Fermenting Liquid Bio-Fertilizer Traditionally and Comparison of Soil Characteristics and Growth of Plants by Bio-fertilizer and Chemical Fertilizer

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Abstract— **This study investigates the production of liquid biofertilizer through traditional fermentation methods and compares its effects on soil characteristics and plant growth with those of chemical fertilizers. Liquid biofertilizer was produced using locally available organic materials through an anaerobic fermentation process. The bio-fertilizer's nutrient content was analyzed and compared with standard chemical fertilizers. Experimental plots were prepared, and identical crops were grown using biofertilizer and chemical fertilizers under controlled conditions. Soil samples were collected and analyzed for key physical and chemical properties, including pH, organic matter content, nutrient levels, and microbial activity. Plant growth parameters such as germination rate, plant height were monitored and recorded. Results indicated that the liquid biofertilizer significantly improved soil health by increasing organic matter content and enhancing microbial activity. The biofertilizer-treated soil maintained a pH of 6.8, compared to 7.2 in the chemical fertilizer-treated soil. Biofertilizer-treated soil showed a 60% increase in organic matter compared to a 3% increase with chemical fertilizers. Nitrogen, phosphorus, and potassium levels in biofertilizer-treated soil were 3.5%, 1.8%, and 2.4% respectively, compared to 2.8%, 1.5%, and 2.0% in chemically treated soil. The microbial biomass in biofertilizer-treated soil was 30% higher than in soil treated with chemical fertilizers. 95% in biofertilizer-treated plots compared to 90% in chemical fertilizer-treated plots. Average plant height was 15% higher in biofertilizer-treated plants. This study highlights the potential of traditionally fermented liquid biofertilizers as a sustainable alternative to chemical fertilizers, promoting healthier soils and robust plant growth while reducing environmental impacts.**

Keywords: Biofertilizer, Fish waste, Organic farming, Gunapaselam, SWM, Anaerobic fermentation.

I. INTRODUCTION

Launch of green revolution in India agricultural has been modified drastically to increase the yield in the name of food security, the incorporation of chemical fertilizers pesticides on crop has ultimately increased productivity as well as the pollution and its ill effects on environment and made agricultural a business-oriented approach. Total world consumption of Nitrogen (N), phosphorus (P), and potassium (K) in 1998 was 81, 14 and 18 TG/ yr respectively. 55% of the nutrients were used for cereal crop production, 12% for oilseed crops, 11% for grasslands, 11% for commodities, and 6% for root crops and for only 5% for Fruit and vegetables [1]. In 1950 fertilizers comprised only a small percentage of nutrients needed for grain production. Under the increasing demand, aquaculture and fisheries have emerged an important source of protein among people. During 2018 to 2019 the contribution of fisheries sector to Indian economy gross value added (GVA) was around 212915 cores about 1.24%. Global food fish consumption increased at an annual average rate of 3.1% from 1961 to 2017, a rate almost twice that of annual population growth (1.6%) for the same period and higher than that of all other animal protein foods (meat, dairy, milk, etc.,) which is increased 2.1% per year. Per FAO report 2020, per capita food consumption grew from 9.0 kg in 1961 to 20.5 kg in 2018 by almost 1.5% per year [2]. Due to that, huge quantity of fish waste is generated in the fish markets. Fish waste involves two categories: liquid and solid waste. Liquid waste is discharged into the sewer line, solid waste consists of head, viscera, skin, bone and some muscle tissue is collected in the collection bins along with the municipal solid waste. Protein content is more in the muscle part and collagen, myofibrils is more in the tail, head and fin part of the fish. However, environmental regulations are becoming stricter, requiring new methods for the treatment of the solid waste. Anaerobic digestion of solid waste is the suitable option for the treatment of the solid waste. Food and agricultural organization arrived at the statistics of fish production during the year 2014-2015. According to that the total quantity of fish production in India was found to be 10.07 X 10 tons per annum and in Tamil Nadu it is 6.9 X 10 tons per annum. From the quantity of waste generation study, arrived that, average of 22.50% of the solid waste is generated from the total fish weight. Therefore, the quantity of waste generated in India is 2.266 tons per annum and in Tamil Nadu 1.55 tons per annum (Basic Animal Husbandry & Fisheries Statistics 2015) [3].

II. OBJECTIVE

- The study investigates the initial characteristics of the anaerobically fermented liquid biofertilizer.
- The objective of the study is to determine the properties of the soil pre and post fertilization.
- To compare the difference in characteristics of soil, and yield of plants after the addition of Bio-fertilizer, chemical fertilizer.

III. EXPERIMENTAL ANALYSIS

The fish waste from slaughter house and jaggery collected was characterized by determining moisture content, Temperature pH. EC, as per the standard methods (Indian Standard). This analysis will be conducted in order to confirm that the waste collected is fit to be converted into bio liquid fertilizer.

Table 4.1 Initial characteristics of fish waste

PARAMETER	UNIT	OBSERVED VALUE
pH	-	6.52
Temperature	℃	30
Turbidity	NTU	2.1
Moisture content	%	63
Ash content	%	18

Table 4.2 Initial characteristics of jaggery

PARAMETER	UNIT	OBSERVED VALUE
pH	-	5.73
Temperature	℃	28
Turbidity	NTU	6.1
Moisture content	%	54.7
Ash content	%	0.03

The pH of the fermenting solution is checked for pH at regular interval of 5 days which showed the decrease in values to acidic range and it is plotted in graph and after 25 days it is noted that the graph shows a linear curve which shows the stabilization of the pH of the solution which facilitates the growth of microbes which digests the solid slaughter house waste and jaggery into a liquid fertilizer.

Figure 4.1 pH stabilization curve

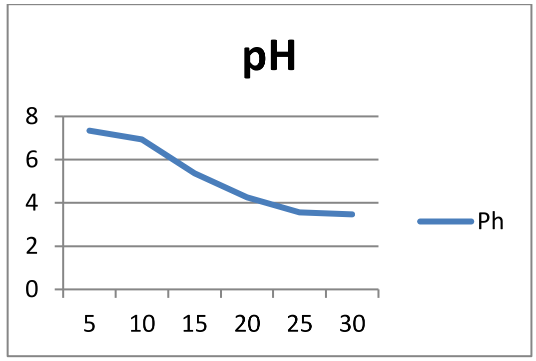


Table 4.3 Concentration test results of the soil

PARAMETER	VALUE OBSERVED	EXPECTED RANGE
Organic carbon	75.6 %	50 – 90 %
Nitrogen	560 mg/l (5.6 %)	2 – 6 %
Phosphorous	319 mg/l (3.19%)	0.5 – 2 %
Potassium	124 mg/l (1.24%)	1 – 3 %
C/N ratio	13.5 : 1	10 : 1
NPK	5.6 : 3.19 :1.24	4 : 2 : 1

The value of OC, N, P, K and C/N ratio determined are to be in the expected range in the soil and the test results ensures that the soil is of good nature to support efficient plant growth. The soil sample incorporated with chemical fertilizer is tested for organic carbon, nitrogen, phosphorous, potassium, C/N ratio, NPK concentration according to the standard procedures and the results are tabulated below in table 4.4.

Table 4.4 Concentration test results of the soil with chemical fertilizer

PARAMETER	VALUE OBSERVED	EXPECTED RANGE
Organic carbon	3.972%	50 – 90 %
Nitrogen	185.58 mg/l (18.5 %)	2 – 6 %
Phosphorous	463 mg/l (4.63%)	0.5 – 2 %
Potassium	67 mg/l (0.67%)	1 – 3 %
C/N ratio	2.14 : 1	10 : 1
NPK	18.58 : 4.63:0.67	4 : 2 : 1

The soil sample incorporated with Bio liquid fertilizer derived from fish waste and jaggery is tested for organic carbon, nitrogen, phosphorous, potassium, C/N ratio, NPK concentration according to the standard procedures and the results are tabulated below in table 4.5.

Table 4.5 Concentration test results of the soil with Bio fertilizer

PARAMETER	VALUE OBSERVED	EXPECTED RANGE
Organic carbon	65.3%	50 – 90 %
Nitrogen	640 mg/l (6.4 %)	2 – 6 %
Phosphorous	218 mg/l (2.18%)	0.5 – 2 %
Potassium	168 mg/l (1.68%)	1 – 3 %
C/N ratio	10.2 : 1	10 : 1
NPK	6.4 : 2.2 : 1.68	4 : 2 : 1

It took around 1 to 2 weeks to germinate. 95 % of germination rate is observed. GI is an important parameter to assess the efficiency of plant growth. GI > 80 % indicates very good and healthy fermented products. GI increased, indicating that the phytotoxic chemical in the weed biomass may have transformed into an efficient product which can be used for supporting plant growth. Following Figures shows seed germination and plants growth on each reactor and shoot length and root length of plants and also show the Seed Germination Index.

Figure 4.2 Shoot length graph

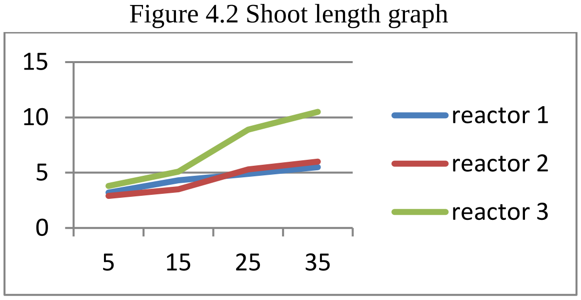
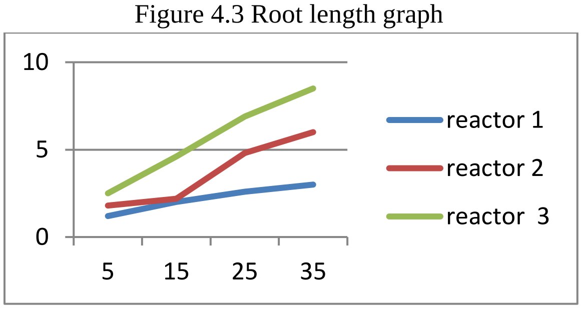


Figure 4.3 Root length graph



IV. CONCLUSION

1. The value of organic carbon, N P K in the soil with bio- liquid fertilizer is found to be in the range of optimum needed for plant growth. Whereas the soil alone and the soil with chemical fertilizer contains required amount of N P K but with a minimum of organic carbon and c/n ratio which is highly essential for plant growth.
2. The use of chemical fertilizer leads to environmental degradation since the source of extraction of raw material till the fate of fertilizer. Hence, the use of bio liquid fertilizer is more beneficial because of the easy preparation and less environmental impacts and cost efficiency at higher rate.
3. Besides the study on the components present in the fertilizer the study on plant growth is also studied which shows the benefits on the growth and sustainability of the plants.
4. The plants are checked for sustainability by not watering for 2 days after 30 day of sowing. It is observed that the plants only incorporated with bio-liquid fertilizer is alive and the other 2 rectors dried up which shows the welfare of incorporation.

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