TABLE I

Virus Efficacy Trial

	Prespray	Post-spray (days)			
		17	24	31	38
Density of larvae/6,450 cm² of foliage					
Check	115.2	100.8	100.4	72.9	55.9
Field-produced virus	227.0	41.9	45.1	34.9	19.9
Laboratory-produced virus	291.8	101.9	54.3	25.4	14.7
Percentage larvae surviving					
Check	100	87.5	87.2	63.3	48.5
Field-produced virus	100	18.5	19.9	15.4	8.8
Laboratory-produced virus	100	34.9	18.6	8.7	5.0
Percentage mortality (adjusted by Abbott's formula)					
Field-produced virus		78.9	77.2	75.7	81.8
Laboratory-produced virus		60.1	78.7	86.3	89.7

produced virus plot and 10% NPV from the check plot. Positive results from the check plot showed that there was some naturally occurring NPV in the area.

The results from these treatments, using 125 billion polyhedra/ha, showed that control could be obtained with this dosage and the efficiency was similar to the operationally recommended dosage of 250 billion polyhedra/ha tested in the same area in 1975 (Stelzer *et. al.*, J. Econ. Entomol., in press). Hence, it may be possible to reduce the operational dosage. The efficacy of laboratory-produced and field-produced NPV was similar.

There are advantages and disadvantages to both methods of virus production. For laboratory production, trained personnel and a well-organized insect rearing program are required. Both white-marked and Douglas-fir tussock moth larvae shed hairs which cause skin irritation and people working with these species frequently contract allergies. Much less organization and expertise are required to propagate virus in larvae in the field and the problem of allergies is almost eliminated. However, due to virus already present in the population and other naturally occurring pathogens, the purity of field-produced virus cannot be guaranteed.—S. Ilnytzky, Pacific Forest Research Centre, Victoria, B.C. and J. R. McPhee and J. C. Cunningham, Insect Pathology Research Institute, Sault Ste. Marie, Ont.

Relative Susceptibility of Red Pine and Jack Pine to *Gremmeniella abietina*.—Both jack pine (*Pinus banksiana* Lamb.) and red pine (*P. resinosa* Ait.) are damaged by the fungus *Gremmeniella abietina* (Lagerb.) Morelet in portions of the Great Lakes-St. Lawrence Forest Region (Dorworth, Can. J. Bot. 50:751-765, 1972). Little damage apart from loss of branches below breast height is experienced after the trees surpass 2 m in height, whereas stems of smaller trees are often girdled or develop extensive basal cankers (Dorworth, Can. For. Serv. Rep. O-X-252, 1976). Mortality greater than 75% is common in red pine plantations wherein *G. abietina* proliferated during the first several years of plantation development. Various degrees of success have been evident where jack pine was used. These two species are the ones most widely employed for afforestation of the sand-gravel outwash plains that abound in the region. Provincial foresters in Sault Ste. Marie and Blind River (Ontario) districts have begun to plant jack pine in areas where *G. abietina* repeatedly caused failures of attempts to establish red pine. The present study evaluated relative susceptibility of red pine and jack pine planted adjacent to one another and challenged equally with inoculum.

Red pine and jack pine seedlings (2+0) were planted in 1970 in four blocks on a site influenced by a pronounced kettle frost pocket. Each block contained two rows of inoculated and one row of uninoculated red pine, and two rows of inoculated and one row of uninoculated jack pine for a total of 1,350 each of inoculated and 450 each of uninoculated red pine and jack pine. Rows extended from the bottom of the pocket to the plain above.

Survival after 1 year included nearly the same number of red pines (648) as jack pines (680). It was presumed that spores of *G. abietina* produced on site after 2-3 years would cause infection of both healthy uninoculated seedlings and those of the inoculated seedlings which escaped initial infection. Both the procedures followed and survival 1 year after inoculation have been discussed in detail elsewhere (Dorworth, Eur. J. For. Pathol. 3:232-242, 1973) and the following deals mostly with survival of seedlings after 6 years.

A recount of survival in the fall of 1976 revealed that 103 or 6% of the red pine, and 294 or 16% of the jack pine were still alive. Most of the surviving red pine were severely deformed as a consequence of infection by *G. abietina*, and the average height was 0.7 m (range 0.3 m to 1.2 m). This species will probably be absent from the site within 5 years. Those jack pines which escaped initial infection generally exhibited adequate form and achieved an average height of 2.0 m (range 0.8 m to 2.6 m). Relatively little jack pine mortality is expected although lower branch infections will yield an unknown percentage of cankered mainstems.

Since symptoms of infection by *G. abietina* are indistinct by autumn, 210 dying branches were removed for laboratory culture on a medium consisting of 200 ml Campbell's V-8 juice: 800 ml water plus 20 g Difco agar to verify the presence of the pathogen. Of the red pine cultured, *G. abietina* was recovered from 80% of the samples taken outside the frost pocket and from 87% of those taken within, whereas *G. abietina* was recovered from 50% of jack pine samples taken outside the pocket and from only 36% of those taken within.

Neither 6% (red pine) nor 16% (jack pine) seedling survival appears satisfactory for afforestation efforts but these figures were calculated on the basis of total outplanting. If trees to which spores were directly applied in 1970 are left out of the calculations and only those which were naturally infected in the course of time by air- and water-borne spores are considered (900 original uninoculated controls), survival percentages are 23% for red pine and 65% for jack pine. These percentages are also valid since only the controls remain alive on the planting site. Direct application of spores in aqueous suspension in 1970 may in some way have circumvented the natural resistance mechanism of jack pine, and this would explain why no difference in survival was recorded in 1971. In any case, three conclusions may be drawn:

1. Jack pine is two to three times as resistant as red pine to *G. abietina* on dry sites in the Great Lakes-St. Lawrence Forest Region and the preference of provincial foresters for replanting with jack pine is entirely justified.
2. Frost damage does not alter the susceptibility of pines to infection by *G. abietina* although frost or other damaging agents may accelerate the rate and extent of ultimate tree mortality.
3. Up to 90% recovery of *G. abietina* from samples known to be infected is expected in early spring, whereas in summer when *G. abietina* is quiescent only 30-40% of such samples generally yield the fungus in culture. This implies that the fungus has resumed active growth by October and is occupying new woody tissues unaccompanied by those various fungal associates which have themselves become quiescent and now fail to compete with *G. abietina*.—C. E. Dorworth, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

Fungicide-drenches Ineffective against Damping-off of Sitka and White Spruces.—In 1971, field trials were started using seed-treatments and fungicide-drenches in an attempt to control pre- and post-emergence damping-off losses in British Columbia Forest Service (BCFS) nurseries. Reports have been prepared on the fungicide-seed treatment experiments with the major seedling species grown in B.C. (Lock, Sutherland and Sluggett, Tree Planter's Notes 26:16-18, 28, 1975) and on the use of fungicide-drenches for control of *Fusarium* root rot (late damping-off) of Douglas-fir (Bloomberg, Phytopathology 64:1153-1154, 1974). Field trial results with fungicide-drenches for control of damping-off of Sitka [*Picea sitchensis* (Bong.) Carr.] and white [*P. glauca* (Moench) Voss] spruce are reported here.

TABLE 1

Seedling emergence, damping-off losses, seedling survival and shoot lengths of Sitka and white spruce in fungicide soil-drench trials at Koksilah and Surrey nurseries.

Species, nurseries and parameters measured[a]	Treatments[b]				
	Captan 31.4 kg/ha	Captan 15.7 kg/ha	Benlate 3.9 kg/ha	Vitavax 4.4 kg/ha	Control
Sitka spruce, Koksilah					
Emergence, %	55.9aa	60.9a	61.5a	60.9a	62.5a
Early damping-off, %	0.6a	0.2a	0.0a	0.0a	0.1a
Late damping-off, %	2.5a	1.3a	1.8a	1.4a	1.4a
Survival, %	52.1a	57.5a	58.4a	57.4a	59.5a
Shoot length, cm	3.5a	3.3a	3.4a	2 8a	3.2a
Sitka spruce, Surrey					
Emergence, %	78.3ab	80.0ab	83.7a	75.5b	81.6a
Early damping-off, %	15.1ab	11.0ab	6.2c	19.2b	7.5ab
Late damping-off, %	4.8a	6.5a	2.8a	4.6a	4.3a
Survival, %	63.2a	66.5a	74.9b	55.7c	71.4ab
Shoot length, cm	2.7a	3.0a	3.1a	2.3a	2.9a
White Spruce, Surrey					
Emergency, %	69.3ab	71.5ab	74.0a	68.3b	74.5a
Early damping-off, %	9.3a	5.0ab	2.0b	6.6ab	1.6b
Late damping-off, %	4.1a	3.0a	2.9a	1.8a	3.2a
Survival, %	59.3a	64.3ab	67.3ab	61.8ab	70.7b
Shoot length, cm	1.9a	2.0a	1.9a	1.9a	2.2a

[a] Seedling emergence and survival based on number of seeds sown, early and late damping-off based on number of germinants, shoot length is soil line to base of the terminal bud.

[b] Values are means of 15 replicates; reading across, means followed by the same letter are not significantly different (P = .05).

The trials were made during the 1973 growing season at the Koksilah (near Duncan) and Surrey nurseries of the BCFS. The experimental design was a randomized complete block, with each treatment and control replicated 15 times. Within each 3.1-m-long block, each of the four treatments, and a control, were applied to randomly selected 1-m-long sections of drill rows 2, 4 and 6 (the other rows were unsown). Each 1-m-long section was sown (May 7 to 15) with 100 evenly-spaced, stratified (van den Driessche, Res. Notes No. 48, B.C. Forest Service, Victoria, 1969) seeds which were covered with 0.6 mm of coarse sand. The germination capacities of the Sitka and white spruce seeds were 82 and 78% respectively.

The fungicides, applied as drenches at 10, 20 and 40 days after seed sowing, and their application rates per ha of seedbed were: Captan 50W, 31.4 kg; Captan 50W, 15.7 kg; Benlate 50W, .9 kg; Vitavax 75W, 4.4 kg. The common and chemical names of these fungicides are given in the CFS, Chemical Control Res. Inst. Inform. Rep CC-X-19, 1975. Control plots received only the same amount of water as used for the fungicide-drenches.

Seedling counts were made 8, 16 and 20 weeks after sowing at Koksilah and after 8, 9, 10, 11, 16 and 20 weeks at Surrey to determine emergence and numbers of seedlings killed by early and late damping-off. Dead seedlings were removed from the plots when counted. The data were subjected to an analysis of variance, using the cumulated data for each parameter for the entire growing season. Percentage data were transformed when needed to correct for heterogeneity of variance. Seedling shoot height (soil line to base of the terminal bud) was measured at the end of the growing season. Treatment means were compared, using the Student-Newman-Keuls' test (Steel and Torrie, Principles and procedures of statistics. McGraw-Hill, N. Y., 1960). The effects of time and time-fungicide interactions were also determined and these data are available from the authors.

None of the treatments (Table 1) significantly affected emergence, disease or shoot growth of Sitka spruce at Koksilah. At Surrey, emergence of Sitka spruce was not improved by any of the treatments; Vitavax caused some reduction in emergence. Disease losses were greater at Surrey than at Koksilah, and Vitavax and the highest dosage of Captan tended to increase early damping-off losses. The significant (P=.05) reduction in seedling survival in the Vitavax-treated plots was probably attributable to the effect of this fungicide on reducing seedling emergence and increasing early damping-off. The highest treatment level of Captan significantly increased early damping-off incidence of white spruce at Surrey. However, no significant treatment effects were evident for the late damping-off, survival or shoot growth parameters. We conclude from these experiments that, even with repeated applications and very high dosages, the test fungicides provided no protection against damping-off of Sitka and white spruce seedlings. Perhaps drenches with these or other fungicides might be of value in nurseries where damping-off is more prevalent, but we do not recommend their use on spruce seedlings in coastal B.C. nurseries.—Jack R. Sutherland and W. Lock, Pacific Forest Research Centre, Victoria, B.C.

FIRE

Effect of Slope on Fire Spread Rate.—As interest in the prediction of actual fire spread rate increases, some way of accounting for the effect of slope is desirable. The literature contains a few references on this question, and five of these are compared here. They are:

1. Anon, 1958. Manual for forest fire control (Table 2, p. 205). Northeastern Forest Fire Prot. Comm., Chatham, N.Y.
2. McArthur, A.G. 1966. Forest fire danger meter, Mark IV. Forest Res. Inst., Forest. and Timber Bureau, Canberra.
3. Van Wagner, C.E. 1968. Fire behaviour mechanisms in a red pine plantation: field and laboratory evidence. Dep. Forest and Rural Develop. Publ. 1229.
4. Sheshukov, M.A. 1970. (Effect of steepness of slope on the propagation rate of fire.) Lesnoe Khozyaystvo 1970 (1): 50-54. Translation 185672, Forest Fire Res. Inst., Ottawa.
5. Rothermel, R.C. 1972. A mathematical model for predicting fire spread in wildland fuels. U.S. Forest Serv. Res. Pap. INT-115. Intermtn. Forest and Range Exp. Sta., Ogden, Utah.

In spite of the large number of forest fires in countries where fire research programs exist, good field observations of the effect of slope on spread rate are scarce if not non-existent. Two of these references (1 and 2) are probably based on informal field observation, although the sources are not explicit. The other three describe laboratory experiments, one of which (described in 3) was performed at this station using 1.2-m-long beds of red pine needles. No matter how carefully such lab experiments are done, however, the question remains whether the results are valid when applied to full-scale real forest fires.