

Bayleton® for Fusiform Rust Control - An Update of Research Findings

by

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Abstract.--Based on a series of studies, a spray schedule is presented that should improve the efficacy of Bayleton for fusiform rust control in nurseries. Many adjuvants appear to be useful in formulations with Bayleton. A seed soak treatment is an approved use in some states under the 24-C label. Use of Bayleton as a seed treatment combined with foliar sprays will improve rust control during the critical germination period. Observations of roots of seedlings at time of lifting indicate little, if any, suppression of mycorrhizal development of foliar sprays of Bayleton.

Although Bayleton (triadimefon) has provided excellent control of fusiform rust in greenhouse and nursery studies, operational use of this fungicide in nurseries using the recommended spray schedule resulted in unacceptable levels of rust losses in some nurseries. Among 32 nurseries using Bayleton on their 1981-1982 crops, 15 reported no rust (the desired goal), 15 reported less than 1 percent, and 2 reported less than 2 percent rust. In the same crop year, however, plots in Florida's Munson nursery had approximately 7 percent infection after 3 foliar sprays of Bayleton and plots at St. Joe Paper Company's nursery in Florida had approximately 3 percent infection after 3 foliar sprays^{2/}.

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In attempts to improve the control obtained with Bayleton, a series of studies were conducted. Results of these studies either have been or are being published elsewhere. One study was designed to determine if Bayleton foliar sprays, like ferbam sprays, must dry before irrigation or rain for rust control. Table 1 shows simulated rain 5 minutes or more after application of sprays did not reduce efficacy of the treatment. Theoretically, however, more fungicide would be on and in pine seedling tissues if sprays were allowed to dry fully before irrigating seedbeds.

Table 1. Effects of simulated rain on efficacy of Bayleton sprays for control of fusiform rust

Time after spray (Minutes)	Seedlings infected ^{1/} (Percent)
Nonsprayed check	86.8 a
0.25	1.2 b
1	1.2 b
5	0.0 c
15	0.0 c
30	0.0 c
60	0.0 c
120	0.0 c

^{1/} Means followed by a common letter do not differ (P=0.05) according to Duncan's Multiple Range Test.

A total of 18 adjuvants were compared for use in formulations with Bayleton for control of fusiform rust in pine seedlings. Results of this test show that, without rain, all tested adjuvants were of equal quality. After 5 cm of rain, however, two of the 18 adjuvants, Bond spreader sticker and Ortho X-77, were slightly inferior.

Table 2. Efficacy of 18 adjuvants in Bayleton sprays for control of fusiform rust of loblolly pine seedlings when applied 2¹/₇ days before seedlings were exposed to 0 and 5 cm of artificial rain ¹/₇

Adjuvant	Rate (ml) per liter	Rainfall (cm)	
		0	5
Nu-film-17	1.25	0.0a ^{2/}	0.0a
Security Spreader-Sticker	0.63	0.0a	0.0a
Exhalt-800	1.25	0.0a	0.0a
Triton X-45	1.25	0.0a	0.0a
Triton X-100	1.25	0.0a	0.0a
Atlas Sur-fac	5.0	0.0a	0.0a
Ortho X-77	0.47	0.0a	1.1b
Olde Worlde	1.25	0.0a	0.0a
Plantgard	200.0	0.0a	0.0a
Bio-film	0.47	0.0a	0.0a
Plyac	1.25	0.0a	0.0a
Dupont Spreader-Sticker	0.31	0.0a	0.0a
Ortho-Chevron Spray-Sticker	0.63	0.0a	0.0a
Agri-Dex	2.5	0.0a	0.0a
Agway Target NL	0.63	0.0a	0.0a
Wex	0.78	0.0a	0.0a
Bio-88	0.63	0.0a	0.0a
Bond Spreader-Sticker	2.5	0.0a	1.2b
No adjuvant	-	1.2b	1.2b
No Bayleton	-	56.0c	69.8c

¹/₇ Infection percentages are the average of five 20-tree-replicates determined 9 months after inoculation. Sprays contained 0.6 grams active Bayleton ingredient per liter.

²/₇ Means followed by a common letter do not differ significantly (P=0.05). Duncan's new Multiple Range Test was used to compare column means and Student's T test was used to compare rainfall effects. Zero percentages were excluded from these analyses.

The high speed at which Bayleton is absorbed by pine seedling tissues (Table 1) probably explains why the adjuvants varied so little. Proper agitation of the spray mix during preparation and application should make most, if not all, adjuvants tested of equal value when used with Bayleton.

In a test to determine how effective a seed soak treatment was for control of fusiform rust, significant reduction in rust incidence was evident through 35 days after seedling emergence (Table 3) and complete control by the seed treatment was obtained through 7 days.

Table 3. Efficacy of Bayleton^{1/} in preventing fusiform rust infections in slash pine seedlings originating from Bayleton treated and nontreated seed and inoculated at differing time intervals after seed germination.

Seedling age at inoculation (days after emergence)	Seedling galled ^{2/} (%)	
	Untreated Checks	Seed treatment only
7	39.0 b	0.0 f
14	49.7 b	4.1 e
21	74.8 a	13.1 de
28	81.7 a	42.3 bc
35	77.7 a	33.7 c
42	79.0 a	62.6 ab
49	82.2 a	53.8 b
56	88.7 a	71.1 a
63	79.1 a	76.7 a
70	86.5 a	70.9 a

^{1/} Bayleton was formulated in aqueous suspension at 0.6 grams active ingredient and 2.5 ml Agri-dex adjuvant per liter and used to soak seed at room temperature for 24 hours.

^{2/} Infection percentages are the average of five 20-tree replicates determined 10 months after inoculation. In each column, means followed by a common letter are not significantly different ($P=0.05$). In each row, means underlined are not significantly different ($P=0.05$) according to Duncan's Multiple Range Test.

Because a seed soak is a preventative measure and foliar sprays have both preventative and eradivative properties, it was reasoned that the combination of the two treatments may increase the degree of rust control. A test was therefore devised in which foliar sprays were applied at differing time intervals before and after inoculation with the rust fungus to seedlings originating from both treated and nontreated seeds. Results of this study show that foliar sprays alone will prevent infections for up to 28 days after spray applications (Table 4) and will eradicate infections up to 7 days old. When both a foliar spray and seed treatment are combined, however, infections up to 14 days old were eradicated. Therefore, when seeds are treated, seedlings need not be sprayed until 14 days after emergence begins.

Table 4. Efficacy of Bayleton^{1/} in preventing or eradicating fusiform rust infections in slash pine seedlings when foliar sprays are applied (with and without seed treatment) at differing time intervals before and after inoculation with the rust fungus

Treatment schedule (days before or after inoculation)	Seedlings galled ^{2/} (%)			
	Sprayed before inoculation		Sprayed after inoculation	
	Foliar spray only	Foliar spray and seed treatment	Foliar spray only	Foliar spray and seed treatment
1	--	--	0.0a	0.0a
7	0.0a	0.0a	0.0a	0.0a
14	0.0a	0.0a	8.7b	0.0a
21	0.0a	0.0a	20.2c	5.5b
28	0.0a	0.0a	48.9d	28.4c

^{1/}Bayleton was formulated in aqueous suspensions at 0.6 grams active ingredient and 2.5 ml Agri-dex adjuvant per liter and used as foliar sprays and to soak seed for 24 hours at room temperature.

^{2/}Means followed by a common letter do not differ significantly (P=0.05) according to Duncan's Multiple Range Test. Infection percentages are the average of five 20-tree replicates determined 10 months after inoculation. Untreated checks were 79.0 percent infected which differed significantly from 48.9 percent infection at 28 days.

Bayleton did not eradicate infections on 4 year old loblolly pines when applied topically (Table 5), giving additional proof that this fungicide will eradicate only the very young infections.

Table 5. Aecial sporulation of fusiform rust galls after topical application of two fungicides

Treatment ^{1/} and rate of a.i. (mg/liter)	Year of observation			
	1977	1978	1979	1980
	-----Percent-----			
Benodanil				
0	76 a	94 a	36 a	60 a
150	66 a	56 b	10 a	30 a
300	68 a	55 b	7 b	40 a
600	56 a	46 b	11 b	50 a
Bayleton				
0		75 a	16 a	30 a
500		75 a	15 a	40 a
1000		77 a	10 a	30 a
2000		65 a	13 a	20 a

^{1/} Benodanil was applied 3/18/77 and Bayleton 10/13/77 at the average rate of 260 ml/gall (runoff) with a paint brush after the outer, rough bark was removed with a gloved hand.

Means within each treatment column followed by a common letter do not differ (P=0.05) according to Duncan's Multiple Range Test.

Bayleton is registered for use in forest nurseries as foliar sprays, and is approved under the 24-C label for use as a seed treatment in the states of Georgia, Arkansas, Virginia, South Carolina, and Florida. All other southern states have not granted approval of this use and nurserymen in these states must await federal or state approval. If seeds germinate over a period of several weeks, repeated spraying appears to be necessary during the emergence period unless seed are treated or sufficient quantities of the fungicide are absorbed by seed sprayed before their germination. A test was therefore, designed in which Bayleton was applied as a spray at intervals during the germination period to seedlings originating from both treated and nontreated seed. The results of this test clearly show that insufficient quantities of Bayleton are absorbed by seed when sprays are applied before germination (Table 6).

Table 6. Efficacy of Bayleton^{1/} in controlling fusiform rust in slash pine seedlings when foliar sprays are applied at intervals during seed germination to seedlings originating from Bayleton treated and nontreated seed

Treatment schedule (days after seed sown)	Seed germination (%) at treatment date	Seedlings galled ^{2/} (%)		
		Untreated checks	Foliar spray only	Foliar Spray & seed treatment
7	48.9	82.0 ab	66.3 d	0.0 a
9	62.9	86.0 b	48.1 c	0.0 a
11	72.2	69.8 a	36.1 c	0.0 a
13	83.0	75.4 ab	22.0 b	0.0 a
15	87.9	79.0 ab	15.7 b	0.0 a
21	100.0	77.1 ab	0.0 a	0.0 a

^{1/} Bayleton was formulated in aqueous suspensions at 0.6 grams active ingredient and 2.5 ml Agri-dex adjuvant per liter and used as foliar sprays and to soak seed at room temperature for 24 hours.

^{2/} Infection percentages are the average of five 30-48 tree replicates (50 seed sown/replicate) determined 10 months after inoculation. Inoculations were made 30 days after seed were sown. In each column means followed by a common letter are not significantly different (P=0.05) according to Duncan's new Multiple Range Test. All row means not underlined differed (P=0.05) according to Fishers F and Duncan's Multiple Range Test.

Incidence of fusiform rust in nurseries having used Bayleton operationally may, therefore, be attributed to: (1) its inability to protect seedlings emerging between any two sprays applied at intervals greater than 7 days; (2) its inability to eradicate infections 14 or more days old; and (3) inadequate coverage of seedling foliage with any spray application. An improved spray schedule is to (a) apply a first spray 7 days after germination begins or no later than 7 days after the first infection period following the beginning of germination; (b) apply a second spray 7 days later or no later than 7 days after the first infection period following the first spray; (c) thereafter, apply two additional sprays during the remaining rust hazard season (until the first week of July) at intervals not to exceed 35 days. Ferbam sprays can be used to help prevent infections where seedlots germinate over an extended period. In states where Bayleton can be used as a seed treatment, the first spray must be applied 14 days after germination begins or no later than 7 days after the first infection period following the first 14 days of seed germination. Thereafter, sprays should be applied at intervals not to exceed 35 days.

In an attempt to determine if operational use of foliar sprays in nurseries are detrimental to the development of mycorrhizae, Bayleton was applied at differing rates and frequencies to slash and loblolly pine seedlings. Roots were examined at the end of the growing season to evaluate mycorrhizal development. Applications of 4 (0.28 kg/ha), 6 (0.42 kg/ha), and 8 (0.56 kg/ha) ounces active ingredient per acre in multiple applications (up to 4) did not harm mycorrhizal development on slash and loblolly pine seedlings (Tables 7 and 8). First year data from a study designed to determine if Bayleton accumulates in soil from operational sprays indicate very little effect on mycorrhizal development even when 24 ounces of the active ingredient are applied per acre (Table 9).

Table 7. Effect of field applications of Bayleton on production of short roots with mycorrhizae by slash pine seedlings

Treatment ^{1/}	Rate (Kg / ha)	Spray interval	No. of applications	Short roots with mycorrhizae (%) ^{2/}
Control	--	--	--	52.7 a ^{3/}
Bayleton	SS --	--	--	49.0 a
Bayleton	SS+FS 0.28	2-wk	4	45.4 a
Bayleton	SS+FS 0.28	3-wk	3	49.0 a
Bayleton	SS+FS 0.42	2-wk	4	43.5 a
Bayleton	SS+FS 0.42	3-wk	3	39.2 a
Bayleton	SS+FS 0.56	3-wk	3	43.7 a
Bayleton	SS+FS 0.56	4-wk	2	44.1 a
Bayleton	PPI 0.56	--	1	44.0 a
Bayleton	PPI 1.12	--	1	37.7 a

^{1/} Abbreviations: SS=seed soak (800 mg Bayleton/l for 24 hr); FS=foliar spray; PPI=preplant soil incorporated.

^{2/} Each figure represents the average of 10 seedlings from each of 8 replicate plots.

^{3/} Means followed by the same letter do not differ ($P = 0.01$) according to Duncan's Multiple Range Test.

Table 8. Effect of field applications of Bayleton on production of short root with mycorrhizae by loblolly pine seedlings

Treatment ^{1/}	Rate (kg / ha)	Spray interval	No. of applications	Short roots with mycorrhizae (%) ^{2/}
Control	--	--	--	35.4 a ^{3/}
Bayleton	SS --	--	--	32.1 a
Bayleton	SS+FS 0.28	2-wk	4	32.0 a
Bayleton	SS+FS 0.28	3-wk	3	35.2 a
Bayleton	SS+FS 0.42	2-wk	4	28.5 a
Bayleton	SS+FS 0.42	3-wk	3	35.3 a
Bayleton	SS+FS 0.56	3-wk	3	24.8 a
Bayleton	SS+FS 0.56	4-wk	2	30.4 a
Bayleton	PPI 0.56	--	1	35.9 a
Bayleton	PPI 1.12	--	1	34.3 a

^{1/} Abbreviations: SS=seed soak (800 mg Bayleton/l for 24 hr); FS=foliar spray; PPI=preplant soil incorporated.

^{2/} Each figure represents the average of 10 seedlings from each of 8 replicate plots.

^{3/} Means followed by the same letter do not differ ($P = 0.01$) according to Duncan's Multiple Range Test.

Table 9. Effect of Bayleton foliar sprays applied to the same seed beds annually on production of mycorrhizal roots by loblolly pine seedlings: first-year-data from MacMillan-Bloedel nursery, 1981-1982.

Treatment	No. mycorrhizal roots/ 10 cm of laterals
Control	33.3
Bayleton 1 X*	34.4
Bayleton 2 X	30.6
Bayleton 4 X	28.6

*1 X rate = 6 oz. a.i./acre

Bayleton was also tested on 1-0 loblolly nursery stock applied at different rates as a top-dip, root-dip, or as a clay-slurry root-dip to determine if such treatments would provide protection against rust infections during the first year in the plantation. The results of this study show that Bayleton applied in a clay-slurry root dip provides control during the first year after outplanting (Table 10).

Table 10. Efficacy of Bayleton^{1/} for control of fusiform rust in 1-0 loblolly pine nursery stock when applied at different rates and methods before artificial inoculation 3 months after treatment or exposure to first year natural-field inoculum

Treatment	Bayleton concentration (mg/liter)	Seedlings galled ^{2/} (%)	
		Greenhouse- artificial inoculations	Nursery- natural infections
Checks	0	10.9 a	4.0 a
Check-clay slurry	0	4.8 a	6.3 a
Top dip	600	0.0 b	4.0 a
	800	0.0 b	4.2 a
	1,000	0.0 b	2.1 b
	1,500	0.0 b	0.0 c
Root dip	600	0.0 b	2.0 b
	800	0.0 b	4.2 a
	1,000	0.0 b	2.0 b
	1,500	0.0 b	0.0 c
Clay-slurry	600	0.0 b	0.0 c
	800	0.0 b	0.0 c
	1,000	0.0 b	0.0 c
	1,500	0.0 b	0.0 c

^{1/}Bayleton was formulated to contain 2.5 ml of the adjuvant, Agri-dex, per liter. The clay slurry contained 45.35 percent kaolinitic clay (weight/volume).

^{2/}In each column, means followed by a common letter do not differ (P = 0.05) according to Duncan's Multiple Range Test.