Managing Organic Matter in Forest Nurseries

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Organic matter has long been recognized as an essential component of a highly productive soil, yet there has been limited focus on this topic despite an exponential increase in nursery production. Recently, soil organic matter has taken on new meaning with the reduction of pesticide use, especially methyl bromide which is slated to be banned. Without the "magic bullet," methyl bromide, the role of organic matter in relation to control of pathogens, nematodes, insects, and weed seed must be better understood in order to successfully integrate it with other forest nursery cultural practices. Addition of organic material is justified when management practices are made easier or more effective, or when those benefits are reflected in better quality or quantity of production.

BENEFITS OF ORGANIC MATTER IN THE SOIL

Improved Physical Properties

Soil Structure: Tilling, seedbed preparation, lifting and other operations are easier and more effective when the soil humus level is high. Organic compounds serve to bond the soil particles together resulting in crumbly, granular structure.

Bulk Density: Organic material, combined with ripping and wrenching, can mitigate compaction due to heavy nursery machinery.

Water Holding Capacity and Availability: Organic amendments, especially in coarse-textured soils, can increase the amount of water stored for plant use and thereby reduce the need for irrigation.

Erosion: Organic matter helps reduce soil erosion by increasing the moisture-holding capacity of soil, improving infiltration, permeability, and drainage and reducing soil crusting and surface runoff.

Temperature: By minimizing fluctuations in temperature in the root zone of plants, mulch protects seedlings from extremes of hot and cold and reduces frost heaving.

Aeration: Organic amendments tend to increase pore space in the soil.

IMPROVED CHEMICAL PROPERTIES

Available Nutrients: As organic material is decomposed by microbial activity, essential nutrients such as nitrogen, phosphorus, and sulfur are slowly made available to plants.

C/N Ratio: The carbon-to-nitrogen ratio is a limiting factor with organic amendments. Those with a high C/N ratio will result in a temporary immobilization of nitrogen as microbes multiply. The condition persists until nitrogen in their tissues is once again

converted to inorganic states available to plants. Through this process the soil becomes richer in both nitrogen and humus. The C/N ratio has been linked to control of soil pathogens.

Cation Exchange Capacity: Increases in organic matter result in proportional increases in CEC thereby allowing the soil to hold necessary cations against loss by leaching while making them available to roots and microbes.

pH: A soil high in organic matter has an increased buffering capacity and will not be as susceptible to sudden changes in acidity as a soil low in organic matter. This is important when considering long-term effects of various fertilizers and pesticides.

Chelation: Organic chelation of toxic metals has been recognized.

IMPROVED BIOLOGICAL PROPERTIES

Disease and Nematode Resistance: Organic material is a critical energy source for soil organisms and is needed to maintain a balance between beneficial and pathogenic microorganisms. Organic amendments represent a potential way to improve fungi and bacteria populations which are antagonistic to some seedling pathogens, nematodes, and insects when used in combination with select herbicides and cultural practices as part of an integrated pest management program.

Mycorrhizae: Establishment and maintenance of populations of desirable mycorrhizal fungi is directly influenced by management of soil organic matter.

Weed Resistance: Mulch is reported to reduce hand weeding 60-90% and to stimulate growth of transplants.

Fauna: Organic matter is important for faunal organisms which play a key role in maintaining a stable soil environment by keeping the number of micro-organisms in check and producing good soil structure.

ORGANIC AMENDMENTS TO FOREST NURSERY SOILS

Because organic matter is continually being reduced by decomposition, weeding, cultivation, irrigation, and fertilization (which promotes microbial activity), maintenance of a suitable level of organic matter requires careful monitoring and periodic application of organic materials. Organic amendments may be added to the surface as a mulch or incorporated into the soil. Mulch protects seeds or seedlings from erosion, prevents puddling and crusting of soil, and minimizes evaporation of water from surface soil. Incorporated organic materials may need additions of supplemental nitrogen.

Reduced dependency on the use of pesticides as well as fluctuation in availability and cost of organic amendments, has led to a greater need for suitable alternative products. Cooperative agreements between forest nurseries and municipalities or industries can lower composting costs and result in an environmentally beneficial soil amendment. Any material to be applied

should be incorporated into the upper 25 cm of soil at least 4 months before conifer seedlings are planted. Preferably, the material should be applied before the cover crop. If analysis of the material indicates the presence of undesirable properties, a cover crop should be selected on the basis of its ability to absorb or reduce those undesirable properties. Leaching through the use of irrigation systems is also a management tool that can be used to ameliorate undesirable properties.

Straw: Fall-sown seedbeds can be protected against frost heaving by covering them with weed-free straw. Straw can also be incorporated directly into soil and will decompose readily with additions of nitrogen. However, because of its bulkiness, straw should be chopped (or mowed), disked, and tilled to alleviate desiccation of plants from air pockets in the soil

Sawdust: As a mulch, sawdust can be applied in both fresh and composted form and can prevent frost damage, control weeds, retain moisture, and improve soil structure.

Bark: Bark is preferred over sawdust or straw as a mulching material because it has a slower decomposition rate, more pleasing color and texture, is free of weed seeds, stays in place better, and reflects less heat and light from its surface to the underside of plants. Bark is useful in preventing abrupt changes in soil temperature because of its corky nature and is used effectively as a weed control. Composted bark can be used as a mulch or an amendment and can be used as a biological control for some soil-borne diseases, especially those caused by fungi.

Sludges: Because many of the organic materials available as an amendment are by-products of an industrial process, they vary considerably in their composition. The use of paper sludge is common in nurseries as well as roadside stabilization. Studies indicate that sewage sludge can increase seedling growth and favorably modify physical properties of the soil. Fish sludge can be sprayed on the soil before planting or directly onto seedlings using a large impact sprinkler. Beneficial effects may be related more to nutrient supply than to addition of soil organic matter. Mint sludge is high in nutrients but requires adjustments in soil pH through the use of acid-forming fertilizers. If sludge is not excessively high in heavy metals, the application rate can be based on quantity needed to provide adequate nitrogen or phosphorus to plants. Immediate incorporation of sludge is advisable to minimize runoff and loss of nutrients, to reduce objectionable odors and to reduce concentrations of trace elements in the surface.

Manure: Increased yield from manure mulch has been attributed to protection from beating raindrops, greater infiltration of water, improved soil structure, and a cooling effect. However, to maximize utilization of its available nutrients, manure should be mixed into the soil. The major disadvantage of using manure is introduction of weed seeds.

Flyash: Wood ash which contains phosphate, potassium, calcium, magnesium, and various trace elements has been used for centuries as a fertilizer. Flyash from bark, however, is considered a better fertilizer because the inner bark contains more nutrients.

Peat: Because additional nitrogen is not required to decompose peat, it provides nitrogen more quickly than other materials. Peat has high water and nutrient retaining characteristics and stimulates the growth of beneficial microorganisms.

Other: Leaves of deciduous trees, pine needles, wood chips, hop waste, cannery waste, seaweed, bracken fern, wastewater effluent and petroleum mulch are some other products which have been used as organic amendments to agricultural soils. Various materials differ widely as to nutrient content, percent moisture, and ease of handling

Green Manure Crops: Green manuring is used in forest nurseries in conjunction with crop rotation. Benefits attributed to green manuring include addition of nitrogen (when using legumes), addition of organic matter, increase in the conservation and availability of nutrients, Improved physical condition of the soil, erosion control, and weed and disease control. Legumes should be inoculated with the appropriate strain of nitrogen-fixing bacteria when they are sown to ensure efficient fixation. Deep-rooted legumes, such as alfalfa, sweet clover, lupines, and kudzu, can penetrate two feet or more thus improving soil physical properties. Green manure crops also shade and cool the soil. By providing a dense vegetative cover, the damage to soil aggregation produced by raindrop splash is eliminated which reduces the tendency toward crust formation.

Ideally, a green manure crop should be easily established and grow rapidly. There are a variety of legumes and non-legumes that produce abundant growth in a short time. Choice of the crop should include consideration of the purpose for green manuring and climatic factors. Nurseries in Oregon and Washington frequently use oats, e, Austrian peas, Sudangrass, crimson clover, and lupines.

This poster is a very brief summary of the material covered in:

Rose, R., D.L. Haase, and D. Boyer. 1995. Organic Matter Management in Forest Nurseries: Theory and Practice. Nursery Technology Cooperative, Oregon State Univ., Corvallis, OR, 65p.

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