Distribution, Prevalence, and Severity of Fungal Leaf and Spike Diseases of Winter Wheat in New York in 1986 and 1987

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ABSTRACT

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Surveys of soft white winter wheat production fields in New York in 1986 and 1987 indicated that leaf spots were moderate to severe in most fields and were the predominant foliar diseases. Septoria nodorum blotch was the most prevalent and severe leaf spot disease, followed in importance by Septoria tritici blotch, tan spot, and Septoria avenae blotch; the latter two occurred sporadically. Several *Ascochyta* spp. were also recovered from leaf lesions. Powdery mildew, previously thought to be the major foliar disease of winter wheat in New York, was generally of low severity throughout both growing seasons. Leaf rust appeared late in both seasons at levels not considered damaging to the crop. Severe scab developed in 1986, reducing grain quality and yield. Other diseases of minor occurrence and/or severity were stem rust, loose smut, Cephalosporium stripe, glume blotch, foot rot, and take-all. In addition, viral diseases were widespread and suspected as yield-limiting factors in many fields during both years.

Additional keywords: *Drechslera tritici-repentis, Erysiphe graminis, Fusarium graminearum, Gibberella zeae, Mycosphaerella graminicola, Phaeosphaeria avenaria* f. sp. *triticea, Phaeosphaeria nodorum, Puccinia recondita* f. sp. *tritici, Pyrenophora tritici-repentis, Septoria avenae* f. sp. *triticea, Septoria nodorum, Septoria tritici, Stagonospora avenae* f. sp. *triticea, Stagonospora nodorum, Triticum aestivum*

Soft white winter wheat (*Triticum aestivum* L.) is an important crop in New York, with production being concentrated in the central and western part of the state because of suitable climate and topography. Approximately 155,000 acres were harvested in 1986, with a production value of $17 million (2). The grain is marketed for the production of high-quality pastry flour. Winter wheat is also an important rotational crop on the state's dairy farms, where it is harvested for feed and straw (5).

Information on the relative importance of diseases affecting this crop in New York is scant. Surveys of New York winter wheat for diseases in 1919 and 1921 (T. F. Tapke and R. S. Kirby, respectively, *unpublished*) revealed a prevalence of loose smut, leaf rust, and take-all. Several generations of improved winter wheat cultivars have been grown in New York since, and management practices have changed dramatically, presumably altering the disease situation.

Surveys of hard red spring wheat, a limited acreage crop in New York, in 1984 and 1985 showed that fungal foliar diseases, specifically leaf spots and powdery mildew, were prevalent and posed a threat to spring wheat production (7,8). Information on fungal leaf and spike diseases affecting winter wheat was also deemed necessary for guidance of wheat disease management and wheat breeding programs. This paper reports the results of surveys conducted in 1986 and 1987 to assess the distribution, prevalence, and severity of components of the disease complex on winter wheat in New York State.

MATERIALS AND METHODS

Field selection. Winter wheat production fields (32 in 1986 and 29 in 1987), located in the predominant wheat-growing areas in the state (Fig. 1), were selected in cooperation with Cornell Cooperative Extension field staff. The main criteria for field selection were representative crop production practices, access to the field, and cultivar. There was no overlap between fields surveyed in 1986 and fields surveyed in 1987. Emphasis was on the widely grown cultivars Houser and Frankenmuth and the newly released cultivar Geneva. The proportion of fields planted to Geneva increased greatly from 1986 to 1987.

Disease assessment. Disease severity was rated and plant samples were taken from separate areas in each field. Disease severity was rated in four areas (4 m^2), located inward of the vertices of a rectangular area marked with stakes. Each vertex was 20–25 m from the edge of the field. In long, narrow fields, the four disease rating areas were arranged in a zigzag pattern along the length of the field, no less than 10 m from the long edge and 20 m from the short edge. A sample of approximately 25 tillers was collected from each of four areas (4 m^2), situated 5 m away from the corresponding disease rating areas, for laboratory identification of leaf- and glume-spotting fungi. Foliar disease severity was rated three times during the growing season as percentage of leaf area showing symptoms or signs of the pathogens, using the disease rating keys devised by James (11). In the case of Cephalosporium stripe, the percentage of tillers affected was recorded. Observations were taken on all leaves at growth stage (GS) 31 (first node detectable) on the decimal scale of Zadoks et al (23), on the upper four leaves at GS 59-65 (spike emergence-anthesis), and on the upper two leaves at GS 80-85 (early-soft dough). The area rated corresponded roughly to the green leaf area normally present on nonsymptomatic plants at each rating period. At the early-soft dough stage, the percentage of spike area affected (11) by powdery mildew, scab, and glume spots was recorded. Incidence ratings for loose smut were taken between spike emergence and anthesis, when the disease was most visible. Leaf spots, as well as glume spots, were rated collectively because of difficulty in visual discernment of specific leaf and glume spotting diseases.

Additional information regarding planting date, previous crops, seed source, fertilizer and pesticide applications, and yield were obtained from cooperating growers by a questionnaire in 1987. In addition, notes were taken on the occurrence and symptom severity of viral diseases as they were encountered.

Recovery and identification of organisms. Organisms were recovered from leaf and glume lesions by plating surface-sterilized sections of the infected tissue on moist filter paper. The sections were surface-sterilized by dipping them into 95% ethanol for 15 sec, then into a 1% sodium hypochlorite solution for 15 sec, and finally into sterile distilled water. The presence of necrotrophic organisms on the leaf and glume sections was recorded after 5–7 days of incubation at 20–25 C under a 12-hr photoperiod of near-ultraviolet light provided by General Electric F40BL lamps. All identifications were based on characteristic fungal morphology in accordance with previously

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published descriptions (9,10,16,20–22,24). Fifty leaf lesions per field were examined at each of the three growth stages, and 10 glume lesions per field were examined at the early-soft dough stage. Severity values of individual leaf spot diseases (Fig. 2) were calculated for each growth stage by multiplying the fraction of leaf lesions from which the respective fungi were recovered by the percentage of the leaf area covered by leaf spots in the corresponding fields (Table 1). These values were depicted according to field location in a stacked column arrangement.

Associations of leaf spot distribution and severity in individual fields with average monthly temperature and total monthly precipitation patterns were sought by overlaying weather maps of the months of April, May, and June of 1986 and 1987 produced by the Northeast Regional Climate Center (3,4) on the maps in Figure 2. Leaf and stem rust races were determined by D. L. Long and A. P. Roelfs, respectively, of the USDA Cereal Rust Laboratory, St. Paul, MN (15,17).

RESULTS

Severity values of the major fungal leaf and spike diseases encountered in 1986 and 1987 are shown in Table 1. Occurrence and severity of these diseases varied considerably among fields.

Powdery mildew, caused by *Erysiphe graminis* DC. f. sp. *tritici*, was recorded in a majority of the fields, but levels were generally low in both 1986 and 1987. A slight increase in average powdery mildew severity was noted from GS 31 to GS 59-65, after which severity decreased again.

Leaf spot diseases were prevalent and moderate to severe in most fields during both years (Table 1), although average severity was less in 1987 than in 1986. Septoria nodorum blotch (Fig. 2A), incited by *Phaeosphaeria nodorum* (Müller) Hedja. = *Leptosphaeria nodorum* Müller (anamorph: *Stagonospora nodorum* (Berk.) Berk. = *Septoria nodorum* (Berk.) Cast. & Germ.), was the predominant component of the leaf spot complex in both 1986 and 1987. All fields were affected by this disease, but to differing degrees. Septoria nodorum blotch was generally most severe at the later growth stages.

Septoria tritici blotch (Fig. 2B), incited by *Mycosphaerella graminicola* (Fckl.) Sand. (anamorph: *Septoria tritici* Rob. in Desm.), was observed in a higher proportion of the fields in 1987 than in 1986. *S. tritici* was the predominant organism recovered from leaf spots at GS 31 in 1987 but made up only a small proportion of the organisms isolated at later growth stages. This was in contrast with 1986, when Septoria tritici blotch was more severe at late than at early growth stages.

Tan spot (Fig. 2C), incited by *Pyrenophora tritici-repentis* (Died.) Drechs. (anamorph: *Drechslera tritici-repentis* (Died.) Shoem.), occurred more sporadically than either Septoria nodorum blotch or Septoria tritici blotch. Tan spot severity was also greater in 1986 than in 1987, following the trend of the other leaf spot diseases. This disease was most severe late in the season.

Septoria avenae blotch (Fig. 2D), incited by *Phaeosphaeria avenaria* (Weber) O. Erikss. f. sp. *triticea* = *Leptosphaeria avenaria* Weber f. sp. *triticea* (anamorph: *Stagonospora avenae* (Frank) Bisset f. sp. *triticea* = *Septoria avenae* Frank f. sp. *triticea*), was sporadic in both years and was most severe after anthesis.

Spot blotch, caused by *Cochliobolus sativus* (Ito & Kurib.) Drechs. ex Dastur (anamorph: *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem.), was observed late in the season at severities ranging from a trace to 3% in 13% of the fields in 1986 and 41% of the fields in 1987.

In 1986 and 1987, several *Ascochyta* spp., including *A. tritici* Hori & Enj. and *A. avenae* (Petrak.) Sprague & Johnson, were consistently associated with leaf necrosis at all growth stages, in either the presence or the absence of the leaf spotting fungi mentioned earlier. Although *Ascochyta* spp. were more commonly found in leaf spots early in the season, associated leaf lesions covered up to 18% of the green leaf area at GS 80-85 in 1986. Average frequency of recovery of *Ascochyta* spp. was less in 1987 than in 1986.

Other fungi, including *Alternaria* spp., *Cladosporium* spp., *Phoma* spp., *Epicoccum nigrum* Link, *Drechslera* spp., *Curvularia* spp., *Nigrospora* sp., *Fusarium* spp., and *Tricellula* sp., were observed regularly on leaf and glume spot sections. Most of these fungi are regarded as common saprophytes or weak pathogens of wheat. Sometimes nonsporulating fungi or no organisms were recovered from leaf or glume lesions.

Leaf rust, caused by *Puccinia recondita* Rob. ex Desm. f. sp. *tritici*, was observed late in the season in 78% of the fields in 1986 and in all fields in 1987 (Table 1). In 1987, the first pustules were observed at anthesis, several weeks earlier than in 1986. The average severity was slightly higher in 1987 as well. The cultivar Geneva appeared more susceptible to leaf rust than either Frankenmuth or Houser when adjacent fields were compared (Table 1). *P. r.* f. sp. *tritici* races identified were UN 6, UN 10, and (most prevalent) UN 14 in 1986 and UN 5, UN 6, UN 13, UN 14, and UN 17 in 1987 (Table 2).

Stem rust, caused by *Puccinia graminis* Pers. f. sp. *tritici*, was encountered in trace amounts in fields 2, 25, and 30 in

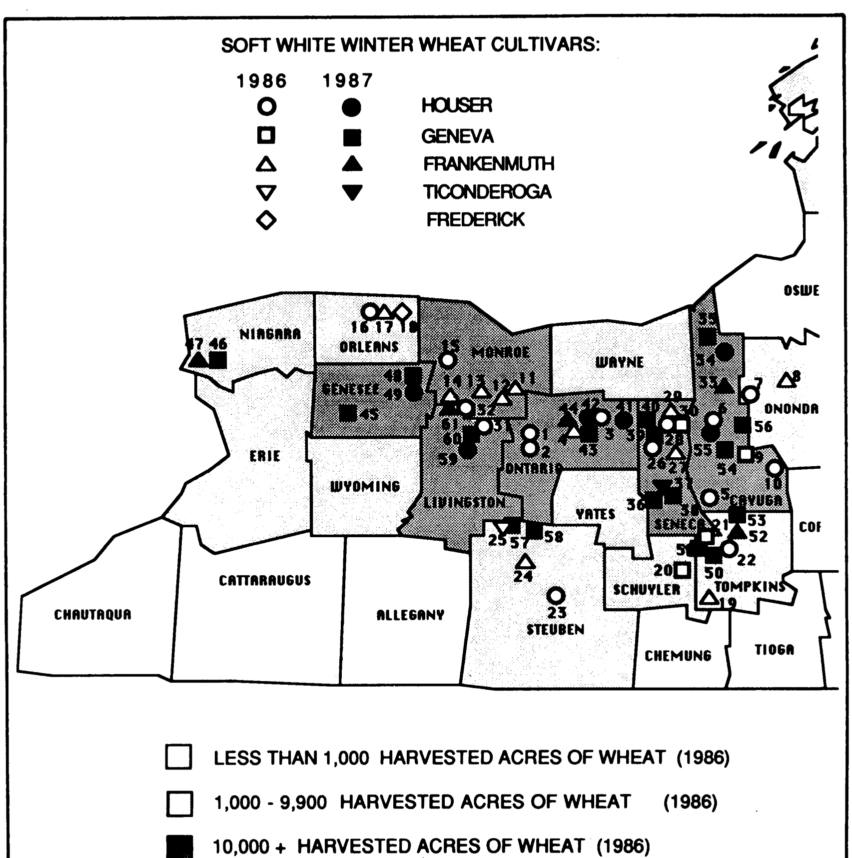

Fig. 1. Location of winter wheat fields surveyed for fungal leaf and spike diseases in New York in 1986 and 1987.

1986 and was not observed in 1987. All isolates were identified as race 15-TNM (virulence genes corresponding to *Sr*5, 7b, 8a, 9c, 9d, 10, 11, 17, and 36), the most common stem rust race in the United States (17).

Loose smut, caused by *Ustilago tritici* (Pers.) Rostr., occurred at low incidence in 28% of the fields in 1986 and in 79% of the fields in 1987, indicating widespread seed infection (mostly of the cultivars Geneva and Frankenmuth), even though growers indicated that in 1987 most fields were planted to certified seed treated with the fungicide carboxin.

In both years, *Erysiphe graminis* f. sp. *tritici* was present in trace amounts on the spikes in many fields (Table 1). Glume spots were present at low severity in a majority of the fields as well. A few fields, however, showed moderate to severe glume spot development. *Stagonospora nodorum* was the main pathogen recovered from the glume spot complex during both years. *S. a.* f. sp. *triticea, Drechslera tritici-repentis, Bipolaris sorokiniana*, and *Ascochyta* spp. were occasionally recovered from glume lesions as well. Lesions frequently yielded common saprophytes, such as *Alternaria* spp., *Epicoccum* spp., and *Cladosporium* spp. A discoloration of the glumes, from which no organisms could be recovered, was noted in some fields.

Scab, caused by *Gibberella zeae* (Schw.) Petch. (anamorph: *Fusarium graminearum* Schwabe), was widespread and severe in many fields in 1986 (Table 1). In 1987, low to moderate scab development occurred only in some fields planted to the cultivars Houser, Frankenmuth, and Ticonderoga.

Cephalosporium stripe, caused by the soilborne fungus *Cephalosporium gramineum* Nis. & Ika., affected a trace to 1% of the tillers in 6% of the fields in 1986, but incidence ranged from a trace to 20% in 41% of the fields in 1987.

Premature senescence of the spikes, also termed "whiteheads," associated most commonly with foot rot, root and

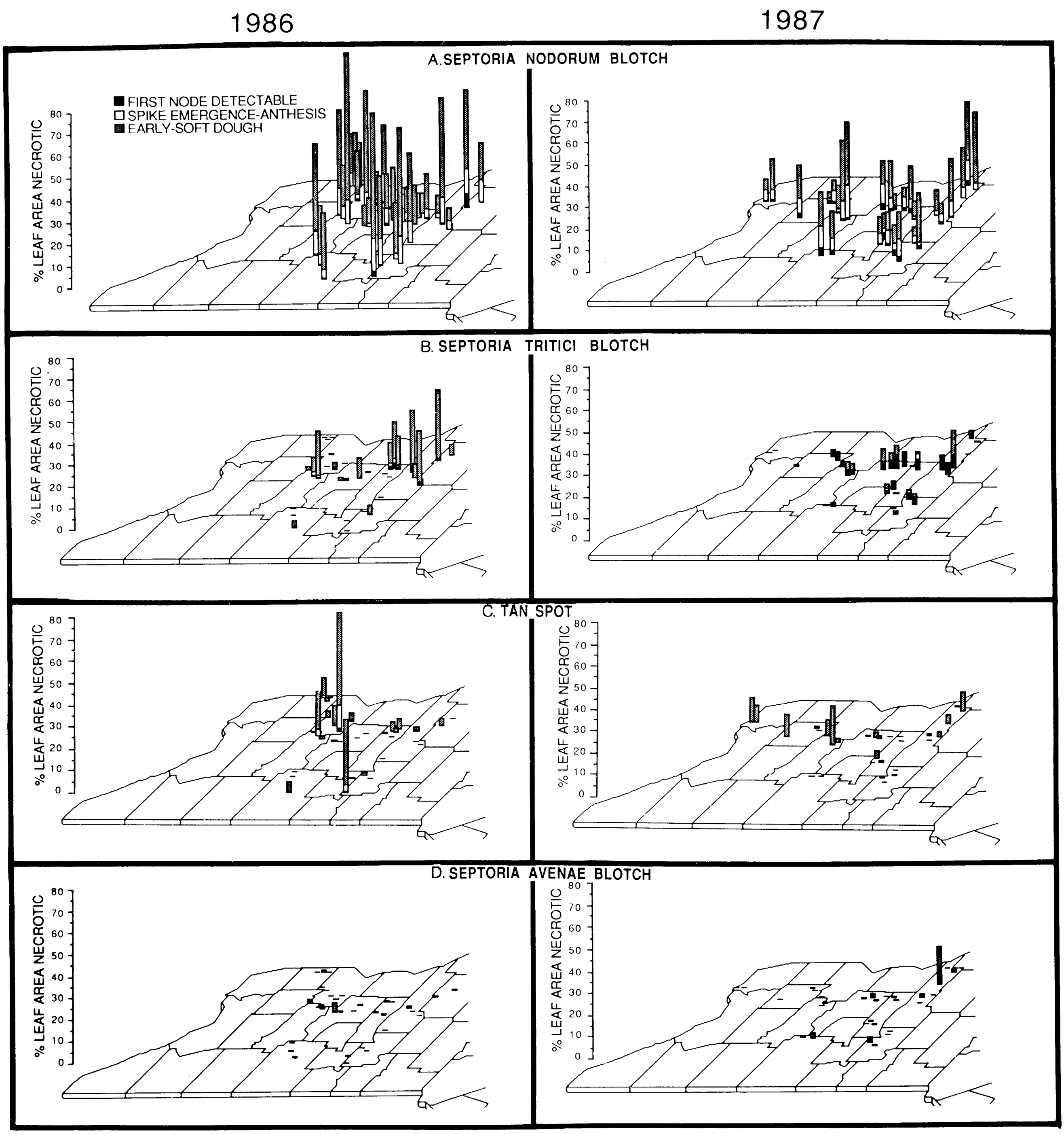

Fig. 2. Severity of fungal leaf spot diseases of winter wheat in New York at three growth stages in 1986 and 1987.

Table 1. Severity of various fungal leaf and spike diseases of winter wheat in New York in 1986 and 1987

		Disease severity (%)												
		Foliage									Spikes			
		Powdery mildew			Leaf spots			Leaf rust			Loose smut	Powdery mildew	Scab	Glume spots
Field no.[a]	Cultivar	31[b]	59-65	80-85	31	59-65	80-85	31	59-65	80-85	59-65	80-85	80-85	80-85
							1986							
1	Houser	3[c]	t	t	1	7	16	0	0	t	0[d]	t[e]	3	1
2	Houser	3	3	t	1	8	15	0	0	t	0	0	3	1
3	Houser	2	7	4	2	5	26	0	0	0	0	2	1	2
4	Frankenmuth	2	t	0	2	7	25	0	0	t	0	0	7	1
5	Houser	t	5	4	t	12	33	0	0	t	0	1	20	t
6	Houser	2	1	0	3	11	38	0	0	0	0	0	5	1
7	Houser	t	t	t	3	15	70	0	0	1	0	t	8	t
8	Frankenmuth	7	5	2	1	14	30	0	0	0	t	1	20	t
9	Geneva	1	3	4	4	13	48	0	0	1	t	0	5	3
10	Houser	2	1	3	3	8	30	0	0	t	0	t	2	1
11	Frankenmuth	6	8	4	1	14	26	0	0	1	t	t	2	2
12	Frankenmuth	1	t	0	6	13	55	0	0	2	1	0	5	t
13	Frankenmuth	2	8	5	2	10	53	0	0	2	0	t	1	10
14	Frankenmuth	2	8	2	2	15	39	0	0	1	0	t	25	3
15	Houser	2	3	2	7	9	26	0	0	0	0	t	5	2
16	Houser	t	4	3	7	13	33	0	0	t	0	2	2	t
17	Frankenmuth	1	6	t	8	10	25	0	0	1	0	t	2	1
18	Frederick	2	2	1	9	11	25	0	0	t	t	1	1	2
19	Frankenmuth	2	1	0	4	15	60	0	0	1	t	t	1	5
20	Geneva	10	2	t	2	13	30	0	0	0	t	0	2	2
21	Geneva	...[f]	3	6	...	8	24	...	0	2	0	0	10	3
22	Houser	10	2	t	2	16	55	0	0	1	0	0	20	3
23	Houser	1	2	t	3	4	30	0	0	t	0	0	15	1
24	Frankenmuth	4	10	5	1	8	25	0	0	t	0	0	5	t
25	Ticonderoga	4	6	3	2	12	40	0	0	0	0	0	7	t
26	Houser	6	9	t	2	6	21	0	0	18	0	0	15	1
27	Frankenmuth	7	7	2	2	5	19	0	0	6	0	0	18	1
28	Houser	2	2	t	6	3	26	0	0	1	0	t	15	1
29	Frankenmuth	1	2	1	6	4	30	0	0	3	0	0	17	t
30	Geneva	1	1	t	6	4	35	0	0	4	t	0	15	1
31	Houser	14	12	2	1	15	75	0	0	50	0	0	6	55
32	Houser	2	2	0	t	11	33	0	0	0	1	t	8	2
Average		3	4	2	3	10	35	0	0	3	t	t	9	3
							1987							
33	Frankenmuth	t	3	2	t	5	44	0	0	1	t	0	t	t
34	Houser	t	t	3	2	3	38	0	t	4	t	t	2	t
35	Geneva	0	2	t	4	9	30	0	t	6	t	0	t	2
36	Geneva	t	4	1	2	9	11	0	0	t	1	0	0	t
37	Ticonderoga	2	3	t	6	9	12	0	0	t	0	0	8	t
38	Geneva	1	5	2	2	8	10	0	0	t	t	t	t	t
39	Geneva	t	3	t	5	3	8	0	t	6	t	0	t	2
40	Geneva	1	5	1	2	6	18	0	0	13	t	0	t	t
41	Houser	t	5	1	7	7	6	0	0	t	0	t	15	t
42	Houser	1	14	2	8	4	13	0	0	t	0	t	7	t
43	Geneva	2	11	1	5	5	23	0	0	8	t	t	t	t
44	Frankenmuth	t	2	0	6	9	18	0	0	5	1	0	1	t
45	Geneva	t	1	0	3	7	23	0	0	1	t	0	t	t
46	Geneva	0	t	0	1	5	21	0	0	t	t	0	0	t
47	Frankenmuth	0	0	0	1	5	21	0	0	t	t	0	0	t
48	Geneva	1	5	2	3	5	8	0	t	t	t	0	0	t
49	Houser	t	5	4	5	3	5	0	t	t	0	t	t	t
50	Geneva	3	11	3	3	8	13	0	0	t	t	t	t	t
51	Geneva	2	5	2	4	4	11	0	0	t	t	t	t	t
52	Frankenmuth	1	7	3	5	4	23	0	0	t	0	t	2	t
53	Geneva	t	4	t	4	5	5	0	0	t	t	0	t	3
54	Geneva	t	3	t	6	6	5	0	0	t	t	0	t	4
55	Houser	t	3	2	6	6	12	0	0	t	0	t	3	t
56	Geneva	t	3	1	6	7	38	0	0	3	t	0	0	6
57	Geneva	t	4	2	4	10	16	0	0	t	t	t	1	5
58	Geneva	t	5	4	3	6	15	0	0	t	t	t	t	2
59	Houser	t	2	t	3	9	54	0	t	20	t	t	1	t
60	Geneva	4	5	2	3	15	48	0	t	45	t	0	t	t
61	Frankenmuth	t	2	1	2	2	21	0	t	13	1	0	t	t
Average		1	4	1	4	6	20	0	t	5	t	t	2	1

[a] See Figure 1.

[b] Growth stages (GS) according to the decimal scale of Zadoks et al (23): 31 = first node detectable, 59-65 = spike emergence-anthesis, 80-85 = early-soft dough.

[c] Percentage of leaf area showing pathogen signs or symptoms based on James (11), modified for use on different sets of leaves (t = less than 1%). Observations done on whole plant (GS 31), four upper leaves (GS 59-65), and two upper leaves (GS 80-85).

[d] Percentage of spikes affected by loose smut (t = less than 1%).

[e] Percentage of spike area showing pathogen signs or symptoms based on James (11) (t = less than 1%).

[f] Data not available.

crown rot, take-all, or stem boring insect injury, occurred at low levels in a majority of fields. In both years, only a few fields showed high incidences, with maximally 30% of the tillers affected.

Yellow dwarf-like symptoms were observed in most fields and were moderate to severe in 31% of the fields in 1986 and in 35% of the fields in 1987. Presence of PAV-like isolates of barley yellow dwarf virus was confirmed in most leaf samples by ELISA procedures in 1987 (A. G. Power, *unpublished*).

Symptoms attributed to wheat spindle streak mosaic virus (WSSMV), ranging from a trace to moderately severe, were observed in 84% of the fields in 1986 and 52% of the fields in 1987. ELISA procedures confirmed the presence of WSSMV in a majority of 67 winter wheat fields surveyed in 1988 for virus diseases. ELISA results correlated well with symptom observations (N. R. Miller, G. C. Bergstrom, and S. M. Gray, *unpublished*).

Information obtained from growers in 1987 indicated that all applied conventional management, 86% planted certified or foundation seed treated with carboxin, and none applied foliar fungicides. Wheat was preceded by spring oats in 45%, spring barley in 10%, and silage corn in 17% of the fields.

DISCUSSION

A 2-yr survey of soft white winter wheat has elucidated considerably the foliar fungal disease complex on this crop in New York. Leaf spot diseases predominate and may be major yield-reducing factors. The survey has shown that the relative importance of many diseases has changed considerably in the past 60–70 yr, presumably because of the advent of seed treatment with systemic fungicides, increased crop rotation, and the release of new winter wheat cultivars with altered disease resistance.

Until recently, powdery mildew was assumed to be the predominant disease of winter wheat in New York. According to data obtained in 1986 and 1987, the importance of powdery mildew on winter wheat appears to be overestimated and the importance of leaf spot diseases appears to be underestimated. However, powdery mildew was both prevalent and severe on the highly susceptible spring wheat cultivar Sinton in 1984 and 1985 (7,8). Low powdery mildew development on winter wheat in New York is most likely due to slow-mildewing resistance in the winter wheat cultivars presently grown (M. E. Sorrells, *personal communication*).

In 1986, the winter wheat growing period was considered very favorable for fungal leaf spot diseases because of high precipitation and high temperatures during part of the season (3). These diseases were less severe in 1987 because of unusually low precipitation, which retarded leaf spot development, during the period from stem elongation to anthesis (3). Previous surveys indicated that powdery mildew, Septoria nodorum blotch, and tan spot were the most prevalent and severe diseases of spring wheat in New York (7,8). Similarly, the present study consistently found Septoria nodorum blotch to be the most prevalent disease of winter wheat. This disease has been reported to be an important yield-reducing factor in wheat production throughout the eastern United States (1). Tan spot, however, occurred more sporadically and was of lesser severity on winter wheat during this survey than on spring wheat in 1984 and 1985. This may be due in part to intermediate levels of resistance possessed by the winter wheat cultivars Houser and Frankenmuth and a rather high level of resistance possessed by Geneva, as compared with the highly susceptible reactions of the spring wheat cultivars Sinton and Max (A. M. C. Schilder, *unpublished*).

Even though average monthly precipitation did not deviate much from normal trends, occurrence of low to moderate Septoria tritici blotch followed periods of high precipitation at the end of May in 1986 and the beginning of April in 1987. This may explain the difference in time of disease development between the two seasons. Septoria tritici blotch was not detected on spring wheat in 1984 and 1985 (7,8).

Climatic factors and possible resistance in the winter wheat cultivars currently grown may account for the sporadic and late occurrence of Septoria avenae blotch on winter wheat in 1986 and 1987. This disease was moderate in severity on spring wheat in 1984 (7,8).

Ascochyta spp. may, in favorable environments, pose a problem to winter wheat production. Pathogenicity of a number of isolates on winter wheat has been confirmed (A. M. C. Schilder, *unpublished*).

Weather patterns, such as average monthly temperatures and total monthly precipitation, could only partially explain the variation in leaf spot severity observed among fields. Both *S. nodorum* and *S. a.* f. sp. *triticea*, and occasionally *D. tritici-repentis*, were recovered from glume lesions, which suggests that seed infection may occur. Infected seed may, as a source of initial inoculum, affect severity levels of these diseases in specific fields, possibly more so than differences in monthly weather patterns. Comparisons of cultivars grown in adjacent fields (fields 16, 17, and 18; fields 28, 29, and 30; fields 46 and 47; fields 48 and 49; and fields 59 and 60; Table 1) also suggested that the cultivar Geneva is more susceptible to the leaf spot complex than Houser or Frankenmuth, yet tan spot as a component tended to be less severe on Geneva than on the other two cultivars (Fig. 2).

The predominance of Septoria nodorum blotch in the foliar disease complex can be partially explained by the wide environmental adaptation of the pathogen (12) and possibly by low leaf rust and powdery mildew severities, which resulted in less competition for available leaf area, during most of its development. A significant inverse relationship between the severities of leaf rust and Septoria nodorum blotch has been detected (19). *S. nodorum* has been reported as neutralistic in its interaction with *D. tritici-repentis* (7) and *S. tritici* (13) on wheat leaves, which suggests that interactions do not play a major role in determining the predominance of Septoria nodorum blotch.

The importance of leaf spot diseases on winter wheat in New York warrants incorporation of adequate levels of rate-reducing (nonspecific) resistance to Septoria nodorum blotch into winter wheat cultivars. Moderate levels of tan spot resistance should be maintained. Other diseases, such as Septoria tritici blotch, Septoria avenae blotch, and Ascochyta leaf spot, could increase in severity when competition for available leaf area is thus reduced, and care should be taken to select against susceptibility. Control of leaf spots by application of foliar fungicides is presently not cost-effective under New York conditions.

Leaf rust is thought to have little impact on yield, as it generally appears late in the season, but may be harmful if epidemics are initiated earlier. Specific UN 14 virulence phenotypes were identified as unique to New York, providing strong circumstantial evidence that leaf rust development is initiated in

Table 2. *Puccinia recondita* f. sp. *tritici* races in New York winter wheat fields in 1986 and 1987[a]

Race	Virulence formula[b]	Field no.[c]
	1986	
UN 6	1, 2c, 3, 10, 11	24
	1, 2c, 3, 3ka, 9	4
	1, 2c, 3, 3ka, 9, 30	23
UN 10	2c, 18	2, 19, 26
UN 14	1, 2c	21, 22
	1, 2c, 10	7, 14, 17, 27
	1, 2c, 10, 18	9, 28
	1, 2c, 10, 11, 18, 30	11, 12, 14, 30
	1987	
UN 5	1, 3, 10, 24	60
	1, 3, 10, 24, 26	40
UN 6	1, 2c, 3, 10	44, 45, 46
	1, 2c, 3, 3ka, 18, 30	61
UN 13	1, 2a, 2c, 3, 10	58, 59
	1, 2a, 2c, 3, 10, 11	43
UN 14	1, 2c, 10, 11, 18	57
	1, 2c, 10, 17, 18	34, 55
UN 17	2a, 2c, 3, 10	60
	2a, 2c, 3, 10, 18	36, 38

[a] Data from D. L. Long, USDA Cereal Rust Laboratory, St. Paul, MN.
[b] *Lr* single-gene differential lines tested = 1, 2a, 2c, 3, 3ka, 9, 10, 11, 16, 17, 18, 24, 26, and 30.
[c] See Figure 1.

part by locally overwintered inoculum (18). Because UN 14 parasitizes predominantly eastern soft white winter wheat cultivars (Augusta, Frankenmuth, Houser, and Geneva) and is avirulent to *Lr*3, these cultivars are thought not to possess *Lr*3, a gene now ineffective against most leaf rust races in the United States (15,18).

Severe stem rust development was observed on the spring wheat cultivar Max in 1984 (7,8) but was rare on winter wheat in New York in 1986 and 1987. Possible resistance may add to the restricted occurrence of this disease on winter wheat.

The scab epidemic in 1986 was significant in that a reduction in germination requirements for certified winter wheat seed was necessary to provide sufficient seed for 1986 planting. In addition, detection of toxic compounds, specifically deoxynivalenol, in grain samples infected by *Gibberella zeae* was a major concern (6). Prolonged periods of precipitation during anthesis, when infection takes place, were considered instrumental in the 1986 scab epidemic. Low precipitation during anthesis in most fields in 1987 resulted in restricted scab development. Foliar fungicides were ineffective in controlling the disease in 1986 (6).

The widespread occurrence of loose smut in 1987 stresses the need for continuing seed treatment with systemic fungicides effective against this disease.

Soilborne diseases were widespread, as had been shown in a survey of New York winter wheat for soilborne diseases in 1981 (R. W. Smiley, *unpublished*), but were severe only in a minority of winter wheat fields. Root and crown rot caused by *Fusarium* spp. is probably the most common soilborne disease of winter wheat in New York (14).

The increased occurrence of Cephalosporium stripe in 1987 can be attributed to excessively wet soil conditions in the fall of 1986 and possibly to infection of the spring oats or spring barley that preceded wheat in about half of the fields surveyed in 1987. Established rotational practices help reduce the severity of soilborne diseases in New York.

The endemic, and in some years epidemic, nature of viral diseases in New York winter wheat warrants further investigation of the prevalence and relative importance of specific viruses involved in the disease complex and of disease/loss relationships.

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