SOIL MANAGEMENT OF SEED ORCHARDS AND EARLY SELECTION TRIAL PLANTATIONS IN NORTHERN IDAHO

Gary L. Ford and Aram Eramian

Management of tree improvement areas is one of the most intensive uses of the soil resource in forestry today. Very site-specific soils information is required for the management of these areas. Practices used include extensive clearing, diskng, ripping, irrigation, fertilization, and use of cover crops. A complete soil management program is essential to the success of tree improvement programs. This paper discusses soil management activities at two tree improvement areas in the Sandpoint Ranger District of the Idaho Panhandle National Forests.

TREE IMPROVEMENT PROGRAM

Tree improvement is a program that combines genetics and tree breeding to improve yields and overall quality of forest tree species. The goal of the Forest Service Northern Region Tree Improvement Program is to increase yields of wood on appropriate lands through genetics and tree breeding.

The Dry Creek Tree Improvement Area, located near Clark Fork, ID, is 80 acres in size and currently supports programs for Douglas-fir (Pseudotsuga menziesii) and western larch (Larix occidentalis). There are three early selection trial (EST) plantations and one established seed orchard on site. The purpose of the early selection trial plantations is to obtain early growth and hardiness data from a large number of families that have been selected from wild stands. The best individuals are selected and planted in seed orchards to produce seed for reforestation programs in that species' breeding zone.

When fully developed, Dry Creek will have two Douglas-fir seed orchards and three lodgepole pine (Pinus contorta) seed orchards producing genetically improved seed for reforestation programs in northern Idaho and western Montana. These five orchards will cover 50 acres and include 5,400 genetically improved trees.

The Grouse Creek Tree Improvement Area, located 18 miles northeast of Sandpoint, ID, will support seed orchards for western larch, western white pine (Pinus monticola), lodgepole pine, Engelmann spruce (Picea engelmannii), and grand fir (Abies grandis). The site currently has an established 12-acre western white pine seed orchard. Approximately 120 acres of seed orchards will be established at Grouse Creek when it is fully developed in the year 2000.

SOIL MANAGEMENT OBJECTIVES

Soil management objectives within the two tree improvement areas are to: (1) locate seed orchards and early selection trial plantations on soils that are suitable for these uses, (2) manage soil fertility and soil moisture so tree improvement program objectives are met, and (3) protect long-term productivity.

SITE SELECTION PROCESS

A regional team first identified site factors considered important to development of a tree improvement area. These were: soils, climate, potential for disease and insects, quality and quantity of irrigation water, availability of power, and proximity to an all-season road.

The initial soil factors considered important were drainage, compactibility, fertility, and pH. The climatic factors identified were length of growing season, amount and pattern of annual precipitation, average temperatures and relative humidities for growing season, cold air drainage, and frost hazard.

SOIL MAPPING

An Order 2 soil survey was completed at the Dry Creek site in the fall of 1983 to determine if the site was suitable for use as a tree improvement area. In 1989, an Order 1 survey was conducted of the soils in each plantation and orchard site. Model soils were identified and sampled for laboratory analysis. Soil boundaries and modal soil locations were recorded on the orchard site map for future reference. Soil moisture monitoring stations have been installed on each modal soil close to where it was described and sampled.

An Order 2 soil survey was conducted at the Grouse Creek site in 1986 to determine if it was suitable for use as a tree improvement area. In the spring of 1990, potential sites for a western larch seed orchard were evaluated.

SOILS AND SOIL MANAGEMENT CONCERNS

The soils at the Dry Creek site have formed in volcanic ash over a variety of water-deposited parent materials. At Grouse Creek, most soils have formed in volcanic ash over glacial till. The principal management concerns for both areas are fertility, irrigation scheduling for the different soils, compaction from the clearing, and some minor areas with shallow, dense layers that restrict root growth and water movement.

CLEARING AND SITE DEVELOPMENT

Dry Creek was selected as a tree improvement site in 1983. Approximately 30 acres were first cleared to prepare sites for Douglas-fir and western larch early selection trial plantations. In August of 1987, an additional 40 acres of land was cleared to prepare sites for two lodgepole pine
Conifers growing under natural conditions in the Northwest complete their height growth in the late spring and early summer when adequate soil moisture is available from seasonal precipitation and snow melt. Trees then set bud and height growth ceases during the summer drought, which usually is at the time of high evaporative demand, high air temperature, and low soil moisture. The plant

**COMPACTION/RIPPING**

In 1987, infiltration tests were conducted at the Grouse Creek site. Infiltration rates were found to be extremely variable and greatly reduced in some areas. Tests were conducted comparing bulk densities and infiltration rates. In general, the greater the compaction (bulk density), the lower the infiltration rate was found to be.

Random transects were established and bulk density samples were collected to determine the amount of soil compaction. These tests indicated that the site had been extensively compacted during the clearing process and the disk that had been used afterwards had only loosened the top 4 inches of soil. Research has shown that this compaction can reduce tree growth (Clayton and others 1987; Froehlich and McNabb 1984; Wert and Thomas 1981).

In the fall of 1988, soils at both the Dry Creek and Grouse Creek sites were ripped with a forest cultivator to reduce the compaction resulting from the clearing process. The compaction usually extended to a depth of approximately 12 inches, and the cultivator satisfactorily loosened the soil to that depth. The purpose of the ripping was to improve water infiltration and reduce bulk densities so root egress would not be restricted.

The cost of ripping the compacted areas at the tree improvement sites was $78.00 per acre for the first two passes with the forest cultivator. Additional passes, if required, cost an additional $36.00 per pass. Production rates were governed by the slope and amount of vegetation on the site. Average production rates experienced were 5 to 6 acres per day.

**SOIL SAMPLING AND TESTING**

Soil samples were collected from the Dry Creek site in May 1989 for analysis at the Intermountain Research Station laboratory in Moscow, ID. The samples were collected from existing plantation and orchard sites on a grid system. The analysis included soil moisture (field capacity and wilting point) and nutrients (N, P, K, S, Ca, Mg, Mn, Fe, and Cu).

Modal soils have been identified, described, and sampled for the Dry Creek site. These samples have also been analyzed for soil moisture and nutrients plus CEC, base saturation, pH, and particle size distribution. The nutrient analysis of existing sites will provide baseline data for the development of fertilizer regimes for each plantation and orchard.

**SOIL MOISTURE MANAGEMENT**

Conifers growing under natural conditions in the Northwest complete their height growth in the late spring and early summer when adequate soil moisture is available from seasonal precipitation and snow melt. Trees then set bud and height growth ceases during the summer drought, which usually is at the time of high evaporative demand, high air temperature, and low soil moisture. The plant

moisture stress level reached during this period prevents second flushing, and the trees enter the dormancy cycle.

Irrigation in seed orchards and early selection trials is used to promote plant growth, protect the seedlings from frost damage, augment other cultural practices such as fertilization, and harden seedlings. Improper application of water in plantations could result in growth reduction, lowering of cold hardiness (Douglas-fir), lowering root and shoot growth, and the reduction of seedling vigor, all of which can increase mortality.

Regional direction (Forest Service Handbook 2409.26g) states that soil moisture in the root zone of early selection trials should be maintained at less than 5 bars for all species except lodgepole pine, which should be maintained at less than 8 bars. Soil moisture in seed orchards should be maintained at or above 50 percent of field capacity for all species.

After the areas have been mapped and soil moisture release curves produced, tensiometers and gypsum blocks are installed to monitor soil moisture. This makes it possible to use irrigation to keep soil moisture tensions within the desired ranges.

**SOIL FERTILITY MANAGEMENT**

Soil fertility will be managed through soil nutrient monitoring and fertilization. The objective will be to provide seedlings with a maintenance level of nutrients to maximize plant vigor while keeping vegetative growth at normal levels. The intent is to not promote vegetative growth. Optimal nutrient levels for Douglas-fir have been reported in various papers and presentations (Boyer 1982, 1989; Mandzak 1988).

Soil and foliar samples will be collected on all EST's and seed orchards to monitor nutrient status. Soil samples will be collected at 2- to 3-year intervals to ensure that soil nutrient levels are being maintained within established guidelines. The soil sampling will also be used to track the location of nutrients in the soil profile. The foliar analysis will be made each year to track nutrient status in the trees. The results of both sampling programs will be used to further refine fertilizer application rates to provide the nutrients that are limiting growth. In the future these sampling techniques will be used to develop fertilizer rates to promote pollen flowers and cones for seed production.

**CONCLUSIONS**

Soil management is a critical part of the management of tree improvement areas. Soils information is needed at several stages of site development. Soil mapping will be needed initially to be sure the site is suitable for a seed orchard or early selection trial. An assessment should also be made to determine the impacts on the soil, such as compaction, displacement, and mixing, from the clearing operations.

Site-specific mapping should be done prior to establishment of each seed orchard and early selection trial plantation. This detailed mapping can locate small inclusions significant to management.

Sampling, testing, and monitoring should be done by soil type. Soil moisture and temperature sensors should be established at sites that are representative of that soil type.