White grubs and white spruce establishment

Roy F. Sutton

and Earl L. Stone, Jr.

Respectively, Department of the Environment. Canadian Forestry Service. Great Lakes Forest Research Centre. Sault Ste. Marie, Ont. P6A 5M7: Agronomy Department Cornell University Ithaca, N. Y. 141k50

On occasion, white grubs cause conspicuous damage in forest nurseries and young plantations (4). Much additional injury to trees in plantations and naturally regenerating old fields apparently goes unrecognized. During studies of constraints on growth of white spruce *(Picea glauca* [Moench] Voss) in plantations, three kinds of observations were made bearing on such injury and on the overwintering of white grubs (larvae *of Phyllophaga* Harris sp. and related genera of Coleoptera, Scarabaeidae):

l. Relative resistance of white spruce to white grub *injury, and growth "check"*

First observations on the un-palatability to white grubs of white spruce relative to white pine *(Pinus strobus L.)* and Japanese larch *(Larix leptolepis* ISieb. & Zucc.] Gord.) were made in July 1963 in a 2-year-old experimental plantation of intimately mixed lines of these species near Burritt's Rapids in eastern Ontario. The soil was a Farmington sandy loam (2) ranging in depth from 13 to 23 cm over fissured dolomitic limestone. It was very dry after 4 weeks in which potential evapotranspiration exceeded precipitation by 8.9 cm at Ottawa, 45 km to the north. Although they were exposed in every spadeful of soil examined throughout the plantation, white grubs were not counted. The majority of pine and larch were severely wilted. Some had recently died, and the few roots remaining on these trees had been heavily girdled. The white spruce were not wilted and the shoots showed no drought injury either at this time or in the late fall. Roots of white spruce were not examined here because of the research nature of the plantation. By the late fall, more than 50 percent of the pines were dead, whereas virtually all of the white spruce were alive.

Similar observations were made in the late summer of 1964 near Bourget in eastern Ontario on a level area of Rubicon loamy medium sand (2) outwash where the water table lies within 120 cm of the surface throughout the year. White spruce had been planted in 1961 in widely spaced rows. White pine was interplanted in 1963 to form alternate rows of pine and spruce. At the time of examination, few spruce but many pine were dead. The pines had died during the previous summer or fall; the remaining roots showed the massive damage characteristic of white grub attack. Some shrubs showed similar root injury. Living spruce that were excavated showed no sign of girdling or feeding along the main roots, but many smalldiameter long roots had regenerated where laterals were presumed to have been severed. Pruning was attributed circumstantially to white grubs.

It was noted during the Bourget observations that, in areas of greatest pine mortality, height increment of spruce was poorer in 1964 than it had been in 1963. Reduction in spruce height growth was often accompanied by reduced needle length and a paling or even yellowing of needles. Pine survival and spruce height increment and survival were therefore measured on four random strips spanning 20 rows, each strip including 100 pine and 100 spruce. The results may be expressed by the linear regression:

$$Y = 159.3 - 4.5 X \quad (r2 = .92^*)$$

*significant P.05

where Y is the 1964 height increment of 4-year-old white spruce expressed as a percentage of the 1963 height increment, and X is the percentage mortality of 2-year-old white pine. Mean height increment of all the measured spruce decreased from 8 cm in 1963 to 7 cm in 1961. However, one-third of these trees in areas where pine survival was high was presumably little affected by white grubs, and increased their height increment from 8 cm in 1963 (i.e.. the same value as the overall mean) to 13 cm in 1964.

Six smaller plots, each containing 20 trees of each species, were then selected to test the whole range of pine mortality. The association was again significant (P .05).

Phvllophaga anxia Lec. was the only species of white grub identified in this area.

The implication drawn from these observations is that white grubs may have an unsuspected impact on the height increment of young white spruce. and hence on the length of the establishment period.

2. Grub density and survival of newly planted white spruce

A low natural population of white grubs. estimated at $3.0/m^2$, was supplemented to give mean populations of 3.0, 6.6. and 10.3 grubs/M2 as one set of treatments in a factorial experiment (Sutton. R.F., unpubl.) involving two densities of ground vegetation, each with and without a chemical weed control treatment. The grubs were second-instar larvae, chiefly *Phyllophaga sp.*. collected nearby. The supplement of grubs represented 0, 1, or 2 grubs per spruce, which were newly planted at 38 cm x 38 ('in spacing in 16-tree (4 x 4) plots. The plots were surrounded by barriers set into the soil to prevent outmigration of grubs. whose survival of the transplanting procedure was confirmed by direct examination of replicate plots.

At these densities, white grubs had no significant effect on survival of white spruce. First-year survival was 91-96 percent and second-year survival 87-90 percent in all treatments except the heavily vegetated plots without weed control. Neither height increment nor foliar nutrient concentrations of N. P, K. Ca. and Mg were affected (luring the first three growing seasons.

3. Soil depth and the overwintering of white grubs

The literature affirms repeatedly that white grubs pass the winter below frost level (e.g., 1, 3). However, neither the bedrock nor seasonally high water tables of observation sites had prevented abundant larvae from reaching their second year. Are young grubs thus able to overwinter close to the surface? One of the authors examined this question near Ottawa, Out. in small studies on upland sand soils *(2)* where grub populations are occasionally high.

Cages of fine mesh aluminum were stink into the ground to specified depths. In the 1966-1967 study the duplicate cages were 45 cm x 90 cm in cross section and 30, 60. or 120 cm deep. In the 1969-1970 study they were cylindrical, 20 cm in diameter and 10, 20, 30, 40, or 90 cm. deep. The excavated soil was replaced by horizons. and the surface mat of vegetation replanted. Large. thirdinstar grubs approaching maturity were collected locally in late summer; eight per cage were introduced into the 1966 cages and five per cage were introduced into the 1969 cages. The cages were excavated the following May and all live grubs were identified.

TABLE 1.—Overwinter survival of caged third-instar white grubs (1966–1967)

Cage depth	Live larvae recovered	Species represented: *Phyllophaga anxia*	*Phyllophaga fusca*	*Phyllophaga futilis*	*Serica* sp
Cm	*Percent*				
30	56		√	√	
60	75	√	√	√	√
120	75	√	√	√	√

Appreciable numbers of grubs survived the 1966-1967 winter, even when unable to penetrate more than 30 cm into the soil (table 1, above). Whether or not the ground had frozen to this depth during the winter is not known, but midafternoon temperature at the 30-cm depth was 3.3°C as early as November 20 when the soil was frozen hard to a depth of 10 cm. At the nearby Central Experimental Farm of the Canada Department of Agriculture, the soil temperature at a depth of 10 cm under natural snow cover did not fall below 0° C during the whole winter.

Survival rates in the 1969-1970 experiment (table 2) were similar despite different weather and smaller cages. Larvae of *P. fusca* Froel. successfully overwintered without descending more than 10 cm into the soil. Depth of soil freezing is not known. but soil temperatures at a depth of 10 cm under snow cover at the Central Experiment Farm reached a minimum of -5.0° C in January.

These results do not indicate whether prevention of soil freezing (by insulating snow cover) or insect tolerance to temperatures below 0° C (through supercooling) is more consequential, but it is plain that grub populations may overwinter successfully in shallow soils without descending into fissures.

TABLE 2.—Overwinter survival of caged third-instar larvae of Phyllophaga fusca *(1969–1970)*

Cage depth	Live larvae recovered
Cm	*Percent*
10	60
20	80
30	80
40	100
90	80

Comment

The impact of grub damage on regeneration silviculture is commonly considered solely in terms of survival. This may be an adequate measure for some species but not for white spruce. Even in heavily infested soils, mortality may he so slight that grub activity is unsuspected, while any root damage reduces uptake of water and nutrients, retards height and diameter increment, and impairs foliage efficiency. Especially among

(Continued next page)

Ortet and season of collection significantly affect rooting of river birch stem cuttings

Ronald C. Dosser and Ray R. Hicks, Jr.

Respectively, forester. Texas Forest Ser vice. Kirbyville Texas: and assistant professor. Stephen F. Austin State University. School of Forests'. Nacogdoches. Texas.

Rooted cuttings can produce genetically homogeneous clones useful for experimental plantations, seed orchards, or afforestation. River birch *(Betula nigra L.) is* of interest as a candidate species for silage cellulose production. This article' investigates variation in rooting of stem cuttings due to season of collection and mother tree (ortet).

White grubs...

(Continued front page 10)

newly planted spruce, deterioration may have serious consequences for many years. The effects of white grub activity may induce, intensify. prolong, or simulate the condition of "check," notably on soils of low fertility or in years of subnormal rainfall.

Literature Cited

I. Hammond. G.11.
1960. Control of white grubs in eastern Canada. Can. Dep. Agric., Res. Branch, Publ. 1069, 8 p.

2. Hills. G.A.. Richards. N.R.. and Morwick, F.F.
1944. Soil survey of Carleton County. Ont. Soil Surv. Rep. 7, 103 p.

3. Speers, C.F. and Schmiege. D.C.
1961. R hire grubs in forest tree nurseries and plantations. U.S. Dep. Agric. 63, 8 p.

4. Sutton, R.F. and Stone. E.L.
1974. White grubs: a description for for. esters, and an evaluation of their silvicultural significance. (an. For. Serv. Sault Ste. Marie. Ont. Inf. Rep. (1-X-212, 21 p.

Methods

Cuttings were collected near Douglas. Texas every 4 weeks from February 19. 1972 until January 8, 1973. Forty cuttings, consisting of the terminal 6 to 8 inches of the twig. were taken from each of 10 opengrown ortet trees at every collection period. The 10 trees were limited to an age range of 8 to 10 years to minimize effects of physiological aging (4). Cuttings were collected from the lower one-third of the crown to avoid juvenile-mature differences which exist within the crown (6).

Cuttings were stored in an ice chest for transport to the greenhouse. and immediately prior to placement in the propagating bench each cutting was wounded and treated with a mixture of synthetic auxin and fungicide. Wounding consisted of making two longitudinal cuts, approximately 1 inch long, on opposite sides of the basal end of the cutting. The auxinfungicide mixture was composed of 0.9 percent indole butyric acid (IBA) (1) , 0.8 percent l-phenyl-3-methyl-5-pyrazolone (PPZ) (5), 5.0 percent captan (2). and 94.4 percent talc by weight. If leaves were present, all but three apical leaves were removed. The above combination was selected on the basis of preliminary trials where several alternatives were tested.

Cuttings were then arranged in a randomized complete-block design in intermittent-mist rooting beds with 10 cuttings from each ortet assigned randomly to row plots in each of four blocks. The rooting medium was a mixture of coarse and fine sand and temperature of the medium was maintained at 72°-76° F during cold periods by imbedded heating cables.

After 8 weeks, cuttings were removed and observed for root formation. Analysis of variance was used to evaluate effects of ortet and collection date on rooting, where percentage rooting per plot was converted to arcsin.

Results

Rooting percentages differed significantly at the 1 percent level of °F with cutting periods, ortets, and cutting period x ortet interaction.

While the rooting percentages of all ortets were erratic, certain of them averaged higher than the mean on most dates (table 1). The average rooting percentage of the four highest rooting ortets during the winterspring season was 52.1 percent as compared with 30.5 percent for the other six ortets tested. This suggests that selection of ortets on the basis of preliminary rooting tests could greatly improve rooting.

Variation due to cutting period is illustrated in figure 1. Among cuttings taken May 30, August 25, and on February 19, less than 13 percent rooted. Among cuttings taken January 8, March 18, and from October 7 to December 12, 30 percent to

------

'This research was supported in part by funds provided under the McIntire-Stennis Act,