SOIL AND STOCK MANAGEMENT PRACTICES AT THE HAYWARD FOREST NURSERY

JOHN E. BORKENHAGEN [1]

This nursery was established in the northwestern part of Wisconsin by the Forest Service, Region 9, 35 years ago. It was operated by the USDA Forest Service until 1945 when it was subleased to the Wisconsin Department of Natural Resources which presently operates it. Under the management of the two agencies, the nursery has supplied close to 150 million seedlings and 50 million transplants, a volume that has replanted some 150,000 acres. The larger part of the produced nursery stock is now forming the young forests of the formerly called "Bayfield Barrens" of the Chequamegon National Forest, and of the fluvial deposits of the Wisconsin State Brule Forest.

The Hayward site was chosen in 1935 after rejection of five other potential locations by Forest Supervisor Van Giesen and Professor Wilde. The site of about 120 acres was not without shortcomings, but fulfilled most of the requirements: it had a level topography, light sandy loam soil, available labor, nearby deposits of peat; it was located near a town, at a crossroad of several hard surface highways, and on the bank of the crystal-clear Namekagon River.

The two suspected adverse features of the area-damage by frost and deer-proved to be only partly substantiated. Intermittent frost injuries are confined to spruce species, and occur at about 4-year intervals. The deer. easily jump the 5-foot fence, but no appreciable destruction of the stock was ever recorded. On the other hand, the site proved to be unfavorable for the production of white pine; blister rust infections are frequent in spite of the systematic annual eradication of *Ribes* species.

Soil Fertility

As is usual with previously farmed lands, one of the tasks necessary before nursery operation was the restoration of soil fertility. Fortunately, most of the area consisted of a reasonable productive soil supporting second-growth stands of jack pine and aspen. A correction of nutrient deficiencies caused by previous cultivation of farm crops was relatively simple, but it did not erase the problem of soil fertility maintenance. Unavailability or excess of nutrients and the disruption of nutrient ratio were frequently caused by measures aiming at the control of weeds and parasitic organisms, such as sulfuric acid and lead arsenate at first, and later, numerous organic biocides. However, the restoration of the soil's productive capacity was greatly facilitated by the availability of organic materials-hardwood-hemlock leafmold and sedge-moss peat; the latter even now is delivered to the nursery at a moderate cost of $1.00 per cubic yard. The deficiency of inorganic constituents was corrected by direct application of commercial fertilizers, often in combination with catch crops, and by supplemental use of fertilizer solutions and liquid humates. (Wilde, 1958).

Average results of analyses (table 1) illustrate the most significant stages in the development of the soil from the beginning of stock production until the fall of 1970.

The maintenance of the high content of soil organic matter, approaching now in many sections 3 percent, undoubtedly moderated the unfavorable effects of biocides like Tersan, Arasan, Captan, Manzate, Mylone, Vorlex, Vapam, Ferbam, methyl bromide, Trizone, Dacthal, and mineral spirits. While some of these chemicals successfully` controlled weeds and parasitic insects, including white grubs, only partially effective suppression of fungus diseases was achieved. Damping-off by *Rhizoctonia* and *Pythium spp.* occurred sporadically in beds of all conifers-jack pine, red pine, white pine, and white and norway spruce. In recent years, root rot, attributed to *Cylindrocladium scoparium,* caused considerable losses of stock, particularly of black spruce, on fungicide-treated beds. Sprays with Manzate compounds are used as a precautionary measure

1 Nursery Manager, Wis. Dept. of Natural Resources. The writer gratefully acknowledges assistance of Mr. W. H. Brener, Reforestation Supervisor, DNR, and Dr. J. G. lyer, Univ. of Wis., in the preparation of this report.

TABLE 1.—*Changes in the level of fertility factors in the soil of the Hayward Tree Nursery.*

Year of soil sampling	pH	Organic matter	Exchange capacity	Total N	Avail. P_2O_5	Avail. K_2O	Exch. Ca	Exchg. Mg
		Pct.	Meq./100 g	Pct.	Lbs/A		Meq./100 g	
1935	5.7	1.9	4.3	.070	60	90	2.18	—
1940	4.9	1.6	4.1	.064	172	171	1.83	—
1944	5.0	1.6	4.0	.045	92	101	1.92	—
1946	4.7	2.2	5.3	.081	173	86	1.74	—
1957	4.8	2.3	5.0	.057	180	182	0.89	0.24
1962	5.6	2.1	4.9	.074	202	268	2.44	1.25
1970	5.7	2.2	5.6	.095	220	220	2.26	0.92

against *Lophodermium* needle cast.

The pre-war use of sulfuric acid for the control of damping-off produced impermeability of the subsoil in places. This alteration occasionally leads to water over-logging and deficiency of aeration in the root zone. The corresponding deterioration of stock at first suggested the toxicity was caused by reduced manganese, but the subsequent determinations of exchangeable and reducible forms of this element failed to establish any relationship; in fact, soils supporting perfectly healthy seedlings showed a concentration of Mn approaching 80 ppm, i.e, about f r times as great as presumably is toxic to so of the field crops.

Stock Management

The stock has never exhibited unavailability of phosphorus that could be related to the suppression of mycorrhiza-forming fungi.

At present, the production of tree ' planting stock is largely limited to 3-0 seedlings and 2-1 or 2-2 transplants of native conifers. Although all grades of plants preserve a satisfagory toproot ratio, in many cases they are too large for the most efficient field outplanting. This is mostly the result of the growth-stimulating influence of certain eradicants. The suppression of the microbiotic competition and enrichment of the soil in proteinaceous tissues of eradicated organisms provide an excess of nitrogen. ..The resulting luxuriant growth imparts to plants, particularly their crowns and stems, succulent structure. This harmful effect is particulktiy pronounced with biocides which possess hormone. like stimulating properties or include nitrogen in their formulation (Iyer *et al.,* 1969). Fortunately, in the past L years, very promising results with retardation of foliar growth were achieved by applications of peat of a high exchange capacity in combination with aluminum sulfate treatments which reduce the release of available nitrogen. Table 2 provides some results achieved in one of the trials.

TABLE 2—*Gross morphological features of 2-year-old red pine seedlings raised on control and aluminum sulphate-treated beds*

Soil treatments on a per acre basis	Length, in. Tops	Length, in. Roots	Weight, g. Tops	Weight, g. Roots	Top-root ratio
Control: 60 cu. yds. of sedge-moss peat	6.2	7.3	0.51	0.15	3.4
60 cu. yds. of sedge-moss peat plus 1,600 lbs. of aluminum sulfate in 1,200 gal. of water	3.5	5.2	0.19	0.08	2.4

References

Iyer, J. G., G. Chesters, and S. A. Wilde.
1969. Recovery of growth potential of nursery stock produced on biocide-treated soils. Silve Fennica, 3 (4): 226–233.

Wilde, S. A.
1958. Forest Soils. Ronald Press Co. New York.