Characteristics of the 1984–1985 Wheat Leaf Rust Epidemic in Central Texas

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ABSTRACT

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Most of the wheat cultivars planted in central Texas in the fall of 1984 were susceptible to leaf rust (*Puccinia recondita*). The cultivar Northrup King Probrand 812 (NK 812) occupied 63% of the hectarage. Rust severity on flag leaves of NK 812 reached 100% at the beginning of flowering at Beeville and at the milky ripe stage at Dallas. The leaf rust isopath progressed northward at a rate of 24 km per day from 1 April through 25 May. Virulence frequency data indicated that the *P. recondita* population had high frequencies of virulence toward the leaf rust resistance genes *Lr*1, 2a, 2c, 3, 10, and 16. Virulence to *Lr*24 was detected in early spring in south Texas, but not at any other time or location. Fungicide trials at Dallas indicated a 40% or greater loss in yield on NK 812 as a result of leaf rust.

During the 1984–1985 growing season, an epidemic of leaf rust (*Puccinia recondita* Rob. ex Desm.) on wheat (*Triticum aestivum* L.) occurred in Texas. The Blacklands and south-central and south Texas were most severely affected (Fig. 1). Cumulatively, 600,000 ha of wheat were sown in these areas in the fall of 1984 (6,7). Hard red winter was the predominant wheat grown, with minor plantings of soft red winter and hard red spring wheats (6,7).

Fall infection by *P. recondita* is common on susceptible cultivars through the region. Sporulating pustules can be found on seedling leaves as early as 4 wk after planting. Generally, the infection cycle of *P. recondita* is slowed with the onset of cooler temperatures in January and February. However, any leaf tissue that contains uredosori and lives through the winter months can show sporulating lesions when warm temperatures resume in the spring (4).

Texas is located near the southern border of the North American "Puccinia Pathway" (3). Wheat is grown contiguously from north-central Mexico through to the Prairie Provinces of Canada. Although there are more localized agroecological areas of *P. recondita* over the region (10), the inoculum produced and subsequently dispersed from Texas influences leaf rust development throughout the region (5).

The purpose of this report is to document the incidence, distribution, and severity of leaf rust in central Texas during 1984–1985.

MATERIALS AND METHODS

Total wheat acreage and cultivar distribution were determined from statistics supplied by the Texas Department of Agriculture (6,7) as well as by county extension agents and wheat researchers.

Distribution and severity of leaf rust were recorded in commercial fields in 44 counties in central Texas. In particular, wheat fields in the vicinity of Beeville (south), McGregor (south-central), and Dallas (Blacklands) were surveyed. The survey was initiated when wheat was in the late tillering stage (Feekes stage 5) (9) and terminated at ripening (Feekes stage 11.3). In central Texas, this typifies the time from mid-February to late May. Severity was estimated according to the modified Cobb scale (12), with the aid of standard drawings (Plant Pathology Laboratory, Herpenden, Herts., U.K., Lab Key No. 1-3-1). Average rust severity was determined and recorded for each commercial field from 20–30 individual assessments over the field.

Rust severity data were tested for equality of variances by the Burr-Foster Q-test and for normality by the Shapiro and Wilk W-test (1). Rust severity data had unequal variances and nonnormal distributions. For this reason, the data were transformed into logits ($ln[Y/1-Y]$), where Y is modified Cobb percent rust severity. The logits of rust severity had equal variances and were normally distributed. Smooth disease progress curves of percent severity vs. time were then generated. The area under this curve (AUDPC) was calculated for the growing period from when the second node was visible to the milky ripe growth stage.

Wheat leaves bearing sporulating uredinia were collected from commercial fields in each county. Urediniospores from each collection were used to inoculate seedlings of the wheat cultivar Thatcher (CI 10003) that had been treated with chlormequate chloride to ensure a more compact plant (8). Subsequently, spores from single uredinium were collected and inoculated onto a differential host series in a dew chamber for a 14-hr dark period at 18 C, then placed on greenhouse benches at 23–26 C. Infection types were recorded 10–12 days after inoculation and classified as 0, 1, or 2, indicating avirulent reactions, or 3 or 4, indicating virulent reactions (11).

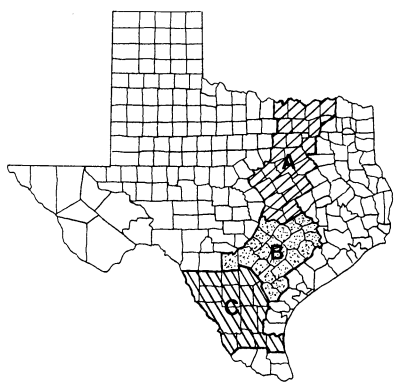

Fig. 1.(A) Blacklands, **(B)** south-central, and **(C)** south Texas, the areas of central Texas most severely affected by leaf rust (*Puccinia recondita*) of wheat during 1984–1985.

RESULTS AND DISCUSSION

The most widely grown wheat in central Texas during the 1984–1985 season was the hard red winter cultivar Northrup King Probrand 812 (NK 812) (Table 1). This cultivar was planted on 63% of the land, representing about 378,000 ha. Other hard red winter wheat cultivars grown were Sturdy, Vona, and TAM 105, representing 7, 3, and 1% of the central Texas area, respectively. Soft wheats were grown on about 8% of the total hectarage, the predominant cultivar being Coker 68-15 (Table 1). Approximately 43 other hard red winter, soft red winter, and hard red spring cultivars made up the remaining 18% of the plantings.

NK 812, Vona, and TAM 105 were susceptible to the naturally occurring populations of *P. recondita*, as indicated by their high disease severities at the soft dough stage (Feekes stage 11.1) in commercial fields and their AUDPC values (Table 1). Sturdy possessed some resistance to *P. recondita*, as indicated by the moderately susceptible infection type and lower AUDPC values. Coker 68-15 was moderately resistant to the prevalent *P. recondita* populations.

Leaf rust severity on NK 812 increased

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Table 1. Development of leaf rust (*Puccinia recondita*) on the predominant wheats in commercial fields in central Texas

Wheat cultivar	Percent of hectarage	Beeville (south)			McGregor (south-central)			Dallas (Blacklands)		
		LR%[w]	IT[x]	AUDPC[y]	LR%	IT	AUDPC	LR%	IT	AUDPC
Hard red winter										
NK 812	63	100 b[z]	S	16.2 c	100 c	S	15.6 c	100 c	S	13.8 c
Sturdy	7	93 b	MS	10.4 b	65 b	MS	8.3 b	62 b	MS	7.8 b
Vona	3	100 b	S	18.1 c	100 c	S	16.2 c	100 c	S	15.4 c
TAM 105	1	100 b	S	17.1 c	100 c	S	15.3 c	100 c	S	14.3 c
Soft red winter										
Coker 68-15	5	34 a	MR	5.4 a	30 a	MR	4.8 a	15 a	MR	3.2 a

[w] Percent severity of leaf rust as measured by the modified Cobb scale on flag leaves at soft dough stage (Feekes stage 11.1).
[x] Infection type: S = susceptible, MS = moderately susceptible, MR = moderately resistant.
[y] Area under the disease progress curve.
[z] Means followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test. Leaf rust severities were converted to logits for statistical analyses but are reported as untransformed values.

Table 2. Percentage of isolates of *Puccinia recondita* virulent to the near-isogenic wheat cultivar Thatcher differential lines in central Texas in 1985

Thatcher *Lr* line	15 Feb.–15 Mar.		16 Mar.–30 Apr.		1 May–1 June	
	SC[a]	BK[a]	SC	BK	SC	BK
1	71	38	77	33	78	36
2a	27	69	27	81	26	83
2c	24	65	25	74	24	75
3	100	100	100	100	100	100
3ka	7	27	8	16	11	17
9	2	0	4	0	2	0
10	90	100	85	100	91	100
11	5	0	2	0	4	0
16	44	24	48	16	45	17
17	15	24	12	7	14	8
18	27	0	13	0	11	0
19	0	0	0	0	0	0
24	12	0	2	0	0	0
26	0	0	0	0	0	0
30	3	0	1	0	0	0
Number of isolates tested	41	45	48	58	50	57

[a] SC = south and south-central areas of Texas, BK = the Blacklands.

Table 3. Yield loss attributable to leaf rust and powdery mildew on the hard red winter wheat cultivars NK 812 and Mit at Dallas in 1985 as determined by triadimefon applications at flag leaf emergence and flowering

Cultivar Treatment	Leaf rust		Powdery mildew		Yield (kg/ha)
	Percent severity[a]	AUDPC[b]	Percent severity[c]	AUDPC	
NK 812					
Untreated	100	13.8	58	10.2	2,255
Treated	7	1.8	0	0.0	4,131
Mit					
Untreated	3	0.9	33	5.4	3,665
Treated	0	0.0	0	0.0	3,888

[a] Measured by the modified Cobb scale on flag leaves at soft dough state (Feekes stage 11.1).
[b] Area under the disease progress curve.
[c] Measured as amount of flag leaf covered by mildew colonies at soft dough stage.

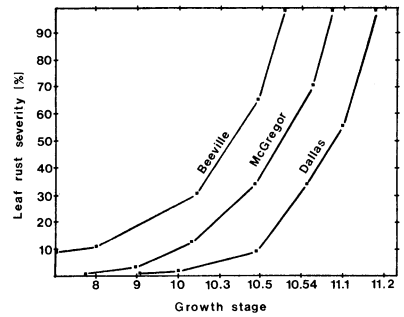

Fig. 2. Development of leaf rust in commercial fields of the wheat cultivar Northrup King Probrand 812 in Texas in 1985 as measured by the modified Cobb scale on flag leaves.

at an earlier growth stage in southern than in northern parts of central Texas in commercial plantings (Fig. 2). Severities reached 100% on flag leaves of NK 812 at the beginning of flowering in Beeville, at the watery ripe stage at McGregor, and at the milky ripe stage at Dallas.

The isopathic movement of leaf rust from south to north Texas was determined by measuring the distance in kilometers between NK 812 fields in the south to those in the north. The time from when the fields in south Texas reached 100% severity until the fields in north Texas reached the same severity was then determined. These data (*unpublished*) indicated that leaf rust moved at a rate of 24 km per day, on the average, from 1 April through 25 May in a south to north direction.

Virulence frequencies in the *P. recondita* population changed somewhat from February through May in central Texas (Table 2). Virulence to *Lr*3 and 10 was present in nearly all isolates collected. The frequency of virulence to *Lr*1, 2a, 2c, and 16 was high. Virulence to *Lr*24 was detected in early spring in south Texas, but not at any other time or location. A low virulence frequency was found to *Lr*9 and 11 in the south, but no virulence to these genes was found in the north. On the basis of seedling reactions, *Lr*9, 11, 19, 26, and 30 were resistant to the greatest proportions of *P. recondita* isolates in Texas. Virulence to *Lr*3ka and 17 was present in greater than 20% of the isolates in the Blacklands early in the season. The frequency of virulence to *Lr*3ka and 17 was less at other times and locations. Of all the isolates collected in the south-central area from 15 February to 15 March, 27% were virulent to *Lr*18. However, virulence to *Lr*18 was less frequent later in the season in the south-central area and was never detected in the Blacklands. Possible explanations for the fluctuations in virulence frequencies include a differential temperature response, as proposed by Browder (2), or errors in sampling.

In a replicated fungicide experiment at Dallas, triadimefon was applied at a rate of 45.7 g a.i. at flag leaf emergence and again at flowering to NK 812 and the cultivar Mit. Both cultivars are susceptible to powdery mildew (*Erysiphe graminis* DC. f. sp. *tritici* E. Marshall), but only NK 812 is also susceptible to leaf rust. Grain yield differences between treated and untreated plots were 1,877 kg/ha, or 46%, and 223 kg/ha, or 6%, on NK 812 and Mit, respectively (Table 3). Although yield

loss attributed to both diseases is probably not additive, the data do suggest that leaf rust was responsible for 40% or more of the yield loss in NK 812 in Dallas.

The cultivation of leaf rust-susceptible wheats in central Texas obviously can result in enormous biological and economic losses. Given a conducive climate, virulence in the *P. recondita* population and resistance in wheat cultivars are among the most important factors determining whether leaf rust epidemics will develop.

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