SOURCES OF RESISTANCE TO BUNT (*TILLETIA* SPP.) IN MODERN SEMIDWARF WINTER WHEAT (*TRITICUM AESTIVUM* L.)

Fraga Oncica[1], Nicolae N. Saulescu[2]

ABSTRACT

Despite availability of efficient chemical control, bunt can still cause important damages, when treatments are not applied, because of economic or ecologic reasons, or treatments are not correct. Genetic resistance is the most convenient way of controlling the disease, as it reduces both costs and environmental impact, but much genetic diversity is needed in order to counteract rapid evolution of virulence. Most sources of resistance have been found in old primitive cultivars that are difficult to use in breeding. This paper presents results of testing semi-dwarf winter wheat lines, obtained by repeatedly crossing sources of known *Bt* genes, or not previously known sources, with modern cultivars, well adapted to the semi-arid conditions of Romanian plains. Winter wheat lines, bred at the National Agricultural Research & Development Institute Fundulea in a special program of breeding for bunt resistance, were tested under artificial inoculation with bunt at the Agricultural Research & Development Station Simnic. Results showed that a large diversity of resistance genes is now available in a modern, semidwarf plant type, much more convenient for use in breeding programs than the original sources of resistance. Possible new sources of resistance were identified among lines selected from crosses involving introgressions from related species (*Triticum monococcum,* Triticale) or exotic parents (Colonias).

Key words: common bunt, resistance, semidwarf wheat.

INTRODUCTION

Common bunt of wheat, produced by two pathogen species (*Tilletia laevis* Kühn and *Tilletia tritici* (Bjerk.) Wint), has been associated with wheat cultivation since the beginning of recorded history (Wilcoxson and Saari, 1996).

Despite availability of efficient chemical control, bunt can still cause important damages, when treatments are not applied, because of economic or ecologic reasons, or treatments are not correct. Field surveys by the Central Phyto-sanitary Quarantine Laboratory found common bunt present in Romania in 29 counties in 2001 and in 11 counties in 2005. Occasionally the degree of attack reached 100%. Organic farming, which prohibits the use of chemicals, might favor an increase of affected areas.

Genetic resistance is the most convenient way of controlling the disease, as it reduces both costs and environmental impact. However, bunt has been known for its high ability to overcome resistance by new, more aggressive races, prompting continuous search for genetic diversity of resistance. On the other hand, most sources of resistance have been found in old primitive cultivars that are difficult to use in breeding.

This paper presents results of testing semidwarf winter wheat lines, obtained by repeatedly crossing sources of known *Bt* genes, or not previously known sources, with modern cultivars, well adapted to the semiarid conditions of Romanian plains.

MATERIAL AND METHODS

Winter wheat lines, bred at the National Agricultural Research & Development Institute Fundulea in a special program of breeding for bunt resistance (Ittu et al., 2001), were tested under artificial inoculation with bunt at the Agricultural Research & Development Station Simnic.

Most lines were obtained by crossing sources of known genes, kindly provided by Dr. R. Metzger (USDA), with winter semidwarf cultivars, adapted to conditions of Romanian plains. Lines with introgressions from related species or genera, and lines selected from crosses with exotic cultivars, were also tested.

Inoculation was done by mixing and shaking common bunt teliospores with seeds in paper envelopes. Five sori were used for 100 grains. Inoculated seeds were planted on one meter long rows in three replications. At maturity, infected spikes (where at least one grain was replaced by

[1] Agricultural Research & Development Station Simnic, 200004 Simnic, Dolj County, Romania
[2] National Agricultural Research & Development Institute Fundulea, 915200 Fundulea, Calarasi County, Romania

bunt balls) were counted and expressed as percentage from total number of spikes.

New lines were progressively introduced for testing, as a result the number of testing years varied between 4 and 2.

RESULTS AND DISCUSSION

Several lines tested for 4 years showed very high resistance under artificial inoculation (Table 1).

Lines F94976G-M2-11, F94978G-M1-51 and F94975G-M1-11 were selected from crosses of gene sources *Bt11*, *Bt13* and *Bt10* with Dropia, presently the most widely grown winter wheat variety in Romania. Lines F95602G-M1-21, F94895G-M1-21 and F94889G-M1-31 were selected after one backcross with the same variety Dropia and involve genes *Bt8*, *Bt12* and *Bt5*. Line F96620G-M4-12 is the result of 5 cycles of crosses, that proved to be necessary to transfer bunt resistance from the Turkish local population PI1783838 to a more adapted and modern background. PI 178383 is known to carry genes *Bt8*, *Bt9* and *Bt10*, but we do not know yet which of these genes confer the resistance of F96620G-M4-12.

Table 1. Results of testing under artificial inoculation with bunt during 2003-2006

No.	Entry name	Genealogy	Infected spikes (%)				
			2003	2004	2005	2006	Average
1	F94976G-M2-11	DROPIA / ***Bt11***	0	0	0	0	0
2	F94978G-M1-51	DROPIA / ***Bt13***	0	0	0	0	0
3	F95602G-M1-21	DROPIA*2 / **R93-233 *(Bt8)***	0	0	0	0	0
4	F94895G-M1-21	DROPIA*2 / ***Bt12***	0	0.6	0	0	0.1
5	F96620G-M4-12	**PI178383**/IULIA//AURA/3/ FL80 /6555W1-1// 508U1-1	1.1	0	0	0	0.3
6	F94975G-M1-11	DROPIA / ***Bt10***	0.9	3.4	0	0	1.1
7	F94889G-M1-31	DROPIA*2 / ***Bt5***	2.5	1.1	1.2	0	1.2
8	F96915G1-1	WGRC23 / DROPIA	0	0	0	0	0
9	DROPIA	Susceptible check	58.8	64.3	59.3	47.9	57.6

Line F96915G1-1, was selected from a cross of the line WGRC23 (a breeding line obtained at Kansas State University Genetic Resource Center carrying an introgression from a *Triticum monococcum* accession PI 355520) with the cultivar Dropia. It is probable that the bunt resistance gene in this line is different from the known genes.

During the period 2004-2006 new lines obtained by further crossing of previously selected resistant lines with newer adapted cultivars (Delabrad, Boema, and Debut) were tested. Low levels of bunt attacks were recorded in these lines, carrying genes *Bt11*, *Bt8*, *Bt5* and at least one of the resistance genes present in PI 178383 (Table 2).

It is highly probable that the small percentage of diseased plants was due to the fact that all these lines were F3 progenies, and the only two cycles of selection were not sufficient to achieve the necessary uniformity.

This explanation is confirmed by the results obtained in 2005 and 2006 with lines from the same crosses (00263G, 00274G, 00281G and 00287G), but with one additional selection, lines that were uniformly resistant (Table 3).

Tests performed in 2005 and 2006 showed high bunt resistance in several other lines for which no known *Bt* genes could be expected to be present. One such line, F00628G34-1, was selected from a cross between a triticale line and wheat. Triticale is known to be bunt resistant, due to its rye genome. Therefore, it is possible that the line F00628G34-1, which also has other traits (powdery mildew and *Seoptoria tritici* resistance) possibly coming from the rye genome, inherited its bunt resistance from rye.

Another resistant line came from a cross of the Brazilian cultivar Colonias with a Romanian breeding line, Bucur. The genealogy of Colonias does not suggest a possible presence of a known *Bt* gene. Further studies should clarify if the resistance gene in this line is different from previously known bunt resistance genes.

Table 2. Results of testing under artificial inoculation with bunt during 2004-2006

No.	Entry name	Genealogy	*Bt* gene	Infected spikes (%)			
				2004	2005	2006	Average
1	F00281G2-1	F94976G-M1/DELABRAD	*Bt11*	0.0	0.0	1.4	0.4
2	F00264G1-1	**PI178383**/IULIA//AURA/3/FL80/4/ Dropia/5/ DEBUT	*Bt8-10*	0.0	0. 0	2.3	0.7
3	F00287G1-1	F95602G-M1/DELABRAD	*Bt8*	1.1	0.0	1.5	0.8
4	F00263G4-1	**PI178383**/IULIA//AURA/3/FL80/4/ Dropia/5/ BOEMA	*Bt8-10*	1.3	0.3	1.3	0.9
5	F00274G2-1	F94889G-M1/DELABRAD	*Bt5*	7.0	0.0	1.2	3.1
6	DROPIA	Susceptible check	none	64.3	59.3	47.9	57.2

Table 3. Results of testing under artificial inoculation with bunt during 2005-2006

No.	Entry name	Genealogy	*Bt* gene	Infected spikes (%)		
				2005	2006	Average
1	F99146G4-111	F7022W1/5/**PI178383**/IULIA//AURA/3/ FL80/4 Dropia /6/ 577U1-106	*Bt8-10*	0	0	0
2	F00263G2-21	**PI178383**/IULIA//AURA/3/FL80/4/ Dropia/5/ Bucur	*Bt8-10*	0	0	0
3	F00274G2-21	F94889G-M1/Delabrad	*Bt5*	0	0	0
4	F00281G2-11	F94976G-M1/Delabrad	*Bt11*	0	0	0
5	F00287G1-11	F95602G-M1/Delabrad	*Bt8*	0	0	0
6	F00399G2-11	F7022W1/5/**PI178383**/IULIA//AURA/3/ FL80/4 Dropia/6/ 577U1-106/7/ Delabrad	*Bt8-10*	0	0	0
7	F01444G2-1	F94889G-M1 /Debut// F96831G3-3	*Bt5*	0	0	0
8	F01450G1-1	F94976G-M1/ Delabrad// F93122G6-209	*Bt11*	0	0	0
9	F02034G1	F94895G-M31/F96831G7-2	*Bt12*	0	0	0
10	F02059G1	F95602G-M46/F96831G7-2	*Bt8*	0	0	0
11	F00628G34-1	191TR-1-1221Fu/ Bucur// open pollination	?(Secale)	0	0	0
12	F99419G4-11	Colonias/Bucur	?	0	0	0
13	DROPIA	Susceptible check	none	59.3	47.9	53.6

CONCLUSIONS

Artificial inoculation tests for common bunt resistance showed that a large diversity of resistance genes is now available in a modern, semidwarf plant type, much more convenient for use in breeding programs than the original sources of resistance.

Possible new sources of resistance were identified among lines selected from crosses involving introgressions from related species or exotic parents.

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