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Plant Disease Suppression Potential of Compost

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Sustainable agricultural practices emphasise the use of soil organic amendments to grow the crops. The organic inputs in the form of compost not only conserve natural resources but add organic matter in soil that can reverse the trend of yield stagnation. Suppression of plant disease is another attribute of compost that can be explored to reduce the input of chemical pesticides and minimize the crop losses from plant diseases. However, the effectiveness of compost to suppress plant disease may vary depending upon the raw material used for its preparation, maturity level of compost and the presence of beneficial microorganisms.

Introduction

Soil borne plant diseases reduce the yield and quality of agricultural/horticultural crops resulting in huge economic losses. The chemicals used to control the plant pathogens exert a detrimental effect not only on environment and human health but also put a financial constraint on marginal farmers. Thus, there is need to adopt some cost effective and environment friendly plant disease control measures. The application of composted amendments can provide an alternate and natural biological control of foliar and soil borne diseases that infect the root and collar of plants. Incorporation of compost in soil adds organic matter and leads to the development of healthy plants that can resist the disease better than plants grown in un-amended soils. Increase in crop yield is an added advantage of improved soil-plant health.

As composts can be prepared from diverse substrates, their physico-chemical and biological characteristics can result in variable suppressive response on some of the most common horticultural/agricultiural crop diseases caused by soil borne pathogens.

- Bacterial spot, caused by *Xanthomonas* spp.,
- Wilt disease caused by *Fusarium*
- Damping off disease caused by *Rhizocotania* spp.
- Root knot caused by *Meloidogyne* Spp.
- Anthracnose fruit rot, caused by *Colletotrichum coccodes*.

Effect of compost properties on disease suppression

Substrates

Compost prepared from woody materials that decompose slowly result in long lasting disease suppression due to slow release of essential nutrients (N, P, K) into the soil. However, municipal

solid waste compost (consisting of mixture of substrates) can control the root rot caused by *Rhizocotania solani* and composted sewage sludge can reduce the incidence of lettuce drop in the field caused by *Sclerotinia*

- Composted grape residues have the potential to control *Fusarium* wilt whereas composted cork effectively suppresses *Verticillium* wilt and *Rhizoctonia* damping off disease.
- Diverse agricultural industry residues compost with a C/N ratio ranging from 8-20 can suppress the root knot disease caused by *Meloidogyne* spp. Yard waste compost is effective in suppression of several pathogens including *Pythium ultimum, Phytophthora cinnamomi,* and *Fusarium spp.* affecting herbs.
- Compost prepared from pyrolised bark is inert and is ineffective in suppressing the disease in plants. However, high organic carbon compost can suppress the plant parasitic nematodes because they favour the growth of plant pathogenic fungi which are antagonistic to nematodes

Nitrogen content

Nitrogen is a key nutrient in disease suppression. Lower is the level of N in compost higher is the incidence of disease. Higher is the NH_4:: NO_3 ratio, higher is the incidence and severity of *Fusarium* wilt. NO_3 –N rich compost may help to subdue *Fusarium* wilt disease in ornamental plants.

pH and salinity of compost

The low pH of compost prepared from pine bark reduces sporangium formation, zoospore release and motility of *Phytophthora* spp. causing root rot disease. However, the high pH values of compost prepared from agricultural residues and industrial wastes exert suppressive effect on *Fusarium* wilt in tomato. The high pH reduces the availability of major and minor nutrients essential for growth, sporulation and virulence of *Fusarium oxysporium* (Jones et al 1991). Highly saline composts cause plant stress and increase the susceptibility of plants to get infected by pathogens.

Particle size of compost

Particle size of compost also affects disease suppression. Smaller the size of composted material, more is the impact on disease suppression and shorter is the duration to suppress the disease

Compost maturity

Compost itself is usually free from plant pathogens as high temperature during thermophillic phase of composting process kills most of the pathogens. Beneficial microbial flora survives in the outer most layer of composting mixture which proliferates during mesophillic and curing phase. Degree of organic matter decomposition affects the microbial communities that play a key role in disease suppression. Unprocessed or inadequately processed organic matter doesn't favour disease suppression. Applying immature compost can increase the incidence of plant disease caused by *Pythium, Phytophthora* and *Rhizocotania* spp. Mature composts can provide disease suppression against root rot caused by *Phytophthora* and *Pythium* sp. Inoculation of mature compost with bio-control agent/beneficial microorganisms such as *Pesudomonas,*

Bacillus or *Pantoea* spp after peak heating, improves the disease suppressive efficiency of composts. Similarly inoculation with *Trichoderma* or *Penicillium* spp. can provide disease suppression against *Phytophthora, Rhizocotania* and *Fusarium.* Disease suppression potential of highly stable compost is also lost due to poor availability of food and energy to support microbial activity.

Mechanism of disease suppression by compost

Disease suppression by compost is based on the following mechanisms

- ✓ Nutritional and spatial competition between compost inhabiting beneficial microorganism and soil inhabiting plant pathogens
- ✓ Antibiotic production by beneficial microorganism present in compost
- ✓ Predation of soil inhabiting pathogens by beneficial microorganism of compost
- ✓ Activation of disease resistant genes in plants due to compost application

Adding compost to soil not only increases the number of microorganisms but also increases the microbial diversity. The diversity of microbial population includes bacteria, fungi, actinomycetes, plant growth promoters, cellulose decomposers, antibiotic producing microorganisms, competitors, bio-control agents (known as beneficial microorganisms). Beneficial microorganisms out compete the disease causing plant pathogens for nutrients. Higher the competition, lower is the probability of pathogens getting established in plant root habitat to cause plant disease. The microbial composition of compost depends upon the chemical composition of the substrates used for its preparation. High lignocellulosic wastes colonize *Trichoderma* sp. whereas low lignocellulosic and carbon enriched waste harbour *Penicillium* and *Aspergillus* sp.

Antibiotics secreted by some of the beneficial microorganisms inhibit the growth of plant pathogens. 2,4-diacetyphloroglucinol produced by *Pseudomonas* spp. can suppress *Fusarium* wilt in peas, and cyst nematode and soft rot in potatoes (Weller et al., 2002). Gliotoxin, produced by *Gliocladium* has been implicated in the suppression of damping off caused by *Pythium ultimum* (Howell and Stipanovic, 1983). The fungus actually wraps itself around the pathogen and releases enzymes that destroy the pathogen's cuticle, leaving the pathogens susceptible to attack.

Organic amendments increase the population of beneficial nematodes, springtails and mites that feed on pathogen propagules in soils (e.g. sclerotia of pathogenic fungus *Rhizoctonia solani*) (Hoitink and Boehm, 1999). Increased abundance of arthropods after application of compost products to apple orchards could slow down the growth of the pathogenic *Monilinia fructicola* (Brown, 2004).

Induced systemic resistance caused by plant growth promoting microorganisms activate plant's disease defences including thickening of cell wall in plant roots and foliage to restrict the entry of plant pathogens

How and when to use compost to suppress diseases

- ✓ Have a complete nutritional analysis of compost before its application and it is preferable to apply compost to the poor performing areas to maximize the benefits of compost.

- ✓ Though, it can be applied any time, but it is always advisable to apply it in dry weather to avoid compaction. Apply compost 4-6 weeks before sowing to allow microbial population to colonize and enhance disease resistance. Early application of compost with higher salinity will allow the salts to leach before planting. Apply compost before the seed bed preparation and mix it well with soil. Amount of compost application per hectare varies with the type of crop to be grown.
- ✓ Mulches should be applied to a depth of 5-10 cm to provide weed control. Deeper mulches can decrease colonisation of trees by mycorrhizal fungi and increase root diseases. If correct amount and type of organic amendments is applied, mycorrhizal fungal growth is stimulated that promotes plant health.
- ✓ Root treatment with water extract of compost can induce resistance to anthracnose caused by *Colletotrichum coccodes* in pepper. Liquid vermicompost extracts can suppress *Pythium* damping off caused by *Pythium aphanidermatum* when used as a container drench.

Conclusion

Composted manures, yard and food waste offer potential as bio-control agents for suppression of plant disease by soil borne pathogens, but consistent quality of compost is a pre-requisite to get the desired benefits.

References

Brown MW, Tworkoski T. 2004. Pest management benefits of compost mulch in apple orchards. *Agriculture, Ecosystems and Environment Article in press.*

Hoitink HAJ, Boehm M J. 1999. Biocontrol within the context of soil microbial communities: A substrate-dependent phenomenon. *Annual Review of Phytopathology*, **37:** 427-446.

Howell CR, Stipanovic R D. 1983. Gliovirin, a new antibiotic from Gliocladium virens, and its role in the biological control of *Pythium ultimum*. *Canadian Journal of Microbilogy*, **29:** 321-324.

Jones JP, Woltz SS, Scott JW. 1991. *Fusarium* crown rot of tomato. Some factors affecting disease development. In: Proceedings of Florida Toamto Institute, SS VEG-01" Veg. Crops Special series, (W.M.Stall, Ed.) Pp. 74-79. Veg. Crops Dept. Univ. Florida.

Weller DM, Raaijmakers JM, McSpadden Gardner BB, Thomashow LS. 2002. Microbial populations responsible for specific soil suppressiveness to plant pathogens. *Annual Review Phytopathology.* **40:** 308–348.