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PLANT INDUSTRY

Evaluation of a Set of Introgressive Spring Bread Wheat Lines Developed for Resistance to Stem Rust Race Ug99 + Sr24 (TTKST) at the Southeast Agricultural Research Institute

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Abstract—Under conditions of a natural stem rust epiphytotic caused by *Puccinia graminis* f. sp. *tritici* race Ug99 + Sr24 (TTKST), a set of introgressive spring bread wheat lines developed at the Southeast Agricultural Research Institute was evaluated at KARI's international stem rust screening nursery (Kenya). New sources of resistance to the pathogen and effective resistance genes have been revealed.

Keywords: spring bread wheat, introgressive lines, resistance to Ug99 + Sr24 (TTKST)

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Stem rust, caused by the fungus *Puccinia graminis* f. sp. *tritici*, is one of the most harmful and dangerous bread wheat diseases. In the past 40 years it has been possible to suppress epiphytotics of this fungus in world wheat production thanks to genetic protection and primarily to gene *Sr31*, which, however, created a pandemic situation. With the emergence in 1999 in Uganda of race Ug99, or TTKSK according to the North American nomenclature [1], a stem rust pandemic encompassed many African and Middle Eastern countries [2]. A real threat developed for Russia because this race with certain changes was noted in Turkey and in northwestern Iran [3]; furthermore, it is evolving toward greater virulence. Thus, gene *Sr24* previously resistant to it was overcome in 2006 [4], race Ug99 + Sr24 (TTKST) emerged, gene *Sr36* was also overcome, as a result, race Ug99 + Sr36 (TTTSK) appeared [5], and this process is continuing. For protection against Ug99, Dr. Borlaug (United States) in 2005 created an international cooperation of scientists under the aegis of FAO—the Borlaug Global Rust Initiative (BGRI). The most widespread and annual constant appearance of *P. graminis* f. sp. *tritici* races are noted in Kenya, where, on the initiative of CIMMYT scientists, genetic bread wheat sources from institutes and centers of various countries began to be evaluated in 2005 in the small town of Njoro at facilities of the Kenyan Agricultural Research Institute (KARI).

The purpose of the present investigation was to evaluate the resistance of a set of introgressive spring bread wheat lines developed at the Southeast Agricultural Research Institute (NIISKhYuV) under conditions of the wheat stem rust resistance screening nurseries in Njoro (Kenya) in 2010 and to reveal genetic sources of resistance to this pathogen.

METHOD

The material, numbering 58 introgressive spring bread wheat lines developed at NIISKhYuV, was sown in the fall of 2009 at KARI's stem rust resistance screening nursery. The lines were sown as two-row plots 1 m long, and perpendicular to them were rows of a mixture of susceptible lines with genes *Sr31* and *Sr24*. Evaluation was carried out twice according to a modified Cobb scale and host response to introduction of the pathogen: R = resistant, 1 point; TR = trace, single pustules, necrotic spots, resistant, 1 point; MR = moderately resistant, 2 points; MS = moderately susceptible, 2–3 points; M = intermediate between resistant and susceptible, 2–3 points; MSS = from moderately susceptible to susceptible, 4 points; TS = trace susceptible, single pustules, susceptible type, 3–4 points; S = susceptible, 4 points; different evaluations of the same line mean a mixture or splitting inside it. The growing season was humid, 700 mm of rain fell from December 2009 through April 2010. The infection load was very high, the degree of infection of control susceptible rows reached 100% and they practically died. Evaluations were made on March 17 and April 20.

RESULTS AND DISCUSSION

Introgressive lines are mainly protected by gene *Sr25* and combinations with it: *Sr25* + *Sr31, Sr25* +

Resistance of a set of introgressive spring bread wheat lines to Ug99 + Sr24 (TTKST)

No. of line	Pedigree	*Sr*-genes	Ug99 + Sr24 (TTKST)	
			17.03.10	20.04.10
Standard		31.24		100 S
6251	Saratovskay 29/*T. persicum*//*T. dicoccum* (1)	?	5R MR	5RMR
6252	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa* (1)	?	TR	5R
6253	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa*(2)	?	5R MR	10R
6254	Saratovskay 29/*T. persicum*//*T. dicoccum* (2)	?	5R MR	5R
6255	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa* (1)	?	TR	1R
6256	Saratovskay 29/*T. persicum*//*T. dicoccum* (3)	–/?	40S	80S, 10RMR
6258	Saratovskay 58/*T. persicum*//*Lr9* (1)	?	10R MR	20R
6259	Saratovskay 58/*T. persicum*//*Lr9* (2)	?	5R	20R
6261	Saratovskay 58/*T. persicum*//*Lr19*	?	TR	15R
6262	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa*	?	5R	20RMR
6263	Saratovskay 29//*T. dicoccum*/*Ae. squarrosa* (1)	?	5R	10R
6264	Saratovskay 55/*T. persicum*//*T. dicoccum* (1)	?	5R	10R
6265	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa* (2)	?	TR	5R
6266	Saratovskay 58//*T. dicoccum*/*Ae. squarrosa* (3)	?	5R	5R
6267	Saratovskay 29/*T. persicum*//*Lr9*	?	TR	5R
6271	Saratovskay 55/*T. dicoccum* (2)	?	10R MR	15RMR
6272	Eritrospermum 149//*T. dicoccum*/*Ae. squarrosa*	?	5R	10R
6273	Saratovskay 29/*T. persicum*//*T. dicoccum*/*Ae. squarrosa* (4)	?	5R	20R
6274	Saratovskay 55/*T. persicum*//*T. dicoccum*	?	10R MR	20R
L485	L503*5/Tc*Lr26*//L505	25 + 31	TR	10M
L403	L505*2/Proch//Belyanka	?	10MS	15M
L609	L161/L2032//Belyanka*2//C60	?	10MSS	20MSS
L496	Ersh.32/L503//S58//Prochorovka//Dobrynya	?	20MSS	20MSS
L497	L503*6/Tc*Lr26*	25 + 31	5R MR	5RMR
L583	L583*2/Tc*Lr24*//Dobrynya*2/4/Belyanka	24 + 25	5R	5R
L681	Yugo-Vostochnaya 3/Belyanka	?	10MSS	20MSS
L484	L505/3/L503*7//Tc*Lr26*	?	10M	20MSS
L405	L2033/Belyanka//L2032/Prochorovka	?	10MSS	25MSS
L580	L2032/S60//Prochorovka*2//S58	?	15S	20MSS
L200	L505//L503//L583/Kukushka//L505	25 + Kuk	TR	TR
L195	L505*2//L503*2/Kukushka	25 + Kuk	5MSS	15MR
L490	L503/Multy Lr6R	?	5MSS	20MSS
L9	L2032*3/Thatcher*Lr9*	?	15MSS	15MSS
L199	L528*2/Saratovskaya zolotistaya	25	10MSS	5RMR
L704	Zhigulevskaya/TEPOCA//S58*4/3/L2032	?	15S	20MSS
L13	Dobrynya	25	20S	20RMR
L107	L503*5//Tc*Lr26*/3/L505	–/25 + 31	20MSS	40S, 5R
L105	L503*6//Tc*Lr26*	25 + 31	15MR	15MR
L611	L583*2//Tc*Lr24*	–/25 + 24	10MSS	10MSS,TR
L196	L503*3//Tc*Lr26*/3/L505	25 + 31	15MR	20RMR
L12	L503*6//Tc*Lr26*	25 + 31	15R MR	20RMR
L10	L503	25	TR	10R
L15	Dobrynya *4//Tc*Lr24*	25 + 24	10R MR	20RMR
L610	L2033*2/Curinda 87//L164//Prochorovka	25 + 31	5R MR	5RMR
L300	Dobrynya*3//Tc*Lr23*/3/Belyanka	25	10R MR	10RMR
L652	Prochorovka*2//L222/3/Prochorovka/L164	25 + ?	10R MR	10RMR
L607	L2033*3/Belyanka*2//L164/Prochorovka	25 + ?	5R	5R
L488	L505/Prochorovka//L505	25 + 31	TR	5R
L656	S70/3/L2032*2//Tc*Lr26*	25 + 31	5MR	5RMR
L608	L528/L400	25	TR	10MR
L308	Dobrynya*3//Genaro 8l/3/S58/Belyanka	?	30S	30M
L211	Ludmila/3/S55*2//*T. dics*/4/Sar. zol/Ll64//S55	?	5R MR	15RMR
L651	L2032*4/Curinda87/Belyanka	?	5MSS	15M
L392	L2032/Prochorovka//L2033/Belyanka	?	10MSS	20M
L659	L164/L503//L2032/L400	25	5MSS	15RMR
L701	Dobrynya*3/Tc*Lr23*//Belyanka	–/25	10S	10S, 5R
L699	L2032*4//GEN81	25 + 31	TR	5MR
L310	Dobrynya*2//L164	?	15MSS	20M

Sr24, and *Sr25* + *SrKuk* (table). The effectiveness of gene *Sr25* against Ug99 was kept in all zones of the spread of this race [2]. As is known, gene *Sr25* is linked with the leaf rust resistance gene *Lr19* and is in the T7DS-7DL-7Ae#1L translocation from *Agropyron elongatum* Host. Extensive investigations into the use of gene *Lr19* in leaf rust protection were carried out at NIISKhYuV. However, the leaf rust resistance gene has been overcome since 1994 [6]. Therefore, for effective protection from the pathogen, lines were obtained with a combination of genes *Lr19* + *Lr26*; the latter is linked with gene *Sr31* in the 1BL-1RS translocation from *Secale cereale* L. Also obtained were combinations *Lr19* + *Lr24; Lr24* is linked with gene *Sr24* in the T3DS.3DL-3Ae#1L translocation from *Aegilops elongatum* Host. and *Lr19* + LrKuk; the latter is linked with *SrKuk* in the 2D-2S translocation from *Aegilops speltoides* Tausch [7, 8]. Thus, lines were obtained with resistance to both leaf and stem rust, including to Ug99 + Sr24 (TTKST). Interspecific spring wheat lines with resistance sources *T. persicum*, *T. dicoccum*, and *Ae. squarrosa*, which, in addition to this have resistance to leaf rust and loose smut, and line L211, obtained with the participation of a number of hard wheat cultivars—Lyudmila, Saratovskaya Zolotistaya, Saratovskaya 57, as well as *T. dicoccoides* (Koern. ex Aschers. et Graebn.) Schweinf. (k-26118), can be called new sources of Ug99 resistance genes.

It should be noted that protection from *Puccinia graminis* f. sp. *tritici* race Ug99 + Sr24 (TTKST) in the Volga region is realistic only for a set of spring bread wheat cultivars with the *Agropyron* T7DS-7DL-7Ae#1L translocation with gene *Sr25*—L503, L505, Samsar, Dobrynya, Yuliya, Volgoural'skaya, and Lebedushka. However, as is known, it is dangerous and not promising to narrow protection from the pathogen to one gene. Especially as cultivar Misir 1 containing genes *Sr2* + *Sr25* was obtained and is being propagated in Iran [9]; consequently, we can expect overcoming of the combination of these *Sr*-genes and the occurrence of a new pathotype of the pathogen. In connection with this, breeding cultivars resistant to race Ug99 in advance is necessary.

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