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Evaluating SeaDust Wildlife Controllant™ as a Repellent to Reduce Deer Browse on Douglas-fir Seedlings

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ABSTRACT: Herbivory by black-tailed deer affects growth form and survival of conifer seedlings in western Oregon and Washington, especially Douglas-fir. Several deterrents have been employed to reduce damage to forest resources yet most are ineffective or cost prohibitive. Use of chemical repellents is socially appealing because they offer a potential non-lethal alternative to reduce plant damage (i.e., browse). Commercial deer repellents may employ one or more mechanisms in their formulation, which affect taste, odor, visual, and/or tactile cues when consumed by deer. I evaluated the commercial SeaDust Wildlife Controllant™ as a tool to repel black-tailed deer from Douglas-fir seedlings during spring bud burst in western Oregon (mid-May through early July), because its ingredients have the potential to employ multiple avoidance mechanisms targeted on tactile, taste, and odor cues. Evidence indicated that deer browse was affected by an interaction of treatment and site; therefore, sites were evaluated separately. Treated seedlings were browsed less by deer than untreated seedlings on 2 of 3 tree farms where percent browse ranged from 0.08%-0.17% in treated plots and 0.15%-0.37% in control plots. Browse was similar at the third tree farm (0.15%). However, number of seedlings browsed in the third tree farm was greater than one site and less than the other, suggesting that statistical significance may not represent biological significance in this study. Future research is needed to incorporate acceptable loss to browsing and cost:benefit analyses.

KEY WORDS: browse, black-tailed deer, Douglas-fir, herbivory, *Odocoileus hemionus columbianus*, *Pseudotsuga menziesii*, reforestation, repellent, seedlings, ungulates

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INTRODUCTION

Mammalian herbivores such as deer are responsible for significant damage to agricultural crops, landscape ornamentals, and timber (Kimball and Taylor 2010). Black-tailed deer (*Odocoileus hemionus columbianus*) population sizes in western Oregon are unknown and difficult to quantify due to the rugged and dense forested areas west of the Cascade crest and in the coastal range. Nevertheless, damage by black-tailed deer to forests, agriculture, horticulture, and viticulture are perceived by stakeholders as significant. Herbivory to conifers during stand initiation causes delayed growth, altered growth form, and tree mortality. Several deterrents have been employed to reduce damage to agricultural and forest resources (Nolte 1999), yet stakeholders seek better, more cost-effective solutions.

Chemical repellents offer a potential non-lethal alternative to reduce plant damage (i.e., browse) and are socially appealing to many user groups. In North America, deer (*Odocoileus* spp.) are a frequent source of wildlife damage to plants, thus most commercial repellent products are marketed to reduce deer browse. Current research suggests mammalian herbivore repellents promote feeding avoidance through four mechanisms: 1) neophobia, 2) irritation, 3) conditioned aversion, and 4) flavor modification (Wagner and Nolte 2001, Kimball and Taylor 2010). Repellents applied directly to plant tissues (i.e., contact repellents) are more effective than area repellents (Wagner and Nolte 2001, Kimball et al. 2009). Commercial deer repellents may employ one or more mechanisms in their formulation that affect taste, odor, visual, and/or tactile cues when consumed by deer.

I evaluated the commercial product SeaDust Wildlife Controllant™ (hereafter "SeaDust"; Wildlife Services Co. Inc., Olympia, WA) as a tool to repel black-tailed deer from Douglas-fir (*Pseudotsuga menziesii*) seedlings during spring bud burst in western Oregon. The ingredients in SeaDust include shellfish waste which has the potential to employ multiple avoidance mechanisms (e.g., targeted on tactile, taste, and odor cues). The observed period of deer browse during spring bud growth for Douglas-fir in western Oregon is generally mid-May through early July. Protection through this critical period will get seedlings closer to a free-to-grow condition (i.e., out of reach of browsing ungulates). The objective of this study was to advance knowledge in reducing deer herbivory during stand initiation and provide information to other stakeholder groups (e.g., Christmas tree farms, vineyards, orchards, grain fields) in the range of black-tailed deer.

METHODS

I identified 3 sites on intensively managed industrial tree farms in western Oregon between the central Willamette Valley and the Oregon Coast where black-tailed deer damage to conifer seedlings was considered high by local foresters. Within each tree farm, I chose 3-4 patches that were recently planted with Douglas-fir seedlings. Within each patch, I randomly assigned treatment and control plots of approximately ¼ ac (0.10 ha) each. Colored flagging was used to identify experimental units (individual seedlings) and distinguish between treatment and control.

All product material was provided by Wildlife Services Company, Inc. in Olympia, WA. Per label instructions, SeaDust can be applied directly to wet vegetation or with a sticker application. To maximize the chance of the repellent holding onto the seedlings throughout the study without reapplying, I used Bond® Sticker Spreader (5% latex/water sticker application; Loveland Products Inc., Greeley, CO) to allow cellulose in the formulation to set up rapidly and hold. During treatment application (19-22 May 2012), I sprayed seedlings in treatment plots with Bond® using a backpack sprayer and immediately applied SeaDust onto the terminal and lateral leaders of wet Douglas-fir seedlings by shaking it from a plastic applicator bottle. Application coincided with the normal period of spring bud burst (leader growth), a critical period in which observed browse of young conifers is highest in western Oregon. Treated and control plots were surveyed after spring bud burst (21-26 July 2012) to determine number of seedlings protected from browse. Cause-specific damage assessments followed Black (1994) and Nolte and Otto (1996). Treated and control seedlings were scored as browsed or not browsed. Browsed seedlings included those that were uprooted or had foliage removed through chewing/biting activity by deer.

I used the maximum-likelihood estimation method in the SAS (SAS Institute Inc. 2008) CATMOD procedure to test the null hypotheses that treatment (SeaDust or control) and site (tree farm) do not affect number of seedlings browsed (response variable). I used PROC FREQ in SAS to calculate simple means and ranges.

RESULTS

Deer browse was affected by an interaction of treatment and site (χ^2 = 9.6, P=0.008); therefore, sites were evaluated separately. Treated seedlings were browsed less by deer than untreated seedlings on 2 of 3 tree farms (Table 1) where browse ranged from 0.08%-0.17% in treated plots and 0.15%-0.37% in control plots. Browse was similar at the third tree farm (P = 0.4) where browse ranged from 0.14%-0.16% in treated and control plots.

Table 1. Effects of black-tailed deer browse on Douglas-fir seedlings treated with SeaDust Wildlife Controllant™ at 3 tree farms in western Oregon.

Tree Farm	Treatment	Percent Browsed	Percent Not Browsed	Chi-Square	Pr > ChiSq
23	No	0.15	0.85	7.22	0.007
	Yes	0.08	0.92		
57	No	0.37	0.63	33.97	<0.001
	Yes	0.17	0.83		
67	No	0.16	0.84	0.69	0.405
	Yes	0.14	0.86		

DISCUSSION

As repellents are not part of the natural landscape, it is possible that any repellent may deter deer, at least initially, by causing fear (neophobia) of a new sight, smell, or taste (Kimball et al. 2009). However, deer are quick to habituate to new cues and may not avoid repellents for long periods of time if there is no negative consequence (Nolte 1999). From these data, I was not able to determine if SeaDust provided negative post-ingestive feedback that reduced return visits from individual deer. However, given the difference in proportions of browsed seedlings between treated and control plots at 2 sites, one may assume that ingredients in SeaDust act as irritants or adversely modify flavor. Future research that incorporates repeated observations of deer behavior in treated and untreated plots of operational forests is needed to test these hypotheses.

Factors that motivate deer to make forage choices are difficult to interpret in captive trials, and more difficult to understand in field trials. In captive trials, Gillingham et al. (1987) found black-tailed deer foraged less on seedlings treated with gaseous selenium compounds than on untreated seedlings, when exposed to both in equal proportions simultaneously. However, in the same study, when deer had controlled access to only one treatment at a time (i.e., all treated with selenium or all untreated), they found no difference in browse damage, even in the presence of *ad libitum* daily ration of 16% protein pellets and alfalfa hay (Gillingham et al. 1987). This suggests that black-tailed deer make forage choices based on physiological needs supported by their levels of tolerance. Kimball et al. (2012) suggested that black-tailed deer used a risk-averse foraging strategy in making foraging choices among seedlings with varying levels of secondary metabolites. A plausible explanation for no difference in treatments at one site (Tree Farm 67) may be that the motivation to forage outweighed the perceived consequence of the repellent. This may have been for a number of reasons which I did not capture, including diversity of food choices and distance to alternative forage patches. Interestingly, the proportion of seedlings browsed on this site (Tree Farm 67 = 15.0%, n = 99) including treatment and control, were intermediate between the two sites that exhibited treatment effects (Tree Farm 23 = 11.4%, n = 77; Tree Farm 57 = 26.7%, n = 183). Thus, statistical relevance in this case may not capture biological significance.

Repellents generally have short-term effects and are influenced by a range or abiotic and biotic factors including but not limited to climatic conditions (e.g., temperature extremes, rainfall), animal density, and food availability (Kimball and Taylor 2010). An evaluation of 10 commercially available deer repellents in Connecticut concluded that no repellents prevented 100% of browse damage and that usage is a trade-off among effectiveness, cost, ability to follow recommended reapplication schedule, and the types of plants to be protected (Ward and Williams 2010). Future repellent research should include cost:benefit analysis and evaluation during other critical foraging periods during stand initiation (e.g., winter browse). Additionally, one should consider the acceptable loss to browse, and consider that detection of a treatment effect may mask the biological effect of gross seedling damage across stands.

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