Effectiveness of New Formulations of Deer Repellants Tested in Douglas-Fir Plantations in the Pacific Northwest

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*Data were collected from 25 sites west of the crest of the Cascade Mountains in Washington and Oregon. Only 14% of Douglas-fir seedlings (*Pseudotsuga menziesii *(Mirb.) Franco, treated with a powder formulation of Deer Away (putrefied egg solids) revealed browse damage by deer or elk. Of control seedlings, and seedlings treated with Repelliff (a 1:1 mix of epi-dihydroandrosterone and androsterone), and Repelliff placebos, 42, 38, and 40%, respectively, were browsed.* Tree Planters' Notes 38(3):22-25; 1987.

Animal damage to conifer seedlings is the leading cause of plantation failures in Oregon (2). Deer have proven to be a major deterrent to reforestation because of their widespread occurrence, mobility, and freedom from natural predators. In Oregon, damage by deer currently costs the forest industry millions of dollars annually (1,2).

Deer inflict damage by browsing and occasionally trampling seedlings and stripping their bark off. They may do this at specific times of the year or continually throughout the year. However, in most areas of western Oregon, damage occurs only in the brief period following bud flush when conifer foliage is nutritious, palatable, and tender (4).

There is a wide variety of approaches to protecting seedlings from browsing deer, but few are both effective and reasonably priced (3). The most frequently chosen approach in the Pacific Northwest has been using staked Vexar tubes, which costs more than $225 per acre. Recently, budcaps (of waterproof paper or spun polyester) were shown to be as effective as Vexar tubes at one-third the cost (4).

A repellant made from putrefied egg solids is available commercially in three formulations. Big Game Repellant (BGR), which costs $20 to $40 to apply, is premixed by the distributor. It must be applied within 2 to 3 days of shipment to minimize deterioration of the active ingredient. Deer Away-L is storeable, can be mixed on site as weather conditions permit, and costs about $50 to $60 to apply. Both liquid formulations must be applied to dry tissue. A powdered formulation, Deer Away-P, was developed for use during wet weather conditions. The cost is $40 to $50 and application requires damp tissue.

All formulations are effective, but they last only 8 to 12 weeks. Plantations frequented by large populations of deer and elk throughout the year may require two to three applications to insure that browsing is prevented. However, in most areas, browsing damage is confined to a 3- to 4-week period following bud flush in the spring.

Seeding new plantations with alternative forage plants costs about $110 per acre but has only been quantitatively assessed on Northwest forest sites not limited by moisture or nutrients (7).

Exclusion fencing in forested areas is very costly and can only be justified for small, high-value operations such as local nurseries, seed orchards, and progeny test sites. The remaining approaches are either only marginally effective (hunting, planting larger seedlings, planting unpalatable seedlings, etc.), very costly (trapping), or impractical for most owners (clearcuts larger than several hundred acres) (3).

In this study, we compared a repellant currently being marketed in Norway, Repelliff (epi-dihydroandrosterone and androsterone in a 1:1 mix), with a powdered formulation of Deer Away. Our purpose was to test their efficacy and to develop general guidelines and specific criteria for their use. Repelliff was evaluated because of its reported efficacy (5,6) as a perimeter repellant of Norwegian red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), and be-

cause an effective perimeter repellant would greatly reduce material and labor costs.

Materials and Methods

Six study regions were selected within the Pacific Northwest: the Oregon Coast Range, Northwest Oregon, Southwest Oregon, Eastern Oregon, the Cascade Range, and the Olympic Peninsula (fig. 1). The experimental design was a randomized complete block. In each region, clearcut units of 30 to 50 acres were chosen. Each unit contained four 5-acre plots separated by a 200-ft buffer. The treatment for each plot was either Repelliff, Repelliff placebo, Deer Away, or control.

The units were all in close proximity to preferred deer/elk habitat (water, food, temperature, and cover) to optimize the potential for browse damage. The 5-acre plots were established on existing 1-yr-old plantations or on units planted to Douglas-fir in the winter of 1983-84. All study plots were established before bud swell in the spring. However, Deer Away was not applied until after bud flush because it must be placed on new foliage to be effective. Data were collected in the late summer and fall of 1984.

The powdered formulation of Deer Away was tested. A small quantity was sprinkled on

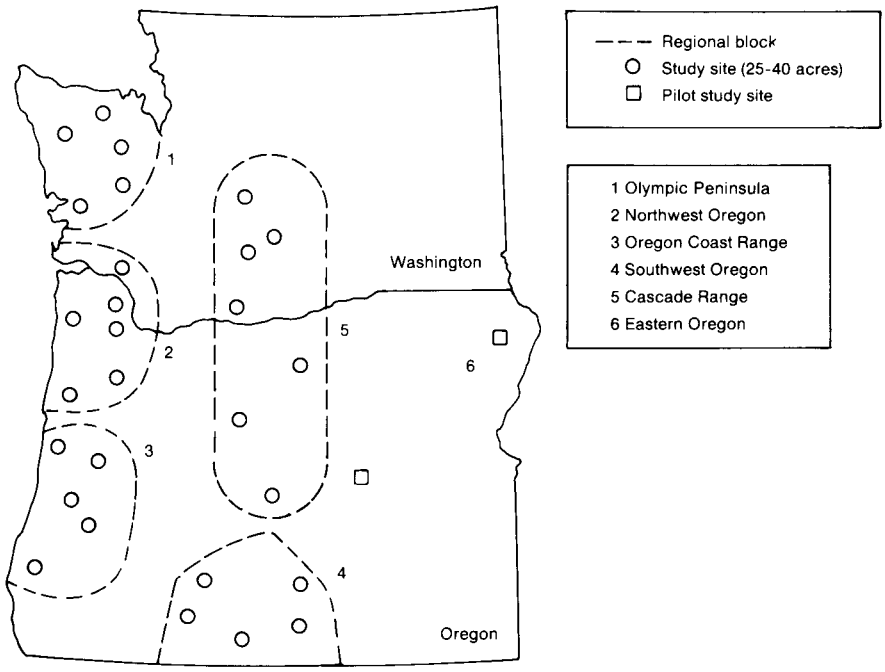

Figure 1—*Location of study regions and sites.*

moistened (naturally or artificially) foliage of emerging terminal leaders. The powder has a hydrophobic (water-repellent) coating to make it adhere to the leaf cuticle. If overapplied, however, it will bind to itself following the first rainy period and form a slimy globule that slides off the terminal without providing protection.

Repelliff was tested as a perimeter repellant. Ten milligrams of each component sterol was incorporated into micropore plastic strips. The concentration of each sterol was 0.12% of the dry weight of the plastic strip. The plastic strips measured about 12 in. long and were consolidated into tassles of about 40 strips. Each tassle was affixed to a 4-ft-long bamboo stake; and the tassled stakes were distributed at 20-ft intervals around the perimeter of a 5-acre plot. The placebo tassles were prepared and installed in the same manner, but contained no sterol mix.

The incidence of browsing on seedlings within each of the treatments was randomly sampled using a sampling intensity of 25%. Seedlings treated

with Deer Away were also evaluated for any visual indication of toxicity. Analysis of variance was performed for each region separately and for all regions together.

Results

Browse damage to seedlings protected by Deer Away was significantly lower than that observed for seedlings subjected to control, placebo, or Repelliff treatments (table 1). No visual signs of toxicity (needle discoloration or formation of stress needles) were observed on seedlings treated with the powder formulation of Deer Away. Powder granules were observed on needles 9 to 11 weeks after application, even though most of the regions experienced strong winds and heavy rain during this time. The Repelliff "fence" was unsuccessful in preventing deer or elk from entering the plots. Deer or elk signs (scat and tracks) were observed on all study sites, and on a few sites, Repelliff tassles actually showed signs of chewing.

All six regions showed similar results (table 1). Most of the sites in the Oregon Coast Range showed signs of both deer and elk. Plots in the Northwest Oregon region showed average browse damage; the 22% for Deer Away could be as low as 13% if missing data calculations are excluded from the analysis (table 1). Damage by elk appeared to be higher in this region, relative to the others, possibly due to the proximity of the sites to a large elk refuge.

Table 1—*Browse damage on 1-year-old Douglas-fir planted in winter 1983–84 and treated with various repellents*

	Percent seedlings browsed			
Site & ownership	Repelliff	Placebo	Deer Away	Control
Oregon Coast Range	40 ± 33 a	45 ± 31 a	10 ± 9 b	48 ± 20 a
Philomath (WI)	38	59	25	52
Alsea (SF)	97	88	12	78
Alsea (FS)	26	37	8	47
Hebo (FS)	29	39	5	38
Coos Bay (BLM)	11	3	0	24
Northwest Oregon	54 ± 19 a	46 ± 31 a	22 ± 14 b	61 ± 17 a
Knappa (BC)	25	15	2	36
Knappa (OR)	45	61	17	81
Elsie (CZ)	74	54	39*	70
Vernonia (CZ)	67	42	31*	62
Cathlamet (CZ)	58	60	19	58
Southwest Oregon	36 ± 29a	38 ± 33a	9 ± 9a	29 ± 25 a
Medford (BLM)	62	53	5	43
Butte Falls (FS)	5	0	0	0
Galice (FS)	40	60	21*	43
Eastern Oregon				
Enterprise (BC)	28	22	0	24
Cascade Range	36 ± 21 a	37 ± 26 a	19 ± 19 a	34 ± 34 a
Mehama (BC)	14	32*	3	53
Mehama (PP)	67	80	45*	67
Mehama (LF)	40	57	40	24
Sweethome (FS)	18	8	6	4
Blue River (RL)	24	22	4	50
Wind River (FS)	55	24	17	23
Olympic Peninsula	28 ± 22 a	36 ± 30 a	8 ± 8 b	35 ± 15 a
Aberdeen (ITT)	39	71	21	55
Aberdeen (W)	22	46	7	42
Quinalt (FS)	7	1	2	33
Forks (ITT)	61	53	8	33
Hoodsport (FS)	10	8	3	13
Overall	38 ± 24 a	40 ± 25 a	14 ± 13 b	42 ± 21 a

FS = USDA Forest Service, BLM = USDI Bureau of Land Management, OR = State of Oregon, BC = Boise Cascade, CZ = Crown Zellerbach, ITT = ITT Rayonier, LF = Longview Fiber, PP = Publishers Paper, RL = Roseburg Lumber, SF = Starker Forests, W = Weyerhaeuser, WI = Willamette Industries. Values (± standard deviation) in a row followed by different letters differ significantly at the 1% level.

*Some sites did not provide information on all treatments, although calculations incorporated estimations for missing data analyses (note the conservativeness of this technique). Other sites, however, did not provide enough valuable information to be included in the statistical analysis. Some of the reasons for this were a) no browsing encountered, b) Deer Away application too late or inappropriate, and c) Repelliff and/or placebo tassels were destroyed by animals or wind.

Elk also appeared responsible for a significant component of the damage occurring in the Olympic Peninsula. Although the Repelliff did maintain damage below the level for controls on two sites in this region, it was still not as effective as Deer Away. Six of the nine sites in the Cascade Range were browsed; the other three, all in Washington, showed no evidence of spring browsing. Only three of the six sites from the Southwest Oregon region provided reliable data; the 9% for Deer Away could be as low as 2.5% if missing data calculations are excluded from the analysis (table 1). One of the two pilot sites in Eastern Oregon yielded reliable data and showed no damage to seedlings treated with Deer Away.

Discussion

The powder formulation of Deer Away was very effective in preventing browse damage by deer and elk unless applied improperly. The powder is easy to overapply. It is very hydrophobic to facilitate strong binding to the waxy leaf cuticle. When a lightly dusted leaf is moistened by rain or by water from a spray bottle (for applications during dry weather), the particles bind tightly to the leaf as the water film evaporates. However, if needles are too heavily dusted, subsequent rainy periods may induce formation of a powdery globule. The globule slips from the terminal, and protection is lost. This happened in all Deer Away plots experiencing browse damage greater than 20%.

The poor performance of the Repelliff, relative to that demonstrated in Norway, is puzzling. The concentration of the sterol mix and the spacing of tassles around the unit are identical to the conditions that were effective in Norway. The frequency of contact with humans and the behavior of the deer and elk towards humans appears similar to that observed in the Pacific Northwest. Feeding of deer and elk by humans occurs in the more populated areas of Norway just as it does in the Northwest. Hunting pressure in Norway appears similar for roe deer (1 month) but slightly more intensive for red deer (3 months).

It appears likely that there are behavioral or physiological differences between the deer and elk species in the two locations that account for the different response to Repelliff; these could be either qualitative (specific sterol mix) or quantitative (concentration). The low material and labor costs of Repelliff and its potential for success, based on product performance in Norway, provide strong incentive to attempt resolution of the problem, particularly if it is only a matter of increasing the concentration of the sterol mix or adjusting the mix ratio.

Regardless, the powder formulation of Deer Away is effective and can be considered a reliable treatment for browse protection.

References

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