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Compost for Agriculture Sustainability

Sunita Gaind
Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi-110012
Email: sugaind175@rediffmail.com

In the present scenario of increasing world population, providing food security to about 9 billion people in 2050 would require increase in the global food production by at least 50-60%. The persistent use of chemical fertilizers for about five decades has severely decreased the soil fertility leading to stagnated yields. Thus, there is desperate need for an economically viable, socially safe and environmentally sustainable alternative to chemical agriculture that would not only maintain itself for an indefinite period of time, but also enhance farm production per hectare of available land.

Introduction

Sustainable agriculture, a technology of growing 'nutritive and protective foods' with the aid of biological based organic fertilizers can minimize the use of agro-chemicals to some extent. Composting is an integral part of sustainable agriculture in that it allows the recycling of nutrients and organic matter from crops back to the soil. Composting is a process of degradation of heterogeneous organic matter by a mixed microbial population in a moist, warm and aerobic environment under controlled conditions. Biodegradation of natural materials produces valuable compost as the major end product along with water and CO_2. The CO_2 produced does not contribute to an increase in greenhouse gases because it is already a part of the biological carbon cycle. Composting that transforms biodegradable waste in to an organic fertilizer not only helps in the reduction of the wastes, the destruction of weed seeds and of pathogenic microorganisms but also leads to production of valuable soil amendments with low operation costs. Thus, use of compost in agriculture can be considered as an essential activity for a sustainable society. Recycling of agricultural wastes through composting is worthy for providing high quality organic fertilizers that can be used to fertilize agricultural lands. The microorganisms play a significant role in the recycling process through enzymatic mechanisms involved in their biological system.

Compostable materials: The choice of material depends upon the availability of biodegradable waste. Mainly these can be classified in two categories:

Dry/Brown material	Fresh/Greens material
Dried Grass Clippings	Wet Grass Clippings
Dried Leaves	Fresh Plant Clippings
Sawdust	Fruit and Vegetable Scrap
Wood Chips	Barnyard manure
Straw/crop residues	Coffee Grounds
Shredded Newspaper	Tea Bags

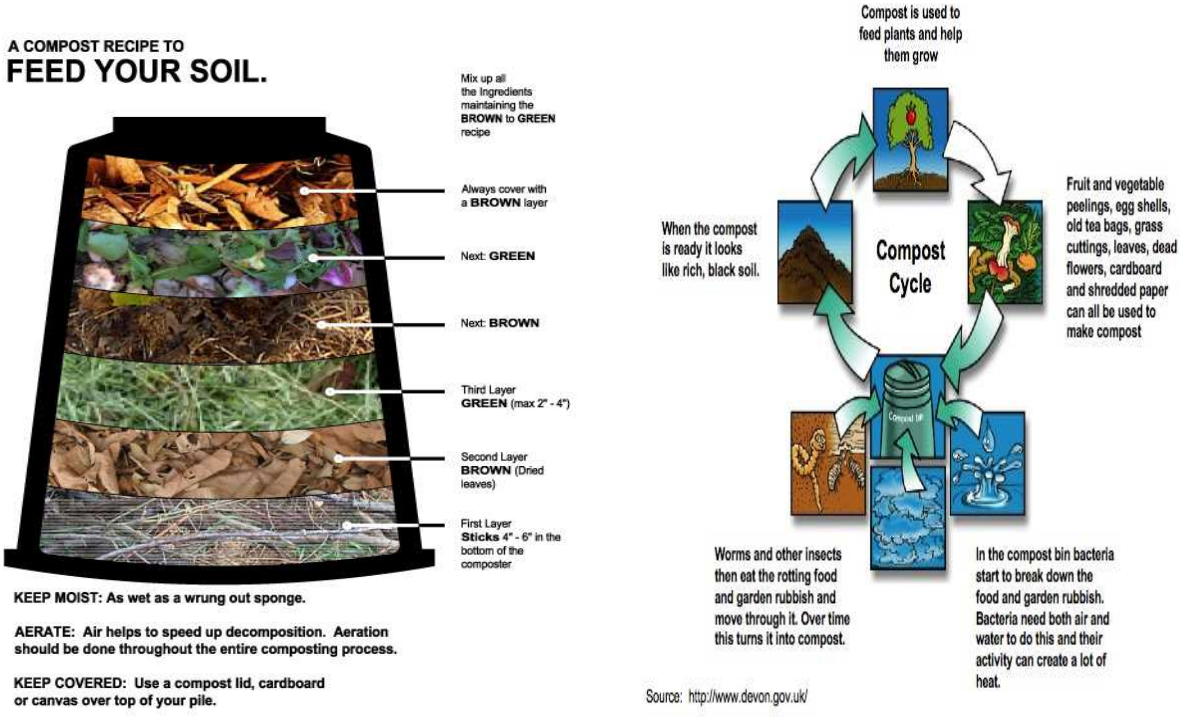
Table 1: C:N ratio of biodegradable substrates

Substrate	C:N ratio
Vegetable waste	10-20:1
Grass	12-15:1
Poultry manure	5-10:1
Cow manure	20-25:1
Swine manure	8-20:1
Paddy straw	80:1
Dry leaves	30-70:1
Corn stalk	50-70:1
News paper	400-800:1
Wood chips	100-400:1

Methodology

Mix a variety of dried/brown substrate (straw/crop residue) with nitrogen rich grass clippings or poultry/cow/swine manure/vegetable or food scraps and dry leaves in a compost pit/bin (size of pit/bin may vary according to availability of space) to bring down the high C:N ratio of composting substrate mixture (Table 1).

- Keep the composting mixture damp, but never soggy (Moisture 60-65 %).
- Turn the mixture at fortnightly interval. The more often you turn your pile, the quicker it will break down into compost.
- Monitor the temperature of the compost using a thermometer.
- The crumbled dark brown colour biomass obtained after 2-3 months of decomposition indicates the formation of humus rich mature compost.
- Enriched composts can also be prepared by mixing rock phosphate with composting substrates and its bio-augmentation with cellulose/lignin decomposing/phosphate dissolving/phosphate mineralizing microorganisms or effective microbe's consortium. Recently emphasis on use of different bio-remediating plants (that have capacity to absorb heavy metals and contaminants) is being given so as to remediate the used water to be used for irrigation purpose. Water lettuce (*Pistia stratiotes*) a bio-remediating plant can be used as substrate to prepare compost. Composting of water lettuce (WL) and rock phosphate (RP) in conjunction with effective microorganisms (EM) resulted in compost with enhanced available phosphorus and other nutrients. Thus, RP enriched compost could be an alternative and viable technology to utilize low grade RPs and re-use water lettuce efficiently.



Primary Benefits of the Compost

- **Compost for the generation of microbial inoculants** that increase the rate of organic matter decomposition. The extracts from cattle rumen composts have shown to enhance the rate of degradation of sugarcane bagasse in the field.
- **Use of composts for seed priming** (a process that reduces the time required for seedling growth): Compost primers hasten carrot seed germination as compared to more conventional priming substrates such as polyethylene glycol (PEG).

- **Helpful for adaptation to climate change**: Compost helps to improve soil fertility that helps in reducing the impacts of climate change. Compost application increases soil moisture and soil cover, as well as reduces soil loss.
- **Helpful for climate change mitigation**: Compost helps reduce the need for fertilizer which decreases greenhouse gas emissions (GHG). GHG mitigation potential of composting is 0.02-1.42 t CO_2-eq/ha/yr.
- **Improves microbial diversity in soil**.
  - Microbes added through compost can transform organic nutrients into plant available forms.
  - Some of the added microorganisms such as fungi and rhizobacteria are effective as bio-control agents. They can out-compete plant pathogens for resources and promote the growth of a plant or boost its resistance to attack from disease.
  - Compost application has been reported to suppress *Verticillium dahlia,* the cause of Verticillium wilt and *Pythium ultimum* causing black root rot disease in straw berry.
  - Some microbes in compost have antibiotic properties that can actually destroy harmful microbes in the soil.
- **Increases in organic matter** due to compost application also attract larger soil organisms, such as earthworms, that help degrade crop residues and release nutrients. The ability of earthworms to grow in bio-solids during vermicompost preparation has shown that not only do worms survive in the substrate but that bio-solids vermicomposts are rich in nutrients and positively improve soil fertility and nutrient availability for plants uptake.
- Helps to raise the pH of acid soils on repeated applications
- **Increase humic matter and cation exchange capacity** (an indicator of the soil's ability to hold nutrients, allowing them to be available for plant uptake and keeping them from leaching away) of soil.
- **Improvements in soil physical properties**: The humic substances in compost, which give it a crumble texture, act as glue that binds soil and organic particles together. As a result, small "crumbs" of soil, called aggregates become more resistant to erosion. Soil aggregation also increases the porosity of the soil that allows deeper root penetration, leading to stronger and healthier plants. Better infiltration of water, conservation of moisture and reduction of erosive surface runoff are additional benefits of compost application on soil.
- Compost provides low levels of all primary, secondary and micronutrients which may not be replenished with conventional fertilizers. Manure-based compost can contain trace metals (copper and zinc) and other substances. These metals if in concentrations more than the permissible limit can be toxic to crops or humans.
- **Compost is a slow release fertilizer**: It's one time application may have a residual effect, releasing nutrients for an additional one to two years.
- Using compost in combination with cover crops enhances soil life and this helps create an environment for healthy plants. It acts as a soil conditioner that can improve the physical, chemical, and biological health of soil.

Conclusion

Transporting and applying compost can be costly but the importance of broad range of benefits associated with its land application illustrates the importance of reconsidering agricultural land management practices. Compost has the potential to result in significant carbon storage in comparison to conventionally managed soils, replacement of synthetic fertilizers and water conservation. Ancillary benefits include increase in total N with increase in available P, decrease in bulk density and increase in water holding capacity, as well as potential yield increases and water savings. Thus, compost application can help in agriculture sustainability but its characterization based on physiochemical and microbial properties is a prerequisite prior to its safe application in soil.