FUSIFORM RUST CONTROL WITH SYSTEMIC FUNGICIDES

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Abstract. Effective control of fusiform rust in southern nurseries is often incomplete with ferbam. Two systemic fungicides offer promise of improving the level of control. Benodanil (four applications) was tested two years in the nursery and shown to be as effective as over 30 applications of ferbam. Bayleton treatment of seed was found to afford protection in a laboratory trial. The fungicide did not impact seed germination, but did significantly reduce rust infections following germination. Future research needs are discussed in light of the findings.

INTRODUCTION

Fusiform rust caused by Cronartium quercuum (Berk.) Miyabe ex Shirai f. sp. fusiforme (Burdsall and Snow, 1977) is the most serious threat to pine seedling production in southern nurseries. Current control methods consist of frequent applications of the contact fungicide, ferbam (ferric dimethyldithiocarbamate) (Foster and Henry, 1956). Despite as many as 30 spray applications during the 90-day infection season, infection levels of 15% to 20% are not uncommon (Rowan, 1972). Most of these infections occur in April and early May during the first few days after seed germination. This is the most difficult time to adequately protect seedlings because the germinating seedlings are rapidly elongating, exposing new succulent tissue to infection; and spring rains often make the nursery impassable for spray equipment (Rowan, 1977).

Other fungicides, especially systemics, have been used experimentally to control fusiform rust with some success. Soil drenches of benodanil or benomyl have proven effective in greenhouse trials (Hare and Snow, 1976). Other chemicals have been tested as foliar sprays, but variable levels of protection have been provided when compared to ferbam (Rowan, 1972, 1977). Coating pine seed with selected fungicides has proven ineffective (Rowan, 1972). This would be expected unless the fungicide was either absorbed through the seed coat or washed off the seed and absorbed by the emerging radicle. Chemicals can penetrate the seed coat of pine (Biswas, et al., 1972), but fungicides have not been studied extensively. Permeation of agronomic seeds with fungicides has been effective in the control of certain fungal diseases (Maude and Kyle, 1970).

The objective of this paper is to discuss the results of two experiments with systemic fungicides used in controlling fusiform rust. One experiment tests the efficacy of benodanil (2-iodobenzanilide) as a foliar spray in nursery field trials. The other tests two systemic fungicides as seed treatments. The chemicals included: benodanil and bayleton (1-(4-chlorophenoxy)-3, 3-dimethyl-1-1(1H-1,2,4-triazol-1-yl)-2-butanone.

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The authors are indebted to G. P. Finger, L. A. Achimon, and W. J. Boeckman for their cooperation and assistance.

MATERIALS AND METHODS

Experiment 1. This experiment was carried out over two years (1976 and 1977) at the Weyerhaeuser Nursery in Aliceville, AL. The 1976 trial consisted of three treatments:

(a) Control - no preventative treatments
(b) Ferbam - applied at the rate of 275 g a.i./ha through the spring and early summer.
(c) Benodanil - four weekly applications at the rate of 370 g a.i./ha, beginning about 14 days after sowing when seedling emergence had just initiated.

The 1977 trial included the above treatments plus two additional treatments:

(d) Benodanil - four weekly applications at the rate of 185 g a.i./ha
(e) Benodanil - four weekly applications at the rate of 740 g a.i./ha

The experimental design for both studies was a randomized complete block with three replications. At the end of the growing season, 1.5 LBM of seedlings were hand lifted from each treatment plot. The seedlings were counted, graded, sampled for morphological measurements and carefully examined for rust infections.

Experiment 2. The results of this study are reported elsewhere (Mexal and Snow, 1978). Seeds from the Mississippi flatwoods seed zone that were known to be susceptible to fusiform rust were stratified for 30 days, soaked in aqueous solutions of the fungicides for 24 hr, and surface dried. The concentrations selected (bayleton at 800 mg a.i./L and benodanil at 80 mg a.i./L) did not significantly alter the rate nor completeness of germination compared to seeds not treated with a fungicide (Mexal and Snow, 1978).

Seedlings representing three stages of development (Fig. 1) were inoculated with rust spores 18 days after the seed treatment using the method described by Snow and Kais (1972). Each treatment X size combination consisted of 24 seedlings and was replicated three times, which constituted a randomized complete block design. Inoculum was prepared from a mixture of aeciospores collected near Laurel, Mississippi, and Bogalusa, Louisiana. Rust infections were determined 12 months after sowing.

In another study, designed to test the effect of bayleton on the germination of various seed lots, three seed orchard lots and two seed sources were stratified for 30 days, soaked in bayleton (800 mg a.i./L) and germinated on cellulose wadding in a growth chamber (21°C). Germination was monitored for 28 days at weekly intervals.

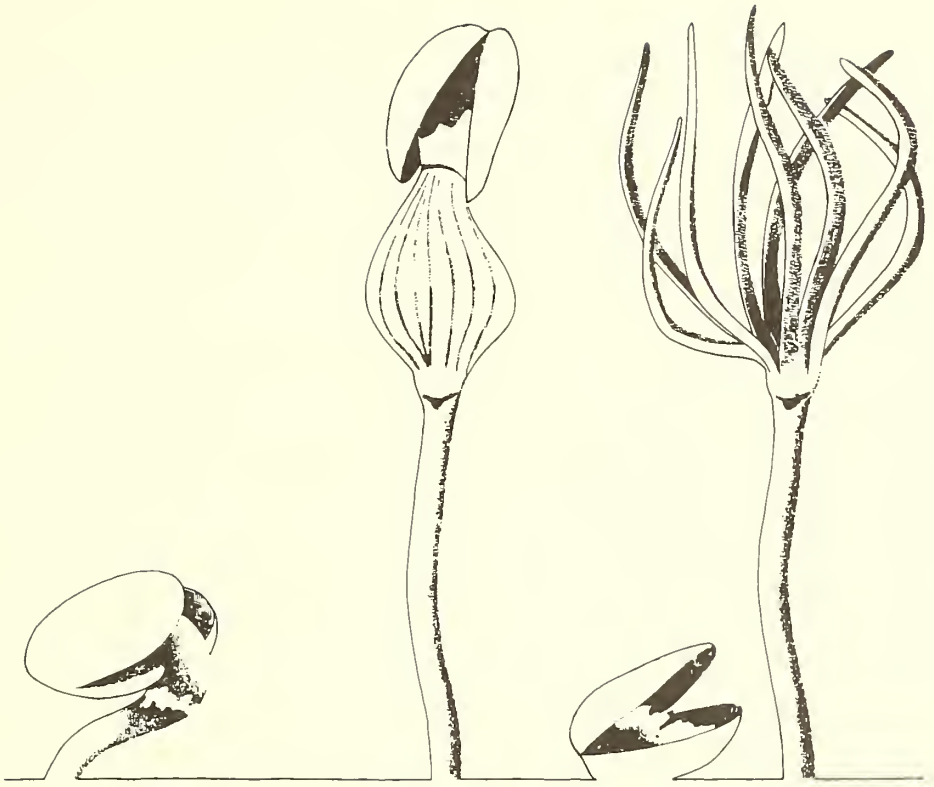

Figure 1.--Stages of seedling development at time of rust inoculation.

RESULTS

Experiment 1. Levels of rust infection were low both years the study was installed in the Aliceville nursery. In 1976, benodanil appeared to be as effective in controlling rust as ferbam. However, high variability among plots resulted in the treatment differences being insignificant (Table 1). In addition to decreasing rust infection, the systemic fungicide, benodanil, also decreased the level of mycorrhizal infection on the roots. The long term effects of this phenomenon are not known.

Table 1. Control of Fusiform Rust in 1976 Using Ferbam and Benodanil in Aliceville, AL Nursery.

Seed Source: Family 8-532

Treatment	Plantable Seedlings (%)	Height (mm)	Caliper (mm)	Mycorrhiza (%)	Rust Infection (%)
Control	50	161	4	77	2.8
Ferbam (40)*	58	158	4	93	1.5
Benodanil (4)*	46	140	4	33	1.6

*Number in parenthesis refers to number of applications during the growing season.

In 1977, all preventative treatments significantly reduced the incidence of rust infections compared to the control (Table 2). The differences among spray treatments were not significant, indicating four sprays of benodanil were as effective as over 30 sprays of ferbam. In this trial, increasing the application rate of benodanil did not significantly reduce rust infections.

Table 2. Control of Fusiform Rust in 1977 Using Ferbam and Benodanil in the Aliceville, AL Nursery.

Seed Source: Flatwood, MS

Treatment	Plantable Seedlings (%)		Height (mm)	Caliper (mm)	Rust Infection (%)
Control	67	*	180	4.5	2.7
Ferbam	67		178	4.8	0.7
Benodanil (86 g/a)	62		186	4.8	0.3
Benodanil (170 g/a)	64		202	5.1	0.4
Benodanil (340 g/a)	73		186	4.7	0.1

*Values opposite the same vertical bar are not significantly different (α = .01) according to Duncan's Multiple Range Test.

Experiment 2. Benodanil as a seed treatment was not effective in controlling rust; treated seedlings averaged 78% and the control seedlings averaged 82% (Table 4). However, since benodanil has been proven effective as a systemic fungicide on pine seedlings, this chemical probably did not permeate into the seeds in this test.

Table 3. The Effect of Seed Infusion with Systemic Fungicides on the Percentage of Seedlings Infected with Rust Galls 12 Months after Rust Spore Inoculation.

Chemical	Concentration	Seedlings with Galls or Lesions (%) Small	Medium	Large
	(mg/L)			
Benodanil	80	89 a*	71 a	71 a
NA_{43410}	300	88 a	76 a	90 a
Bayleton	800	14 b	22 b	22 b
Control	---	96 a	66 a	83 a

*Values followed by the same letter are not significantly different (α = .05) according to Duncan's Multiple Range Test.

Bayleton significantly reduced the incidence of rust infection. When the three size classes of seedlings were averaged, only 18% of those treated with this chemical had rust infections after 12 mos. (Table 3). The protection afforded by bayleton appeared to diminish as seedlings developed, but the increase in infection with increasing seedling size was not significant (α = .05). This would appear to result from a dilution or degradation of the fungicide as the seedling developed.

Bayleton at the rate of 800 mg a.i./L did not influence total germination of any of the seed lots tested (Table 4). In fact, the seed treatment significantly increased the speed of germination of three seed sources. However, it did not improve the germination of a lot (17-34) infected with Fusarium.

Table 4. The Effect of Bayleton (800 mg a.i./L) on the Germination of Loblolly Pine Seed.

Seed Source	Rust Susceptibility[1]	Germination	
		Control	Bayleton
	(%)		
17 - 27*	36	82 ± 9	83 ± 1
17 - 34	30	54 ± 5 (moldy)	37 ± 7 (moldy)
8-505*	29	93 ± 3	91 ± 3
Livingston Pa., LA	10	94 ± 4	92 ± 3
Howard Co., AR*	5	94 ± 4	92 ± 3

*Speed of germination significantly improved by treatment with Bayleton.

[1]Unpublished data (courtesy of F. E. Bridgwater).

FUTURE RESEARCH

These data, along with unpublished data collected by S. J. Rowan, G. A. Snow, W. D. Kelley, C. E. Cordell, and C. E. Affeltranger demonstrate the potential of controlling fusiform rust through the use of systemic fungicides. This year, Drs. S. J. Rowan, W. D. Kelley, G. A. Snow and I are testing both chemicals in nursery trials. Bayleton is being tested both as a seed treatment and as a foliar spray, and benodanil is being tested as a spray. Results to date indicate these chemicals can be as effective as ferbam and certainly more economical.

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