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KANSAS

KANSAS STATE UNIVERSITY
Environmental Physics Group, Department of Agronomy, Kansas State University, 2004 Throckmorton Plant Sciences Center, Manhattan, KS 66506-5501, USA.

Elevated Carbon Dioxide: Soil and Plant Water Relations.

M.B. Kirkham.

I have finished writing a book entitled ***Elevated Carbon Dioxide: Soil and Plant Water Relations***, now being considered for publication by Wiley-Blackwell. The book is developed from research that we in the Evapotranspiration Laboratory at Kansas State University did between 1984 and 1990 with field-grown sorghum, winter wheat, and rangeland plants under elevated carbon dioxide. Such experiments had not been done before in the semiarid Great Plains of the U.S. The rising levels of carbon dioxide in the atmosphere were of interest to the Department of Energy, which funded our work.

As the years have passed, the carbon dioxide levels in the atmosphere have increased, along with increasing interest concerning their effects. The carbon dioxide concentration in the atmosphere was first recorded by Charles D. Keeling (1928–2005) of the Scripps Institution of Oceanography, University of California, San Diego. He monitored it beginning in 1957 at Mauna Loa, Hawaii, and in Antarctica at the South Pole. In the 50-year period between 1958 and 2008, the carbon dioxide concentration in the atmosphere increased from 316 ppm to 385 ppm. Because no book documents soil- and plant-water relations under elevated carbon dioxide, I wrote this book to put the information in one source. It has been 26 years since we started our first experiments (1984–2010), so we can make some predictions, based on our early results, about how plants in the semiarid Great Plains of the U.S. are responding to elevated carbon dioxide, which has increased 55 ppm (from 330 ppm to 385 ppm) during this time.

Water and carbon dioxide are the two most important compounds affecting plant growth. In introductory botany textbooks, we have seen the familiar equation for photosynthesis, which shows carbon dioxide (CO_2) joining with water (H_2O), in the presence of light and chlorophyll, to form sugar ($C_6H_{12}O_6$) and oxygen (O_2), as follows:

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

Life on earth would not be possible without photosynthesis. We survive because of the oxygen produced by photosynthesis, as well as the food (sugars) produced by photosynthesis. Therefore, it is of critical importance to look at the water relations of plants under elevated carbon dioxide.

The book is technical and is based on information from peer-reviewed journal articles. I have written the book as if I were speaking to my graduate students and is organized as follows. I start with an introductory chapter dealing with drought, because it is predicted that the central Great Plains, where Kansas is located, will become drier as the carbon dioxide concentration in the atmosphere increases. In this chapter, I give a preliminary overview of the three types of photosynthesis: C3, C4, and Crassulacean acid metabolism.

The book then takes the water from the soil through the plant and out into the atmosphere. This is the way that water moves through the soil–plant–atmosphere continuum. Four chapters deal with soil. After I discuss soil and elevated carbon dioxide, I move the water into the root. One chapter deals with elevated carbon dioxide and root growth. And the following chapter deals with the effects of elevated carbon dioxide on plant water potential, osmotic potential, and turgor potential. Then the next two chapters deal with stomata under elevated carbon dioxide. Next, I take the water out of the plant into the atmosphere and discuss the effects of elevated carbon dioxide on transpiration, evapotranspiration, and water use efficiency. One chapter compares C3 and C4 plants under elevated carbon dioxide and goes into detail about C4 photosynthesis, its advantage, and how it has evolved. One chapter deals with plant anatomy under elevated carbon dioxide focusing on xylem (including wood), because this is the tissue that carries water in plants. One chapter deals with phenology and how elevated carbon dioxide affects it. The final chapter deals with growth of many different kinds of plants under elevated carbon dioxide and well-watered conditions.

Here follows a brief summary of the effects of elevated carbon dioxide on soil and plant water relations. The key factor is stomatal closure under elevated carbon dioxide. Stomata are extremely sensitive to the concentration of carbon dioxide in the atmosphere and close when the concentration increases. For example, in our first study, with grain sorghum in 1984, we elevated the atmospheric carbon dioxide 155 ppm above ambient. During that season, the average stomatal resistance of the plants under the ambient concentration (330 ppm) was 0.86 s/cm, wereas under elevated concentration (485 ppm), the stomatal resistance was 0.97 s/cm, an increase of 13%. When the stomata close, transpiration and evapotranspiration are reduced, resulting in more water in the soil. Less water is needed to produce a certain amount of grain, so water use efficiency is increased under elevated carbon dioxide. With an increased soil water content under elevated carbon dioxide, the plants have more water for uptake, and this results in an increased (less negative) plant water potential. Even though stomata close, the elevated carbon dioxide still stimulates growth, and consequently yield is usually increased under elevated carbon dioxide. When drought occurs, the elevated carbon dioxide often compensates for reduction of growth due to the drought stress. In our three-year (1984–1987) experiment with winter wheat, the grain yield of wheat under drought (half field capacity) and elevated carbon dioxide (825 ppm) was the same as the grain yield of wheat under well-watered conditions (field capacity) and ambient carbon dioxide (340 ppm). The year-to-year increase in wheat yields that have been observed over the last 50 years may be related in part to the increased carbon dioxide concentration in the atmosphere.

News.

Master's degree graduate student, Nicole A. Rud, graduated in December, 2009, and is now pursuing a Ph.D. at the University of Toledo in Ohio. Her results showed that one cause of the physiological disorder, edema, which occurs under greenhouse conditions, is a lack of ultra-violet light. When she added UV-B light back to tomato plants grown in a greenhouse (UV-B light is filtered out by the glass of the greenhouse), the plants developed no edema.

Ms. Kalaiyarasi Pidaran (kalai@ksu.edu), started work toward the master's degree in the autumn of 2009. She is working jointly under the direction of M.B. Kirkham and R.M. Aiken. She is studying growth of sorghum under different planting patterns (clumped versus a standard row spacing).

Ms. Rattiypaorn Jaidee, a Ph.D. student at the University of Khon Kaen in Khon Kaen, Thailand, spent six months (July–December, 2009) in the laboratory of M.B. Kirkham. She studied the effect of drought on the uptake of phosphorus by two cultivars of soybean, a traditional Thai cultivar and a commercially developed cultivar.

Publications.

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THE WHEAT GENETIC & GENOMIC RESOURCES CENTER
Department of Plant Pathology, Throckmorton Hall, Manhattan, KS 66506-5502, USA.
http://www.ksu.edu/wgrc

Notice of release of KS11WGGRC53-J AND KS11WGGRC53-O leaf rust and stripe rust resistant hard red winter wheat germ plasms.

The Agricultural Research Service, U.S. Department of Agriculture and the Kansas Agricultural Experiment Station announce the release of KS11WGGRC53-J AND KS11WGGRC53-O hard red winter wheat (*T. aestivum* L.) germ plasm with resistance to leaf rust and stripe rust for breeding and experimental purposes. Scientists participating in this development were Vasu Kuraparthy, Crop Science Department, North Carolina State University, Raleigh, NC 27695; Parveen Chunneja, Department of Genetics & Biotechnology, Punjab Agricultural University, Ludhiana, Punjab, India; Shilpa Sood, Crop Science Department, North Carolina State University, Raleigh, NC 27695; H.S. Dhaliwal, Biotechnology department, Indian Institute of Technology, Roorkee, Uttaranchal, India; Deven See, USDA–ARS Western Regional Small Grains Genotyping Laboratory, Washington State University, Pullman, WA 99164-6420; and Duane Wilson and B.S. Gill, Wheat Genetic and Genomic Resources Center, Department of Plant Pathology, Kansas State University, Manhattan, KS 66506.

KS11WGGRC53-J and KS11WGGRC53-O are derivatives of WL711 (TA5602) with the rust resistance genes *Lr57* and *Yr40* in the form of a wheat-goat grass (*Ae. geniculata*) recombinant chromosome T5DL·5DS-5M^{g}S(0.95). The recombinant chromosome consists of the long arm of wheat chromosome 5D, most of the short arm of 5D, and a small distal segment derived from the short arm of the *Ae. geniculata* chromosome 5M^g harboring *Lr57* and *Yr40*. KS11WGGRC53-J is derived from the cross 'WL711 (T5DL·5DS-5M^{g}S(0.95)/3*Jagger'. KS11WGGRC53-O is derived from the cross 'WL711 (T5DL·5DS-5M^{g}S(0.95)/3*Overley'. The F_4-derived families are homozygous for *Lr57* and *Yr40* but segregating for other traits.

Small quantities (3 grams) of seed of KS11WGGRC53-J and KS11WGGRC53-O are available upon written request. We request that the appropriate source be given when this germ plasm contributes to research or development of new cultivars. Seed stocks are maintained by the Wheat Genetic and Genomic Resources Center, Throckmorton Plant Sciences Center, Kansas State University, Manhattan, KS 66506. Genetic material of this release will be deposited in the National Plant Germplasm System where it will be available for research purposes, including the development of new cultivars.

Notice of release of KS11WGGRC54-J and KS11WGGRC54-O leaf rust resistant hard red winter wheat germ plams.

The Agricultural Research Service, U.S. Department of Agriculture and the Kansas Agricultural Experiment Station announce the release of KS11WGGRC54-J and KS11WGGRC54-O hard red winter wheat (*T. aestivum* L.) germ plasm with resistance to leaf rust for breeding and experimental purposes. Scientists participating in this development were Vasu Kuraparthy, Crop Science Department, North Carolina State University, Raleigh, NC 27695; Parveen Chunneja, Department of Genetics & Biotechnology, Punjab Agricultural University, Ludhiana, Punjab, India; Shilpa Sood, Crop Science Department, North Carolina State University, Raleigh, NC 27695; H.S. Dhaliwal, Biotechnology department, Indian Institute of Technology, Roorkee, Uttaranchal, India; Gina Brown-Guedira, USDA–ARS, Small Grains Genotyping Laboratory, North Carolina State University, Raleigh, NC 27695; and Duane Wilson and B.S. Gill, Wheat Genetic and Genomic Resources Center, Department of Plant Pathology, Kansas State University, Manhattan, KS 66506.

KS11WGGRC54-J and KS11WGGRC54-O are improved derivatives of WL711 (TA5605) with the rust resistance gene *Lr58* in the form of a wheat–*Ae. triuncialis* recombinant chromosome T2BS·2BL-2^{t}L(0.95). The recombinant chromosome consists of the short arm of wheat chromosome 2B, most of the long arm of 2B, and a small distal segment derived from the long arm of the *Ae. triuncialis* chromosome 2^{t}L harboring *Lr58*. KS11WGGRC54-J is derived from the cross 'WL711 (T2BS·2BL-2^{t}L(0.95))/3*Jagger'. KS11WGGRC54-O is derived from the cross 'WL711 (T2BS·2BL-2^{t}L(0.95))/3*Overley'. The F_4-derived families are homozygous for *Lr58* but segregating for other traits.

Small quantities (3 grams) of seed of KS11WGGRC54-J and KS11WGGRC54-O are available upon written request. We request that the appropriate source be given when this germ plasm contributes to research or development of new cultivars. Seed stocks are maintained by the Wheat Genetic and Genomic Resources Center, Throckmorton Plant Sciences Center, Kansas State University, Manhattan, KS 66506. Genetic material of this release will be deposited in the National Plant Germplasm System where it will be available for research purposes, including the development of new cultivars.

Evaluation of wild wheat lines in the field for various foliar diseases.

Duane L. Wilson, Bikram S. Gill, and W. John Raupp.

We evaluated a collection of *Triticum monococcum* subsp. *monococcum* in the field at Manhattan, Kansas, during the spring of 2010 for leaf rust, stripe rust, and barley yellow dwarf virus; heading dates also were recorded (Table 1, pp. 238-242). We also evaluated a representative sample of accessions from the primary and secondary gene pools (Table 2, pp. 242-245). Field plots at the Rocky Ford Research Area north of Manhattan were inoculated on 7 May with a mixture of leaf rust and stripe rust spores. Spores were in a suspension of oil and mist applied in late evening. The leaf rust culture used is referred to as 'Lr Composite'. This culture is a composite of the following cultures: 2003 wild culture, 2007 wild culture, and PRTUS3, 6, 42, 50, and 52. The stripe rust culture is referred to as 'PST-100'. These cultures were kindly supplied by Dr. Bob Bowden, UDSA–ARS, Manhattan, Kansas. Infection type was described using the Cobb scale and visual assessment. The Cobb scale is a combination of the percent of leaf area covered by rust and the pustule size. The number in the score is the percentage of leaf area covered by pustules, which could be from 1 to 100. The second part of the scoring are letter designations for size of pustules present as follows: 0 = no infection visible, R = resistant or very small pustules, MR = moderately resistant or small pustules, M = moderate or intermediate reaction, pustules larger, MS = moderately susceptible or large pustules, and S = susceptible with very large pustules in both diameter and height of the pustule. For example, an IT of 10R indicates 10 percent of the leaf area infected with very small pustules, 40M indicates 40 percent of the leaf area infected with moderate to larger pustules, and 60MS indicates 60 percent of the leaf area infected with large pustules. Plants were artificially inoculated with cultures mentioned but most likely, natural infection also occurred. Commonly, leaf rust and occasionally stripe rust are present in the wheat plots at the experiment station.

Table 1. Field observations on a *Triticum monococcum* subsp. *monococcum* collection for leaf rust, stem rust, barley yellow dwarf virus, and heading date in 2010. For most accessions, at least two replications were evaluated. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	Leaf rust		Stripe rust		Barley yellow dwarf		Heading date	Country of origin
	26/5/10	2/6/10	26/5/10	2/6/10	13/5/10	26/5/10		
136	30R	30MR	0	5R	M	H	31/5	Sweden
	10R	10R	1R	5R	H	H	31/5	
137	5R	20MR	0	5R	M	M	2/6	Turkey
	30R	30MR	5R	10MR	H	H	1/6	
138	5R	15MR	0	1R	L	M	16/5	USA
	30R	30MR	5R	10MR	L	L	23/5	
	15MR	15MR	5MR	10MR	L	M	16/5	
139	1R	20MR	0	5MR	L	M	2/6	USA
	10R	10R	0	1R	H	H	5/6	
141	1R	15MR	0	1R	L	M	3/6	Unknown
	15R	15MR	0	5R	L	M	3/6	
	10R	25R	0	1R	0	L	4/6	

Table 1. Field observations on a *Triticum monococcum* subsp. *monococcum* collection for leaf rust, stem rust, barley yellow dwarf virus, and heading date in 2010. For most accessions, at least two replications were evaluated. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	Leaf rust		Stripe rust		Barley yellow dwarf		Heading date	Country of origin
	26/5/10	2/6/10	26/5/10	2/6/10	13/5/10	26/5/10		
142	5R	10R	0	0	L	L	1/6	Bosnia–Herzegovina
	1R	10R	0	1R	M	M	31/5	
	20R	20MR	1R	5R	M	M	29/5	
	10R	10R	0	1R	L	M	1/6	
1988	1R	5R	0	1R	M	M	1/6	United Kingdom
	20R	25MR	0	10MR	L	M	3/6	
	5R	15R	0	5R	H	H	1/6	
	5R	30MR	0	5R	L	L	2/6	
	5R	20MR	0	15R	L	L	5/6	
2024	10R	10MR	0	5R	M	H	31/5	Turkey
	20MR	20MR	5MR	5MR	H	H	31/5	
2025	5R	15R	0	5MR	M	H	31/5	Turkey
	20R	10R	1R	5R	M	H	28/5	
2026	10R	15R	0	1R	M	M	2/6	Turkey
	30R	40R	0	5R	M	H	5/6	
2027	1R	15R	0	0	L	L	4/6	Turkey
	—	—	—	—	H	H	—	
	5R	10R	5MR	15MR	M	M	2/6	
2028	5R	15MR	0	5R	M	M	31/5	Turkey
	5R	5R	0	1R	M	M	30/5	
2029	10R	15R	1R	1R	M	H	30/5	Turkey
2030	30R	25MR	1R	5R	L	M	2/6	Spain
	10R	10R	5R	10R	M	H	30/5	
2031	20R	20MR	0	5R	L	L	31/5	Spain
	10R	10MR	1R	5R	M	M	28/5	
2032	30R	25MR	1R	5R	L	M	1/6	Spain
	20R	20MR	0	5R	L	M	4/6	
2033	1R	15MR	0	1R	M	M	31/5	Portugal
	5R	5R	0	1R	M	M	30/5	
2034	1R	20MR	0	1R	M	H	31/5	Bosnia–Herzegovina
	1R	5R	5R	5R	M	M	29/5	
2035	10R	20MR	0	1R	L	L	4/6	Hungary
	15R	15MR	0	1R	M	M	3/6	
2036	5R	25MR	0	5R	M	M	31/5	Hungary
	10R	20R	0	1R	M	M	29/5	
2037	5R	5R	1R	0	L	L	4/6	Albania
	10R	10R	0	1R	L	M	3/6	
2038	5R	10MR	0	5R	M	H	3/6	Albania
	5R	10R	0	1R	M	M	3/6	
2039	1R	15MR	0	5R	H	H	3/6	Albania
	15R	20R	0	1R	M	M	3/6	
	5R	10R	0	15R	M	H	4/6	
2701	5R	30MR	1R	5R	L	L	1/6	Romania
	10R	15R	0	1R	L	M	3/6	
2702	10R	20MR	0	5R	L	M	31/5	Italy
2703	5R	15R	5R	5R	M	H	31/5	USA
	5R	20MR	1R	5MR	H	H	29/5	
2704	15R	20MR	1R	5R	H	H	2/6	United Kingdom
	10R	20R	1R	1R	H	H	2/6	
2705	30R	25MR	0	10R	L	M	28/5	United Kingdom
2706	10R	30MR	5R	5R	H	H	1/6	United Kingdom
2706	15R	15MR	0	1R	M	M	5/6	
2707	5R	20R	0	0	L	L	4/6	United Kingdom
	15R	15MR	0	1R	M	M	5/6	
2708	10R	25MR	0	10R	L	L	28/5	Former USSR
	10R	25MR	0	5R	M	H	1/6	
2709	20R	30MR	10MR	15MR	L	L	28/5	Spain
2710	20R	15MR	10R	10MR	0	M	3/6	Unknown
	5R	25MR	20MR	1R	L	L	4/6	

Table 1. Field observations on a *Triticum monococcum* subsp. *monococcum* collection for leaf rust, stem rust, barley yellow dwarf virus, and heading date in 2010. For most accessions, at least two replications were evaluated. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	Leaf rust		Stripe rust		Barley yellow dwarf		Heading date	Country of origin
	26/5/10	2/6/10	26/5/10	2/6/10	13/5/10	26/5/10		
2711	10R	20R	0	5R	L	M	4/6	Serbia
	5R	25MR	0	15MR	L	M	2/6	
	5R	20R	0	5R	M	H	3/6	
2712	30R	30MR	0	5R	M	H	1/6	Serbia
	30R	30MR	0	5R	M	H	1/6	
	5R	30R	1R	5R	M	H	5/6	
2713	20R	NT	0	NT	H	H	1/6	Hungary
	5MR	20MR	10MR	1R	H	H	4/6	
2714	20R	20MR	1R	10R	M	M	31/5	Albania
	20MR	20MR	5MR	5R	H	H	2/6	
	5R	30R	0	5R	L	M	2/6	
2715	30R	40MR	1R	5R	M	H	31/5	Germany
	10MR	30MR	0	15R	H	H	2/6	
2716	5R	20MR	1R	5R	M	M	2/6	United Kingdom
	1R	30MR	0	10R	L	M	31/5	
2717	20R	30MR	1R	5R	M	H	5/6	Austria
	30R	35MR	5R	10R	L	M	5/6	
2718	20R	25MR	0	5R	L	M	3/6	Azerbaijan
	15R	30R	0	5R	M	M	31/5	
2719	1R	30MR	5R	10R	M	M	14/5	Germany
	5R	30MR	10MR	5R	M	H	14/5	
	1R	1R	5MR	10M	L	L	31/5	
	10R	30MR	20MR	10R	M	H	16/5	
	5R	25MR	15MR	20MR	L	M	1/6	
2720	10R	15MR	0	5R	M	H	4/6	Germany
	20R	30MR	5R	5MR	H	H	3/6	
2722	10R	15R	0	1R	L	L	3/6	Former USSR
	15R	15R	0	1R	L	L	4/6	
2723	10R	25MR	1R	5R	M	H	3/6	Germany
	5R	30MR	1R	10R	M	M	3/6	
	10R	30MR	0	10R	0	M	30/5	
2724	10R	10R	10MR	5R	M	H	28/5	United Kingdom
	5R	10R	0	5R	L	M	31/5	
2725	10R	15MR	0	5R	L	L	28/5	Japan
4447	30R	35MR	1R	5R	L	M	5/6	Reduced-height mutant
	30R	40MR	0	5R	L	L	5/6	
10418	30R	35MR	0	10R	H	H	4/6	Turkey
	15MR	20MR	5MR	5MR	H	H	3/6	
10555	15R	15MR	0	5R	L	M	5/6	Serbia
	10R	20MR	5MR	5R	M	H	5/6	
10556	5R	25MR	10R	10MR	M	H	3/6	Serbia
	20R	25MR	10M	5R	M	H	3/6	
10557	5R	10MR	0	1R	L	L	3/6	Albania
	5R	10R	0	10R	M	H	2/6	
10558	1R	10MR	1MR	10MR	L	M	28/5	Bulgaria
	20R	25R	20MR	10R	H	H	30/5	
10559	5R	15MR	5R	5R	L	M	5/6	Romania
	5R	10R	0	1R	H	H	5/6	
10560	20R	25MR	0	5R	L	M	5/6	Romania
	15R	15MR	0	5R	M	H	5/6	
10561	30R	35MR	5R	10R	L	L	3/6	Romania
	10R	20MR	1R	10MR	H	H	5/6	
10562	15R	20MR	0	5R	L	M	5/6	Romania
	15R	20MR	0	5R	L	L	5/6	
10563	15R	25MR	0	5R	M	H	5/6	Romania
	10R	35MR	1R	5R	H	H	5/6	
10564	30R	30MR	1R	5R	H	H	5/6	Romania
	5R	35M	5MR	10MR	H	H	5/6	
10565	5R	10MR	0	5R	H	H	5/6	Romania
	15R	15MR	0	1R	L	M	3/6	

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TA #	Leaf rust		Stripe rust		Barley yellow dwarf		Heading date	Country of origin
	26/5/10	2/6/10	26/5/10	2/6/10	13/5/10	26/5/10		
10566	30MR	30MR	0	5R	M	H	4/6	Romania
	20R	25MR	5R	10MR	M	H	4/6	
10567	30R	30MR	0	5R	L	L	1/6	Turkey
	15R	15R	0	1R	L	L	4/6	
10568	10R	20MR	0	5R	L	M	5/6	Italy
	5R	5R	0	1R	M	M	3/6	
10569	20R	25MR	1R	5R	M	H	5/6	Germany
	20R	40MR	1R	5MR	M	M	1/6	
10571	10MR	25MR	0	5R	M	H	31/5	Asia Minor
	10R	10MR	0	1R	L	L	30/5	
10573	10R	10R	0	10R	L	L	29/5	Asia Minor
	10R	15R	5R	10MR	L	L	30/5	
10574	1R	25R	1R	5R	M	H	5/6	Belgium
	10R	10MR	5R	5R	M	H	2/6	
10575	20R	25R	5R	5R	L	M	5/6	Italy
	15R	10R	0	1R	M	M	3/6	
10576	5R	25MR	0	10MR	M	H	5/6	Italy
	15R	15R	0	1R	M	M	5/6	
10577	10MR	20MR	5MR	20MR	L	M	2/6	Germany
	10R	15R	5R	5MR	L	M	3/6	
10578	5R	25MR	0	5R	L	M	4/6	Balkans
	10R	10R	0	1R	M	H	4/6	
10579	20MR	40MR	1R	10R	M	H	5/6	Germany
	20R	30MR	0	5MR	L	M	5/6	
10580	10R	20MR	0	5R	M	H	1/6	Germany
	15R	30MR	0	10MR	L	M	5/6	
10581	30R	30MR	1R	5R	L	L	5/6	Austria
	20R	25MR	5R	5R	L	L	5/6	
10582	25R	25MR	0	5R	L	M	5/6	Austria
	10R	25MR	0	5R	M	M	5/6	
10583	30R	30MR	0	1R	L	L	5/6	Austria
	10R	25MR	0	5R	L	L	4/6	
10584	20R	25MR	1R	5R	L	M	5/6	Austria
	20R	20R	5MR	5MR	M	H	5/6	
10585	5R	10R	5R	1R	L	L	4/6	Kosovo
	10R	10R	5R	5R	L	L	5/6	
10586	10R	30MR	1R	20MR	L	M	29/5	Turkey
	5R	25MR	0	15MR	L	M	3/6	
10587	20R	20MR	10R	10MR	M	H	28/5	Montenegro
	10R	10R	1R	5R	M	M	29/5	
10588	5R	15MR	5R	5MR	L	M	3/6	Turkey
	15R	15R	0	5R	L	L	3/6	
10589	10R	25MR	0	10R	O	L	4/6	Unknown
	20R	30MR	0	5R	L	L	5/6	
10590	30R	30MR	10R	10R	L	M	3/6	Turkey
	25R	25MR	10MR	10MR	L	M	5/6	
10591	5R	20MR	5R	5MR	H	H	3/6	Turkey
	25R	25MR	0	1R	M	H	5/6	
10593	20MR	40MR	1R	10R	M	H	29/5	Turkey
	15MR	30MR	5MR	10MR	L	H	28/5	
10594	10R	35MR	0	5R	L	M	31/5	Turkey
	10R	25MR	0	1R	L	L	1/6	
10595	10MR	35MR	5R	10R	L	H	3/6	Turkey
	15MR	30MR	5R	5R	L	M	2/6	
10598	40R	25MR	0	5R	M	M	1/6	Turkey
	1R	10R	0	1R	L	L	5/6	
10623	5R	10R	0	1R	M	M	5/6	Albania
	10R	20R	0	10MR	L	M	5/6	
10624	5R	10R	0	0	L	L	5/6	Albania
	1R	15MR	0	5R	L	L	5/6	

Table 1. Field observations on a *Triticum monococcum* subsp. *monococcum* collection for leaf rust, stem rust, barley yellow dwarf virus, and heading date in 2010. For most accessions, at least two replications were evaluated. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	Leaf rust		Stripe rust		Barley yellow dwarf		Heading date	Country of origin
	26/5/10	2/6/10	26/5/10	2/6/10	13/5/10	26/5/10		
10625	10R	15R	0	5R	L	M	3/6	Albania
	10R	20R	0	1R	L	L	4/6	
10626	10R	30MR	0	5R	L	L	5/6	Unknown
	10R	25R	0	5R	0	L	5/6	
10627	15R	25MR	0	5R	L	M	3/6	Unknown
	20R	30MR	0	5MR	0	L	5/6	
10628	25R	35MR	10MR	1R	L	M	4/6	Unknown
	30R	40MR	5MR	10MR	M	H	4/6	
10629	30R	35MR	5MR	5MR	L	H	5/6	Balkans
	10R	15R	5MR	10MR	M	H	5/6	
10630	5R	10MR	5R	10MR	M	H	5/6	Unknown
	5R	15R	10MR	20MR	0	L	5/6	
10631	10R	35MR	1R	5R	M	H	5/6	Unknown
	20R	25R	0	1R	L	L	4/6	
10632	10R	30MR	0	1R	L	M	4/6	Romania
	10R	15R	5MR	10MR	L	L	5/6	
10634	20R	30MR	0	1R	L	M	5/6	Italy
	25R	25MR	0	5R	0	L	4/6	
10635	20R	25MR	0	1R	L	M	5/6	Georgia
	10R	15R	5R	5R	L	M	4/6	
10636	15R	25MR	0	1R	L	L	5/6	Georgia
	5R	15MR	0	1R	L	M	5/6	
10637	20MR	30MR	5R	5MR	M	H	5/6	Unknown
	30R	30MR	0	15MR	L	L	5/6	
10639	15R	35MR	0	5MR	L	M	3/6	Unknown
	20R	25MR	5R	5MR	L	L	5/6	
10640	30R	45MR	0	5MR	L	M	5/6	Germany
	15MR	30MR	5R	5MR	L	H	4/6	
10641	20R	30MR	0	1R	0	L	1/6	Unknown
	10R	25MR	1R	5R	L	M	5/6	
10642	15R	15MR	0	1R	M	M	1/6	Unknown
	15R	15R	0	1R	0	L	5/6	
10643	20R	25MR	0	1R	M	M	5/6	Unknown
	20R	20R	5R	5R	L	M	4/6	
10644	10R	15R	10R	10MR	L	H	6/6	Unknown
10645	20R	25MR	5R	10MR	0	L	5/6	Unknown
	20R	30MR	1R	5R	L	M	5/6	
10646	20R	30MR	0	1R	L	M	6/6	Unknown
	15R	40MR	0	5R	L	M	6/6	

Table 2. Field observations on a collection of *Triticum* and *Aegilops* species for leaf and stem rust, barley yellow dwarf, and heading date in the 2009–10 growing seasons. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf {BYD) and powdery mildew (PM) incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	2010							2009							Species	Country of origin
	Leaf rust		Stripe rust		BYD		HD	Leaf rust			BYD		PM	HD		
	5/26	6/2	5/26	6/2	5/13	5/26		5/21	6/1	6/5	5/21	6/1	5/21			
10	5R	NT	0	NT	M	H	17/5	0	1R	5MR	0	H	0	23/5	timopheevii	Iraq
18	5M	10M	10M	20MR	L	M	24/5	1R	1R	1R	H	H	0	24/5	timopheevii	Iraq
39	5MR	NT	5R	NT	M	H	24/5	1R	5R	10MR	M	H	0	23/5	timopheevii	Iraq
49	30M	30M	10MR	15MR	H	H	27/5	5R	30R	50M	0	H	0	25/5	timopheevii	Azerbaijan
89	40M	NT	20MR	NT	H	H	29/5	1R	10MR	35M	H	H	0	24/5	turgidum	Turkey
109	20MS	30M	10M	20M	M	H	17/5	10R	40MS	50S	L	H	0	24/5	turgidum	Syria
122	—	—	—	—	—	—	—	5R	30MR	40MS	H	H	0	24/5	turgidum	Syria
129	10R	20MR	1R	5R	H	H	25/5	5R	20M	40MS	H	H	0	23/5	turgidum	Israel
149	15R	25MR	5R	5MR	M	H	23/5	1R	40MR	35MS	L	H	0	23/5	timopheevii	Iraq
169	20M	25M	10R	10MR	M	H	17/5	0	10MR	10MR	L	H	0	22/5	timopheevii	Iraq
183	30R	30MR	5R	10MR	M	H	28/5	0	5R	5R	M	H	M	26/5	aegilopoides	Iran
	10R	25MR	1R	5R	L	M	2/6									
	20R	25MR	5R	10R	L	M	2/6									

Table 2. Field observations on a collection of *Triticum* and *Aegilops* species for leaf and stem rust, barley yellow dwarf, and heading date in the 2009–10 growing seasons. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf {BYD) and powdery mildew (PM) incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	2010							2009							Species	Country of origin
	Leaf rust		Stripe rust		BYD		HD	Leaf rust			BYD		PM	HD		
	5/26	6/2	5/26	6/2	5/13	5/26		5/21	6/1	6/5	5/21	6/1	5/21			
186	30R	30MR	15MR	20MR	M	H	30/5	0	5R	1R	L	H	0	26/5	aegilopoides	Iran
	15R	25MR	5R	15MR	L	M	3/6	0	5MR	5MR	0	H	0	26/5		
	15R	20MR	5R	5MR	M	M	2/6									
196	5MR	25MR	5MR	10MR	L	M	24/5	0	5R	5R	L	H	L	26/5	aegilopoides	Iran
	10R	30MR	5MR	5MR	L	M	24/5									
	5R	25MR	0	5R	L	L	31/5									
199	5R	15MR	5MR	5MR	0	L	3/6	0	1R	1R	L	M	0	1/6	aegilopoides	Azerbaijan
203	5R	15MR	5R	5MR	0	M	31/5	1R	5MR	5R	H	H	0	23/5	aegilopoides	Iraq
	10MR	30MR	5MR	10MR	L	M	23/5									
	5R	15MR	1R	5R	0	L	28/5									
206	10R	30M	5MR	10MR	M	M	23/5	0	5MR	15MR	M	H	0	26/5	aegilopoides	Iraq
	5R	10MR	1R	5R	M	L	25/5	0	10M	5R	M	H	0	26/5		
	5R	15MR	0	5R	0	0	28/5									
215	5R	15MR	5R	5MR	H	H	15/6	1R	5R	5M	M	H	0	25/5	aegilopoides	Iraq
	5R	15MR	10R	15MR	L	L	25/5									
	5R	25MR	1R	5R	L	L	24/5									
223	5MR	20M	5MR	10MR	M	H	15/5	0	1R	5MR	L	M	L	22/5	aegilopoides	Iraq
	5MR	25MR	5R	5MR	L	M	27/5									
	10R	25MR	5MR	20MR	L	L	28/5									
237	5R	10R	5MR	5MR	L	L	17/5	0	5R	5R	L	H	0	25/5	aegilopoides	Iraq
	5R	10R	1R	5MR	0	L	27/5									
	5R	15R	1R	5R	L	L	24/5									
249	10R	35MR	1R	10MR	L	M	24/5	0	10R	10MR	M	H	0	26/5	aegilopoides	Iraq
289	5R	15MR	1R	10R	L	L	24/5	0	1R	5MR	L	H	L	17/5	aegilopoides	Iraq
300	5R	25MR	5R	5R	L	M	25/5	0	5R	5R	L	H	0	26/5	aegilopoides	Iraq
326	5R	15R	0	10R	L	L	30/5	0	1R	10M	L	M	L	26/5	aegilopoides	Iraq
	5R	25MR	1R	5R	L	L	30/5									
	5R	15MR	1R	5R	L	L	30/5									
349	10MR	25M	5MR	10MR	M	H	30/5	0	10R	25MR	L	H	0	26/5	aegilopoides	Iraq
389	5R	15MR	1R	5M	L	M	23/5	0	1R	5MR	L	M	0	18/5	aegilopoides	Iraq
396	15R	25MR	0	10R	L	M	30/5								aegilopoides	Iraq
	20R	30MR	0	5R	L	L	30/5									
	10R	15R	0	5R	0	L	29/5									
399	5R	15MR	5R	5R	L	M	24/5	1R	5R	5MR	L	H	0	24/5	aegilopoides	Iraq
419	5R	30MR	1R	5R	M	M	13/5	0	1R	10MR	L	H	L	17/5	aegilopoides	Iraq
439	5MR	15MR	1R	5R	L	M	25/5	1R	1R	20M	L	H	0	25/5	aegilopoides	Iraq
527	20R	20M	0	10MR	0	L	2/6								aegilopoides	Turkey
	15MR	15MR	0	5R	0	L	1/6									
	10R	20MR	0	5R	0	L	2/6									
709	20R	—	5MR	NT	L	M	15/5	10R	10MR	10R	L	H	0	22/5	urartu	Turkey
739	5R	30M	15MR	20MR	L	M	15/5	0	5R	5MR	L	H	0	17/5	urartu	Turkey
789	10R	25MR	0	5R	L	L	15/5	0	1R	5R	L	H	0	18/5	urartu	Lebanon
799	10R	20M	1R	10R	L	L	27/5	0	1R	5MR	L	H	0	24/5	urartu	Lebanon
810	15R	30MR	5R	10MR	L	H	17/5	5R	NT	NT	M	H	0	18/5	urartu	Turkey
819	5R	NT	40M	NT	M	M	13/5	0	5R	20MR	O	H	0	17/5	urartu	Turkey
829	20R	30MR	10MR	20MR	L	L	5/6	1M	1R	20MR	L	M	0	3/6	urartu	Armenia
879	20R	20R	5R	5R	L	L	27/5	0	5R	20MR	L	H	L	25/5	aegilopoides	Iraq
909	10R	NT	25M	NT	M	H	24/5	0	1R	1MR	L	M	0	23/5	timopheevii	Iraq
991	30M	40M	5MR	20MR	H	H	23/5	5MR	50MS	60S	H	H	H	26/5	turgidum	Turkey
1009	30M	30M	10MR	25M	H	H	23/5	10M	10M	50MS	H	H	H	26/5	turgidum	Turkey
1019	10R	40MS	20MR	20M	M	H	30/5	10MR	60MS	70S	M	H	0	26/5	turgidum	Turkey
1339	10R	15R	5R	5R	L	M	28/5	0	1R	5MR	L	H	0	25/5	aegilopoides	Iraq
1369	15MR	NT	20MR	NT	H	H	28/5	0	1R	5R	L	H	L	17/5	aegilopoides	Iraq
1489	10MR	15MR	5MR	5MR	L	M	24/5	0	1R	1M	L	H	0	18/5	timopheevii	Iraq
1528	5R	25MR	1R	5R	M	M	27/5	0	10MR	15MR	L	H	0	25/5	timopheevii	Iraq
1569	20MR	20MR	10R	10MR	M	H	30/5	0	5R	10R	M	H	0	26/5	timopheevii	Armenia
1579	10R	25M	15MR	5R	M	M	12/5	0	NT	30MR	H	H	0	16/5	tauschii	Unknown
1599	10R	30MR	15MR	15MR	L	M	15/6	0	1R	1R	L	H	0	17/5	tauschii	Iran

Table 2. Field observations on a collection of *Triticum* and *Aegilops* species for leaf and stem rust, barley yellow dwarf, and heading date in the 2009–10 growing seasons. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf {BYD} and powdery mildew (PM) incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	2010							2009							Species	Country of origin
	Leaf rust		Stripe rust		BYD		HD	Leaf rust			BYD		PM	HD		
	5/26	6/2	5/26	6/2	5/13	5/26		5/21	6/1	6/5	5/21	6/1	5/21			
1669	10MR	20M	5R	5R	M	M	25/6	0	1R	1R	M	H	M	24/5	tauschii	Azerbaijan
1689	30S	NT	70S	NT	0	L	12/5	0	30MS	NT	H	H	0	5/15	tauschii	Japan
1702	10R	10MR	10MR	15MR	0	L	14/5	0	5R	5MR	L	H	0	16/5	geniculata	Romania
1729	10R	10R	15R	15MR	M	H	23/5	1R	10R	10M	L	H	0	23/5	triuncialis	Turkey
1749	5R	25R	0	5R	M	M	13/5	0	1R	1R	M	H	0	17/5	triuncialis	Afghanistan
1769	10R	NT	15MR	NT	M	M	13/5	0	1R	5R	0	M	0	17/5	triuncialis	Iran
1771	5R	5R	1R	1R	L	L	27/5	0	0	1R	L	H	0	25/5	speltoides	Turkey
1789	5R	15MR	0	1R	L	L	25/5	0	1R	5R	0	M	0	24/5	speltoides	Iraq
1794	5R	NT	1R	NT	M	M	11/5	5R	1R	1R	0	H	0	5/15	neglecta	Iraq
1799	5R	20MR	1R	10R	L	L	17/5	0	1R	5R	0	L	0	23/5	geniculata	Turkey
1819	5R	10MR	5R	5R	L	L	14/5	0	5R	5R	L	M	0	17/5	geniculata	Japan
1823	10R	NT	15MR	NT	L	M	12/5	0	5R	NT	L	H	0	16/5	umbellulata	Turkey
1826	5R	20MR	0	5R	0	L	25/6	0	1R	5R	0	H	0	24/5	umbellulata	Turkey
1833	10R	NT	5R	NT	M	M	12/5	1R	1R	NT	H	H	0	12/5	umbellulata	Iran
1843	5R	15R	0	1R	L	L	30/5	0	1R	10MS	L	M	0	26/5	cylindrica	Turkey
1859	25M	30M	20MR	20M	L	M	24/5	0	25MR	50M	L	H	0	25/5	cylindrica	Turkey
1868	5R	25MR	1R	5R	L	L	15/5	1R	1R	5R	L	H	0	21/5	neglecta	Japan
1874	50S	NT	20MS	NT	H	H	14/5	10MR	40MS	40M	M	H	0	17/5	crassa	Iran
1875	60S	NT	10MR	NT	M	M	13/5	10M	NT	NT	H	H	0	5/15	crassa	Iran
1878	NT	NT	NT	NT	H	H	14/5	5M	50MR	60MS	L	H	0	17/5	vavilovii	Turkey
1881	40MS	NT	30MS	NT	0	M	15/5	10M	NT	NT	M	H	0	16/5	crassa	Afghanistan
1883	70MS	25MR	30M	35M	M	M	14/5	5M	50M	60M	H	H	0	17/5	vavilovii	Italy
1906	20MR	NT	30MR	NT	M	M	14/5	15M	30MR	NT	L	H	0	17/5	caudata	Turkey
1909	60MS	NT	15M	NT	M	H	27/5	0	30M	40MR	L	H	0	25/5	caudata	Turkey
1960	5MR	NT	0	NT	H	H	10/5	1R	NT	NT	H	H	0	12/5	biuncialis	Israel
1963	10R	NT	5R	NT	M	M	14/5	0	10MR	5R	0	H	0	14/5	biuncialis	Canada
1965	10R	10R	1R	1R	L	M	28/5	0	5R	1R	L	M	0	26/5	comosa	Turkey
1967	5R	10MR	1R	1R	0	L	30/5	0	0	5R	0	M	0	25/5	comosa	Greece
1972	20R	NT	20MR	NT	H	H	11/5	1R	NT	NT	H	H	0	14/5	biuncialis	Turkey
1983	NT	NT	NT	NT	M	H	12/5	1R	10R	NT	L	H	0	13/5	kotschyi	Egypt
1989	10R	25MR	10MR	15MR	H	H	15/6	1R	5R	30MS	M	H	0	23/5	ventricosa	England
1991	5R	15MR	5MR	10MR	L	M	15/6	0	1R	1R	M	H	0	21/5	biuncialis	Turkey
1993	20MR	25MR	10MR	20MR	L	H	25/5	0	15R	30M	H	H	0	22/5	ventricosa	Romania
1996	NT	NT	NT	NT	M	H	12/5	0	NT	NT	M	NT	0	22/5	sharonensis	Israel
2004	5R	30MR	1R	5R	M	M	25/6	0	1R	NT	M	H	0	23/5	aegilopoides	Turkey
	5R	35MR	1R	10MR	L	L	28/5									
	10R	30MR	0	10MR	L	L	25/6									
	5R	30MR	1R	10MR	L	L	27/5									
2061	5R	5MR	1R	1R	L	L	15/5	0	10MR	5R	L	H	0	18/5	geniculata	Morocco
2074	10R	NT	1R	NT	L	M	27/5	0	25M	10R	0	M	0	24/5	biuncialis	Turkey
2084	10MR	35MR	5R	25M	L	M	28/5	1R	NT	NT	H	H	0	23/5	columnaris	Turkey
2102	5R	15MR	5MR	5MR	0	L	25/6	0	1R	5R	L	M	0	25/5	comosa	Greece
2104	5R	20MR	0	5R	L	L	30/5	0	5R	5R	L	H	0	26/5	comosa	Greece
2108	20MR	25MR	10R	10R	M	H	28/5	0	5MR	5R	L	H	0	24/5	columnaris	Turkey
2115	30MS	NT	25M	NT	M	H	15/6	0	30M	30M	L	H	0	18/5	juvenalis	Canada
2142	10R	10R	5R	10MR	H	H	10/5	0	1R	5R	H	H	0	12/5	villosa	Croatia
2202	20M	NT	5MR	NT	M	H	5/21	1R	40MR	50M	L	H	0	24/5	cylindrica	Romania
2211	20MR	NT	30M	NT	L	M	25/6	0	1R	5MR	M	H	0	23/5	ventricosa	Spain
2216	40S	NT	60S	NT	M	H	15/6	20M	60M	NT	H	H	0	18/5	crassa	Kyrgyzstan
2304	5R	10MR	1R	1R	L	L	30/5	0	5R	5R	0	M	0	26/5	triuncialis	Turkey
2319	30M	30MS	25M	30M	L	M	15/5	1R	15MR	40MS	M	H	0	17/5	crassa	Turkey
2322	10R	NT	10MR	NT	M	M	14/5	0	5R	5R	L	M	0	17/5	triuncialis	Turkey
2344	10R	10R	30M	40M	0	L	30/5	0	5R	NT	H	H	0	23/5	searsii	Syria
2348	5R	30MR	0	5R	M	M	17/5	0	5R	5R	M	H	0	18/5	speltoides	Israel
2369	5R	5R	1R	1R	L	L	27/5	0	1R	1R	L	M	0	26/5	tauschii	Russia
2399	30M	30MR	20M	25MR	L	H	12/5	1R	20MR	NT	H	H	0	18/5	tauschii	Afghanistan
2429	30MS	NT	20M	NT	M	H	14/5	5R	NT	NT	H	H	H	14/5	tauschii	Afghanistan
2601	15MR	15MS	20MR	20M	M	M	23/5	0	10MR	30MS	H	H	H	26/5	aestivum	Turkey
2602	14R	15MR	0	5R	M	H	5/6	0	20R	15MS	L	M	0	4/6	aestivum	UK

Table 2. Field observations on a collection of *Triticum* and *Aegilops* species for leaf and stem rust, barley yellow dwarf, and heading date in the 2009–10 growing seasons. TA# indicates the accession number in the Wheat Genetic and Genomic Resources Center Gene Bank. The leaf and strip rust screening data is described in detail on p. 238. For barley yellow dwarf {BYD) and powdery mildew (PM) incidence; H = high, M = medium, L = low, and 0 = no disease; — = missing data. The country of origin for the accession is listed if known.

TA #	2010							2009							Species	Country of origin
	Leaf rust		Stripe rust		BYD		HD	Leaf rust			BYD		PM	HD		
	5/26	6/2	5/26	6/2	5/13	5/26		5/21	6/1	6/5	5/21	6/1	5/21			
2619	10R	15MR	5R	5R	L	L	28/5	0	5R	10R	0	L	0	25/5	triuncialis	Turkey
2661	10MR	NT	0	NT	M	M	10/5	0	5MR	5MR	L	H	0	12/5	biuncialis	Syria
2686	10R	10R	1R	5R	0	L	30/5	1R	1R	5MR	M	H	0	25/5	uniaristata	Russia
2688	5R	25MR	1R	10MR	M	M	28/5	0	5R	15MR	L	H	L	25/5	uniaristata	Greece
2774	5R	10R	20MR	25MR	L	L	30/5	0	1R	1R	L	M	0	5/20	speltoides	Turkey
2783	10R	20R	5R	5R	M	M	28/5	0	5R	1R	L	M	0	24/5	biuncialis	Bosnia
2790	10R	10R	5R	15MR	L	L	23/5	0	1R	10R	M	H	0	18/5	neglecta	Bosnia
2799	10R	30MR	5R	5MR	L	M	28/5	0	10MR	10R	M	H	0	24/5	cylindrica	Turkey
2805	10R	25MR	20MR	25MR	M	H	28/5	1R	10MR	10M	M	H	0	18/5	turgidum	Unknown
10059	30M	NT	10MR	NT	H	H	12/5	0	10R	NT	L	H	0	5/15	biuncialis	Turkey
10069	30MR	35M	30MR	30M	M	H	15/5	15R	15M	4OM	0	H	0	18/5	tauschii	Afghanistan
10099	25M	NT	20M	NT	M	H	25/5	1R	30MR	60M	L	H	0	24/5	tauschii	Armenia
10339	30MS	35MS	20MR	20M	M	M	30/5	20M	60M	60MS	M	H	0	22/5	crassa	Tajikistan
10348	20MR	30MR	5MR	20MR	L	M	15/6	1R	10R	20R	L	H	0	23/5	cylindrica	Tajikistan
10372	5R	15MR	5R	5R	L	L	15/6	0	5R	5R	L	H	0	18/5	triuncialis	Tajikistan
10426	30MR	35M	15MR	20MR	M	H	14/5	0	5MR	40MS	H	H	0	18/5	aestivum	Turkey
10570	10MR	20MR	10R	15MR	M	M	28/5								aegilopoides	Switzerland
	10R	20MR	0	5R	M	H	31/5									
10572	10MR	30MR	10MR	15MR	M	H	15/5								aegilopoides	Iran
	15M	15MR	10R	15MR	L	M	14/5									
10592	10R	20MR	5R	10MR	L	M	29/5								aegilopoides	Turkey
	5R	10MR	5MR	10MR	L	M	30/5									
10596	20MR	30MR	10R	10MR	M	H	3/6								aegilopoides	Turkey
	25R	25MR	0	10R	L	M	5/6									
10597	30R	40MR	5MR	10MR	L	H	3/6								aegilopoides	Turkey
	20R	30MR	0	5R	O	L	5/6									

MINNESOTA

CEREAL DISEASE LABORATORY, USDA–ARS
University of Minnesota, 1551 Lindig St., St. Paul, MN 55108, USA.
www.ars.usda.gov/mwa/cdl

D.L. Long, J.A. Kolmer, Y. Jin, M.E. Hughes, and L.A. Wanschura.

Wheat rusts in the United States in 2009.

Wheat stem rust (*Puccinia graminis f. sp. tritici*). Texas. The first report of wheat stem rust in 2009 was of low levels found on spelt wheat and barley planted as a windbreak for watermelons in Hidalgo County along the Rio Grande Valley in southeast Texas on 23 March. Low levels of wheat stem rust were found on flag leaves and stems in McNair 701 disease-detection plots in irrigated nurseries at Beeville and Castroville in south Texas on 9 April. The pustules developed from spores that were likely rain deposited approximately 10–14 days earlier. On 22 April, stem rust was developing slowly on susceptible cultivars (McNair 701), a few winter wheat lines, and on a winter triticale (Tamcale 5019) in the Castroville irrigated plots in south Texas. On 27 April, a few pustules of wheat stem rust were found in the McNair 701 stem rust trap plot at College Station in central Texas. In early May, wheat stem rust was found on the susceptible cultivar McNair 701 at McGregor and College Station and in plots of susceptible cultivars at Bardwell and Giddings in central Texas. On 6 May, low levels of stem rust were found in a field in Jones County in northwest Texas. In late June, low levels of stem rust were reported in a Texas Panhandle wheat plot.