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Organic Waste as Soil Substitute through Box Composting

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Abstract: Due to urbanization and the modern lifestyle the waste load on earth have increased which in turn pollutes the environment. The existing landfills and dumping sites are full beyond capacity and under unhygienic conditions leading to the pollution of water sources, foul smells and odour, unaesthetic feel and ambiance. In this paper, we have discussed about converting the municipal organic waste into soil substitute. Basic idea of this is to develop a method to convert compost waste into soil substitute. In this project box composting technique is adopted. Fly ash, saw dust, coconut husk, slurry along with organic waste is mixed with soil in this technique. Various micro-organisms acting in the soil helps in decomposing the organic waste also enhances the soil properties and fertility. It can be also used as a soil remediation technique. Through this we are adopting a way in which the organic waste can be effectively treated and reused.

Keywords: Urbanization, Composting, Soil remediation, Soil substitute, Organic waste

I. INTRODUCTION

Municipal solid wastes (MSWs) are the undesirable wastes consisting of household wastes. It also includes the wastes of industries, schools, hotels, public services, etc. As the world's population size has grown, the waste generation rate has increased rapidly. The growth of the world's population, urbanization, socio-economic development and the advancements in the living standards leads to the increase in the municipal solid waste generation in the whole world. The quantities of municipal solid waste (MSW) have been growing for many years in many countries especially in developing countries. The nature of waste is changing due to the rise in the use of hi-tech products.

In the present scenario, many kinds of research have been carried out for finding an effective way for the disposal of municipal solid wastes. Landfilling is a common method adopted for the disposal of municipal solid wastes. Open landfills are the only available way for the elimination of municipal solid wastes. These landfills and the dumping sites are full beyond their capacity and it is in an unhygienic condition.

Many negative issues are associated with the landfill. The most important problems are toxins, leachate and greenhouse gases. If the municipal solid waste is not handled effectively, there are high chances of causing environmental hazards. Municipal solid waste can be composted and recycled. It can be used as a source of increasing the plant nutrients and also for improving the soil properties. Municipal solid waste can be converted to soil substitute through box composting. Thereby reducing the waste load on earth and also increases soil fertility. It also reduces the use of chemical fertilizers in the soil.

II. PRESENT SCENARIO OF MSW IN INDIA

Waste management in India falls under the Union Ministry of Environment, forests and climate change (MoEF & CC). This ministry released the rules relating to Solid Waste Management (SWM) in 2016. India generates about 62 million tonnes of municipal solid waste each year of this 70% (43 million tonnes) is collected and 20% (11.9 million tonnes) is treated and about 50% (31 million tonnes) is dumped in landfill sites. A study conducted by Indian Metro Cities in 2007 estimates MSW composition to be 41% organic, 40% inert, 6% paper, 4% plastic, 4% textiles, 2% glass, 2% metals and 1% leather.

III. PROCESSES INVOLVED

A. Box Composting

Box composting is a method which involves recycling of various organic materials as soil conditioners. In this process soil along with coconut husk were laid as bottom layer. Then a layer of waste was laid above it. Fly ash and slurry was laid as the next layer. Finally saw dust was laid as topmost layer.

Compost mix was kept for an incubation period of 21 days. Thorough mixing was done during incubation time after a period of 7 days.

B. Planting Seeds

Pea seeds were selected and these were planted on both normal as well as on mixed soil. Their growth was evaluated for 10 days. Pea seeds were selected on the basis of the following two reasons.

- 1) Pea seeds show a better growth when they are planted in soil ranging pH from 6 to 6.5.
- 2) Pea seeds show their germination and primary growth within 7 to 14 days and this helps in plant growth evaluation in both normal and mixed soil.

C. Optimum waste Content Evaluation

Compost mix were made by varying the waste content from 10% to 50% in order to find out the optimum waste content for effective plant growth.

Table I. Varied proportioning of materials

| Materials | Varied percentage of materials | | | | | |
|---------------------|--------------------------------|--------------|--------|---------|-------|------|
| | Saw dust | Coconut husk | Slurry | Fly ash | Waste | Soil |
| 1 st mix | 10% | 10% | 10% | 10% | 10% | 10% |
| 2 nd mix | 10% | 10% | 10% | 10% | 20% | 20% |
| 3 rd mix | 10% | 10% | 10% | 10% | 30% | 30% |
| 4 th mix | 10% | 10% | 10% | 10% | 40% | 40% |
| 5 th mix | 10% | 10% | 10% | 10% | 50% | 50% |

IV. MATERIALS USED

A. Fly Ash

Fly ash is produced from the coal combustion in a thermal power station. It has a great potentiality in agriculture due to its efficacy in the modification of soil health and crop performance. It increases the yield of crops because of the high concentration of elements in it. The use of fly ash in agriculture provides an alternative method for its safe disposal and improves the soil environment and enhances crop productivity.



Fig.1 Fly ash

B. Slurry

Biogas slurry may be considered as a good organic fertilizer for agriculture. By applying the biogas slurry in the field provides a huge nutrient potential for vegetative and reproductive growth of the crop. It also produces an eco-friendly way of maintaining productivity and soil health.

C. Coconut Husk

Coconut husk is a good medium to grow plants. Coconut husk contains large lignin content and hence it is resistant to bacterial and fungal growth. It supplies the oxygen to the roots of plants because it is highly porous and hence the root will not rot.



Fig. 2 Coconut husk

D. Saw Dust

Saw dust is the waste product of wood working operations such as milling, sawing, sanding etc. It helps in building up soil organic matter thus enhancing the nutrient retention and water holding capacity. It is readily available and sustainable. It is a local source and safe to soils and crops.



Fig .3 Saw dust

E. Organic Food Waste

As the population increases the discharge of food waste is also increases. Food waste has become a large environmental problem in country. It has a good biodegradable rate. The food waste is unique as a compost agent and it is the main source of organic matter.



Fig .4 Organic food waste

V. TESTING

The soil should pass through the following tests;

A. pH

The pH in the soil is calculated by pH meter and pH paper. Take 20g of soil and add 40ml of water to it mix it for 5 minutes then allow the sample to settle. The sample is prepared for normal and mixed soil. The pH meter shall be calibrated by using standard buffer solutions (pH 4 and pH 7). The electrode is washed and dipped in the sample. The corresponding value of pH is displayed on the pH meter. The electrode shall be removed from the sample immediately and washed with distilled water. The same procedure is repeated for mixed soil. Take pH paper and dipped in the sample, the corresponding colour of the pH paper is gives the value of pH.

B. Moisture Content

The moisture content in the soil is calculated by oven dry method. Take clean dry and weigh the container (w1). The required quantity of sample is taken in the container and weighs it (w2). Place the container in the oven at a constant standard temperature (1050c to 1100c) for 24 hrs. After drying remove the container and allow it to cool down. Take the weight (w3).

$$\text{Moisture content } W = \frac{w_2 - w_3}{w_3 - w_1} * 100$$

VI. RESULTS AND DISCUSSION

A. pH

Table II. The pH values for normal and mixed soil

| | Normal soil | Mixed soil |
|----------|-------------|------------|
| pH meter | 5.5 | 6.2 |
| pH paper | 5 | 5.9 |

The pH from normal soil is 5.5 which is less than the permissible limit 6-6.5. For mixed soil the pH is 6.2 is within the limits. The optimum value of the soil pH is 6.5 which is usually considered for the nutrients.

B. Moisture Content

The moisture content from normal and mixed soil is 20 and 32. Generally the moisture content varies from 10% to 45% but it can be varied during and after the watering.

C. Nitrogen, Phosphorous and Potassium

Table III. The table shows n,p,k values in mg/kg

| Parameters | Normal soil | Mixed soil |
|-------------|-------------|------------|
| Nitrogen | 110.3 | 140.5 |
| Phosphorous | 21.2 | 39.3 |
| Potassium | 59.6 | 76.4 |

The nitrogen is a key nutrient for plants to grow. Nitrogen supports the plants growth and encourages the healthy development of the plant. Fertilizers typically contain a mix of nitrogen, phosphorus and potassium, with nitrogen is being responsible for the foliage growth. Phosphorus helps a plant to convert other nutrients into usable building blocks with which to grow. Potassium is the third key nutrient of the fertilizers. It helps to strengthen the plants to resist disease and plays an important role in increasing crop yield and the overall quality. Nitrogen, phosphorus and potassium values obtained for mixed soil and normal soil are almost the same. Hence this mixed soil can be used as soil substitute.

VII. CONCLUSION

One of the important challenges to the environment is solid waste. Insufficient waste management affects the ecosystem including the air, water and soil pollution, thus it represents real harm to human health. The utilization of MSW in agriculture is one of the most promising and cost-effective option for municipal solid waste management. It reduces the negative impact of MSW on the environment and society. It also adds nutritive value to the soil and plants. It also helps in the restoration of degraded land. Thus it provides sustainability to the ecosystem and the soil ecology. The presence of toxic substances like heavy metals and other organic pollutants in MSW compost is a potential trait to the enzyme activities, ultimately productivity to the land. So it is necessary to find out the optimum content of the municipal solid waste in the soil. The optimum content of municipal solid waste in the soil is 30%, up to which it shows a better growth. Beyond 30% the plant growth is poor and the plant will soon die out.

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