

1977, disease-free planting stock of rooted cuttings was available from 32 of them (Khalil, Nfld. Forest Res. Cent. Inf. Rep. N-X-142, 1976).

Soil-nutrient status and physical condition at the plantingsite are important for the establishment and good growth of hybrid poplars. Soil quality and weed competition have been found to greatly influence early growth of hybrid poplars in Ontario (Zsuffa et al., For. Chron. 53:195-200, 1977), and in Pennsylvania (Czapowskyj, USDA Forest Serv. Res. Note NE-267, 1978).

Concern has recently been expressed at the lack of detailed soil-chemical and physical data related to forest productivity (Rennie, Utilization of northern soils, pages 305-331 in Proc. 11th Int. Congr. Soil Sci., Edmonton, Alta., 1978). In this study we consequently felt the need to obtain detailed vegetation and soil data for the six selected areas representing the range of common Boreal Forest soils in Newfoundland that were tentatively selected for poplar field trials.

Chemical and physical data on forest soils from Newfoundland are inadequate at this time, notwithstanding the availability of the results of some chemical analyses (Page, Can. J. Forest Res. 1:174-192, 1971) for western and eastern Newfoundland. With the exception of data from a 1 300 km<sup>2</sup> area covered in a soil survey (Wells and Heringa, Can. Dep. Agric., Nfld. Soil Surv. Rep. 1, 1972) few data on the nutrient content of forest soils exist for central Newfoundland. Several reports (Damman, Soc. Am. For. Forest Sci. Monogr. 8, 1964; Wells et al., Nfld. Forest Res. Cent. Inf. Rep. N-X-83, 1972; Wells and Roberts, Nfld. Forest Res. Cent. Inf. Rep. N-X-101, 1973) give detailed soil descriptions and classification but report very few chemical data.

Although all macronutrients are important for tree growth, recent studies in fertilization of poplars have shown that nitrogen and potassium are most effective in increasing and maintaining growth (Einspahr and Wyckoff, Tappi 61(3):49-52, 1978). In the present study, these elements were analyzed together with phosphorus, calcium, magnesium, and sodium. Table 1 summarizes the site characteristics and the total nutrient contents of the soils of the proposed experimental areas. Table 2 shows the available nutrients, cation exchange capacity (CEC), and base saturation for each of the soils. The analytical methods used were those of Jackson (Soil chemical analyses, Prentice-Hall Inc., Englewood, N.J., 1958). Two soil pits were dug at each site and soil samples were collected on a horizon basis. The results are the averages of each set of duplicate samples from each horizon. The sites were then evaluated on the basis of the upper organic and B horizons for the total exchangeable bases (TEB), CEC, and the total and available percentages of nitrogen, phosphorus, potassium, and calcium. The nutrient content of the upper B horizon was considered to be a critical factor in selection of sites because of the moderately deep rooting system of hybrid poplars. The percentage of total nutrients in this horizon was also considered important because the planting sites were to be limed to raise the pH to 5.5-6.0 and increase the quantities of available nutrients.

In addition to the chemical data collected, our knowledge of the former forest types helped in evaluation of the sites. Sites K5, K4, and K1 are in productivity class I and K3, K2, and K0 are in productivity class II (Bajzak et al., Nfld. Forest Res. Cent. Inf. Rep. N-X-7, 1968; Damman, 1964). This information provided the initial site grouping for hybrid poplar planting and the chemical data were used for the further evaluation of each site. The sites rank in decreasing order as K5, K1, K4, K0, K3, and K2 on the basis of the soil analyses (Table 1). The first three sites have more favorable soil texture for the growth of poplars than the others. Because of the expected increase in pH by liming, K2 is expected to move above K3 and all sites are expected to improve by release of increased amounts of available nutrients.

All sites except K3 should have adequate quantities of available moisture. Site K3 also has a fragipan in the lower B horizon that may adversely affect growth by retarding root penetration. Czapowskyj (1978) reported good growth of hybrid poplar on coal mine sites derived from glacial till with similar levels of available nutrients. He reported mean values of 0.08% N, and 2.40, 1.55, and 0.10 meq/100 g for Ca, Mg, and K respectively; the average CEC was 4.85. His pH values were 1-2 units higher than those for local sites investigated.

Correct assessment of site quality is particularly important for areas selected for planting hybrid poplars where an annual height growth of more than 2 m is expected under favorable conditions. Our results show that the nutrient contents and texture of the soils on the proposed planting sites are comparable to those generally prescribed

for growing hybrid poplars. The nutrient contents of Newfoundland Boreal Forest soils are generally low in all essential elements, but the limiting factor in the growth of hybrid poplars may be the excessive soil acidity. This could be improved by liming. We recommend that, in future, detailed soil-site studies be a major basis for selecting suitable areas for plantations of fast-growing species. Hybrid poplars have now been outplanted on all six sites in replicated experiments. Future growth measurements will test our site ranking. Our detailed chemical results provide a summary of the major properties of predominant forest soils of Newfoundland.—B.A. Roberts and M.A.K. Khalil, Newfoundland Forest Research Centre, St. John's, Nfld.

## PATHOLOGY

### Influence of Splash Cones on Outplanted Conifer Seedlings.—

Rain splashes mud and light debris that often encrust needles and stems of seedlings to form splash cones (Fig. 1). Splash cones are an important factor in frost heaving and injury to seedlings under freeze-thaw conditions (Schramm, Repr. Proc. Am. Philos. Soc. 102(4):333-50, 1958). Persistent splash cones may also be a hazard to seedlings during the growing season. This paper discusses some effects of such splash cones on the early development of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) and white spruce (*Picea glauca* [Moench] Voss) outplanted in 1976-78 in north-central Alberta.

The mean height of seedlings before outplanting ranged from 5 to 9 cm (Table 1). The 5- and 13-wk-old lodgepole pine seedlings were in the early epicotyl stage without secondary needles or a terminal bud, while the 45-wk-old seedlings usually had a fully developed terminal bud and secondary needles. The 41- and 55-wk-old white spruce seedlings had fully developed terminal buds. The seedlings were outplanted between 13 May and 22 June, 1976, in two adjacent

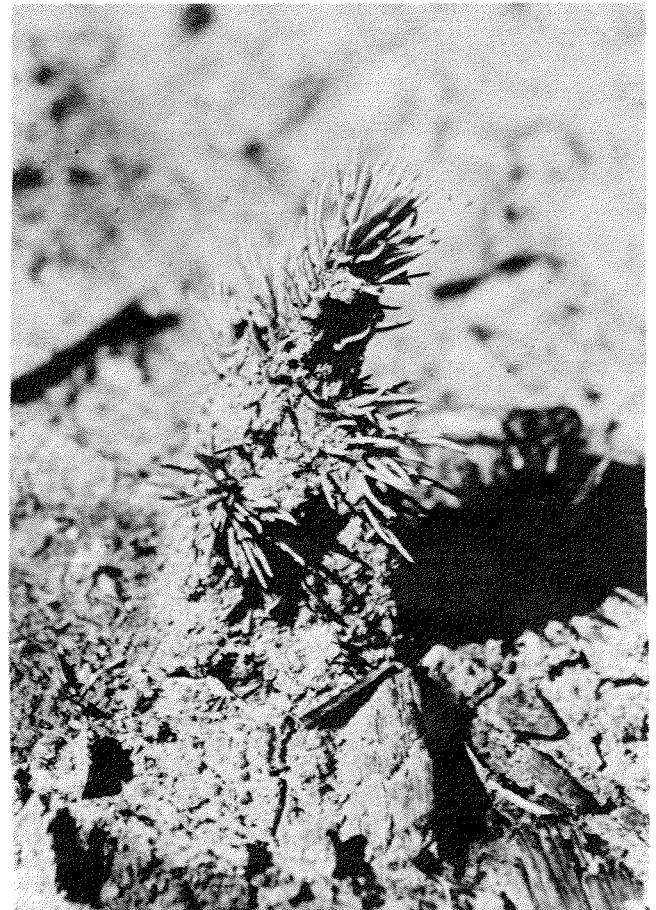


Figure 1. White spruce seedling showing a splash cone (arrow).

TABLE 1  
Occurrence of splash cones on outplanted lodgepole pine and white spruce on two cutover areas

Species and numbers of outplanted seedlings	Age (wk)	Mean height (cm)	Percent of total seedlings with splash cones					
			Cutblock 36			Cutblock 38		
			1976	1977	1978	1976	1977	1978
Lodgepole pine								
50	5	5	24	0	36	100	56	50
75	13	7	28	0	32	100	49	60
125	45	9	19	5	26	98	31	51
White spruce								
75	41	8	5	12	52	98	23	50
50	55	8	0	24	44	100	70	46

cutblocks (36 and 38) at latitude 54°40' and longitude 118°53'. 81 km south of Grande Prairie Alta.

The weakly to moderately calcareous soil of both cutblocks belongs to the Smoky soil group (Gleysol), although cutblock 38 is overlaid with a shallow cover of the Edson group (Orthic Gray Luvisol). The mineral soils involved in splash-cone production were clay loam (30% clay, 35% silt, and 35% sand) within cutblock 36 and clay (48% clay, 35% silt, and 17% sand) within cutblock 38. Twardy and Corns (Alta. Inst. Pedol. Rep. 39, in press) have described the Smoky soil group as poorly drained Gleysolic soils associated with significant amounts of moderately well drained Orthic and Brunisolic Gray Luvisols developed on Edson continental till parent material.

The two cutblocks differed in the amount of mechanical disturbance at the time of planting. In 1976, cutblock 36 was mostly undisturbed, with little or no exposure of mineral soil or loss of vegetation cover. In contrast, cutblock 38 was severely disturbed: it had lost its 8-15 cm humus layer and most of its herbaceous shrub cover because of churning and compaction that occurred during logging under conditions of wetness. Its ground cover rejuvenated very gradually from 1975 to 1978. Originally the stand consisted of lodgepole pine and black spruce *Picea mariana* [Mill.] B.S.P.). Labrador tea (*Ledum groenlandicum* Oeder) and tall bilberry (*Vaccinium membranaceum* Dougl.) were the main species of ground vegetation (Corns, Growth prediction in Alberta foothills, Ph.D. Thesis, Univ. Alta., 1978). The timber was cut between May 1974 and July 1975.

Rain in the experimental area usually came in short, heavy cloudbursts or as a steady drizzle lasting for a day or more. According to our May-to-October data for 1976-78 and those of Schultz and Co. Ltd. (Environmental effects of timber harvesting in Alberta, vol. 1, Alta. Dep. Lands Forests, 1973), the seasonal precipitation in this area varied from 53 to 63 cm. Heavy showers were most frequent during August 1976, May and July 1977, and September 1978; 1977 was the wettest season. During wet months the water table rose above the surface in some parts of cutblock 36, where the soil is underlain with impervious bedrock. When rainfall was not abundant, as in 1976, the churned soil in cutblock 38 tended to dry into hard clods.

Observations on splash cones affecting bud size, needle color, and growth were made from 1976 to 1978. Fully and partly developed splash cones were recorded.

A substantial number of splash cones were recorded during these first 3 yr after the seedlings were outplanted. They occurred on seedlings planted on mineral-soil microsites within cutblock 36 and were particularly prevalent on those planted in churned soils within cutblock 38. Lodgepole pine and white spruce were equally susceptible to splash cones. Cutblock 36, with considerably less scarification and better ground cover, had fewer splash cones than cutblock 38 (Table 1). Splash-cone production on lodgepole pine decreased in 1977 within cutblock 36 because the water table rising there that year obliterated most splash cones except the ones that were not standing in water. Spruce seedlings were not affected to the same extent because they were planted on higher ground. In 1978 splash-cone production within cutblock 36 increased over the 1976 level because many seedlings were stunted from frost damage and frost heave and had a bushy-growth habit, which was more common in spruce than in pine. Bushy seedlings

trapped more soil than nonbushy seedlings. The percentage of seedlings affected by splash cones increased gradually from May to August-September. Differences in cutblock 38 between seedlings with decreasing and fluctuating percentages of splash cones were due to small differences in recovery from frost damage and frost heave.

In severe cases the splash cone covered the seedling entirely or almost to the tip of the leading shoot, with the columns measuring 8-10 cm (Fig. 1). Lodgepole pine with long needles fared better than pine or spruce with short needles. Spruce and pine measuring 4 cm were generally covered entirely and were devoid of light until drizzle washed off the encrusted needles. Seedlings taller than 4 cm were bent over by the weight of their soil-encrusted stem tips. Encrusted needles were bleached but regained some of the chlorophyll as they became free of encrustation. The older needles tended to be pale in the first year after planting.

Seedlings with persistent splash cones rooted poorly and usually formed smaller terminal buds, particularly noticeable in white spruce. Seedlings with small splash cones or none developed reasonably good roots and tops. Splash cones on second-year and succeeding growth interfered with flushing. New shoots were small and spindly and had short needles. Affected seedlings lost vigor and had little or no top development.

Splash cones can be prevented by confining logging activity to winter months, when saturated soils are frozen, and by using proper silvicultural measures for most fine-textured soils. Cutblocks that have intact ground covers can be outplanted within a year of clear-cutting because the soil has better aggregation and structure. Cutblocks with bare, unstable, mineral soil may have to be left for a few years after clear-cutting to allow establishment of ground cover, which would protect the disturbed soil from compaction and leaching by pounding rains and help to bind soil particles into aggregates. As soil structure improves, seedlings root better (Perry, Tree Plant. Notes 69:9, 1964).

Conifer seedlings must not be planted too deep (i.e., past the root collar) on disturbed microsites, because deep planting slows rooting. The rooting process is hindered even more by persistent splash cones, which smother and weaken seedlings by denying them most of the light, aeration, and means to produce chlorophyll and starch. Observations suggest that weak seedlings are prime targets of frost damage and frost heave.—H. Zalasky, Northern Forest Research Centre, Edmonton, Alta.

## ENTOMOLOGY

**Web-spinning in Spiders Is Unaffected by the Molt-inhibiting Insect-growth Regulator BAY SIR 8514.**—Upon ingestion, N-[[[4-(trifluoromethoxy) phenyl] amino] carbonyl]-2-chlorobenzamide, or BAY SIR 8514, selectively inhibits chitin synthesis in larval instars of Lepidoptera. After extensive laboratory and greenhouse studies, this material was field-tested on 40 ha (100 acre) plots of spruce-fir forest infested with spruce budworm near Wawa, Ont., in June 1979. Four different dosages, 280, 210, 140, and 70 g in 4.7 L/ha (4, 3, 2, and 1 oz in 0.5 U.S. gal/acre) were sprayed from an aircraft, and at the highest concentration the budworm population reduction due to treatment was 83 and 60% in balsam fir and white spruce, respectively (Retnakaran, J. Econ. Entomol., in press). Examination of this particular plot soon after spraying revealed that very few spider webs were present. A preliminary experiment to determine whether or not BAY SIR 8514 had any deleterious effect on web-spinning in spiders was conducted, and the results are presented in this report.

Twenty spiders of varying ages belonging to the genus *Aranea* were collected locally and maintained individually at 22°C, 60% RH, under continuous light in 5 L jars covered with cheesecloth, 10 of which served as controls and the other 10 as treatment. Each spider was fed one sixth-instar budworm at 2-day intervals for 1 mo before the start of the experiment. For the test CO<sub>2</sub> anesthetized sixth-instar budworm were each injected with 2 µL of a 4% aqueous suspension of BAY SIR 8514 and fed to the treatment spiders; control spiders were fed untreated budworm. After a period of 24-48 h, when the spiders had consumed the budworm larvae, the webs in all the jars were removed. Within 2 days all the spiders had spun new webs that appeared normal. One spider that had fed on a treated larva attempted to molt within 48 h after feeding and died during the process, showing evidence of molt inhibition (Fig. 1). Four other spiders that had fed on treated budworm molted

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