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Lodgepole Pine Seedling Chlorosis and Mortality at Bessey Nursery, Nebraska

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ABSTRACT

Evaluation of chlorosis and mortality of 1-0 lodgepole pine seedlings at Bessey Nursery, Nebraska indicated possible association of soil nutrient imbalances with infection by soil-inhabiting fungi (primarily *Phoma* spp.). Excessive overhead irrigation used primarily for wind erosion control caused accumulation of the light soil around the base and into the foliage of some seedlings. These conditions were ideal for attack and damage by *Phoma* spp. Approaches to reducing losses are discussed.

INTRODUCTION

Chlorosis and mortality of 1-0 lodgepole pine (*Pinus contorta* Dougl.) seedlings at Bessey Nursery, Nebraska was evaluated in September, 1978 by Robert James, Plant Pathologist, FI&DM. Symptomatic trees displayed general chlorosis of needle and stem tissues. Needle tip necrosis often followed chlorosis. Necrosis occurred progressively from the lower needles upward through the remainder of the foliage. Upon death, foliage turned red and then brown.

Seedbeds in which symptomatic trees were noted have been fallow for the last 12 years. Symptom development was non-uniform throughout affected beds.

Soils in affected beds were very light, sandy and easily eroded by wind and water. Soil accumulated around the base of most seedlings. In some cases, seedlings were nearly buried. Frequent overhead irrigation was necessary for wind erosion control and to replenish water which quickly leaches and evaporates from the light soil. Excessive buildup of the soil around seedlings was attributed to irrigation practices.

An evaluation was conducted to determine: (1) the role and identity of pathogenic organisms associated with the disorder and (2) the mineral composition of affected seedlings and soil to determine deficiencies or excesses.

METHODS

Diseased seedlings were microscopically examined for presence of pathogenic organisms. Symptomatic tissues were cultured on water agar and incubated in the dark at about 24 C for 5-7 days. Associated fungi were identified under the compound microscope and maintained on potato dextrose agar slants.

Two groups of foliage samples from symptomatic seedlings were analyzed for nutrient mineral content. Nutrients were expressed as percent or parts per million (ppm) of the oven-dry weight of tissues. Four soil samples from different locations in affected beds were analyzed for texture, pH, cation exchange capacity, excessive soluble salts, exchangeable sodium, organic matter, organic nitrogen, and required nutrients available. Both sets of analyses were conducted by Agricultural Consultants Laboratory (Brighton, Colorado).

RESULTS AND DISCUSSION

Representative fungal genera isolated from symptomatic seedlings included *Alternaria, Pencillium, Trichoderma* and *Phoma*. Most of these fungi are plant pathogenic under certain conditions and all are normal soil inhabitants (11). *Phoma* sp. probably deserves the most attention as a potential pathogen. *Phoma* sp. was identified from characteristic pycnidia (Fig. 1). These fruiting bodies measured 108-135 µm x 110-135 µm and produced typical hyaline conidia characteristic of the genus (1).

Phoma spp. have been associated with diseases of beets, citrus, turnips and other crucifers (3, 11, 13). Fungi of this genus have also caused leaf blotch of white poplar (8) and mortality of Douglas-fir seedlings (9, 10). At the Humbolt Nursery near McKinleyville, California, major losses (over 6 million seedlings) have occurred to 1-0 Douglas-fir between 1971 and 1975 (9). *Phoma* spp. were found causing blight of the foliage of smaller seedlings during the winter and early spring. Investigators hypothesized that rain and irrigation water splash caused buildup of soil around the stem and into the lower crown of smaller seedlings. *Phoma* spp. grew out of the soil and initially infected cotyledons. It then spread up the crown of seedlings killing the needles. Affected seedlings were initially chlorotic; later their foliage turned golden brown and was cast (9).

Tissue analysis of symptomatic seedlings (Table 1) indicated some differences from nutrient levels considered adequate for growth (4, 5, 6, 7, 12). For example, calcium and iron were apparently in excess.

Soil analyses of affected lodgepole pine seedbeds are summarized in Table 2. Soil texture was classified as sandy-loam for all samples. The relatively low cation exchange capacity (CEC) is characteristic of light soils with low organic matter. Nitrogen levels were also low (1 part per million NO_3-N is equivalent to 2-4 lbs/acre N depending on crop and soil conditions). It is difficult to conclude whether other elements, especially those required in small amounts, were present in sufficient concentrations. Analysis of soil nutrient content do not always indicate amounts available to plants, e.g., some nutrients may be "fixed" and thus unavailable (5).

Nutrient imbalances, such as calcium and iron excesses, may have weakened young lodgepole pine seedlings. Weakened trees were then attacked by *Phoma* spp., which were present in soil accumulated around the base of seedlings. Infection by *Phoma* spp., normally

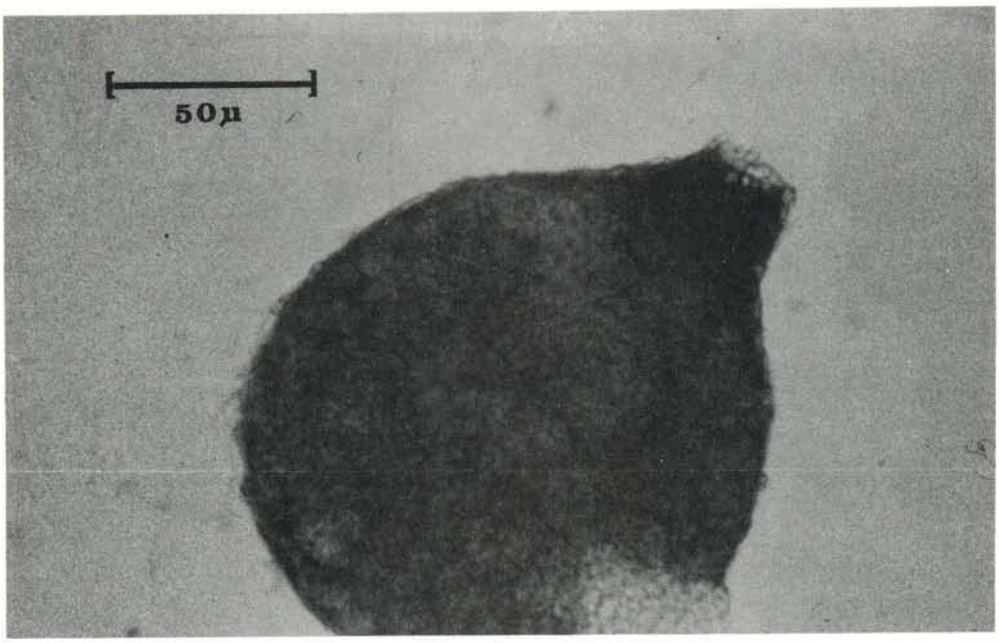

FIGURE 1. Pycnidium of *Phoma* sp. associated with chlorosis and mortality of lodgepole pine seedlings at Bessey Nursery, Nebraska (X450).

Table 1. Comparison of nutrient element levels in chlorotic lodgepole pine seedlings and levels considered adequate. [1/]

Element	Chemical Symbol	Lodgepole Pine Samples [2/]		Adequate Levels [2, 3/]		
		1	2	Crops	Lodgepole Pine	Conifers
Nitrogen	N	0.0074	0.0089	1.5	0.0089	Unknown
Phosphorus	P	0.19	0.28	0.2	0.17	0.10 - 0.30
Potassium	K	0.56	0.90	1.0	0.34	0.50 - 1.60
Calcium	Ca	1.40	2.00	0.5	0.64	0.12 - 0.70
Magnesium	Mg	0.20	0.31	0.2	0.14	0.07 - 0.20
Sulfur	S	0.29	0.46	0.1	0.05	Unknown
Iron	Fe	614	623	100	381	50 - 100
Manganese	Mn	56	106	50	702	100 - 5,000
Zinc	Zn	23	37	20	265	10 - 125
Copper	Cu	5	7	6	6	4 - 12
Boron	B	40	70	20	51	10 - 100

1/ Lodgepole pine analysis conducted by Agricultural Consultants Laboratory, Brighton, Colorado.

2/ Values for N, P, K, Ca, Mg & S given in percent; those for Fe, Mn, Zn, Cu & B in parts per million. All values expressed on the basis of oven-dry weight of plant tissues.

3/ Adequate levels for crops derived from Stout (12) and Epstein (4, 5); those for lodgepole pine are from Landis (6), and those for conifers from Powers (7).

Table 2. Soil characteristics of lodgepole pine seedbeds, Bessey Nursery, Nebraska. [1/]

Sample Identity	Texture	pH	CEC [2/]	SALT [3/]	Na [4/]	OM [5/]	O-N [6/]	Available Nutrients [7/]										
								NO_3	P	K	Ca	Mg	W	B	Zn	Fe	Mn	Cu
A102 - 1939	Sandy-loam	5.6	10	0.4	0.1	1.3	45	5	3	46	380	35	15	0.2	1.6	17.0	3.6	0.3
A013 - 1940	Sandy-loam	5.9	11	0.3	0.2	1.4	49	4	8	44	310	44	0	0.2	1.7	19.0	2.8	0.4
A024 - 1941	Sandy-loam	5.3	11	0.4	0.2	1.1	38	4	11	38	280	40	0	0.4	0.3	18.0	3.0	0.2
A070 - 1942	Sandy-loam	5.4	10	0.4	0.2	1.2	42	7	20	45	360	32	12	0.4	1.4	15.0	3.2	0.3

1/ Analyses conducted by Agricultural Consultants Laboratory, Brighton, Colorado.

2/ Cation exchange capacity - an index of the soils ability to store exchangeable ions.

3/ An index of excessive soluble salts in the soil water.

4/ An index of the exchangeable sodium in the soil.

5/ Organic matter (percent).

6/ Organic nitrogen is the nitrogen calculated (lbs./acre) to be released by the organic matter during the growing season.

7/ Reported in parts per million.

facultative parasites, may have caused most of the tissue necrosis noted. Another possibility is colonization by the fungus subsequent to death of seedlings due to soil nutrient imbalances. Additional investigation is needed to ascertain the exact sequence of events leading to seedling mortality and the role of soil fungi.

Several treatments for reducing losses of lodgepole pine seedlings are suggested. Each require trials to compare relative effectiveness. The first treatment involves fungicide application to reduce incidence of and colonization by *Phoma* spp. Chlorothalonil (Bravo ® 6 F) [1/] has been effective in protecting Douglas-fir from this fungus in California (9). The fungicide was applied at 2 to 4 week intervals from October to April. At Bessey Nursery, fungicide application should coincide with periods of highest risk, i.e. during the summer and early fall when moisture and temperature conditions are ideal for fungal colonization.

Investigators in California attributed Douglas-fir seedling mortality by *Phoma* to poor seedling growth during the first season and soil accumulation on foliage (10). Therefore, trials were conducted to determine if seedlings infected with mycorrhizal symbionts would grow faster and thus be less susceptible to damage by *Phoma*. They found that larger seedlings (those infected with mycorrhizal fungi) survived attacks by the pathogen because only the lower foliage was affected. Mycorrhizal seedlings "outgrew" the pathogen and no chemical treatment was necessary. A similar approach may be useful at Bessey Nursery.

Since chlorosis and mortality of lodgepole pine seedlings seems most acute in beds highly susceptible to erosion, it may be possible to reduce losses by growing susceptible seedlings in beds adjacent to windbreaks. Less wind erosion and dying would occur in beds near windbreaks; in such areas, less watering may be required and conditions conducive to damage by *Phoma* spp. may be avoided.

A combination of the previously-described treatments may be necessary to reduce future losses of lodgepole pine seedlings. Small scale field trials should be evaluated before production-scale treatments are attempted. Personnel from our office, as well as Steve McDonald, Westwide Nursery Specialist, should be consulted prior to development of these field trials.

1/ Tetrachloroisophthalonitrile

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

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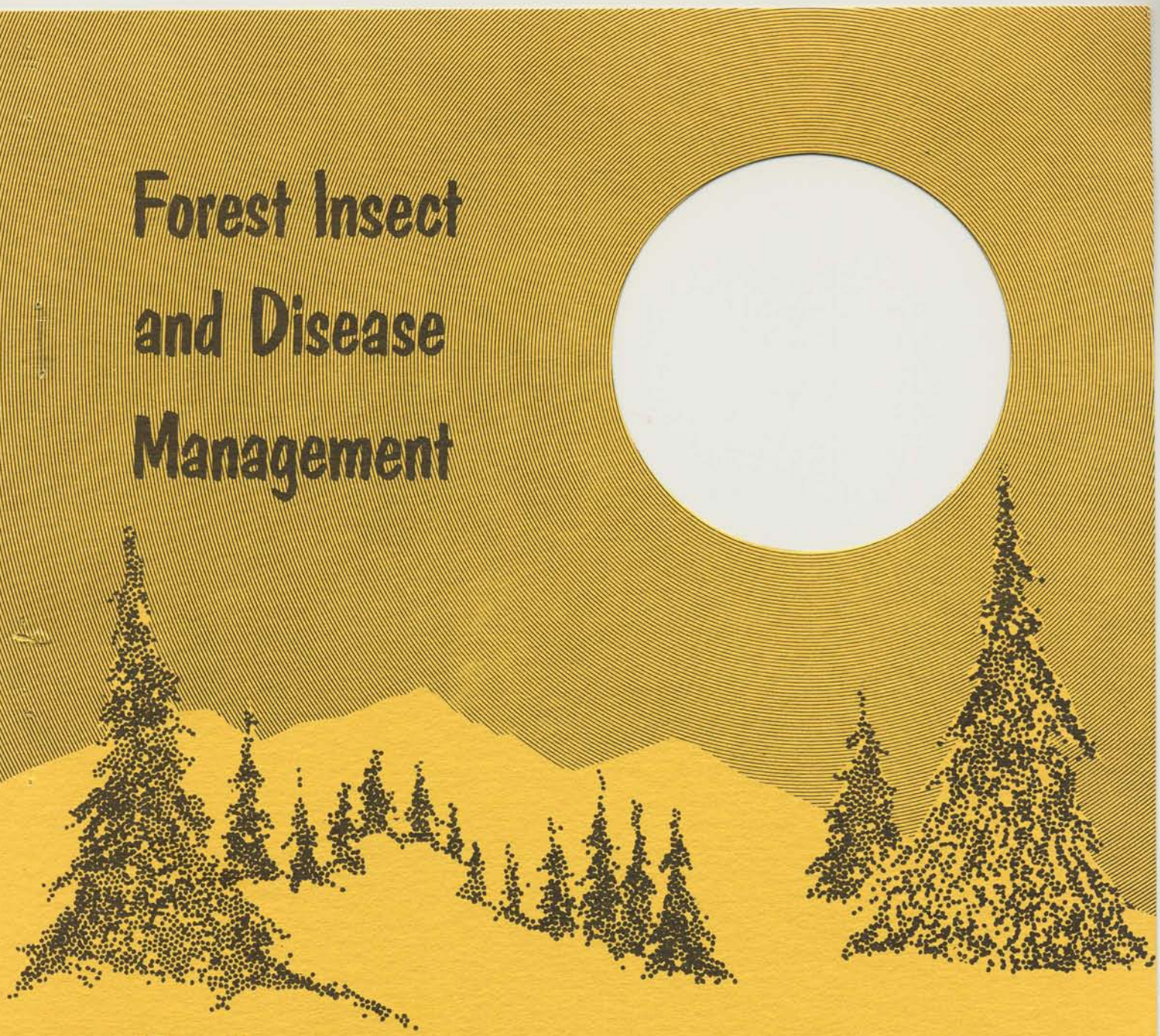

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