What Is a Soil Management Plan, and Why Would You Want One?—Part III

This is the last of a three part series on how to develop a Soil *Management Plan* and use it in your nursery. The first installment in the January, 1995 issue covered the various parts of a Plan and how to organize the soil survey. The second part, "How to perform the soils survey and interpret the results" was covered in the last FNN issue. Now, we'll wrap up the subject by showing how to assess the production potential of your nursery soil and implement the Soil Management Plan.

Assessing Soil Production Potential.

Continuing with the example from the Colorado State Forest Service (CSFS) nursery that we began in the first two segments of this series, we can now discuss how the potential productivity of nursery blocks can be evaluated. Using the soil survey data (Table 1 from the July, 1995 issue) and the soil productivity targets that we developed (Table 2 from that same issue), we can rank the nursery blocks for their suitability for growing the various crops and stock types that the nursery produces (Table 2).

Although we only discussed two of them in the last *FNN* issue, four criteria were used in the soil productivity ranking at the CSFS nursery: soil depth, texture, pH, and % calcium carbonate ($CaC0_3$) (Figure 6). Like most forest and conservation nurseries, the CSFS nursery grows a wide variety of species that have different soil preferences but we can group them into 3 general classes. "Conifers" prefer low pH and coarser soils, whereas many shelterbelt species are deciduous trees and shrubs ("Hardwoods") that can tolerate medium texture soils with a neutral pH. Conifer "Transplants", such as plug+one stock, are also more tolerant of the soil conditions in this middle class (Table 2). Soils that did not meet the criteria for either of these productivity classes were assigned to a third "Marginal" soil class which, although they are unsuitable for seedling production, can be used for seed production areas or stool blocks.

Some of these productivity classes are not permanent, and the soils can be improved. If the limiting factor is a physical condition, such as depth or texture, then it is usually not economical to try and fix it. But, if the problem is chemical in nature, then the condition may be corrected with amendments. For example, blocks C-5 and C-6 at the CSFS nursery have deep, fine sandy loam soils that would be suitable for conifer seedlings, but their pH values of 7.2 and 7.3 are slightly too high. High soil pH can slowly be corrected by adding sulfur soil amendments and using acidifying fertilizers which will lower the pH into the acceptable range within a few years.

Figure 6. Calcareous soils can be easily identified by putting a drop of dilute acid on the surface—bubbling indicates the presence of calcium carbonate.

Implementing and Updating The Soil Management Plan

Once a Soil Management Plan has been developed, it can be used for many different purposes, such as: determining irrigation applications, scheduling soil amendments (such as sawdust), and prescribing cultural treatments (such as deep ripping). One of the most immediate and practical uses of a Soil Management Plan is to compute fertilizer rates and application schedules. The mineral nutrient tests that were performed during the soil survey can be used to scientifically calculate the types and amount of fertilizer that should be added to a particular nursery block. By comparing the soil test values to target levels, the exact amount of fertilizer to apply to each block can be calculated. The following example shows the calculations for a nursery block with a phosphorus soil test of 18 ppm:

1. Determine how much P is needed to bring the soil up to the target level:

Target Level	*= 35 ppm P*
- Base Soil Level	*= 18,ppm P*
Need to Add	*= 17 ppm P*

2. Convert from parts per million to pounds per acre (or kilograms per hectare)

$$17 \text{ ppm} = \frac{17 \text{ parts}}{1,000,000 \text{ parts}} \quad \text{or} \quad \frac{17 \text{ lbs}}{1,000,000 \text{ lbs}}$$

Table 2. Potential Productivity of Nursery Blocks at the Colorado State Forest Service Nursery Using Limiting Factors from the Soil Survey.

	Soil Productivity Classes		
Evaluation Criteria	Conifers	Hardwoods or Transplants	Marginal
Soil Depth	> 12 inches	> 12 inches	< 12 inches
Soil Texture	Coarse (Sandy)	Medium (Loam)	Heavy (clay)
pH	<7.0	7.Oto8.0	>8.0
%CaC03	< 0.0	< 0.0	> 0.0

Nursery Block Rankings—Listed in Decreasing Order of Acceptability.

Conifer Culture Block	Conifer Culture Acres	Hardwood Culture Block	Hardwood Culture Acres	Marginal Productivity Block	Marginal Productivity Acres
A-1	1.7	C-5	1.5	B-1	1.5
B-3	2.2	C-6	2.2	D-3	0.6
A-6	1.0	E-1	2.0	D-7	0.7
C-4	2.4	B-7	3.9	D-2	2.4
B-6	1.2	D-6	1.0	D-1	4.2
C-1	1.7	D-10	0.9	B-5	3.1
C-3	2.4	C-2	1.4	B-2	3.7
B-4	1.4	A-4	1.7	E-8	2.9
A-2	1.6	E-3	3.7		
		E-2	3.7	Total	19.1
Total	15.6	A-3	1.7		
		A-5	1.6		
		E-4	3.4		
		D-5	0.9		
		D-9	0.9		
		E-6	2.9		
		E-5	1.9		
		D-4	2.0		
		D-8	2.0		
		E-7	2.9		
		Total	42.2		

3. One acre-foot of average soil weighs approximately 4,000,000 lbs, so 1 plow slice (9 in. deep) of soil would weigh 3,000,000 lbs per acre. Therefore, the weight of P needed for 1 acre can be determined by solving the following proportion with cross-multiplication:

$$\frac{17 \text{ lbs}}{1,000,000 \text{ lbs}} = \frac{X \text{ lbs}}{3,000,000 \text{ lbs}}$$

X= 51 lbs of P per acre

4. Fertilizers are rated in phosphoric acid (P205) instead of elemental P, however, so we need to add more bulk fertilizer to meet our target:

51 lbs of P/ac x 2.3 = 117.3 lbs. of P_2O_5 */ ac.*

5. Finally, we need to compute the application rate for a specific fertilizer. For example, concentrated superphosphate has an analysis of 0-46-0, which means that it contains 46% P_2O_5, so:

117.3 = 0.46 = 255 lbs. of 0-46-0 should be added per acre.

Using the soil fertility targets for the other mineral nutrients, and the data from the soil fertility tests, you can use this process to calculate a scientifically-based fertilizer application schedule for your bareroot crops.

Soil Management Plans are not meant to be fixed or inflexible documents, and they do have a limited shelf-life. Most nursery managers find that their Plans must be adjusted at regular intervals as more information on seedling performance is accumulated and soil characteristics become modified with amendments. Storing soils information on computer databases allows easy updating, and CAD programs help visualize the process.

Well, hopefully this discussion will convince you that your nursery could use a well-designed Soil Management Plan. Contact the USDA Natural Resource Conservation Service (formerly Soil Conservation Service), your state university extension service, or other government soils agency for help. There are also consulting soil scientists who can help you develop a Plan on a contract basis.

Sources:

Bickelhaupt, D.H.; Davey, C.B.; White, E. H. 1983. Laboratory Methods for Forest Tree Nursery Soil Analysis. Misc. Publ. No. 2. Syracuse, NY: State University of New York, College of Environmental Science and Forestry. 16 p.

Landis, T.D.; Boyer, D.S. What is a soil management plan and why would you want one? Escanaba, MI: Northeastern Area Nurseryman's Conference and Nursery Soil Workshop; 1992 July 29-30. Portland, OR: USDA Forest Service, Cooperative Forestry. 12 p.

Meinert, D.; Viele, D.; Knoernschild, T.; Moore, M. 1994. Soil management plan for the G.O. White State Forest Nursery. In: Landis, T.D. tech. coord. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1993 August 2-5; St. Louis, MO. General Technical Report RM243. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 9-18.

van den Driessche, R. 1984. Soil fertility in forest nurseries. IN: Duryea, M.L.; Landis, T.D. eds. Forest Nursery Manual: Production of Bareroot Seedlings. Boston: MartinusNijhoff/Dr. W. Junk Publ. 75-80

Youngberg, C.T.1984. Soil and tissue analysis: tools for maintaining soil fertility. IN: Duryea, M.L.; Landis, T.D. eds. Forest Nursery Manual: Production of Bareroot Seedlings. Boston: Martinus-Nijhoff/Dr. W. Junk Publ.: 75-80