Wheat Reaction to Common Bunt in the Field and in the Greenhouse

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Abstract: Tests of winter wheat cultivars for resistance to bunt have been carried out in the Research Institute of Crop Production, Prague-Ruzyně since 1988. In 2005 and 2006 also spring wheat cultivars were included in the tests. Of the tested foreign winter wheat cultivars 13 showed relative bunt incidence below 15%. Among them were also two cultivars registered in the Czech Republic, Globus and Bill. Of the Czech and Slovak cultivars only one, Roxana, showed relative bunt incidence below 10% and five other cultivars between 11% and 18%. Resistance of cultivars (mostly of North American origin) described as resistant was validated. Other potential sources of resistance can be bunt races differentials. Bunt incidence in field tests with spring wheat cultivars was too low for reliable evaluation of resistance. Under greenhouse conditions favourable for bunt development cv. Aranka showed lower incidence than cvs Munk and Vinjett. As secondary effects of bunt infection spots on leaves of inoculated plants, growth depression and increased tillering were observed.

Keywords: *Bt* genes; common bunt; resistance; secondary effects; *Tilletia tritici*; *T. laevis*; wheat

After the introduction of effective chemical seed treatment seemed the bunt problem on wheat to be solved once and for all. Though common bunt (*Tilletia tritici* /Bjerk./ Winter, *T. laevis* Kühn) and dwarf bunt (*T. controversa* Kühn) still occur repeatedly. Small scale farming where repeated seed sowing without chemical treatment, reduced doses of fungicides or improper application is not exceptional, caused increase of bunt incidence.

To avoid common bunt many fungicides are registered for the seed treatment. To control dwarf bunt Dividend 030 FS (difenoconazole) or Sibutol 398 FS (bitertanole, fuberidazole) are used in the Czech Republic.

Organic farming does not allow seed treatment with synthesized fungicides. Only seed treatment with natural organic substances like preparations of the mustard seed or microorganisms antagonistic to the bunt fungi can be applied. Physical treatments (e.g., treatment with electrones) is allowed, too. Crop management like early sowing of winter wheat or late sowing of spring wheat can also help to control common bunt. However, the most economic means of bunt control is growing bunt resistant cultivars. Results of our research on wheat resistance to common bunt are summarized in this paper.

MATERIAL AND METHODS

Tests of resistance of winter wheat cultivars to bunt have been carried out in the Research Institute of Crop Production, Prague-Ruzyně since 1988 in irregular intervals. Domestic as well as foreign winter wheat cultivars and sources of resistance were tested. In 2005 and 2006 also registered spring wheat cultivars were included in the tests. Because bunt incidence on spring wheat cultivars was low three the most widespread cultivars were tested also in the greenhouse where favourable conditions for the bunt development were arranged. Bunt inoculum for tests was obtained from different locations of the Czech Republic. It contained a mixture of *T. tritici* and *T. laevis* teliospores in all experimental years except in 1995 when samples of these bunt species were applied separately. Seed was inoculated by shaking with bunt teliospores (10 mg per 10 g of seed) and sown in late October after the customary winter wheat sowing term. Spring wheat was sown in March as early as possible. For the greenhouse experiments inoculated seed was first kept in Petri dishes on moist filter paper at 5–10°C unless the coleoptiles appeared. The germinating seed was planted in pots with soil and kept in an air conditioned greenhouse at temperature 10–22°C till maturity. A similar procedure was used when two winter wheat cultivars were tested. After the treatment at 5–10°C the germinated seed were planted in pots and vernalized at 2–4°C for 6 weeks and then kept in a greenhouse as spring wheat cultivars. Bunt incidence was evaluated as percentage of diseased ears, i.e. number of bunt infected ears related to the total number of evaluated ears. Ninety foreign commercial winter wheat cultivars, sixty two cultivars of Czech or Slovak origin and twenty one bunt resistant mostly North American cultivars as potential sources of resistance were tested. Common bunt samples of different origin were tested for their virulence on bunt race differentials with *Bt1–Bt13*. To make the comparison of results obtained in different years and different experiments easier, data were related to the maximum bunt incidence that was set at 100%. The maximum bunt incidence was 64.9, 63.5, 87.1, 98.3 (*T. tritici*), 94.3 (*T. laevis)*, 80.3, 54.3, 83.9, 56.9 and 54.7% in 1988, 1989, 1994, 1995 (*T. tritici*), 1995 (*T. laevis*), 1996, 1999, 2004, 2005, 2006, respectively. Data in tables refer to relative bunt incidence.

RESULTS

Resistance of winter wheat cultivars. Tests of foreign cultivars (Table 1) have proved that a number of them possessed resistance, relative bunt incidence below 15%. Among them were also two cultivars registered in the Czech Republic, Globus and Bill. To check resistance of the cv. Globus under a high infection pressure it was also tested in the greenhouse together with the susceptible check cv. Batis. Cv. Batis had 80.5% of ears infected with bunt, whereas cv. Globus had only partial infection (1 to 2 the lowest spikelets) in 32.8% of ears.

Of the Czech and Slovak cultivars (Table 2) only one, cv. Roxana, displayed relative bunt incidence below 10% and five cultivars had relative bunt incidence between 11% and 18%. Of them only cv. Niagara has remained on the Czech National List of Varieties of July 31, 2005.

Table 1. Foreign commercial cultivars that showed average relative bunt incidence below 15%

Cultivar	Average relative bunt incidence (%)	Tested in years
Bill	9.1	2004, 2005, 2006
Bold	0.0	2004
Globus	0.9	2004, 2005, 2006
Lars	14.4	2005, 2006
Magnifik	0.0	2005, 2006
Mikon	9.2	2005, 2006
Ramiro	0.0	2005
Stava	0.6	2005, 2006
SW 51136	0.0	2005, 2006
Tarso	13.5	2005, 2006
Tjelvar	0.7	1994, 1995
Tommi	0.0	2005, 2006
Trintella	0.6	2005, 2006

Detailed results of our tests for bunt resistance will be published elsewhere (Dumalasová & Bartoš 2006, 2007 in print)

Sources of resistance. Most cultivars already described as resistant (Table 3) remained without infection after inoculation. Other potential sources of resistance can be bunt races differentials, lines possessing resistance genes *Bt3, Bt4, Bt5, Bt6, Bt8, Bt9, Bt10, Bt11, Bt12, Bt13* that were resistant to all Czech bunt samples tested till now.

Resistance of spring wheat cultivars. Tests with spring wheat cultivars (Table 4) showed that in spite of early sowing bunt incidence was much lower than in winter wheat cultivars though the same inoculation procedure was used. As the results were inconclusive we carried out two greenhouse experiments with the three most widespread cultivars. Under the greenhouse conditions favourable for bunt development cv. Aranka showed the lowest bunt incidence having 68.6% diseased ears, Munk 90.3% and Vinjett 97.4% (average of two experiments). In the field tests Aranka was ranked in one experimental year to cultivars with below average bunt incidence whereas in the other year it had a high bunt incidence. Bunt incidence on the cv. Munk in the field was below average. Cv. Vinjett belonged only in one year to cultivars with high bunt incidence. In the other year it showed a below average bunt incidence.

Table 2. Czech and Slovak wheat cultivars that showed average relative bunt incidence below 25%

Cultivar	Average relative bunt incidence (%)	Tested in years
Česká přesívka	23.7	1996
Danubia	22.0	1988, 1989, 1994, 1995
Dobrovická přesívka	11.3	1996
Hela	15.4	1988, 1989
Mara	13.4	1988, 1989
Niagara	11.5	2004, 2005
Roxana	6.6	1988, 1989
Vala	15.5	1988, 1989

Table 3. Relative bunt incidence on sources of resistance

Cultivars	Relative bunt incidence (%)
Amigo, Crest, Franklin, Blizzard, KW 9403, KW 9410, Lewjain, Manning, Meridian, Promontory, Sprague, Ute, Winnridge, Wanser, Bonneville, Hansel	0.0
Cardon, Wasatch, Hildebrands Weissweizen, Weston	1.1–1.9
Shekhurdinovka, Nebred	6.1–6.7

Table 4. Relative bunt incidence on spring wheat cultivars

Year	Cultivars	Relative bunt incidence (%)
2005	Linda, SW Kadrilj, Bruncka, Corso, Vanek, SG-S-55-01	0.0–10.5
	Saxana, Munk, Vinjett, Zuzana, Sandra, Maja	11.9–19.6
	Aranka, Leguan, Granny, SG-S-1098	20.3–36.4
	Amaretto, Swedjet	48.9–100.0
2006	Saxana, Leguan, Corso	25.0–28.4
	Munk, Zuzana	31.9–41.4
	Aranka, Bruncka, Vinjett	85.3–100.0

Secondary effects of bunt infection. As secondary effects of bunt infection spots on leaves of inoculated plants at early stages of development, growth depression and increased tillering were observed. Compared with uninoculated checks the height reduction was 2.9. 16.8, and 19.6%, whereas the number of ears of inoculated plants was higher by 3, 18, and 23% in cvs Aranka, Munk and Vinjett, respectively. In the field tests with winter wheat cultivars when different inoculation doses were applied worse overwintering and growth depression was observed in plots where the highest dose of inoculum was applied.

DISCUSSION

Of foreign winter wheat cultivars resistance of cvs Globus and Bill is of special interest because these cultivars are registered in the Czech Republic. Cv. Globus was developed in Germany from the cross Ralf/Astron//Haven; of the same pedigree is cv. Tommi. Cv. Bill is of Danish origin and was derived from a multicross dihaploid. It possesses a translocation from *Aegilops ventricosa* with rust resistance genes *Lr37, Yr17* and *Sr38.* In the both cultivars above average resistance to the most important wheat diseases and a high yielding capacity were recorded (Horáková *et al.* 2005). Váňová *et al.* (2006) described resistance of the cv. Bill not only to common bunt but also to dwarf bunt. Dwarf bunt resistance of cv. Globus was lower than resistance to common bunt. On a field with a heavy dwarf bunt infection bunt incidence on Globus was 84.6% compared with the susceptible cv. Batis; on another field where dwarf bunt infestation was lower it was only 36.0% (Dumalasová & Bartoš unpublished). Similar results with the cv. Tommi of the same pedigree as cv. Globus were recorded in Germany. Under a lower infection pressure the difference between dwarf bunt incidence of the cv. Tommi and susceptible check was more pronounced than under high infection pressure (Koch *et al.* 2006).

Of the Czech cultivars registered at present only cv. Niagara seems to offer some protection against common bunt, however its growing area is small. Cv. Niagara was medium resistant in the trials by Váňová *et al.* (2006).

Our results confirmed that among foreign European and American commercial cultivars sources of resistance are available. Also bunt races differentials could be used in bunt resistance breeding. Nevertheless our knowledge on bunt virulence in the bunt population in the Czech Republic is not still sufficient. In other European countries also virulence on *Bt1*, *Bt2, Bt4, Bt6, Bt7, Bt10* was recorded (Blažková & Bartoš 2002). In Germany no virulence only on *Bt5, Bt8, Bt10, Bt11, Bt12* and *Bt14* has been recorded till now (Koch *et al.* 2006).

In the USA and Canada resistant cultivars have solved the problem of common and dwarf bunt. Breeding for bunt resistance was successful in Sweden (e.g., cvs Tjelvar and Stava). Breeding for bunt resistant cultivars for organic farming is also on the way in Germany. Attention to the bunt resistance breeding is also paid in Rumania, Bulgaria and Ukraine.

Field tests with spring wheat cultivars proved to be unreliable because of low bunt incidence. Greenhouse tests carried out for two years showed lower bunt incidence on the cv. Aranka than on cvs Munk and Vinjett. In the Czech Republic common bunt in spring wheat cultivars is less significant than in winter wheat cultivars because of a relative small area of this crop and because environmental conditions are usually less favourable for the bunt development in spring.

Secondary effects of bunt infection have been already described by many authors and summarized in the monograph on Smut fungi by Fischer and Holton (1957). In the former Czechoslovakia the effect of bunt infection on the reduction of stem height was studied by Huszár (1992) who recorded the height reduction 54.1%, 23.2% and 28.2% of tillers infected with *T. controversa*, *T. tritici* and *T. laevis*, respectively. Our experiments showed a less pronounced reduction in the plant height; the cultivar with the highest bunt incidence suffered the highest height reduction. In the occurrence of spots on leaves as a secondary effect of bunt infection differences between resistant and susceptible cultivars were not observed. Spots in the greenhouse were registered also on resistant cultivars Globus and Bill. Occurrence of spots on leaves due to infection by bunt was recently studied by Koch and Spiess (2002). They confirmed presence of bunt mycelium in the leaves with spots and low or no correlation with bunt resistance. Though the described secondary effects of bunt infection may also contribute to the yield decrease, the most important economic loss of the harvest infested with bunt consists in the contamination by stinking teliospores of bunt. The odour can cause that the harvest loses completely its mercantile value.

Acknowledgements. We thank Dr. habil. H. Spiess and Dr. B.J. Goates for the seed of resistant cultivars and differentials. Technical assistance of Ms. J. Hanzlíková is highly appreciated. The study was supported by a project of Ministry of Agriculture of the Czech Republic No. MZe 0002700602 and a project of the National Agency for Agricultural Research NAZV 1G58083.

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