Nursery Site Preparation:

An Overview of Some Physical Aspects

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Site preparation in a forest nursery involves numerous concerns, including fertility and pH adjustment, fumigation, or other pre-plant treatments. My assignment, however, is an overview of the mechanical and physical aspects of soil preparation.

The overview begins with four obvious questions, each followed by situational statements and queries as self-evident reminders to anyone familiar with nursery operations (figure 1). Applicability of such generalities differs greatly from one nursery to the next, of course, and the comments that follow are only a few of those that might be r.ade in expanding general statements.

do we start with in considering soil preparation?

Porous soils, inherent good drainage, effective land shaping, and organic matter maintenance leave some nurseries with few tillage problems. They are the fortunate few. Most nurseries have an array of problems or, at least, "concerns" and "non-satisfactory situations" related to tilth, tillage, or water handling. Some are well-recognized, others only guessed at or speculated about.

Soil preparation needs, precautions, and sometimes equipment vary greatly with soil texture. In this region we have "sand" nurseries, "clay" nurseries, and sand over clay at variable depths. Actually, sands vary from fairly pure sands, as in Florida, to sandy loans, with considerable range in water retention. Surface "clays" are commonly sandy clay loans or sandy clays; subsurface clays include a

variety of heavier textures and permeabilities. The actual clay mineral component varies with soil origin. Some clays develop excellent structure when handled properly; others never do; but "clay" never provides the opportunities for wet weather tillage nor the forgivingness of sands.

More often than not, preparation for seedbeds means plowing down a cover crop in late summer or autumn, allowing time for decomposition before tillage and bed formation in the following Spring. Alternatively, when seedlings follow seedlings, lifted areas are disked one or more times and reformed into beds. Although both alternatives provide opportunity for land smoothing, grade repair, organic additions, or deep tillage, the limited time for such activities during the lifting and sowing season means that only acute or pre-planned needs are likely to be considered.

What Do We Want From Nursery Site Preparation?

It's easy to make a shopping list of needs or desiderata although each nursery would have a different set of priorities based on experience with particular soils and species. Perhaps many would consider]and shaping, grading, and associated water control as permanent features rather than part of site preparation. Grade uniformity and disposal of excess water, however, are major concerns except on the most porous sands. Likewise, good preparation includes good subsurface drainage and pentrability to roots as mentioned later. Even the best tilth means little if the beds are flooded or swept by excess water, and subsoil wetness favors severe compaction even when the surface is dry enough to till.

The immediate emphasis probably would be on well-formed beds, with a fine grained soil structure favorable to sowing and early seedling development. Clods and coarse organic debris interfere; they also prevent complete soil coverage by herbicide sprays. Such things, along with subsequent uniformity or non-uniformity of the seedling stand, are highly visible, and so much tillage is aimed at seed bed appearance. Far less visible or predictable from visual evidences is the ability of the surface soil to stand up under rain- or irrigation-drop impact, and resist crusting or sealing, surface washing, and sand splash. As said later, extra tillage operations expended in the interest of good-looking seed beds may actual work against the stability of tilth and subsurface porosity.

flow <u>To Get and Keep Desirable Soil Conditions?</u>

Inclusion of nursery site selection under this heading is a reminder that not all of our water control, and tillage problems are easily correctable or perhaps not correctable at all. Some were ordained when the nursery site was selected and the excess costs incurred in dealing with them are continuing part of the price paid for the land.

"Site engineering" here means soil engineering, that is, land leveling, filling, grading, terracing, etc., plus a an effective and durable drainage system, including subdrainage if needed. Some nurseries begin with such soil modifications; some accumulate them later or piece-meal; and some manage--either well or poorly--without them. Some persistent problems such as wet spots, outcropping clay, mid alley cutting or overflow plainly call for engineering remedies.

The cure should not be worse than the disease, however, and its worth remembering how effectively heavy equipment can compact moist soil.

Soils settle after grading; tillage, and erosion and deposition alter once-uniform grades. Periodic upkeep of previously established grades and waterways, and sometimes modification, need to be planned for in advance. Otherwise, some seed bed drainage problems disappear under a cover crop and reappear with the next seedling crop. A particular concern are areas of subsoil wetness that lead to poor aeration and subsurface compaction, even though the surface soil appears suitable for tillage.

Few nursery soils will ever have optional organic matter contents, but the efforts to maintain or increase organic matter are all-important for good tilth, especially on the finer-textured soils.

Generalizations about cover cropping fail in the the face of large differences in soils, crops, and crop management. Systematic studies of how best to use present and potential new cover crop species for nursery benefits are lacking. Most measurements show little if any increase in stable soil organic matter from alternate-year or less frequent cover cropping. Yet, on the plus side, microbial products from easily decomposed tissue, plus temporarily resistent coarse stems, plus the aggregating action of fibrous root systems all contribute towards a soil structure favorable for tree root development.

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substance, only a third of which will remain in the soil after a few months decomposition. Such costs would not properly credit root system effects but otherwise might be compared with the delivered cost (per pound) of other "outside" organic materials such as sawdust, woodchips, bark, or locally produced peat. A nursery with limited land area might want to consider options other than alternate year cover cropping as a means of improving tilth.

Often we do not get maximum growth of cover crops, however, and It's not certain that we get full benefit of what is grown. Heavy crops commonly are plowed down well before the end of their growth to allow substantial breakdown of coarse stems and root clumps before spring sowing. Doing so favors goodlooking seed bed surfaces. Quite likely it also means that the time of maximum tilth benefit falls sometime before spring sowing, rather than during the period of sedling development. Trade-offs are inevitable but nurseries with soil structural problems might consider how to maximize the time under crop cover, including temporary winter covers, while minimizing both length of fallow periods and number of diskings.

The how, when, and why of tillage operations vary among nurseries and there are few general rules. One of these should be to minimize tillage; to do no more than is actually required. A major lesson from agriculture is that plowing and harrowing are commonly overdone simply because the tractor operator wants to see a clean, uniform, clod-free surface. Yet every pass with a plow or disk weakens soil aggregation and contributes to formation of plow pans or traffic pans, especially when the subsoil is overly moist.

Another rule or guide might be to plow deep when incorporating cover crops and also just before fumigation. Plowing deeper than normal when breaking land out of cover crops helps develop a thicker layer of "top soil" easily reached by roots. It also disrupts any compaction at shallower depths. (Plowing down loose fine organic material such as saw dust or bark, however, may simply layer these at the furrow bottom). Plowing deeper than normal just before fumigation facilitates fumigant penetration and reduces the likelyhood that subsequent normal-depth tillage will turn up unfumigated soil.

It is now widely recognized that downward root development, and sometimes penetration of air and water also, are often limited by plow pans, traffic pans or other zones of compacted soil. Row crops on sandy soils in Florida often show marked growth increases when planted directly over chiseled lines. Roots penetrate the disrupted zone and may spread laterally beneath the pan, increasing the volume of useable soil. Such treatment must be repeated with each crop.

Similarly, chiseling or subsoiling fine-textured soil can be highly beneficial in some but not all circumstances, many of which are unspecified. A chisel can leave behind a shattered zone in dry firm subsoil, or puddled sealed trough in wet clayey materials.

How to use chiseling or subsoiling in nurseries, apart from occasional row crop sowings? One evident use is to breakup the compracted alleyway between beds when fitting for a cover crop after seedlings. There are occasional claims of improved subsurface drainage along subsoiled lines in fine-textured soils. Chisels also can be set directly behind tractor tires, especially when working on newly tilled soil. Doubtless there is much other experience that

needs to brought together. So far as I know, there has been no attempt to chisel beneath each of the closely spaced rows in pine seedbeds. The problems associated with tractor draft, **fumigation** effectiveness and seedbed formation would be bery considerable.

In recent years Dr. Charles Elkins, USDA-ARS (230 Funchess Hall, Auburn University, Auburn, Alabama 36849) has pioneered "slit tillage." Very narrow blades cut through plow pans, allowing root penetration but requiring less draft than conventional chiseling, and disturbing the soil less. This development is still considered experimental, but worth close study where disrupting a dense subsoil Is not the aim. In particular, if subsoiling under individual tree rows were ever to be considered, "slit tillage" might be appropriate.

Two minor issues in maintaing surface tilth concern mulches and fumigation. The pros, cons, and difficulties of mulch covers other than the hydromulch types are too well known for discussion here, except to emphasize that persistant mulches protect susceptible soils against surface sealing and sand splash.

Decisions on fumigant use will not be greatly influenced by considerations of tilth. Fumigants kill fungi, however, and fungal hyphae are important to the fragile crumb structure of sands. When prepared seed bed surfaces are fumigated, visible settling and increased density may follow. The consequences for seed beds formed after fumigation are not known but obviously are not severe. New fungi develop rapidly and likely restabilize soil crumbs.

Synopsis

Nursery soil preparation begins with control of excess surface water to minimize localized flooding and erosion, on the one hand, and ponding or persistent subsoil wetness on the other.

A second major concern is developing and maintaining a deep friable surface soil. The requirements and use limitations to achieve this vary greatly with soil texture. In all cases organic matter is the key to a durable soil structure. Although cover crops added little to the stable organic content, their root effects and easily-decomposed foliage improve tilth, at lease in the short run. Although there is a general interest in using other sources of organic matter to supplement or replace cover crops, much greater attention to this issue seems warranted. Maximizing time under crop cover, and minimizing traffic and tillage are additional measures that eventually favor durable seed bed tilth.

Equipment traffic almost inevitably causes some degree of compaction reaching below the plow layer, and this tends to be cumulative over time. Disrupting compacted zones by subsoiling, chiseling, or slitting may or may not significantly increase soil volume available to roots, and/or drainage of excess water. The promise is great enough to justify compiling existing experience with various soils, and perhaps more systematic studies under nursery conditions.

The final steps in nursery soil preparation are seed bed formation and associated before and after activities, such as tillage, fumigation and mulching. The procedures for advance tilling and forming seed beds, and the quality of their performance are obviously

important to germination and early seedling development. Equally important at this stage and later, are factors of tilth and whole-soil physical behavior that have already been determined by previous soil management.

Figure 1. An overview of preparing for good tilth.

WHAT DO WE START WITH?

1. "No Problem" Nursery
2. Something Other
   - Evaluate
   - Soil: "Sand", "Sand over clay", "Clay"
   - Previous Crop: Cover? Seedlings? Growth? Root systems?
3. New Land

WHAT DO WE WANT?

1. Uniform, Graded Slopes
   - Water Management
   - Low soil loss
   - Uniform tractor speeds
2. Subsoils
   - No wet spots
   - No clay turn up
   - Air and water penetration
   - Root development
3. Topsoil and Surface Tilth
   - Fumigation
   - Seeding; seedling establishment
   - Spray coverage of soil
   - Water penetration
   - Resistance to sand splash, sealing

HOW TO GET IT?

1. Nursery Site Selection
" Site Engineering
   - Leveling, filling, terracing
   - Drainage
   - Don't create problems
3. Site Maintenance
   - Regrading
   - Waterways and ditches
4. Organic Matter
   - Cover crops: Maximize duration? Rootsystems important? Effectiveness and cost?
   - Other OM sources: Wood, bark, peat, etc.
   - When to add?
5. Tillage
   - Why till?
   - Deep, for penetration of fumigants and roots
   - Minimize traffic
6. Subsoiling, Chiseling, Slitting
   - What soil? What purpose?
   - Equipment; spacing
   - Wheel track loosening
   - Before cover crops
   - Subsurface water flow
   - "Slitting" beneath tree rows???

Figures 1. (Continued)

HOW TO KEEP IT?

1. Repeat "How to Get i•?"
2. Water Control
   - Surface; bed erosion
   - Subsurface
3. Tillage
   - Minimize
   - Only when moisture suitable
4. Maximize Crop Cover
   Mulch??
5. Minimize Fumigation Events