THE RELATIVE EFFICIENCY OF THREE HARE- REPELLENTS IN PROTECTING DOUGLAS-FIR SEEDLINGS¹

By J. WALTERS and J. SOOS²

J. Walters was born in England in 1921. After serving with the British Army from 1939 to 1941 and the Royal Air Force from 1941 to 1946 he attended the University of British Columbia and was granted a B.Sc.F. in 1951 and an M.F. in 1955. He was employed by the Forest Biology Division at Vernon from 1951 to 1956. Since 1956 he has been Research Forester at the University of British Columbia Research Forest, Haney, B.C.

Joseph Soos was born in Hungary in 1930. After graduating from Sopron University in 1953 with the degree of Forest Engineer, he was employed by the Hungarian Forest Service. He came to Canada in 1957 where he attended the University of British Columbia for post-graduate study. Since May 1959 he has been employed at the University of British Columbia Research Forest as Assistant-to-the-Research Forester.

ABSTRACT

Damage to plantations by animals is often serious. In the Douglas-fir region, damage by hares is particularly severe. Following extensive damage to Douglas-fir plantations on the University of British Columbia Research Forest, Haney, B.C., by varying hares, three repellents were tested. This paper describes the nature of the damage and assesses the relative efficiency of repellents tested in terms of the protection afforded to treated seedlings.

INTRODUCTION

The success of planting is limited by agencies causing injury or mortality. Although seedlings cannot be protected from some injurious agencies (particularly climatic extremes) numerous studies have demonstrated effective means of controlling others. Animals frequently cause damage to plantations. Wimmer-v Furst (1924) recommended fencing plantations in Germany to prevent damage by hares. Hawley and Lutz (1943) referred to damage to plantations caused by mice, rabbits, and squirrels in Connecticut. Kummel, Rindt, and Munger (1944) stated "The archenemies of plantations in the Douglas-fir region are the brush rabbit, the snowshoe hare, and the mountain beaver." To these the Pacific Northwest Douglas-Fir Second Growth Management Committee (1947) added ground squirrels and gophers. Rudolf (1950) listed snowshoe hares, rabbits, cattle, and deer as cause of damage in the Lake States. In Hungary, Bencze (1952) recommended the use of natural predators and chemicals in the protection of plantations from rabbits. Haracsi (1953) described the damage done by hares in Hungary.

The literature on the subject of animal damage to plantations is universal and voluminous. However, it is to the capacity of hares and rabbits to cause more damage than any other animal group that the literature bears the most consistent witness. Cook and Robeson (1945), working in New York, showed that hares killed white pine, red pine, and white spruce under four feet in

¹ Research Paper 37, The Faculty of Forestry, University of British Columbia, Vancouver 8, B.C.

² Respectively Research Forester and Assistant-to-Research-Forester, U.B.C. Research Forest, Haney, B.C.

height. Hildreth and Brown (1955) emphasized that "perhaps no other part of the United States has suffered greater loss from rabbit damage to woody plants than the western half of the Great Plains." Rudolf (1950) stated "The animal most destructive to forest plantations in the Lake States is the snowshoe or varying hare. During periods of peak population these animals practically preclude planting in certain areas." Rudolf referred to a 24-year-old plantation of white and red pine that had an average height of little more than one foot as a result of damage by hares. Moore (1940) reported that, in a Douglas-fir plantation in Oregon, 38 percent of the seedlings were cropped by the varying hare within a month and 94.4 percent within the first year. Of the injured trees, 35 percent were fatally cropped. In Great Britain, the Forestry Commission (1943) stated "It is, of course, absolutely essential to fence securely against rabbits. . . . One rabbit may do ten pounds (Sterling) worth of damage in a night."

In North America the word "rabbit" is often used to refer collectively and indiscriminately to the species and subspecies of *Lepus* (Hares) and *Sylvilagus* (Rabbits), all of which comprise the Rabbit family. The varying hare or snowshoe rabbit is an example of confused terminology. The animal is a hare, *Lepus americanus* (Cowan and Giguet, 1956). Other members of the Rabbit family in North America include the antelope jackrabbit, white-tailed jackrabbit, black-tailed jackrabbit, and introduced European hares, all of the genus *Lepus*, and cottontail, marsh rabbit, and pygmy rabbit, of the genus *Sylvilagus*.

This paper refers to the damage to Douglas-fir plantations on the University of British Columbia Research Forest, Haney, B.C., caused by the varying hare. The nature of the damage is described and the efficiency of three animal repellents is assessed in terms of the degree of protection afforded to the seedlings.

LOCALITY

The University of B.C. Research Forest consists of 9,774 acres situated in the Fraser Valley four miles north of Haney and 35 miles east of Vancouver, B.C. (U.B.C. Forest Committee, 1959). Elevations range from sea level to 2,600 feet. The area is situated within the Southern Coast Section (C2) of Rowe's (1959) Forest Regions of Canada and in the Coastal Western Hemlock Zone of Krajina's (1959) Bioclimatic Zones in British Columbia. The main association comprises the two coastal dominants, western red cedar, *Thuja plicata* Donn, and western hemlock, *Tsuga heterophylla* (Raf.) Sarg. in combination with Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.

NATURE AND OCCURRENCE OF HARE DAMAGE

The varying hare damages seedlings by severing the leader and/or the lateral shoots as shown in Figures 1, 2, and 3. The cut surface of the stem or branch has the appearance of having been cut with a knife or shears. In this way the damage may be differentiated from deer browsing which characteristically leaves a rough, stringy surface. In this paper, the authors refer to hare damage as *clipping* to indicate the nature of the injury and to avoid con-

(See Figures on page 19)

fusion with damage caused by deer browsing. The severed portions are usually eaten, but occasionally are left on the ground. This habit may be a test of palatability or result from pure mischief (Rudolf, 1950; Hildreth and Brown, 1955). Clipping is often fatal when seedlings are severed near the root collar. The incidence of mortality varies with condition and size of the seedlings and their ability to recover, and the habit of the species of hare. Nevertheless, the effect on the form and height growth of the seedling is serious (Figure 4). Other types of damage have been reported (Hildreth and Brown, 1955) but all clipping observed by the authors on the University Forest is consistent with the description and figures in this paper.

Attacks seem to be heaviest immediately following planting, but continue throughout the year. Seedlings on the University Forest have been clipped within two days of planting. The leaders of young trees have been clipped occasionally at a height of three feet when hares stood on logs. Severe clipping has followed snow which covered other food plants but enabled the hares to reach the terminal shoots of young trees.

The search for protective measures on the Research Forest was prompted by annual seedling tallies showing from ten to 50 percent of the seedlings clipped by hares. Control measures tested elsewhere have included: (1) destruction of the hares; (2) fencing; and (3) coating plants with repellent materials. Probably the cheapest protection is provided by chemical repellents applied to the seedling, particularly when the chemical can be applied in the nursery beds.

REPELLENTS TESTED

Many materials have been tested in other studies of repellents. Hildreth and Brown (1955) described many materials including gunpowder, dunghill drainings, putrescent flesh, and an ingenious mixture of ox-blood, dog dung, and warm water. These materials, fortunately, are considered to be less effective than the three chemicals tested in this study that are described below:

- 1) TN 2500 — 5 percent (E14786.2); a proprietary compound made by Panogen Incorporated, Ringwood, Illinois.
- 2) Nicotine-asphalt emulsion, with Triton X151 and Triton X171 as stabilizer and spreader, containing a minimum of 3.63 percent nicotine.
- 3) Tetramethylthiuram disulphide (TMTD)—asphalt emulsion, with Triton X151 and Triton X171 as stabilizer and spreader, containing a minimum of 7.27 percent active ingredient.

METHOD

The study area was logged in 1955 and 1956 and then cleared of light slash by piling and burning. Brush areas were sprayed with 2,4-D and 2,4,5-T in diesel oil to kill vine maple, salmonberry, elderberry, and huckleberry. In addition to these plants, the area supported dense patches of fireweed and pearly everlasting.

The Douglas-fir seedlings were 2-0 stock when planted in March 1959. The basic design of the experiment was a block with 4x4 Latin-square arrangement of 16 plots with each plot representing a different provenance. (At the time the study was made only 14 of the plots had been planted.) Spacing of

Fig. 5. The influence of animal repellents on percent seedlings clipped on three dates.

Fig. 6. Relative percent change in seedlings clipped

seedlings was 8 feet by 8 feet and each plot contained 121 seedlings. The design was replicated on a contiguous area (Blocks A and B) and replicated twice more (Blocks C and D) approximately 2,000 feet distant. The plantations were established as part of a cooperative study of Douglas-fir provenance. The repellent applications were, therefore, primarily protective and secondly experimental.

Average applications on nursery beds spray approximately 50,000 seedlings with 10 gallons of formulated repellent. In this study 2 gallons of repellent per 1,000 seedlings were applied by brush.

The repellents were applied in August 1959 to plots, selected at random, each containing 121 seedlings. Controls were untreated and consisted of a 33-foot-wide strip along the boundaries of the plantations. A total of 56 plots containing 6,776 seedlings was treated with repellents. Clipping was assessed by tallying 49 seedlings in each plot at the time the repellent was applied and in May and October of 1960. The tallies included only fresh clipping. In the case of the latter two tallies, only seedlings clipped subsequently to the preceding tally were counted.

RESULTS

The percentages of seedlings clipped for each treatment are summarised in Table 1 and shown graphically in Figure 5. On the basis of the percentages clipped (Table 1) it appears that the experiment was made in a period when the population of hares was expanding. Total feeding in May 1960 was slightly higher than in August 1959 and by October 1960 had increased by about 50 percent.

The three repellents were of approximately equal efficiency in depressing the level of clipping, although the percentage decrease in seedlings clipped was greatest for seedlings treated with TMTD and least for seedlings treated with nicotine. The considerable increase in the proportion of seedlings clipped in the control during May 1960 is probably due to a local migration of hares away from the repellent-treated areas and also to a population increase. Differences in the percentage of seedlings clipped between control and treatments over time indicate a decreasing, but still significant, level of protection that lasts for at least 14 months after treatment. Figure 6 shows the relative percentage change in clipping frequency with that of August 1959 as the standard. From this histogram it appears that the persistence of the repellents varied in the same order as their relative efficiency during the first nine months, viz. TMTD, TN-2500, and nicotine. The repellents provided complete protection only to that portion of the seedling covered by repellent. New growth, appearing after the repellent was applied, was clipped with increasing frequency as the repellent became weathered.

CONCLUSION

Applications of tetramethylthiuram disulphide-asphalt emulsion, the proprietary mixture TN-2500, and nicotine-asphalt emulsion, to Douglas-fir seedlings reduced clipping by varying hares. No ill effects from the applications were observed. The relative efficiency in terms of immediate and continuing protection for up to 14 months was in the order listed above. Under the conditions of this study on the University of British Columbia Research Forest,

TABLE 1
NUMBER AND PERCENTAGE OF SEEDLINGS CLIPPED BY HARES BY TREATMENT

Treatment													
Blocks	Tally	TMTD			Nicotine			TN-2500			Control		
		Aug.	May	Oct.	Aug.	May	Oct.	Aug.	May	Oct.	Aug.	May	Oct.
		1959	1960	1960	1959	1960	1960	1959	1960	1960	1959	1960	1960
No. Freshly													
A and B	Clipped	42	18	40	51	54	112	23	12	26	18	74	83
	Total	539	539	539	686	686	686	147	147	147	198	207	195
	%	7.8	3.3	7.4	7.4	7.9	16.3	15.6	8.2	17.7	9.1	35.7	42.6
No. Freshly													
C and D	Clipped	37	6	43	81	15	59	11	0	12	24	36	66
	Total	637	637	637	686	686	686	49	49	49	142	89	151
	%	5.8	0.9	6.8	11.8	2.2	8.6	22.4	0	24.5	16.9	40.4	43.7
No. Freshly													
A, B,	Clipped	79	24	83	132	69	171	34	12	38	42	110	149
C and D	Total	1176	1176	1176	1372	1372	1372	196	196	196	340	296	346
	%	6.7	2.0	7.0	9.6	5.0	12.5	17.3	6.1	19.4	12.3	37.2	43.1

MARCH, 1961

annual applications are necessary for satisfactory protection until the seedlings outgrow the reach of hares. The planting of small seedlings aggravates this requirement.

In view of the large proportion of seedlings clipped one year after treatment and the expense of subsequent field applications of repellents, this system of protection is considered inadequate. The use of repellents should be supplemented with other protective measures. The planting of large seedlings is an obvious, if partial, solution. The varying hare is preyed upon by nearly all species of carnivorous mammals as well as by hawks and owls. The encouragement and protection of the natural predator population should be a function of the forester in the local areas in which the success of plantations is jeopardized by hares.

LITERATURE CITED

- BENCE, L. 1952. Vadgazdasagtan. Mezogazdasagi Fordito Iroda, Budapest. 1-12.
- COWAN, I. M. and C. J. Giguet. 1956. The mammals of British Columbia. Handbook No. 11. British Columbia Provincial Museum, Victoria, B.C. 413 pages.
- Douglas-Fir Second Growth Management Committee. 1947. Management of Second-growth forests in the Douglas-fir region. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon. 151 pages.
- Forestry Commission. 1943. Forestry practice. Bulletin No. 14. H. M. Stationery Office, London, W.C. 2. 99 pages.
- HARACSI, L. 1953. Erdovedelemtan. Mezogazdasagi Kiado. Budapest. 138-148.
- HAWLEY, R. C. and H. J. LUTZ. 1943. Establishment, development, and management of conifer plantations in the Eli Whitney Forest, New Haven, Connecticut. Bulletin No. 53. Yale University, New Haven, Conn. 81 pages.
- HILDRETH, A. C. and G. B. BROWN. 1955. Repellents to protect trees and shrubs from damage by rabbits. Tech. Bulletin No. 1134. U.S. Dept. of Agriculture, Wash. D.C. 31 pages.
- KRAJINA, V. J. 1959. Bioclimatic zones in British Columbia. Bot. Series No. 1. University of B.C. Vancouver, B.C. 47 pages.
- KUMMEL, J. F., RINDT, C. A. and T. T. MUNGER. 1944. Forest planting in the Douglas-fir region. Forest Service. U.S. Dept. of Agriculture, Portland, Oregon. 154 pages.
- MOORE, A. W. 1940. Wild animal damage to seed and seedlings on cut-over Douglas-fir lands of Oregon and Washington. Tech. Bulletin No. 706. U.S. Dept. of Agriculture, Wash. D.C. 28 pages.
- ROWE, J. S. 1959. Forest regions of Canada. Bulletin No. 123, Forestry Branch, Canada Dept. of Northern Affairs and National Resources, Ottawa. 71 pages.
- RUDOLF, P. O. 1950. Forest plantations in the Lake States. Tech. Bulletin No. 1010. U.S. Dept. of Agriculture, Wash. D.C. 171 pages.
- U.B.C. Forest Committee, 1959. The first decade of management and research—U.B.C. Forest, 1949 - 1958. Faculty of Forestry, U.B.C. 82 pages.
- WIMMER-v. FURST. 1924. Die Lehre vom Forstschutz. Berlin. Verlagbuchhandlung Paul Parey. 120-126.