Organic Matter Management in Forest Nurseries: Theory and Practice

BY

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The original document "Organic Amendments in Forest Nursery Management in the Pacific Northwest", by Susan G. Blumenthal and Donald E. Boyer, was produced in response to Wind River Nursery Manager Stuart Slayton's suggestions, and through the encouragement and administrative support of Asa (Bud) Twombly, Silviculturist, Division of Timber Management, USFS, Portland, OR.

Reduced dependency on the use of pesticides in forest nurseries, as well as the current fluctuation in availability and cost of typically preferred organic amendments, has caused a greater need for alternatives in selecting suitable products. As in the original document, this revised edition attempts to offer the nursery managers additional choices.

If an adequate area is available, nursery managers should consider the possibilities of creating their own source of organic material for incorporation into the nursery soil management program rather than relying on a volatile market product. Also, more municipalities are switching over to composted sewage treatment facilities thereby providing another source of material for nursery use.

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A cooperative publication between the *NurseryTechnology* Cooperative *(Oregon* State *University) and the* USDA Forest Service, State *and Private* Forestry.

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INTRODUCTION

The topic of organic matter in forest nursery soils has remained dormant for a long time as evidenced by the paucity of literature on this topic for the past 25 years. In that time nursery production in the United States, Canada, New Zealand, South Africa, Brazil, and Venezuela has increased exponentially. Organic matter content in soil has always been a concern, yet there has been limited focus on this topic within academic research circles from the applied perspective.

A large part of the reason for this lack of research on organic matter has been a perceived need to study more pressing concerns such as seedling morphological and physiological quality, The interaction of soil microbiology with soil organic matter was not concern so long as there were powerful chemicals like methyl bromide. The "magic bullet" effect of methyl bromide made the explosion in seedling production levels possible because there was little need to be concerned with controlling diseases, nematodes, insects, and weed seed.

Rodriquez-Kabana and Morgan-Jones (1987) made an important point that "recent removal of key nematicides (DBCP,EDB) from use in several industrialized countries through regulatory action has spurred research on "unconventional" nematode management methods." The very same statement can be modified to include herbicides, fungicides, sterilants, or chemicals in general. Regulatory measures are making it necessary to rethink all forest nursery cultural practices which impact the environment. The mandated termination of methyl bromide in the United States by the year 2000 has made it critical to find alternatives. "Unconventional" methods include poorly studied technologies and practices such as microwave sterilization of soil, steam sterilization of soil over large fields, and natural chemicals from decomposing organic amendments to retard or kill soil borne pests and disease.

Using organic matter in soil to control nematodes and pathogens is by no means well understood. Organic matter exists in many forms and within those forms it varies considerably. Certainly, the increased use of methyl bromide came about because organic additions from cover crops, some organic amendments, and fertilizers actually led to increased disease, nematode, and insect problems.

The role of organic matter in soil must be better understood in order to successfully integrate it with the other forest nursery management cultural practices. The scope of the power of organic matter will be limited within the agricultural soil environment where fertilizers, irrigation, weed control, and soil cultivation are necessary practices if target seedlings (Rose et al. 1990) are to be produced. Soil organic matter is one component of the nursery soil system and must be considered along with other confounding factors such as soil drainage, timing and amounts of fertilizer, fallow and cover crop schedules, and tillage practices. The overall management objective is to produce quality seedlings for outplanting through improved tilth, soil structure, and microbial populations. Soil organic matter is also an important component in any integrated pest management program.

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. In recent times organic matter chemistry in soils has taken a new meaning with the reduction of pesticide use in nurseries, especially methyl bromide which is suspected of being an ozone depleting compound. With the potential loss of methyl bromide the nursery industry is faced with no chemicals that work as well. Soil organic amendments represent a potential way to improve fungi and bacteria populations which can combat some seedling pathogens, nematodes, and insects when used in combination with select herbicides and cultural practices as part of an integrated pest management program (USDA, 1993).

This paper provides a general reference for the addition of organic amendments to forest nursery soils. The effects of organic matter on physical, biological, and chemical properties of soil are discussed. The characteristics, benefits, and side effects of the more commonly used organic amendments are reviewed in addition to the need for supplemental fertilizer. Information on various techniques for composting and practices of green manuring are given. No attempt is made to evaluate cost effectiveness of various organic amendments because organic materials vary widely in availability and cost.

Many of the terms used in this paper are defined in the Glossary. In addition, Appendix A gives examples of the calculations needed for figuring the amount of additional nitrogen to be added to mulch or incorporated amendments.

MEASURING ORGANIC MATTER

An understanding of how organic matter is determined in soil is critical to understanding how to interpret the results. There are three common methods for measuring organic matter content in soil (Horneck et al. 1989). (1) The Walkley-Black method determines the amount of carbon using potassium dichromate and sulfuric acid. This method usually recovers 60% to 80% of the total carbon in a sample. Note that organic matter can have carbon contents from 48% to 58%. (2) The carbon analyzer method combusts the sample and measures the carbon in the gas. (3) The loss-on-ignition method where the sample is heated to 105°C, weighed, then ashed at 400°C, and weighed again. Then, the sample is put into a 550°C muffle furnace. The organic matter content is calculated as the difference between the 105°C and 550°C measurements.

These three methods are not likely to give similar organic matter contents on the same sample within the same laboratory. The problem is in the assumptions that are made. The Walkley-Black method measures carbon well, but the method assumes all organic matter types have the same levels of carbon. The loss-on-ignition method is not a direct method because it measures loss after drying. The carbon analyzer may be the best method, but few laboratories can afford the $30,000+ for the instrument. It is accepted that loss-on-ignition is probably the better method to use when the sample is high in organic matter.

Methods for determining organic matter content are known to vary from laboratory to laboratory across the United States. Other sources of variation exist among laboratories using identical methods due to differences in equipment and subtle differences in how the samples are handled. For this reason it is highly adviseable to investigate what the soils analysis laboratory methods are. Some laboratories will no longer use the Walkley-Black method because it uses potassium dichromate which is expensive, hazardous to handle and costly to dispose of safely. Many labs now use the loss-on-ignition method.

To get the best information to monitor soil organic matter, it is recommended to choose a laboratory which is capable of giving reliable and consistent results with "blind" samples (i.e. sam ples that are duplicates and unknown to be duplicates by the laboratory) that are sent in with yearly soil samples. Collect a large soil sample (2000g), completely homogenize it by repeated mixing, divide the sample into four lots, and submit as if they were four different samples from different areas. If the sample analyses are not reasonably close to one another, it would be adviseable to discuss the discrepancies with the laboratory. Once it has been determined that a laboratory gives consistent results, it is a good idea to remain with that laboratory.

The dilemma of how to use and interpret results from more than one laboratory is not uncommon. This is not difficult, but it can be expensive and time consuming. One method is to collect a range of soil samples, split them, and send half of each sample to each of the laboratories. Upon getting the samples back, it is then a simple matter to generate a regression equation to determine differences, if any, between laboratories. A good coefficient of determination (R^2) would be .85 or better. It is a good idea to consult a statistician with a soils background. Comparing the data from samples measured years ago with data from samples measured today should be done with some caution. The methods, the quality of the chemicals, and the technology have changed dramatically over the last two decades.