Soil and Water Management Plans for Bareroot Nurseries

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Abstract: A soil management plan should include historical and current environmental assets and liabilities, including geomorphic origin and past land use. Each nursery has its own unique soil, water, and climatic conditions, and these should be considered. Primarily, a plan should represent a team effort by the soils specialist and the nursery personnel who work the ground and raise the seedlings. With contributions from all those involved, the plan can address operational functions such as tillage, irrigation, cultivation, fertilization, trafficability, and harvesting. The success of a management plan as a useful tool depends upon the commitment of all concerned.

Keywords: soil nutrient status, foliar nutrient status, cultural practices, soil amendments, cover crops, soil texture

Introduction

In preparation of the *Forest Nursery Manual: Production of Bareroot Seedlings* (Duryea and Landis 1984), a questionnaire was sent to 21 Northwest bareroot nurseries. The response indicated that the 6 most important considerations (in site selection characteristics) were: 1) soil workability and drainage; 2) soil texture; 3) water supply; 4) land cost; 5) climate; and 6) soil depth (Morby 1984). It is evident that nursery managers consider soil and water characteristics as major concerns.

Additional, and more specific, guidance comes from Warkentin (1984), who has offered a list of physical characteristics desired in a nursery soil. These characteristics are optimal proportions of air and water in soil pores after natural drainage, rapid drainage of excess water from the soil, adequate infiltration rate for rainfall or irrigation water, high resistance to compaction, low shear strength for easy harvest of seedlings, low adhesion of soil to seedling roots, and absence of frost heaving, erosion, and soil splash onto seedlings. These features provide the starting points for gathering basic information necessary to make the ultimate interpretations for the needs of the nursery staff.

It can't be overly emphasized that the majority of soil and water problems (including chemical or nutrient imbalances) in bareroot production result from changes in the physical conditions. Therefore, both the existing and the potential status (resulting from cultural activities) must be recognized or anticipated by the soils specialist as well as the nursery staff.

Of utmost importance is the concept that a soil and water plan must be visualized as a management tool, not merely as an inventory of existing conditions. This requires a working knowledge of all the cultural activities that routinely take place at the nursery. Most soils specialists are not familiar with these operations, such as the number of necessary tractor trips, what implements are involved during specific moisture conditions, and the irrigation schedules. It is important that the nursery staff become involved in educating the soils specialists as to all the events included in raising the seedling stock. A bareroot nursery operation is undoubtedly one of the most intensive farming operations existing.

The following discussion on the content and substance of a soil and water management plan is offered to assist the nursery personnel in the development of a working and dynamic product. The soil and water management plan for J Herbert Stone Nursery (USDA Forest Service, Medford, OR) serves as an example.

Plan Introduction

Long-term nursery objectives are recorded in the Management Plan introduction (Boyer 1993). These can be short and simple, but necessarily explicit. For example, objectives might include developing more uniform crops, reducing chemical usage, managing the soils to their best potential, and increasing the quality of water leaving the nursery, including reduction of sediments and nitrates.

The introduction may also include past land use, climatic factors, soil origin, and source of irrigation water. Historical information, such as past studies regarding soil physical and chemical properties and water quality analyses, could be presented.

Soil/Foliar Nutrient Status

The "Nutrient Regime" is a logical place to begin the plan's second part. A discussion of macronutrients and micronutrients and past laboratory analyses of both soil and foliar samples is appropriate to this section. Target levels for the individual species to be grown, as well as guidelines for different stages of seedling development, could be defined. As an example, every species and cultural group requires a different level of nitrogen. Some generalities that have been used in the past include: 1) high rates of nitrogen are used for 1+0 for shipping, high elevation species and species to be grown "large"; 2) moderate rates of nitrogen are applied to low elevation species; and 3) low rates of nitrogen are significant to transplants and sugar pine.

A discussion of fertilizers and soil amendments is also useful when it provides data regarding acid-producing products or sources of sulfur and/or micronutrients. A table of Standard Treatments, including fertilizer types, rates, and schedules of applications might be included in this section. The annual fertilizer schedule can be presented, along with the quantity and type of fertilizer to be applied at specific times during the season, starting with the planting dates. These treatments can be specific according to the various cultural groups, such as ponderosa pine for shipping at 1+0, ponderosa pine to be grown for 2+0, or ponderosa pine and Jeffery pine grown for 2+0 of medium height and caliper, and so on. This information can be useful in ordering annual purchases. It also gives the soils specialist an insight as to what and how much is being applied and the number of applications.

Any past research pertaining to growth and cultural practices should be included, such as the report on root and shoot growth of Douglas-fir and ponderosa pine in bareroot nursery seedbeds at J Herbert Stone Nursery (Riley 1992). This report was especially useful, as it recognizes important stages in the life of the seedling and the timing of cultural activities to maximize the potential growth.

One of the most significant contributions from the Stone Nursery staff was to provide an example of the Pre- and Post-Soil Treatments. This included field location, species to be grown, and target height and caliper. All of the scheduled cultural activities involved were also listed, including sowing density, wrenching, mulching, fertilizer banding, and irrigation at various growth stages. Pest management and root pruning were also mentioned. This schedule provides guidance to the nursery personnel performing the tasks. In addition, the nursery culturist, or soils specialist, developing the fertilizer regime will find it useful in fine-tuning fertilizer applications to obtain objectives with the least amount of effort. It also gives a clear view of all the activities involved and their specific points in time.

Soil Amendments

Discussion of amendments (organic and inorganic) and cover crops is included in Section 3 of the Management Plan (Boyer 1993). (See Rose and others 1995 for further information.)

The JH Stone Nursery Soil and Water Plan also provides sawdust prescription guidelines, including timing of application, storage areas, sampling, sawdust size distribution, application rates, supplemental additions of nitrogen, and inspection of delivered product.

Laboratory Analysis

Section 4 includes lab analysis and comments regarding irrigation water, surface waters, sediment traps, ground water (including subsurface drainage system water quality), and studies dealing with nitrate and other chemical leaching.

Nursery Soil and Water Conditions

Section 5 presents the soil and water conditions for the entire nursery and each production field. Maps were prepared to illustrate surface soil color, surface soil textures, particle size analysis (lab tests), abrupt change in soil texture from surface soil, mottling (by depth increments), and water tables (immediate and 24-hour readings). A discussion of trafficability (listing those operations that produce the least to the most compactive effect) and nutrient status trends are also provided. All of these factors are of an "inventory" nature, but are useful in the selection of certain fields for specific species as well as indicating where potential problems might arise, such as subsurface drainage system failures.

One distinct product of the field investigation is the map of particle size distribution. A major concern at this nursery was the location and extent of the fine- and very fine-sized mica fragments. The inferences of this map indicate potential compaction, surface crusting, inhibitors to seedling emergence, infiltration rates for irrigation waters, and adhesion of soil particles to roots during lifting operations.

Other maps, such as soil color, infer differences in organic matter content or presence of coarse (gravel-sized) fragments that may interfere with sowing operations or contain abrasive properties damaging to field implements.

The map indicating abrupt changes in soil textures from surface soil has references to irrigation duration and frequency. It may also infer reduced soil water downward movement, which ultimately raises the potential for compaction, pathogenic activity, or at least, problems in trafficability.

All these observations are the basis for the interpretations that follow. They also represent the elements the nursery staff deem essential to operations. Along with all the past soil and foliar analyses, a list of interpretations for each field is given, which includes germination/survival, soil tilth,

practices to maintain organic matter levels, limitations for farm machinery, irrigation, and best use of the land.

There is a large difference between developing field data and providing soil and water interpretations. The nursery staff has an obligation to question any of the interpretations. The rationale should be obvious to the personnel concerned so that there is no misunderstanding or lack of agreement. This is part of the total commitment! If this doesn't occur, the plan will not be useful and will stand the danger of being relegated to a dusty shelf.

Another requirement, particularly if the soil resource specialist is involved in the annual fertilizer recommendations, is that he/she should be present at lifting time. The specialist can then observe whether seedling morphology (height, caliper, and root mass) meet the objectives desired by the nursery. If this is not convenient, then a copy of the cull percentage and/or comments by the staff as to whether the fertilizer regime met or did not meet necessary goals should be provided.

The soils specialist must have the desire to perform to the highest technical standards possible and thoroughly understand all the operations involved in bareroot production. This is a tall order, but necessary for a solid and functional plan. The interpretations must be sound and backed by sufficient rationale. This requires questioning his/her own judgment and either gathering additional supporting data or rejecting the interpretation.

A soil and water management plan that will serve as a dynamic, functioning tool can be accomplished if the individuals, from tractor driver to nursery manager to soils specialist, are willing participants and are committed to mutual objectives.

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