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SUGAR PINE SEEDLINGS NOT PROTECTED FROM BLISTER RUST BY CHEMOTHERAPEUTANTS

by

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ABSTRACT

None of several types of chemotherapeutants applied before inoculation (antibiotics, metallic salts, systemic fungicides) prevented infection of sugar pine seedlings by white pine blister rust. DMSO (dimethyl sulfoxide) did not enhance the action of any material with which it was applied.

Keywords: Sugar pine, *Pinus lambertiana*, white pine blister rust, *Cronartium ribicola*, fungicides.

Since 1965 we have installed eight nursery tests of chemotherapeutants against white pine blister rust (*Cronartium ribicola* Fisch.) on sugar pine (*Pinus lambertiana* Dougl.) seedlings. This has been an empirical search among systemic fungicides and other compounds which might impart either temporary (up to 3 years) or lasting (5 or more years) protection to the seedlings from blister rust. Materials used have ranged from simple nickel salts reported by Ram (1964) as effective against blister blight (*Exobasidium vexans* Massee) on tea plants grown in nickel-augmented soil to the systemic oxathiin fungicides reported by Powelson and Shaner (1966), Hardison (1966), and von Schmeling and Kulka (1966). This note briefly describes the results of these tests.

METHODS AND MATERIALS

Sugar pine 2-0 seedlings, either from refrigerated storage or directly from the seed beds, were transplanted in May or June at a test site at the nursery. Each of the eight tests consisted of a unit of sixty 2- x 2-ft (0.6- x 0.6-m) cells arranged in four rows of 15 cells each. A single 2-ft-wide (0.6-m) longitudinal path separated rows two and three of each unit. Each cell was planted with 13 sugar pine seedlings. All seedlings were Rogue River National Forest seed source, Union Creek or Prospect District, 3,000- to 5,000-ft (914- to 1524-m) elevation.

Chemicals were applied to each cell in a completely randomized design in July or August of the transplanting year. Each of the eight treatments and two controls were replicated six times per unit. Four methods were used to apply the chemicals. These were:

Root soak.--Seedlings were placed in solutions and then outplanted.

Soil drench.--Solutions of chemicals were flooded onto the surface of each cell and contained until absorbed by the soil.

Foliar spray.--Seedlings were either sprayed to the point of runoff or seedlings and soil surface were sprayed with a premeasured dose. Application was made with gardentype pump-up or laboratory-type Freon-pressured sprayers. All sprays were confined within a 2-ft (0.6-m) cubic "spray box" to prevent drifting to adjacent cells.

Soil amendment.--Dry chemical dosage for each cell was thoroughly mixed with 1 kg (2.2 lb) of dry, white, washed mason's sand, spread evenly on each cell, and then worked gently into the top inch (2.5 cm) of soil with a hand cultivator.

The first artificial inoculation with blister rust was made in August or September of the planting and treatment year. The first four units (treatments of 1965 and 1966, table 1) were inoculated twice (2 consecutive years), while the last four units (treatments of 1967 and 1969, table 1) were inoculated three times (3 consecutive years). Inoculations were made in large, tentlike movable chambers of canvas and polyethylene film temporarily erected over each 60-cell unit. Interior and exterior sprinkler systems maintained temperatures below 70° F (21.1° C) and relative humidity above 95 percent through the 72-hour inoculation period. Sporidia, cast from infected *Ribes* cuttings distributed among the seedlings, were monitored during each inoculation on 10 spore-trap slides per unit. One set of controls was inoculated the first inoculation, the second set the second inoculation, and both sets the third inoculation (last four units only--treatments of 1967 and 1969, table 1). Controls were covered by polyethylene film. Treatment effectiveness was evaluated annually

Table 1.--*Summary of chemical treatments of sugar pine seedlings, Wind River Nursery, Washington, 1965-69*

Year treatment was: Applied	Year treatment was: Evaluated	Chemical, adjuvant, and application method	Concentration	Best treatment[1]	Range of blister rust infection	Range of treatment phytotoxic mortality
				Number and Percent	- - - Percent	- - - -
1965	1968	Untreated controls	--	--	97-100	--
1965	1968	Phytoactin L-318:[2] *12, 24-, 36-hour root soak	100 p/m	1/49 = 2.0	98-100	25-35
1965	1968	Cycloheximide semicarbazone:[3] soil drench	100, 200, *300 p/m	1/8 = 12.5	88-100	35-90
1965	1968	Phleomycin: 24-hour root soak	100 p/m	1/67 = 1.4	99	13
1965	1968	Cycloheximide semicarbazone:[3] 24-hour root soak	10 p/m	0/0 = 0	0	100
1965	1968	Untreated controls	--	--	97- 99	--
1965	1968	Nickel ammonium sulfate: soil drench	5, 10, *15 g/ft^2 ($0.3\ m^2$)	2/64 = 3.1	97-100	0- 2
1965	1968	Nickel nitrate: soil drench	5, 10, *15 g/ft^2 ($0.3\ m^2$)	3/59 = 5.1	95-100	0-12
1965	1968	Phleomycin: foliar spray	100, 200 p/m	0/74 = 0	100	0
1966	1969	Untreated controls	--	--	99-100	--
1966	1969	Nickel chloride + DMSO:[4] foliar spray	2.5, *5% (w/v)	1/66 = 1.5	98- 99	5-14
1966	1969	Cupric chloride + DMSO:[4] foliar spray	*1.25, 2.5% (w/v)	2/72 = 2.8	97-100	8-10
1966	1969	Naphthalene acetic acid + DMSO:[4] foliar spray	1.5, *3% (w/v)	4/10 = 40.0	60- 93	25-87
1966	1969	Iodine + DMSO:[4] foliar spray	1.5, 3% (w/v)	0/74 = 0	100	5
1966	1969	Untreated controls	--	--	96-100	--
1966	1969	Oxathiin F-461-W:[5] foliar spray	*1, 25, 50, 100 lb active/acre[6]	1/69 = 1.4	98-100	0-12
1966	1969	Oxathiin F-461-ST:[5] soil drench	1, 25, 50, *100 lb active/acre[6]	4/76 = 5.3	95-100	0- 5
1967	1971	Untreated controls	--	--	97	--
1967	1971	Nickel nitrate + DMSO:[4] foliar spray	*0.6, 1.2, 2.5, 5% (w/v)	2/59 = 3.4	0-100	16-100
1967	1971	Nickel nitrate: foliar spray	*0.6, 1.2, 2.5, 5% (w/v)	2/60 = 3.3	97-100	13-99
1967	1971	Untreated controls	--	--	99-100	--
1967	1971	Nickel nitrate: soil drench	15, 20, *25, 30 g/ft^2 ($0.3\ m^2$)	1/9 = 11.1	89-100	26-96
1967	1971	Nickel nitrate: soil amendment	15, *20, 25, 30 g/ft^2 ($0.3\ m^2$)	8/63 = 12.7	87- 95	11-38
1969	1973	Untreated controls	--	--	99	--
1969	1973	Oxathiin F-461-W:[5] foliar spray	1, *25, 50, 100 lb active/acre[6]	2/72 = 2.8	97-100	0- 3
1969	1973	Oxathiin F-461-ST:[5] soil amendment	1, 25, 50, 100 lb active/acre[6]	0/75 = 0	100	0- 3
1969	1973	Untreated controls	--	--	100	--
1969	1973	Benlate-WP[7] + DMSO:[4] foliar spray	1, 25, 50, 100 lb active/acre[6]	0/75 = 0	100	0- 1
1969	1973	Benlate-WP[7] soil amendment	1, *25, 50, 100 lb active/acre[6]	1/73 = 1.4	99-100	0- 1

1/ Best treatment is largest number of surviving uninfected sugar pine seedlings (numerator) in relation to number planted minus mortality from treatment, sampling for nickel analyses (1967 nickel treatments only), or other causes; blister rust is denominator. Best treatment indicated by asterisk (*); lack of asterisk indicates no best treatment.

2/ Supplied by PL Biochemicals, Inc., Milwaukee, Wisconsin 53205.

3/ Supplied by the Upjohn Co., Kalamazoo, Michigan 49001.

4/ DMSO and ready-to-apply solutions furnished by Crown Zellerbach Corp., Camas, Washington 98607.

5/ Oxathiin F-461-W and F-461-ST = 2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin-4, 4-dioxide supplied by U.S. Rubber Co., Naugatuck, Connecticut 06771.

6/ 1, 25, 50, 100 lb active/acre = 1.12, 28.02, 56.04, 112.08 kg active/hectare.

7/ Benlate = benomyl = methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate supplied by E. I. duPont de Nemours & Co., Wilmington, Delaware 19898.

NOTES.--Complete test results will be furnished on request by the Forestry Sciences Laboratory, Corvallis, Oregon 97331.

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on the basis of uninfected trees. Year of final evaluation is given in table 1.

RESULTS AND DISCUSSION

Seedling response, as indicated either by damaging *C. ribicola* infection or by high treatment mortality, signifies that all the treatments were either ineffective or too phytotoxic to be useful (table 1). For example, the oxathiin and Benlate treatments (1966 and 1969) were neither phytotoxic nor particularly effective. In contrast, a 3-percent naphthalene acetic acid solution plus DMSO applied as a foliar spray (1966 treatment) was 40 percent effective in preventing *C. ribicola* infection. However, this 40-percent effectiveness is based upon 4 uninfected seedlings from a total of 10 which survived the treatment (78 planted and treated). DMSO (dimethyl sulfoxide) did not enhance the protective action of any material with which it was applied. Tests of hypotheses were not appropriate due to lack of useful protective response from the treatments.

In May 1967, the 1965 application of nickel nitrate at 15 grams per square foot (0.3 m^2) had a very promising infection level of only 35 percent (21/60) compared with a 100-percent infection level (74/74) for the controls. However, 1 year later (May 1968), the infection level had increased to 95 percent. Similar results were obtained from increased nickel dosages made in 1967. Analyses for nickel of the first-year soil samples from the 1967 applications indicated that under the conditions of our tests, nickel leached from the seedling root zone very rapidly. These results suggest that nickel salts may provide transitory protection from *C. ribicola* but that frequent reapplications would be necessary for continuous protection. Such reapplication and the risk of serious phytotoxicity make nickel salts impractical for field use.

It is possible only to speculate why oxathiin and Benlate were not effective against *C. ribicola* under the conditions of our tests. Perhaps an effective application rate for a one-time application was not reached, or perhaps each fungicide needs to be continuously available for uptake by the plant root system for effective protection. The low phytotoxicity of these two materials suggests that greatly increased application rates might be effective; however, we have no plans for further tests. None of the materials tested here in the concentrations used can be recommended for control of *C. ribicola* on sugar pine seedlings.

LITERATURE CITED

Hardison, John R.
1966. Systemic activity of two derivatives of 1,4-oxathiin against smut and rust diseases of grasses. Plant Dis. Rep. 50: 624.

Powelson, R. L., and G. E. Shaner
1966. An effective chemical seed treatment for systemic control of seedling infection of wheat by stripe rust (*Puccinia striiformis*). Plant Dis. Rep. 50: 806-807.

Ram, C. S. Venkata
1964. Resistance of tea plants to blister blight in soils augmented with nickel. Nature 204(4964): 1227.

von Schmeling, B., and M. Kulka
1966. Systemic fungicidal activity of 1,4-oxathiin derivatives. Science 152: 659-660.

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