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MINNESOTA

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Wheat leaf rust caused by Puccinia triticina in the United States in 2013.

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Summary. Wheat leaf rust (*Puccinia triticina*) was widely distributed across the U.S. from the Great Plains to the east coast but was generally found at low levels. Cool spring weather in the Great Plains and eastern states delayed small grain development, planting and field work. In late May, wheat leaf rust was at atypically low levels for the time of year, particularly in the southern and central Great Plains. Inoculum levels from Texas into the central and northern Great Plains were low, due to cooler spring temperatures, dry conditions, and the application of fungicides. Races with virulence to both *Lr39*/*Lr41* that is present in many hard red winter wheat cultivars grown from Texas to Kansas, and *Lr21* that is in many hard red spring wheat cultivars, were present in Texas and Minnesota. Races with virulence to *Lr3ka*, *Lr11*, *Lr26*, and *Lr18* were most common in the soft red winter wheat areas of the southeastern states and Ohio Valley. In the hard red wheat area of the southern and northern Great Plains, races with virulence to *Lr24*, *Lr17*, *Lr21*, and *Lr39*/*Lr41* were the most common.

Estimated losses in wheat due to leaf rust of 1–2% occurred in North Carolina, South Carolina, Mississippi, Missouri, Wisconsin, Illinois, Indiana, and Lousiana with trace level of losses in other states.

Texas. Wheat leaf rust severity was high in plots (up to 80S) at Pearsall and uniform in the lower canopy of plots at Uvalde in south Texas in early February. Leaf rust continued to develop at Uvalde and susceptible cultivars at Feekes 4–5 growth stage had high leaf rust severity by late February. Leaf rust was at trace levels and was uniformly distributed through the spreader rows in plots at Castroville in south central Texas in early February and continued to develop in the spreader rows and lower to mid-canopy of the cultivar TAM 110 reaching 50S in early March. By mid-April, high levels of leaf rust were observed in plots at Castroville. Generally, leaf rust was at low levels in commercial fields in the state due to cool spring temperatures, dry conditions, and the application of fungicides.

Oklahoma. Low levels of wheat leaf rust were found on the winter wheat cultivar Overley (boot to head emergence) near Devol in south-central Oklahoma the second week of April. This was the first cereal rust report in Oklahoma in 2013. No leaf rust was found in plots and fields (at boot stage) in central Oklahoma on 26 April. By the second week of May, there appeared to be very little wheat leaf rust in the state. Leaf rust was found in plots at Perkins (5–20S) and Stillwater in north-central Oklahoma the fourth week of May. Drought and late season freezes severely impacted wheat production in the panhandle in 2013. Trace amounts of wheat leaf rust were found in north-central Oklahoma on 5 June. Generally, wheat leaf was at atypically low levels in the state in 2013.

Kansas. A single wheat leaf rust pustule was found in Stafford County in south-central Kansas the second week of May. This was the only report of wheat leaf rust in in the state by the second week of May. Wheat in southwestern Kansas suffered from drought and freeze damage, whereas wheat in south-central and central Kansas was in better condition due to some much needed rain. By late May, there were only a few reports of wheat leaf rust in state. Trace amounts of wheat leaf rust were found in susceptible plots of Winterhawk in Saline County in central Kansas. On 31 May, trace amounts of wheat leaf rust were found in plots in Reno County in south-central Kansas. Trace amounts of wheat leaf rust were found in fields in south-central Kansas, and plots in north-central and northeastern Kansas in early June. Susceptible cultivars such as Overley (*Lr39*/*Lr41*), Jagger (*Lr17*), Jackpot (*Lr39*/*Lr41*), and Fuller (*Lr17*, *Lr39*/*Lr41*) had higher severities but incidence was low. Trace amounts of leaf were observed on the cultivars Everest (*Lr1*, *Lr14a*), Armour (*Lr39*/*Lr41*) and Cedar (*Lr14a*, *Lr37*). No rust was reported in Ellis, Rush, Ness, Lane, and Russell Counties in central and west-central Kanas where the wheat was in very poor condition due to drought.

Nebraska. Wheat leaf rust had not yet been reported in the state by 30 May. A hot-spot of wheat leaf rust was found in plots at Lincoln in southeastern Nebraska on 7 June. The lower leaves had 40% rust severity and higher, whereas the flag leaves had only trace amounts. Wheat in the plots was at flowering to milk stage. This was the first report of wheat leaf rust in the state in 2013. Wheat leaf rust development increased rapidly in mid-late June in winter wheat plots and surrounding fields at Mead and Lincoln in southeastern Nebraska. Flag leaves of susceptible lines had high severities and the rust was widespread in the fields. Leaf rust also was observed in fields in south-central Nebraska where wheat was mostly in dough growth stages.

Iowa. Trace amounts of wheat leaf rust were reported in a field in Lee County in extreme southeastern Iowa on 8 June.

Louisiana. Low levels of wheat leaf rust were found in plots at Baton Rouge in southeastern Louisiana in early March. High levels of leaf rust were found in plots in south-central and southwestern Louisiana on 2 April. Rains and morning dews in late March created conditions conducive for further development. Wheat leaf rust was found in cultlivar and fungicide tests around the state in 2013.

Mississippi. Low levels of leaf rust were found in three counties in the Delta area in late March. Leaf rust was confirmed in six counties scattered across the state by mid-April and, by 20 May, leaf rust had been found in 10 counties across the state.

Arkansas. Low levels of leaf rust were found in plots at Kibler in northwestern Arkansas on 17 May. The first report of wheat leaf rust in the state was at low levels in plots at Rohwer in southeastern Arkansas on 10 May. Generally, wheat leaf rust appeared just before crop maturity and caused little damage.

Missouri. Wheat leaf rust was found in plots in Johnson, Pettis, and Boone Counties in west-central and central Missouri in early June. Severities ranged from trace to 20% and incidence from trace up to 40%. Trace levels also were found in fields in Lincoln and Marion Counties in northeastern Missouri.

Georgia. Wheat leaf rust was at very low levels in the state in 2013, likely due to the widespread use of fungicides to control stripe rust.

North Carolina. Leaf rust disease pressure was moderately severe in the Kinston and Plymouth plots in eastern North Carolina in 2013. The leaf rust arrived early in the plots and severely attacked the Saluda (*Lr11*) border rows. Other lines and cultivars in the plots were not as severely impacted as Saluda. Leaf rust also was found in plots at Clayton and Lake Wheeler in east-central North Carolina. Many commercial fields were sprayed with fungicides to reduce leaf rust losses. Wheat leaf rust was generally at low levels in commercial wheat fields, below average levels for the state.

Virginia. Low levels of leaf rust were found in plots at Painter in eastern Virginia in mid-May. Relatively higher incidences were found on susceptible cultivars, such as Massey, as well as cultivars with *Lr9*. Lower leaf rust incidence was found on cultivars with *Lr24* and much lower incidence on cultivars with *Lr26*. No rusts were found on visits to the plots at Blackstone (southern Virginia) and Holland (northeastern Virginia) in mid-May. Wheat leaf rust was found in plots at Blacksburg in western Virginia in late May. Leaf rust was severe on susceptible lines in plots at Warsaw in eastern

Virginia on 11 June. A few weeks earlier only trace amounts of wheat leaf rust were found in the plots.

South Dakota. Very low levels of leaf rust were found in fields in Douglas and Buffalo County in central and south central South Dakota, respectively, in late June. On 10 July, low levels of leaf rust were found in a winter wheat field in Clark County in northeastern South Dakota. Leaf rust was readily found in the southern half of the state at levels from trace to 40% infection in research plots in early July, however, it was difficult to find in commercial fields possibly due to fungicide applications. Wheat ranged form soft dough to dough stage. Wheat leaf rust was difficult to find in northern South Dakota even in research plots. It appeared many of the commercial fields were treated with fungicides. Generally, leaf rust was found at trace levels in fields with some fields having moderate levels.

North Dakota. Trace amounts of wheat leaf rust were found in Baart-Wolfe spreader rows and spring wheat entries in nurseries at Carrington in east-central North Dakota on 11 July. Low levels of wheat leaf rust were found on lower leaves in plots at Casselton in eastern North Dakota on 16 July. There was some flecking on flag leaves. Wheat leaf rust development increased in plots of Decade and other susceptible cultivars in plots maintained by Ducks Unlimited in the Dakotas by mid-July. High levels of infection were noted at Napoleon in south-central North Dakota. Wheat leaf rust was present at low levels in plots in central North Dakota and at trace levels in north-central North Dakota in late July. Plots of Faller wheat (*Lr21*) in northwestern North Dakota had large uredinia although at low severity. The leaf rust races with virulence to *Lr21* are now well established in the Great Plains, as these races also were found in plots of Faller and Glenn wheat in Castroville, Texas, earlier in 2013. In northeastern North Dakota, wheat leaf rust was present at trace levels in plots of susceptible wheat cultivars.

Minnesota. Trace levels of wheat leaf rust were found in winter wheat plots in southeastern Minnesota on 14 June. The infections were highly localized and not distributed throughout the plots. A single pustule of wheat leaf rust was found on a hard red winter wheat line in a nursery in northwestern Minnesota on 26 June. Low levels of wheat leaf rust were found on Baart in plots at Lamberton in southwestern Minnesota in early July. Wheat leaf rust was present at moderate to high levels in plots in west-central Minnesota the last week of July. Trace levels of leaf rust were found in wheat fields in the same area that had been sprayed with fungicide. In northwestern Minnesota, wheat leaf rust was present at trace levels in plots of susceptible wheat cultivars.

Wisconsin. Very low levels of wheat leaf rust were found on winter wheat in plots at Janesville in south-central Wisconsin on 20 June. Wheat leaf rust was widespread in soft red winter wheat plots at Arlington in south-central Wisconsin in early July. Flag leaf severities ranged from 10–50%. Wheat was at dough stage. Low levels of wheat leaf rust were found in fields in eastern and northeastern Wisconsin in early July.

Michigan. Wheat leaf rust was found in plots at Mason in central Michigan in mid-June. High levels of wheat leaf rust were found in Sanilac County in the thumb region of Michigan in early July. Leaf rust likely was present throughout the state by early July.

Ohio, Indiana, and Illinois. Wheat leaf rust at low levels was readily found in winter wheat fields across the northern halves of these states in late June. One field in Shelby County in west-central Ohio had higher leaf rust severities. Wheat was generally at hard dough stage.

New York. The first report of wheat leaf rust in the state was made at Brockport in northwestern New York on 5 June. The rust was found on a single leaf of an unknown cultivar in a commercial field. The wheat was a number of days past flowering and rainy, cool conditions continued in the area. Low levels of wheat leaf rust were observed on winter wheat in central and western New York the fourth week of June.

Washington. Wheat leaf rust was found at lower than typical levels in plots at Mt. Vernon in northwestern Washington but was not found in eastern Washington and northern Idaho in 2013.

Ontario, Canada. Trace amounts of wheat leaf rust were found in winter wheat plots at Ridgetown in southwestern Ontario (about an hour east of Detroit) on 21 June.

The number and frequency of virulence phenotypes of *Puccinia triticina* found in 2013 in the U.S. can be found in Table 1 (pp. 132-133), Table 2 (p. 134), Table 3 (pp. 135-136), and Table 4 (p. 137).

Table 1. Number and frequency (%) of virulence phenotypes of *Puccinia triticina* in the United States in 2011 identified by virulence to 19 lines of wheat with single genes for leaf rust resistance. Lines tested were Thatcher lines with genes *Lr1*, *Lr2a*, *Lr2c*, *Lr3a*, *Lr9*, *Lr16*, *Lr24*, *Lr26*, *Lr3ka*, *Lr11*, *Lr17*, *Lr30*, *LrB*, *Lr10*, *Lr14a*, *Lr18*, *Lr21*, *Lr28*, Lr39/*Lr41* and *Lr42*.

Pheno-type	Virulences	AL, AR, GA, LA, MS, NC, SC, TN, VA		NY		IL, IN, MI, eastern MO, OH, WI		OK, TX		CO, IA, KS, western MO, NE		MN, ND, SD		Total	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
BBBBD	39/41	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
CCPSB	3,26,3ka,17,30,B,10,14a	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
FBPSB	2c,3,3ka,17,30,B,10,14a	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
FCPLB	2c,3,26,3ka,17,30,B	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
KFBJG	2a,2c,3,24,26,10,14a,28	0	0	0	0	1	1.2	0	0	1	1.1	0	0	2	0.4
LBBGG	1,10,28	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
MBDSB	1,3,17,B,10,14a	0	0	0	0	0	0	1	1.4	0	0	1	0.9	2	0.4
MBDSD	1,3,17,B,10,14a,39/41	0	0	0	0	0	0	5	7.2	6	6.5	13	11.5	24	4.9
MBPSB	1,3,3ka,17,30,B,10,14a	0	0	0	0	1	1.2	7	10.1	0	0	4	3.5	12	2.4
MBPSD	1,3,3ka,17,30,B,10,14a,39/41	2	1.6	0	0	0	0	1	1.4	1	1.1	1	0.9	5	1.0
MBTNB	1,3,3ka,11,17,30,B,14a	28	22.8	0	0	42	49.4	1	1.4	5	5.4	1	0.9	77	15.7
MBTSB	1,3,3ka,11,17,30,B,10,14a	4	3.3	0	0	1	1.2	0	0	3	3.2	0	0	8	1.6
MCDSB	1,3,26,17,B,10,14a	0	0	0	0	0	0	1	1.4	0	0	0	0	1	0.2
MCDSD	1,3,26,17,B,10,14a,39/41	0	0	0	0	1	1.2	0	0	1	1.1	2	1.8	4	0.8
MCPSD	1,3,26,3ka,17,30,B,10,14a,39/41	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
MCRHG	1,3,26,3ka,11,30,10,18,28	0	0	2	28.6	0	0	0	0	0	0	0	0	2	0.4
MCSQB	1,3,26,3ka,11,17,B,10	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
MCTNB	1,3,26,3ka,11,17,30,B,14a	20	16.3	0	0	7	8.2	2	2.9	2	2.2	0	0	31	6.3
MCTQB	1,3,26,3ka,11,17,30,B,10	0	0	0	0	1	1.2	0	0	0	0	0	0	1	0.2
MCTSB	1,3,26,3ka,11,17,30,B,10,14a	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
MDPSB	1,3,24,3ka,17,30,B,10,14a	0	0	0	0	0	0	2	2.9	0	0	0	0	2	0.4
MFBSB	1,3,24,26,B,10,14a	0	0	0	0	0	0	1	1.4	0	0	0	0	1	0.2
MFDSB	1,3,24,26,17,B,10,14a	0	0	0	0	0	0	0	0	0	0	2	1.8	2	0.4
MFNSB	1,3,24,26,3ka,17,B,10,14a	0	0	0	0	0	0	2	2.9	1	1.1	4	3.5	7	1.4
MFNSD	1,3,24,26,3ka,17,B,10,14a,39/41	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
MFPSB	1,3,24,26,3ka,17,30,B,10,14a	2	1.6	0	0	0	0	9	13.0	4	4.3	5	4.4	20	4.1
MFQHG	1,3,24,26,3ka,11,10,18,28	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
MHDNB	1,3,16,26,17,B,14a	1	0.8	0	0	1	1.2	0	0	1	1.1	0	0	3	0.6
MHDSB	1,3,16,26,17,B,10,14a	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
MJBJG	1,3,16,24,10,14a,28	0	0	0	0	0	0	0	0	2	2.2	0	0	2	0.4
MJPSB	1,3,16,24,3ka,17,30,B,10,14a	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
MLDSD	1,3,9,17,B,10,14a,39/41	0	0	2	28.6	0	0	2	2.9	1	1.1	0	0	5	1.0
MLPSD	1,3,9,3ka,17,30,B,10,14a,39/41	0	0	0	0	0	0	1	1.4	7	7.5	1	0.9	9	1.8
MMPSD	1,3,9,26,3ka,17,30,B,10,14a,39/41	0	0	0	0	0	0	1	1.4	0	0	1	0.9	2	0.4
NBBRG	1,2c,B,10,18,28	0	0	0	0	1	1.2	0	0	0	0	1	0.9	2	0.4
PBDBG	1,2c,3,17,28	0	0	0	0	0	0	1	1.4	0	0	0	0	1	0.2
PBDGG	1,2c,3,17,10,28	0	0	0	0	0	0	3	4.3	0	0	2	1.8	5	1.0
PBDGJ	1,2c,3,17,10,28,39/41	0	0	0	0	0	0	2	2.9	0	0	4	3.5	6	1.2
PBDQJ	1,2c,3,17,B,10,28,39/41	0	0	0	0	0	0	0	0	3	3.2	3	2.7	6	1.2
PCDGJ	1,2c,3,26,17,10,28,39/41	0	0	0	0	0	0	3	4.3	0	0	0	0	3	0.6
PCLQG	1,2c,3,26,3ka,B,10,28	0	0	1	14.3	0	0	0	0	0	0	0	0	1	0.2
SBDGG	1,2a,2c,17,10,28	2	1.6	2	28.6	0	0	2	2.9	3	3.2	0	0	9	1.8
TBBBJ	1,2a,2c,3,28,39/41	0	0	0	0	1	1.2	0	0	1	1.1	0	0	2	0.4
TBBGJ	1,2a,2c,3,10,28,39/41	0	0	0	0	2	2.4	4	5.8	8	8.6	10	8.8	24	4.9
TBBGS	1,2a,2c,3,10,21,28,39/41	0	0	0	0	0	0	1	1.4	0	0	10	8.8	11	2.2
TBBJG	1,2a,2c,3,10,14a,28	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
TBRKG	1,2a,2c,3,3ka,11,30,10,14a,18,28	22	17.9	0	0	4	4.7	0	0	2	2.2	2	1.8	30	6.1
TCBJG	1,2a,2c,3,26,10,14a,28	0	0	0	0	0	0	0	0	0	0	2	1.8	2	0.4
TCDSB	1,2a,2c,3,26,17,B,10,14a	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2

Table 1. Number and frequency (%) of virulence phenotypes of *Puccinia triticina* in the United States in 2011 identified by virulence to 19 lines of wheat with single genes for leaf rust resistance. Lines tested were Thatcher lines with genes *Lr1*, *Lr2a*, *Lr2c*, *Lr3a*, *Lr9*, *Lr16*, *Lr24*, *Lr26*, *Lr3ka*, *Lr11*, *Lr17*, *Lr30*, *LrB*, *Lr10*, *Lr14a*, *Lr18*, *Lr21*, *Lr28*, Lr39/*Lr41* and *Lr42*.

Phenotype	Virulences	AL, AR, GA, LA, MS, NC, SC, TN, VA		NY		IL, IN, MI, eastern MO, OH, WI		OK, TX		CO, IA, KS, western MO, NE		MN, ND, SD		Total	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
TCGJG	1,2a,2c,3,26,11,10,14a,28	3	2.4	0	0	0	0	0	0	0	0	0	0	3	0.6
TCJSB	1,2a,2c,3,26,11,17,B,10,14a	4	3.3	0	0	0	0	0	0	1	1.1	2	1.8	7	1.4
TCQJG	1,2a,2c,3,26,3ka,11,10,14a,28	0	0	0	0	0	0	0	0	0	0	3	2.7	3	0.6
TCRFG	1,2a,2c,3,26,3ka,11,30,14a,18,28	0	0	0	0	1	1.2	0	0	0	0	0	0	1	0.2
TCRKG	1,2a,2c,3,26,3ka,11,30,10,14a,18,28	16	13.0	0	0	9	10.6	0	0	2	2.2	0	0	27	5.5
TCTSB	1,2a,2c,3,26,3ka,11,17,30,B,10,14a	2	1.6	0	0	2	2.4	0	0	0	0	0	0	4	0.8
TDBGJ	1,2a,2c,3,24,10,28,39/41	0	0	0	0	1	1.2	1	1.4	2	2.2	3	2.7	7	1.4
TDBGQ	1,2a,2c,3,24,10,21,28	0	0	0	0	0	0	0	0	0	0	4	3.5	4	0.8
TDBJG	1,2a,2c,3,24,10,14a,28	0	0	0	0	0	0	1	1.4	1	1.1	2	1.8	4	0.8
TDBJJ	1,2a,2c,3,24,10,14a,28,39/41	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
TDBJQ	1,2a,2c,3,24,10,14a,21,28	0	0	0	0	0	0	3	4.3	0	0	2	1.8	5	1.0
TDBSB	1,2a,2c,3,24,B,10,14a	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
TDGJG	1,2a,2c,3,24,11,10,14a,28	0	0	0	0	1	1.2	0	0	0	0	0	0	1	0.2
TDPSB	1,2a,2c,3,24,3ka,17,30,B,10,14a	0	0	0	0	0	0	1	1.4	0	0	1	0.9	2	0.4
TFBGJ	1,2a,2c,3,24,26,10,28,39/41	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
TFBJQ	1,2a,2c,3,24,26,10,14a,21,28	0	0	0	0	0	0	0	0	1	1.1	0	0	1	0.2
TFKDB	1,2a,2c,3,24,26,11,17,30,14a	0	0	0	0	2	2.4	0	0	0	0	0	0	2	0.4
TFKNB	1,2a,2c,3,24,26,11,17,30,B,14a	0	0	0	0	1	1.2	0	0	0	0	0	0	1	0.2
TFPSB	1,2a,2c,3,24,26,3ka,17,30,B,10,14a	1	0.8	0	0	1	1.2	0	0	0	0	0	0	2	0.4
TJBJG	1,2a,2c,3,16,24,10,14a,28	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.2
TBRFG	1,2a,2c,3,3ka,11,30,14a,18,28	2	1.6	0	0	0	0	0	0	1	1.1	0	0	3	0.6
TNBGJ	1,2a,2c,3,9,24,10,28,39/41	0	0	0	0	1	1.2	5	7.2	17	18.3	16	14.2	39	8.0
TNBJJ	1,2a,2c,3,9,24,10,14a,28,39/41	2	1.6	0	0	1	1.2	5	7.2	6	6.5	2	1.8	16	3.3
TNRJJ	1,2a,2c,3,9,24,3ka,11,30,10,14a,28,39/41	4	3.3	0	0	0	0	0	0	0	0	0	0	4	0.8
TPBGJ	1,2a,2c,3,9,24,26,10,28,39/41	0	0	0	0	0	0	1	1.4	2	2.2	3	2.7	6	1.2
TPBJJ	1,2a,2c,3,9,24,26,10,14a,28,39/41	0	0	0	0	0	0	0	0	2	2.2	0	0	2	0.4
TPRJJ	1,2a,2c,3,9,24,26,3ka,11,30,10,14a,28,39/41	1	0.8	0	0	0	0	0	0	0	0	0	0	1	0.2
Total		123		7		85		69		93		113		490	

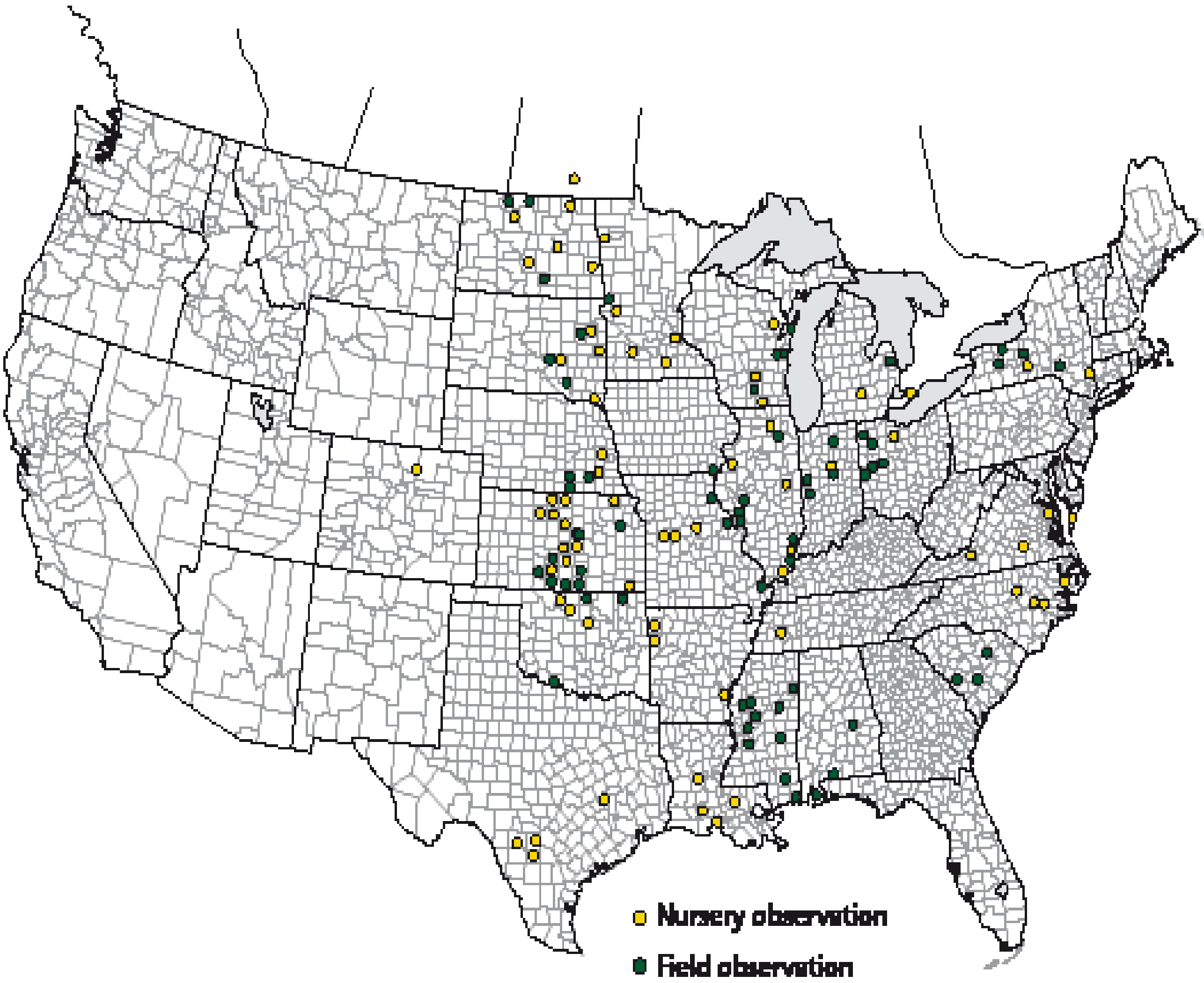
The 2013 wheat leaf rust observation map can be found at: http://www.ars.usda.gov/Main/docs.htm?docid=9757 (Fig. 1).

Lr gene postulations of current soft red winter, hard red winter, and hard red spring wheat cultivars are available in a searchable database at:

http://160.94.131.160/fmi/iwp/cgi?-db=Lr%20gene%20postulations&-loadframes

Fig. 1 Wheat Leaf Rust Observations - 2013

Reports from specific locations



Please visit the Cereal Disease Laboratory (http://www.ars.usda.gov/mwa/cdl) website for the latest cereal rust situation reports.

Table 2. Number and frequency (%) of isolates of *Puccinia triticina* in the United States in 2013 virulent to 20 lines of wheat with single resistance genes for leaf rust resistance.

Resistance gene	AL, AR, GA, LA, MS, NC, SC, TN, VA		NY		IL, IN, MI, eastern MO, OH, WI		OK, TX		CO, IA, KS, western MO, NE		MN, ND, SD		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Lr1	123	100.0	7	100.0	84	98.8	69	100.0	89	95.7	112	99.1	484	98.8
Lr2a	63	51.2	2	28.6	30	35.3	24	34.8	51	54.8	64	56.6	234	47.8
Lr2c	63	51.2	3	42.9	31	36.5	33	47.8	55	59.1	75	66.4	260	53.1
Lr3	121	98.4	5	71.4	84	98.8	67	97.1	88	94.6	112	99.1	477	97.3
Lr9	7	5.7	2	28.6	2	2.4	15	21.7	35	37.6	23	20.4	84	17.1
Lr16	1	0.8	0	0.0	1	1.2	0	0.0	4	4.3	2	1.8	8	1.6
Lr24	12	9.8	0	0.0	9	10.6	31	44.9	41	44.1	47	41.6	140	28.6
Lr26	54	43.9	3	42.9	27	31.8	20	29.0	20	21.5	28	24.8	152	31.0
Lr3ka	107	87.0	3	42.9	69	81.2	27	39.1	31	33.3	26	23.0	263	53.7
Lr11	110	89.4	2	28.6	72	84.7	3	4.3	16	17.2	8	7.1	211	43.1
Lr17	70	56.9	4	57.1	61	71.8	47	68.1	42	45.2	51	45.1	275	56.1
Lr30	105	85.4	2	28.6	72	84.7	25	36.2	30	32.3	18	15.9	252	51.4
LrB	69	56.1	3	42.9	59	69.4	37	53.6	39	41.9	46	40.7	253	51.6
Lr10	72	58.5	7	100.0	30	35.3	65	94.2	82	88.2	111	98.2	367	74.9
Lr14a	119	96.7	2	28.6	78	91.8	46	66.7	54	58.1	56	49.6	355	72.4
Lr18	41	33.3	2	28.6	15	17.6	0	0.0	5	5.4	3	2.7	66	13.5
Lr21	0	0.0	0	0.0	1	1.2	4	5.8	1	1.1	16	14.2	22	4.5
Lr28	54	43.9	5	71.4	25	29.4	32	46.4	56	60.2	71	62.8	243	49.6
Lr39/Lr41	9	7.3	2	28.6	7	8.2	32	46.4	59	63.4	72	63.7	181	36.9
Lr42	0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	123		7		85		69		93		113		490	

Table 3. Estimated losses in winter wheat due to rust in 2013 (T = trace, less than 1% loss statewide; — no state estimates available; and * = preliminary 2013 Kansas wheat disease loss estimate).

State	1,000 acres harvested	Yields in bushels per acre	Production in 1,000 of bushels	Losses due to: Stem rust		Leaf rust		Stripe rust	
				%	1,000 bu	%	1,000 bu	%	1,000 bu
AL	270	69.0	18,630	0.0	0.0	T	T	2.0	380
AZ	10	99.5	800	—	—	—	—	—	—
AR	615	62.0	38,130	0.0	0	0.0	0	T	T
CA	340	83.3	27,200	0.0	0	0.0	0	2.0	555
CO	1,640	27.3	44,280	0.0	0	0.0	0	0.0	0
DE	78	68.0	5,304	—	—	—	—	T	T
FL	19	59.0	1,121	—	—	—	—	—	—
GA	350	60.0	21,000	0.0	0	T	T	3.0	649
ID	720	82.1	61,920	0.0	0	0.0	0	1.0	625
IL	830	67.0	55,610	0.0	0	1.0	562	3.0	1,720
IN	440	73.0	32,120	T	T	1.0	324	1.0	324
IA	21	52.0	1,092	0.0	0	T	T	0.0	0
KS *	8,400	38.0	319,200	0.0	0	T	T	T	T
KY	610	75.0	45,750	0.0	0	T	T	0.0	0
LA	250	58.0	14,500	0.0	0	1.0	146	3.0	448
MD	260	67.0	17,420	—	—	—	—	—	—
MI	600	75.0	45,000	T	T	T	T	T	T
MN	27	56.7	1,161	0.0	0	T	T	0.0	0
MS	385	58.0	22,330	T	T	1.0	226	3.0	69
MO	1,000	56.0	56,000	0.0	0	2.0	1,143	T	T
MT	1,900	38.9	81,700	0.0	0	0.0	0	3.0	2,527
NE	1,130	35.0	39,550	0.0	0	T	T	T	T
NV	11	86.8	990	—	—	—	—	—	—

Table 3. Estimated losses in winter wheat due to rust in 2013 (T = trace, less than 1% loss statewide; — no state estimates available; and * = preliminary 2013 Kansas wheat disease loss estimate).

State	1,000 acres harvested	Yields in bushels per acre	Production in 1,000 of bushels	Losses due to:					
				Stem rust		Leaf rust		Stripe rust	
				%	1,000 bu	%	1,000 bu	%	1,000 bu
NJ	29	54.0	1,566	—	—	—	—	—	—
NM	70	44.0	3,080	—	—	—	—	—	—
NY	115	68.0	7,820	0.0	0	T	T	0.0	0
NC	920	57.0	52,440	0.0	0	2.0	1,070	T	T
ND	205	44.9	8,815	T	T	T	T	0.0	0
OH	665	70.0	46,550	T	T	T	T	T	T
OK	3,400	31.0	105,400	0.0	0	0.0	0	T	T
OR	780	62.1	48,360	0.0	0	0.0	0	2.0	987
PA	160	68.0	10,880	—	—	—	—	—	—
SC	255	54.0	13,770	0.0	0	1.0	139	T	T
SD	670	42.2	26,130	T	T	T	T	T	T
TN	540	71.0	38,340	0.0	0	T	T	2.0	T
TX	2,250	29.0	65,250	—	—	—	—	—	—
UT	110	44.5	4,840	—	—	—	—	—	—
VA	275	62.0	17,050	—	—	—	—	—	—
WA	1,660	66.9	114,540	0.0	0	T	T	1.0	1,157
WV	7	52.0	364	—	—	—	—	—	—
WI	265	58.0	15,370	T	T	2.0	314	2.0	314
WY	120	24.0	2,880	—	—	—	—	—	—
U.S. % loss				T		0.3		0.7	
U.S. total	32,402	47.4	1,534,253		T		3,924		10,378

. **SOUTH DAKOTA**

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Fine mapping and metabolic and physiological characterization of the glume glaucousness inhibitor locus Iw3 derived from wild wheat.

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Cuticular wax constitutes the outermost layer of plant skin and its composition greatly impacts plant appearance and plant-environment interaction. Epicuticular wax in the upper part of adult wheat plants can form the glaucousness, which associates with drought tolerance. We characterized the glume-specific, glaucousness inhibitor *Iw3* by fine mapping and physiological and molecular approaches. *Iw3* inhibits glaucousness formation by altering wax composition. Compared to the wild type, *Iw3* eliminates β-diketone, reduces primary alcohols by 47%, but increases aldehyde 400-fold and alkanes fivefold, which leads to a 30% reduction of total glume wax load. Loss of glaucousness increased cuticle permeability, suggesting an important role in drought sensitivity. Genetically, the glaucousness-inhibiting effect of *Iw3* is partially dominant in a dosage-dependent manner. We localized the *Iw3* locus within a 0.13-cM interval delimited by marker loci *Xpsp3000* and *XWL3096*. Of the 53 wax genes assayed, we detected transcription changes in nine genes by *Iw3*, down-