Reaction of Spring Wheat Cultivars to Common Bunt Caused by *Tilletia tritici* (Bjerk.) Wint. and *Tilletia laevis* (Kühn)

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Abstract: In 2005, 2006 and 2007 nineteen, eight and nine spring wheat cultivars, respectively, were tested in field trials for resistance to common bunt after inoculation with bunt teliospores. Nine spring wheat cultivars were tested in a greenhouse under favourable conditions for the bunt infection. Bunt incidence in the field trials varied between 0% and 38.7%, in the greenhouse between 52.9% and 100%. The results of individual cultivars and years fluctuated. A reduction in plant height, ear length, root system and increased tillering were registered in the inoculated plants. Spots on the leaves of inoculated plants were observed in three out of the four greenhouse experiments.

Keywords: common bunt; spring wheat; resistance; secondary effects of bunt

In the last decade common bunt and dwarf bunt have gained considerable economic importance in the Czech Republic. Limited seed exchange, use of untreated seed, reduced doses of fungicides or improper application of seed treatment, limited crop rotation and use of reduced tillage contributed to an increased bunt incidence. Besides the chemical seed treatment and crop rotation, genetic resistance to bunt can contribute to a reduction in bunt incidence. The present paper complements data on the resistance of winter wheat cultivars (Dumalasová & Bartoš 2006a, b) by data on the bunt resistance of spring wheat cultivars registered in the Czech Republic and one advanced spring wheat line. Secondary effects of common bunt infection on wheat plants are also recorded.

MATERIAL AND METHODS

Seed of the tested cultivars originated from the Central Institute for Supervising and Testing in Agriculture, Czech Republic. In 2005 all registered cultivars except Kronjet were tested whereas in 2006 only cultivars with the seed increase area over 1% of the total seed increase area of registered spring wheat cultivars (Horáková *et al.* 2005) were included in a field trial. A mixture of *T. tritici* and *T. laevis* from several locations was used for inoculation. The seed was inoculated by shaking a flask with bunt teliospores for one minute. For inoculation 10 mg of teliospores was applied per 10 g of seed. Each seed sample was sown in 4 replications, in rows 1 m long 0.2 m apart as early as possible in March (1995, 1997) or in early April (1996). In a greenhouse test the most widespread cultivars according to the seed increase area and cultivars that were expected to show a lower susceptibility were tested. Greenhouse tests were carried out during winter (planted in September–November), except the last one that was planted in April. Bunt incidence was recorded after 4 months. In the greenhouse experiments the inoculated seed was kept in Petri dishes on moist filter paper at 8°C until the coleoptiles appeared. The germinated seed was planted in pots with soil and kept in the greenhouse. The temperature was

Supported by the Ministry of Agriculture of the Czech Republic, Projects No. MZE 0002700602 and 1G58083.

increased stepwise from 10°C to 22°C till maturity. The bunt incidence both in field and greenhouse experiments was recorded as percentage of diseased ears, i.e. the number of bunt infected ears related to the total number of ears. A secondary effect of bunt infection on tillering, plant height and ear length was determined by counting/measuring 50 inoculated and 50 uninoculated plants in the 2006 greenhouse experiment. For the statistical evaluation of results t-test and ANOVA after angular transformation of the percent data were applied.

RESULTS

Reaction of spring wheat cultivars to common bunt. The bunt incidence in field trials was relatively low. In 2005, when 18 cultivars and one advanced line were tested, it varied between 0% and 10.4%, in 2006, when only 8 cultivars were tested, it varied between 2.9% and 11.6% and in 2007, when nine cultivars were tested, it varied between 8.2% and 38.7%. Data presented in Table 1 show the percentage of bunted ears after angular transformation. In all three years cultivars Corso and Saxana had a relatively low bunt incidence whereas cv. Vinjett displayed a higher bunt incidence. The bunt incidence of other cultivars varied. Average ranking of cultivars tested in three field trials was as follows: Saxana, Corso, Leguan, Munk, Aranka, Bruncka, Zuzana and Vinjett. Cv. Linda tested only in two years had no bunted ears in 2005 and a relatively low bunt incidence in 2007.

Because of the low bunt incidence in the 2005 field trial we tested 3 cultivars also in the greenhouse in 2005 and 2006, 7 cultivars in 2007a trial and 2 cultivars in 2007b trial. In these experiments a very high bunt incidence (up to 100%)

Table 1. Bunt incidence in the field trials

Cultivar	Registered in	Bunt incidence*					
		2005		2006		2007	
Linda	1992	0.0	a	–	–	18.9	ab
Bruncka	2001	1.9	ab	17.9	b	28.7	bc
SW Kadrilj	2006	1.9	ab	–	–	–	–
Corso	2001	2.3	ab	8.8	a	21.6	ab
SG-S5-01		3.2	ab	–	–	–	–
Vánek	2004	4.0	abc	–	–	–	–
Saxana	1990	5.1	abc	8.6	a	18.9	ab
Aranka	1998	6.5	abc	17.9	b	24.6	ab
Munk	1995	6.6	abc	10.8	a	27.2	b
Vinjett	2001	6.7	abc	19.5	b	38.3	c
Leguan	1998	7.6	bcd	9.8	a	15.6	a
Sandra	1984	7.9	bcd	–	–	–	–
Granny	2004	7.9	bcd	–	–	–	–
Zuzana	2003	8.4	bcd	11.9	a	21.2	ab
Maja	1990	8.5	bcd	–	–	–	–
Sirael	2005	10.5	cde	–	–	–	–
Amaretto	2006	14.3	de	–	–	–	–
Swedjet	2003	15.9	e	–	–	–	–
Triso	2002	16.1	e	–	–	–	–

*Percentage of bunted ears after angular transformation

Figures within columns followed by different letters are statistically different on the $P = 0.05$ level

Figure 1. Reduction in the root system caused by common bunt infection (cv. Vinjett – on the left healthy plants, on the right bunt infected plants)

was achieved (Table 2). In 2005, 2006 as well as in 2007 (b trial) cultivar Aranka showed a lower bunt incidence than cv. Vinjett. Greenhouse experiments verified the high susceptibility of cv. Vinjett and a lower susceptibility of cv. Aranka and possibly of Linda. However, in all experiments cv. Linda was less vigorous and produced more sterile ears than the other tested cultivars, which could affect the results.

Secondary effects of common bunt on wheat plants. Secondary effects of common bunt were studied in cultivars Munk, Vinjett and Aranka. The inoculated plants of all three cultivars had retarded initial growth, reduced height, higher number of tillers and reduced length of the spikes (cvs Vinjett and Munk). The height reduction was 19.6% (significant), 16.8% (significant), and 2.9% (insignificant) in cvs Vinjett, Munk and Aranka, respectively (Table 3). Only data recorded for the cv. Vinjett with bunt incidence of almost 100% directly reflect the effect of the bunt. As healthy plants in the set of the other two inoculated cultivars were not excluded from the measurement, data reflect not only the effect of the bunt but also the level of the bunt incidence in the individual cultivars. For this reason in inoculated cvs Munk and Aranka the plant height was measured once more separately in healthy and bunt diseased plants within the inoculated set of plants. In these measurements the height reduction was adequately higher, namely 22.7% and 15.2% in cvs Munk and Aranka, respectively. A reduction in the spike length was less pronounced, being 6.6% in cv. Munk and only 1.7% in cv. Vinjett. Differences were not statistically significant. In the inoculated set of plants tillering

Table 2. Bunt incidence in the greenhouse trial

Year	Cultivar	Number of tested plants	Bunt incidence (%)
2005	Aranka	116	75.9
	Munk	243	99.2
	Vinjett	204	95.6
2006	Aranka	101	61.4
	Munk	118	81.4
	Vinjett	123	99.2
2007a	Bruncka	91	100.0
	Corso	118	92.4
	Linda	34	52.9
	SW Kadrilj	126	96.8
	Vánek	119	98.3
	Vinjett	125	86.4
2007b	Aranka	21	89.0
	Vinjett	31	100.0

Figure 2. Chlorotic spots on wheat leaves caused by common bunt infection

Table 3. Effect of common bunt on plant height, ear length and number of tillers (plant height and ear length and number of tillers were measured in 50 plants)

Cultivar	Average plant height (cm)			Average ear length (cm)			Number of tillers		
	control	inoculated plants	difference (in %)	control	inoculated plants	difference (in %)	control	inoculated plants	difference (in %)
Aranka	69.6	67.6	–2.9	–	–	–	50	51	+2.0
Munk	75.5	62.8	–16.8*	6.6	6.2	–6.6	50	59	+18.0
Vinjett	80.8	65.0	–19.6*	6.3	6.2	–1.7	50	62	+24.0

*significant on $P = 0.05$ level

was increased by 24.0%, 18.0% and 2.0% in cultivars Vinjett, Munk and Aranka, respectively. A reduction in the root system in the inoculated plants of cv. Vinjett, which had the highest bunt incidence, was estimated by a quarter (Figure 1). Inoculated plants manifested yellowish spots on leaves already at the early stages of development that were visible until the leaves turned yellow (Figure 2). No difference in the occurrence of these spots was observed between the cultivars. Detailed analysis of the number and size of the spots on individual cultivars was not carried out.

DISCUSSION

In the Czech Republic weather conditions for the bunt incidence in spring wheat cultivars are usually unfavourable. Already in 1954 Fadrhons stated that spring wheat cultivars suffered less from common bunt than winter wheat cultivars. In his two-year field trials he found no significant differences in the bunt incidence between the registered cultivars with bunt incidence 6.0–9.1%. Slovak, Canadian and Russian cultivars had a lower bunt incidence (0.2–3.5%). Only cv. Hope was resistant. However, severe infection of spring wheat can also occur. Polišenská *et al.* (1998) recorded severe infection of spring wheat cultivars in Kroměříž in 1995 but the infection was negligible in the next year. She inoculated 6 spring wheat cultivars separately with *T. tritici* and *T. laevis.* The number of bunt diseased ears was very low and varied between 0 (cvs Grandur and Saxana) and 7 (cv. Sandra) ears per square meter. Cvs Linda, Maja, Munk had only 1–4 ears infected with bunt per square meter. In Germany (Koch *et al.* 2006) out of 52 spring wheat cultivars tested in 2001 and 2002 more than a half showed the bunt incidence below 1% though the highest bunt incidence was 36%.

In spite of variations in the individual experiments we could determine differences in the susceptibility of the tested cultivars to common bunt. These results may be of use for the choice of cultivars in organic farming and broaden the information on the traits of the tested cultivars that can be interesting for breeders.

Secondary effects of bunt infection such as stem height reduction, ear length reduction or increased tillering were described by many authors already earlier and summarized by Fischer and Holton (1957). In former Czechoslovakia Huszár (1993) recorded the stem height reduction by 23.2%, 28.2% and 54.1% in wheat cultivars infected with *T. tritici* (winter wheat cultivar Michigan Amber), *T. laevis* (spring wheat cultivar Sylva) and *T. controversa* (unknown cultivar), respectively. The highest ear length reduction (28.8%) was recorded by Huszár in the long straw cv. Michigan Amber while differences in the cv. Sylva (8%) and in an unknown cultivar (0.2%) were insignificant. Data reported by Huszár (1992) are higher than those recorded by us but the average effect of bunt on ear length observed by him is also relatively low. A reduction obviously depends on the cultivar, environmental conditions and on the genotype of the bunt sample. It can be expected that the longer the stem, the larger the stem reduction. A reduction in the root system in the cv. Vinjett seems to correlate with the stem length reduction. Our estimation of root reduction is similar to the earlier published data. Sampson and Davis (1927, cit. according to Fischer & Holton 1957) recorded a 22% reduction in the root development of bunt infected plants. Hely *et al.* (1938, cit. according to Fischer & Holton 1957) determined a root depression of 19.3% in bunt inoculated plants grown in pots for 8 weeks. In 1927 Sampson and Davis (cited according to Fischer & Holton 1957) reported a stimulation of tillering by *T. tritici* by 16%, which is comparable with our results.

Spots on leaves as a secondary effect of bunt infection were also recorded already earlier (Fischer & Holton 1957). Johnston and Lefebvre (1939, cit. according to Fischer & Holton 1957) observed "chlorotic mottling of the leaves, particularly the basal ones of wheat from seed inoculated with *Tilletia foetida* in the greenhouse". Recently attention to spots on leaves caused by common bunt was paid in Germany. Koch and Spiess (2002) and Koch *et al.* (2004) proved the presence of the mycelium in leaves with chlorotic spots by staining. On average 88% of plants with chlorotic spots showed later bunt infected ears. The presence of the mycelium in leaves does not prove its presence in the apical meristem necessary for the ear infection. In our greenhouse experiments leaf spots were very distinct and widespread only in 2005 and 2007. In the 2006 experiment, although the same cultivars inoculated with the same bunt samples were tested, spots were observed only sporadically. Environmental conditions seem to play an important role in the appearance of spots on the leaves of wheat plants inoculated with common bunt.

Our results confirmed many secondary effects of common bunt on the wheat plants. However, the most important negative economic effect of common bunt is the spread of stinking bunt teliospores in harvested grain that often render the harvest unmarketable.

Acknowledgements. Technical assistance of Ms Jitka Hanzlíková was greatly appreciated.

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Received for publication February 12, 2007
Accepted after corrections August 1, 2007

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