Effects of Powdery Mildew, Triadimenol Seed Treatment, and Triadimefon Foliar Sprays on Yield of Winter Wheat in North Carolina

S. Leath and K. L. Bowen

USDA-ARS, Department of Plant Pathology, North Carolina State University, Raleigh 27695-7616.

We thank F. J. Schultz and L. C. Whitcher for technical assistance, and M. W. Baker and H. F. Harrison for providing seed.

Paper 11466 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh 27695-7643.

Accepted for publication 9 August 1988 (submitted for electronic processing).

ABSTRACT

Leath, S., and Bowen, K. L. 1989. Effects of powdery mildew, triadimenol seed treatment, and triadimefon foliar sprays on yield of winter wheat in North Carolina. Phytopathology 79:152-155.

Wheat plots were established in central and eastern North Carolina in the falls of 1985 and 1986 to determine yield reduction caused by *Erysiphe graminis* f. sp. *tritici* on winter wheat cultivars Saluda and Coker 983. Check plots were compared with plots kept nearly disease-free with three to four foliar applications of triadimefon. The efficacy of triadimenol for mildew control when applied as a seed treatment, with or without different triadimefon foliar spray schedules, also was determined. Significant disease control resulted from foliar applications of triadimefon on both cultivars; however, the only consistent yield reductions were observed with Saluda. Triadimenol seed treatments lowered mildew severity and increased grain yields. Area under the powdery mildew curve was negatively correlated with yield; the correlation coefficient averaged −0.55 across four environments. No clear associations between disease and various yield components were detected. Regression models were constructed, and yield reductions of approximately 17% were observed in Saluda when disease severity reached 10% on the flag leaf by heading. Powdery mildew can limit yield in modern soft red winter wheat cultivars, although current levels of resistance in certain cultivars are sufficient to prevent large yield reductions.

Powdery mildew, caused by *Erysiphe graminis* DC., is an important disease of wheat (*Triticum aestivum* L). Yield losses due to this disease have been shown in small grain crops throughout the world wherever the environment is favorable to disease development (1,2,3,7,12). In North Carolina, powdery mildew epidemics occur yearly, though resulting losses on currently grown wheat cultivars have not been documented (5). Although yield reductions due to powdery mildew were not observed in a recent study completed in South Carolina (8), research with near-isogenic lines in Maryland (7) and a multiyear study in Pennsylvania (3) found significant yield reductions in winter wheat due to powdery mildew. Therefore, there is a need for further study to clarify the relationship between powdery mildew and yield of winter wheat in the southeastern United States.

Genetic resistance and foliar fungicides are available for control of mildew, as well as other important small grain diseases. However, fungicide use is not always economically feasible, and with current information, thresholds can not be accurately determined. Resistance is widely used, yet prevalent races of *E. graminis* f. sp. *tritici* may not be controlled on some lines with specific resistance, particularly because pathogen populations may shift during the growing season. Such shifts have been observed in North Carolina (S. Leath, unpublished) in field plots of wheat lines with known powdery mildew resistance genes. Recent work has shown that virulence to the 10 most widely used genes for resistance to wheat powdery mildew already exists in the Southeast (12). Similarly, cultivars resistant to all important endemic pests may not be available, so it may be necessary to plant a mildew-susceptible cultivar to avoid susceptibility to other potentially more damaging pathogens or pests. Therefore, it is necessary to study yield relationships on susceptible and resistant genotypes with and without fungicides to develop accurate control recommendations for future situations.

In North Carolina, we have observed that powdery mildew often becomes established on winter wheat in the fall and can be found through much of December. Controlling fall infections may be important in reducing or even preventing yield reductions. If this is true, the use of systemic seed treatments or fall foliar sprays could prove cost effective. Recently, Frank and Ayers (3) showed that triadimenol seed treatments reduced powdery mildew and increased wheat yields even when disease severity remained below 10% on the penultimate leaves. Similarly, Rawlinson et al (13) showed that soil treatments with triadimefon suppressed powdery mildew on spring barley and increased yields by 22% 11 mo after fungicide application (13). Unfortunately, in both of these studies, fungicide treatments were compared only with untreated plots. No evaluation of yields in nearly disease-free checks were obtained for comparison.

Wright and Hughes did make such a comparison with powdery mildew on spring barley with triadimenol seed treatments and/or foliar triadimefon sprays. Their results indicated that both seed treatment and foliar sprays were highly effective in reducing mildew, but yield increases were realized in only one of three years (16). It is uncertain whether such treatments will be adequate to control the mildew severity levels that commonly occur on winter wheat in the southeastern United States.

The objectives of this study were to determine the yield reductions due to powdery mildew on two wheat cultivars that varied in susceptibility and to evaluate the efficacy of triadimenol applied as a seed treatment for control of powdery mildew on soft red winter wheat in the southeastern United States. A preliminary report has been published (10).

MATERIALS AND METHODS

Experiments were conducted over two growing seasons at the Central Crops and Tidewater Research Stations near Clayton and Plymouth, NC, respectively, beginning in the fall of 1985. Experiments consisted of a randomized complete block design of five replications (blocks) grouped within environments, with cultivars, seed treatment, and foliar fungicide applications as the experimental factors. Two cultivars of winter wheat were used: Saluda (PI 480474) and Coker 983, moderately susceptible and resistant to powdery mildew, respectively. Seed were either left untreated, the usual practice, or treated with 26 g of a.i. triadimenol per 100 kg of seed (Baytan 30, Mobay Corp., Kansas

---

City, MO). The four foliar fungicide treatments used to determine yield reduction and to evaluate triadimenol efficacy were: no foliar spray (check); full season foliar fungicide applications (a fall application plus two or three spring applications); a single fall foliar spray; and a conventional schedule (applications at Feekes scale growth stages 8 and 10; [9]). All foliar sprays consisted of triadimefon at 125 g of a.i./ha (Bayleton 1.8 EC, Mobay Corp.) applied with CO_2 pressurized backpack sprayer delivering 327 L/ha at 240 kPa.

In 1985, wheat was planted on 29 October at Clayton and 14 November at Plymouth. Before planting at Clayton, 672 kg/ha of 8-8-24 (N-P-K) fertilizer was applied to the land, whereas land at Plymouth received 510 kg/ha of 10-20-20. In late February or March, at both locations, approximately 118 kg/ha nitrogen was applied as a liquid topdressing. In 1986, wheat was planted on 15 October at Clayton and 30 October at Plymouth. Preplant fertilizer applications were 448 kg/ha of 12-6-24 at Clayton and 672 of 5-10-10 at Plymouth. Spring applications were 141 kg/ha N at Clayton and 82 kg/ha N at Plymouth in 1987. All wheat was machine planted, and plots consisted of eight rows spaced 0.3 m apart, with those at Clayton planted after tobacco in both seasons, whereas those at Plymouth followed corn. Plots were 2.4 × 2.4 m and bordered with 1.2 m of barley (*Hordeum vulgare* L. 'Anson') to reduce interplot interference.

Powdery mildew was allowed to develop naturally, and disease severity was assessed regularly, based on James' assessment key (6). Four weekly assessments of powdery mildew were made on the flag leaf, beginning 16 April and 30 April, in 1986 and 1987, respectively, at Clayton and 1 day later at Plymouth.

Plants were harvested at maturity from the center four rows (2.9 m^2) of each plot with a single pass of a small-plot combine. Yield variables measured were total grain weight (adjusted to 13% moisture), 500-kernel weight, and test weight. In addition, early-season stand counts were taken at Plymouth in 1986 and at both locations in 1987. Numbers of tillers per meter of row and numbers of kernels per 10 heads also were counted at both locations just before harvest in 1987.

Data analyses. Areas under powdery mildew progress curves (AUMPC) were calculated from powdery mildew assessment data (14). Analyses of variance were performed on disease severity data from each assessment date, AUMPC, and yield variables to determine treatment effects. Interactions involving multiple experimental factors and environment were not large and aggregated into an error term (Error B) that was used to test all first order and the second order interaction of the three primary factors. Aggregation was based on procedures similar to those of Green and Tukey (4), and with one exception, results did not differ where an aggregated error term was utilized as opposed to terms indicated by examining expected mean squares. Means comparisons for variables were made among treatments by using Fisher's protected LSD ($P \leqslant 0.05$). Correlation and regression analyses were used to determine the relationship between yield variables and disease severities at single assessment dates or AUMPC.

RESULTS

Analyses of variance indicated that AUMPC was significantly affected by environment (locations and years), seed treatment, foliar fungicide spray schedule, and all interactions ($P \leqslant 0.05$). Likewise, grain weight was significantly affected by environment, replication within environment, foliar fungicide application, and the cultivar by seed treatment and cultivar by foliar fungicide interactions; 500-kernel weight was affected by environment and cultivar (Table 1).

Few clear treatment effects were evident with the resistant cultivar, Coker 983 (Table 2). However, clear treatment effects were evident with Saluda in all four environments (Table 2). The AUMPC was consistently lowered by seed and foliar treatments with triadimenol and triadimefon, respectively. Seed treatment also resulted in higher yields, although the difference was not significant in one environment (Plymouth in 1987). No clear relationship between treatments and components of yield was evident from the data.

Treatment means summarized by cultivar and environment indicated that full fungicide spray schedules reduced AUMPC, compared with the untreated check, in every test except on Coker 983 at Clayton in 1987 (Table 2). Fall application of triadimefon also reduced AUMPC relative to no-foliar fungicide applications, except in Saluda at Plymouth in 1986 and in Coker 983 at both locations in 1987. Reductions in AUMPC on Saluda ranged from 246.6 units for the check to 2.9 for full disease control at Clayton in 1986. In a poor environment for mildew development, Plymouth, 1987, AUMPC values for Saluda ranged from 22.4 to 0.4. The greatest degree of mildew reduction for Coker 983 also occurred at Clayton in 1986 with AUMPC for check plots averaging 45.6, whereas full disease control plots had a mean AUMPC of 1.2 (Table 2). Yields were higher from full fungicide treatments than from no fungicide, except in Coker 983 at Plymouth in 1986 and both cultivars at Plymouth in 1987 (Table 2). Yield reductions for Saluda and Coker 983 were 20% and 7% at Clayton in 1986, but were reduced to zero at Plymouth in 1987 (Table 2).

In 1987 at Clayton, kernel weight of Saluda was greater ($P \leqslant 0.05$) with any fungicide application than with no foliar fungicide. However, kernel weight of Coker 983 was greater ($P \leqslant 0.05$) with no foliar fungicide treatments than with full or fall fungicide treatments. Analysis of data over all environments showed no significant effects on yield components due to foliar fungicides. Similarly, early-season stand counts were not consistently affected by seed treatment.

Triadimenol seed treatment without foliar fungicide applications suppressed powdery mildew development (AUMPC) as much as full and/or fall foliar fungicide treatments without seed treatment, except in Saluda at Clayton in 1987. Correspondingly, in six of eight cultivar-environment combinations, seed treatment reduced the AUMPC as compared with the appropriate check plot. Yield differences reflected AUMPC differences (Table 2), although yield increases due to triadimenol seed treatments were not significant in most instances.

For Saluda, significant negative correlations existed between AUMPC and yield and averaged −0.55 across the four environments. Yield components were not consistently associated with AUMPC. However, when significant associations occurred, they were negative (Table 3). Data from the more resistant cultivar, Coker 983, indicated little relationship between mildew severity over the season and yield components; consequently, correlation coefficients were low.

Simple regression models for predicting losses due to powdery mildew were constructed for Saluda based on individual and

TABLE 1. Analysis of variance of area under the powdery mildew progress curve (AUMPC)[a] and yield data from two wheat cultivars grown with or without triadimenol seed treatments or triadimefon foliar sprays at two North Carolina locations in two growing seasons (1985-86, 1986-87)

		Mean squares		
Factor	DF	AUMPC	Yield (kg/ha)	500-kernel weight
Environment (E)	3	21,550**	5,039,340**	407.3**
Error A (Rep [Env.])	16	896	119,397	1.2
Cultivar (C)	1	50,244**	55,990	110.3**
Seed treatment (ST)	1	61,246**	268	0.4
Foliar fungicide (FF)	3	23,957**	69,648*[b]	0.7
C × ST	1	24,216**	209,394**	0.2
C × FF	3	12,710**	99,484*	1.0
ST × FF	3	14,676**	37,784	0.3
C × ST × FF	3	7,464**	19,621	0.2
Error B	285	1,279	37,982	0.8

[a] AUMPC was calculated according to the method of Tooley and Grau (14) and based on four visual assessments of powdery mildew severity on the flag leaves of 10 tillers per replication.

[b] This yield mean square for foliar fungicide treatment was tested against FF × Rep (Env.) with three and 57 degrees of freedom rather than against Error B. * and ** represent significant treatment effects at the 0.05 and 0.01 levels of probability, respectively.

TABLE 2. Effects of triadimenol seed treatment with or without foliar fungicide applications on area under mildew progress curve (AUMPC)[y] and on yield

Location	1985-86		1986-87	
Cultivar Treatment	AUMPC	Yield (kg/ha)	AUMPC	Yield (kg/ha)
Clayton				
Saluda				
NSdTrt full foliar	2.74 a[z]	6,782.2 ab	0.28 a	4,294.5 a
SdTrt full foliar	1.89 a	7,084.2 a	0.14 a	4,535.77 abc
NSdTrt fall foliar	32.57 cd	5,611.8 bc	0.42 a	4,044.2 ab
SdTrt fall foliar	10.36 ab	6,722.7 ab	1.26 a	3,962.1 bd
NSdTrt conventional foliar	207.81 e	5,644.5 d	0.42 a	4,287.8 a
SdTrt conventional foliar	26.12 bc	6,634.0 ab	0.49 a	4,701.9 abc
Check	246.61 f	5,682.8 d	130.55 c	2,831.8 c
Seed treatment alone	14.20 ab	6,284.3 bc	24.78 b	3,851.8 b
Coker 983				
NSdTrt full foliar	3.24 a	5,933.4 a	0.56	4,529.6
SdTrt full foliar	1.24 a	5,244.5 b	0.00	4,039.8
NSdTrt fall foliar	5.47 a	5,853.4 a	0.56	4,292.1
SdTrt fall foliar	1.62 a	5,190.0 b	0.42	4,224.8
NsdTrt conventional foliar	59.99 b	5,588.6 ab	0.14	4,225.9
SdTrt conventional foliar	4.20 a	5,257.6 b	0.14	4,202.0
Check	45.55 b	5,520.7 ab	0.28	4,415.3
Seed treatment alone	1.78 a	5,396.5 b	0.14	4,738.2
Plymouth				
Saluda				
NSdTrt full foliar	2.85 ab	5,880.9 a	12.25 c	4,074.5
SdTrt full foliar	1.19 a	5,678.3 ab	0.45 a	3,758.6
NSdTrt fall foliar	60.13 cd	5,388.1 abc	1.40 ab	4,168.7
SdTrt fall foliar	14.67 bc	5,696.4 ab	3.75 b	4,270.6
NSdTrt conventional foliar	54.93 cde	5,340.7 bc	4.75 bc	4,044.5
SdTrt conventional foliar	15.58 bc	5,998.1 a	2.60 bc	4,498.0
Check	89.10 d	4,923.6 c	22.40 d	4,230.9
Seed treatment alone	17.60 bc	5,856.7 ab	13.05 c	4,028.4
Coker 983				
NSdTrt full foliar	1.35 a	5,462.8	1.20 a	5,036.6
SdTrt full foliar	2.56 a	5,281.8	0.05 a	4,288.1
NSdTrt fall foliar	6.69 a	5,445.3	0.70 a	4,841.8
SdTrt fall foliar	0.31 a	5,351.9	0.90 a	4,540.7
NSdTrt conventional foliar	33.74 b	5,514.3	3.35 b	4,701.2
SdTrt conventional foliar	3.33 a	5,761.9	0.60 a	4,373.2
Check	25.34 b	5,477.6	1.70 a	4,313.3
Seed treatment alone	7.29 a	5,451.0	0.95 a	4,976.7

[y] AUMPC was calculated according to the method of Tooley and Grau (14) and based on four visual assessments of powdery mildew severity on the flag leaves of 10 tillers per replication.

[z] Means within a column for each location-cultivar combination are not significantly different if followed by the same letters, according to Fisher's protected LSD statistic ($P = 0.05$).

TABLE 3. Correlation coefficients between area under the mildew progress curve (AUMPC)[a] and four yield components

	Saluda					Coker 983				
AUMPC	Yield	Test weight	500-kernel weight	Tillers/ m row	Kernels/ 10 heads	Yield	Test weight	500-kernel weight	Tillers/ m row	Kernels/ 10 heads
Clayton 86	−.64*	.25	−.04	···	···	−.10	.32*	.18	···	···
Plymouth 86	−.40**	.30	.05	···	···	.02	.20	.07	···	···
Clayton 87	−.65**	−.50**	−.55**	−.30	−.15	−.17	.05	.02	.08	−.38**
Plymouth 87	−.52**	.14	−.16	−.02	−.20	−.62	.25	−.25	−.13	−.34

[a] AUMPC was calculated according to the method of Tooley and Grau (14) and based on four visual assessments of powdery mildew severity on the flag leaves of 10 tillers per replication. * and ** represent significant treatment effects at the 0.10 and 0.01 levels of probability, respectively.

cumulative (AUMPC) assessments of disease severity. Models showed that the yield differences observed were due largely to uncontrolled effects, because disease accounted for only 31–44% of the variation in yield in models. Models based on disease assessment at heading (GS 10.3, Feekes scale) were as good as models with AUMPC or multiple-disease assessments as predictors of yield (Fig. 1). The difference in environments is reflected both in yield potential and in the relationship between severity and yield.

DISCUSSION

The relationship between powdery mildew severity and yield indicates that with modern cultivars, disease can be an important yield constraint. Yield reductions from powdery mildew in untreated plots of Saluda were 34.1, 16.3, 16.2, and 0% (mean = 16.7%) in four environments, whereas yield reductions in triadimenol-treated plots were 10.3, 7.4, 1.2, and 0% (mean = 4.8%), compared with the plots that received full fungicide schedules. However, because Coker 983 had an effective level of resistance, smaller losses occurred; yield reductions in untreated plots averaged 6.0% over the four environments. Mildew alone may have caused even smaller losses on Coker 983, as reductions in yield were only 7.0, 2.5, and 0% (mean = 3.2%) in three of the four environments. No consistent association between disease and yield components was observed. This may mean disease affected numerous components or, with regard to seeds per head, the sample size of 10 heads per plot may have been inadequate.

Seasons in which these studies were conducted were unusual in being too hot and dry for Septoria development. However, at Plymouth in 1986-87, leaf rust (*Puccinia recondita* f. sp. *tritici*) developed after anthesis and may have been partially responsible for the nonsignificant but large yield reduction of 14.4% in untreated plots of Coker 983. Rust also developed on Saluda, but comparative data analyses showed that it did not affect the mildew-yield relationship. The lack of significant spray or seed treatment effects in that environment may be due to both low mildew severity and to a masking of treatment effects by the leaf rust observed. It is doubtful that yield increases with seed treatment are due to early control of foliar pathogens other than powdery mildew because no other diseases were observed. Frank and Ayers (3) showed that uniform late season disease can obscure yield effects due to early-season mildew. Observation and analysis of the rust data supported the idea of its effect on yield; however, such an effect was not a confounding factor in the other three environments. The fact that significant mildew control was obtained on Coker 983 without a subsequent yield response with data at Clayton (1986-87) and Plymouth (1985-86) is understandable, as disease levels remained low, especially at Clayton.

The yield reductions that are documented here are not fully supported by recent work from South Carolina. Although triadimefon sprayed plots outyielded check plots in the study from South Carolina, yield reductions were not statistically significant (8). However, yield reductions of 672 and 471 kg/ha in the two cultivars were not detected as significant in Kingsland's study, and these amounts represented 20% of the maximum yields. Therefore, our reported yield reductions, which averaged 16.7% for Saluda, are, in fact, similar to those reported by Kingsland (8).

The relationship between mildew severity and yield was linear for Saluda and did not change dramatically across environments (Fig. 1). The critical point models presented suggest Saluda would incur yield decreases of less than 2% at either location with 1% powdery mildew severity on the flag leaf at heading (GS 10.3). The predicted yield reductions would rise to 18% and 16% at Clayton and Plymouth, respectively, if mildew severity reached 10% by heading (GS 10.3) (9).

Mildew severities that we observed were not unusual in North Carolina and indicate that control of natural levels of mildew is merited on at least this susceptible cultivar. Yield reductions of the magnitude seen on Saluda (16.7%) resulted in reductions of 825 kg/ha (12 bu/A), which support ample control costs. However, these figures are based on average yields of 5,258 kg/ha (78 bushels per acre), which are not regularly obtained by growers in the Southeast. Yield potentials near 2,600 kg/ha are more common with this cultivar and would result in only 408 kg/ha (6.0 bushels per acre) to offset control costs.

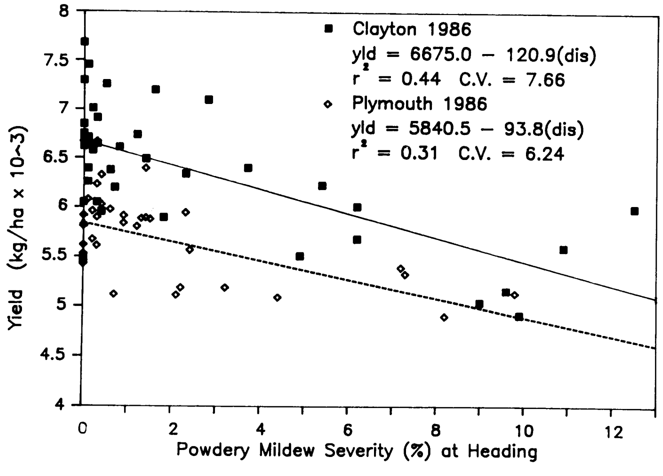

Fig. 1. Plots of yield in kg/ha (adjusted to 13.0% moisture) versus percentage of mildew severity at heading (Feekes Scale growth stage 10.3) on flag leaves of Saluda wheat from two North Carolina locations in 1986 with corresponding regression equations and related statistics.

Triadimenol seed treatment may be the only economical treatment available to growers who anticipate low- to moderate-yield potentials. Seed treated plots of Saluda yielded 95.2% of the nearly disease-free plots treated with full fungicide schedules, whereas untreated plots yielded just 83.3% of the nearly disease-free checks. The fact that seed treatment with triadimenol was very effective in North Carolina may be related to the hot spring weather encountered regularly. It is not unusual for temperatures to exceed 25 C in late April and in May in the Southeast, and these temperatures have been reported to markedly retard powdery mildew development (15). Hence, protection is needed only until hot weather begins, and this may make triadimenol seed treatments more valuable in the Southeast than in regions where the temperatures do not rise above 25 C until near or after anthesis. Implications are that at least some of the yield reduction observed in these tests was due to early-season mildew, as indicated in a preliminary report (11). This helps explain why a single fall foliar spray with triadimefon, as well as a seed treatment, controlled mildew and provided yield increases in the present study. Yield losses due to powdery mildew of winter wheat in North Carolina, and probably through much of the Southeast, may be prevented through the use of resistance and/or seed treatment. Both of these measures need to be studied more comprehensively, especially when multiple diseases are present. Such work could result in the development of economical control measures for use by small grain producers in this region.

LITERATURE CITED

1. Brooks, D. H. 1972. Observations on the effects of mildew, *Erysiphe graminis*, on the growth of spring and winter barley. Ann. Appl. Biol. 70:149-156.
2. da Luz, W. C. 1984. Yield losses caused by fungal foliar wheat pathogens in Brazil. Phytopathology 74:1403-1407.
3. Frank, J. A., and Ayers, J. E. 1986. Effect of triadimenol seed treatment on powdery mildew epidemics on winter wheat. Phytopathology 76:254-257.
4. Green, B. F., and Tukey, J. W. 1960. Complex analyses of variance: General problems. Psychometrika 25:127-152.
5. Hebert, T. T., Rankin, W. H., and Middleton, G. K. 1948. Interaction of nitrogen fertilization and powdery mildew on yield of wheat. (Abstr.) Phytopathology 38:569-570.
6. James, C. 1971. A manual of assessment keys for plant diseases. Canada Dept. Agric. Publ. No. 1458. American Phytopathological Society, St. Paul, MN.
7. Johnson, J. W., Baenziger, P. S., Yamazaki, W. T., and Smith, R. T. 1979. Effects of powdery mildew on yield and quality of isogenic lines of 'Chancellor' wheat. Crop. Sci. 19:349-352.
8. Kingsland, G. C. 1982. Triadimefon for control of powdery mildew of wheat. Plant Dis. 66:139-141.
9. Large, E. C. 1954. Growth stages in cereals: Illustration of the Feekes scale. Plant Pathol. 3:128-129.
10. Leath, S. 1987. Effects of powdery mildew, triadimenol seed treatments, and triadimefon foliar sprays on yield of winter wheat in North Carolina. (Abstr.) Phytopathology 77:642.
11. Leath, S. 1987. The effects of early-season infection of wheat by *Erysiphe graminis* f. sp. *tritici* on late-season leaf area and yield. (Abstr.) Phytopathology 77:1741.
12. Leath, S., and Murphy, J. P. 1985. Virulence genes of the wheat powdery mildew fungus, *Erysiphe graminis* f. sp. *tritici*, in North Carolina. Plant Dis. 69:905.
13. Rawlinson, C. J., Muthyalu, G., and Cayley, G. R. 1982. Residual effects of triadimefon in soil on powdery mildew and yield of spring barley. Plant Pathol. 31:143-155.
14. Tooley, P. W , and Grau, C. R. 1984. Field characterization of rate-reducing resistance to *Phytophthora megasperma* f. sp. *glycinea* in soybean. Phytopathology 74:1201-1208.
15. Wiese, M. V. 1977. Compendium of Wheat Diseases. American Phytopathological Society, St. Paul, MN. 106 pp.
16. Wright, D., and Hughes, L. G. 1987. Effects of fungicide treatments and variety on development, grain growth and yield of spring barley. Ann. Appl. Biol. 111:89-102.