SO-238

Southern Forest Experiment Station

Research Note

1978

Seed Treatment with Systemic Fungicides for the Control of Fusiform Rust in Loblolly Pine

JOHN G. MEXAL AND *GLENN* A. SNOW

SUMMARY

A new systemic fungicide, Bayleton, may economically control fusiform rust in southern pine nurseries. Stratified seeds of loblolly pine (*Pinus taeda* L.) were imbibed with Bayleton and two other systemic fungicides, and the seedlings were inoculated at three stages of emergence with spores of *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme.* Bayleton was the only effective fungicide. Soaking seed at a concentration of 800 mg/L did not inhibit seed germination and afforded significant protection against the disease.

Additional keywords: Bayleton, *Cronartium quercuum.*

CONTROLLING RUST IN NURSERIES

Fusiform rust caused by *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme* (Burdsall and Snow 1977) is a serious disease of pines in southern nurseries. Current control methods consist of frequent applications of the contact fungicide, ferric dimethyldithiocarbamate (ferbam) (Foster and Henry 1956). Despite as many as 30 spray applications during the 90-day infection season, infection levels of 15 to 20 percent are not uncommon (Rowan 1972). Many infections occur during the first few days after seed germination, the most difficult time to protect the germinating seedlings adequately. One reason is that they are rapidly elongating and new growth is not protected by previously applied contact fungicides. Also, repeatedly moving tractors carrying spray equipment through the nursery during spring rains can cause considerable mud damage to seedlings.

Several systemic fungicides have been used experimentally to control fusiform rust with some success. However, control was accomplished by spraying, the foliage or by soil drenching (Hare and Snow 1976, Rowan 1972, 1977). Seed coating has been attempted but with little success (Rowan 1972); unless the fungicide is washed off the seed coat before seedling emergence so that it can be taken up by the roots, it is unlikely that this method could be effective. The objective of our trial was to permeate stratified pine seed with systemic fungicides, a method that has not been investigated before. Our aim was to: (a) determine the effect of systemic fungicides on loblolly pine seed germination, and (b) determine if seed permeation affords protection against rust during the early phases of seedling emergence.

Biswas and others 1972, permeated stratified loblolly pine seed with plant growth regulators, which improved germination. Effective control of other diseases through seed permeation has

Southern Forest Experiment Station/T-10210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.
Serving Alabama, Arkansas, Louisiana, Mississippi, Eastern Oklahoma, Tennessee, Eastern Texas.

been proven for dry seed only (Maude and Kyle 1970, Tao and others 1974).

MATERIALS AND METHODS

The fungicides tested were 2-iodobenzaniiide (Benodanil), 1-(4-chlorophenoxy)-3, 3-dimethyl-1-1-(1H-1,2,4-triazol-1-yl)-2-butanone (Bayleton), and Thiadiazole Compound (NA_{43410}).

To determine the best concentration of fungicides to use in solutions, seeds were germinated after treatment with three levels of the chemicals (table 1). Seeds from the flatwoods seed zone in Mississippi that were known to be susceptible to rust were stratified for 30 days, soaked in aqueous solutions of a fungicide for 24 hours, and surface dried. They were then germinated in the laboratory on moist cellulose wadding at room temperature. Each treatment consisted of three replicates of 100 seeds each, and germination was monitored daily for 2 weeks. A seed was counted as germinated when the radical protruded 2 mm from the coat.

After the germination trial seeds from the same source were soaked in the highest concentration of each fungicide that did not inhibit the rate of germination. These treatments were: (1) Benodanil (80 mg/L), (2) NA_{43410} (300 mg/L), and (3) Bayleton (800 mg/L). These concentrations and a control (no fungicide) were used in the inoculation trial.

Table 1 .-Percentage *germination of loblolly pine seed infused with various systemic fungicides.*

Chemical	Concentration	Germination Test (%)[1] By Day 5	Total
	mg/L		
Benodanil	30	23.0 d[2]	80 a
	80	13.7 abc	79a
	200	6.3 a	79a
NA_{43410}	30	13.7 abc	80a
	300	14.0 bc	81 a
	3000	10.7 ab	71 a
Bayleton	50	18.0 bcd	76a
	200	14.0 lx	82 a
	800	13.3 abc	77a
Control		19.0 cd	77 a

[1] Germination percentage of seed used in rust inoculation trial.

[2] Percentages in a column followed by the same letter are not significantly different (a = 0.05).

Seedlings representing three stages of development were inoculated with rust spores 18 days after the seed treatment (fig. 1). 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. Each plant received 18 ±3 basidiospores/mm² using the pine inoculation method described by Snow and Kais (1972). Percent infection was determined 12 months after sowing.

RESULTS

The concentrations of the fungicides used in the germination test did not significantly influence total germination, but speed of germination (as indicated by percent germination 5 days after sowing) was significantly affected (table 1). However, no difference existed in rate of germination between concentrations of the fungicides used in the inoculation trial and the control.

Neither Benodanil nor NA_{43410} was effective in controlling rust; treated seedlings averaged 78 and 84 percent infection, respectively (table 2). However, Benodanil and NA_{43410}

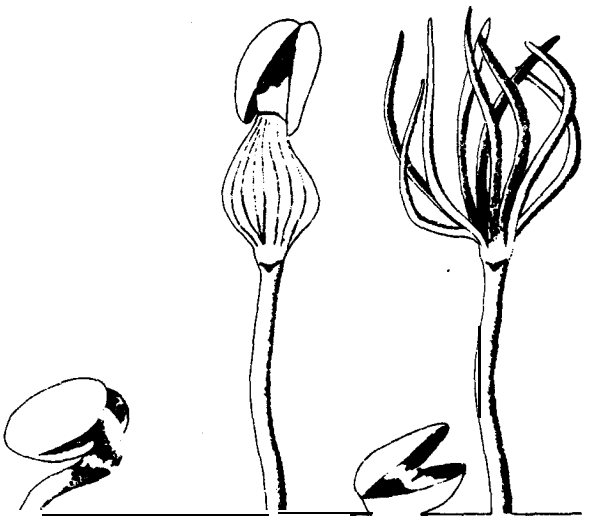

Figure 1 .-*Stages of seedling development at time of rust inoculation.*

John Mexal is Regeneration Specialist, Weyerhaeuser Company, Southern Forestry Research Center, Hot Springs, Arkansas, and Glenn Snow is Principal Plant Pathologist, Southern Forest Experiment Station, Forest Service, USDA, Gulfport, Mississippi.

Table 2.—*The effect of seed treatment with systemic fungicides on seedling infection 12 months after inoculation with rust spores.*

Chemical	Concentration	Seedlings with rust galls > 5 mm[1] (%)			Seedlings with galls or lesions (%)		
		Small	Medium	Large	Small	Medium	Large
	(mg/L)						
Benodanil	80	88 a*	67a	67 a	89a	71 a	71 a
NA_{43410}	300	88 a	75 a	87 a	88 a	76 a	90 a
Bayleton	800	14b	22 b	21 b	14 b	22 b	22 b
Control	-	93 a	63 a	77a	96 a	66a	83 a

[1] Rust galls >5 mm long were considered active.

[2] Values followed by the same letter are not significantly different (a = 0.05) according to Duncan's multiple range test.

(Rowan, personal communication) have been effective as systemic fungicides in pine seedlings; thus, these chemicals may not have permeated the seeds in our test.

Bayleton was significantly more effective than any other treatment. When the three size classes of seedlings were averaged, only 18% of those treated with this chemical had active galls (that is, galls greater than 5 mm long) after 12 months (table 2). The protection afforded by Bayleton appeared to diminish as seedlings developed, but the increase in infection with increasing seedling size was not significant ($a = .05$). This probably occurred because the fungicide was diluted or degraded as the seedlings developed.

DISCUSSION

About 500 ha of nursery space are devoted to the production of pine seedings in the South, and more than $100,000 is spent annually on the control of fusiform rust. Often control is poor, especially during seedling emergence when most infections occur. Treating seeds with Bayleton may afford better early spring protection than current methods, at a considerable savings. It is difficult to extrapolate these results to a field response, but Snow and others (1977), indicated that high spore densities, such as used in this study, result in maximum rust infections. Densities this high rarely occur in nature. We are testing this fungicide further in nursery trials, both as a seed treatment and as a foliar spray.

Acknowledgments

The authors thank Wyandotte Corporation for supplying Benodanil, Chemagro for Bayleton, and North American Chemical Company and Dr. S. J. Rowan, USFS, for Thiadiazole Compound.

Note: This paper reports the results of research involving fungicides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of fungicides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Mention of a trademark or proprietary product does not imply a recommendation of the product by the USDA to the exclusion of other products that may also be suitable.

LITERATURE CITED

Biswas, P. K., P. A. Bonamy, and K. B. Paul.
1972. Germination promotion of loblolly pine and bald cypress seeds by stratification and chemical treatments. Physiol. Plant. 27: 71-76.

Burdsall, Harold H., Jr., and Glenn A. Snow.
1977. Taxonomy of *Cronartium quercuum* and C. *fusiforme*. Mycologia 69: 503-508.

Foster, A. A., and B. W. Henry.
1956. Nursery control of fusiform rust demands careful spraying. Tree Planters' Notes 24: 13-l 5.

Hare, R. C., and G. A. Snow.
1976. Two systemic fungicides show promise for control of fusiform rust. Plant Dis. Rep. 60: 530-531.

Maude, R. B., and Ann M. Kyle.
1970. Seed treatments with benomyl and other fungicides for the control of *Ascochyta pisi* on peas. Ann. Appl. Biol. 66: 37-41.

Rowan, S. J.
1972. Selected systemic fungicides provide little control of fusiform rust of loblolly pine in forest tree nurseries. Plant Dis. Rep. 56: 628-630.

Rowan, S. J.
1977. Fusiform rust management strategies in concept: nursery management, p. 116-121. *In* R. J. Dinus and R. A. Schmidt (eds.)

Management of fusiform rust in southern pines. Symp. Proc. Univ. Fla., Gainesville.

Snow, G. A., and A. G. Kais.
1972. Technique for inoculating pine seedlings with *Cronartium fusiforme.* p. 325-326. In Biology of rust resistance in forest trees: Proceedings of a NATO-IUFRO Advanced Study Institute. US. Dep. Agric. Misc. Pub. 1221.

Snow, G. A., R. J. Dinus, H. R. Powers, Jr., and F. R. Matthews.
1977. Influence of pathogenic variability and inoculum density on fusiform rust, p. 71-79. In R. J. Dinus and R. A. Schmidt (eds.) Management of fusiform rust in southern pines. Symp. Proc. Univ. Fla., Gainesville.

Tao, K. L., A. A. Khan, G. E. Harman, and C. J. Eckenrode.
1974. Practical significance of the application of chemicals in organic solvents to dry seeds. J. Amer. Soc. Hort. Sci. 99: 217-220.

U.S. GOVERNMENT PRINTING OFFICE: 773-383