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Effect of Protectant and Eradicant Fungicides

on Area Under the Leaf Rust Progress Curve, Yield, and Kernel Weight of Mississippi Winter Wheat

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Introduction

Leaf rust, caused by *Puccinia recondita* f. sp. *tritici*, occurs commonly on winter wheat (*Triticum aestivum* L.) in Mississippi and continues to be a threat to wheat production. This disease appears early in the spring on winter wheat and progresses rapidly when temperatures range from 59-72 °F and the relative humidity is high.

Wheat cultivars grown in the Southeast have less resistance to this fungus than cultivars grown in other areas of the United States (4). This has been attributed to local overwintering/oversummering of inoculum and the presence of diverse virulences of *P. recondita* f. sp. *tritici* (4,5). Wheat cultivars with monogenic resistance have been developed, but most have succumbed to new virulent races of the pathogen.

Because of the absence of durable resistance in available high yielding wheat cultivars adaptable to the Southeast, chemotherapy of moderately resistant to moderately susceptible cultivars has potential value to combat leaf rust.

Research in Mississippi was initiated in 1988 to characterize the chemotherapeutic response of available cultivars with acceptable yield potential (7). Fungicide application in these studies not only reduced disease pressure but also enhanced wheat yield and kernel weight. In order to maximize wheat yield and minimize cost-benefit ratios, proper timing of fungicide applications is critical.

This study was conducted to determine the response of wheat to fungicide applications based on crop growth stage and initial appearance of disease symptoms. Results of this study could be helpful in providing base-line information for determining the optimum timing of fungicide application.

Materials and Methods

Experimental plots were established in a randomized complete block design with five replications at the MAFES Plant Science Research Center, Mississippi State University, Starkville, and at the MAFES Black Belt Branch Experiment Station, Brooksville.

Wheat cultivars Coker 9323, Coker 9733, Coker 9835, Pioneer 2548, and Pioneer 2555 were sown in November 1991. These cultivars were selected because they represent a range of response to the foliar pathogens occurring in the state (1). The seeding rate was 90 pounds per acre.

Plots were limed and fertilized based on soil analysis with P_2O_5 and K_2O according to recommendations of the Mississippi Cooperative Extension Service. Nitrogen was applied to plots at the rate of 90 pounds per acre in a single spring application at both locations.

Hoelon® and Harmony® were applied at the 3- to 4-leaf stage at 42.6 fluid ounces and 0.7 ounces per acre, respectively, for the control of wild garlic (*Allium vineale* L.) and winter annuals.

A fungicide spray schedule was developed based on consideration of the mode of the active ingredient, effective dosage, crop growth stage (GS), weather conditions, and initial appearance of disease symptoms. At both locations, natural inoculum provided the source of infection.

The eradicant fungicides Punch®, Tilt®, RH-7592, and Folicur®, and the protectant fungicides Dithane® and Bayleton (which has both eradicant and protectant properties) were applied with a CO_2 backpack sprayer in one or two foliar applications in 20 gallons of water per acre. Treatments and application rates are listed for each location in Table 1. Climatological data were obtained from weather stations at each location.

Disease observations were made at 3-day intervals to determine effectiveness of each treatment for suppressing rust development. The flag leaf of each of 10 plants, chosen at random from each plot, was rated for rust severity by comparing the percent leaf area covered by rust lesions with the leaf rust severity scale developed by James (3).

The data were subjected to regression analysis, and slopes of mean disease severity were calculated. Area under the disease progress curve (AUDPC) for rust

development on the flag leaf was calculated by using the procedure of Shaner and Finney (6).

At physical maturity, wheat was harvested from a 20-foot by 5-foot swath in each plot. Grain weight was adjusted to 13 percent moisture and yield comparisons were made. Data were subjected to analysis of variance and means separated by the least significance difference (LSD) test (P = 0.05).

Results

At Starkville, leaf rust symptoms (2) were observed on the lower leaves of Coker 9733 on April 13, 1992. Similar symptoms were recorded on flag leaves of this variety April 21, and maximum disease severity (25% of the flag leaf area covered with rust lesions) occurred 2 weeks later. Leaves became necrotic on Coker 9733 earlier than on any other cultivar, and no disease ratings could be made on this cultivar after May 6.

Symptoms of leaf rust were recorded on the flag leaves of Pioneer 2548 and Pioneer 2555 May 3, while disease symptoms were not observed on Coker 9323 until May 6. Leaf rust severity on Coker 9323 and on Pioneer 2548 and 2555 lasted until May 12, after which further disease ratings could not be made due to drying of leaves and physical maturity of the crop. Coker 9835 remained free of disease at this location.

At Brooksville, symptoms of leaf rust were observed

Table 1. Comparison of parameter estimates of linear regression equations for effect of fungicides in suppressing leaf rust severity on winter wheat at Starkville and Brooksville, Mississippi, 1992.[1]

Treatments	Slopes (b_1)	R^2
Starkville		
Punch[2] (1.0 oz ai/A) applied at Feekes' growth stage 8	1.46	0.90
Punch (1.5 oz ai/A) applied at Feekes' growth stage 8	1.52	0.88
Punch (2.0 oz ai/A) applied at Feekes' growth stage 8	1.12	0.87
Punch (1.5 oz ai/A) applied at heading	1.31	0.85
Punch (2.0 oz ai/A) applied at heading	1.22	0.84
Punch + Punch (1.0 oz ai/A) applied at flag leaf followed by heading	1.03	0.82
Punch + Punch (1.5 oz ai/A) applied at flag leaf followed by heading	1.32	0.87
Tilt 3.6 EC[3] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9	1.38	0.87
Dithane 75 DF[4] (24 oz ai/A) + Bayleton 50 DF[5] (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9	1.25	0.85
Dithane 75 DF (24 oz ai/A) + Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	1.25	0.82
Tilt 3.6 EC (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	1.25	0.86
RH-7592 2F[4] (0.96 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	1.55	0.86
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 8	1.21	0.87
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	1.35	0.85
Bayleton 50 DF (1.0 oz ai/A) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	1.37	0.83
Untreated control	1.35	0.85
Brooksville		
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	3.42	0.90
RH-7592 2F (0.96 oz ai/A) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	0.00*	0.60
Folicur[5] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	0.15*	0.63
Folicur (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	0.06*	0.60
Punch (2.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	0.14*	0.33
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	3.65	0.89
Dithane 75 DF (24 oz ai/A) applied at flag leaf leaf stage followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	1.74*	0.75
Untreated control	3.48	0.79

[1] Rust severity based on ratings of percent leaf area covered by pustules
[2] Product of E. I. duPont deNemours & Co., Inc.
[3] Product of Ciba-Giegy Corporation
[4] Product of Rohm & Haas Co.
[5] Product of Miles, Inc.
* Indicates significant difference compared to untreated control based on F test for homogeneity (P = 0.05).

April 27 on Pioneer 2548 and 2555. Maximum disease development on these cultivars occurred in untreated control plots May 6. There were no leaf rust symptoms on Coker 9323, 9733, and 9835 at this location. However, powdery mildew was observed on Coker 9733 April 16; no symptoms of this disease were observed after this date.

Fungicide Effect on Leaf Rust Development

At Starkville, delays in the onset of disease of up to one week occurred in fungicide-treated plots compared to the untreated control. By the end of the evaluation period, mean disease severity in most of the treatments compared to the untreated control was statistically nonsignificant. However, sequential applications of Punch (1 oz ai/A applied at flag leaf stage followed by heading), and Punch (2 oz ai/A) applied at growth stage 8 (GS-8), consistently suppressed disease development compared to the untreated control (Table 1). Dithane applied at GS-8, or Punch (2 oz ai/A) applied at heading, proved equally effective in suppressing rust development.

At Brooksville, all treatments (except Dithane applied at heading and Bayleton applied at the flag leaf

Table 2. Area under disease progress curve (AUDPC) for winter wheat treated with fungicides at Starkville and Brooksville, Mississippi 1992.

	Cultivar			
	Coker		Pioneer	
Treatments	9323	9733	2548	2555
Starkville				
Punch[1] (1.0 oz ai/A) applied at Feekes' growth stage 8	22	241	27	45
Punch (1.5 oz ai/A) applied at Feekes' growth stage 8	22	203	48	67
Punch (2.0 oz ai/A) applied at Feekes' growth stage 8	17	245	16	25
Punch (1.5 oz ai/A) applied at heading	31	227	62	30
Punch (2.0 oz ai/A) applied at heading	22	194	48	39
Punch + Punch (1.0 oz ai/A) applied at flag leaf followed by heading	27	241	31	33
Punch + Punch (1.5 oz ai/A) applied at flag leaf followed by heading	25	265	62	41
Tilt 3.6 EC[2] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9	36	272	56	33
Dithane 75 DF[3] (24 oz ai/A) + Bayleton 50 DF[4] (1.0 oz ai/A) + Triton CS-7 (0.125%) applied at Feekes' growth stage 9	31	199	60	41
Dithane 75 DF (24 oz ai/A) + Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	34	185	54	45
Tilt 3.6 EC (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	35	242	62	39
RH-7592 2F[3] (0.96 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	43	224	89	51
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 8	34	258	65	49
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	39	246	98	48
Bayleton 50 DF (1.0 oz ai/A) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	36	244	87	62
Untreated control	29	210	87	37
Brooksville				
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	0	0	92	3
RH-7592 2F (0.96 oz ai/A) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	0	0	3	3
Folicur[4] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	0	0	3	8
Folicur (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	0	0	6	9
Punch (2 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	0	0	8	20
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	0	0	110	158
Dithane 75 DF (24 oz ai/A) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	0	0	38	119
Untreated control	0	0	154	195

[1]Product of E. I. duPont deNemours & Co., Inc.
[2]Product of Ciba-Giegy Corporation
[3]Product of Rohm & Haas Co.
[4]Product of Miles, Inc.

Table 3. Yield (Y) and 1,000 kernel weight (KW) of winter wheat treated with fungicides at Starkville and Brooksville, Mississippi, 1992.

Treatments	Coker						Pioneer			
	9323		9733		9835		2548		2555	
	Y	KW	Y	KW	Y	KW	Y	KW	Y	KW
	bu/A	g	b/A	g	bu/A	g	bu/A	g	bu/A	g
Starkville										
Punch[1] (1.0 oz ai/A) applied at Feekes' growth stage 8	73	29	57	33	87	34	83	29	79	34
Punch (1.5 oz ai/A) applied at Feekes' growth stage 8	75	29	57	35	96	33	85	29	84	43
Punch (2.0 oz ai/A) applied at Feekes' growth stage 8	79	30	58	29	93	33	84	29	92	36
Punch (1.5 oz ai/A) applied at heading	70	30	50	32	89	34	88	30	86	37
Punch (2.0 oz ai/A) applied at heading	74	30	56	34	91	33	90	30	91	36
Punch + Punch (1.0 oz ai/A) applied at flag leaf followed by heading	75	31	51	33	89	35	96	30	85	37
Punch + Punch (1.5 oz ai/A) applied at flag leaf followed by heading	76	30	53	33	90	33	93	30	89	37
Tilt 3.6 EC[2] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9	63	30	44	33	87	32	91	30	89	37
Dithane 75 DF[3] (24 oz ai/A) + Bayleton 50 DF[4] (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 9	79	31	64	34	93	33	91	30	85	35
Dithane 75 DF (24 oz ai/A) + Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	79	30	51	33	95	33	89	29	86	34
Tilt 3.6 EC (1.8 oz ai/A) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	75	30	64	35	96	35	94	30	91	37
RH-7592 2F[3] (0.96 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	73	31	52	33	90	34	92	30	87	36
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at Feekes' growth stage 8	79	29	58	34	89	33	91	29	84	35
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at the appearance of disease symptoms on flag leaf	66	30	52	32	91	33	88	29	73	33
Bayleton 50 DF (1.0 oz ai/A) applied at Feekes' growth stage 9 followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	79	30	52	33	94	34	87	30	84	35
Untreated control	72	30	45	33	87	33	83	28	72	33
*LSD (P ≤ 0.05)	16	1	9	3	10	1	12	1	9	2
Brooksville										
Bayleton 50 DF (1.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	94	30	63	34	106	33	105	30	96	35
RH-7592 2F (0.96 oz ai/A) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) at heading	92	29	73	35	106	33	102	30	104	37
Folicur[4] (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage	92	30	68	34	102	33	104	30	109	38
Folicur (1.8 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75DF (24 oz ai/A) at heading	90	30	65	33	106	32	106	30	103	38
Punch (2.0 oz ai/A) + Triton CS-7 (0.125% v/v) applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	85	29	64	34	102	34	104	30	103	38
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v) applied at heading	82	30	68	34	109	32	103	29	89	35
Dithane 75 DF (24 oz ai/A) + Triton CS-7 (0.125% v/v- applied at flag leaf stage followed by Dithane 75 DF (24 oz ai/A) at heading	95	30	65	34	109	33	104	31	96	36
Untreated control	87	30	67	35	105	33	104	30	89	35
*LSD (P ≤ 0.05)	12	2	8	1	12	1	6	1	10	1

[1] Product of E. I. duPont deNemours & Co., Inc.
[2] Product of Ciba-Giegy Corporation
[3] Product of Rohm and Haas Co.
[4] Product of Miles, Inc.

stage) significantly reduced disease development compared to the untreated control throughout the season. This suppressive effect occurred from the initial appearance of disease symptoms until the last observation.

Effect of Fungicides on Area under Disease Progress Curve

At Starkville, maximum area under the disease progress curve (AUDPC) was recorded on Coker 9733, followed by Pioneer 2548, Pioneer 2555, and Coker 9323 (Table 2). The treatment with the lowest AUDPC for Coker 9733 was Dithane plus Bayleton applied at heading. The only other treatments on Coker 9733 with lower AUDPC than the untreated control were Punch (2 oz ai/A) applied at heading and Dithane plus Bayleton applied at the flag leaf stage. The lowest AUDPC was recorded on Coker 9323, Pioneer 2548, and Pioneer 2555 when Punch (2 oz ai/A) was applied at GS-8. When this fungicide was tested at lower rates (1.0 or 1.5 oz ai/A) at GS-8 or at heading, greater AUDPC was recorded on these cultivars.

At Brooksville, AUDPC was recorded on Pioneer 2548 and 2555. Other cultivars did not have symptoms of leaf rust on flag leaves. RH-7592 (0.96 oz ai/A) applied at the flag leaf stage, followed by Dithane (24 oz ai/A) at heading, was the most effective treatment compared to the untreated control. Folicur (1.8 oz ai/A) applied at the flag leaf stage, and in another application at the flag leaf stage followed by Dithane at heading, were the next most effective treatments. All other fungicide treatments resulted in less AUDPC compared to the untreated control. Compared to other treatments, AUDPC was greater when Dithane was applied in a single application at heading.

Effect of Fungicides on Yield and 1,000-Kernel Weight

At Starkville, Punch at the rate of 2 oz ai/A applied at GS-8 provided the greatest increase in yield of Coker 9323 and Pioneer 2555 (Table 3). Sequential applications of Punch (1 oz ai/A) at flag leaf and at heading were most effective in providing increased yield in Pioneer 2548. Dithane (24 oz ai/A) plus Bayleton (1 oz ai/A) application at GS-9 increased the yield of Coker 9323 and 9733. The same treatment applied at heading was less effective in increasing yield of Coker 9733 compared to the untreated control.

Tilt (1.8 oz ai/A) applied at GS-9, followed by Dithane at heading, resulted in increased yield of Coker 9733 and 9835. RH-7592 applied at the appearance of disease symptoms on the flag leaf significantly increased yield of Pioneer 2555. Dithane applied at GS-8 significantly increased yield of Coker 9733 and Pioneer 2555. Bayleton applied at the flag leaf stage, followed by Dithane at heading, resulted in significant increases in yield of Pioneer 2555.

At Brooksville, RH-7592 (0.96 oz ai/A) applied at the flag leaf stage followed by Dithane at heading, Folicur (1.8 oz ai/A) applied at the flag leaf stage or in another application at the flag leaf stage followed by Dithane at heading, and Punch (2 oz ai/A) applied at the flag leaf stage followed by Dithane at heading increased the yield of Pioneer 2555 significantly compared to the untreated control.

Kernel weight of Coker 9323, 9733, and 9835 was not affected significantly by most treatments at either location. Considerable variation in kernel weight of Pioneer 2548 and 2555 was recorded at both locations.

Discussion

In the last 2 weeks of November 1991, weekly maximum/minimum and average temperatures were higher at Starkville than at Brooksville (Table 4). During December and January, temperatures were lower at Starkville than at Brooksville. During the last 3 weeks of February, temperatures and rainfall at both locations were similar.

Total rainfall during March and April was 6.65 inches at Starkville and 6.56 inches at Brooksville. However, rainfall events were more frequent at Starkville than at Brooksville. At Starkville, greater frequency of rain showers probably resulted in higher humidity and more free moisture, which provided more favorable conditions for increased disease pressure. At Brooksville, a lower frequency of rainfall during March and April resulted in comparatively less wet and humid conditions and lower disease pressure. At an average temperature range of 60-70 °F, maximum disease severity was recorded at both locations.

Disease increased from April 14 to May 9, after which disease severity decreased. Certain fungicide-treated plots showed reduced disease severity during the first week. Later in the growing season, differences between fungicide-treated plots and untreated controls were less apparent. Despite the fact that average disease severity values were not significantly different between treated plots and untreated plots, some fungicide treatments resulted in significant increases in yield. Disease severity remained consistently low throughout the season in plots treated with Punch at the rate of 2 oz ai/A applied at GS-8, and Dithane plus Bayleton applied at GS-9 or 10.5, based on less area under the disease progress curve and lower slope values for mean disease severity (Tables 1 and 2).

Consistently low disease severity in fungicide-

Table 4. Weekly maximum/minimum and average air temperature and rainfall amounts at Brooksville and Starkville, Mississippi, 1991-92.

	Week 1			Week 2			Week 3			Week 4			
	Temperature(F)		Rain-fall	Temperature(F)		Rain-fall	Temperature(F)		Rain-fall	Temperature(F)		Rain-fall	Rainfall Total
	max/min	avg	in	max/min	avg	in	max/min	avg	in	max/min	avg	in	in
Starkville													
November	53/28	39	0.10	57/30	42	0.00	71/53	62	0.23	57/33	57	0.00	3.37
December	60/35	46	0.52	64/44	55	0.26	55/32	42	0.00	57/39	48	0.06	5.98
January	53/32	42	0.02	50/32	44	0.10	44/23	32	0.04	50/35	44	0.10	1.86
February	57/33	44	0.03	57/33	44	0.14	66/41	53	0.11	62/41	51	0.27	3.95
March	73/46	59	0.00	64/37	50	0.09	64/39	51	0.06	60/37	46	0.08	2.57
April	62/39	51	0.06	78/53	66	0.01	77/59	68	0.35	71/48	60	0.01	3.08
May	77/50	64	0.00	80/51	68	0.04	86/62	73	0.00	77/57	66	0.12	1.20
Brooksville													
November	52/31	41	0.11	53/31	42	0.01	60/55	58	0.20	54/35	44	0.01	2.48
December	78/47	81	0.05	84/48	55	0.02	58/34	46	0.16	59/42	50	0.24	3.34
January	61/42	51	0.03	51/33	42	0.25	48/22	35	0.95	52/37	45	0.18	3.91
February	63/41	52	0.04	56/37	47	0.01	65/42	54	0.00	61/44	52	0.27	3.89
March	70/49	59	0.01	64/40	52	0.13	64/42	53	0.09	60/40	50	0.08	2.33
April	63/39	51	0.05	76/53	65	0.00	77/58	67	0.52	74/51	62	0.00	4.23
May	80/54	67	0.01	81/50	66	0.01	89/66	77	0.01	82/61	71	0.29	2.46

treated plots was reflected in statistically significant increases in yield compared to the untreated control. This is considered to be due to the activity of fungicides against *P. recondita* f. sp. *tritici*. Thus, Punch at 2 oz ai/A was most effective when applied at GS-8. At the lower rate (1 oz ai/A), two applications were required for effective disease control. Dithane was more effective when applied at GS-8 compared to Bayleton applied at the initial appearance of disease symptoms on leaves below the flag leaf. The efficacy of Dithane was reduced when applied at heading compared to sequential applications at the flag leaf stage and at heading.

Application of a protectant and an eradicant significantly reduced disease severity and increased yield. Compared with the combined application of a protectant and an eradicant, the effect in certain treatments was more pronounced when the protectant was applied after the eradicant.

In cases where the protectant and eradicant were applied in combined form, crop growth stage was important. When Dithane and Bayleton were applied at GS-9, an additional 13 bu/A increase over the untreated control was recorded in Coker 9733 compared to the same treatment at heading.

Maximum AUDPC recorded for Coker 9733 indicates epidemic development on this cultivar as expressed by a highly susceptible response. Coker 9323 was moderately resistant, and Pioneer cultivars were moderately susceptible at Starkville.

Weather conditions at the Black Belt Branch contributed to yields that were generally higher compared to 1990-1991, with the exception that yield of Coker 9733 was relatively low. This may be due, in part, to an attack of powdery mildew in the early spring. Generally, yield variation was greater for plots receiving different fungicide treatments than for untreated controls of all cultivars tested.

Despite large treatment differences, no statistically significant differences were recorded in yield or kernel weight of certain cultivars. However, certain fungicide treatments increased yield of Pioneer 2555 significantly compared to untreated controls at both locations. This suggests a differential cultivar response to fungicide treatment.

No phytotoxic response to any fungicide treatment was recorded on any variety. However, Tilt (1.8 oz ai/A) applied at flag leaf stage reduced the yield of Coker 9323 and 9733 by 10 and 1 bushel/acre, respectively, compared to untreated controls.

Results of these studies provide useful guidelines for future fungicide applications to control leaf rust on wheat. Punch (2 oz ai/A) is effective in reducing disease severity and increasing yield of treated wheat compared to untreated controls.

Application of a protectant at an early crop growth stage (e.g. Dithane at GS-8) is more effective than an eradicant (Bayleton or Folicur) at the appearance of disease symptoms or at later growth stages. If an application of Bayleton plus Dithane is to be made, then GS-9 is more suitable than GS-10.5. A 20-bushel increase in yield of Pioneer 2555 treated with Punch (2 oz ai/A) or Folicur (1.8 oz ai/A), and a 19-bushel increase in Coker 9733 treated with Tilt followed by

Dithane or with Dithane plus Bayleton, offers considerable promise for leaf rust management. However, further studies are needed to characterize the relationship of environmental conditions and cultivars to leaf rust development on Mississippi winter wheat so that the correct timing of fungicide applications may be determined.

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