PHYSICAL VERSUS CHEMICAL MEANS OF DETERRING BROWSING OF DOUGLAS-FIR BY BLACK-TAILED DEER [1]

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Winter browsing on newly established Douglas-fir *(Pseudotsuga menziesii* var. *menziesii)* plantations by black-tailed deer *(Odocoileus hemionus columbian*us) can contribute toward inadequate stocking in young plantations. Before the first growing season after outplanting, browsing deer are capable of pulling 2-0 seedlings from the ground. The incidence of such removals increases in areas of coarse-textured soils and with repeated seedling browsing on overstocked deer ranges. Previous work [3] has shown that with heavy browsing pressure, deer have pulled from 15 to 20 percent of all browsed seedlings from the ground and under extreme conditions, losses have amounted to 10 percent of the total plantation. Such mortality, when combined with that from all other causes, can result in inadequate plantation stocking by the end of the first growing season. Removal of seedlings by browsing deer is uncommon after 1 year of root growth and soil compaction.

The purpose of the investigation [4] was to compare the efficiency of the best of three terminal leader envelopes with the commercially prepared contact repellent TMTD[5] in discouraging browsing of terminal leaders on 2-0 Douglas-fir plantations during the winter of outplanting.

The technique of using plastic sheeting to shield seedlings from animal browsing has previously been used by McNeel and Kennedy (1959) to protect *Pinus strobus, P. resinosa,* and P. *banksiana.* Mason and Davidson (1964) used perforated polyethylene tubing to shield pine seedlings from rabbits during the winter after outplanting.

Methods

Three types of terminal bud protectors were initially tested in the winter of 1959-60 to determine if

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3 Unpublished data on file.

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5 Tetramethyl thiuram disulfide.

Douglas-fir could be protected from browsing ofterminal leaders during the first winter after planting.

Fiber glass window screen, 2 mm. Saran plastic, and 5 nun. translucent polyethylene sheeting, were used.

The fiber glass screen material was folded into isosceles triangles approximately 2 inches across the base and 1 inch high. A soldering iron was used to fuse the edges along the two equal-length sides. The caps were placed over terminal buds so that the surrounding needles projected through the screen mesh to hold the protector in position.

A single thickness of Saran or polyethylene materials was folded around the terminal leader of the seedlings to form an envelope surrounding the terminal 2 inches of leader growth. A wire paper staple secured envelopes to trees joining both ends of the plastic and entrapping several adjacent needles.

Forty randomized blocks of 20 trees each were established in March 1960. Each block contained six trees of each treatment and two untreated seedlings.

Tests during the winter of 1962 and 1963 were moved into a 3-7 acre deer enclosure, where the number of deer using the plantations could be regulated.

The enclosure contained deer habitat that developed following the 1945 Tillamook Burn and subsequent salvage logging activities. Vegetation was characteristic of that described as the *Acer circinatum/ Polystichum mnunitum* associated by Bailey and Poulton (1968). A detailed description of the habitat, forage availability, and deer use within the enclosure was reported by Crouch (1966), who conducted a concurrent study.

Enclosure tests were designed to compare the relative effectiveness of a previously-tested polyethylene physical protector and the chemical contact repellent TMTD in deterring terminal leader browsing on Douglas-fir.

Twenty replications of 30 Douglas-fir 2-0 seedlings per block were established with 200 trees in each of the physical, chemical, and control groups. Each treatment was represented by a row of 10 trees within each block.

High pressure spray equipment was used to apply the TMTD repellent to seedlings in the nursery beds in the fall before they were lifted and bundled for outplanting. Polyethylene bud protectors were applied to unsprayed trees after planting, using the technique described for 1960 tests.

Deer were not permitted within the enclosure during the summer and fall months preceding the introduction of two animals on February 2, 1962, so that maximum amounts of native forage would be available to start tests.

Following deer introductions, weekly inspections were made for terminal leader browsing, except during periods when snow covered the plantations. The 1962 trial was terminated and the deer removed on March 28 when the forage supply was nearly depleted. No deer were permitted within the enclosure during the following 10 months to insure that maximum amounts of native forage would again be available to start 1963 tests. Two deer were again introduced on January 30, 1963. They were retained within the enclosure until May 5, 1963, when spring vegetation growth was well advanced and Douglas-fir was no longer being browsed.

During March 1963, polyethylene protectors were applied to 600 Douglas-fir seedlings to determine if the terminal envelopes affected the survival, height growth, or growth form of seedlings if they were not removed before bud burst in the spring. Protectors were applied to 100 newly planted 2-0 trees. The same number was also applied to similar stock in randomly selected rows that had been planted 1 and 2 years previously. Each of the three treatments also contained 100 untreated trees in randomly selected rows for growth comparisons. After three growing seasons, all trees were remeasured to determine what effects the protectors had upon seedling performance.

Statistical analysis of animal browsing data was by the Mantel-Haenszel (1959) method for summary of two or three contingency tables, using the normal scores (1) Thiram vs. untreated adjusted for polyethylene vs. the remainder, (2) polyethylene vs. untreated adjusted for Thiram vs. the remainder, and (3) Thiram vs. polyethylene adjusted for treated vs. untreated.

Results

The 1960 tests of the efficiency of the three physical bud protectors revealed that rodent utilization of Douglas-fir was not measurably influenced by terminal protectors (table 1). Two months after planting, 51 percent of all sample trees had their terminal leaders excised by rodents. On protected trees, the point of excision occurred below the envelope. Plant material between the base of the envelope and the clip

TABLE 1.—*Terminal browsing on protected Douglas-fir within 2 months of plantation establishment*

Treatment	Total trees	Trees terminally browsed Rodent	Deer	Rodent-browsed
	Number	*Number*	*Number*	*Percent*
Fiber glass cap	240	135	3	56
Saran sleeve	240	115	1	48
Polyethylene sleeve	240	122	1	51
Untreated	80	35	2	44

was usually consumed, leaving only a shielded part of the excised leader in the envelope near the base of the tree. Snowshoe hare *(Lepus americanus),* brush rabbits *(Sylvilagus bachmani),* and mountain beaver *(Aplodentia rufa)* are the three tree-eating rodent species inhabiting the area.

Big game animals browsed so few trees in 1960 that it was not possible to evaluate the protectors as deterrents of big game browsing.

Initial tests revealed that the fiber glass screen cap was unacceptable because 10 percent of those applied were shed within 2 months of application, and new growth beneath the remaining caps became discolored shortly after bud burst in the spring.

New terminal growth enclosed within the polyethylene and Saran envelopes was damaged if envelopes were applied so that they tightly enclosed the dormant terminal buds. Subsequent tests revealed that loosefitting polyethylene envelopes, when applied to seedlings at the time of planting and also to trees planted 1 and 2 years after planting, need not be removed before spring tree growth occurred. New growth extended out the top of the open envelopes without causing a significant difference (t values ranging from .483 with 78 d.f. to .995 with 88 d.f.) in height growth after three growing seasons.

Following 2 years of exposure, weathering of the plastic sheeting surrounding the main stem was sufficient to cause the brittle envelopes to be shed by approximately one-half of the seedlings.

Rodent Repellency

In both years, rodents began browsing Douglas-fir as soon as the 600-tree plantations were established. Most use occurred during the first 30 days of exposure (fig. 1). Apparently, rodent use of plantations declined rapidly because their movements were largely influenced by existing cover, and they were reluctant to forage into open areas where they would be more

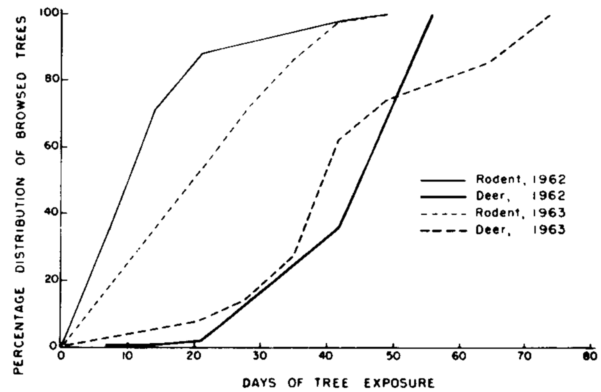

Figure 1.—Distribution of enclosure animal browsing on Douglas-fir seedlings.

conspicuous and where most predators operate with greater efficiency.

Each year, rodent browsing on terminal leaders of TMTD-treated Douglas-fir was significantly less than on untreated seedlings (table 2). Overall rodent browsing on TMTD-treated trees was also significantly less than on polyethylene-wrapped seedlings. Ambiguous results were obtained from 1962 and 1963 tests of the comparative effectiveness of rodent protection provided by the polyethylene and untreated seedlings.

Deer Repellency

Winter forage demands by enclosure deer greatly exceeded the pressure that would be expected elsewhere in the Tillamook Burn. Table 3 gives a generalized comparison of that pressure, assuming an average winter density of 64 deer per square mile in the lower elevation areas of the Burn for a 120-day winter period when most of the Douglas-fir browsing occurs.

Regardless of treatment, Douglas-fir browsing by enclosure deer rapidly accelerated both years after

TABLE 2.—*Statistical summary of treatment comparisons of the effectiveness of physical and chemical browse deterrents*

Analysis	Test	Normal score	p-value	Conclusion
1962 rodent	(1)	–4.20	< .001	Advantage for TMTD vs. untreated.
	(2)	–4.39	< .001	Advantage for poly. vs. untreated.
	(3)	.20	NS	No difference between poly vs. TMTD.
1963 rodent	(1)	–2.94	.003	Advantage for TMTD vs. untreated.
	(2)	2.80	.005	Disadvantage for poly. vs. untr.
	(3)	–5.74	< .001	Advantage for TMTD vs. poly.
1962 deer	(1)	–4.69	< .001	Advantage for TMTD vs. untreated.
	(2)	–10.74	< .001	Advantage for poly. vs. untreated.
	(3)	6.17	< .001	Advantage for poly. vs. TMTD.
1963 deer	(1)	.30	NS	No difference between TMTD and untr.
	(2)	–4.16	< .001	Advantage for poly. vs. untreated
	(3)	4.62	< .001	Advantage for poly. vs. TMTD

TABLE 3.—*Comparison of deer foraging pressure within and adjacent to a 3-acre test enclosure*

Location	Population	Winter deer-days use	Winter deer density
Tillamook Burn	64 deer/sq. mile	12/acre	64/sq. mi.
Enclosure			
1962	2 deer/3 acres[1]	37/acre	197/sq. mi.
1963	2 deer/3 acres[1]	41/acre	219/sq. mi.

[1] Portion of winter.

approximately 42 deer-days of forage use (fig. 2). This is equivalent to 14 deer-days-use/acre or a winter foraging pressure of approximately 73 deer/square mile. Optimum conditions were present within the enclosure since no deer use was permitted before tests began.

A rapid acceleration of conifer use in 1962 coincided with periods of snow cover that tended to conceal much of the ground forage and leave Douglasfir seedlings exposed to foraging deer. Deer continued to feed heavily upon Douglas-fir until March 28 when tests were discontinued after 56 days because a noticeable decline in the body condition of test animals had occurred. Continuation of study would undoubtedly have resulted in the death of test animals since the enclosure forage resource was obviously depleted.

Eighty-five percent of the untreated seedlings showed terminal leader deer browsing when 1962 studies were terminated. Terminal browsing on the TMTD and polyethylene-treated trees was signifi-

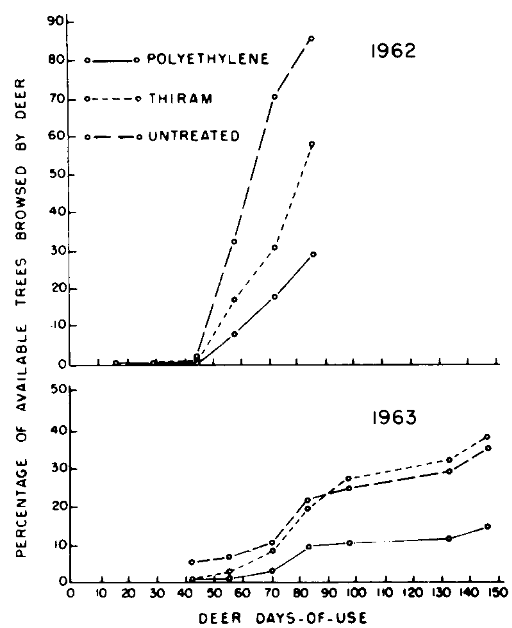

Figure 2.—Distribution of Douglas-fir browsing by treatment.

cantly less than on untreated trees, with the physical protector providing better protection than the chemically treated TMTD seedlings (table 2).

Crouch (1966) noted that compared with 1962 totals, twice as many trailing blackberry leaves were present within the enclosure when 1963 test animals were introduced. Exceptionally mild weather prevailed in 1963. No snow cover occurred and mild temperatures prompted considerable growth on winter-active grasses and forbs. Little browsing was observed on Douglas-fir during the first 25 days of exposure. The level of 1963 conifer use never approached that of 1962 even though the two test animals were held in the enclosure throughout the remainder of the winter.

Again as in 1962, the polyethylene treated trees provided significantly better protection than did either TMTD or untreated trees. Unlike 1962 results, no repellency was obtained by using TMTD to deter deer browsing.

Conclusions

Results showed that TMTD foliar repellent was effective in discouraging winter rodent use on Douglas-fir terminal leaders for at least 2 months after outplanting. Polyethylene envelopes proved ineffective in deterring rodent browsing, but they were highly effective in preventing browsing of terminal leaders by deer, even when extremely heavy deer browsing pressure was exerted on the enclosure forage supply.

Data related to the deer repelling qualities of TMTD were ambiguous so it is suggested that seedlings should be protected by a combination of TMTD and polyethylene envelopes in those areas where rodent and deer use will probably be significant. When singular use by rodents or deer is expected, either TMTD or polyethylene envelopes can be used, depending upon which type of use is expected.

The method of applying polyethylene envelopes, as used in the study, does not encourage its widespread use because of the cost of application. Further work is needed to develop rectangular pads of polyethylene leaves, held together on one edge by a nonhardening adhesive, which when individually stripped from the pad and folded around the terminal leader would secure the envelope in place and provide protection.

Treatment costs can be further pared by recognizing that the distribution of Douglas-fir browsing by the various mammals is not uniform throughout areas to be reforested. Animal needs and preferences influence their movement and distribution, which results in variations in the amount of conifer browsing across the landscape.

Costs of protecting Douglas-fir from browsing by any technique can be greatly reduced if the resource manager will apply; remedial measures only in those areas where their need is forecast.

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