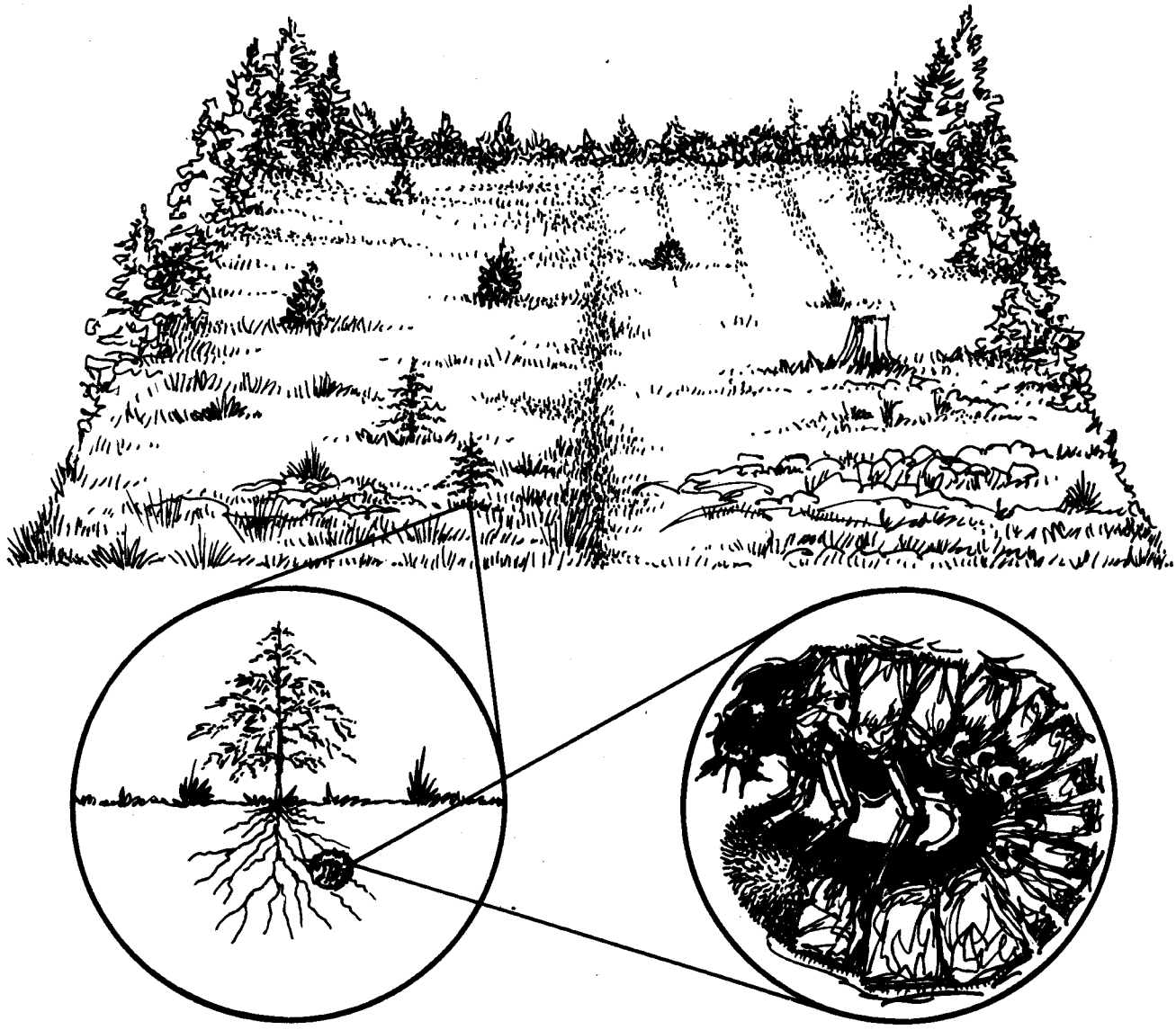
Research Notes

Reforestation Trials on Harsh Sandy Sites in Michigan's Upper Peninsula White Grub Interactions



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REFORESTATION TRIALS ON HARSH SANDY SITES IN MICHIGAN'S UPPER PENINSULA - WHITE GRUB INTERACTIONS

by

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ABSTRACT

Three pine plantations established in May, 1982, in Schoolcraft County, MI, were surveyed at the close of the 1983 growing season. Survival dropped drastically in 1983 due to severe drought and white grub activity. The granular formulation of Isophenphos applied at time of planting failed to satisfactorily control grub activity. A liquid formulation might be more effective and deserves consideration, as does application of a granular formulation late during the year prior to planting. Sizable differences in tree mortality were found between herbicide treatments. Grub and drought induced seedling mortality was greatest in the Glyphosate-treated blocks on all three plantations. Glyphosate apparently focused grub feeding onto conifer seedlings. Survival was greatest on both Danaher Plains plantations in the unfurrowed no-Glyphosate treatment; the furrowed no-Glyphosate treatment resulted in slightly greater survival on the Stanley Lake plantation.

Approximately 10 per cent of the surviving red pine seedlings were infested with red pine needle midge. Midge activity was not correlated with site preparation techniques. From this experience, it is clear that climatic factors and levels of forest pest incidence must be carefully considered when selecting appropriate site preparation strategies.

INTRODUCTION

A large portion of Michigan's Upper Peninsula once supported productive stands of eastern white pine. Clearcutting in the early twentieth century liquidated these stands, and subsequent fires over large areas have removed much of the soil humus so important to forest growth on sandy soils (Larsen et al. 1980). Among the most seriously affected areas are the Kingston Plains, Fox River Plains, and Danaher Plains (approximately 75 sections in Schoolcraft and Luce Counties, Figure 1). These sites now support ground cover of grasses, lichens and other annual and perennial vegetation characteristic of sandy plains. Attempts to reforest portions of these plains with red and jack pine over the last 30 years have been hampered by the low soil organic matter

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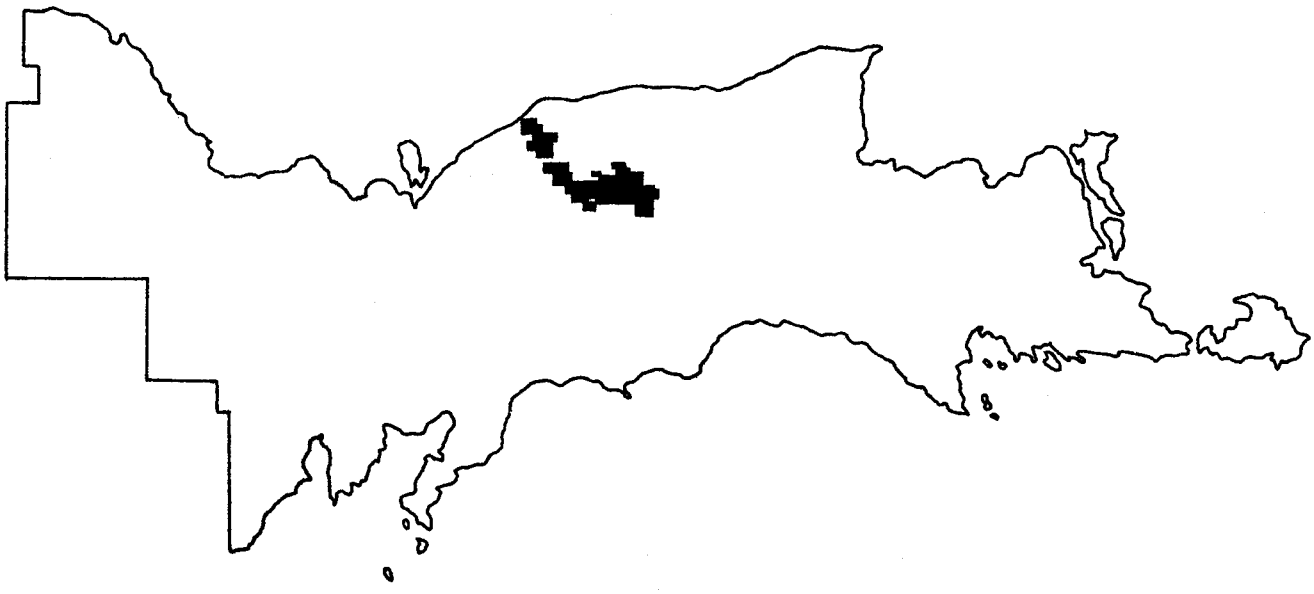

Figure 1. The Kingston, Fox River, and Danaher Plains of Michigan's Upper Peninsula.

content, drought, white grubs (Fowler and Wilson 1971, 1974; Sutton and Stone 1974), Scleroderris canker (Skilling and Cordell 1966, Robbins and Hawkins 1980), competing vegetation, and other factors. Nevertheless, individual trees which survive to reach a height of approximately 8 ft. generally produce acceptable growth. The underlying problem is therefore to achieve satisfactory initial establishment.

Evaluation of reforestation trials on representative sites followed by tests of resulting hypotheses should lead to development of silvicultural systems for successful reforestation of similar sites. For example, technological advances in forestry provide management tools to deal with white grubs through insecticides (Fowler and Wilson 1974), Scleroderris canker through site evaluation (Dorworth 1973, 1978; Robbins and Hawkins 1980), and competing vegetation through herbicides and mechanical site preparation. Effects of drought and adverse nutrient regimes may be minimized through selection of appropriate conifer genotypes associated with mycorrhizal fungi adapted to the particular outplanting sites (Shoulders 1972, Trappe 1977, Molina and Trappe 1982, Riffle and Tinus 1982). This report offers hypotheses concerning the failure of two red pine plantations and one jack pine plantation established in Schoolcraft County in 1982.

METHODS

All three plantations studied comprise a single reforestation trial established between 3 and 7 May, 1982, in conjunction with MICHCOTIP (Michigan Cooperative Tree Improvement Program). One-half of each plantation was furrowed at the time of planting; the remaining halves were slit-planted without furrowing. One-half of each furrowed and unfurrowed block had been treated in August, 1981, with the herbicide Glyphosate (Monsanto Chemical Company: Roundup) at 2 quarts per acre for control of ground cover vegetation, primarily grass and bracken fern. A Whitfield planter was used throughout. All planting stock was high quality, either 3-0 bare root red pine from a western Upper Peninsula seed source or 2-0 bare root jack pine from a Huron National Forest seed source. Seedlings were lifted, graded and bagged at the U.S. Forest Service Toumey Nursery (in Watersmeet, MI) and stored cool prior to planting a week later. Isophenphos (Mobay Chemical Company: Amaze 5 percent granular) was applied for white grub control in a 12 inch wide strip over each plantation row with a Gandy model 4-50 fertilizer spreader pulled behind the planting machine. At that time, only the granular formulation was available to the project; 5 pounds per acre were actually applied in rows for an effective rate of 40 pounds per acre (the recommended rate for grub control in turf).

One red pine plantation (2.6 acres on 8x7 foot centers) was established at Stanley Lake on the Fox River Plains (T47N, R15W, Sec. 3). Contiguous red pine (2.6 acres on 8x8 foot centers) and jack pine (2.1 acres on 8x8 foot centers) plantations were established on the Danaher Plains north of Seney (T47N, R13W, Sec. 35).

A preliminary evaluation of seedling survival and development was conducted at the close of 1982 to evaluate site preparation effectiveness. At this time, 34 to 38 per cent of the seedlings in each plantation were examined. At the close of 1983, a 100 per cent survey for mortality and red pine needle midge incidence was conducted at each of the three plantations.

In order to statistically evaluate the effects of Roundup and furrowing on seedling survival, ANOVA (analysis of variance, split-block design) was performed using per cent survival for each plantation row as the basic sampling unit (Steel and Torrie 1980). Each plantation consists of furrowed and unfurrowed rows replicated within Roundup and no-Roundup blocks. Results are presented as: (P), where P is the attained significance probability of the test statistic, F.

RESULTS

Weather conditions for seedling survival and development during the 1982 field season were normal or better for the two planting sites. The major concerns were high white grub popula-

tions at both planting sites and the apparent discrepancy between mycorrhizal fungi present on red pine planting stock and those evident in pine plantations adjacent to the reforestation trials. As a rule of thumb, an average of 1/4 grub or more per cubic foot of soil (one square foot surface area) is considered to represent a damaging population level (Fowler and Wilson 1971, Sutton and Stone 1974). Ocular estimation of white grub abundance during the furrowing portions of the planting operation revealed high populations in all three plantations.

At the close of the 1982 field season, partial surveys of the three plantations showed approximately 90 per cent survival in each. By the close of the 1983 growing season, severe mortality caused by drought, white grubs, and their interaction with site preparation treatments, had significantly reduced survival. The Byram-Keetch fire drought index exceeded 400 from mid-July through mid-August, 1983. Less than 1.5 inches of precipitation occurred from June through August. For perspective, the 1983 drought exceeded in severity the drought of 1976 in the eastern Upper Peninsula. We conducted a 100 per cent survey of live seedlings at this time. Survival data are presented in Table 1 along with the incidence of red pine needle midge [Cecidomyiidae: Contarinia baeri (Prell)] on living red pine seedlings.

Table 1.--Survival (%) of seedlings after 2 growing seasons in 3 plantations by site preparation treatment, and incidence (%) of red pine needle midge at the close of the second growing season.

Planting Site	Pine Species	Survival (%)[a] Furrow Roundup	Furrow No Roundup	No Furrow Roundup	No Furrow No Roundup	Red Pine Needle Midge (%)[b]
Stanley Lake	red pine	26.3 (417)[c]	43.5 (577)	20.7 (546)	40.2 (425)	8.6 (659)[d]
Danaher Plains	red pine	16.6 (439)	25.9 (398)	10.6 (535)	37.4 (366)	11.1 (370)
Danaher Plains	jack pine	6.8 (499)	8.4 (263)	3.8 (289)	11.0 (399)	-[e]

a/ calculated as percentage of number of seedlings originally planted
b/ calculated as percentage attacked of seedlings surviving on sampling date
c/ original number of seedlings planted
d/ number of seedlings surviving on sampling date
e/ Jack pine is not attacked by this species of midge.

All three plantations suffered greatest mortality in portions of blocks treated with Roundup ($P = .000$). This strongly suggests that pre-plant herbicide may have focused grub activity on the conifer growing stock. Dead seedlings exhibited varying degrees of white grub feeding damage, as evidenced by root girdling and/or severance of lateral roots from the taproot (Fowler and Wilson 1971). A direct effect of Roundup on seedling survival is unlikely. Roundup is not soil active, and application the year before planting provided ample opportunity for the herbicide to degrade.

ANOVA did not detect a significant Roundup x furrowing interaction ($.25<P<.50$). No evidence for a direct effect of furrowing was detected by ANOVA ($.75<P<1.00$), nor did one apparently exist.

The occurrence of red pine needle midge was unexpected. Incidence averaged roughly 10 per cent among living red pine seedlings and showed no relationships to site preparation treatments. This insect pest has become increasingly common in the Upper Peninsula over recent years. The midge mines current year needles inside the fascicle sheath. Symptoms develop in late summer as basal reddening and drooping of infested needles. Development of the infestations at each site will be followed in 1984.

DISCUSSION

Insights gained from these three plantations may apply to other white grub habitats as well. White grubs can be abundant wherever herbaceous vegetation, especially grass, is well established. Competing vegetation is widely recognized as a threat to plantation establishment, possibly greater on better sites than on poorer ones. The effectiveness of herbicides for control of competing vegetation has clearly made their use very popular in forestry. The value of furrowing, scalping and other techniques for physically removing competing vegetation, however, is less clear on nutrient-poor sites, due to displacement of top soil and organic matter. Grub damage can be increased by drought and by scalping as a means of site preparation (Sutton and Stone 1974). Still less clear are the interactions of herbicides and physical methods with levels of white grub activity. No significant influence of furrowing was detected in this study. In light of the increasing interest in establishing conifer plantations throughout the Upper Great Lakes region, understanding the impact of site preparation techniques on both competing vegetation and white grub damage will become increasingly important.

While the three plantations discussed in this report were operationally unsuccessful, they suggest that until an effective white grub insecticide treatment is available, herbicide treatment is inadvisable where grub populations are high enough to reduce seedling establishment. Two possibilities which warrant

consideration are 1) application of a liquid formulation of an effective insecticide at the time of planting, and 2) application of either a granular or a liquid formulation late in the year prior to planting. The granular formulation requires moisture, which may not be available following spring planting, in order to dissolve and enter the rooting zone. Fall application would favor leaching of the insecticide into the rooting zone with snowmelt.

In spite of the severe mortality in all three plantations, a small percentage of seedlings in each plantation performed very well. For example, 3 of the 1450 jack pine seedlings planted exceeded 50 centimeters in total height by the close of the 1983 growing season and 9 others exceeded 40 centimeters. Genotypic variation among seedlings may well explain such superior growth. Each plantation site was extremely uniform in terms of soil and ground cover. However, considering the extreme drought of 1983 and the obligately mycorrhizal nature of pines, it is clear that the mycorrhizal fungi associated with superior surviving seedlings are well-adapted to droughty sites. A number of these fungi have been isolated into pure culture and will be included in greenhouse inoculation tests to determine the feasibility of producing pine seedlings better adapted to droughty sites.

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