Wheat Leaf Rust in the United States in 2022

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In 2022 wheat leaf rust caused by *Puccinia triticina* was reported from 16 states. Incidence and severity levels were at low levels in 2022. Many of the areas in the hard red winter wheat region and the soft red winter wheat region had lower than average precipitation and higher than average temperatures in March and April. The dry and hot conditions slowed the development and spread of leaf rust early in the epidemic, that also reduced the amount of urediniospores carried north to the hard red spring wheat region and the northern soft red winter wheat region. Drought and high temperatures persisted throughout the Great Plains region into July, further diminishing the spread and increase of leaf rust.

Leaf rust was first observed in early March in research plots in south Texas and was at high severity level on susceptible cultivars by the first week of April. In central Oklahoma leaf rust was first observed in the second week of May, and first appeared in early June in Kansas. In the northern Great Plains, leaf rust was first reported in the last week of June in southeast South Dakota. In Minnesota and eastern North Dakota, leaf rust was first detected in winter wheat plots in the first week of July, and was at low to moderate levels in plots of susceptible spring wheat cultivars in mid to late July. Leaf rust was also reported generally at low to moderate severity levels in Michigan, Illinois, Ohio, New York, Maryland, Virginia, North Carolina, Georgia, Alabama, Louisiana, and California. Infections were first observed late in the growing season at many of these locations. Plots of triticale in New York and California were infected by *P. triticina*.

Yield loss in wheat in Pennsylvania due to leaf rust was estimated to be 3% or 474,000 bushels. All other states had losses estimated as less than 1%. Total losses in the U.S. due to leaf rust were estimated to be 689,000 bushels.

Races and virulence of *Puccinia triticina*

In 2022, 37 races of *P. triticina* were identified in collections of leaf rust infected leaves that were sent to the USDA-ARS Cereal Disease Laboratory. A total of 243 isolates were processed for race identification. The hot and dry weather throughout the wheat-growing regions reduced the number of collections received in 2022.

MNPSD was the most common race across the United States at 29.2% of all isolates. Isolates with this race designation were found at very high levels throughout the hard red *Lr39*. These genes are present in hard red winter wheat cultivars. MPPSD was the second most common race, at 14.4% of overall isolates. This race was also found throughout the Great Plains region. MPPSD is virulent to wheat lines with *Lr24, Lr26, Lr37*, and *Lr39.* Races MNPSD, and MPPSD, have been selected by the hard red winter wheat cultivar

SY Monument that was widely grown in Oklahoma, Kansas, and Nebraska in 2022. Race TNBJS was the third most common race at 8.2% of all isolates. TNBJS is virulent to *Lr2a, Lr24*, and *Lr21*, and was found only in Minnesota and North Dakota. Many of the hard red spring wheat cultivars in this region have *Lr2a* or *Lr21*.

In the soft red wheat region of area 1, TBRDG was the most common race at 34.3% of isolates in this region. This race has not been detected prior to this year. Most of the isolates with this race designation came from wheat breeding plots in Alabama. MCTNB, and TBTNB were the second and third most common races, respectively in the southeastern region of area 1, at 14.3% and 11.4% of isolates. Race MCTNB was also found in the soft wheat region of areas 2 and 3. TBRDG, MCTNB, and TBTNB are virulent to *Lr11*, which has historically been in the soft red winter wheat germplasm.

Races MJBJG and MGPSB are virulent to *Lr16* and were found at low frequency in area 6. Hard red spring wheat cultivars with *Lr16* have been grown in area 6.

Isolates of race PBDGG were collected from triticale in New York and in northern California. Isolates of this race were previously collected from triticale in Florida and other states. Race PBDGG may be adapted to triticale.

The complete listing of races found in the United States in 2022 is given in Table 1. The frequency of isolates with virulence to the individual *Lr* genes is given in Table 2. The complete listing of collections, host cultivars, date of collection, collectors, location of collections, and identified races are given in the attached Excel file. Table 3 lists the most commonly grown cultivars grown in 2022 in the hard red winter wheat states of Oklahoma, Kansas, and Nebraska, and also the most prevalent hard red spring wheat cultivars in Minnesota and North Dakota. When possible, the *Lr* genes were postulated based on infection type data to different races of *P. triticina* and also on molecular marker data obtained from testing of the SRPN and NRPN and the UHRSWN by USDA-ARS genotyping laboratories in Manhattan KS and Fargo ND.

Table 1. Number and frequency (%) of the predominant virulence phenotypes of Puccinia triticina in the United States in 2022 identified by virulence to 20[a] lines of Thatcher wheat with single genes for leaf rust resistance.

	Area 1[b]		Area 2[c]		Area 3[d]		Area 4[e]		Area 5[f]		Area 6[g]		Area 7[h]		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
MBDJD 1,3,17,10,14a,39	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	7	5.6	0	0.0	8	3.3
MBDSD 1,3,17,B,10,14a,39	0	0.0	0	0.0	0	0.0	1	2.0	3	18.8	3	2.4	0	0.0	7	2.9
MBPSD 1,3,3ka,17,30,B,11,14a,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.4
MBTNB 1,3,3ka,11,17,30,B,14a	3	8.6	0	0.0	2	15.4	0	0.0	1	6.3	3	2.4	0	0.0	9	3.7
MCDJD 1,3,26,17,10,14a,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	3.2	0	0.0	4	1.6
MCTNB 1,3,26,3ka,11,17,30,B,14a	5	14.3	2	66.7	4	30.8	4	8.2	0	0.0	1	0.8	0	0.0	16	6.6
MDPSB 1,3,24,3ka,17,30,B,10,14a	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.4
MGPSB 1,3,16,3ka,17,30,B,10,14a	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.6	0	0.0	2	0.8
MJBJG 1,3,16,24,10,14a,28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.6	0	0.0	2	0.8
MKPSB 1,3,16,24,26,3ka,17,30,B, 10,14a	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.4
MLPSD 1,3,9,3ka,17,30,B,10,14a, 39	0	0.0	0	0.0	0	0.0	0	0.0	1	6.3	2	1.6	0	0.0	3	1.2
MNPSD 1,3,9,24,3ka,17,30,B,10, 14a,39	1	2.9	0	0.0	0	0.0	27	55.1	3	18.8	40	32.0	0	0.0	71	29.2
MNTSD 1,3,9,24,3ka,11,17,30,B,10, 14a,39	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	1	0.8	0	0.0	2	0.8
MPDSD 1,3,9,24,26,17,B,10,14a,39	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	0	0.0	0	0.0	1	0.4
MPPSD 1,3,9,24,26,3ka,17,30,B,10, 14a,39	0	0.0	0	0.0	0	0.0	9	18.4	7	43.8	19	15.2	0	0.0	35	14.4
MPTSB 1,3,9,24,26,3ka,11,17,30,B, 10,14a	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	0	0.0	0	0.0	1	0.4
MPTSD 1,3,9,24,26,3ka,11,17,30,B, 10,14,39	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	1	0.8	0	0.0	3	1.2
PBDGG 1,2c,3,17,10,28	0	0.0	1	33.3	0	0.0	0	0.0	0	0.0	0	0.0	2	100	3	12
PBDGJ 1,2c,3,17,10,28,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.4
TBBGS 1,2a,2c,3,10, 21,28,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	2.4	0	0.0	3	1.2
TBBJG 1,2a,2c,3,10,14a,28	0	0.0	0	0.0	1	7.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
TBRDG 1,2a,2c,3,3ka,11,30,14a,28	12	34.3	0	0.0	0	0.0	1	2.0	0	0.0	1	0.8	0	0.0	14	5.8
TBRFG 1,2a,2c,3,3ka,11,30,14a,18, 28	1	2.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
TBRNG 1,2a,2c,3,3ka,11,30,B,14a, 28	3	8.6	0	0.0	0	0.0	0	0.0	0.0	0.0	3	2.4	0	0.0	6	2.4

TBRPG 1,2a,2c,3,3ka,11,30,B,14a, 18,28	1	2.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
TBTNB 1,2a,2c,3,3ka,11,17,30,B, 14a	4	11.4	0	0.0	0	0.0	0	0.0	0	0.0	2	1.6	0	0.0	6	2.4
TCGJG 1,2a,2c,3,26,11,10,14a,28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.4
TCRDG 1,2a,2c,3,26,3ka,11,30,14a, 28	1	2.9	0	0.0	1	7.7	0	0.0	1	6.3	0	0.0	0	0.0	3	1.2
TCRKG 1,2a,2c,3,26,3ka,11,30,10, 14a,18,28	1	2.9	0	0.0	0	0.0	1	2.0	0	0.0	0	0.0	0	0.0	2	0.8
TCTLB 1,2a,2c,3,26,3ka,11,17,30, B	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	2.4	0	0.0	3	1.2
TCTNB 1,2a,2c,3,26,3ka,11,17,30, B,14a	1	2.9	0	0.0	1	7.7	0	0.0	0	0.0	0	0.0	0	0.0	2	0.8
TCTSB 1,2a,2c,3,26,3ka,11,17,30, B,10,14a	2	5.7	0	0.0	1	7.7	0	0.0	0	0.0	0	0.0	0	0.0	3	1.2
TDPSB 1,2a,2c,3,24,3ka,17,30,B, 10,14a	0	0.0	0	0.0	3	15.4	0	0.0	0	0.0	0	0.0	0	0.0	3	1.2
TFPSB 1,2a,2c,3,24,26,3ka,17,30, B,10,14a	0	0.0	0	0.0	1	7.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
THTLB 1,2a,2c,3,16,26,3ka,11,17, 30,B	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	0	0.0	0	0.0	1	0.4
TNBGS 1,2a,2c,3,9,24,10,21,28,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	2.4	0	0.0	3	1.2
TNBJS 1,2a,2c,3,9,24,10,14a,21, 28,39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	16.0	0	0.0	20	8.2
Total	35		3		13		49		16		125		2		243	

[a] Thatcher lines with genes Lr1, Lr2a, Lr2c, Lr3, Lr9, Lr16, Lr24, Lr26, Lr3ka, Lr11, Lr17, Lr30, LrB, Lr10, Lr14a, Lr18, Lr21, Lr28, Lr39 and Lr42.
[b] States of MS, GA, LA, AL, NC, and VA.
[c] State of NY.
[d] States of MO, IN, KY, OH, IL.
[e] States of TX and OK.
[f] States of KS and NE.
[g] States of MN, SD, and ND
[h] State of CA.
[I] Sate of ID, WA

Table 2. Number and frequency (%) of isolates of *Puccinia triticina* in the United States in 2022 virulent to 20[a] lines of wheat with single resistance genes for leaf rust resistance.

	Area1[b]		Area 2[c]		Area 3[d]		Area 4[e]		Area 5[f]		Area 6[g]		Area 7[h]		Total	
Gene	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Lr1	35	100.0	3	100.0	13	100.0	49	100.0	16	100.0	125	100.0	2	100.0	243	100.0
Lr2a	26	74.3	0	0.0	7	53.8	3	6.1	1	6.3	36	28.8	0	0.0	73	30.0
Lr2c	26	74.3	1	33.3	7	53.8	3	6.1	1	6.3	37	29.6	2	100.0	77	31.7
Lr3	35	100.0	3	100.0	13	100.0	49	100.0	16	100.0	125	100.0	2	100.0	243	100.0
Lr9	1	2.9	0	0.0	0	0.0	40	81.6	11	68.8	86	68.8	0	0.0	138	56.8
Lr16	0	0.0	0	0.0	0	0.0	1	2.0	0	0.0	5	4.0	0	0.0	6	2.5
Lr24	1	2.9	0	0.0	3	23.1	40	81.6	10	62.5	88	70.4	0	0.0	142	58.4
Lr26	10	28.6	2	66.7	8	61.5	18	36.7	8	50.0	30	24.0	0	0.0	76	31.3
Lr3ka	35	100.0	2	66.7	12	92.3	46	93.9	13	81.3	82	64.8	0	0.0	189	77.8
Lr11	34	97.1	2	66.7	9	69.2	10	20.4	2	12.5	16	12.8	0	0.0	73	30.0
Lr17	16	45.7	3	10.0	11	84.6	47	95.9	15	93.8	92	73.6	2	100.0	186	76.5
Lr30	35	100.0	2	66.7	12	92.3	46	93.9	13	81.3	81	64.8	0	0.0	189	77.8
LrB	20	57.1	2	66.7	11	84.6	46	93.9	15	93.8	83	66.4	0	0.0	177	72.8
Lr10	4	11.4	1	33.3	5	38.5	43	87.8	14	87.5	112	89.6	2	100.0	181	74.5
Lr14a	35	100.0	2	66.7	13	100.0	48	98.0	16	100.0	115	92	0	0.0	229	94.2
Lr18	3	8.6	0	0.0	0	0.0	1	2.0	0	0.0	0	0.0	0	0.0	4	1.6
Lr21	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	26	20.8	0	0.0	26	10.7
Lr28	19	54.3	1	33.3	2	15.4	2	4.1	1	6.3	34	27.2	2	100.0	61	25.1
Lr39	1	2.9	0	0.0	0	0.0	41	83.7	14	87.5	105	84.0	0	0.0	161	66.3
Lr42	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.	0.0	0	0.0

[a] Thatcher lines with genes *Lr1, Lr2a, Lr2c, Lr3, Lr9, Lr16, Lr24, Lr26, Lr3ka, Lr11, Lr17, Lr30, LrB, Lr10, Lr14a, Lr18, Lr21, Lr28*, *Lr39* and *Lr42*.
[b] States of MS, GA, LA, AL, NC, and VA.
[c] State of NY.
[d] States of MO, KY, IN, OH, IL.
[e] States of TX and OK.
[f] States of KS and NE.
[g] States of MN, ND, and SD.
[h] State of CA

Table 3. Hard Red Winter and Hard Red Spring Wheat Cultivars grown in 2022

Texas	**Oklahoma**	**Kansas**	**Nebraska**	**North Dakota**	**Minnesota**
TAM 114 Lr26, Lr37	Doublestop CL none	SY Monument	SY Monument	SY Valda +	MN Torgy Lr16, Lr34
TAM 204 +	Gallagher *Lr26*	WB Grainfield *Lr39*	SY Wolverine	SY Ingmar Lr21	WB 9590 Lr21
TAM 111 Lr17 (Lr37)	Green Hammer	Bob Dole Lr37, Lr39	Husker Genetics: Ruth	AP Mudock Lr21	SY Valda + Lr34
TAM 112 Lr39	Smith's Gold Lr34, Lr37	Langin none	Settler CL *Lr11*	WB 9590 Lr21	WB9479 Lr21
Gallagher Lr26	OK Corral none	Winterhaw*k* *Lr39*	WB Grainfield *Lr39*	WB 9719	AP Murdock Lr21
SY Razor	Endurance *Lr1, Lr26*	SY Wolverine	Brawl CL Plus *Lr14a Lr3*	Shelly Lr21, Lr23	Linkert Lr16, Lr23,Lr34
TAM 105	Iba Lr34, Lr37	Everest Lr1, Lr14a	WB4595	ND Vitpro	Shelly Lr21, Lr23
Winterhawk Lr39	Bently Lr21, Lr39	T158 *Lr37, Lr39*	WB4303	Elgin ND Lr21	TDG-Wildcat Lr2a+
Smith's Gold Lr34, Lr37	WB 4515	Zenda Lr37	LCS Link	Faller Lr21	LCS Trigger Lr21
TAM 113 Lr24	SY Monument	WB 4515	Husker Genetics: Robidoux	Glenn Lr21	