BI-MONTHLY

RESEARCH NOTES

A selection of notes on current research conducted by the Canadian Forestry Service, Department of Fisheries and Forestry

BOTANY

Effect of Light Intensity on Growth of Western Hemlock and Douglas-fir Seedlings.—There is currently much interest in improving planting procedures and success through development of a system for producing high-quality container stock in as short a time as possible. The need for better knowledge of seedling growth has increased accordingly. This report describes first-year growth response of western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] and Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] seedlings when maintained under six light intensity regimes and in two soil types.

For both species, 20 plants were grown in each of the 12 treatment combinations comprising six light regimes, ranging from 10 to 100% of full natural light and two soil types. One soil was a clay-loam; the other, a mixture of equal volumes of peat moss and coarse sand supplemented with a balanced liquid fertilizer at weekly intervals. This growing-medium is commonly used for growth of tree seedlings in containers.

Green polyvinyl chloride fabric (saran cloth), woven to different densities, was used for light screens. This fabric provides a uniform diffused light. The commonly used "half shade", made from 1-inch slat tied together with wire at 1-inch spacing (snowfence), was included as a treatment. Plants under this shade are subjected to alternating low and full light (designated L/100%).

Seeds were germinated and the plants were transplanted (9 June) in the cotyledon stage into 7-inch plastic pots, five plants to a pot, then kept under 50% of full light for 1 week. Light effect on seed germination was not included in the study. On 17 June, screens giving the desired degrees of shading were placed about 12 inches above different groups of seedlings. However, the 50% screen was kept over the full-light treatment until 28 June. Although plants for the full-light treatment were shaded (50%) for about 3 weeks following germination, survival and growth following shade removal was poor, especially for western hemlock. As a substitute, some surplus plants under 50% light were moved to full light on 14 July, about 5 weeks after germination. Survival for this group was good and they were used for the full-light treatment.

The experiment was terminated 16 Sept. for Douglas-fir and 8 Oct. for hemlock, i.e., 14 and 17 weeks after germination, respectively. Soil was washed gently from the roots and the data presented in Table 1 recorded. The oven dry weight (105 C for 24 hr) was determined (Fig. 1). Only growth of the plants in the peat moss and sand mixture is given. The response to light was similar for the other soil type although growth was considerably less.

Fifty and seventy per cent light were clearly the most favorable for dry matter production of hemlock (Fig.1). There was no statistically significant difference between these two treatments except for dry matter of roots, which was greatest with 70% light. Light also affected extension growth of hemlock and 50% light provided the best condition (Table 1). For Douglas-fir, total dry matter production increased with increase in light up to 50%. Further increase to full light did not affect total production significantly, but it decreased dry weight of leaves and of stem plus branches and increased root dry weight (Fig. 1). Fifty per cent light was optimum for stem, branch and leaf elongation and production of branches of Douglas-fir, as it was for hemlock. Growth in stem diameter was not affected by light regimes be-

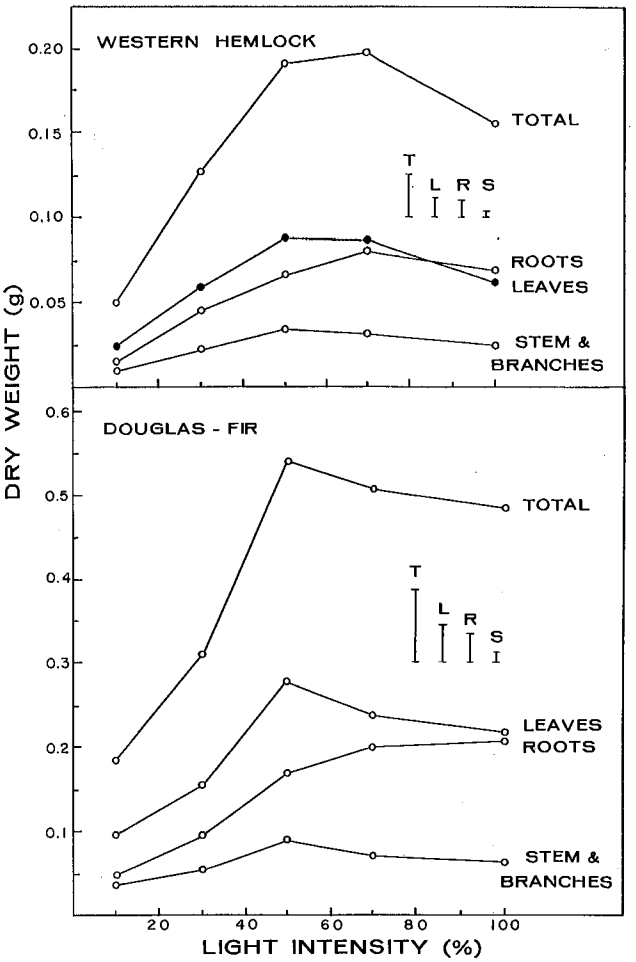

FIGURE 1. Light effect on dry matter production of leaves, roots, stem plus branches and total plant for western hemlock and Douglas-fir seedlings. Bars indicate statistically significant differences (5% level) for the different curves.

TABLE 1
Size (mm) of plant organs and number of branches of western hemlock and Douglas-fir seedlings grown under different light intensities

Light %	Stem Length	Stem Diameter	Root (longest)	Leaf Length	Leaf Width	Branch Length (longest)	Branch Numbers
W. Hemlock							
10	41	0.7	187	11.8	1.14	4	2.2
30	56	0.9	217	13.6	1.31	16	3.7
50	67	1.2	251	14.6	1.48	23	4.7
70	55	1.1	230	13.4	1.51	19	4.3
100	42	1.0	249	12.2	1.29	11	3.8
L/100	63	1.1	246	14.0	1.41	20	4.4
Douglas-fir							
10	90	1.0	282	29.0	—	9	1.9
30	91	1.2	489	31.2	—	18	4.6
50	101	1.5	350	32.2	—	29	7.1
70	81	1.6	346	29.6	—	21	6.4
100	65	1.5	350	27.3	—	15	5.8
L/100	94	1.4	361	31.5	—	23	6.0

tween 50% and full light, and root elongation was greatest at 30% light (Table 1). However, a study of root elongation may be of limited significance in experiments when pots restrict root extension.

Total dry matter production for plants under fluctuating light (L/100%) was 0.17 g for hemlock and 0.457 for Douglas-fir. This is significantly lower than weights of plants grown under 50% light from shadecloth. Stem length and diameter and number and length of branches were also slightly smaller (Table 1).

In the study area (Victoria, B.C.), where skies are mostly clear during the summer, growth was best during the first season for both species under 50 to 70% of full light. Full light should not be given until 5 weeks after germination or after mid-July, since poor survival and growth would result, especially in hemlock. Even with full light after this time, as was the case with the full-light treatment in this study, some reduction in growth will result for both species. But whether this light condition will produce seedlings better adapted to high light intensity in the field remains to be studied.—H. Brix, Forest Research Laboratory, Victoria, B.C.

ENTOMOLOGY

Susceptibility of Spruce Budworm to Pure Nuclear Polyhedrosis Virus (NPV) Sprays.—The spruce budworm [*Choristoneura fumiferana* Clem.] has been shown to be more susceptible to pure NPV than to NPV mixed with a cytoplasmic polyhedrosis virus (Bird, Can. Entomol. 101: 1269-1285, 1969). This paper presents preliminary results of a study to determine effective viral concentrations of suspensions, the larval stage or stages most susceptible to viral sprays, and whether or not sprays can be effectively applied as the larvae are emerging from overwintering hibernacula (second instar).

Based on quantitative laboratory studies, suspension containing 1 g of pulverized, freeze-dried, virus-infected larvae (about 80 sixth-instar larvae) in 1,000, 10,000 and 100,000 ml of water were selected for field trials. Freeze-dried larvae were chosen because such material is very easily processed and may be stored for several months at room temperatures without serious degradation.

The test site was 5 acres of white spruce [*Picea glassca* (Moench) Voss] 6-12 ft high, near Iron Bridge, Ont. The trees were heavily infested. The budworm population showed no evidence of viral disease but about 2% were infected with microsporidia. About 10% of the larvae and up to 60% of the pupae were parasitized. Predaceous insects, particularly ants, appeared to be numerous. The possibility of viral transmission by parasites and predators, therefore, appeared to be good.

Spraying commenced on May 9, soon after the first larvae were observed emerging from hibernacula, and continued every second or third day thereafter until June 16, about 1 week before pupation commenced. Each tree received only one application. Samples consisting of 20-30 larvae were taken periodically. From each larva smears were prepared and examined under the phase-contrast light microscope for symptoms of disease. A single infected cell was accepted as proof of virus infection.

Figure 1 shows the results obtained on second-instar larvae. Disease appeared 20-29 days after the trees were sprayed. Figure 1C shows two peaks of infection: the first (40% infection) occurring after 32 days, the second (66% infection) about 22 days later. The first was due to virus sprayed on the foliage (primary infection), the second is attributed to transmission of virus from diseased to healthy larvae (secondary infection). Thus it appears that 40% primary infection is sufficient to initiate an epizootic, whereas primary infection of 20% (Fig. 1B) was not.

Primary infections of similar magnitudes were obtained from sprays applied until June 9. At this time, about 50% of the larvae were in the third instar, 40% in the fourth and 10% in the fifth instar. Incubation periods decreased quite consistently from the 20-29 days required for sprays on May 9 to 11 days for sprays on June 9. This was due mostly to a gradual increase in temperature. (The maximal/minimal temperatures on May 9 were 53° and

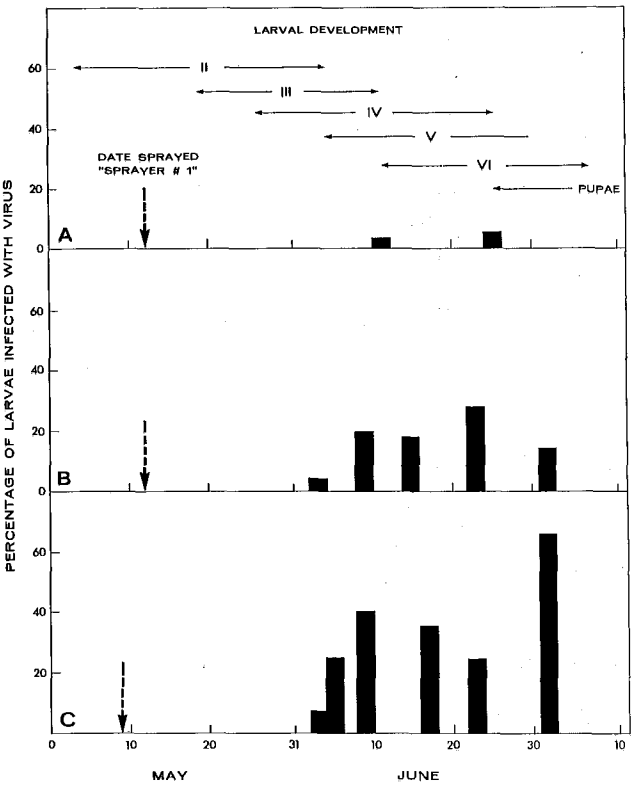

FIGURE 1. Virus infection resulting from the dissemination of NPV in water suspension: (A) 1 g/100,000 ml; (B) 1 g/10,000 ml; and (C) 1 g/1,000 ml sprayed at the rate of 50-100 ml per 6-12 ft. tree.

37°F and on June 9, 70° and 46°F). It was also due to some extent to adjusting the sprayer to yield larger spray droplets which increased percentages of infection to 75% from sprays with 1 gm of virus material in 1000 ml of water and to 54% from sprays with 1 gm of virus material in 10,000 ml of water.

These results suggest that epizootics can be induced by viral sprays applied when budworm populations are emerging from hibernacula. At this time, a primary infection of 40% would be sufficient to initiate a secondary infection of epizootic proportions through natural transmission of the virus.—F. T. Bird and J. R. McPhee, Insect Pathology Research Institute, Sault Ste. Marie, Ont.

Host Characteristics, Brood Density and Size of Mountain Pine Beetles Emerging from Lodgepole Pine.—Fecundity and rate of oviposition of the mountain pine beetle *Dendroctonus ponderosae* Hopk. are strongly related to female size (Reid, Can. Entomol., 94:605-613, 1962). This paper reports the relationship of tree diameter, height and aspect on the stem, bark thickness, moisture content of the outer sapwood, and brood density to the size of mountain pine beetles emerging from lodgepole pine *Pinus contorta* Dougl. var. *latifolia* Engelm. in southeastern British Columbia. The relationship between height on the stem and the size of attacking beetles was also investigated.

Adult beetles were collected from the bottom 20-ft sections of 22 infested lodgepole pine trees in 1967, 1968 and 1969. Three trees were sampled in 1967, 9 in 1968, and 10 in 1969; all trees were located in the same experimental area. From all of the 1967 and three of the 1968 sample trees, the beetles were hand-collected from beneath circumferential strips of bark about 10-inches wide, which were removed at 2-ft intervals on the stem starting from 2 ft above the ground up to 20 ft. Sampling commenced when about 95% of the beetles had matured. From the remaining 16 trees, emerging beetles were collected in special traps (Safranyik and Jahren, Bi-mon. Res. Notes, 26:10-11, 19, 1970) attached to