Incidence and Severity of Comandra Blister Rust on Lodgepole Pine in Northwestern Wyoming

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ABSTRACT

Geils, B. W., and Jacobi, W. R. 1984. Incidence and severity of comandra blister rust on lodgepole pine in northwestern Wyoming. Plant Disease 68:1049-1051.

A survey of the Wind River District, Shoshone National Forest, WY, was conducted in 1981–1982 to assess the incidence and severity of comandra blister rust in lodgepole pine. In the commercial forest, more than 30% of the basal area was lodgepole pine, and 50% of that was damaged by *Cronartium comandrae*. The average diseased tree was 107 yr old, 24 cm in diameter, 15 m tall, and growing among other lodgepole pines. The average canker was several decades old and had killed the top third of the crown. Although the rust was not found in stands less than 20 yr old, these stands may become infested.

Comandra blister rust, induced by *Cronartium comandrae* Peck, is a serious canker disease of hard pines. The disease is locally important in numerous areas of North America (11). The fungus is a full-cycle, heteroecious rust that alternates to the perennial herbs *Comandra* and *Geocaulon*. Stem cankers caused by this fungus increase cull and mortality and reduce volume growth and seed production (11,14).

Accepted for publication 12 May 1984.

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Comandra blister rust was reported in 1915 on lodgepole pine (*Pinus contorta* Dougl.) (6). Concern over losses increased during the 1950s with notice of extensive damage in the Rocky Mountains (10). Peterson (13) and Krebill (8), reconstructing the history of this outbreak, found that most cankers present in 1963 had developed from infections established between 1910 and 1945. Krebill (9) suggested that comandra blister rust outbreaks were rare because they resulted from a series of years of unusual weather that favored infection.

Since 1963, comandra blister rust has continued to damage lodgepole pine forests in Wyoming (1,4). Brown (1) reported that as many as 73% of lodgepole pine in some locations were diseased. Johnson (7) reported that 23% of rust-infected trees in a 20-yr-old stand had died during a 5-yr period. No studies, however, provided sufficient data to assess the damage caused by *C. comandrae* throughout a large forest area. Therefore, in 1981 and 1982, a survey was conducted in the Wind River District, Shoshone National Forest, WY (Fig. 1), to characterize the rust-damaged lodgepole pines and estimate disease incidence and severity.

MATERIALS AND METHODS

Commercial forestland in the Wind River District was sampled by a series of

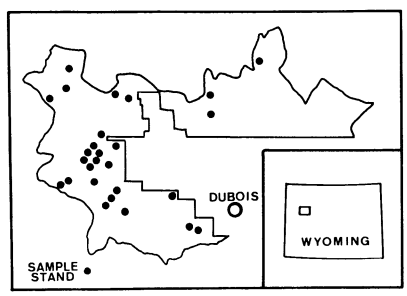

Fig. 1. Locations of stands in the Wind River District, Shoshone National Forest, WY, that were sampled for incidence of comandra blister rust on lodgepole pine.

plots in randomly selected stands (Fig. 1). Twenty-seven of 1,014 stands were chosen with probability of selection proportional to stand area (2). The sample made up 6% of the 20,170 ha in the district. In each stand, an average of nine sample points (one per 5 ha) were systematically located from a single, predetermined origin.

At each sample point, a variable-radius (5) and two fixed-radius plots were established. Living and standing dead pole-size trees 12 cm or greater in diameter at 1.3 m dbh were tallied on the variable-radius plot. Within each stand, a basal area factor was used that included at least an average of four trees per point or was equal to 1 m^2/ha. Living and standing dead saplings taller than 1.3 m and less than 12 cm dbh were tallied on a fixed-area plot. The radius of this plot was the same as the limiting distance of a tree of 12 cm dbh. Living seedlings less than 1.3 m tall were counted on a second fixed-radius plot. That radius was chosen to include at least an average of four seedlings per point but could be no larger than 6 m.

Location, habitat type (15), and previous history of each stand were noted. Data obtained for 2,457 trees included species, size, and causes of damage. Comandra blister rust cankers were classified as 1) restricted to a branch, 2) on a nongirdled stem, or 3) on a stem that was dead above the canker. Also recorded was the occurrence of lodgepole pine dwarf mistletoe, *Arceuthobium americanum* Nutt. ex Engelm., another important pathogen that caused crown mortality. One hundred diseased trees selected from stands throughout the district were felled and sectioned to determine growth rate, canker age, and age when the top died.

Data were transcribed into an automated data processing file, edited, and summarized with the file manipulation and statistical routines of the SPSS program (12). Cluster analysis and linear regression were done with BMDP programs 2M and 1R (3). Because trees were selected with different probabilities, for many procedures, sample values were weighted by the number of stems per unit area.

RESULTS AND DISCUSSION

Across the entire commercial forest, lodgepole pine made up about one-third of living stems and basal area (Tables 1 and 2). Lodgepole pine made up 40% of the basal area of trees less than 36 cm dbh but only accounted for 16% of basal area in larger trees. More than 50% of the living pole-size lodgepole pines were infected by comandra blister rust (Tables 1 and 2). The disease affected 6% of saplings, making up 12% of the sapling basal area. Only one infected seedling was seen.

Rust-infected and disease-free living poles differed in size and appearance (Table 3). Comandra blister rust occurred more frequently in trees of large diameter. On 85% of infected poles, a canker had girdled and killed the upper one-third of the crown. Top-kill significantly reduced live crown length of diseased trees (Table 3) and caused a 50–90% reduction of radial increments. Most infections occurred from 1955 to 1970.

Lodgepole pine occurred in three stand types, and disease impact on their management varied with age and composition. The first stand type, making up 40% of the sample area, was adequately stocked (37 m^2/ha) with pole-size and larger trees of subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), Engelmann spruce (*Picea engelmannii* Parry), white bark pine (*P. ablicaulis* Engelm.), and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Lodgepole pine accounted for 17% of live basal area. Comandra blister rust was found on 50% of the living lodgepole pines, and diseased trees were restricted to 50% of the plots with lodgepole pine. Because lodgepole pine was a minor component of these stands, the high percentage of loss represented only a few trees per hectare. Therefore, rust impact in these stands would be minimal.

The second stand type, with 22% of the area, was dominated by pole-size lodgepole pine. Comandra blister rust had infected 52% of living trees and was found on 85% of plots. Snags and spike-topped trees were highly visible in these stands. Although most of the damage from the 1955–1970 infection wave has

Table 1. Incidence of infection of lodgepole pines by *Cronartium comandrae* in commercial stands in the Wind River District, Shoshone National Forest, WY, in 1981–1982

	Lodgepole pine				
	Living		Dead		
Size class[a]	Total (million stems ± *SE*)	Rust-infected (%)	Total (million stems ± *SE*)	Rust-killed (%)	Other species (total living, million stems ± *SE*)
Seedling	7.8 ± 2.1	—[b]	...	...	25.4 ± 6.3
Sapling	6.5 ± 1.3	6	0.7 ± 0.4	43	13.7 ± 2.8
Pole	2.9 ± 0.7	52	0.6 ± 0.2	67	5.2 ± 1.1

[a] Seedling = tree <1.3 m tall, sapling = tree >1.3 m tall and <12 cm dbh, and pole = tree >12 cm dbh.
[b] Only one infected seedling observed.

Table 2. Basal area of lodgepole pines infected or killed by comandra blister rust in relation to total basal area in commercial stands in the Wind River District, Shoshone National Forest, WY, in 1981–1982

	Lodgepole pine				
	Living		Dead		
Size class[a]	Total ([$m^2 \times 10^3$] ± *SE*)	Rust-infected (%)	Total ([$m^2 \times 10^3$] ± *SE*)	Rust-killed (%)	Other species (total living ([$m^2 \times 10^3$] ± *SE*)
Sapling	15.1 ± 3.4	12	3.6 ± 1.8	58	25.4 ± 5.6
Small poles	46.7 ± 12.9	43	10.6 ± 3.4	76	76.2 ± 16.0
Medium poles	60.2 ± 15.5	68	9.6 ± 4.0	33	88.5 ± 20.6
Large poles	20.7 ± 10.9	43	5.5 ± 2.4	38	112.6 ± 31.8

[a] Sapling = tree >1.3 m tall and <12 cm dbh, small pole = tree 12–23.9 cm dbh, medium pole = tree 24–35.9 cm dbh, and large pole = tree >36 cm dbh.

Table 3. Comparisons of *Cronartium comandrae*-infected lodgepole pines with healthy lodgepole pines in the Wind River District, Shoshone National Forest, WY, in 1981–1982

	Diameter (cm)		Stem length (m)		Live crown length (m)		Age (yr)	
Tree class	Mean ± *SE*[a]	Sample size	Mean ± *SE*	Sample size	Mean ± *SE*	Sample size	Mean ± *SE*	Sample size
Rust-infected	23.8 ± 0.6	141	15.6 ± 0.3	134	6.4 ± 0.3	131	107 ± 6	70
Healthy	21.1 ± 0.7	121	15.3 ± 0.5	60	8.1 ± 0.4	55	99 ± 7	45
	$P = 0.003$*[b]		$P = 0.59$		$P = 0.001$*		$P = 0.43$	

[a] To calculate means and standard errors, observations were weighted to equalize selection probability.
[b] * = Computed two-tailed probability from *t* test procedure.

already occurred, some additional losses are expected from those cankers. The trees with dead tops will accrue little additional volume and trees with low stem cankers will die after becoming girdled. New lethal infections are unlikely in these mature stands (7,9).

Stands in the remaining 38% of the area supported seedlings and saplings of lodgepole pine, subalpine fir, Engelmann spruce, white bark pine, and aspen (*Populus tremuloides* Michx.). These stands had slowly regenerated after clear-cutting in the 1960s. Although two-thirds of this area had lodgepole pine, comandra blister rust was rare. The disease, however, had occurred in prior stands and was present in adjacent stands. These seedlings may become infected because they are likely to be exposed sometime within the next 50 yr to warm, moist fronts, which promote rust infection (9).

Forest diversity was limited by the predominance of two habitat types and the lack of some age classes of lodgepole pine. Most stands were *A. lasiocarpa/ Vaccinium scoparium* or *A. lasiocarpa/ Juniperus communis* habitat types (15). Stands 20–50 yr old were uncommon in the district and not represented in the survey. A few ancillary plots in this age class were established and we observed that most cankers there were lethal.

Lodgepole pine dwarf mistletoe was the only other serious pathogen in the district. Although dwarf mistletoe was found on only 15% of living saplings and poles, infestations of this parasite occurred in pockets; therefore, at some locations, dwarf mistletoe was more damaging than comandra blister rust. Only 2% of living trees had infections of both diseases and there was no evidence that their distributions were related.

The extent and seriousness of comandra blister rust in this district necessitate that this disease be considered when selecting areas to manage, stocking levels, and crop trees. Before specific recommendations can be made, however, two relationships need to be better understood: 1) how infection probability is affected by stand and site conditions and 2) how growth and survival are influenced by canker location and tree size.

ACKNOWLEDGMENTS

Research support provided by USDA Forest Service: Timber, Forest Pest and Cooperative Forestry Management, Rocky Mountain Region; Rocky Mountain Forest and Range Experiment Station; and Shoshone National Forest. We wish to thank R. M. King, Biometrician, Rocky Mountain Forest and Range Experiment Station, for statistical advice.

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