Review Paper:

Compost in improving soil properties and control of pests - a review

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Abstract

Composting is a biological process of the breakdown of complex matter into simple matter. The present review describes in detail the effect of compost on soil quality properties and reduction in bulk density. The review also highlights use of compost in control of pathogenic microorganisms, pest control, maintaining the soil moisture content; increase of cation-exchange capacity, carbon sequestration, compost in mulching and stabilization of algae waste. The economic benefits of the compost are also described. The applications of compost are very eco-friendly as composting is a biological process.

Keywords: Bioremediation, Agriculture, Biocontrol, Soil conditioner, Recycle.

Introduction

Landfill and incineration are the ways of solid waste disposal throughout the world. Methane is the greenhouse gas responsible for global warming which needs to be reduced. Recycling of the waste nutrients and organic matter back to agricultural land is most desirable. Composting is one of the most promising technologies as a means of recycling organic matter back to the soil to improve soil structure and fertility[4,10]. The landfilling of biodegradable waste contributes to environmental degradation due to the production of methane gas. Methane is a greenhouse gas and causes global warming[18]. Tons of biodegradable organic wastes are generated in cities and towns in the countries and their disposal is a problem. Composting is a natural process that turns organic material into a dark rich substance called as compost and is a good soil conditioner.

During composting process, microorganisms convert complex organic compounds into simpler substances and produce carbon dioxide, water, minerals and stabilized organic matter called as the compost. During the composting process, heat is generated which kills the pathogens and weeds etc. Among the waste management strategies, composting is gaining interest to dispose organic wastes as a treatment with more economic and environmental profits, with the formation of a stabilized product[34]. The objective of this review paper is to highlight the various applications of compost and also how it improves the soil physico-chemical parameters and helps in the plant growth and yield which will ultimately benefit the farmers in their field. The addition of amendment to the soil to help the plant growth is important. So, it is therefore necessary to study the compost as amendment to the soil.

Different Types of Compost and their uses: The different types of compost and their uses are represented in table 1. Composting is a natural process where the microorganisms breakdown the complex matter into simple matter and form dark rich stabilized substance i.e. compost. Applications of compost and potential market size are shown in table 2.

Tricho-compost: In the composting process, when the spores of fungus, *Trichoderma* sp. are used, it is tricho-compost. *Trichoderma* sp. is beneficial against many other harmful fungi and thus protects the crops on addition of tricho-compost. Biological control is eco-friendly approach for the protection of plants from soil-borne pathogens[15]. About 90% of biocontrol agents are different species of *Trichoderma* genus such as *T. harzianum*, *T. virens* and *T. viride*. There are several reports on *T. harzianum* as biocontrol agent against *S. rolfsii* and *F. oxysporum*.

Among these, *T. harzianum* is commonly used to control several soil borne plant pathogenic fungi. Tricho-compost is a good source of nitrogen, phosphorus, potassium and sulphur[28] and thus helps to increase the yield of many crops. Tricho-compost can be used for vegetable production on a large-scale which can solve the problem for waste disposal as well as solves the lack of organic matter.

Tricho-compost acts as bio-pesticide and also helps to increase disease resistance[25]. The combination of organic and inorganic nutrients will help to maintain good soil health which will be beneficial for many crops.

Table 1
Different types of compost and their uses[29].

Types of Compost	Uses
Green compost	Mulching; soil amendment
Compost from household waste	Mulching; soil amendment
Compost with municipal sludge	Soil amendment

Table 2
Applications of compost and potential market size[11].

Application	Size (million cubic yards/year)
Agriculture	895.0
Silviculture	104.0
Sod production	20.0
Residential retail	8.0
Delivered topsoil	3.7
Landscaping	2.0
Nurseries	0.90
Landfill cover, surface mine reclamation	0.60

Root colonization by *Trichoderma* spp. helps to increase root growth, resistance to abiotic stress and also uptake of nutrients[14]. *Trichoderma* spp. protect plants from the pathogens because they act as biofungicides[6]. *Trichoderma* spp. minimizes the plant diseases by inhibiting plant pathogens through their antagonistic activity[16].

Applications of Compost

Effect of Compost on the Soil Properties: Good soil structure allows gas and water transfer in soil, seed germination and root growth. The humus in the compost facilitates formation of aggregates[31]. The soil aggregation is improved by the microbial activity. The compost from municipal solid waste added to clay soils has been reported to improve aeration[13]. The use of compost in high saline soil can help to determine an improvement of biological fertility[19]. The soil organic matter can be enhanced by compost application which also increases the organic carbon[32].

There is a report where combination of manure and household wastes compost increased the organic carbon due to compost[7]. There has been improvement in soil properties and organic matter with the use of composted organic material. The organic matter of agriculturally used soils is met by application of 7-10 mg (dry matter) compost ha^{-1} [3]. As the soil organic matter content increases due to composts, the physical properties of the soil viz. structural stability[33], total porosity and hydraulic conductivity[2], aggregate formation[31] and water holding capacity are improved[9].

Reduction of Bulk Density: Compost application helps to maintain soil structure by reducing soil density. This increases the porosity and allows interactions between organic and inorganic fractions[3]. Low bulk density is indicative of improved soil tilt. The compost increases the meso- and macro-pores due to aggregation and stabilization of soil by the soil microbes[20]. Due to increase in the organic fraction, the bulk density of the soil is reduced[8].

Control of Pathogenic Microorganisms and Pests by Composting: The composting process helps to control pathogenic microorganisms present in municipal sewage and solid waste. Composting involves aerobic respiration where the organic matter breaks down. During the degradation process, the temperature in the compost pile rises to between 45 ^{0}C and 70 ^{0}C where many pathogenic bacteria and weed seeds are killed[5,12]. Compost applied to important crops viz. wheat, pepper, tomato, okra etc. can suppress pathogens and weeds[36]. Significant effect of humic fractions from composts has been seen on the mycelial growth and conidial germination of *Fusarium oxysporum*, on the growth of sclerotial formation of *Sclerotinia sclerotiorum* and two *Trichoderma* species[21].

The mechanism of how the compost and their humic fractions inhibit plant pathogens is not known. There is a report where Chinese Medicinal Herbal Residue-based compost is a good biological anti-pathogenic agent and is also required for plant growth, adding value to the compost[37].

Compost can help to eradicate some pests like parasitic nematode infections. Compost can help eradicate the pests by providing nutrients to the soils, which allows the growth of fungi and other organisms which in turn compete and destroy the nematodes.

Compost as Backfill for Planting: Compost is used as backfill mix component during planting of shrubberies, bushes and trees. The excavated soil is mixed with compost in the ratio 1 part nutrient-poor compost to 2 or 3 parts soil or 1 part nutrient-rich compost to 4-6 parts soil.

Compost for Soil Moisture Content: Compost helps to increase the capacity of soil to retain green water i.e. rainfall and irrigation water stored in soil as soil moisture. This will minimize irrigation and blue water consumption (water from surface and groundwater resources). This will save blue water and increase crop yield where there is no irrigation water[24]. Compost application increases soil water content and plant available water[35,36].

Compost for Increase of Cation Exchange Capacity: Compost increases soil cation exchange capacity when applied[1,26]. This is due to stabilized organic matter which is

rich in functional groups. Humic acids, major components of compost can bind cations because they have carboxylic acid groups which can bind positively charged ions viz. Mg^{2+}, Ca^{2+}, Fe^{2+}, Fe^{3+} etc. The cation exchange capacity is one of the indicators for evaluating soil fertility.

Compost in Carbon Sequestration: Compost also plays some part in carbon sequestration. Due to application of the compost on reclaimed desert soils, the soil organic matter content increased. There is a report where the application of 47,6 ton compost/ha/yr over 30 years on organic arable fields in Egypt resulted in carbon sequestration of 0,88 ton C/ha/yr (or 3,23 ton CO_2/ha/yr)[22].

Compost for Stabilization of Algae Waste: Windrow composting has been found to be effective for algae stabilization[17,23,30]. Also, the aerated static pile along with composting has been applied to stabilize algae.

Economic Benefits of the Compost: The use of compost is eco-friendly and cheap because it reduces the need of fertilizers, water and pesticides. It is low-cost alternative to standard landfill and artificial soil amendments. It helps in extension of landfill life by diversion of organic materials from the waste stream. Compost is cost-effective alternative to bioremediation approach.

Conclusion

The compost greatly improves the soil physico-chemical properties and also the stability of the soil. Compost is good soil conditioner and can enhance the growth of crops and many plants due to supply of various nutrients viz. nitrogen, phosphorus, potassium etc. and minerals and this will thus be very helpful to many farmers. Compost also provides protection to the crops and plants from diseases by soil borne phytopathogens.

The use of chemical fertilizers will be minimized due to application of compost to the soil and also it is very cost-effective. Also, compost increases the microbial diversity. The application of compost will be very effective for the organic farming.

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