Nursery Soil Management

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ABSTRACT. Some soil properties, such as texture, are essentially permanent and are not realistically changeable. Those properties do, however, affect how our nursery soil can be managed. Soil management may be divided into three general areas for discussion. These include physical aspects such as soil compaction, **water** infiltration, and aeration; chemical aspects such as soil fertility and acidity; and biological aspects such as mycorrhizae, pathogens, insects, and weeds. A fourth subject, soil organic matter, cuts across and integrates all the others.

Soil management can be discussed in generalities, but it can only be practiced in specifics. In the approximately 70 forest nurseries across the South, we are working with many different soils in several different climates, and we are raising at least 20 different tree species and several cover crops. This diversity requires a range of approaches.

For purposes of discussion, soil management may be divided into three or four general areas, but we must remember that in the Real World **they are all inter-connected and when we work to alter one factor we often** change others as well. The three basic areas include physical, chemical, and biological properties. A fourth aspect, soil organic matter, cuts across and integrates all the others.

PHYSICAL PROPERTY CONSIDERATIONS

Because of the diversity of soils, problems differ from nursery to nursery. Some soil properties, such as texture, are essentially permanent and whatever benefits or troubles that exist because of them are "selected" when the nursery is established. We may modify their impact, but we can seldom truly change them.

Compaction of soil results in impeded root growth, reduced drainage, and poor soil aeration. Thus, it is important to minimize and

correct it. Some compaction is unavoidable because of the extensive traffic in a nursery. However, its impact con be greatly reduced. Prevention is possible by ensuring that all vehicles use only the roads and paths between beds. Even one diagonal pass by a tractor across a field during lifting is likely to have an obvious effect on the next crop, whether it be seedlings or cover crop. In most soils, even with careful traffic management, they eventually become compacted beneath the beds and some subsoiling or ripping is required. Of importance when fracturing compacted soil is that the soil be as dry, and thus as brittle, as possible. Working in wet soil is a waste of both time and resources. Often it is necessary to rip or subsoil compacted areas in two directions. The second direction should be between 45 and 60 degrees to the first for both optimum effect and least wear and tear on both equipment and personnel.

Surface drainage is very important and, because of the slight slopes of most nursery fields, minor changes in surface configuration can occur unnoticed. These often result in the formation of a very shallow saucer-like depression that occupies a major area in the middle of a field. As a consequence, surface drainage is restricted and the soil in such an area tends to be wet much of the time. The use of a land plane can easily correct such problems, if they are properly diagnosed. They are most easily seen when the field is bare, such as following fumigation **or after lifting.**

CHEMICAL PROPERTY CONSIDERATIONS

Fertilizers and lime are not the only things added to the soil that **can have marked effects on the chemical properties.** All nurseries use irrigation. Water quality is a variable that affects both soil fertility and acidity, and should be taken into consideration when initially establishing a nursery and annually when developing a fertility **management plan. The effects may vary from leaching of nutrients below the rooting depth to the addition of needed nutrients or unwanted salts.** These salts may increase or decrease soil acidity and they may be concentrated enough to put the young seedlings under an osmotic stress. In a few cases, it has been necessary to either install water treatment equipment or relocate the nursery. The source of water can be either surface or subsurface. Wells have the advantages of being reasonably consistent in quality, hopefully dependable in supply, and free of weed seeds and sediment. Surface water sources, although usually less expensive than wells to develop, may have problems with consistent quality, dependable supply, and the carrying of weed seeds and sediment.

Like organic matter, soil fertility is always declining. Consequently, we must plan for maintaining fertility through proper applications of fertilizer or lime at appropriate times throughout the growing season. Unlike organic matter, even the temporary lack of lime or fertilizer is usually obvious. Not only the amount and timing of nutrient applications are important, but the form of nutrient can be very important. For example, when the total N supply is held constant, most species of trees seem to be able to use the ammonium form of nitrogen more effectively than the nitrate form (Table 1).

Table 1. Above-ground fresh weight of loblolly pine seedlings as affected by nitrogen form and pine family.

	Nitrogen form			
Family	All ammonium	ammonium nitrate	All nitrate	Average
	(gm)			
1	39.8	36.5	17.8	31.4
2	35.6	36.2	10.8	27.5
3	38.3	449	23.6	35.6
Average	37.9	39.2	17.4	

The data in this table show two things quite clearly. First, **all three families utilize** ammonium better than nitrate, and second, family three is better able to utilize nitrate than the other two families. Even in the case of family three, however, growth with all nitrate is less than 60% of that with ammonium-containing fertilizer. Of importance is the fact that all three families can utilize nitrate when given sufficient ammonium with it. Similar results have been obtained with sweetgum and green ash.

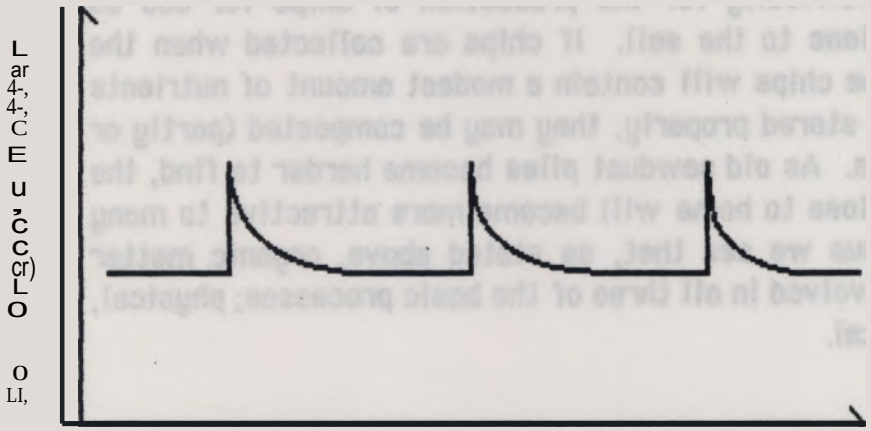
CONSIDERATIONS

Biological aspects of nursery soil management include both pests and beneficial organisms. Pests include pathogens, insects, and weeds. These are all covered in detail elsewhere in these Proceedings and will be dealt with here only to note that they can be very serious management problems. The directly beneficial organisms include

mycorrhizal fungi and in the case of a few tree species and some cover crops, nitrogen-fixing bacteria or actinomycetes. Other more subtle, but none-the-less important, beneficial organisms are the myriad of saprophytic microbes that decompose cover crops and added organic materials such as sawdust or bark. The addition of readily-decomposable organic matter results in improved soil structure, increased water-holding capacity (and usually increased water availability), and the suppression of pathogens. This last effect is usually not appreciated since we do not worry about diseases that don't occur. Often there is also an enhancement of mycorrhiza formation. The cause of this benefit has been variously attributed to a better physical environment, the presence of specific hormones, improved soil fertility, or the suppression of other microbes that, if active, would reduce mycorrhiza formation. The only things certain are that it happens and it is very complex.

ORGANIC MATTER CONSIDERATIONS

Rapid decomposition of organic materials such as cover crops prevent them from permanently affecting the soil organic matter level (Figure 1).



Time

amounts of nutrients, they do affect the soil physical properties immediately and eventually, when the cellulose has decomposed, the remaining lignin residues increase the soil's cation exchange capacity (CEC). This, in turn, holds various nutrients in the soil against the leaching forces of rain and irrigation water. An increased CEC also buffers a soil against rapid changes in acidity, and lignin derivatives act as a chelator of iron and will reduce the severity of iron chlorosis. In most soils, the primary source of boron is the organic matter. This is especially true in sandy soils and since many nursery soils are sandy, we find that a low organic matter content frequently leads to a **boron** deficiency.

Some soils are naturally higher in organic matter than others. Unfortunately, the warmer and sandier a soil is the more rapidly the organic matter decomposes. As a consequence of this, nursery managers in the South are constantly looking for sources of sawdust, bark, or other similar residues. One idea that has been mentioned in the past, but is only now catching on, is to use a chipper to produce your own organic matter from low quality trees (green junk). Often, such material is free, is within a very short hauling distance of the nursery, and it can be harvested and transported to the nursery whenever there is slack time. Eventually, I expect some nurserymen will set aside a few acres where they will raise fast-growing, easily-coppiced species (sycamore, cottonwood, etc.) specifically for the production of chips for use as organic matter additions to the soil. If chips are collected when the trees have foliage, the chips will contain a modest amount of nutrients and thus, if piled and stored properly, they may be composted (partly or thoroughly) before use. As old sawdust piles become harder to find, the production of chips close to home will become more attractive to many nursery managers. Thus we see that, as stated above, organic matter added to the soil is involved in all three of the basic processes; physical, chemical, and biological.

CONCLUSION

Nursery soil management has changed, is changing, and will continue to change as we learn more about both the soil and the trees we are growing. As the data in Table 1 show, different families may vary in their response to fertilization. As tree improvement programs continue to provide the nursery manager with seed from families with greater genetic potential, it will be important that each family be given the best opportunity to express that potential. We may eventually develop groups of families that respond similarly to fertilization and provide each **group with its own fertilization schedule.**

In the somewhat more distant future, with vegetative propagation, tissue culture, and genetic engineering making progress, there is no telling how soil management will change. However, we can be sure of two things: 1. Change will occur, and we may as well embrace it rather than fight it and 2. The basics of soil management will remain. We do have a foundation upon which to build and with which to grow.