of tuber crop fertilizer and 10 ml of water were mixed and applied to the soil. The procedure was followed for the rest of the fruits as well. At regular intervals, the fertilizer was sprinkled on the soil.

2.5.1 Applicability of the biofertilizers

The biofertilizers were applied on the ground nut seed(Use any vegetative plants) sample of 2 weeks of age in order to determine the effectiveness of the biofertilizers. Each batch of the biofertilizers were applied on ground nut plant samples. At the same time, ground nut sample were planted in the absence of any fertilizer.

The fertilizer is applied daily to the soil. The following method is carried out for other fertilizers. The growth of the plants was observed periodically and the height was noted **(Figure 4 & 5).**

Figure 4 Growth of plant in soil (biofertilizers)

Figure 5 Growth of plant in soil (other fertilizers)

3.3 Quantitative analysis of plant growth

Each tuber crops unique in its nutritional elements which make the plant growth differ in their morphological characters such as length of root, shoot and height of plant and seed germination. Tuber crop waste shows better growth in plant rate with reference to the height of plant, length of root, shoot and seeds germinated in soil sample.

The feedstock/fossil fuels are decreasing, while the cost of fertilizer manufacturing is increasing with faster rate. This is becoming too expensive mainly by small and marginal farmers. Inadequate application of plant nutrient during crop production is also depleting soil health due to widening gap between nutrient removal and supplies. It is one of the major causes of environmental hazards. Apart from the above facts, the continuous use of biofertilizers is cost-effective, environment-friendly, more proficient, productive, and easily accessible to marginal and small farmers over chemical fertilizers (Mahajan et al. 2003).

3 RESULTS AND DISCUSSION

3.1 Solid state fermentation

The fermented solution from Batch II is used to check the efficiency of vegetation plantation.

Figure 3 Batch II tuber crop waste fertilizer

3.2 Pot culture

500g of soil sample was weighed and taken in a tray. 50 g of seeds (Ground nut) was taken. 5ml of the biofertilizer (tuber crop waste) and 5ml of water is taken and mixed well.

3.4 Application of biofertilizers

Farmers need to better understand how microorganisms are acting in soil in order to learn the appropriate methods to perform a successful crop inoculation. The method of application can indeed affect the performance of the biofertilizer (Deaker et al. 2004). However, very little work has been done to assess and optimize the application of biofertilizers, in order to meet the farmers' requirement of using technologies already available in the farm or to verify how much the application method utilized can affect the viability of the distributed inocula (Bashan et al. 2014 ; Malusà et al. 2012). Among the few efforts in this regard can be mentioned by the development of machines to apply biofertilizers having different physical form (Malusà and Sas Paszt 2009).

The application of liquid formulations with a normal sprayer based on hydraulic atomization system only slightly affected bacteria viability, but a prolonged working time reduced the amount of living cells up to 50 % (Świechowski et al. 2012). Effect of water volume and adjuvants were also affecting the amount of spores delivered and their efficacy in case of a fungus (Bailey et al. 2007).

Table 1 Quantitative analysis of plant growth

S.No	Fertilizers	Total height of plant	Root length	Shoot length	No.of seed Germinated
1	Tuber crops waste fertilizers	10 – 15 cm	5 – 10 cm	3 – 10 cm	85 - 90%
2	Other fertilizers	2 - 4 cm	2cm	3cm	20 - 45%

3.5 Soil Fertility

Soil refers to the part of the earth on which plant grow. It consists of three layers: top soil, sub- soil, and parent material. However we are more concerned with the top soil since it is the part that favours plant growth. It contains minerals, air, water, living organism and inorganic and organic matter all of which have to be in a particular ratio with at least a medium pH to constitute a fertile soil. According to Purves et al., a good quality soil is one that is 45% minerals (sand, silt, and clay), 25% water, 25% air, and 5% organic and living matter.

The mineral portion of a soil which makes up half of the volume contains about 93% silica, aluminium and iron oxides; 4% calcium, potassium and magnesium oxides and 3% titanium, sodium and very small amount of nitrogen, sulphur, phosphorous, boron, manganese, zinc, copper, chlorine, molybdenum and many other elements. However, of all these minerals only fourteen are essential to plant and these are called essential elements.

3.6 Limitation of Bio-Fertilizer

The most important limitation of bio-fertilizer is their nutrient content when compared to inorganic fertilizers. This might result to deficiency symptoms in plants grown with the bio-fertilizer. However, this problem can be curbed by the addition of substances such as bone meal (rich in phosphorus), wood ash (rich in potassium) or other substances of natural origin such as phosphate rock to enrich the fertilizer. Also the use of nutrient rich wastes such as palm wastes (rich in potassium), wood ash (rich in potassium also) in making bio-fertilizer can help to remedy the problem.

Again storage of bio-fertilizer goes a long way in affecting its efficacy. Even though bio-fertilizer has many positive aspects, its use can sometimes not lead to the expected positive results and this could be because of exposure to high temperature or hostile conditions before usage. Bio-fertilizer should be stored at room temperature or in cold storage conditions away from heat or direct sunlight and polythene bags used in packaging bio-fertilizer should be of low density grade with a thickness of about 50 –75 microns. Other constraints limiting the use of biofertilizer technology may be environmental, human resource, unawareness, unavailability of suitable strains, and unavailability of suitable carrier and so on. Short shelf life, lack of suitable carrier material, susceptibility to high temperature, problem in transportation, and storage are biofertilizers bottlenecks effective inoculation.

4. Conclusion

Biofertilizers are defined as carrier based materials which improves soil fertility. The collected tuber crop wastes were subjected to Solid State Fermentation process to produce soluble fermented solution. The tuber crop wastes used were cassava, potato, sweet potato, carrot and beet root. Solid state fermentation aided in the formation of soluble product and helped to produce the microorganism such as bacteria, fungi and yeast. The fermented solution was applied to vegetation to check the efficiency of the Biofertilizer. The soil collected and testes showed better seed germination due to the presence of *Aspergillus spp*. It was also able to prevent root diseases. Ground nut (Arachis hypogaea) seeds were tested using the biofertilizer. The elongation of root, shoot and germination of seeds were compared. Tuber crops waste fertilizer showed the best efficiency in comparison to others.

It is important to realize the useful aspects of bio-fertilizers so as to apply it in modern agricultural practice. The application of bio-fertilizers containing beneficial microbes promote to a large extent, crop productivity. These potential biological fertilizers would play a key role in productivity and sustainability of soil and protect the environment as eco-friendly and cost effective inputs for the farmers as righted stated by Khosro. Using the biological and organic fertilizers, a low input system can help to achieve sustainability of farming.

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