Auburn University
Southern Forest Nursery Management Cooperative

RESEARCH REPORT 08-04

FUNGICIDES FOR THE CONTROL OF FUSIFORM RUST

by
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INTRODUCTION

The most important disease of loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliottii*) seedlings in the southeastern United States is fusiform rust (*Cronartium quercuum f.sp. fusiforme).* Since 1951, Ferbam® (ferric dimethyldithiocarbamate) and later Bayleton® (triadimefon) are the only two chemicals used to control this disease (Rowan 1979, Carey & Kelley 1993). Ferbam required multiple applications and did not provide adequate, consistent nor cost-effective control (Rowan 1976). Therefore, Bayleton® was readily accepted by nursery managers as it required fewer applications and provided excellent cost-effective control (Snow et al 1979, Carey & Kelley 1993, Carey 2004). It proved to be very effective as a seed treatment and foliar spray.

However, over the past two years, events have occurred that potentially threaten the availability and use of Bayleton®. In July 2007, Bayer CropScience received EPA's cancellation order for many uses for Bayleton®. Most of the food crops such as apples, pears, grapes and raspberries were dropped from the label. Fortunately, the use on pine seed and seedlings remained. However, the availability of the labeled formulation has been reduced, which resulted in nurseries having difficulty finding the labeled product. In an effort to find a suitable alternative to Bayleton®, a number of fungicides were evaluated for their efficacy against fusiform rust.

METHODOLOGY

Bayleton® was included in the studies as well as a water-only treatment (control). In 2006, Folicur® was tested and found to have poor rust control results as a seed treatment. After reviewing the 2006 methodology, it was realized that the seed treatment was not conducted properly. Consequently, the methodology for the Folicur® seed treatment was changed in 2007. Dividend Extreme® is only labeled as a seed treatment and therefore was not tested as a foliar spray in 2007. Eagle® was included in 2007 because it is labeled for loblolly pine. The other fungicides chosen in 2006 and 2007 were the result of recommendations from research scientists of the various chemical companies (Table 1).

Seed Application. Loblolly pine seed were stratified for 4 weeks and then were treated with the fungicides (Table 2 & 3). For dry formulation fungicides, the seed was first moistened in a seed tumbler and then the fungicide was added at the rate of 2 oz/50 lbs of seed. For all liquid fungicides, 1 ml of the fungicide was slowly added to the dry seed in the seed tumbler. The seed remained in the tumbler for several minutes until dry. All seed treated with the test fungicides as well as a Bayleton DF® check and non-treated seed for both positive and negative controls were double sown to Ray-Leach containers and then thinned to one seedling per cell as they germinated. In 2006, six replications of twenty seedlings each were considered the treatment unit. In 2007, eight replications of twenty seedlings were used. The percent germination was recorded.

Foliar Application. Loblolly pine seed were stratified for 4 weeks and then double sown into Ray-Leach containers. Following germination, containers were thinned to one seedling per container and then randomly assigned fungicidal treatments. Six replications of twenty seedlings each were considered the treatment unit in both 2006 and 2007. Seven weeks after sowing, seedlings were treated at Auburn University's Pesticide Research Facility. Application rates for each fungicide included a 1x and 2x rate (except Bayleton® which only had a 1x rate). After treatment, seedlings were returned to the greenhouse.

One day following the foliar application, all seedlings were transported to the USDA Rust Screening Laboratory in Asheville, North Carolina. Seedlings were allowed to acclimate for 5-7 days and then they were challenged with 20,000 basidiospore spores/ml of *Cronartium quercum f.sp. fusiforme* (collected from rust Zone 7). Seedlings remained at the Rust Laboratory for the duration of the growing season. At three and six months the seedlings were evaluated for swellings along the main stem, an indication of infection, by the personnel at the Rust Lab. Six months after inoculation, seedlings were returned to Auburn University where height, RCD and seedling biomass was measured.

Table 1. Trade names, formulation, manufacturer and active ingredient of selected fungicides

Fungicide	Formulation	Manufacturer	Active Ingredient
Bayleton®	Dry flowable	Bayer Cropscience	triadimefon 50%
Eagle®	Emulsifiable Concentrate	Dow Agroscience	myclobutanil 19.7%
Heritage®	Water Dispersible Granules	Syngenta	azoxystrobin 50%
Inspire®	Emulsifiable Concentrate	Sygenta	difenconazole 25%
Dividend Extreme®	Dust	Sygenta	difenoconazole 7.73% & mefenoxam 1.93%
Medallion®	Wettable Powder	Syngenta	fludioxonil 50%
Provost®	Emulsifiable Concentrate	Bayer Cropscience	prothioconazole 12.9% & tebuconazole 25.8%
Absolute®	Emulsifiable Concentrate	Bayer Cropscience	tebuconazole 22.6% & trifloxystrobin 22.6%
Folicur®	Flowable Concentrate	Bayer Cropscience	tebuconazole 38.7%

Table 2. Fungicides rates (product per acre or per 50 lbs) for 2006

Fungicide	Foliar Treatment[1]		Seed Treatment
	1X	2X	1X
Bayleton®	4 oz/a		2 oz/50 lb seed
Heritage®	11 oz/a	18 o/a	2 oz/50 lb seed
Medallion®	9 oz/a	18 oz/a	2 oz/50 lb seed
Folicur®	4 fl oz/a	8 fl oz/a	**

[1] Based upon 30 gal water /a

** Due to an error in rate calculation, the seed treatment data for Folicur® was not analyzed.

Table 3. Fungicides rates (product per acre or pound) for 2007

Fungicides	Foliar Treatment[1]		Seed Treatment
	1X	2X	1X
Check (water)			
Bayleton®	8 oz/a		2 oz /50 lb seed
Eagle®	15 fl oz/a	30 fl oz/a	1 ml
Inspire®	7 fl oz/a	14 fl oz/a	1 ml
Dividend Extreme®			1 ml
Provost®	8.5 fl oz/a	17 fl oz/a	1 ml
Absolute®	5 fl oz/a	10 fl oz/a	1 ml
Folicur®			1 ml

[1] Based upon 30 gal of water /acre

Table 4. Germination and mean percent infection for seed treatments, 2006

Seed Treatment	% Germination Following Seed Treatment	6 Month % Infection
Check	100%	44%
Bayleton®	100%	0%
Heritage®	100%	23%
Medallion®	100%	38%
Folicur®	55%	0%

Table 5. Percent infection six months after foliar treatment, 2006

Spray Treatment	Foliar Treatment	
	1X	2X
Check	51%	
Bayleton®	24%	
Heritage®	48%	58%
Medallion®	63%	54%
Folicur®	50%	50%

Table 6. Seed germination, percent infection, RCD, shoot length and dry weight for seed treatment, 2007

Seed Treatment	Seed Germination	% Infection	RCD (mm)	Height (cm)	Dry Wt (g)
Check	99%	45% a	4.7 a	28.4 ab	2.86 a
Bayleton®	92%	23% de	4.4 b	29.5 a	2.68 ab
Eagle®	31%	0% e	3.7 d	25.5 c	2.00 c
Inspire®	30%	12% c	3.8 d	26.5 c	1.90 c
Dividend Extreme®	71%	25% b	4.0 c	27.3 bc	2.14 bc
Provost®	100%	0% e	4.3 b	30.0 a	2.84 a
Absolute®	95%	10% cd	4.2 bc	27.3 bc	2.42 bc
Folicur®	100%	4% cde	4.0 c	29.4 a	2.73 a

[1]Means in columns followed by the same letter are not significantly different (α =0.05; Duncan's new multiple range test).

Table 7. Percent infection, RCD, shoot length and dry weight for foliar spray treatment, 2007

Spray Treatment	Rate	% infection	RCD (mm)	Height (cm)	Dry Wt (g)
Check		24% ab	4.5 ab	24.3 b	2.43 b
Bayleton®	1X	20% cb	4.3 b	25.5 ab	2.36 b
Eagle®	1X	2% e	4.5 ab	26.1 ab	2.59 ab
Eagle®	2X	2% e	4.4 ab	26.8 a	2.51 ab
Inspire®	1X	33% a	4.7 a	26.6 a	2.85 a
Inspire®	2X	23% ab	4.2 b	25.5 ab	2.40 b
Provost®	1X	5% de	4.3 b	26.8 a	2.48 ab
Provost®	2X	2% e	4.3 b	26.0 ab	2.40 b
Absolute®	1X	16% bcd	4.5 ab	26.4 a	2.74 ab
Absolute®	2X	9% cde	4.4 ab	25.5 ab	2.50 ab

[1]Means in columns followed by the same letter are not significantly different (α =0.05; Duncan's new multiple range test).

RESULTS

Germination Following Seed Treatment. In 2006, all treatments had acceptable germination except for Folicur® (Table 4). In 2007, the effect of Eagle®, Inspire® and Dividend Extreme® on loblolly pine germination was unacceptable (Table 6). Low germination of seed treated with Dividend Extreme® was unexpected since this product is labeled for seed treatment. Germination reported in Table 6 was recorded when seedlings were transported to the Rust Lab and germination continued for several weeks after arrival and inoculation. An extended period of germination is undesirable for nursery production. Both Folicur® and Provost® had 100% germination while a slight reduction in germination occurred with Bayleton® and Absolute® (Table 6).

Rust Control. In 2006 none of the foliar applied fungicides provided adequate control when compared to Bayleton (Table 5). As a seed treatment in 2006 only Bayleton® and Folicur® provided effective control (Table 4). The low germination rate of Folicur® in 2006 was due to faulty methodology and application. Since no fungicide provided adequate rust control in 2006, the seedling quality data is not reported. In 2007, both the fungicides Eagle® and Provost® had 0% infection as a seed treatment and Folicur® had 4% (Table 6). Folicur® should not be considered as a possible Bayleton® alternative due to the high level of foliar infection in 2006. Eagle® (which contains petroleum as an inert ingredient) inhibited seed germination and thus this formulation may not prove useful as a seed treatment (Table 6). The fungicide is labeled as a foliar fungicide for fusiform rust and these results (Table 7) indicate that it would provide effective control as a foliar spray. Provost®, however, had no effect on seed germination and provided effective rust control when used as either a seed treatment or foliar spray (Tables 6 &

7). When germination infection rates were considered for all fungicides, Provost® provided effective control.

Provost® had no effect on seedling growth as measured by RCD, height or top dry weight. RCD is not a suitable measure of seedling quality in seedling rust studies. In 2007, we identified those seedlings that visually had lower swollen stems as a result of galls on the stem. The correlation (Pearson's r) between percent infection and those seedlings with swollen lower stems was 0.77.

Future Investigations. To be considered as an alternative to Bayleton DF®, a product must provide good rust control (preferably both as a spray and as a seed treatment). Provost® was effective in preventing rust infection when used as both a seed treatment and as a foliar spray.

Provost® is registered as a fungicide for control of foliar peanut diseases and is a combination of two fungicides listed in Table 2. The first ingredient is tebuconazole which is the active ingredient in Folicur®. In 2006, Folicur® did not show good foliar activity. However, the second ingredient in Provost® is prothioconazole which, according to Bayer CropScience, belongs to a new advanced class of azole - triazolinthiones. The good response we had with Provost® can probably be attributed to the prothiaconazole fraction.

REFERENCES

Carey, W.A. 2004. Evaluating fungicides for the control of fusiform rust in a greenhouse study. Auburn University Southern Forest Nursery Management Cooperative. Research Report 04-6. 3p.

Carey, W.A. and W.D. Kelley. 1993. Seedling production trends and fusiform rust control practices at southern nurseries, 1981-1991. South. J. Appl. For. 17(4): 207-211.

Rowan, S.J. 1976. Incidence of fusiform rust in Georgia forest tree nurseries, 1959-1973. USDA Tree Planters' Notes 28: 17-18, 29.

Rowan, S.J. 1979. Rainfall and frequency of ferbam sprays important for fusiform rust control. South. J. Appl. For. 3(4):167-168.

Snow, G.A., S.J. Rowan, J.P. Jones, W.D. Kelley, and J.G. Mexal. 1979. Using Bayleton® (triadimefon) to control fusiform rust in pine tree nurseries. USDA For. Serv. Res. Note 50-253. 5p.