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Synthesis Of Bio Fertilizer Using Fish Waste And Its Utilization- An Eco-Friendly Approach

C.M. Noorjahan

Assistant Professor, Post Graduate and Research Department of Zoology, Justice Basheer Ahmed Sayeed College for Women, Chennai, Tamilnadu, India

ABSTRACT

Mindless usage of chemical fertilizers and spraying pesticides to increase yields have made farming a commercial exercise profiting only some private companies rather than small farmers. Application of chemical fertilizers to increase the food production slowly robs the soil nutrients, harm the soil fauna and microbes and cause side effects to the consumers. Fish processing industry is one of the important sectors that generate large amounts of waste by processing and also through fish markets. The disposal of this fish waste material poses a big problem. Addressing this issue would also solve the problem of pollution and waste disposal. Hence this study aims to determine biochemical components - carbohydrates, amino acids, fatty acids, minerals – calcium and zinc present in fish waste, to analyse nutrients present in soil before and after addition of fish manure, to synthesize an eco-friendly bio fertilizer using fish waste and test its efficiency on the germination and growth of balsam plant – Impatiens balsamina and the growth of the plant were compared with that of the same plants that were grown using chemical fertilizer and commercially available fish waste fertilizer. The results of the study revealed that the maximum growth of the plant was recorded using synthesized bio fertilizer than that of chemical fertilizer and commercially available fish waste fertilizer.

Keywords: Fish waste, Bio fertilizer, Chemical fertilizer, Commercially available fish waste fertilizer, Soil nutrients, Balsam plant.

INTRODUCTION

Increased use of chemical fertilizers on the plants and soil is affecting the fertility of the soil to a greater extent. Fertilizers, over centuries have come a long way. As the awareness of bio fertilizers increase, the demand for an economical and bio fertilizer is also increasing. The demand for organic products in the local and global markets is growing and is likely to gain more significance in the future. However, bio fertilizer of sufficient quality to be used in this

type of production is currently quite expensive, in spite of the increase in organic livestock farming. Bio fertilizer improves soil structure (Qian., Schoenau,. Wu and Mooleki, 2003). slowly releases the nutrients and increases beneficial microbial activity (Dauda, Ajayi, and Ndor, 2008) and thus serves as a perfect alternative to chemical fertilizers (Suresh, Sneh, Krishna, and Mool,. 2004). In recent times, attention has been paid on safer organic foods with high quality. Environmental issues forces the reutilization of animal manure, agricultural waste, animal waste etc., into a better form of the nutrient as a good waste management practice for sustainable agriculture.

More than 70% of fish waste is obtained from the fish processing industry. Environmental problems caused by fish waste can be minimized by transforming them into useful products like fertilizers as they are rich in essential micro and macro nutrients .Fermentation of the fish waste is the right method with many advantages. Vincent et al, (2014) has reported the fermentation of fish waste using jaggery and it was used under the trade name 'Gunapaselam'. Fish waste being a reservoir of essential nutrients, helps in improving the fertility of the soil thereby increasing its lifetime. It is a rich source of amino acids, fatty acids, carbohydrates, enzymes and minerals.

Thus the present study aims to determine biochemical components - carbohydrates, amino acids, fatty acids, minerals – calcium and zinc present in fish waste,, to analyse nutrients present in soil before and after addition of fish manure, to synthesize bio fertilizerin small scale using fish waste. The synthesized bio fertilizer was used for the germination and the growth of plant- Balsam, Impatiens balsamina..The growth of the plants using the synthesized bio fertilizer was compared with that of the growth of the same plants using chemical fertilizer and commercially available fish waste fertilizer.

MATERIALS AND METHODS:

Collection and storage of Sample

20 kgs of fish waste was collected from a fish market located in Chennai, Tamil Nadu, India and stored in a plastic can of 40 litres capacity.

Analysis of Biochemical components of Fish waste

The biochemical components of the fish waste were analysed to determine the amount of nutrients present in the fish waste. Parameters such as presence of carbohydrate was determined using Benedicts test (Arti S.Pandey , 2015) , presence of amino acid was determined by Aldehyde test (Arti S. Pandey ,2015), amylase enzyme was analysed using starch iodine test (Jayaraman ,1996) , presence of fatty acids was determined using titration method (Jayaraman ,1996), calcium was determined using Ammonium oxalate method (Harold Varley , 2005) and presence of zinc was determined using Ammonium hydroxide method (chemiday.com , 2015).

Preparation of bio Fertilizer using fish waste (Nardeep, 2013).

10 litres of water was added to 20 kgs of fish waste followed by 20 – 30 ml of pineapple extract. The material was mixed well with pineapple extract and kept for 5 – 8 hours. The vessel was kept closed with stirring every hour.

Fermentation

Jaggery solution (4 kgs of jaggery was dissolved in 5 litres of water) was added to the fish substrate after 5 to 8 hours of storage and stirred well. This mixture was allowed to ferment well for 15 – 20 days. The scales and fish bones get degraded well within this period.

Extraction of Fertilizer

After the stipulated period, the extract was prepared by adding 2 to 5 times of water to the fermented material. The extract was filtered using a muslin cloth. The undigested part was shade dried and used as manure for the soil. The filtrate was used as bio fertilizer for the growth of I.balsamina.

Collection of Soil and Seeds for Germination and Growth of Plant, I.balsamina.

The soil and seeds of Balsam plant, Impatiens balsaminawas procured from the TamilNadu Horticulture Centre, Chennai for germination and growth of the above said plant using synthesized biofertilizer, chemical fertilizer and commercially available fish waste fertilizer.

Physico-Chemical Analysis of Soil before and after the addition of the Fish waste manure

The physico-chemical parameters of the soil such as Nitrogen, Potassium, Phosphorus, Calcium, Magnesium and Sulphur were analysed by following the method of Motsara and Roy (2008) .

Determination of Germination and Growth (Shoot Length, Root Length, No. of Roots and No. of Leaves) of Balsam – Impatiens balsamina exposed to Control (Tap Water), synthesized bio fertilizer, Commercial Fish Waste Fertilizer and Chemical Fertilizer (Noorjahan, et.al., 2018)

Earthen pots were filled with soil and manure (the shade dried remnant of the fish waste extract). Seeds of Impatiens balsamina was sown in the soil of the pots. The seeds were sprayed with bio fertilizer, commercial fish waste fertilizer and chemical fertilizer separately (separate pots) to compare the efficiency of the fertilizers for the growth of the plants. They were sprayed regularly. Control was also maintained using tap water. Duplicates were maintained for each sample.Morphological features such as root length, shoot length, number of leaves and number of roots of the plants were recorded with a time interval of 15 days for a period of 60 days.

Tools used for Statistical Analysis

The tools used for statistical analysis are Mean Standard Deviation and Variance.

RESULTS:

Analysis of Biochemical components of Fish waste (Table – 1)

Determination of Carbohydrates

The results of determination of carbohydrates revealed the appearance of greenish blue precipitate thereby indicates the presence of trace amount of carbohydrates in fish waste.

Determination of Amino Acid – Tryptophan

The results of determination of amino acids present in the fish waste using aldehyde test showed the formation of a violet ring in the sample and confirmed the presence of amino acid containing in dole group tryptophan in the fish waste.

Determination of Amylase Enzyme

The results of determination of amylase enzyme present in fish waste showed that there was no colour change after a period of time indicating the presence of amylase.

Determination of Fatty Acids

The results of determination of fatty acids present in fish waste using conventional titration method revealed the appearance of permanent pale pink colour in the sample and confirmed the presence of fatty acids in fish waste.

Determination of Minerals – Calcium

Ammonium oxalate precipitation method was used to determine the presence of calcium. The appearance of white precipitate confirmed the presence of calcium in the fish waste.

Zinc

The result of determination of zinc present in fish waste using Ammonium hydroxide showed the presence of zinc by the formation of a white precipitate.

Table – 1. Analysis of Biochemical components of Fish waste

S.No.	Biochemical components	Result - Appearance / Formation of precipitate / colour	Present / Absent
1.	Carbohydrates	Greenish blue precipitate	Present
2.	Amino Acid – Tryptophan	Formation of a violet ring	Present
3.	Amylase Enzyme	No colour change	Present
4.	Fatty Acids	Appearance of permanent pale pink colour	Present
5.	Calcium	Appearance of white precipitate	Present
6.	Zinc	Formation of a white precipitate	Present

Physico-Chemical analysis of Soil before and after the addition of the Manure

The results of physico-chemical analysis of soil before and after the addition of the manure were depicted in Table 2.The results of the study revealed that nutrients of the soil treated with

manure were increased compared to that of soil before the addition of manure thereby indicating the efficiency of fish waste for the growth of the plants.

Table - 2. Physico-Chemical analysis of Soil before and after the addition of the Manure:

S.No	Parameters	Untreated soil		Treated soil	
		± Standard Deviation	Variance	± Standard Deviation	Variance
1.	Nitrogen	56.7 ± 0082	0.007	193.9 ± 0.082	0.007
2.	Phosphorus	312.6 ± 0.082	0.007	339.34 ± 0.082	0.007
3.	Potassium	418 ± 0.816	0.667	3360 ± 0.816	0.667
4.	Calcium	1834 ± 0.816	0.667	1839 ± 0.816	0.667
5.	Magnesium	817 ± 0.816	0.667	994 ± 0.816	0.667
6.	Sulphur	35.7 ± 0.082	0.007	198.3 ± 0.082	0.007

Determination of Germination and Growth (Shoot Length, Root Length, No. of Roots and No. of Leaves) of Balsam – Impatiens balsamina exposed to Control (Tap Water), synthesized bio fertilizer, Commercial Fish Waste Fertilizer and Chemical Fertilizer

The results of germination and growth of balsam – Impatiens balsamina exposed to control (tap water), bio fertilizer, commercial fish waste fertilizer and chemical fertilizer were depicted in Tables 3a – 3d.

The results of the growth study revealed that the growth of Balsam plant (Impatiens balsamina) on day 15 (Table 3a) in control (tap water) plant, revealed that the shoot length was 10.5±0.082, root length was 4±0.816, no. of leaves was 6±0.816 and no. of roots was 8±0.816 were recorded. In synthesized bio fertilizer, the growth of shoot length was 10.4±0.082, root length was 3.3±0.082, no. of leaves was 6±0.816 and no. of roots was 7±0.816 were recorded. In commercial fish waste fertilizer, the growth of shoot length was 9±0.816, root length was 3±0.816, no. of leaves was 6±0.816 and no. of roots was 5±0.816 were recorded, whereas in chemical fertilizer, the growth of shoot length was 9±0.082, root length was 3±0.816, no. of leaves was 6±0.816 and no. of roots was 5±0.816 were recorded. Similar results of increasing trend of plants growth were recorded on 30^{th} day (Table – 3c) and 45 thday(Table – 3d.) where maximum plant growth using synthesized bio fertilizer was recorded compared to that of commercially available fish waste fertilizer and chemical fertilizer..

On day 60 (Table 3d) in control (tap water), the growth of shoot length was 30±0.816, root length was 9±0.816, no. of leaves was 32±0.816 and no. of roots was 44±0.816 were recorded. In bio fertilizer, the growth of shoot length was 34±0.816, root length was 12.5±0.816, no. of leaves was 37±0.816 and no. of roots was 59±0.816 were recorded. In commercial fish waste fertilizer, the growth of shoot length was 26.5±0.082, root length was 11±0.816, no. of leaves was

35±0.816 and no. of roots was 28±0.816 were recorded. In chemical fertilizer, the growth of shoot length was 10.5±0.082, root length was 19±0.816, no. of leaves was 29±0.816 and no. of roots was 27±0.816 were recorded.

Table 3 a. Growth of Balsam – Impatiens balsamina exposed to Control (Tap water), Synthesized Bio fertilizer, Commercial fish waste fertilizer and Chemical fertilizer

Day 15 - Balsam plant									
		Control (tap water)		Synthesized Bio fertilizer		Commercial fish waste fertilizer		Chemical fertilizer	
S.No.	Parameters	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance
1.	Root length	4±0.816	0.667	3.3±0.082	0.007	3±0.816	0.667	2.5±0.082	0.007
2.	shoot length	10.5±0.082	0.007	10.4±0.082	0.007	9±0.816	0.667	8±0.816	0.667
3.	No. of leaves	6±0.816	0.667	6±0.816	0.667	6±0.816	0.667	4±0.816	0.667
4.	No. of roots	8±0.816	0.667	7±0.816	0.667	5±0.816	0.667	5±0.816	0.667

Table 3 b. Growth of Balsam – Impatiens balsamina Exposed to Control (Tap water), Synthesized biofertilizer, Commercial fish waste fertilizer and Chemical fertilizer

Day 30 - Balsam plant									
		Control (tap water)		Synthesized Bio fertilizer		Commercial fish waste fertilizer		Chemical fertilizer	
S.No.	Parameters	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance
1.	Root length	4.5±0.082	0.007	3.5±0.082	0.007	5.5±0.082	0.667	3.5±0.082	0.007
2.	Shoot length	20±0.816	0.667	20±0.816	0.667	18.5±0.082	0.007	10.5±0.082	0.007
3.	No. of leaves	13±0.816	0.667	12±0.816	0.667	8±0.816	0.667	8±0.816	0.667
4.	No. of roots	16±0.816	0.667	11±0.816	0.667	7±0.816	0.667	8±0.816	0.667

Table 3 c. Growth of Balsam – Impatiens balsamina exposed to Control (Tap water), Synthesized bio fertilizer, Commercial fish waste fertilizer and Chemical fertilizer

Day 45 - Balsam plant									
		Control (tap water)		Synthesized Bio fertilizer		Commercial fish waste fertilizer		Chemical fertilizer	
S.No	Parameters	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance	±Standard Deviation	Variance
1.	Root length	5.5±0.082	0.007	5.5±0.082	0.007	4±0.816	0.667	5±0.816	0.667

2.	Shoot length	22±0.816	0.667	20.5±0.082	0.007	19±0.816	0.667	18±0.816	0.667
3.	No. of leaves	11±0.816	0.667	15±0.816	0.667	13±0.816	0.667	11±0.816	0.667
4.	No. of roots	16±0.816	0.667	25±0.816	0.667	13±0.816	0.667	15±0.816	0.667

Table 3 d. Growth of Balsam – Impatiens balsamina exposed to Control (Tap Water), Synthesized bio fertilizer, Commercial fish waste fertilizer and Chemical fertilizer

Day 60 - Balsam plant									
		Control (tap water)		**Synthesized bio fertilizer**		**Commercial fish waste fertilizer**		**Chemical fertilizer**	
S.No.	**Parameters**	**±Standard Deviation**	**Variance**	**±Standard Deviation**	**Variance**	**±Standard Deviation**	**Variance**	**±Standard Deviation**	**Variance**
1.	Root length	9±0.816	0.667	12.5 ± 0.082	0.007	11±0.816	0.667	10.5±0.0982	0.007
2.	Shoot length	30±0.816	0.667	34 ±0.816	0.667	26.5±0.082	0.007	19±0.816	0.667
3.	No. of leaves	32±0.816	0.667	37 ± 0.816	0.667	35±0.816	0.667	29±0.816	0.667
4.	No. of roots	44±0.816	0.667	59 ± 0.816	0.667	28±0.816	0.667	27±0.816	0.667

DISCUSSION

India owns its backbone to agriculture. The increased use of chemicals in the soil and the plants has affected the eco-system to a great extent. Agricultural lands are being sold commercially due to decreased amount of nutrients in the soil and their inability to support plant growth. On the other hand, the environment is under threat due to a lot of factors. Dumping of waste, especially ocean dumping is considered as a major threat to both the land and marine ecosystem. Fertilizers were initially introduced to increase the yield of crops due to increasing human population. These fertilizers have played a vital role in the World agriculture history. There are various natural fertilizers that were used by our ancestors that lost their identity due to the introduction of new methods. Agriculture is a way of living and should be protected with utmost concern. Waste products such as cow dung, poultry waste, fish waste were identified as rich source of nutrients and were used in crop production. These practical methods, though time consuming, have never affected the environment. In fact, these methods also helped in waste management. A lot of researchers and farmers have experimented with fish waste and it has always left them surprised with the results on the growth and yield of plant crops.

The evolving trend of the use of fertilizer, many say our waterways are facing serious challenges with the overflowing amounts of nitrogen from farm fertilizers. Not only do these farming practices affect our drinking water, but also threaten wildlife and recreation. Phosphorus found in

chemical fertilizers can get into the soil and will eventually end up in lakes that result in plant and algae growth which poses health and environmental threats. This environmental problem will turn healthy lakes into weed-infested waters with a lot of dead fish. Furthermore, researchers believe that fertilizers runoff from massive farm operations can cause marine algae that negatively affects ocean ecosystems that create "dead zones" in the sea. Hence alternative ways to reduce nitrogen and phosphorus emissions found in conventional farming methods of today should be implemented. Thus, fish waste fertilizer is a great alternative for the commercial fertilizers which are eroding our soil out of nutrients and minerals. This source can act both as a fertilizer and manure. Surprisingly, the fish waste as a foliar spray can also act as a pesticide thereby preventing crop damage.

Hatiet.al., (2007) reported on the positive impacts of bio fertilizers on the root growth and yield of maize while Ayeni and Adentunji (2010) reported on the highly positive impacts of integrated applications of poultry manure and mineral fertilizers on nutrient uptake and yield of maize. Several researchers have reported that soils amended with animal manures significantly improved soil productivity and the yield of crops. Iren et.al., (2011),John Keatingeet.al.(2011), John et.al., (2013) and Iren et.al., (2015) . Iren et.al., (2015) have reported on the positive impacts of organic manures on the sustained production of waterleaf. Thus the results of the present study showed that the synthesized bio fertilizer using fish waste was brown in colour enriched with nutrients which increase the fertility of the soil and enhanced the growth of the plants and crops. The determination of soil nutrients in both untreated and soil treated with fish waste manure revealed that the quantity of nutrients were enhanced after treatment of soil with fish waste manure. Thus the result of the soil parameters indicates that the quantity of the minerals essential for the fertility of the soil has been increased after the addition of the fish waste manure thereby proving the efficiency of the fish waste as manure. The plants that were sprayed with the bio fertilizer tend to grow faster with more number of roots and leaves when compared to the plants that were sprayed with chemical fertilizer, commercially available fish waste fertilizer and control, thereby proving that the synthesized bio fertilizer is more efficient than that of the other fertilizers. The results of the above study is in accordance with the reports of Iren et.al. (2015).

CONCLUSION:

Thus the synthesized bio fertilizer was found to be a biological source with enriched nutrient composition and mineral properties. The role of this bio fertilizer was evident from the reports that were obtained before and after the application of the fish waste manure in the above study. Thus this study concludes that fish waste is an amazing source of minerals, nutrients and various biological components that are required for the plant growth and soil fertility. This is also a cost effective method as the main ingredient is a waste product that is available in all households.

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