ORGANIC MATTER IN NURSERY SOILS

Jack T. May

Professor Emeritus
School of Forest Resources
University of Georgia

I will not consider the advantages of organic matter in the soil as it has been discussed thoroughly at several of the Nurserymen's Conferences. In this paper I will discuss how to maintain or increase the organic matter content of the soil.

The minimum levels of organic matter in soils of southern nurseries should be:

1.0 to 1.5 percent for sands and loamy sands.

2.0 to 2.5 percent for sandy loams.

3.0+ percent for loams and heavier textured soils.

These levels are considerably lower than organic matter levels of nursery soils in colder and/or drier climates and may be below optimum levels. Only a few nursery managers have seriously attempted to maintain the organic matter content of the soil at the above levels. This phase of nursery management has received about as much attention as a poor relative.

The best means of increasing organic matter in nursery soils are (1) with the use of soil additives, (2) with a combination of soil additives and cover crops and (3) with cover crops alone.

Factors which must be considered as one develops a system of maintaining the organic matter are:

1. Type of rotation.
2. Availability and use of soil additives.
3. Types of cover crops.
4. Time of sowing of cover crops.
5. Maintenance of cover crops.
6. Harvest of cover crops.
7. Cost of alternative systems.

1. Type of rotation

Previously we thought that a 1 : 1 (1 year seedlings and 1 year cover crop) rotation was adequate for maintaining the productivity of a nursery soil. Later we found that sawdust, peat, chicken litter or other additives were needed in conjunction with a good cover crop.

The advent of methyl bromide made the 2 : 2 rotation popular. This type rotation spread the cost of fumigation over two seedling crops. Also, it allows the growing of three cover crops during the two-year period. The system functions well when additives are available and the lifting is completed in February and sowing of tree seed is done in April. The time interval is adequate for soil preparation plus fertilization. The system does not work well when lifting extends into late March and April.

Rotations such as 2 : 1, 3 : 1, and 4 : 1 developed from necessity as production increased while the seedbed area remained constant. Without exception, these rotations eventually resulted in a reduction of soil fertility.

The present trend is toward a 1 : 2, 1 : 3 or a 2 : 3 rotation. This system requires more cultivatable land but provides more flexibility in maintaining soil productivity.

2. Availability and use of soil additives.

Each nursery can be considered an island. Some are close to sources of organic additives; others are not. The cost of delivering sawdust, bark, etc. differs for each nursery. At what point on the dollar scale does the cost eliminate the use of these additives?

The classic example of the use of soil additives is the use of peat. Many nurseries in the Lake States, Canada, England, Sweden, Norway and Finland are located near sphagnum swamps or peat bogs. Peat is excavated using draglines or rubber-tired equipment. The method of mixing and applying peat or compost varies with the equipment and facilities available. The simplest method is to apply 60 to 200 cubic yards per acre directly on the nursery site with a manure spreader and incorporate the peat into the soil with disks, cultivators or harrows. An alternative is to compost peat or mixtures of peat and other materials for several weeks, months, or even up to two years.

In the southern region, soil additives have included sawdust, chips, shavings, post peelings, bark, shredded pine cones, peat, chicken litter, bagase, grain straw, tobacco plants, manure, sewage sludge and possibly other materials. Many of these additives are now used in the manufacture of pulp or for fuel and are not available for use in a nursery.

Most soil additives contain low levels of plant nutrients and have a high carbon/nitrogen (C/N) ratio. Peat, for example, has a wide C/N

ratio ranging from about 20/1 to 75/1, depending on the original plant material and the degree of decay. Sawdust has a C/N ratio of about 400/1, dead pine needles - 225/1 and dead oak leaves - 65/1. Most other additives have C/N ratios between that of peat and sawdust.

Many soil additives are most effective when used in conjunction with a cover crop. At the Auburn (J. M. Stauffer) Nursery, 100 cubic yards of sawdust per acre followed by a summer cover crop in a 1 : 1 rotation maintained the organic matter content of the soil at a constant level for years.

3. Cover Crops.

Prior to the 1960's, the principal cover crops were field peas, velvet beans, soy beans, crotalaria, sesbania, Austrian winter peas, hairy vetch, rye and oats. Yields of green matter ranged from 8 to 20 tons per acre (2 to 5 tons O.D. matter).

The cover crops of today produce greater yields of green matter per acre and contain more fiber. Some varieties of corn and sorghum grow 10 to 15 feet tall and produce yields of 40 to 55 tons of green matter per acre (10 to 14 tons dry matter).

The most frequently used summer crops on a 1 : 1 rotation are sorghum-sudan grass hybrid (sudex), millet (Gahi, Pearl or Tift), silage corn and silage or grain sorghum.

For a 1 : 2 or a 2 : 2 rotation, a good combination is corn or sorghum during the first summer; followed by rye, wheat, or oats in the winter; and sudex or millet during the second summer.

In selecting a cover crop, the nursery manager should consider the approximate days to maturity. Sorghum-sudan grass hybrids mature in about 50 days unless the plants are clipped or mowed. Under good conditions, the hybrids often grow more than a foot a week and can yield two tons of dry matter (15 tons of green weight) per acre per month if clipped and fertilized regularly. Corn varieties are grouped into three maturity dates, namely Early (85 to 100 days), Mid-season (100 to 120 days) and Full-season (120 to 140 days). Silage sorghum will mature in about 70 days unless mowed. Grain sorghum matures in 90 to 120 days depending on the variety.

Four new varieties of vetch have been developed as green manure crops or cover crops for soil building purposes. These are resistant to many of the parasitic nematodes and act as a trap crop for nematodes. They can be

overseeded in standing row crops of corn or sorghum; but they do better on a well prepared seedbed. They can be interseeded with rye, wheat or oats.

Different varieties of corn, sorghum, rye, millet, vetch and sorghum-sudangrass hybrids are developed for different climatic and soil zones. Nursery managers should consult the Agricultural Extension Specialist and local seed dealers for the varieties best suited for their nursery.

4. Time of sowing.

A critical factor in the establishment and growth of cover crops is the time of sowing. Nursery managers tend to delay sowing of cover crop seed until after the tree seed are sown. Then it may be too late to get good germination without irrigation. The best time to plant in the deep south is in March or April; or when the soil temperature is above 65° F. at seed depth.

5. Maintenance of cover crops.

Cover crops require nutrients, water and freedom from weed pests. A 25 ton silage corn crop removes 200 pounds of nitrogen, 75 pounds of phosphate and 150 pounds of potash per acre. Fertilizers can be applied as a preplant application or as a side-dressing early in the growing season. When side-dressing corn or sorghum with a ground rig, apply fertilizer to the row middles to avoid root pruning.

A lack of water at the critical time has resulted in a failure or in a poor yield. Cover crops need water for germination of seed. Water is needed for growth when the soil has reached 25 to 50 percent of its available water capacity. Each nursery should have sprinklers available for irrigating the cover crop. One or more portable big gun nozzles may be adequate.

Weed control in the cover crops is as essential as it is in the seedling crop. Choose the best herbicides possible for your soil type(s), cover crops and weed species.

6. Harvest of cover crops.

The stage of development of the cover crop when it is cut or plowed under is extremely important. For the most part, the carbon/nitrogen ratio of plant tissue reflects the kind and age of the plant from which it was derived. The normal consequence of plant maturation is a decrease in the protein (N) content and a build-up of carbonaceous structural tissue high in cellulose and lignin. For these reasons aging results in the gradual decrease in the susceptibility of plant tissue to decay and a paralleling

increase in the C/N ratio. C/N ratios associated with some cover crop tissue are:

Young rye plants	20/1
Mature rye plants	350/1
Legumes	25/1
Corn stalks	40/1 to 60/1

If a soil additive with a high C/N ratio is mixed with the soil prior to sowing of the cover crop or late in the season, maximum microbial action will occur if the cover crop is turned under when still green. If the objective is to add maximum amounts of slowly decomposable material, the cover crop should be left until full maturity. Some nursery managers reduce the cost of the cover crop by selling the seed produced on the crop. In some varieties of corn approximately two-thirds of the nutrients and one-half of the feed tonnage is concentrated in the ear. The question is - will the dollar value of 50 to 100 bushels of corn be sufficient to offset the removal of nutrients from the soil?

7. Cost of alternate systems of maintaining soil organic matter.

To date there is not enough information to make reasonable comparisons of the potential systems, i.e.:

1. Use of soil additives only (sawdust, bark, etc.).
2. Use of soil additives plus cover crops on a 1 : 1 or a 2 : 2 rotation.
3. Use of cover crops alone on a 1 : 2, 1 : 3 or a 2 : 3 rotation.

We must obtain yields from cover crops over a period of several years before reliable comparisons can be made. This will require sufficient acreage for a 1 : 2 and a 1 : 3 rotation; intensive sampling of the soil; and finally the production of good cover crops, i.e. yields of 30 to 50 tons of green material per acre during the growing season. The Auburn University Nursery Coop., in 1980, initiated a long term study of cover crops in nurseries in Alabama, Georgia, and South Carolina.

NURSERIES WITH WORN-OUT OR UNPRODUCTIVE SOIL

Continuous seedling production on the same land is beginning to create some serious problems in some nurseries. Seedlings are stunted, chlorotic and infected with root-rot and have a high mortality. Soil organic matter is usually low and nutrient ratios are frequently out of

balance. These sites need a crash program to rebuild productivity of the soil. The best program is with the use of soil additives which have been composted.

In the 1930's compost pits were used for material such as peat, bagase, etc. The process required one to two years. Chuck Davey described a more useful process in 1952 and again in 1955. He stated that "Anhydrous ammonia was applied at the rate of 12 to 15 pounds per cubic yard of sawdust. Then after letting the sawdust stand for several days, phosphoric acid was added in dilute solution in sufficient amount to bring the reaction down to approximately pH 8. Then one pound of potassium as potassium sulfate was added to complete the addition of the major nutrients, nitrogen, phosphorus and potash. Also, a mixture of minor elements, at one pound per cubic yard, was added. This chemically treated or enriched sawdust was then inoculated with Coprinus ephemerus, which in the presence of abundant ammonia is a very active cellulose decomposer. Within six weeks, under favorable climatic conditions, a majority of the cellulose was removed; the carbon-nitrogen ratio was lowered to approximately 20; and the cation exchange capacity, that is the ability to hold nutrients against leaching, was increased at least 100 percent".

Charles Berry has just discussed sewage sludge. This is timely for both nurseries and for planting operations on adverse sites, especially since cities and states are faced with the problem of disposing of increased amounts of waste (garbage and sewage sludge) on less and less land.

Grinding the material to be composted speeds its decomposition by increasing its surface area and hence its susceptibility to microbial invasion. Moisture content of the material is important in composting - with optimum contents of 50 to 60 percent moisture content (wet weight). Oxygen is required by aerobic microorganisms during the decomposition process. Windrows 7 feet wide and 5 feet high can be aerated by turning or thoroughly mixing by mechanical means. Two to three turns per week can maintain the aerobic state. Methods of handling material vary, depending on the ratio of carbonaceous material to nitrogenous material. The "Berkely" method can produce compost in two weeks. Other methods may require up to three months.

Compost should be "ripened" before being applied to the soil as it undergoes further changes in composition after it has been cooled to ambient temperature. The time of ripening varies from two to seven weeks.

Municipal and industrial waste may contain pathogens, parasites and heavy metals which can cause problems. Composting can destroy many pathogens and change the chemistry of the material. However, use of these waste materials should be carefully monitored.

COVER CROP VARIETIES IN USE IN THE LATE 1970's

Silage corn	Sorghum	Sorghum-sudan grass hybrid	Millet	Vetch	Rye
Coker 54 and 57	Acco FS 531	Acco Sweet Sioux IV	Gahi	Cahaba White	Abruzzi
DeKalb XL 395	DeKalb D-60	Funk's 83F	Pearl	Nova II	Ebon
Funk's G 4776	DeKalb FS-25a	Funk's 86F	Tift	Vanguard	
Golden Harvest H 2775	Funk's 99S	McCurdy Sweet M	McCurdy Grazex	Vantage	
McCurdy 72A	McNair HO-K	Northrup-King Sordon 70A	NAPB Pearlex 24		
	NAPB 55F	Northrup-King Trudan 5	Ring Around Millhy		
	Northrup-King 367	Ring Around Super Chowmaker			
	Pennington Pennsilage A	Taylor-Evans Haygrazer			

SOME SOURCES OF COVER CROP SEED

Acco Seed Co.
P. O. Box 1630
Plainview, TX 79072
or Rte. 1, Champaign, Illinois 61820

Coker's Pedigreed Seed Co.
Hartsville, S.C. 29550

Columbia Seed Co. (Golden Harvest)
Eldred, Illinois 62027

DeKalb Agricultural Research, Inc.
Rte. 3, Box 132
Leesburg, GA 31763

Everett Seed Co. (Imperial)
P. O. Box 90992
Atlanta, GA 30344

FMC Corporation (Oro)
Agricultural Chemicals Division
6065 Roswell Road N.E.
Atlanta, GA 30328

Louisiana Seed Co., Inc. (Funk's)
P. O. Box 7498
Alexandria, LA 71301
(Distributors throughout the south)

McNair Seed Co.
P. O. Box 706
Laurinburg, N.C. 28352

Northrup - King & Co.
P. O. Box 151
Columbus, MS 39701

Pioneer Hi-bred International, Inc.
221 N. Main St.
Tipton, Indiana 46072

Pennington Seed Co.
P. O. Box 290
Madison, GA 30650

Ring Around Products, Inc. (Choumaker)
Reynolds Mill Road
Prattville, AL
or P. O. Box 1629
Plainview, TX 79072