Reaction of Wheat, Alternative Wheat and Triticale Cultivars to Common Bunt

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Abstract: Seventeen winter wheat cultivars registered in the Czech Republic were tested for reaction to common bunt in 2–3 year field trials. Bunt infection of resistant checks Globus and Bill varied between 4.1% and 10.6%; the highest infection in cv. Pitbull reached 85.9%. Of the recently registered cultivars Nikol has a relatively low bunt incidence (26.9%). In addition to bread wheat seventeen triticale, seven durum wheat cultivars, two spelt wheat cultivars and one emmer wheat cultivar were tested in the field and some of them also in the greenhouse. Bunt infection of durum wheats was lower than that of bread wheat cultivars. All seventeen tested triticale cultivars were resistant. The reaction of emmer wheat cultivar and spelt wheat cultivars to common bunt was lower than that of susceptible bread wheat checks.

Keywords: common bunt resistance; *Triticum aestivum*; *T. durum*; *T. spelta*; *T. turgidum* var. *dicoccum*; ×*Triticosecale*; *Tilletia tritici*; *Tilletia laevis*

In the last decades restricted seed treatment and limited seed exchange caused an increase in common bunt (*Tilletia tritici*/Bjerk./Wint. and *T. laevis* Kühn) incidence in the Czech Republic. Though seed treatment with chemicals is effective against common bunt, resistant cultivars are important for organic farming and can limit the bunt incidence in common farming. To evaluate the resistance of registered cultivars of winter wheat, tests for resistance have been performed in the Crop Research Institute Prague-Ruzyně since the 1990's. Results have been published in several papers (Blažková & Bartoš 1995, 1997; Dumalasová & Bartoš 2006a, b, 2007a, b). This paper contains additional data on the common bunt resistance of recently registered winter wheat cultivars not previously tested and data obtained in resistance tests of triticale, spelt wheat, durum wheat and emmer wheat.

MATERIALS AND METHODS

Seed. Seed of wheat cultivars registered in the Czech Republic originated from the Central Institute for Supervising and Testing in Agriculture, Brno. Description of the examined winter wheat cultivars registered in the Czech Republic is available on the website of the Central Institute for Supervising and Testing in Agriculture (CISTA), Brno, Czech Republic: http://www.ukzuz.cz/. Seed of triticale, durum wheat, spelt wheat and emmer wheat was provided by the Gene Bank of the Crop Research Institute, Prague-Ruzyně.

Inoculum. A mixture of *T. tritici* and *T. laevis* (1:1) was used for inoculation in all experiments. The mixture contained samples of *T. tritici* from Červený Újezd, Jičín and Kroměříž and samples of *T. laevis* from Kralovice, Praha-Ruzyně and Kroměříž. The mixture was tested on *Bt0–Bt13*

lines. The mixture displayed the following virulence (% of bunted ears on *Bt* lines): *Bt0*-57.2, *Bt1*-30.6, *Bt2*-36.6, *Bt3*-7.3, *Bt4*-3.6, *Bt5*-1.6, *Bt6*-7.5, *Bt7*-54.6, *Bt8*-7.8, *Bt9*-0.0, *Bt10*-0.0, *Bt11*-0.0, *Bt12*-0.0, *Bt13*-5.4. For inoculation 0.1 g of teliospores was applied to 250 seeds. Seed was inoculated by shaking the seed with inoculum in a flask for 1 minute.

Field trials. Inoculated seed was sown in late October after the usual winter wheat sowing period. Each seed sample was sown in 4 replications in rows 1 m long, 0.2 m apart. Healthy and diseased ears were scored in July. The reaction to bunt was expressed as percentage of bunted ears. Partially infected ears were considered as diseased. Neither fertilizers nor pesticides were applied in field trials. The resistant checks cvs Globus and Bill were included in the winter wheat tests. In the tests with spring triticale, durum wheat and emmer wheat, the susceptible spring wheat cultivar Vinjett was included, in the tests with winter triticale and spelt wheats the susceptible winter wheat cv. Batis was included. Results of the trials with registered winter wheat cultivars were analyzed by ANOVA – UNISTAT 5.0 package (Unistat Ltd., London, UK).

Greenhouse trials. Greenhouse tests were carried out with spring cultivars of durum and emmer wheat and one triticale cultivar because the bunt infection in trials sown in spring is usually low and unreliable. Seed inoculation (250 seeds) was carried out with the same inoculum and in the same way as for field trials. In the greenhouse tests the inoculated seed was kept in Petri dishes on moist filter paper at 8°C in a refrigerator until coleoptiles appeared and were about 5–10 mm long. The germinating seed was planted in pots with soil (6–7 plants per pot/14 cm diameter) and grown in the greenhouse to maturity. The greenhouse temperature was increased stepwise. Plants were kept at 10°C till the growth stage BBCH 10, 13°C till BBCH 13, 15°C till BBCH 31, 18°C till BBCH 47 and 22°C till maturity. The susceptible check spring wheat cv. Vinjett was included in the tests.

RESULTS AND DISCUSSION

Reaction of registered winter wheat cultivars to common bunt

None of the tested recently registered wheat cultivars displayed high resistance to common bunt. Low infection was recorded in both tests only in the resistant checks Globus and Bill, as was also observed in our previous trials (Dumalasová & Bartoš 2006a, b, 2007a, b). The lowest bunt incidence among the cultivars tested for three years – series # 1 (Table 1) was determined in cvs Bohemia and Mulan (below 50% bunted ears), the highest infection in cvs Raduza and Barryton (over

Table 1. Bunt infection on winter wheat cultivars tested for three years (experimental series #1)

Cultivar	Registered	% of bunted ears			
		2007	2008	2009	mean
Globus (check)	2003	5.6	4.6	4.1	4.8[a]
Bill (check)	2002	10.6	6.0	8.1	8.2[a]
Bohemia	2007	58.1	30.8	50.9	46.6[b]
Mulan	2007	55.0	47.1	42.6	48.2[bc]
Mladka	2002	48.0	51.2	73.8	57.7[cd]
Sakura	2007	59.9	64.1	62.0	62.0[d]
Kerubino	2007	64.5	51.4	71.2	62.4[d]
Anduril	2006	67.1	63.8	68.2	66.4[de]
Raduza	2006	66.3	72.3	79.7	72.8[e]
Baryton	2007	71.3	63.4	85.5	73.4[e]

Means in columns followed by the same letter are not significantly different from each other at $P = 0.05$ of LSD test

Table 2. Bunt infection on winter wheat cultivars registered in 2008 tested for two years (experimental series #2)

Cultivar	% of bunted ears		
	2008	2009	mean
Globus (check)	4.6	4.1	4.4[a]
Bill (check)	6.0	8.1	7.1[a]
Nikol	22.1	31.7	26.9[b]
Helmut	35.6	28.9	32.3[bc]
Orlando	34.7	45.7	40.2[c]
Sultan	66.6	61.8	64.2[d]
Baletka	74.9	57.2	66.1[de]
Bakfis	59.6	80.3	70.0[de]
Megas	65.9	80.4	73.2[de]
Pitbull	64.7	85.9	75.3[e]
Kodex	72.5	80.1	76.3[e]

Means in columns followed by the same letter are not significantly different from each other at $P = 0.05$ of LSD test

70% bunted ears). Among cultivars tested only for two years – series # 2 (Table 2) the lowest bunt infection was recorded in cvs Nikol, Orlando and Helmut (up to 40.2% bunted ears), the highest in cvs Pitbull and Kodex (over 75% bunted ears). Statistically significant differences between the examined cultivars are shown in Tables 1 and 2. Tables 3 and 4 indicate a very high cultivar effect on the level of bunt infection. The contribution of cultivar to the overall variation exceeded 80%. Year and cultivar × year interactions were also significant, but they contributed 0.9%–5.0% to the total variation.

Like in our trials, cv. Mulan was susceptible in the experiments conducted by Liatukas and Ruzgas (2008). However, unlike our trials, where Kodex was highly susceptible (76.3% bunt infection), the trials of Liatukas and Ruzgas (2008) rated cv. Kodex resistant (bunt infection 4.7%). This difference may be caused by different virulence pattern in the inoculum.

The bunt resistance of cultivars Globus and Bill (checks) has been described by several authors. Huber and Buerstmayr (2006) recorded bunt infection of Globus 0.3%, Liatukas and Ruzgas (2007) bunt infection of Bill 10%–22%, Liatukas and Ruzgas (2008) bunt infection of Globus 3.4%, of Bill 8.8%, Fontaine *et al*. (2009) bunt infection of Globus less than 2%.

Reaction of *Triticum durum* to common bunt

We tested the spring *T. durum* cultivars Megadur, Durafit and Durabon, registered in Germany, for two years in the greenhouse and for one year in the field (Table 5). In addition to the above-mentioned cultivars, other five cultivars registered in the EU were tested in field trials. The infection level in the field was lower than in the greenhouse tests where conditions were more favourable for bunt development. In the greenhouse the highest infection was recorded in cv. Durabon, which had 49.4% and 28.9% of bunted ears in 2006 and 2008, respectively. Cv. Megadur showed 17.4% and 14.3% bunt infection, with higher mean infection in both years than cvs Ambrodur and Durafit. Cultivars Ambrodur and Megadur were bunt-free in the field. The infection of other cultivars varied between 0% and 6.2% (cv. Duramar). All tested *T. durum* cultivars were less infected in our trials than the check cv. Vinjett.

Reaction of *Triticum spelta* to common bunt

Of the two spelt wheat cultivars tested (Table 6) Franckenkorn was highly resistant both in 2008 and

Table 3. Results of ANOVA for % of bunted ears in experimental series #1 with winter wheat cultivars

Source of variability	Sum of squares	% variation	df	Mean square	*F*-value	*P*-value
Cultivar	65 951.6	80.56	9	7327.96	65.11	0.0000
Year	1 677.22	2.05	2	838.61	7.45	0.0010
Cultivar × year	4 110.27	5.02	18	228.35	2.03	0.0155
Error	10 128.8	12.37	90	112.54		
Total	81 867.89	100.000	119	687.97		

df – degrees of freedom

Table 4. Results of ANOVA for % of bunted ears in experimental series #2 with winter wheat cultivars

Source of variability	Sum of squares	% variation	df	Mean square	*F*-value	*P*-value
Cultivar	60 621.82	88.04	10	6062.18	84.17	0.0000
Year	590.73	0.86	1	590.73	8.202	0.0056
Cultivar × year	2 893.770	4.2	10	289.38	4.02	0
Error	4 753.32	6.9	66	72.020		
Total	68 859.64	100.000	87	791.490		

df – degrees of freedom

in 2009 with bunt infection 1.9% and 1.7%, respectively, cv. Rubiota had 22.5% and 1.9% of infected ears, respectively. In these cultivars both hulled and dehulled kernels were inoculated. The inoculation of dehulled kernels increased the level of infection in both cultivars. This increase was particularly high in cv. Rubiota in 2009. The infection of the susceptible check Batis was higher than in spelt wheats.

Two spelt wheat cultivars Rubiota and Franckenkorn (Stehno *et al.* 2005) have been registered in the Czech Republic since 2001 and 2002, respectively, and are grown mostly in organic farming on more than 1000 ha.

Reaction of *Triticum turgidum* var. *dicoccum* to common bunt

One cultivar, Rudico, was tested (Table 6). It was relatively resistant to common bunt with disease infection in the field trial 5.6% where the susceptible check Vinjett had bunt infection 17.8%. Dehulling of the Rudico seed enhanced the bunt level to 25.3%. In the greenhouse bunt infection in Rudico reached 45.6%, in the susceptible check cv. Vinjett it was 92.8%.

Emmer wheat cv. Rudico is a Czech cultivar that has been under plant variety protection since 2006 and it is grown on a small area of organic farming.

Reaction of ×*Triticosecale* to common bunt

Winter triticale cvs Kitaro, Lamberto, Lupus, Marko, Modus, Ticino, Triamant, Tricolor and spring triticale cvs Kargo, Gabo and Legalo, were tested in 2006 and 2008, winter triticale Disko, Kolor, Presto, Semundo, Gutek and SW Talento just in a one-year trial, either in 2006 or 2008 (Table 7). No bunt infection was observed with the exception of very low infection on cvs Ticino and Triamant. These cultivars were tested for three years because in 2006 they showed bunt infection 0.4% and 2.0%, respectively. For this reason both cultivars were tested in 2007 again, when bunt infection 2.4% was detected only in cv. Triamant, no infection was observed in cv. Ticino though the inoculum from the same cultivars of the 2006 trial was used for inoculation. In 2008 neither of the cultivars showed any infection. To verify the high resistance of triticale to common bunt under very favourable conditions for bunt

Table 5. Reaction of durum wheats to common bunt

Greenhouse			Field (2008)			
Cultivar	% of bunted ears		cultivar	% of bunted ears	cultivar	% of bunted ears
	2006	2008				
Durabon	49.4	28.9	Durabon	3.6	Loyd	1.9
Megadur	17.4	19.3	Megadur	0.0	Biodur	2.1
Durafit	20.3	8.9	Durafit	1.9	Orjaune	2.1
			Ambrodur	0.0	Duramar	6.2
Vinjett (check)	100.0	86.0			Vinjett (check)	28.2

Table 6. Reaction of spelt and emmer wheat to common bunt

Wheat species	Cultivar	% of bunted ears	
		2008	2009
Spelt wheat	Franckenkorn	1.9	1.7
	Franckenkorn dehulled	–	28.5
	Rubiota	22.5	1.9
	Rubiota dehulled	34.8	47.9
Bread wheat	Batis (check)	37.2	66.5
		year 2009	
		field	greenhouse
Emmer wheat	Rudico	5.6	45.6
	Rudico dehulled	25.3	–
Bread wheat	Vinjett (check)	17.8	92.8

development we tested 120 plants of the cv. Kargo in the greenhouse. Cv. Kargo had no infection whereas the check cv. Vinjett showed 86.6% bunt infection.

Differences in the susceptibility of different *Triticum* species to common bunt were described previously in the monograph on smut fungi by Fischer and Holton (1957). Lower susceptibility was recorded in *T. durum*, *T. polonicum* and *T. monococcum*. Specialization of common bunt on *T. durum* wheats was suggested by several authors in Palestine, Australia, China and Argentina (Fischer & Holton 1957). Holton (1930) (cited according to Fischer & Holton 1957) suggested the existence of a race of common bunt specialized on *T. durum*. Geshele (1978) demonstrated higher resistance of *T. durum* compared to *T. aestivum.* Ismail *et al.* (2002) found *Tilletia caries* (*T. tritici*) as predominant on durum wheat, and *T. laevis* on bread wheat in Syria.

Our results, which showed a higher resistance of *T. durum* cultivars to the common bunt inoculum used in our trials compared to bread wheat cultivars, do not allow to speculate about the specialization of common bunt on durum wheat. However, the bunt in our inoculum may be better adapted

Table 7. Reaction of triticale to common bunt (field trial)

Cultivar	% of bunted ears		Cultivar	% of bunted ears	
	2006	2008		2006	2008
Kitaro	0	0	Presto	0	–
Lamberto	0	0	Semundo	0	–
Lupus	0	0	Gutek	–	0
Marko	0	0	SW Talantro	–	0
Modus	0	0	Kargo^{+}	0	0
Tricolor	0	0	Gabo^{+}	0	0
Ticino	0.4	0	Legato^{+}	0	0
Triamant	2.0	0			
Disco	0	–	Batis (check)	54.7	37.2
Kolor	0	–	Vinjett (check)	2.0	28.2

$^{+}$spring triticale

to bread wheat than to only sporadically grown durum wheat in Central Europe.

Several authors have recorded that triticale is usually resistant to common bunt. Winter *et al.* (1992) (cited according to Fischer *et al.* 2002) tested the triticale cultivar Lasco for resistance to common bunt, found it resistant and concluded that triticale does not generally suffer from common bunt. Atac (1988) found that all of the 34 triticale cultivars tested were resistant to common bunt (*T. laevis*) whereas all 7 wheat cultivars tested were susceptible. In the trials conducted by Mehrabani (1970) (cited according to Fischer *et al.* 2002) twenty-four triticale cultivars out of the thirty tested were resistant to four common bunt isolates.

Our results also show that the common bunt inoculum used in our trials caused the bunt infection in triticale only very rarely, and when it did occur, the incidence was very low. On the other hand, the incidence of dwarf bunt in triticale in the field has been commonly observed in the Czech Republic since 1988 (Trčálek 2005). Obviously, dwarf bunt possesses virulence genes that overcome the resistance of triticale. Goates (1996) listed triticale among hosts of dwarf bunt but not of common bunt.

Results of our tests can be useful for farmers neglecting the seed treatment mostly for economic reasons. Resistant cultivars are valuable for organic farming, where the use of pesticides is not allowed. The risk of common bunt incidence is lower in resistant cultivars.

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References

Atac A. (1988): Investigation on the reactions of some triticale and wheat varieties against wheat bunt diseases (*Tilletia foetida* /Wall./Liro) in Cukurova region. Journal of Turkish Phytopathology, **17**: 75–79.

Blažková V., Bartoš P. (1995): Resistance of Czech and Slovak winter wheat cultivars to *Tilletia caries* (DC.) Tul. and *Tilletia laevis* Kühn. Genetika a Šlechtění, **31**: 267–276. (in Czech)

Blažková V., Bartoš P. (1997): Reaction of winter wheat cultivars registered in the Czech Republic to the common bunt (*Tilletia tritici (*Bjerk.) Wint. and *T. laevis* Kühn) and sources of resistance. Cereal Research Communications, **25**: 985–992.

Dumalasová V., Bartoš P. (2006a): Reaction of winter wheat cultivars registered in the Czech Republic to common bunt *Tilletia tritici* (Bjerk.) Wint. and *T. laevis* Kühn. Cereal Research Communications, **34**: 1275–1282.

Dumalasová V., Bartoš P. (2006b): Resistance of winter wheat cultivars to common bunt, *Tilletia tritici* (Bjerk.) Wint. and *T. laevis* Kühn. Zeitschricht für Pflanzenkrankheiten und Pflanzenschutz – Journal of Plant Diseases and Protection, **113**: 159–163.

Dumalasová V., Bartoš P. (2007a): Reaction of spring wheat cultivars to common bunt *Tilletia tritici* (Bjerk.) Wint. and *T. laevis* Kühn. Czech Journal of Genetics and Plant Breeding, **43**: 82–86.

Dumalasová V., Bartoš P. (2007b): Reaction of winter wheat cultivars to common bunt *Tilletia tritici* (Bjerk.) Wint. and *T. laevis* Kühn. Plant Protection Science, **43**: 138–141.

Fischer G.W., Holton C.S. (1957): Biology and Control of the Smut Fungi. Ronald Press, New York.

Fischer K., Schön C.C., Miedaner T. (2002): Chancen der Resistenzzüchtung gegen Brandpilze bei Weizen für den ökologischen Pflanzenbau. Universität Hohenheim, Stuttgart-Hohenheim.

Fontaine L., Du Cheyron P., Morand P., Skikers S. (2009): Assessing varietal resistances to control common wheat bunt under organic cereal production and soft wheat, in particular. Innovations Agronomiques, **4**: 513–518. (in French)

Geshele E.E. (1978): The Basis of Phytopathological Assessment in Plant Selection. Kolos, Moskva. (in Russian)

Goates B.J. (1996): Common bunt and dwarf bunt. In: Wilcoxson R.D., Saari E.E. (eds): Bunt and Smut Diseases of Wheat: Concepts and Methods of Disease Management, CIMMYT, Mexico, 12–25.

Holton C.S. (1930): Susceptibility of durum wheats and emmer to *Tilletia tritici*. Phytopathology, **20**: 119.

Huber K., Buerstmayr H. (2006): Development of methods for bunt resistance breeding for organic farming. Czech Journal of Genetics and Plant Breeding, **42** (Special Issue): 66–71.

Ismail S., Mamluk O. F., Azmeh M. F (2002): Geographical distribution and host preference of common bunt *Tilletia foetida* (Wallr.) Liro and *Tilletia caries* (DC) Tul. on bread wheat and durum wheat. Mededelingen-Faculteit-Landbouwkundige-en-Toegepaste-Biologische Wetenschappen, Universiteit-Gent, **67**: 333–339.

Liatukas Ž., Ruzgas V. (2007): The effect of alien translocations on winter wheat resistance to *Tilletia tritici* (DC.) Tul. Biologija (Lithuania), **53**: 59–62.

Liatukas Ž., Ruzgas V. (2008): Common bunt (*Tilletia tritici* (Bjerk.) resistance of winter wheat varieties included and investigated for inclusion into the Lithuanian National List of Plant Varieties. Žemės ūkio mokslai – Agricultural Sciences, **15**: 25–31. (in Lithuanian)

Mehrabani A. (1970): Untersuchungen über die Resistenz des Weizens gegen *Tilletia caries* (DC.) Tul. und *Tilletia controversa* Kühn. Zeitschrift für Pflanzenzüchtung, **64**: 110–132.

Stehno Z., Dotlačil L., Faberová I., Bareš I. (2005): Development and Structure of Wheat Collection in the Research Institute for Crop Production, Prague. Czech Journal of Genetics and Plant Breeding, **41** (Special Issue): 198–200.

Trčálek Z. (2005): Dwarf bunt always threatens. Rostlinolékař, **5**: 13–14. (in Czech)

Winter W., Krebs H., Bänziger I. (1992): Anfälligkeit von Getreidesorten für einige Brandkrankheiten. Landwirtschaft Schweiz, **5**: 293–297.

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