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Resistance in Azerbaijani durum and bread wheat accessions to leaf and stem rust.

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World food security will depend on increased production of cereal crops — wheat, maize, barley, and rice. Of these, wheat is of greater importance, in terms of tonnage if not in financial value. One significant constraint to increased wheat production is the variety of rust diseases attacking this crop. Cereal rusts have no doubt been present and evolving during domestication of cereal crops as a major segment of agriculture. Kislev reported archaeological evidence of Puccinia graminis on wheat lemma fragments dated at 1400-1200 B.C. Savile and Urban reviewed the evolution of cereal rusts relative to human-guided evolution of cereal crops. Sources of resistance to these diseases are known, and have been utilized by wheat breeders for a long time. Zhukovsky (1959, 1961) postulated that the home of wheat is Transcaucasia, the central and western parts of Asia Minor, the eastern Mediterranean areas, and the western part of Iran. These regions abound in endemic wild and cultivated wheat and store the variation potential of the genera *Triticum*, *Aegilops*, and *Secale*. Vavilov (1939) maintained that in the mentioned regions there is the world's richest concentration of wild relatives of small grains. Azerbaijan is also one of the primary gene centres of speciation of the genus Triticum. Zhukovsky (1961) and Vavilov (1939) also ascertained the epicenters of wheat are also the homeland of the most destructive wheat rust parasites, *Puccinia triticina*, *P. striiformis*, and *P. graminis*. Therefore the screening for resistance genes to biotic and abiotic stresses in wheat germplasm available in centers of origin is of paramount importance.

Materials and methods. For this study, 121 durum and bread wheat accessions representing different botanical varieties (germplasm) and differing for some morphological traits (spike, awn and seed color, and hairiness) and 36 modern Azerbaijani durum and bread wheat varieties from the Azerbaijan Genebank were studied (Table 1, p. 65).

Phenotype screening. Seedlings were grown in '20 x 20 x 5'-cm aluminum pans in Metromix 360, a peat/perlite/bark ash growing mix, with 30 entries of five to six seedlings each. Each pan contained the cultivar Morocco as a susceptible control. Plants were grown in the greenhouse at 20±4°C and ambient light. Spores were thawed and heat-shocked for 6 min in a water bath at 42°C just prior to use. Spores were suspended in Soltrol 170 isoparaffin oil at a concentration of approximately 5×10^6/mL and sprayed onto seedlings at the two-leaf stage. The oil was allowed to evaporate for at least 10 min, and then plants were placed in a dew chamber at 20±1°C with 100% relative humidity in the dark for approximately 16 hours. For stem rust, the dew chamber was illuminated for the last hour to stimulate infection. Plants were moved to a growth chamber at 20±1°C with a 16 hour photoperiod and light intensity of 300–400 μmol/m^2/sec for symptom development. Infection types (ITs) were recorded using the Stakman 0 to 4 scale at 12 days (leaf rust) or 14 days (stem rust) post-inoculation. Leaf rust races BBBDB (avirulence – 1, 2a, 2c, 3, 9, 16, 24, 26, 3ka, 11, 17, 30, B, 10, 18, 21, 28, 39, 42 / virulence – 14a), MFBJG (avirulence – 2a, 2c, 9, 16, 3ka, 11, 17, 30, B, 18, 21, 39, 42 / virulence – 1, 3, 24, 26, 10, 14a, 28), TTRSD (avirulence – 17, 18, 21, 28, 42 / virulence - 1, 2a, 2c, 3, 9, 16, 24, 26, 3ka, 11, 30, B, 10, 14a, 39), and MRDSD (avirulence – 2a, 2c, 24, 3ka, 11, 30, 18, 21, 28, 42 / virulence – 1, 3, 9, 16, 26, 17, B, 10, 14a, 39) were used. Plants were inoculated with stem rust races MCCFC (avirulence – 21, 9e, 11, 6, 8a, 36, 9b, 30, 9a, 9d, 24, 31, 38 / virulence – 5, 7b, 9g, 17, 10, Tmp, McN), TPMKC (avirulence – 6, 9b, 30, 9a, 24, 31, 38 / virulence – 5, 21, 9e, 7b, 11, 8a, 9g, 36, 17, 9d, 10, Tmp, McN) and RKQQC (avirulence – 9e, 11, 30, 17, 10, Tmp, 24, 31, 38 / virulence – 5, 21, 7b, 6, 8a, 9g, 36, 9b, 9a, 9d, McN).

Table 1. Characteristics of the *Triticum turgidum* subsp. *durum* and *T. aestivum* subsp. *aestivum* lines used in the study.

Number of lines	Variety	Spike color	Awn color	Seed color	Hairiness	% low IT	
						leaf rust	stem rust
***T. turdigum* subsp. *durum* accessions**							
14	v. *leucurum*	white	white	white	absent	86	21
1	v. *affine*	white	white	red	absent	100	0
9	v. *leucomelan*	white	black	white	absent	44	66
5	v. *melanopus*	white	black	white	present	40	40
2	v. *reichenbachii*	white	black	red	absent	100	100
11	v. *hordeiforme*	red	red	white	absent	45	18
3	v. *murciense*	red	red	red	absent	33	66
6	v. *apulicum*	red	black	white	present	17	17
3	v. *erytromelan*	red	black	white	absent	0	2
1	v. *niloticum*	red	black	red	present	1	0
1	v. *libycum*	black	black	red	present	1	1
2	v. *boeffi*	black/white background	black	white	present	100	100
2	v. *alboprovinchiale*	black/white background	black	white	absent	50	0
2	v. *coerulescens*	black/red background	black	white	present	0	0
2	v. *obscurum*	black/red background	black	white	absent	0	0
***T. aestivum* subsp. *aestivum* accessions**							
5	v. *graecum*	white	white	white	absent	0	100
2	v. *meridionale*	white	white	white	present	50	50
7	v. *erythrospermum*	white	white	red	absent	14	71
3	v. *hostianum*	white	white	red	present	0	100
5	v. *albidum*	white	awnless	white	absent	20	80
6	v. *lutescens*	white	awnless	red	absent	50	100
1	v. *velutinum*	white	awnless	red	present	0	50
2	v. *triticum*	red	red	white	present	0	100
4	v. *barbarossa*	red	red	red	present	0	100
9	v. *ferrugineum*	red	red	red	absent	0	89
5	v. *alborubrum*	red	awnless	white	absent	0	20
7	v. *milturum*	red	awnless	red	absent	0	71
1	v. *leucospermum*	white	awnless	white	present	0	50
5	v. *graecum*	white	white	white	absent	0	100
2	v. *meridionale*	white	white	white	present	50	50

Genotype screening. DNA extraction from young leaves was done using a BioSprint96 robot, and 16 markers were used for screening for 16 resistance genes. Fragment analysis was used an ABI DNA 3730 analyzer. A (+) and (–) control was used for each marker, and the results were analyzed by GeneMarker software.

Phenotyping results. *Leaf rust*. Eighteen of 82 durum wheat accessions were resistant to leaf rust, 23 were moderately resistant, and 41 were susceptible. A majority of the resistant accessions (61%) belonged to var. leucurum, i.e., they had white spikes, awns, and seed, and the spikes lacked hair. White spikes were observed in 83.3% of resistant genotypes. Moreover, among the 23 moderately resistant genotypes, 14 (60.9%) also had white spikes. On the contrary, in 70.7% of the 41 wheat genotypes that were rated susceptible, the spike color was red. Therefore, using leucurum varieties and/or white spikes may accelerate breeding for leaf rust resistance. Most bread wheat accessions (61) are susceptible to leaf rust; we have selected four highly resistant and nine moderately resistant bread wheat accessions.

Stem rust. In contrast to leaf rust, a majority of bread wheats were resistant or moderately resistant to stem rust. Our results showed that 29 of the bread wheats were highly resistant and 33 were moderately resistant to stem rust. Only 13 bread wheat genotypes were classified as susceptible. Among the durum wheats, 14 were resistant and 12 moderately resistant to stem rust. Material identified as leaf and stem rust resistant in these experiments will be grouped into germplasm pools and incorporated into our breeding program as potential sources of resistance or tested for yield performance in target environments.

Genotyping results. Sixteen markers were used to screen for 16 genes (*Lr21*, *Lr24*/*Sr24*, *Lr34*/*Yr18*, *Lr37*/*Sr38*/*Yr17*, *Lr39*, *Lr46*/*Yr29*, *Lr50*, *Sr36*, HGPC/*Yr36*, T1RS·1BL (*Lr26*/*Sr31*/*Yr9*), and T1RS·1AL (*Sr1A.1R*)). *Lr34* was recorded in 12 bread wheat accessions, most of which (eight accessions) were highly resistant only to the BBBDB race. *Lr46* was found in six durum wheats and 55 bread wheats; most were susceptible to leaf rust at the seedling stage. Results of the molecular screening revealed the presence of the T1RS·1BL rye translocation in nine bread wheat accessions (Fig. 1); all were highly resistant to stem rust and most were highly or moderately resistant to leaf rust.

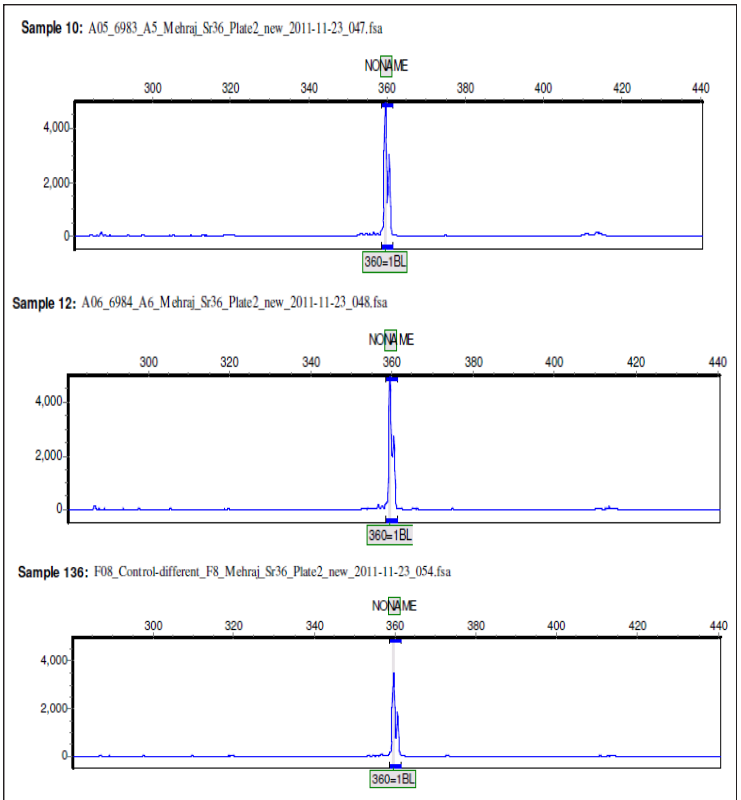

Fig. 1. T1RS·1BL translocation in two bread wheat accessions (top two) and in the control (bottom).

Conclusions. Bread wheats are more resistant to stem rust than to leaf rust. Compared with bread wheats, durum wheats are resistant to leaf rust and susceptible to stem rust. Additional tests are planned with durum-specific races of leaf rust. Spike color and leaf rust resistance are correlated in durum wheats. T1RS·1BL translocation carrying *Lr26* and *Sr31* has an important role in rust resistance in this collection of bread wheats. All accessions with T1RS·1BL have white spikes, seeds and awns. *Lr34*/*Yr18* was present in both old and new bread wheat cultivars from Azerbaijan but not the durums. Highly resistant accessions can be useful in breeding programs.

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References.

Vavilov NI. 1939. Selekstia ustoichovykh sortov kak osnovnoi metod borby s rshavchinoi (Selection of resistant varieties as a basic method for rust control). *In:* Rshavchina Zernovykh Kultur (Rusts of Cereal Crops) (Naumov NZ and Zubareva AK Eds), pp. 3-20. Selkhozgyz, Moscow.

Zhukovsky PM. 1965. Main gene centers of cultivated plants and their wild relatives within the territory of the U.S.S.R. Euphytica 14:177-188.

Zhukovsky PM. 1959. Interrelation between host and parasite in their origin and beyond it. Vestn. S-kh. Nauki (Moscow) 4(6), 25-34 (in Russian, with English summary).