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Open Access Journal of Waste Management & Xenobiotics
ISSN: 2640-2718

Compost Production for Soil Nutrition

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Mini Review
Volume 5 Issue 2
Received Date: July 11, 2022
Published Date: August 05, 2022
DOI: 10.23880/oajwx-16000173

Abstract

One of the biggest problems fans face is maintaining soil fertility. The constant use of chemical fertilizers is also harmful. Therefore, a supplemental dose of compost is necessary to improve soil fertility. Organic fertilizers like compost make better use of all farm and animal waste and convert nutrients into an easily available form, increasing soil fertility. Compost is the product of an aerobic process during which microorganisms break down organic matter into a stable amendment to improve soil quality and fertility. During the composting process, microorganisms use organic matter as a food source, and produce heat, carbon dioxide, water vapor and humus as a result of their vigorous growth and activity. When applied to and mixed in soil, humus can promote good soil structure, improve water and nutrient holding capacity, and help control erosion. Humus makes up approximately 60 per cent of the final compost.

Keywords: Compost; Soil fertility; Plant Nutrition

Introduction

The practice of composting is an excellent way to improve the fertility of the smallholdings of marginal farmers and small farmers in the country. The practice of composting converts all types of organic waste into humus which provides an opportunity for farmers to make better use of waste and excreta already present either on the farm or in the neighbourhood. All kinds of organic matter that would normally be considered waste can be used, and can be disposed of or burned in composting.

Sources of Organic Waste for Composting

Compost is decomposing waste such as leaves, twigs, roots, plants, bossa, crop residues, hedge clippings, street droppings collected from towns and villages, water hyacinth and bagasse. The decomposition process is accelerated by adding a nitrogenous substance such as cow manure, night soil, urine or nitrogen fertilizers. All materials can be obtained from various sources listed below.

Livestock and Human Waste

Livestock droppings, dung, urine, human excrement and by-products of slaughterhouses, animal carcasses, blood and bone meat residues, horns and hooves, and other livestock and human waste.

Crop Residues, Tree Residues and Aquatic Weeds

Waste crops of cereals, pulses and oilseeds (wheat, rice, guar, bajra, gram, yord, mung, cowpea, ahar, masur, groundnut, linseed, etc).

B. Com stalks, cotton, tobacco, sugarcane waste, cotton leaves, jute, tapioca, orchid, tree leaves, water hyacinth, forest litter, etc.

Green Manure

Sunnhemp (*Crotolaria juncea*), dhaincha (*Sesbania aculeata*), cluster bean (*Cyamposis telragonoloba*), senji (*Melilotus parviflora*), cowpea (*Vigna caljang*), horse gram (*Dolichosbiflorus*) etc. are good examples of green manure.

Urban and Rural Waste

Rural and urban solid waste, household waste, and effluents such as sewage and sludge are a good source of compost.

Agro-Industry Products

Oil cakes, rice husks, bran, bagasse and pressed, sawdust, fruit and vegetable industry residues, cotton, wool, silk residues, tea and tobacco residues etc. are the agro-industrial products used in compost.

Fertilizer "Composting"

Compost is the result of accumulating (in a heap, pit or box) all kinds of organic matter to rot for a certain period. It is used as a fertilizer to provide nutrients to the soil and improve its structure and fertility.

All organic matter requires decomposition before nutrients are released from it. In the compost, this rotting process has already occurred to the desired extent and the material is transformed into humus from which nutrients are gradually released. However, in materials other than compost, rotting begins only after it is placed on the ground, so that nutrients are not directly available. The time it takes for nutrients to be released depends on the type of substance used and the climate. Small and soft animal dung and plant materials can be spread directly in the field because they rot very easily, but materials such as straw twigs, wood residues, mature grass, etc. are not easy to rot. Moreover, it will have a negative effect on the availability of nutrients. This is due to the fact that there is not enough nitrogen in the substance. Therefore, the microbes responsible for rotting dead plants do not find any nitrogen from the additive, but rather absorb nitrogen from the soil and growing plants and the substance will be left in the field. However, when these microbes die and their bodies rot, nitrogen is released again. The whole process may take two months or more. Nitrogen fixation with the newly added residue is beneficial when there is no crop grown in the field. This fixation may avoid nitrogen loss from the soil by leaching or volatilization.

Fourthly Principles of Compost

Composting is a process caused by microorganisms. The huge number of microorganisms such as bacteria, fungi, actinomycetes and micro-fauna in the soil such as worms found in damp places. Warm and inviting environment. It attacks organic residues and produces humus. Microorganisms are the smallest and simplest members of the plant and animal kingdom that can only be seen through a microscope.

Microorganisms increase in number to decompose organic residues by multiplying themselves. To increase their number, they need a large amount of carbon, nitrogen, and energy, which they obtain from the remains themselves. They get oxygen and moisture from the surrounding atmosphere. The complex organic compounds of the residue are broken down into carbon dioxide, water vapour and energy. Part of this energy is used by microorganisms to carry out their own life processes, but much of it is converted into heat, which increases the temperature inside the compost pit or heap. The temperature of the pit rises to 60-70 ° C, which is enough to destroy many pathogens, harmful insects and weed seeds. The carbon dioxide which is produced in large quantity leaves the pit with some steam and thus the heap size or the contents of the pit is reduced. The temperature drops again when the decomposition is over. The resistant part of the organic matter such as humus, other inactivated products, live and dead microbial cells is left in the pit as end products of fertilization.

Certain important conditions are prerequisites for obtaining a satisfactory fertilizer product. These terms are discussed below.

Compost is only suitable for biodegradable waste [1]. There are many advantages that can it arises from composting, including reducing the volume, weight and water content of the waste as well as the production of inactive pathogenic organisms [2,3]. Therefore, manure can contribute to improve the soil and nutrient contents needed for harvesting plants, and it will significantly reduce use of synthetic fertilizers [4] Hernandez, et al. Applying manure can improve soil properties. It is in dire need of renovation as it can increase the organic carbon content in the soil. While, compost also acts as a soil intervention in improving soil structure and water intrusion rate absorption and plowing capacity [5].

Temperature

Soon after the material is placed in a pile, rapid decomposition occurs. The pile goes through all stages of warming up, high temperature, cooling and maturation. Initially, complex basic organic compounds such as starch, sugars, and fats are broken down and the heat generated during this process heats up shortly after reaching a peak of 60 to 70°C. At the peak stage, the heat loss from the heap is more or less equal to the amount of heat generated by microorganisms.

The period of peak heat in the heap is necessary for the destruction of pathogenic organisms and weed seeds. This generally occurs 2-5 days after piling or pitting. The temperature in the middle of the pile rises from 70 to 75 °C and gradually cools down. However, the optimum temperature is maintained at 60 ° C.

The temperature of piles with high C: N residues such as wheat straw, rice straw, jowar stalk, jamun leaves etc. seldom exceeds 52°C. This indicates that how hot the compost will be depends on the type of material used and the size of the heap. In the center of large piles, the temperature rises significantly. In tropical countries, the pile size should be kept 2.5m wide and 1.5m high to prevent overheating and to ensure proper ventilation and the reaction or pH.

The initial pH of compost piles is slightly acidic, i.e. pH 6as is present in the cell sap of most plants. The production of organic acids during the early stages of composting leads to more acidification (pH 4.5 -5.0), but with higher temperature, the pH increases to a slightly alkaline reaction (pH 7.3-8.5).

Compost piles are rarely very alkaline. However, in some cases when the fertilization is highly alkaline, nitrogen loss occurs through volatilization. Whereas, in initially very acidic conditions, the heap fails to warm up. In general, liming is not required to adjust acidity. Using household ash or eggshell helps prevent too much acidity. Ash should be used if young, juicy materials are predominantly used for composting. Normal1y, if careful attention is paid to the pile composition especially in the humid and aerated area content, acidity or alkalinity will not be an issue.

Changes during Fertilization

Plant and animal residues consist mainly of sugars, starch, cellulose, hemicellulose-1, lignin, resins, proteins, fats and waxes. When this waste is placed in a heap or pit for composting, it is attacked by a variety of microorganisms including bacteria, fungi, actinomycetes, protozoa, worms and insect larvae. As a result of these activities, a large part of some of the compounds formed in the residues decomposes from their original complex forms to the new simple soluble forms. These simple substances may be solids or liquids such as phosphates, potassium, ammonium, nitrates, organic acids, etc. or gases such as carbon dioxide, methane, hydrogen sulfide, hydrogen and ammonia. One of the most important solid products formed during the decomposition process is yellowish humus, which resists microbial attack and forms a significant part of organic residues. Among the organic fractions, those that decompose easily are hemicellulose, proteins, waxes and other nitrogenous substances.

Microorganism Fertilizer

The microorganisms needed for composting are found throughout the natural environment. It is present in organic compost ore as well as in water, air, soil and machinery to which feedstock and manure are exposed during processing.

These sources ensure a high diversity of microorganisms, helping to maintain an active microbial population during the dynamic chemical and physical processes of fertilization, such as shifts in pH, temperature, water, organic matter, and nutrient availability.

Types of microbes and their requirements. The microbiological components of manure consist of bacteria and fungi. Due to its unique nature, Actinomycetes are discussed here as a third microbiological component, although in fact Actinomycetes are a special type of bacteria. The majority of the microorganisms responsible for compost formation are aerobes in that they require or function better in the presence of oxygen.

Fungi form their individual cells into long filaments called hyphae. The fungal hyphae are larger than the actinomycetes and can be seen with the naked eye more easily. It penetrates the compost material, chemically and mechanically decomposing the most recalcitrant fraction of organic matter such as lignin and cellulose.

Bacteria the most numerous biological component of compost is bacteria. Although they can often exceed 1 billion microorganisms per gram of soil, bacteria (except for Actinomycetes) do not contribute as much to the overall microbiological mass as fungi due to their relatively small size. Although bacteria (except for Actinomycetes) exist as individuals and do not form hyphae, they also contribute to the stability of the aggregate through the secretion of organic compounds that bind adjacent organic matter and soil particles together. Bacteria are usually associated with the consumption of easily decomposing organic matter.

Fertilization Process

The composting process takes place in predictable stages. During the different stages, temperatures and availability of nutrients vary and influence the types and numbers of microorganisms that develop. Initially, the stack is at approximately room temperature. The compost material is heated through the medium temperature range (50°C - 105°F) where microorganisms become most active. Bacterial activity quickly raises the temperature of the mound to thermophilic temperatures (106 - 170°F). This is the most productive stage of the composting process.

Mesophiles and thermophiles are microbes that are adapted to mesophilic and thermophilic conditions, respectively. The composting process takes place at a much faster rate under thermophilic conditions. Eventually, the readily available substrates within the feedstocks are exhausted, the temperatures gradually return to the granular middle range, and curing begins. The next section expands on the microbiology of each stage.

The availability of easily used organic matter allows the multiplication of the fastest growing microorganisms, namely bacteria. Therefore, the primary decomposition is dominated by Mesophilic bacteria. These bacteria release heat from decomposing large amounts of easily decomposing organic matter. This heat begins to raise the temperature inside the heap due to the high insulating capacity of the compost heap of appropriate size. In just a matter of hours the temperature of a compost pile can rise above the thermophilic threshold of 106 degrees Fahrenheit. Active phase. When the compost reaches higher temperatures, the heat begins to take over the bacterial community. The active phase is usually the one when most of the organic matter is converted to carbon dioxide and humus, and the number of microorganisms grows. The heat-loving population continues to generate more heat by decomposing the remaining organic matter.

High temperature. If the heap temperature rises, and exceeds about 170 degrees Fahrenheit, most of the microbes will be destroyed and microbial activity will almost stop. Only the remaining microorganisms can survive as spores. The spores will germinate when the compost pile returns to a more favorable temperature. These spores are thick-walled structures formed by microorganisms under stress such as heat, cold, drought and low nutrient conditions.

After the temperature rises, the compost heap will cool to a mesophilic state, requiring the activity of mesophilic microorganisms to return the heap to thermophilic conditions. If the compost pile is low in easily usable organic substrates, the heap may not be able to support the microbial activity needed to return to thermophilic conditions. In such a situation, it may be necessary to supplement the compost pile with additional feedstock to ensure maximum degradation and removal of pathogens.

Microbiology of Processed Compost

Identify compost microbes. Compost microbes are very diverse and their environments are very complex. Methods used to identify individual species include analysis based on metabolic activity and/or fatty acid content.

However, due to the great variety, individual species are rarely identified in treated compost and are generally considered too impractical and expensive. Instead, laboratories are more likely to identify and count species by group of organisms, such as actinomycetes, aerobic, anaerobic, fungi, nitrogen-fixing bacteria, or pseudomonas.

Guidelines for desired levels for each of these microbial groups are listed in the compost quality standards document referenced at the end of this factsheet. These levels are developed by a commercial laboratory specializing in compost analysis, which are based on numerous samples and observations in various applications.

Manure pollination. Many researchers and companies suggest that they can determine the “health” of a compost product and recommend vaccines to improve its quality or performance. However, there is no conclusive evidence that adding any specific microorganism to compost will improve any property of the compost. The original microorganisms may rapidly dominate the introduced microorganisms. The introduced microorganisms may provide perhaps nothing more than additional nutrients to the organisms already in the compost. Vaccines can be added, if desired, just before fertilizer application.

Contributions of Compost to the Soil Food Web and Plant Health

Many farmers believe that compost is an essential source of nutrients to add to the soil. However, its contribution to a variety of microorganisms combined with its high levels of organic matter may provide more significant benefits.

Soil consists of many organic and inorganic components that interact with each other in a living and dynamic system. From small organisms such as bacteria to larger insects such as earthworms, all of these actors aid in the cycling of nutrients and contribute to the overall health of the soil food web and surrounding plant life.

Good compost prepared in aerobic conditions and appropriately treated can contribute to the health of plants and the soil food web in many ways. Compost introduces a variety of microorganisms that may help in cycling nutrients and controlling pathogens. Compost also contributes organic matter to the soil that may serve as a food source for various microbes, among other functions.

Compost Introduces Beneficial Microorganisms

When incorporated into the soil, compost presents a wealth of beneficial microorganisms. As discussed in Part

One, plant and human pathogens are destroyed during the composting process. The remaining beneficial microbes assist in a number of functions that aid in soil and plant health.

Nutrient cycle. For nitrogen to be available to plants, it must be in an inorganic form, such as nitrate (NO3-) or ammonium (NH4+). Plants are unable to convert organic nitrogen into these inorganic forms. Fortunately, microorganisms commonly found in soil and compost convert organic nitrogen into inorganic nitrogen, a process called mineralization. The plants can then take in the nutrients that these plants release.

Soil that has been exposed to harsh agricultural pesticides, such as methyl bromide, may have reduced the numbers of these beneficial microorganisms. Compost may help re-inoculate these soils with nutrient cycle microbes. It is important to note that untreated, unstable compost may immobilize nitrogen in the soil. Detailed information on assessing compost stability and maturity is included in the CIWMB [6-14] Compost: Matching Performance Needs with Product Characteristics listed at the end of this document.

Compost Provides a Source of Organic Matter

Soil organic matter can come from a variety of sources, including crop or plant residues, cover crops, and manure. Compost consists mainly of organic matter, which performs a variety of vital functions in the soil:

- Provides food for microorganisms. Bacteria and fungi that release nutrients from the soil use organic matter as food or an energy source. Thus, compost provides a source of both microorganisms and their fuel. Compost also provides an excellent habitat for microorganisms.
- Retains nutrients and water. In addition to providing a source of nutrients, organic matter can retain many nutrients through its cation exchange capacity. Because fertilizer particles are negatively charged, they attract and hold positively charged ions, such as calcium, potassium, ammonium, and magnesium.
- Forms aggregates and increases porosity. Organic matter increases soil buildup resulting in a crumb-like structure. Changes in porosity can alter the water retention properties and rate of water infiltration. Thus, consistent use of organic manure may improve irrigation efficiency.

References

1. Ahmad R, Jilani G, Arshad M, Zahir ZA, Khalid A (2007) Bio-conversion of organic wastes for their recycling in agriculture: An overview of perspectives and prospects. Annals of Microbiology 57(4): 471-479.
2. Işıl Arslan E, Unlu AA, Topal M (2011) Determination of the effect of aeration rate on composting of vegetables-fruit wastes. Clean Soil Air Water 39(11): 1014-1021.
3. Hangreaves JC, Adl MS, Warman PR (2008) A review of the use of composted municipal solid waste in agriculture. Agriculture Ecosystems and Environment 123(1-3): 1-14.
4. Hernandez A, Castillo H, Ojeda D, Arras A, Lopez J, et al. (2010) Effect of vermicompost and compost on lettuce production. Chilean J of Agricultural Research 70(4): 583-589.
5. Risse M, Faucette B (2012) Food waste composing: Institutional and industrial applications. UGA, University of Georgia, USA.
6. Compost: Matching Performance Needs with Product Characteristics. CWMB Publication, pp: 1-8.
7. Composting Reduces Growers' Concerns About Pathogens. CIWMB Publication.
8. Persistence and Activity of Pesticides in Composting, CIWMB Publication
9. Compost Quality Standards, Organic Ag Advisors and BBC Laboratories,
10. California Integrated Waste Management Board.
11. Soil Quality Institute's Soil Biology Primer.
12. U.S. EPA's Bioremediation Fact Sheet.
13. BBC New Laboratories, Inc.
14. Soil Foodweb, Inc.