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Qualitative Effect of Mechanical Turner on *N-P-K* Concentration of Compost

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***Abstract* –** Solid waste management is the most significant issue from an environmental and agricultural perspective. Composting of the waste is a process to turn the trash into organic fertilizer. This study turns the waste into small size materials using a wood shredder for making organic compost. The nutrient concentration of the compost enriches by turning with the windrow turner machine. The nitrogen concentration increases from 75.1 to 2075 ppm, phosphorus from 1.5 to 12.9, and the same as for potassium. The results of the study concluded that good-quality compost could be produced by adopting the mechanically operated compost windrow turner.

Keywords – Compost, Organic Fertilizer, Turner, Enrichment, Nutrients

I. Introduction

Waste Management (WM) is the most critical environmental issue across Pakistan. Most of the waste is base on the house or agriculture which is known as organic waste [1]. Composting is a feasible and economical way to use waste as a value-added product[2]. As an agricultural base country, Sustainable productivity is the key goal of our agricultural ecosystems. The health of the land and people is the main focus of sustainable agriculture for better productivity [3]. Pakistan's soils don't have enough organic matter (OM), which prevents them from being sufficiently nutritive to enhance crop productivity. [4]. Composting is the decomposition of organic matter into a nutrient-rich soil amendment. Finished compost is an earthy humus-rich material that helps soil retain nutrients and moisture to improve plant growth [5]. Three essential ingredients are required for composting, including browns, greens, and water. Materials such as dried leaves, branches, and twigs are considered browns. Materials including grass clippings, vegetable trash, fruit pits, and coffee grounds are included in the category of "greens." For compost to develop, it's critical to have the appropriate amount of water, greens, and browns. [6]. Since this is an aerobic process, it is necessary to regularly mix and aerate the composed material to prevent anaerobic cores which help out to make good quality compost [7].

For the aerobic decomposition of the compost pile the oxygen, moisture, and C:N ratio are the key parameters which monitored regularly to timely and successful composting of the pile or windrow. Although yard waste compost has low nitrogen quantity, if it is applied in large volumes, this organic form of nitrogen will slowly release. The yard waste has a very low percentage of nitrogen (N) Phosphorus (P) and potassium (K) which is insufficient to produce good quality organic fertilizer [8]. However, some grass clippings or manures add as supplementary nitrogen sources to enhance the quality of compost [9]. Therefore, to add up these supplements and maintain the moisture and aeration Pile turning method introduces which reduces the size of feedstock and control the necessary content up to the optimum level. In the earlies, conventional methods were used for turning the compost material which was laborious and time-consuming process. The late turning of decomposed material effect nutrient values in the compost [10]. Various modifications and adjustments have been made in windrow turning equipment due to the

changing demands and trends in the composting sector as well as manufacturers' efforts to enhance machine performance [11]. Therefore, the mechanized tractor-operated compost windrow turning technology is the most famous and effective method to reduce labor cost, less time consuming and proper turning of compost with maximum efficiency.

This study aims to turn the compost with indigenized windrow tuner to improve the compost nutrients with timely and proper mixing. By this, the amount of nitrogen, phosphorus, and potassium enhances within a limited time which will be less than the conventional method. The main focus of the research is to enhance soil health with good-quality compost.

II. Materials and Method.

A-Site Selection:

The waste crushing, compost pile development, and compost turner performance evaluation of the solid waste management site of MNS-University of Agriculture Multan, Pakistan was utilized. The experimental site had all the facilities which were used for the windrow compost pile formation and proper machine working. The experimental area was also at walking distance to the compost formation site.

B-Waste Handling for Compost:

Three essential ingredients are required for composting, including browns, greens, and water. Materials such as dried leaves, branches, and twigs are considered browns. Materials including grass clippings, vegetable trash, fruit pits, and coffee grounds are included in the category of "greens" which were collected from the university experimental fields and gardens and tree pruning. Fig. 1. shows the waste collection process on the experimental site.

Fig. 1 Waste collection on the site

C-On-site Waste Management:

The material collected from the gardens and tree pruning waste not directly use for the compost. Therefore, the collected waste was crushed using a hydraulic conveyor base tractor-operated wood shredder to reduce its size up to 10mm which is good for better composting. For shredding the waste material, the wood shredder operated at 540 rpm as shown in Fig. 2. This crusher was developed at the department of the agriculture engineering MNS university of Multan, Pakistan.

Fig. 2 Waste residue crushing with hydraulic base PTO-operated wood crusher

D-Compost Pile Formation:

There are many ways to make compost, but the three most popular methods are static piles, windrows (stretched piles), and container composting. For their composting, farmers generally adopted windrows or substantial piles of material that are regularly turned over easily[12]. Therefore, for this research, our team selected the windrow or static piles system to investigate the impact of windrow turner on compost nutrients. Three piles were made manually by the layering method of different variations of material. The maximum height was selected up to 4 feet, breath was 5-6 feet, and the length of each pile was up to 20 feet as shown in the Fig.3. For the compost pile formation use animal manure, green leaves, and brown material tree, maize stalks and rice residue add up to increase the amount of nitrogen, phosphorus, and potassium in the compost. The moisture in the form of sugar liquid and water add to the aerobic decomposition of the crushed material. The pile was turned after one weak, and continued to 7 weeks to increase the nutrient values in the compost.

Fig. 3 Windrow compost pile

E-Windrow Turner Operation:

Compost piles, especially those kept in windrows, can be aerated and mixed using a variety of various equipment. These machines properly mix, churn, and aerate the compost using a rotating drum with flails. Additionally, earlier compost-turning machinery is generally expensive and needs a lot of maintenance, and some of them are problematic to clean. Therefore, there is a need to make it simple and easy-to-use technology with fewer maintenance issues and high durability. Therefore, the indigenized windrow turner was developed at the department of agriculture engineering MNS university of agriculture Multan, Pakistan. The developed machine operated in the compost windrow at 800 rpm rotation of turner blades to mixed the material as shown in Fig. 4. The developes machine operated at 700-1000 rpm of the rotor blade with optimum compost mixing efficiency.

Fig. 4 Compost Turning with indigenized windrow turner

III. RESULTS:

N-P-K Analysis of Farm Compost:

A-Total Nitrogen Concentration:

The indigenized compost windrow turner mixes the compost pile after every week. The amount of total nitrogen starts increasing from 3rd week and reaches at maximum after 7 weeks as shown in Fig.7. The increase in total nitrogen started due to carbon dioxide emissions by dry mass loss, evaporation by water loss, and nitrogen-fixing bacterial action. The increased total nitrogen content after 20 days of composting showed that it might have been caused by a net loss of dry mass in the form of carbon dioxide and water loss through evaporation induced by heat generated during organic carbon oxidation.

Fig. 7, represents the trend in the amount of TN increasing progressively week by week, and getting its maximum at week 7 for all piles. The results indicated that the highest concentrations attain the last week.

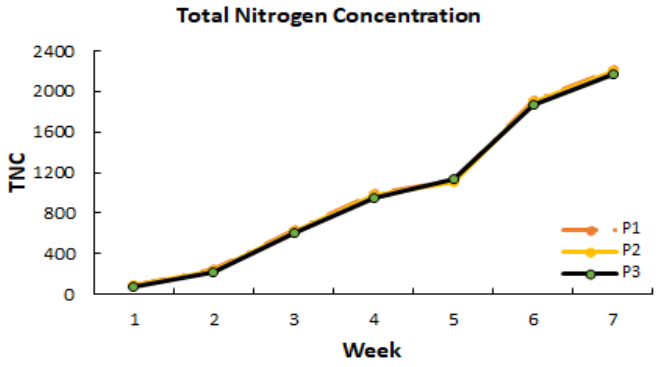

Fig. 5 Total nitrogen concentration variation with indigenized compost turner

B-Total Phosphorus Concentration in Farm Compost:

Weekly changes in the concentration of phosphorus in the piles are often moderate. The total phosphorus content of the three piles, P1, P2, and P3, progressively increased throughout the composting process, as shown in Figure 6. The last week had the highest concentration, whereas the first few days had the lowest. There were 1.5 to 12.95 ppm of concentrations. This is due to the possibility that the higher rate of carbon loss carried by the decomposition of organic materials by mixing the compost with a windrow turner after each week contributed to the rise in total phosphorus during composting.

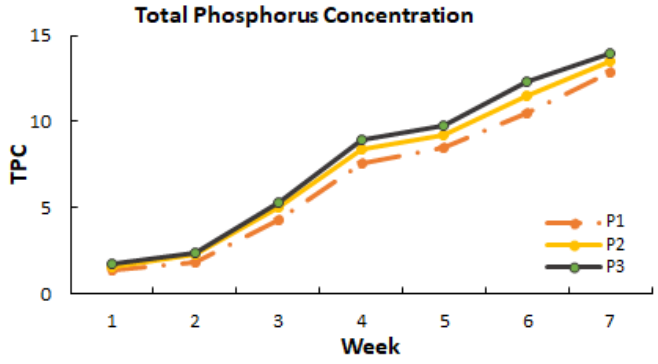

Fig. 6 Total phosphorus concentration variation with indigenized compost turner

C-Potassium Concentration:

In this study, the potassium level rises but varies week by week. The graph line in Figure 7 shows that the potassium value isn't increasing constantly since all three piles of farm manure were properly mixed after each week, which disrupted the bacteria. Due to the actions of microorganisms found in compost also need nutrients, weekly levels varied and can be unstable. The compost concentration may become unstable and start to decline before it reaches maturity as a result of the migration of microorganisms, which need nutrients at particular times. Most compost concentrations are getting stronger every week.

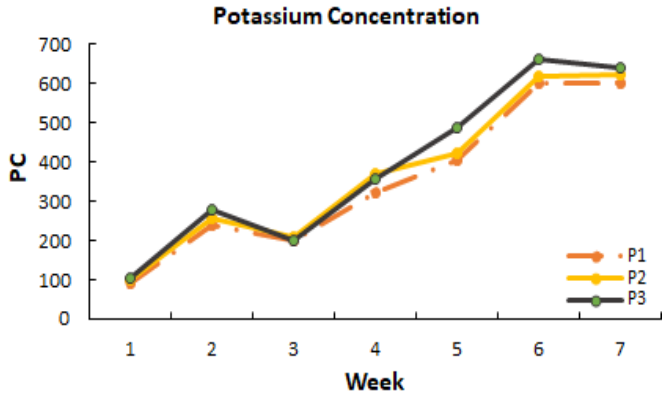

Fig. 7 Total phosphorus concentration variation with indigenized compost turner

IV. Discussion:

More mechanical equipment are used in high-level technology methods to achieve optimum temperature control and aeration in the pile windrows. The quality of the compost has been significantly impacted by indigenized compost windrow turner. After 20 days of composting, the increased total nitrogen content suggested that it has been carried out by a significant loss of dry mass in the form of carbon dioxide and water loss through evaporation brought on by heat produced during organic carbon oxidation. The results of the conducted study concluded that the highest concentration of Total N, P, K was seen in the last week, while the lowest was observed in the initial phases [13,14]. The composting time of the material also reduces by this turning process. This is study comparatively better than other conventional turning methods which are time-consuming and labor-intensive.

V. Conclusion:

This study aims to evaluate the effect of the intervention of the windrow turner machine in nutrient enrichment of the compost. The conducted study provides effective results to adopt this technology for turning the compost. The turning of compost increases the concentration of total nitrogen content range from 75.1 to 2075 ppm, total phosphorus concentrations get range from 1.5 to 12.95, while the potassium concentration gets range from 88.2 ppm to 631 ppm in farm compost. From the study outcomes, its concluded that when the material crushed with the wood shredder to reduce the size is most successful for the composting procedure. The material's size helps in producing compost rapidly whereas the level of total nitrogen increases between each pile. The total phosphorus and potassium concentrations increase regularly with turning the compost by turner. The different concentrations showed that the addition of various types of agricultural waste will change the amount of NPK due to microbial activity. There is a possibility that the compost employed in this study might be used for agricultural purposes, given the nutrient performance, or N-P-K, continues to improve weekly. This study provides guidelines to use the compost turning technology for good quality compost to the framers and academia for further research.

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