

Development of an Organic Fertilizer

Udara. S. P. R. Arachchige, S.J. Ranaweera, A.A.L.T. Ampemohotti, Sumedha R.G. Weliwaththage, Siriwardena M.B.D.K, Jaliya Weerakoon

Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka

Abstract— Waste management has become a prominent topic as waste is a burning dispute in the modern world. There will be so many social and environmental issues if the generated waste is not managed properly. There are so many valuable compounds mixed with this waste that can be effectively used in a more beneficial and profitable way. The preparation of organic fertilizer by utilizing those valuable compounds will create a solution to reduce the harmful effects on waste and the effects occurred by using chemical fertilizers as well. Underused waste which are used to prepare this fertilizer contains the nutrients which plant required for their growth. In this research, paddy is focused as it is one of the major crops in Sri Lanka which has so many complain about being contaminated with heavy metals with the use of chemical fertilizers. Organic fertilizer is developed with cow bone, citrus peel, banana peel, eggshells as well as adding dried neem leaves. Neem is added to give pest repellent behavior to the fertilizer. The developed fertilizer is added to the paddy field to identify the impact of organic fertilizer. The paddy after three weeks of the fertilizer applied start fast-growing without any pest damages.

Index Terms— Organic fertilizer, Fruit waste, recycle, agriculture, chemicals.

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1 INTRODUCTION

Most of the farmers basically use manures, vegetable lettuce and chemical fertilizers for cultivation of agro crops. The total amount of chemical fertilizers use around the world is drastically increasing. From a chemical point of view, Nitrogen, Phosphorus and Potassium (N, P, K) which is required for the plant growth are commonly found in the manure in certain proportions[1].

In comparison with chemical fertilizers, manures are supplying relatively less amount of nutrients [2]. However, total amount of manure added to the farmland is relatively high compared to the chemical composition. It will be important to develop the organic fertilizer with higher amount of nutrient to supply adequate level of nutrients with less quantity.

Therefore, development of organic fertilizer as a raw materials of cow bone, and fruit waste will be providing supplementary level of nutrients with low cost. As cow bone and fruit waste are waste of the food industry, raw material cost is almost negligible. The most essential nutrition for the agricultural crop is nitrogen (N). The rapid development, industrialization and urbanization all around the world causes for the significant changes of the environment due to high amount of waste generation. A suitable approach to handle municipal solid waste is to produce organic fertilizer with the available waste. The development of an organic fertilizer using citrus peel, cow bone, egg shell and the banana peel found to be a good solution to get the nutrients enriched fertilizer for agricultural crops. The applications of organic fertilizers in agriculture presents multiple environmental benefits since it reduces the use of chemical fertilizers as well as avoid the cost of less appropriate waste treatment techniques such as incineration and landfilling.

The water, CO₂ and foods are considered as the primary requirements of the plants. When concerning the functions of living organisms cell and tissue maintenance, reproduction like things include in to the growth and development of plant. Therefore, for these growth and development, it is important to supply macro and micro nutrients as fertilizer. Generally plant need around 16 elements essentially. Among them carbon, hydrogen and

oxygen are obtain from the soil and atmosphere. Other 13 of elements such as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine are taken by either soil minerals and soil organic matter or by organic or inorganic fertilizers.

In generally crop need C:N on optimum range of 25-27:1. The lower C:N ratio can responsible for malabsorption of nitrogen due to volatilization of ammonia as well as the higher C:N ratio might affect for the nitrogen immobilization in compost and deduct the decomposition rate as well. Normally fruits and vegetable wastes have C:N ratio of <27:1 is good for fermentation and composting [3].

According to the type of plant the optimum level and minimum level nutrition requirement can be vary. If that level goes beyond the minimum level of requirement plant begin to show nutritional deficiencies by physical symptoms. If provide excessive amount of nutrients it also can be affect for the growth because excessive nutrients can be convert into toxic substances. Therefore, it is very important to use optimum level of nutrients. Among all these nutrients N,P,K play vital role as macro nutrients inside the plant body.

2 FOOD WASTE

Food waste is produced in tons per year in each and every country. Converting these in to valuable products is a major concern in the world mainly in order to reduce the waste generation problems. To reduce harmful effects of the food waste such as the offensive smell, production of methane which is a green house gas and to increase the profit by converting them in to useful products are major concerned. Food waste can be taken to produce organic fertilizers as they contain lot of major nutrients as well as minor nutrients. Moreover, it contains high amount of useful energy [4], [5].

This fertilizer is made by using cow bones, egg shells ,banana peels, citrus peel and neem leaves which is a powerful and a successful mixture to use as a fertilizer due to many reasons. While inorganic fertilizers contains harmful compounds organic fertilizers which are made by above compounds contain different carbonaceous matters as well as anti oxidants.

Even though the beef meat industry is facing lot of religious and cultural constrains, it still have a high production and a growing rate. The bone part is discarding as a waste which is 15% from the whole carcass [6]. Egg shells are also discarding which is 12% of the total proportion.

Not only fertilizer is important for agriculture, pesticides also important to maintain the quality of the crops without being damaged by pests. All chemical pesticides are harmful to the environment as well as for humans. Therefore, biological pesticide is important to improve the production capacity of the agricultural crops. Any substance which is intended for preventing, destroying or repelling any pest, or any plant regulator are can be considered as organic pests. Neem is considered as one of the best organic pest which has Azadirachtin as active ingredient.

3 PRODUCTION PROCESS

The production process flow diagram of the fertipest is given in the Fig. 1.

Procedure:

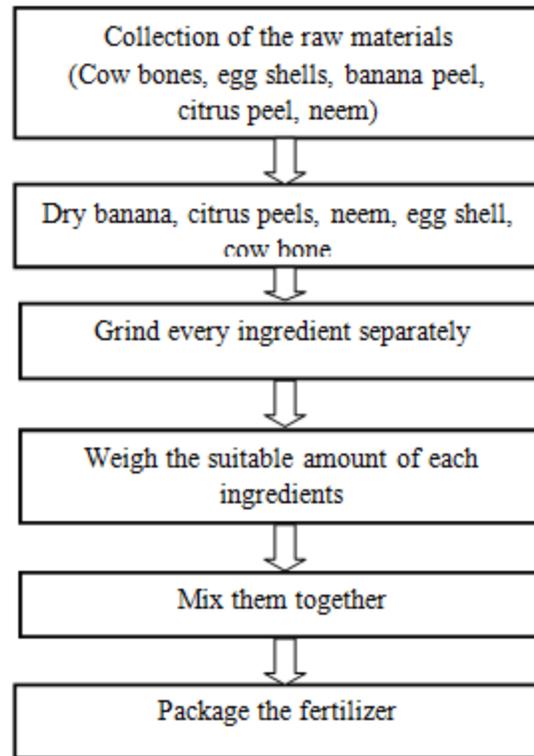


Fig. 1. Production process of the fertipest

Organic fertipest (Fertilizer + pesticide) is produced by adding cow bone, citrus peel, banana peel, egg shells, and neem with 1000 : 100 : 50 : 500 : 200 ratios. It can be simplified as 20:2:1:10:4 ratio for better performance in the rice cultivation. Fig. 2 are representing Cow bone, Citrus peel, Banana peel, egg shells, and neem.



Fig. 2. Raw materials for fertipest, (a) Cow bone, (b) Citrus peel, (c) Banana peel, (d) Egg shell, (e) Neem.

The prepared fertipest is shown in the Fig. 3 as a combination of above raw ingredients in a specified ratio.



Fig. 3. Developed Fertipest

4 DISCUSSION

Food waste can be mainly divide into two groups as edible and inedible. Edible once can be utilized to develop pet foods, other pharmaceutical products and etc. Inedible once are commonly throwing away as waste but they can utilize as a fuel or fertilizer. These by products can be collected from farms, animal shelters, slaughter houses, processing and production plants, supermarkets, restaurants and etc [7]. Banana peel got an alkali pH as it contains potash while citrus peel got an acidic pH. So mixing both of them in a suitable ratio helps to regulate the soil pH. Checking the pH and regulating is essential as if not it is undesirable for soil, plants and organisms. Peels should be dried for 21-25 days in the sunlight[8]. Oven drying method can be used to increase the productivity but the energy consumption is the drawback. Even though there is a reduction of some nutrients drying is important to facilitate the grinding process and also to enhance the market acceptance by presenting a powder rather than a slurry as it increasing the convenience.

In meat industry, nearly half of the animal is removed as waste because they are not suitable for human consumption due to the physical and chemical characteristics of them. In bovine slaughter house 27.5% of the animal weight is discarded as waste. But they should be utilized for some other purposes like production of pet foods ,fuel , fertilizers and give a value without throwing them away as a waste. According to the research service of the United States Dept. of Agriculture Economic, 11.4% of the gross income of beef industry is by the effective utilization of beef by products. These waste are generating in slaughter house, production areas and processing plants.

The amount of 15% of beef carcasses is bone [6]. So nearly 150g of bones will generate from 1kg of a beef carcass. This can be used as a phosphorus rich fertilizer. Cow bone meal contains nearly 19.3% of Ca and 9.39% of P which are essential for plant growth [9]. Egg shell is 12% of an egg which means 120g of shells is generating from 1kg of eggs. Egg shells contain high calcium content due to the presence of calcium carbonate and also miner amount of Mg and P due to the presence of magnesium carbonate and calcium phosphate . Citrus peel is "% from the total fruit. Citrus peel contains N 1-2g per 1kg [10]. Banana peel is "% from the total banana fruit and it contains high amount of potassium (K) around 78.10 mg/g which is essential for plant growth. Also 19.20mg/100g of calcium,0.61mg/100g of iron,76.20mg/100g of manganese are present in banana peel [11].

The use of chemicals has become famous among the farmers because of its high potential to destroy pests and quick activation to break the pest population chain. However, use of chemical pesticides has caused considerable impact on the environment, ecological balance and human health due to degrade of the quality of the food. Therefore, organic pesticides are important to develop and apply on the crops to minimize the impact. Neem is considered as the one of the best option to control the pest. Neem, derived from neem tree can be used as a organic pesticide either neem seed or neem leaves. The main active ingredient of neem is identified as azadiractin which is capable of kills many pests including caterpillars, thrips and whitefly.

Nutritional composition of the ingredients we are taking to produce the fertilizer can be slightly vary with the factors like growing conditions, climate, maturity, root stock, variety for plant materials and nutrition, bread, climate for animal ingredients.

Importance of essential plant nutrients

Nitrogen(N)

obtain to the plant available as nitrate and ammonium ions. Nitrogen help to form amino acids and protein by combining with C,H,O and S like elements. Amino acids essential for the creating protoplasm. In addition to that chlorophyll molecule mainly made from nitrogen so it involves for the photosynthesis as well. Nitrogen contributing for the enzymatic reactions as well because enzymes are also a type of globular protein. Quality and quantity of dry matter in leafy vegetables and protein content of grain crops will be increase due to presence of nitrogen.

If plant cannot absorb enough nitrogen amount it will affect for the growth rate due to deduction of cell division. The first symptom of nitrogen deficiency appearing in older leaves of plant as chlorosis the color is varying from pale green to yellow. That chlorosis may cause for the drop or death of the leaves. Otherwise the flowering is can be reduce and the protein content of seeds and vegetative parts become lower. N deficiency will cause for the considerable decrement in yield and quality of product due to early maturity.

Phosphorus (P)

Available as orthophosphate. When photosynthesis and respiration, P contribute for the energy storage and transformation of ADP and ATP. in addition to that RNA and DNA are part of genetic information. So P involve for that too as a main part of those genetic information. Seeds of maturity plant have high concentration of P and it is required for the young cells such as shoots and root tips. Apart from that P involves to the enhancement of the quality in crops and reduce the disease susceptibility as well. Less P amount will cause for the delayed maturity, poor fruits and seed development. P need from large quantities during premature stages in the plant because it is important to cell division. As deficiency symptoms colorations can be appearing on older leaves. Purpling of leaves and stems may appear under severe deficiency.

Potassium (K)

Available as K ions. K help to promote metabolism by act as an enzyme activator. K help to regulate the leaf stomates where water is released to cool the plant. In photosynthesis K has an ability to maintaining the balance of electrical charges at the site of ATP production. K contribute for the plant growth or storage in fruits or roots by promoting the translocation of photosynthesis. In addition to that k involve for the of size of the grains and

seeds it also improve the quality of yield and improve the disease resistance. Chlorosis appearing of the edge of older leaves. K is an essential element of photosynthesis and the synthesis of protein. Lack of K resulting the reducing the quality and size of seeds and fruits as well as the production and yield.

Calcium (Ca)

Calcium available as Ca²⁺ ions. Calcium help to maintaining cell integrity and membrane permeability and it will important for the normal cell division. In addition to that Ca involve for the formation of cell wall membrane. Ca act as activator of some enzyme systems in protein synthesis and carbohydrate transfer. Ca plays a major role to enhance the crop yield by reducing soil acidity. First symptoms appear on leaf tips and younger leaves. The growing leaves and root tips turn in to brown and die. Lack of Ca result for the reduce the rigidity of cell walls and weekend the stem structure. Because Ca need for formation of calcium pectate. In addition to that buds and blossoms fall prematurely in some crops.

Nutrition requirements for agro crops

In this chapter, the required Nitrogen (N), Phosphorus (P), and Potassium (K) ratio for the coconut, rubber, rice and vegetable crops are discussed.

COCONUT

The NPK ratio of coconut cultivation of Sri lanka can categorize as young palm in wet and intermediate zones, young palm in dry zones, adult palm in wet and intermediate zones and adult palm in dry zones. The NPK ratio of above each particular zones can mention in the Table 1 [12].

Table 1. NPK ratio of agro crops

	Young palm in wet & intermediate zones	Young palm in dry zones	Adult palm in wet and intermediate zones	Adult palm in dry zones
N	11	13	11	13
P	16	15	8	7
K	14	20	29	34

RICE

It is required for getting the higher rice yields than the other treatments , add the 175 kg of N, 60kg of P, 120kg of K, 25kg of Mg , 50kg of S and 2kg of Zn per hectare [13]. N: P:K =17.5: 6: 12

The developed fertipest are added to the rice plantation to check the impact of the product (Fig.4). At the same time parallel crop plantation area were also maintained without fertipest for comparison. The best thing with the fertipest is that can be added to the farm or paddy field by bare hand. After 10 days of the fertipest added to the paddy field, results are analyzed. There was no any pests in the farm area where fertipest is added. At the same time, rice plants are well grown and the size of the plantations are longer than the plants in the remaining area. The fertipest has been perfectly worked for the rice plantation. Moreover, some amount of water is added to transfer nutrients to the rice plants efficiently. The total amount of fertipest added to the farming is less compared to the chemical fertilizer.



Fig. 4. Developed Fertipest applying to the paddy field.

8 CONCLUSION

The organic fertilizer developed with active organic pesticide. The cow bone, banana peel, citrus peel, and egg shells are used to generate the fertilizer. At the same time, neem is added to the fertilizer to get the pesticides effect on the farming. The final product is applied to the rice farming. It is clear that developed fertipest is properly working. There is no any kind of environmental impact or pollution with fertipest. All the ingredients are either waste products or widely available products at free of charge. Therefore, total production cost of the fertipest is less than 5 rupees per kilogram. However, if it is decided to buy the cow bone, the total production cost of the fertipest will increase to 50 rupees. Further studies has to perform to check the other organic leaves and trees for fertipest manufacturing process. The fertipest production reactor should be designed to run the process faster.

REFERENCES

- [1] R.P. Singh, "Fertilizers, Types Production and environmental impacts", Nova Science Publishers, New York, 2012, ISBN: ISBN: 978-1-62081-457-4.
- [2] G.. Füleky and S. Benedek, Replenishing soil organic matter with organic fertilizers, Types Production and environmental impacts, , Nova Science Publishers, Inc, 2012.
- [3] S. Ahmad, S. Gul, M. Islam, M. Athar "Seed Dispersal And Soil Seed Bank Of Seriphidium Quettense (Asteraceae) In Highland Balochistan, Pakistan. Journal Of Botanical Research Institute Of Texas 1(1):569-575.2007.
- [4] D. Pleissner, C.S.K. Lin, Valorisation of food waste in biotechnological processes. sustain chem process 1, 21 (2013)
- [5] O.T. Okareh, A.T. Adeolu, and O. Shittu, Enrichment of pig dung with selected crops waste from the production of biogas, International Research Journal Of Microbiology 3 (7): 258-263, 2012.
- [6] G.. C. West and D.L. Shaw, Fatty acid composition of dall sheep bone marrow. Comp Biochem Physiol B Biochem Mol Biol. 50(4):599–601,1975. doi: 10.1016/0305-0491(75)90096-6.
- [7] U.S. Environmental Protection Agency, Emission factor documentation for AP-42 Section 9.5.3. Meat rendering plants final report. EPA Contract No. 68-D2-0159, Washington, DC (DCN 00125), 1995.
- [8] H. Jariwala, H. S. Syed, Study on Use of Fruit Peels Powder as a Fertilizer, Conference: Recent Advances in Environmental Sciences and Engineering, 2016
- [9] Khalil and S. Anwar, Studies on mineral composition of Bukit Kamangs' limestone as mineral feed. Media Peternakan, 30: 18-25, (In Indonesian), 2007.
- [10] A. Henry, V.O. Akinyosoye, Tropical Agriculture, Macmillan Publishers Limited, Ibadan p. 65 – 68. 1991.
- [11] B.A. Anhwange, Chemical composition of Musa sapientum (Banana) peels, Journal of food technology, 6 (6), 263-266, 2008.
- [12] Inorganic fertilizer activation for Coconut, Coconut research Institute of Sri Lanka, Advisory circular number A5, 2018.
- [13] H. Ekanayaka, The Impact of Fertilizer Subsidy on Paddy Cultivation in Sri Lanka. Staff Studies, 36(1), pp.73–101., 2009.