

The soil data provided information about the change in soil properties after a winter season with the cover crops (Table 1, p. 69). The pH, organic matter, nitrogen, and carbon were not changed by the presence of either of the cover crops. Values before planting of the cover crops were similar to those after their harvest. Nitrogen in the soil was not increased by the presence of the peas. The results showed that there is no advantage of increased nitrogen in the soil, if winter pea is a cover crop. They reinforced the fact that the winter cover crop in Manhattan, KS, should be wheat.

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Acknowledgements. We thank Dr. Scott A. Staggenborg, Director, Product Portfolio and Technology Advancement, Chromatin, Inc., Lubbock, TX, for suggesting that research be done with cover crops. We thank Kathleen M. Lowe, Assistant Scientist, Soil Testing Laboratory, Manhattan, KS, for soil analyses and reporting of the data.

Publications.

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*Mining novel genetic diversity in *Aegilops tauschii*, the D-genome progenitor of hexaploid wheat.*

Narinder Singh, Sunish K. Sehgal (South Dakota State University, Brookings), Duane L. Wilson, W. Jon Raupp, Bikram S. Gill, and Jesse Poland.

Wheat production is threatened by depleting resources, increasing cost of production and climate change. An estimated 60% increase in wheat production is needed by 2050 to feed the projected population of 9 billion. Hexaploid wheat, like many other crops, has undergone bottlenecks during polyploidization and domestication resulting in narrow genetic base. *Aegilops tauschii* the D-genome progenitor of bread wheat, has remained genetically diverse and is an excellent source for broadening the genetic base of wheat. With this vision, we assessed the diversity in the *Ae. tauschii* collection at the Wheat Genetics Resource Center at Kansas State University and developed PowerCore and MiniCore sets. We genotyped 551 accessions representing the world collection by genotyping-by-sequencing (GBS). More than 120K SNPs were discovered using TASSEL pipeline. SNPs with less than 50% missing data were filtered, and a random subset of 15K SNPs was selected to identify a PowerCore consisting of 144 accessions retaining most of the genetic diversity and maintaining frequency of alleles in core set similar to the entire collection. The PowerCore was optimized based on genetic distance to represent the major clusters of phylogenetic tree. A MiniCore set of 52 accessions was selected from the PowerCore set to represent all the major clusters in the phylogenetic tree. The MiniCore set of 52 accessions will be crossed to elite wheat cultivars to produce wheat-*Ae. tauschii* amphiploids. These amphiploids will be selfed and backcrossed to elite wheat lines to enhance the diversity of bread wheat.

In addition, the *Ae. tauschii* accessions were evaluated for a second year at the Rocky Ford Research Area, Manhattan, KS, for field resistance to leaf and strip rust and barley yellow dwarf virus (Table 1, pp. 72-81). The lines also were evaluated for heading date. Field data was recorded on two dates. Virus infection was rated as symptoms on visible as chlorosis, necrosis of the leaf tips and leaves, or purpling of the leaves. Hessian fly and seedling and adult-plant stripe rust reactions were scored on greenhouse-grown plants.

The Wheat Genetics Resource Center Genebank and the rapid curation of germplasm Collections using Genotyping-by-Sequencing.

W. Jon Raupp, Shuangye Wu, Narinder Singh, Jesse Poland, and Bikram Gill.

The main mission of the WGRC, collecting, conserving, and utilizing germplasm in wheat improvement for sustainable production, broadens the crop genetic base assuring future advances in breeding. The WGRC genebank contains passport and evaluation data on ~3,800 wheat species accessions and, in addition, houses ~3,400 cytogenetic stocks.

In wheat, accessions from genebanks and individuals have been widely circulated for the last century. Historically, each genebank has used their own accession identification numbers, often resulting in the loss of globally unique identifiers, cross-referenced collection information, or passport data. Thus, once an accession travels from genebank to genebank, the ability to discern duplicates is confounded. In this context, much effort is given at the WGRC to cross-reference our accessions with those of other wheat gene banks.

Recognizing the importance of identifying duplicity and cross-referencing collections, we used genotyping-by-sequencing (GBS) to ascertain the genetic diversity in our collection of 568 *Aegilops tauschii* accessions and compare it to an undocumented collection. After de novo SNP calling using the TASSEL pipeline, removing duplicate tags, and SNP filtering for missing data, 14k SNPs were mapped on wheat D genome. Using allele matching accounting for a ~1% sequencing error (>99% match), we could identify accessions with similar, yet incomplete, passport data as possible duplicates. Of 551 *Ae. tauschii* accessions assayed, 402 were unique, representing a 27% duplication. We also were able to match 118 unidentified accessions from the genebank at Punjab Agricultural University as the same accession represented the WGRC collection. We currently are using this same approach to characterize and curate our collection of over 900 tetraploid wheats.

With a rapid and cost-effective tool to study genetic diversity, giving a consistent characterization of genetic and phenotypic diversity in wheat germplasm GBS will be important in the genetic curation of accessions within and between collection(s). With such information across global collections, it becomes possible identify the truly unique accessions across all of our gene banks, enabling more targeted access to genetic diversity.

Detection of adult-plant resistance to Puccinia triticina in native wheat species; transfer and mapping in wheat.

Bhanu Kalia, Jesse Poland, and Bikram S. Gill; Robert L. Bowden and Erena Edae, USDA-ARS, Manhattan; and Ravi P. Singh, CIMMYT, Mexico.

Resistance to wheat rusts may be race-specific and subject to boom and bust cycles, or race-nonspecific or adult-plant resistance (APR), which is associated with durability. We evaluated *Aegilops tauschii*, one of the diploid ancestors of wheat, for APR to *P. triticina*. The *Ae. tauschii* populations in Caspian Iran and eastern Afghanistan commonly exhibited APR, suggesting that APR may be an important defense in nature against leaf rust. We transferred APR to leaf rust from *Ae. tauschii* (TA2474) to wheat through production of synthetic-hexaploid wheat (SHW), but expression was suppressed in the progeny. To unlock the expression of APR, a population of 261 recombinant inbred lines (RILs) was developed from a cross of SHW with the cultivar WL711. The RILs were phenotyped for maximum disease severity at Manhattan, KS, in 2013-14 and at CIMMYT, Mexico, in 2013. Genotyping-by-sequencing (GBS) detected QTL associated with APR and was contributed by both the parents. Two major QTL from WL711 were mapped on chromosome 1BL, explaining 11-24% of the phenotypic variance across environments; two additional QTL were mapped on 5AL and 6BL. SHW-derived QTL for APR were mapped on 1AL, 1BS, 2DS, 2DL, and 5DL. The results demonstrate complex genetic

control and evolution of APR. The novel APR genes and their linked GBS-based ,SNP markers are potentially useful for durable control of leaf rust in wheat.

Table 1. Data from the set of *Aegilops tauschii* evaluated for disease severity in the field, Manhattan, KS, during the 2014–15 crop season, for field resistance to leaf (Lr) and stripe (Yr) rust and barley yellow dwarf virus (BYDV). Heading date also was recorded. Leaf and stripe rusts were evaluated at two dates on the Cobb scale, where a number indicating the percent of leaf area affected is followed by a letter designation, R = resistant flecks or very small pustules, MR = moderately resistant small pustules, M = moderate small to medium size pustules, MS = moderately susceptible medium to large pustules, and S = susceptible with large pustules. Rating of the leaves with BYDV symptoms was 0 = no visible signs of infection, L = low infection with 10% or less of the leaf area with visible symptoms, M = moderate infection with up to 40% of the leaf area with visible symptoms, and H = high infection with over 40% of the leaf area showing symptoms. — = no test. Seedling and adult-plant stripe rust reactions were scored in the greenhouse; the superscript indicates the number of plants scored; seedling test is a 0 to 9 scale with 1–3 resistant, 4–6 intermediate, and 7–9 susceptible; adult-plant reaction also used the Cobb scale; 0 = immune/no infection observed. Hessian Fly scored as R = resistant or S = susceptible; segregating lines given as number of resistant plants/number of susceptible plants.

ID / accession number	Country of origin	Leaf rust		Stripe rust				BYDV		Hessian fly	Heading date
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May	8 June		
Triumph 64	Check	50MS	—	30MS	—		—	H	—		27 May
Newton	Check	30M	—	15MS	—		—	H	—		21 May
Fuller	Check	70S	—	25MS	—		—	H	—		8 May
Everest	Check	20M	—	10MS	—		—	H	—		8 May
Kingbird	Check	—	—	—	—		5R ⁵	—	—		—
Morocco	Check	—	—	—	—	8 ¹⁰	70S ⁵	—	—		—
Karl 92	Check									S	
Carol	Check									S	
Caldwell	Check									S	
WGRC1 (H13)	Check									R	
TA1585	Turkey	20MR	20MR	30MS	30MS	5 ⁶	20MS ³	L	L	S	13 May
		10MR	25MR	30M	30M			M	M		14 May
		5MR	25MR	20M	20M			M	M		15 May
TA1586	Turkey	5R	10R	30MS	30MS	5 ⁶	40MS ³	M	M	S	26 May
		10R	15MR	20M	20M			M	M		27 May
		5MR	20MR	20MR	20MR			M	M		18 May
TA1592	Turkey	70S	70S	30MS	30MS	5 ⁶	40MS ³	H	H	S	27 May
		60MS	—	30MS	—			H	H		16 May
		60MS	—	30MS	—			H	H		17 May
TA1604	Afghanistan	WINTER KILLED				4 ⁵	60MS ³			S	
		70S	—	20MS	—			H	H		16 May
		WINTER KILLED									
TA1606	Afghanistan	10MR	10MR	5R	5MR	4 ²	5R ²	L	M	S	14 May
		1R	30MR	5R	5MR			M	H		13 May
		WINTER KILLED									
TA1620	Afghanistan	10MS	10MS	30M	40MS	5 ⁶	20M ²	H	H	S	15 May
		30M	35M	30M	30MS			H	H		12 May
		30MS	—	40MS	—			M	H		12 May
TA1621	Georgia	50MS	50MS	10M	20MS	5 ⁴	5R ⁵	M	H	S	29 May
		50MS	50MS	20M	20MS			M	M		28 May
		30MS	30MS	20MS	20MS			H	H		1-Jun
TA1629	Afghanistan	10M	30M	40MS	40MS	3 ⁵	50S ³	H	H	S	12 May
		20MS	—	40MS	—			H	H		10 May
		20M	30M	10MR	15M			H	H		13 May
TA1631	Afghanistan	25MS	—	30MS	—	4 ⁶	50S ³	H	H	S	11 May
		30MS	—	40MS	—			H	H		9 May
		25MS	—	30MS	—			H	H		10 May
TA1642	Iran	20MR	20MR	25R	25MR	3 ⁶	1R ³	L	L	R	24 May
		15R	25MR	5R	10MR			L	M		16 May
		5MR	20MR	1R	5MR			L	M		16 May

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date	
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June
TA1644	Iran	10R	15MR	20MR	20MR	3 ⁶	1R ³	L	L	R	14 May
		10R	25MR	5R	15MR			M	M		13 May
		10MR	30MR	5MR	20MR			M	M		12 May
TA1645	Iran	15MR	20MR	25MR	25MR	3 ⁶	15R ³	L	M	R	22 May
		10MR	—	5MR	—			M	H		16 May
		10M	15M	1R	20MR			L	H		15 May
TA1655	Afghanistan	WINTER KILLED				5 ⁵	70S ³			S	11 May
		20MS	—	40MS	—			H	H		
		WINTER KILLED									
TA1657	Afghanistan	20M	—	20MS	—	3 ⁵	30M ³	H	H	S	22 May
		30MS	—	40MS	—			H	H		10 May
		40M	—	25MS	—			H	H		10 May
TA1662	Azerbaijan	20R	30MS	10R	10MR	2 ⁴	5R ³	L	L	S	14 May
		15M	30M	10MR	20M			M	M		28 May
		WINTER KILLED									
TA1664	Azerbaijan	20R	20MR	15R	15MR	3 ⁶	5MR ³	L	L	R	22 May
		10MR	25M	15MR	15MR			L	M		15 May
		1R	20M	5R	20MS			H	H		14 May
TA1667	Azerbaijan	WINTER KILLED				3 ⁶	20MS ³			R	30 May
		10M	25M	5MR	15R			M	H		
		30M	30M	20MR	20M			M	M		
TA1668	Azerbaijan	30R	30M	30MR	30MR	3 ⁶	10MR ³	M	M	R	24 May
		10MR	30MS	5R	20MR			M	M		16 May
		30M	30M	5MR	25M			M	M		22 May
TA1670	Azerbaijan	1R	—	5R	—	4 ⁵	20MR ³	M	H	R	22 May
		1R	5R	5R	5R			L	L		16 May
		1R	20MR	5R	10MR			L	M		16 May
TA1679	Azerbaijan	20M	40MS	10MR	20MS	6 ⁶	10M ³	M	M	S	26 May
		40MS	50MS	20MR	20M			L	M		30 May
		50MS	50MS	20M	20M			M	M		1-Jun
TA1680	Azerbaijan	30M	30M	10MR	15MR	3 ²	20MR ²	L	L	R	28 May
		15MR	25MR	10MR	10MR			M	M		28 May
		10M	30M	5MR	20MR			L	M		30 May
TA1681	Azerbaijan	40MS	40MS	10MR	10MR	4 ⁶	10MR ³	M	M	S	27 May
		30M	30M	5R	25M			H	H		22 May
		40MS	50MS	5MR	20MR			H	H		17 May
TA1690	Afghanistan	20M	10MR	5MR	10MR	4 ⁶	10R ²	M	M	R	15 May
		20M	20M	5MR	25M			M	H		16 May
		30MS	30MS	10MR	25M			L	M		17 May
TA1691	Unknown	20MR	20MR	10R	10MR	4 ⁵	20MR ³	L	L	4/7	13 May
		1R	20MR	5R	5MR			L	M		15 May
		10MR	20MR	1R	5MR			L	M		15 May
TA1697	Unknown	60S	—	50MS	—	4 ⁵	25MS ³	H	H	S	12 May
		20M	—	60MS	—			H	H		12 May
		20M	—	40MS	—			H	H		13 May

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date		
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June	
TA1698	Russian Federation	50MS	—	20MS	—	5 ⁴	10M ³	H	H	4/14	11 May	
		40MS	—	20MS	—			H	H		10 May	
		60MS	—	20MS	—			H	H		11 May	
TA1704	Tajikistan	60S	—	30MS	—	5 ⁵	20MS ³	H	H	S	12 May	
		30MS	—	30MS	—			H	H		12 May	
		WINTER KILLED										
TA1707	Unknown	20MR	20M	10R	10MR	4 ¹	30R ²	M	M	5/6	12 May	
		WINTER KILLED										
		WINTER KILLED										
TA1708	Unknown	40MS	—	40MS	—	4 ⁶	40MS ³	H	H	S	10 May	
		30MS	—	40MS	—			H	H		10 May	
		40MS	—	25MS	—			H	H		10 May	
TA1713	Turkey	5R	10M	1R	5MR	4 ⁶	20MS ³	M	M	R	22 May	
		30M	30M	15MR	20M			M	M		31 May	
		25M	40MS	15MR	20M			M	M		31 May	
TA2370	Unknown	5MR	20MR	30M	40MS	8 ⁶	60MS ³	H	H	S	14 May	
		5R	30MR	5R	15MR			H	H		13 May	
		10MR	20MR	40M	50M			H	H		12 May	
TA2377	Iran	50MS	—	40MS	—	6 ⁶	35MS ³	H	H	S	11 May	
		40MS	—	50MS	—			H	H		12 May	
		40MS	—	40MS	—			H	H		13 May	
TA2384	Pakistan	WINTER KILLED				6 ⁶	40MS ³			S		
		WINTER KILLED										
		WINTER KILLED										
TA2387	Afghanistan	5MR	—	50MS	—	4 ⁶	20MS ³	H	H	3/14	10 May	
		20MS	—	60MS	—			H	H		10 May	
		25MS	—	30MS	—			H	H		10 May	
TA2388	Afghanistan	30MS	—	50MS	—	7 ⁴	50MS ³	H	H	S	10 May	
		20MS	—	40MS	—			H	H		11 May	
		20MR	30MR	10MR	20MR			M	H		10 May	
TA2395	Afghanistan	10MS	—	60MS	—	7 ⁵	60S ³	H	H	S	14 May	
		40MS	—	50S	—			H	H		12 May	
		40MS	—	50MS	—			H	H		12 May	
TA2369	Afghanistan	1R	15MR	1R	10MR	3 ⁶	15MR ³	L	L	R	2-Jun	
		5R	20MR	10R	10MR			L	M		1-Jun	
		1R	25MR	5R	15MR			L	M		1-Jun	
TA2401	Afghanistan	35MS	—	1R	—	3 ²	30M ²	H	H	S	13 May	
		40MS	—	5MR	—			H	H		15 May	
		30MS	—	20MS	—			H	H		14 May	
TA2407	Afghanistan	40MS	—	5R	—	7 ³	20M ¹	H	H	S	10 May	
		20MS	—	40MS	—			H	H		10 May	
		25MS	—	10MS	—			H	H		13 May	
TA2412	Afghanistan	40MS	—	30MS	—	4 ⁵	15MR ³	H	H	S	10 May	
		40MS	—	10M	—			H	H		9 May	
		40MS	—	10M	—			H	H		10 May	

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date		
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June	
TA2413	Afghanistan	50MS	—	30MS	—	5 ⁵	30MR ³	H	H	S	10 May	
		70S	—	25MS	—			H	H		10 May	
		WINTER KILLED										
TA2420	Afghanistan	10M	—	50MS	—	5 ⁶	60MS ³	H	H	S	9 May	
		40MS	—	40MS	—			H	H		9 May	
		WINTER KILLED										
TA2424	Afghanistan	30M	—	25MS	—	5 ⁶	40MS ²	H	H	S	10 May	
		30MS	—	25MS	—			H	H		9 May	
		WINTER KILLED										
TA2433	Afghanistan	20M	—	10MS	—	4 ⁶	70MS ³	H	H	S	9 May	
		15MR	—	5R	—			H	H		11 May	
		5MR	—	20M	—			H	H		11 May	
TA2434	Afghanistan	WINTER KILLED				8 ⁶	20M ²			S		
		25MS	—	40MS	—			H	H		9 May	
		50MS	—	40MS	—			H	H		9 May	
TA2437	Afghanistan	10MS	—	40MS	—	7 ⁶	60S ³	H	H	S	9 May	
		30MS	—	50MS	—			H	H		9 May	
		25MS	—	60S	—			H	H		9 May	
TA2442	Afghanistan	WINTER KILLED				3 ⁵	15M ²			S		
		30M	—	20MS	—			H	H		10 May	
		WINTER KILLED										
TA2448	Iran	20MS	30MS	15MR	15MR	4 ³	0	H	H	S	13 May	
		30M	30M	10MR	15M			H	H		13 May	
		10M	30M	5R	20M			M	H		14 May	
TA2450	Iran	WINTER KILLED				4 ⁶	1R ³			S		
		10R	20MR	5MR	5MR			L	M		16 May	
		1R	20MR	5R	5R			L	L		18 May	
TA2455	Iran	15R	15MR	20M	20M	4 ⁶	1R ³	L	L	8/6	14 May	
		5R	25MR	1R	20MR			M	H		15 May	
		5R	20MR	1R	10MR			L	M		23 May	
TA2457	Iran	10R	10R	5R	5R	5 ⁶	1R ³	H	H	R	14 May	
		5R	30MR	5R	15MR			M	H		15 May	
		1R	10MR	5R	15MR			M	M		22 May	
TA2458	Iran	10MR	—	5R	—	4 ⁵	20MS ³	M	H	S	14 May	
		WINTER KILLED										
		1R	20MR	1R	15MR			L	H		21 May	
TA2459	Iran	15MR	15MR	5R	5R	4 ⁶	20MR ³	M	M	S	15 May	
		25MR	30M	15MR	15MR			M	H		22 May	
		5MR	25MR	5MR	10MR			M	H		16 May	
TA2460	Iran	5MR	25M	5R	15MR	2 ²	—	L	M	2/10	15 May	
		10MR	15M	1R	5MR			L	M		17 May	
		10MR	20M	1R	5MR			L			17 May	
TA2461	Iran	25MS	30MS	5R	15MR	4 ⁶	20MR ³	M	M	S	28 May	
		30MS	40MS	15M	25M			M	M		28 May	
		20MS	50MS	15M	15MS			M	M		22 May	

Table 1. Data from the set of *Aegilops tauschii* evaluated for disease severity in the field, Manhattan, KS, during the 2014–15 crop season, for field resistance to leaf (Lr) and stripe (Yr) rust and barley yellow dwarf virus (BYDV). Heading date also was recorded. Leaf and stripe rusts were evaluated at two dates on the Cobb scale, where a number indicating the percent of leaf area affected is followed by a letter designation, R = resistant flecks or very small pustules, MR = moderately resistant small pustules, M = moderate small to medium size pustules, MS = moderately susceptible medium to large pustules, and S = susceptible with large pustules. Rating of the leaves with BYDV symptoms was 0 = no visible signs of infection, L = low infection with 10% or less of the leaf area with visible symptoms, M = moderate infection with up to 40% of the leaf area with visible symptoms, and H = high infection with over 40% of the leaf area showing symptoms. — = no test. Seedling and adult-plant stripe rust reactions were scored in the greenhouse; the superscript indicates the number of plants scored; seedling test is a 0 to 9 scale with 1–3 resistant, 4–6 intermediate, and 7–9 susceptible; adult-plant reaction also used the Cobb scale; 0 = immune/no infection observed. Hessian Fly scored as R = resistant or S = susceptible; segregating lines given as number of resistant plants/number of susceptible plants.

ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date	
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June
TA2464	Iran	30MR	30M	10MR	20MR	5 ⁵	15MR ³	M	H	S	15 May
		10MR	30MR	5MR	20M			M	H		17 May
		—	—	—	—			—	—		15 May
TA2468	Iran	WINTER KILLED				5 ⁵	5R ³			R	
		1MR	15MR	5MR	10MR			L	L		2-Jun
		—	—	—	—			—	—		16 May
TA2469	Iran	WINTER KILLED				4 ⁶	15R ³			R	
		20MR	30MR	5R	20MR			M	H		15 May
		5R	30MR	1R	20MR			L	M		12 May
TA2471	Iran	20M	30MS	5R	15M	5 ⁶	10R ³	M	M	S	14 May
		15MR	15M	5R	20M			L	M		15 May
		5M	40M	5R	15MS			L	M		16 May
TA2472	Iran	WINTER KILLED				4 ⁶	10R ³			R	
		WINTER KILLED									
		1R	20MR	1R	5MR			L	L		18 May
TA2474	Iran	30MR	30MR	5MR	10MR	3 ⁶	40R ³	M	M	R	15 May
		20MR	20MR	10MR	15MR			M	H		14 May
		5M	30M	1R	15MR			M	H		14 May
TA2479	Iran	20M	25M	10MR	15MR	2 ⁶	5R ³	M	H	S	13 May
		20M	30MS	10M	15MS			M	H		15 May
		10MS	25MS	1R	15MR			M	H		16 May
TA2482	Iran	15MR	30MR	10R	25MR	4 ⁶	60MS ³	H	H	S	15 May
		5R	20MR	30M	30MS			H	H		16 May
		5MR	—	25MS	—			H	H		16 May
TA2484	Iran	15MS	30MS	10R	25MS	4 ⁵	0	M	M	S	30 May
		30MS	30MS	20MS	25MS			M	M		1-Jun
		30M	30M	1R	20M			L	M		17 May
TA2488	Iran	40MS	—	20M	—	4 ⁵	30S ³	H	H	S	12 May
		20S	—	20MS	—			H	H		14 May
		70S	—	20MS	—			H	H		18 May
TA2491	Iran	50S	—	15MS	—	4 ⁶	20M ³	M	H	S	15 May
		40MS	—	20MS	—			H	H		15 May
		60MS	—	20MS	—			M	H		16 May
TA2496	Iran	30MR	30MR	20MR	20MR	3 ³	1R ³	M	M	S	15 May
		10MR	20M	5MR	15MR			M	H		15 May
		5MR	30MR	5MR	20MR			L	M		16 May
TA2502	Turkey	40MS	—	40MS	—	3 ³	50MS ³	H	H	S	27 May
		60MS	—	30MS	—			H	H		17 May
		40MS	—	30MS	—			H	H		17 May
TA2510	Turkey	50MS	—	40MS	—	6 ⁶	40MS ³	M	H	S	29 May
		70MS	—	30MS	—			H	H		24 May
		30M	30M	20M	30M			H	H		18 May
TA2512	Iran	60S	—	30MS	—	4 ⁶	30MS	H	H	S	26 May
		50MS	50MS	5R	30MS			M	H		17 May
		50MS	—	40MS	—			H	H		25 May

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date	
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June
TA2516	Iran	10MR	30M	5MR	25M	5 ⁶	20MS ³	H	H	S	15 May
		60MS	—	10MR	—			H	H		16 May
		40MS	—	10MR	—			H	H		17 May
TA2521	Iran	70S	—	25M	—	5 ⁶	50MS ³	H	H	S	15 May
		50MS	—	40MS	—			H	H		14 May
		30MS	—	40MS	—			H	H		16 May
TA2525	Iran	20M	20M	10MR	15M	4 ⁶	10R ³	M	H	S	15 May
		20M	30M	15M	25M			M	H		15 May
		10MS	30MS	1MR	25M			M	M		16 May
TA2530	Iran	WINTER KILLED				4 ³	5R ³			S	
		5MR	20MR	1R	15MR			L	M		14 May
		10MR	30MR	5MR	20MR			M	H		12 May
TA2536	Afghanistan	40MS	—	40MS	—	4 ³	50S ³	M	H	S	13 May
		40MS	—	20M	—			H	H		13 May
		25MS	—	30MS	—			H	H		11 May
TA2538	Afghanistan	40MS	—	20MS	—	4 ⁵	30MS ³	H	H	—	14 May
		20M	25MS	20MS	30MS			M	H		12 May
		40MS	—	40MS	—			M	H		12 May
TA2539	Afghanistan	20MR	20M	15MR	20M	4 ⁶	30MS ³	M	H	—	16 May
		40MS	40MS	20MS	20MS			H	H		16 May
		20MS	—	40MS	—			M	H		15 May
TA2540	Afghanistan	60MS	—	40MS	—	3 ⁵	40MS ³	H	H	S	14 May
		60MS	—	30MS	—			H	H		15 May
		60MS	—	30MS	—			M	H		14 May
TA2544	Afghanistan	30MS	30MS	20MR	20MR	4 ⁵	50MS ³	M	H	S	16 May
		10M	30M	15MS	25MS			M	H		15 May
		10MR	30MS	20M	25MS			M	H		16 May
TA2556	Afghanistan	30M	—	40MS	—	4 ⁵	70MS ³	H	H	S	12 May
		60MS	—	30MS	—			M	H		14 May
		70S	—	20MS	—			H	H		15 May
TA2561	Azerbaijan	5R	20MR	15MR	15MR	4 ⁵	30M ³	M	L	R	29 May
		10R	30MR	5R	25MR			M	M		31 May
		WINTER KILLED									
TA2564	Azerbaijan	30MS	60S	15MR	20MS	4 ⁶	10MR ³	M	L	S	30 May
		15MS	40MS	5R	15M			M	M		30 May
		20MS	25MS	15MS	20MS			L	L		22 May
TA2565	Azerbaijan	20MR	20M	5MR	15M	4 ⁵	0	M	L	R	30 May
		5R	25MR	5MR	10MR			L	L		1-Jun
		WINTER KILLED									
TA2569	Armenia	10MR	—	60MS	—	5 ⁶	50MS ³	H	H	S	15 May
		5R	30MR	20M	30M			H	H		15 May
		1R	25MR	5R	20M			H	H		18 May
TA2575	Armenia	60MS	—	25MS	—	4 ⁴	30MS ³	H	H	S	16 May
		40MS	—	30MS	—			H	H		16 May
		70MS	—	20MS	—			H	H		17 May

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date			
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June		
TA2581	Georgia	60MS	—	10M	—	4 ⁶	30S ³	H	H	S	15 May		
		20M	30M	10M	15M			H	H		14 May		
		50MS	30MS	20MS	20MS			H	H		18 May		
TA10069	Afghanistan	60MS	—	40M	—	3 ⁶	40S ³	H	H	S	14 May		
		40MS	—	30MS	—			H	H		15 May		
		50MS	—	40MS	—			H	H		17 May		
TA10080	Armenia	60MS	—	30MS	—	3 ⁴	30MS ³	H	H	S	24 May		
		10MS	—	50MS	—			H	H		15 May		
		60MS	—	20MS	—			H	H		17 May		
TA10087	Azerbaijan	20MR	30M	20MR	20MR	4 ⁶	30M ³	M	H	R	13 May		
		20M	30M	10M	20M			M	H		15 May		
		10MS	—	5M	—			L	H		17 May		
TA10088	Azerbaijan	20MR	20MR	5R	10MR	4 ³	20M ³	M	H	S	13 May		
		5R	30MR	1R	10MR			M	H		13 May		
		5MR	30M	5MR	15MR			M	H		14 May		
TA10089	Azerbaijan	20M	40MS	5R	5MR	3 ⁵	5R ³	M	M	S	30 May		
		1R	20M	5R	5R			L	L		2-Jun		
		5MR	40MS	1R	15M			M	M		29 May		
TA10090	Azerbaijan	5R	15MR	15MR	20MR	3 ⁵	25MR ³	M	M	S	31 May		
		10MR	25MR	1MR	15MR			L	L		31 May		
		10R	5R	1R	5R			L	L		2-Jun		
TA10104	Georgia	30MS	35MS	15MS	20MS	2 ⁶	70S ³	M	M	S	29 May		
		10MR	30M	5MR	25M			M	M		30 May		
		30MS	30M	5M	20MS			M	M		1-Jun		
TA10105	Georgia	10R	20MR	5R	15MR	2 ²	50S ²	M	M	S	30 May		
		10MR	25MR	5MR	10MR			M	M		22 May		
		—	—	—	—			—	—		18 May		
TA10108	Tajikistan	30MS	—	40MS	—	7 ⁵	50S ³	H	H	S	9 May		
		WINTER KILLED											
		WINTER KILLED											
TA10113	Turkmenistan	70S	—	20MS	—	7 ⁴	50S ³	M	H	S	14 May		
		70S	—	20MS	—			H	H		10 May		
		50MS	—	20M	—			H	H		14 May		
TA10115	Turkmenistan	40MS	—	40MS	—	6 ⁴	20MS ³	H	H	S	15 May		
		20MS	—	40MS	—			H	H		11 May		
		15MS	—	40MS	—			H	H		15 May		
TA10116	Turkmenistan	20M	30M	30M	30M	3 ²	30M ³	H	H	S	14 May		
		10M	30M	20M	25M			H	H		11 May		
		5R	35MR	10R	20MR			H	H		14 May		
TA10124	Uzbekistan	20M	20M	5MR	15MR	3 ⁵	20R ³	M	M	S	28 May		
		15R	30MR	10R	15MR			M	M		13 May		
		5R	25MR	1R	15M			M	M		22 May		
TA10130	Armenia	5R	30MS	15MR	15MR	4 ⁶	40MR ³	M	M	R	31 May		
		5R	20M	1R	5MR			L	L		1-Jun		
		25MS	25MS	1R	15MR			L	L		2-Jun		

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ID / accession number	Country of origin	Leaf rust		Stripe rust				BYDV		Hessian fly	Heading date
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May	8 June		
TA10132	Armenia	20MS	40MS	30MS	30MS	6 ⁶	40MS ³	M	H	S	29 May
		20MS	30MS	10MS	25MS			M	H		16 May
		30MS	25MS	10MS	15MR			L	M		22 May
TA10136	PR China	20M	30M	5MR	20MR	5 ¹	25MS ²	M	L	S	16 May
		15MR	25MR	5R	10R			M	M		24 May
		5MR	30MR	1R	20MR			M	M		16 May
TA10140	PR China	5M	—	60S	—	6 ⁶	40M ²	H	H	S	10 May
		5M	—	15MS	—			H	H		10 May
		5MR	—	70S	—			H	H		12 May
TA10142	Syrian Arab Republic	1R	25MR	30MS	35MS	5 ⁶	30M ³	L	H	R	11 May
		1R	—	40MS	—			M	H		9 May
		1R	25M	40MS	40MS			L	H		11 May
TA10145	Syrian Arab Republic	25MS	—	30MS	—	5 ⁶	60MS ³	H	H	S	11 May
		40MS	—	20MS	—			H	H		10 May
		30MS	—	10MS	—			H	H		9 May
TA10156	Tajikistan	5MR	—	15MR	—	2 ⁶	30MR ³	H	H	S	9 May
		30MS	—	20MS	—			H	H		10 May
		15MS	—	10R	—			H	H		9 May
TA10158	Tajikistan	25MS	—	30MS	—	3 ³	10MR ³	H	H	S	11 May
		30MS	—	30MS	—			H	H		10 May
		30MS	—	40MS	—			H	H		12 May
TA10160	Turkmenistan	20MR	30MR	15M	15M	5 ⁵	40MS ³	H	H	S	12 May
		10M	20M	20M	30M			H	H		11 May
		10M	—	25MS	—			H	H		11 May
TA10168	Turkmenistan	20MR	25MR	15MR	15MR	6 ³	20M ³	H	H	S	11 May
		20M	—	15MS	—			H	H		10 May
		1R	30M	1R	20MR			M	H		13 May
TA10172	Turkmenistan	WINTER KILLED				2 ⁵	50MS ²			S	
		WINTER KILLED									
		10MR	—	30MS	—			H	H		12 May
TA10174	Turkmenistan	5MR	—	60S	—	6 ⁵	50MS ²	M	H	S	9 May
		WINTER KILLED									
		10MR	—	50MS	—			H	H		10 May
TA10176	Turkmenistan	WINTER KILLED				6 ⁶	60MS ³			S	
		20M	30MS	20M	30M			H	H		13 May
		10MS	—	30MS	—			H	H		13 May
TA10177	Turkmenistan	10MR	30MR	5M	20MR	6 ⁴	40M ³	M	H	S	11 May
		10MR	30MR	5MR	15M			M	H		11 May
		25M	20M	20M	20M			H	H		12 May
TA10185	Turkmenistan	WINTER KILLED				7 ⁶	40MS ³			S	
		WINTER KILLED									
		5M	—	1R	—			M	—		13 May
TA10187	Turkmenistan	20MR	35MR	15R	15MR	2 ⁴	10R ³	H	H	S	16 May
		WINTER KILLED									
		5MR	25MR	5MR	15MR			M	H		18 May

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ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date	
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June
TA10192	Uzbekistan	5MR	—	50MS	—	6 ⁵	40S ³	H	H	S	13 May
		10MR	—	30MS	—			H	H		13 May
		30M	—	40MS	—			H	H		12 May
TA10197	Uzbekistan	30M	40MS	25M	30M	3 ³	25MS ³	M	H	S	30 May
		30MS	40MS	20MS	20MS			H	H		17 May
		60MS	40MS	25MS	25M			M	H		28 May
TA10210	Uzbekistan	40MR	40MS	30MR	30M	2 ⁴	10MR ³	M	H	S	16 May
		WINTER KILLED						H	H		S
TA10211	Uzbekistan	30MR	—	10MR	—	3 ⁵	50MS ³			H	
		20M	—	40MS	—			H	H	9 May	
		25MS	—	40MS	—			H	H	12 May	
TA10292	Tajikistan	20M	20M	5MR	15MR	5 ⁶	20MS ³	M	M	S	29 May
		20M	35M	1MR	10MR			H	H		27 May
		10MR	30M	5MR	15MR			H	H		30 May
TA10296	Tajikistan	WINTER KILLED				2 ⁶	15M ²			S	
		50MS	—	20MS	—			H	H		10 May
		20MS	—	25MS	—			H	H		11 May
TA10303	Tajikistan	WINTER KILLED				2 ³	50MS ³			S	
		30MS	—	40MS	—			M	H		14 May
		20MS	—	25MS	—			H	H		12 May
TA10308	Tajikistan	40MS	50S	30M	30M	4 ⁶	30MS ³	H	H	S	22 May
		20MS	30S	30M	30M			H	H		16 May
		30M	30M	40MS	20MR			H	H		22 May
TA10309	Tajikistan	30MS	40MS	20M	20M	1 ⁶	40MS ³	H		S	16 May
		30MS	30MS	25MS	25MS			M	H		16 May
		WINTER KILLED									
TA10316	Tajikistan	—	—	—	—	3 ⁶	40M ³	—	—	S	12 May
		30MS	—	50MS	—			H	H		10 May
		40MS	—	30MS	—			H	H		12 May
TA10323	Tajikistan	40MS	—	20M	—	3 ⁶	15M ³	H	H	S	12 May
		40MS	—	10MS	—			M	H		10 May
		40MS	—	20MS	—			H	H		13 May
TA10327	Tajikistan	60MS	—	40MS	—	7 ⁴	40MS ³	H	H	S	11 May
		30MS	—	20M	—			M	H		13 May
		30M	30MS	10MR	20M			H	H		15 May
TA10330	Tajikistan	50MS	—	20MS	—	1 ²	30MS ²	H	H	S	10 May
		60S	—	20MS	—			H	H		9 May
		30MS	—	30MS	—			H	H		13 May
TA10417	Unknown	5MR	30MR	10MR	15MR	4 ⁶	10MR ³	L	M	15/2	14 May
		10MR	25M	5R	15MR			L	M		13 May
		10M	30M	5MR	20MR			M	H		18 May
TA10918	Georgia	5R	20MR	20M	20MS	4 ⁶	50MS ³	M	H	S	15 May
		10M	35M	20M	20M			H	H		17 May
		10MR	30MR	5R	15MR			M	H		16 May

Table 1. Data from the set of *Aegilops tauschii* evaluated for disease severity in the field, Manhattan, KS, during the 2014–15 crop season, for field resistance to leaf (Lr) and stripe (Yr) rust and barley yellow dwarf virus (BYDV). Heading date also was recorded. Leaf and stripe rusts were evaluated at two dates on the Cobb scale, where a number indicating the percent of leaf area affected is followed by a letter designation, R = resistant flecks or very small pustules, MR = moderately resistant small pustules, M = moderate small to medium size pustules, MS = moderately susceptible medium to large pustules, and S = susceptible with large pustules. Rating of the leaves with BYDV symptoms was 0 = no visible signs of infection, L = low infection with 10% or less of the leaf area with visible symptoms, M = moderate infection with up to 40% of the leaf area with visible symptoms, and H = high infection with over 40% of the leaf area showing symptoms. — = no test. Seedling and adult-plant stripe rust reactions were scored in the greenhouse; the superscript indicates the number of plants scored; seedling test is a 0 to 9 scale with 1–3 resistant, 4–6 intermediate, and 7–9 susceptible; adult-plant reaction also used the Cobb scale; 0 = immune/no infection observed. Hessian Fly scored as R = resistant or S = susceptible; segregating lines given as number of resistant plants/number of susceptible plants.

ID / accession number	Country of origin	Leaf rust		Stripe rust			BYDV		Hessian fly	Heading date	
		27 May	8 June	27 May	8 June	Seedling	Adult	27 May			8 June
TA10921	Georgia	10R	15MR	20M	20M	4 ⁵	60MS ³	M	M	R	30 May
		1R	20MR	20M	20M			M	M		28 May
		5MR	20MR	1R	20MR			M	M		30 May
TA10922	Georgia	10MR	10MR	15MR	15MR	6 ⁵	30MS ³	H	H	S	16 May
		5R	20MR	1R	5MR			M	M		17 May
		10MR	30MR	5MR	25MR			H	H		17 May
TA10923	Georgia	1R	5R	5R	5R	4 ⁵	5R ³	L	L	4/8	15 May
		5R	20MR	1R	5R			L	L		22 May
		1R	15MR	1R	5R			L	L		2-Jun
TA10926	Georgia	10R	10R	5R	10R	4 ⁶	20M ³	L	L	R	1-Jun
		5MR	15MR	20M	30M			L	L		29 May
		20M	20MS	25M	25M			M	M		1-Jun
TA10929	Georgia	10M	30M	10MR	15MR	4 ⁵	20MS ³	M	M	10/3	31 May
		10MR	25MS	1R	20MS			M	M		30 May
		40MS	40MS	20MS	20MS			M	M		31 May
TA10930	Georgia	30M	—	5MR	—	5 ⁶	30M ³	M	—	R	16 May
		10M	20M	1R	15MR			L	L		30 May
		40MS	40MS	20MS	20MS			L	L		17 May
TA10940	Azerbaijan	WINTER KILLED				3 ⁶	20MR ²			R	
		20MS	20MS	5R	10MR			L	M		1-Jun
		10MR	30MS	1R	5MR			L	L		2-Jun
TA10943	Azerbaijan	10MR	35MR	15MR	15MR	3 ⁶	35M ²	M	M	S	15 May
		20M	30M	5MR	15MR			L	M		16 May
		10R	35MR	5R	15MR			M	H		18 May
TA10944	Azerbaijan	WINTER KILLED				3 ⁵	15MR ³			S	
		40M	50M	20MS	20MS			M	M		1-Jun
		5MR	30MR	1R	20MR			L	M		1-Jun
TA10949	Azerbaijan	WINTER KILLED				5 ⁶	25M ²			S	
		5R	10MR	1R	5MR			L	M		18 May
		5R	30MR	5R	15MR			L	M		29 May
TA10952	Azerbaijan	WINTER KILLED				1 ⁵	20MR ³			5/7	
		10MS	15MS	5MR	20MS			L	M		22 May
		WINTER KILLED									
TA10954	Azerbaijan	10M	—	60S	—	7 ⁵	40MS ³	H	H	8/3	16 May
		10MR	25MR	30M	30M			H	H		16 May
		15M	—	30MS	—			H	H		17 May
TA10957	Azerbaijan	50MS	—	40MS	—	6 ³	70S ³	H	H	2/10	16 May
		30MS	30MS	20MS	20MS			H	H		17 May
		40MS	—	30MS	—			H	H		17 May
TA10960	Azerbaijan	40MS	—	40MS	—	6 ⁶	30MS ³	H	H	9/2	15 May
		60MS	—	30MS	—			H	H		15 May
		40MS	—	25MS	—			H	H		14 May

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