Tilletia caries and Resistance of Wheat to this Pathogen in Ukraine

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Abstract: *Tilletia caries* Tul. is the main pathogen for common bunt in Ukraine. Most of the wheat varieties grown in the country are susceptible to the disease. Some of the varieties are very seriously affected by the disease that makes it necessary to treat the seed with fungicides. At Plant Breeding and Genetics Institute wheat breeding for resistance to diseases, including common bunt, has been carried out for a long time and especially intensively and purposefully it has been done during the last 12 years. It has been found that in Ukraine the population of *Tilletia caries* (DC.) Tul. consists of 12 races. Among domestic and foreign wheat varieties some varieties were found to be resistant. Complex resistance to phytopathogens was found to be the best in winter bread wheat lines derived from crosses with *Aegilops ventricosa* and *Triticum erebuni.* On the basis of these lines the initial breeding material and the first resistant wheat varieties have been developed. The varieties are being tested in an institute competitive trial.

Keywords: wheat; common bunt; *Bt*-genes resistance; varieties; races

In Ukraine common bunt is the most spread and damageous among all species of wheat Ustilaginales (Peresipkin 1989; Dubinina & Baranovskaya 2002; Rachenko 2003; Babayants *et al.* 2004). It is spread in all areas of the country and its predominant pathogen is *Tilletia caries*. *Tilletia laevis* occurred very rarely and is not important as infestant in wheat.

The majority of wheat varieties cultivated in Ukraine are to different degree susceptible to common bunt (Dubinina *et al.* 2004). Some of them can be affected very badly, and that causes necessity of seed treatment with fungicides. However this important agronomical measure is not always carried out for objective and subjective reasons.

At Plant Breeding and Genetics Institute the wheat breeding for resistance to *Ustilaginales* has been carried out for a long time (Geshele 1964, 1978). It has purposefully and intensively been made during the last 12 years.

MATERIAL AND METHODS

The winter bread wheat lines from interspecific hybridization, varieties and lines with known Bt-genes were studied. The identification of common bunt races, degree of resistance to the pathogen in wheat varieties and lines was conducted by conventional methods (Babayants *et al.* 1988). Genetic base of resistance to common bunt was investigated by hybridological analysis (Lobashev 1967).

RESULTS AND DISCUSSION

We investigated racial structure of *Tilletia caries*. It was established that in Ukraine the population of the pathogen consists of twelve races (Babayants *et al.* 1988). Seven of them are well-known and are included in the conventional international key of Hoffmann and Metzger (1976). They are races T-1, T-2, T-3, T-7, T-9, T-17 and T-20 (Table 1).

Table 1. Races of *Tilletia caries* in Ukraine (2001–2005)

Race	Varieties – differentiators														
	Sel. 2092	Sel.1102	Ridit	CI 1558	Hohenheimer	Rio	Sel.50077	P1173438 × Elgin	Elgin × P1178383	P1178338 × Elgin	Elgin × PI66910	PI 119333	Thule III	Doubbi	Carleton
	Bt1	*Bt2*	*Bt3*	*Bt4*	*Bt5*	*Bt6*	*Bt7*	*Bt8*	*Bt9*	*Bt10*	*Bt11*	*Bt12*	*Bt13*	*Bt14*	*Bt15*
T-1	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R
T-2	S	R	R	R	R	R	S	R	R	R	R	R	R	R	S
T-3	R	S	R	R	R	R	S	R	R	R	R	R	R	R	R
T-7	S	S	R	R	R	R	S	R	R	R	R	R	R	R	R
T-9	R	R	R	R	S	R	S	R	R	R	R	R	R	R	R
T-17	R	R	R	S	R	S	S	R	R	R	R	R	R	R	R
T-20	S	S	R	R	R	R	R	R	R	R	R	R	R	R	R
To-1	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
To-2	S	S	S	R	R	R	R	R	R	R	R	R	R	R	R
To-3	S	S	R	S	R	R	R	R	R	R	R	R	R	R	R
To-4	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R
To-5	S	R	R	S	R	R	S	R	R	R	R	R	R	R	R

The remaining races are not included in the key and they got symbol "To", in which "T" means *Tilletia caries*, "o" – Odessa. Race To-1 is avirulent to all varieties – differentiators, while the remaining races, missing in the key, are virulent to carriers of the following *Bt*-genes: To-2 – *Bt1*, *Bt2* and *Bt3*; To-3 – *Bt1*, *Bt2* and *Bt4*; To-4 – *Bt2*; To-5 – *Bt1*, *Bt4* and *Bt7*. These results show that in the pathogen population virulence to carriers of genes *Bt8–Bt14* is absent. Till now variety Hohenheimer with gene *Bt5* exhibited high resistance. However, the race T-9 affected it considerably and this gene has lost effectiveness for breeding. Race T-7 is basic and its frequency of occurrence from year to year varies from 50% to 70% and more (Geshele 1964). It prevails in all areas of Ukraine, while other races were detected: T-1 – in Kharkov and Cherkassy areas; T-3 – in Kherson and Kiev areas; T-9 and T-17 – in Odessa area; T-20 – in Kharkov and Kherson areas; T-2 – in Odessa area and in Crimea; To-races in Odessa area.

Among wheats of foreign and domestic breeding the resistant lines and varieties were selected. From foreign ones: (PI173438 × Elgin) (*Bt8*), PI 178383 (*Bt9*, *Bt10*), Ranger (*Bt9*, *Bt10*), Jeff (*Bt9*, *Bt10*), Other (*Bt10*), Sel. M69-2073 (*Bt9*), Sel. 6623 (*Bt10*), (Elgin × PI 1669910) (*Bt11*), PI 119333 (*Bt12*), Tulle III (*Bt13*), Doubbi (*Bt14*), F. 900, New Gaines; from domestic ones: Lutescens 6028, Erythrospermum 5221, Rozovskaya 7, Ferrugineum 220/85, Erythrospermum 60-89, Ferrugineum 124-89, Erythrospermum 204/04.

Erythrospermum 5221 has one, and Lutescens 6028 – two *Bt*-genes which derived from *Agropyron* (Baranovskaya *et al.* 2003). The resistance of Ferrugineum 220/85 is controlled by two dominant complementary genes, which derived from *Triticum durum* (Hoffmann & Metzger 1976). The resistance of Erythrospermum 60-89 and Ferrugineum 124-89 is also controlled by two complementary *Bt*-genes origin of which is not established (Novochatka *et al.* 1990). The genes of these lines and varieties are not identical to genes *Bt1–Bt10* and it is the authors' opinion that they are new ones. The genetic basis of resistance of Erythrospermum 204/04 is not established yet.

Table 2. Lines of winter bread wheat resistant to *Tilletia caries*

Line	Origin	*Bt*-genes
1/74-91,5/20-91,5/35-91, 5/55-91	Odesskaya polukarlikovaya × *Aegilops cylindrica* × Odesskaya polukarlikovaya	*1*
4/3-91,4/11-91,5/43-91, 5/81-91,7/31-91,8/2-91, 8/16-91		*2*
27/27-95,9/43-96,9/46-96,	Donskaya polukarlikovaya × *Aegilops variabilis*	*1*
41/46-95	Obriy × *Triticum erebuni*	*1*
26/34-96	Obriy × *Aegilops triaristata*	
39/22-96	Obriy × *Agropyron aelongatum*	
38/66-95,45/61-97	Albatros × Odesskaya polukarlikovaya × Orenburgskaya rannaya	
6/19-96,7/16-96,7/43-96, 7/73-96,42/44-96,31/5-97	Obriy × Odesskaya polukarlikovaya × *Triticum dicoccoides*	
29/49-2000	Donskaya polukarlikovaya × *Aegilops ventricosa*	*1*
3/93-04,12/84-04,12/86-04, 12/92-04	Albatros × *Triticum dicoccoides* × *Triticum tauschii*	

The successful work on introgression of effective genes of resistance to pathogens of bunt, rust of different types, powdery mildew, septoria and fusarium into cultivated varieties of winter bread wheat from *Aegilops*, *Agropyron* and other related species has been done. As a result of interspecific hybridization and repeated selections on artificially infected background, lines of winter bread wheat possessing high resistance to a separate pathogen and to group of them, including *Tilletia caries*, were developed (Table 2).

By group resistance to the phytopathogens the best lines were obtained from crossing with *Aegilops cylindrica*, *Aegilops variabilis*, *Triticum erebuni* and *Triticum tauschii.* Within some of them new high effective *Bt*-genes (Babayants & Dubinina 1990; Babayants *et al.* 1999) were identified using method of hybridological analysis. In line 5/55-91 the molecular marker for *Bt*-gene was found which was localized in chromosome 1B (Babayants *et al.* 2000). This high effective gene derived from *Aegilops cylindrica.*

On the basis of a number of lines with resistance derived from *Aegilops cylindrica* (5/55-91, 7/31-91), *Aegilops variabilis* (27/27-95), *Triticum erebuni* (41/46-95) the initial breeding material and first economic valuable varieties of winter bread wheat resistant to pathogens of common bunt and loose smut were developed. They are also resistant to pathogens of powdery mildew, rust of different types, ear and grain septoria and fusarium. The lines also have good index of grain quality, productivity and winterhardiness. The breeding work was started to develop initial breeding material on the basis of lines from interspecific hybridization with *Triticum tauschii*. As our studies have shown, these lines have effective *Bt*, *Lr*, *Sr*, *Un*-genes, along with number of valuable traits and properties.

Summarizing 12-year researches and breeding work it is necessary to mark that we were able to develop a number of winter bread wheat varieties, possessing group resistance to pathogens of basic diseases of this crop, including *Tilletia caries.*

References

Babayants L.T., Dubinina L.A. (1990): Noviy donor ustoichivosti pshenicy k tverdoy golovne (*Tilletia caries* (DC.) Tul.; *T. levis* Kuehn i ee geneticheskaya osnova. Genetika, **26** (12): 2186–2190.

Babayants L.T. *et al.* (1988): Metodi selekcii i otsenki ustoychivosti pshenici i yachmenay k bolesnaym. Prague, 321.

Babayants L.T., Dubinina L.A., Yshenko G.M. (1999): Geneticheskaya osnova ustoichivosti k vozbuditelu tverdoy golovni (*Tilletia caries* (DC.) Tul. novih liniy pshenici. Zitologiya i genetika, **33** (6): 25–30.

Babayants L.T., Dubinina L.A., Yshenko G.M. (2000): Viyavlenie neallelnich izvestnim genov ustoichivosti k *Tilletia caries* (DC.) Tul. liniy pshenici ot mesh-

vidovoy gibridizacii (*Triticum aestivum* × *Aegilops cylindrica*). Zitologya i genetika, **34** (4): 32–40.

Babayants L.T., Baranovskaya V.L., Dubinina L.A. (2004): Ustoichivost ozimoy pshenici k tverdoy golovne v Ukraine. Zbornik naukovich prac SGI, Odesa, **6**: 254–260.

Baranovskaya V.L., Babayants L.T., Babayants O.V., Dubinina L.O. (2003): Vidovoy ta rasoviy sklad zbudnikiv tverdoy sajki pshenici v Ukraini. Zachist i karantin roslin. Mizvidomchiy tematichniy naucoviy zbirnik, Kiev, **49**: 50–55.

Dubinina L.A., Baranovskaya V.L. (2002): Vidovoy sostav vozbuditeley tverdoy golovni pshenici i sortoustoichivost //Agrarniy visnik Prichornomor'ya, OSCHI, Odesa, **18**: 176–182.

Dubinina L.A., Babayants L.T., Goncharuk N.A., Baranovskaya V.L. (2004): Ustoichivost pshenici i yachmenay k vozbuditelyam golovnevich zabolevaniy. Integrovaniy zachist roslin na pochatku XXI stolittya. Materiali miznarodniy naukovo-praktichnoy konferencii, Kiev, 205–709.

Geshele E.E. (1964): Osnovi fitopathologicheskoy ozenki v selekcii. M. Izd. Kolos, 200.

Geshele E.E. (1978): Osnovi fitopathologicheskoy ozenki v selekcii rasteniy. M. Izd. Kolos, 206.

Hoffmann J.A., Metzger R.J. (1976): Current status of virulence genes and pathogenic races of the wheat bunt fungi in the northwestern USA. Phytopathology, **66**: 657–660.

Lobashev M.E. (1967): Genetica. Izd-vo Leningr. unta, 103–177.

Novochatka V.G., Mochalova L.I., Odinzova I.G. (1990): Novie geni ustoychivosti pshenici k tverdoy i karlikovoy golovne (*Tilletia caries* (DC.) Tul., *T. levis* Kuehn, *T. controversa* Kuehn. Genetika, **26**: 1808–1814.

Peresipkin V.F. (1989): Bolezni zernovich i zernobobovich kultur. K. Urozay, 6–11.

Rachenko L.M. (2003): Tverda sachka ozimoy pshenici ta obgruntuvannya imunologishnich metodiv zachistu. Avtoreferat dissertacii na zdobuttya naukovogo stupenya kandidata silskogospodarskich nauk. Kiev, 1–19.