Light Affects Penetration and Infection of Pines by Dwarf Mistletoe

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ABSTRACT

Light appears necessary for the infection of Digger pine, *Pinus sabiniana*, by *Arceuthobium occidentale*. Highest percentage of infection occurred under full and half sunlight. Little infection occurred in the absence of light.

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Additional key word: temperature.

Previous studies have shown that penetration and infection of hosts by dwarf mistletoe in nature are slow processes, often requiring several months (5). Thus, the germinated seed, growing radicle, and

penetrating structure of the parasite must be able to survive in a regime of changing environmental conditions.

Certain physical factors (specifically, temperature and light) have a marked effect on dwarf mistletoe seeds. Temperature influences not only the viability of seeds, but also germination, radicle growth, penetration, and infection (3, 4, 5).

Light affects germination and radicle growth (1, 2, 4, 5), but its influence on penetration and infection of hosts is not known.

Field studies suggest that light affects infection by dwarf mistletoes. Wagener (6) suggested that partial sunlight is more favorable for infection on ponderosa pine, *Pinus ponderosa* Laws., and Jeffrey pine, *Pinus jeffreyi* A. Murr., than relatively full sunlight. Hawksworth (1) noted more infection of *Arceuthobium vaginatum* Willd. on the lower rather than upper surface of branches of ponderosa pine. He suggested that perhaps seeds exposed to direct sunlight were killed by excessive insolation. But neither Wagener nor Hawksworth reported whether light affected the parasite during the stage of penetration and infection.

This paper reports a study of the effect of different intensities of sunlight on penetration and infection of Digger pine, *P. sabiniana* Dougl., by dwarf mistletoe, *A. occidentale* Engelm.

MATERIALS AND METHODS.—To investigate the influence of different intensities of light on penetration and infection by dwarf mistletoe, inoculated host branches were artificially shaded. Specially constructed bags were placed over the inoculated portions of branches (Fig. 1). The bags were designed to exclude light but allow for some air exchange. The intensity of light reaching a branch depended on the type of bag: Clear bags made from 0.25-inch wire screen coated with a clear plastic film reduced light intensities by only about 5%. White bags made from ordinary aluminum window screen and covered with four layers of cheesecloth reduced light intensity by about 50%. Black bags were made the same way as the white bags, but the cheesecloth was sprayed with flat black enamel. They reduced light by about 90%. Aluminum bags made by covering window screen with two layers of heavy duty aluminum foil excluded light altogether. Uncovered seeds on branches served as controls.

Six-year-old potted Digger pines were used as test trees. The trees were kept in the open at the University of California, Berkeley. Forty inoculations were made per test at each level of light. Seeds pregerminated in the laboratory (5) were placed on needle-bearing branches in groups of 10. The 10 seeds in each test were placed at about 0.5-inch intervals and at the base of needle fascicles so that they could be adequately covered by a bag. The bags were left in place from March to September. Growth of the radicle, holdfast formation, and infection were noted periodically for 6 months while the bags were in place, and for 14 months thereafter.

Light intensity and temperature were periodically recorded during the time the bags were in place. Light intensity was measured by a Weston Model 756 photometer. Temperatures were measured by metallic dial-type thermometers. Light and temperature conditions changed somewhat with respect to differences in cloud cover and day length (Table 1). The proportion of light reaching seeds in each bag did not, however, change markedly.

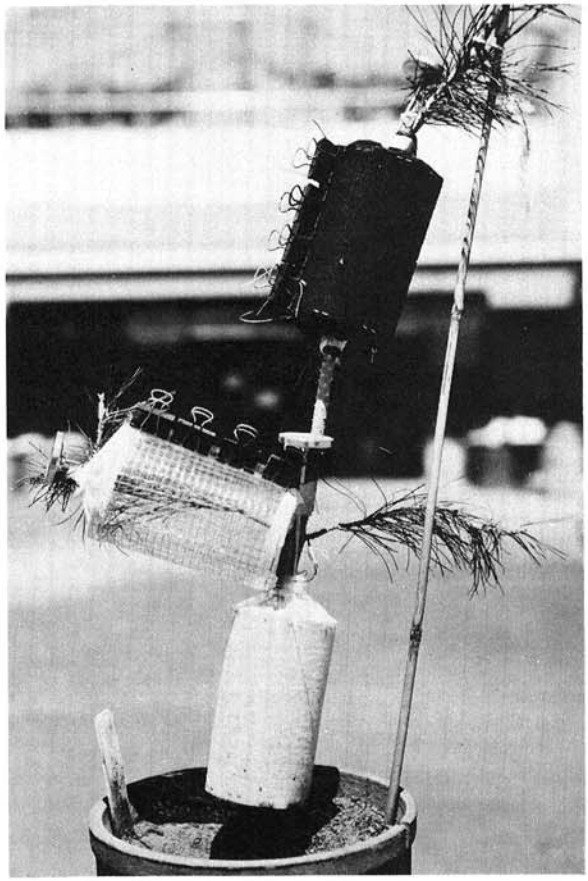

Fig. 1. Three types of bags (black, clear, and white) were placed on branches of Digger pine to test the effect of light on infection by dwarf mistletoe.

RESULTS.—During the test, one tree was mistakenly discarded before results were recorded. Consequently, the number of inoculations on which results are based varies among the tests.

Infections were readily recognized by localized swelling of the host branch where seed was placed and the subsequent development of the aerial portions of the parasite. No further infection occurred 14 months after removal of the bags.

The greatest percentage of infection occurred where dwarf mistletoe had been placed on nonbagged branches and on branches covered by white bags (Table 1). Noticeably lower percentage of infection occurred in the black and aluminum bags, and no infection occurred on branches covered by clear bags.

DISCUSSION.—Previous studies have shown that temperatures much greater than ambient lead to increased radicle mortality and decreased penetration

TABLE 1. Effect of light on radicle survival and infection by dwarf mistletoe, by type of bag tested

Bag	Available light	Daytime temperature (deviation from ambient)	Seeds	Radicles alive after 6 months	Infections	Infection
	%	*C*	*No.*	*No.*	*No.*	*%*
Clear	90-95	3.3-10.0	40	0	0	0
White	35-50	1.1-4.4	30	20	11	37
Black	10-15	2.2-6.7	30	1	3	10
Aluminum	0	-0.6-0.6	30	0	1	3
No bag	100		30	18	12	40

and infection of pines by dwarf mistletoes (3, 4, 5). The low percentage of infection that occurred in the clear and black bags was probably the result of increased temperatures rather than the influence of light. Temperatures slightly above ambient in the white bags apparently did not influence radicle survival and infection.

A reduction in light intensity by one-half had no noticeable effect on infection, but when light was eliminated altogether, little infection occurred. It appears that light has both a direct and indirect effect on radicle growth, survival, and subsequent infection of hosts. Some light is necessary for the photosynthetic activities and tropic responses in the radicle that are necessary for growth and infection. On the other hand, as suggested by Hawksworth (1), excessive insolation affects radicle survival adversely, thus limiting penetration and infection.

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