67. Tagung

21.-23. November 2016
Raumberg-Gumpenstein

Resistance against biotic pathogens
Plant-microbe interactions

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Vereinigung der Pflanzenzüchter
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Evaluation of resistance against common bunt in spelt wheat

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Abstract

Spelt wheat (*Triticum spelta* L.) is an old domesticated species. Spelt is often considered to be a valuable genetic source of desirable genes. An increasing attention is payed to spelt with respect to production of healthy and organic food products. Common bunt, caused by *Tilletia caries* (syn. *T. tritici*) and *T. laevis* (syn. *T. foetida*), reduces yield and quality in organic as well as in conventional production. Genetic resistance represents a promising tool of control of common bunt of spelt wheat in low input and organic farming conditions, where the possibilities of seed treatment are limited. Within the framework of the HealthyMinorCereals project, the resistance to common bunt, together with leaf rust, yellow rust, stem rust and Fusarium head blight resistance was evaluated. In total, 80 genotypes of winter spelt wheat of different origin were included in the tests. The contribution presents data on common bunt resistance of the evaluations from 2015 and 2016. Results from the Czech Republic, Austria and Switzerland revealed the highest resistance level against common bunt in genotypes 'Albin' and 'Sofia 1'.

Keywords

Genetic resources · hulled wheat · organic agriculture · seedborne disease · *Triticum spelta*

Introduction

Spelt wheat (*Triticum spelta* L.) is considered to be an old cultivated European wheat species. Spelt's popularity has been rising in recent years, especially with regard to its nutritional value, digestibility and taste. This is also a reason, why more attention is paid to the health condition of spelt. Spelt wheat is attacked by the same diseases and in a similar way as common wheat (*T. aestivum* L.), nevertheless it is generally considered to be more resistant. Common bunt control has a significant importance for spelt cultivation, as it is mostly cultivated in organic farming or in low input systems. Protection against harmful organisms in organic farming is based especially on a good cropping practice, growth morphology and selection of crop species. With regard to the fact that the use of chemical protection is limited in organic farming, it is necessary to pay appropriate attention to the utilisation of resistance sources.

Tilletia caries (D.C.) Tul. & C. Tul. (syn. *T. tritici* (Bjerk.) G. Winter and *T. laevis* J.G. Kühn (syn. *T. foetida* (Wallr.) Liro may cause serious damages due to the decrease of crop yield and quality. In case of heavy incidence it is not possible to use the seed as food or feed. Already low doses of the spores represent a problem for seed sales and multiplication. The spores contain trimethylamin causing an unpleasant odour.

In field tests with artificial infection of common bunt strains that are maintained at the Crop Research Institute in Prague, we usually encounter a high bunt incidence in registered winter wheat varieties (DUMALASOVÁ & BARTOŠ 2016). Resistance to common bunt in European wheat varieties is rather seldom. For spelt wheat, there is not much information available on resistance to common bunt (HE & HUGHES 2003).

Material and methods

A panel of 80 genotypes of winter spelt wheat was established within the framework of the FP7 project HealthyMinorCereals and evaluated for the resistance to common bunt. Additionally, 23 winter wheat cultivars registered in the Czech Republic were tested.

Field tests with artificial inoculation of common bunt were carried out in Prague, Czech Republic (Crop Research Institute), Tulln, Austria (BOKU-University of Natural Resources and Life Sciences, Vienna) and Stäfa, Switzerland (Getreidezüchtung Peter Kunz, Feldbach). The inoculum was a mix of strains of common bunt of local prevenience. Results from the first two years of testing are available so far.

Field trials in Prague had two replicates, each of them represented by one 1 m long and 0.2 m distance between rows. Seed was inoculated with a mixture of common bunt teliospores before sowing. Inoculation was done by shaking 250 seeds with 0.1 g of teliospores in Erlenmayer flasks for 1-2 min. Inoculations and sowing were carried out by hand in October. The methods applied on the two other localities were adapted to their specific conditions. In Stäfa seeds were dehulled before sowing.

The total amount of spikes and total amount of infected spikes per replicate was counted in July. The reaction to bunt was expressed as a percentage of spikes exhibiting bunt. For the identification of races an infection incidence above 10% of the spikes indicates virulence (GOATES 1996). On the basis of this rule we assume that the breeding potential of genotypes showing more than 10% of infection is low.

The same set of genotypes was evaluated also for reaction to leaf rust, yellow rust, stem rust and Fusarium head blight. The reaction to rusts quoted in this contribution was determined as described by HANZALOVÁ & BARTOŠ (2014).

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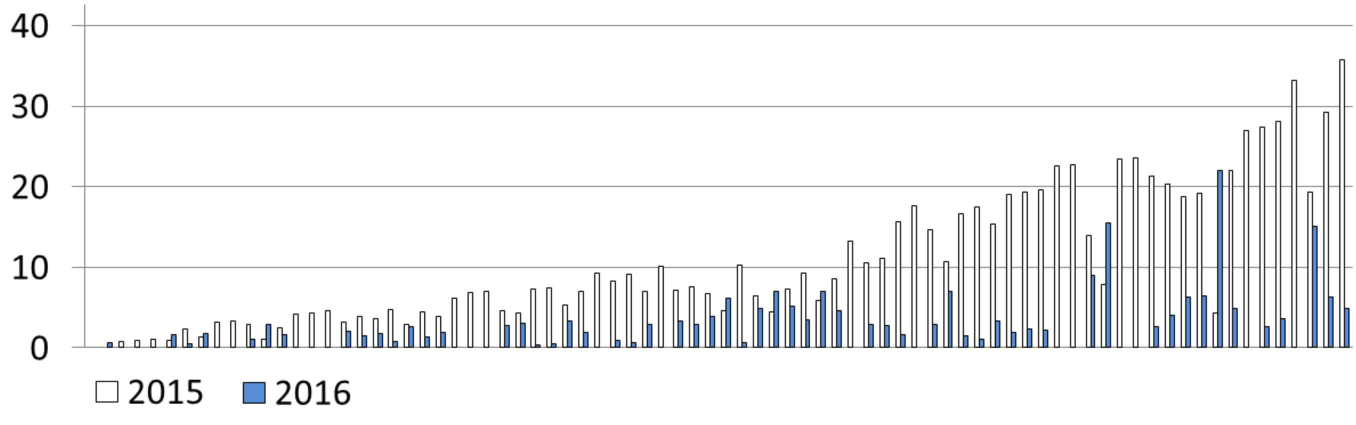

Figure 1: Common bunt infection (% infected spikes) of 80 *Triticum spelta* genotypes in 2015 and 2016 in Prague, Czech Republic. Artificial inoculation was carried out on hulled seeds.

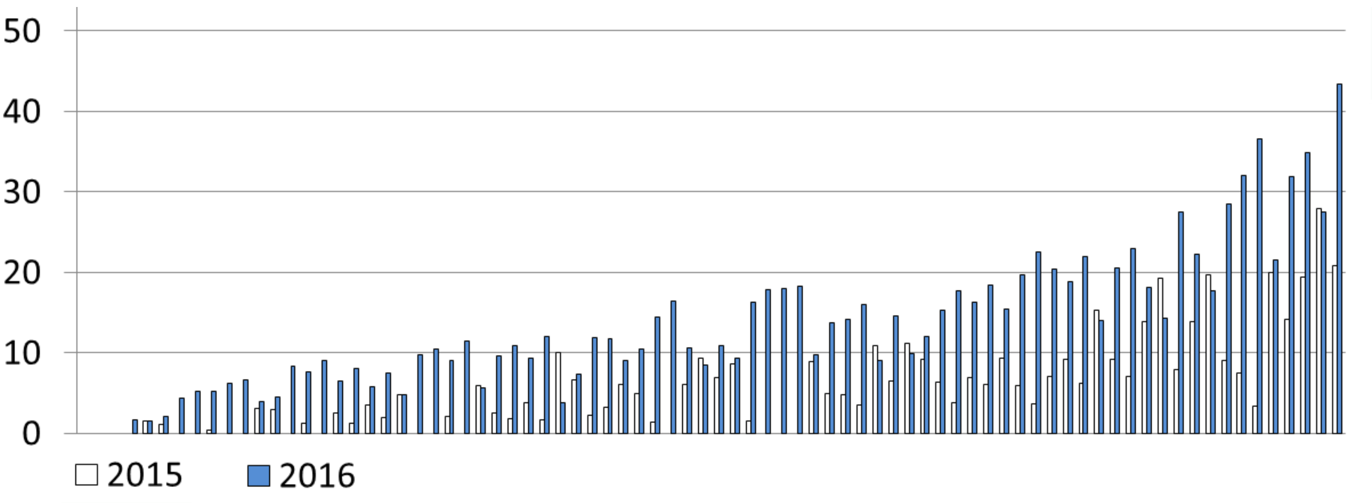

Figure 2: Common bunt infection (% infected spikes) of 80 *Triticum spelta* genotypes in 2015 and 2016 in Tulln, Austria. Artificial inoculation was carried out on hulled seeds.

Results and discussion

The level of bunt incidence in the replications corresponded to each other well with respect to the localities Prague and Tulln in both years and most cases. Significant differences were rare and they appeared mainly if the level of bunt infection on the locality in the year was not sufficient.

From the tests in Prague and Tulln the fluctuations in the level of bunt incidence due to various conditions of the environment in the different years could be determined.

Common bunt infection observed in field trials at Prague-Ruzyně in 2015 and 2016 is shown in Table 1. The bunt incidence obtained in 2015 in Prague was sufficient. The mean value was 10.7% and the maximum value reached 35.7% of infected spikes.

The level of infection in Prague was lower in 2016 (Figure 1), with 2.7% as mean and 22.0% as maximum. The reason for the lower infection in 2016 was most probably the unfavorable climatic conditions in autumn 2015, i.e. warm and dry weather.

Contrary to Prague, in Tulln the bunt incidence was lower in 2015 with a mean value of 5.8% and a maximum of 27.9%. In 2016, the level of infection in Tulln was similar to Prague in 2015 with a mean of was 13.5% and a maximum of 43.4% (Figure 2).

For Stäfa a significant higher bunt infection was recorded. Mean infection in 2016 was 53.7% and the maximum was 94.9% (Figure 3). This really high level of infection can be explained by the different infection method. Whereas in Prague and Tulln hulled seeds were inoculated, dehulled seeds were inoculated in Stäfa. Hence, it is obvious that the presence of glumes in hulled seeds of spelt wheat is responsible for a lower level of infection. This finding is in accordance with former results from tests with hulled and dehulled wheat genotypes (DUMALASOVÁ & BARTOŠ 2010).

The seed may present a mixture of hulled and dehulled seeds. Their ratio influences the level of infection, which could be lower when more seeds are covered with glumes. The fact that dehulling removes a part of the spores together with the glumes and contributes to a decrease of infection is important for practice. The presence or absence of glumes has probably a lower effect on the infection of plantlets with dwarf bunt because of the mainly soil-borne origin of the inoculum of this pathogen.

Compared to the hulled spelt wheat, naked common wheat was more susceptible to common bunt in the 2015 and 2016 tests in Prague. The mean level of infection of 23 common wheat cultivars currently registered in the Czech Republic was 30.8% in 2015 (maximum 47.5%) and 14.4% in 2016 (maximum 51.6%) (Figure 4).

Table 1: Mean levels of common bunt infection observed in field trials in Prague in 2015 and 2016

Genotype	% bunted ears			Genotype	% bunted ears		
	2015	2016	Mean		2015	2016	Mean
ALBIN	1.0	1.6	1.3	NEUEGGER WEISSKORN	0.0	0.6	0.3
ALKOR	7.0	2.9	5.0	OBERKULMER ROTKORN	7.6	2.9	5.3
ALTGOLD	9.3	3.4	6.4	OEKO 10	7.4	0.5	4.0
BADENGOLD	7.3	5.1	6.2	OSTRO	4.1	0.0	2.1
BADENKRONE	23.5	0.0	11.7	POEME	3.3	0.0	1.6
BADENSTERN	6.4	4.9	5.6	RINIKER WEISSKORN	14.7	3.0	8.8
BLACK FOREST	26.9	0.0	13.5	ROSÉN	17.6	0.0	8.8
BURGDORF WEISSKORN	33.2	0.0	16.6	ROTER SCHLEGEL DINKEL	6.2	0.0	3.1
BURGHOF	7.0	0.0	3.5	ROTTWEILER DINKEL ST.6	2.9	2.7	2.8
CERALIO	7.1	1.9	4.5	ROTTWEILER FRÜHKORN	7.3	0.4	3.8
COSMOS	19.7	2.2	10.9	ROUQUIN	6.9	0.0	3.4
EBNERS ROTKORN	9.3	0.0	4.6	RUBIOTA	11.1	2.7	6.9
ELSENEGGER	20.2	4.0	12.1	RUEFENACHTER WEISSKORN	19.0	2.0	10.5
EPANIS	10.6	2.9	6.7	SALEZ	15.3	3.3	9.3
FARNSBURGER ROTKORN	4.5	7.0	5.7	SAMIR	35.7	4.9	20.3
FILDERSTOLZ	3.2	0.0	1.6	SCHAFFISHEIM WEISSKORN	2.9	1.1	2.0
FRANCKENKORN	3.1	2.1	2.6	SCHNOTTWILER WEISSKORN	5.4	3.3	4.3
FRIENISBERGER WEISSKORN	10.3	0.6	5.4	SCHWABENSPELZ	19.4	15.1	17.2
FUGGERS BABENHAUSENER ZUCHTVEESEN	2.4	0.4	1.4	SOFIA 1	0.0	0.0	0.0
GOLDIR	6.8	3.9	5.4	SPY	4.6	2.7	3.6
GUGG 11A	16.7	1.4	9.1	STRICKHOF	22.1	4.8	13.4
GUGG 2F	1.3	1.7	1.5	T. SPELTA RUZYNE SVTLA	19.2	6.4	12.8
GUGG 2G	1.1	2.9	2.0	T. SPELTA ALBUM	27.4	2.6	15.0
GUGG 4E	3.8	1.4	2.6	TAURO	13.3	0.0	6.6
GUGG 4H	4.4	22.0	13.2	THUERIG ROTKORN	28.1	3.6	15.8
GUGG 5A	10.7	7.0	8.9	TITAN	22.5	0.0	11.3
GUGG 5C	4.3	3.1	3.7	TOESS 5B	7.1	3.3	5.2
GUGG 6A	0.9	0.0	0.4	TOESS 6D	19.3	2.3	10.8
GUGG 9A	4.6	6.1	5.4	T. SPELTA KROMERIZ	0.8	0.0	0.4
GUGG 9F	2.5	1.6	2.0	VON RECHBERGS BRAUNER WINTERSPELZ	4.4	1.3	2.9
H57-7	5.8	7.1	6.4	VÖGELERS	17.5	1.0	9.3
HERCULE	4.4	0.0	2.2	VON RECHBERGS FRÜHER WINTERDINKEL	29.3	6.2	17.8
HOLSTENKORN	3.6	1.7	2.7	VORENWALDER WEISSKORN	15.7	1.6	8.6
HUESLERS-NIEDERWIL 19	8.3	1.0	4.6	WAGGERSHAUSER WEISSER KOLBEN	18.7	6.4	12.5
LANTVETE FRAN GOTLAND	21.4	2.6	12.0	WILLISAUER WEISSKORN	9.2	0.6	4.9
LIESTALER ROTKORN L11	7.8	15.5	11.6	WINIGER-EGG WEISSKORN	22.7	0.0	11.4
LONIGO	14.0	9.1	11.5	ZEINERS WEISSER SCHLEGELDINKEL	23.6	0.0	11.8
LW 12 NUERTINGEN	3.9	1.9	2.9	ZOLLERNSPELZ	4.7	0.8	2.7
LW 13 NUERTINGEN	4.6	0.0	2.3	ZÜRCHER OBERLÄNDER ROTKORN	8.6	4.6	6.6
MURI ROTKORN	1.1	0.0	0.5	ZUZGER	10.2	0.0	5.1

Table 2 shows the most susceptible genotypes from the trials performed in Prague, Stäfa and Tulln, *i.e*. 'Strickhof', 'Vögelers', 'Von Rechbergs Früher Winterdinkel', 'Black Forest', 'Cosmos', 'Lantvete fran Gotland', 'Samir' and 'Schwabenspelz'. The absence of effective resistance genes to bunt was most obvious in the dehulled variant tested in Stäfa, where the most susceptible genotypes had 68.5% - 88.5% infected spikes. Variability of bunt infection was higher when the hulls were still present at artificial inoculation; in this case a bunt incidence below 10% was more frequent.

The most resistant genotypes (Table 3) were 'Sofia 1', 'Albin', *T. spelta* Kromeriz, 'Gugg 2G', 'Ostro', 'Altgold', 'Ceralio' and 'Spy'. Also in this group some variation occurred. For some genotypes in some years and localities the bunt incidence exceeded 10%. Such genotypes are not suitable sources of resistance. For resistance breeding the genotypes with zero bunt incidence in the infection tests are desired. It is not clear, whether the varieties with varying bunt incidence escaped infection in some cases or whether specific resistance genes to the used inoculum strains are present.

Genotypes 'Sofia 1' and 'Albin' had a very low bunt incidence both in the hulled and dehulled variant. 'Sofia 1' had also an intermediate resistance to stem rust, while the other spelt wheat genotypes showed high susceptibility to stem rust in the field test, and was the most resistant genotype to leaf rust in the both test years.

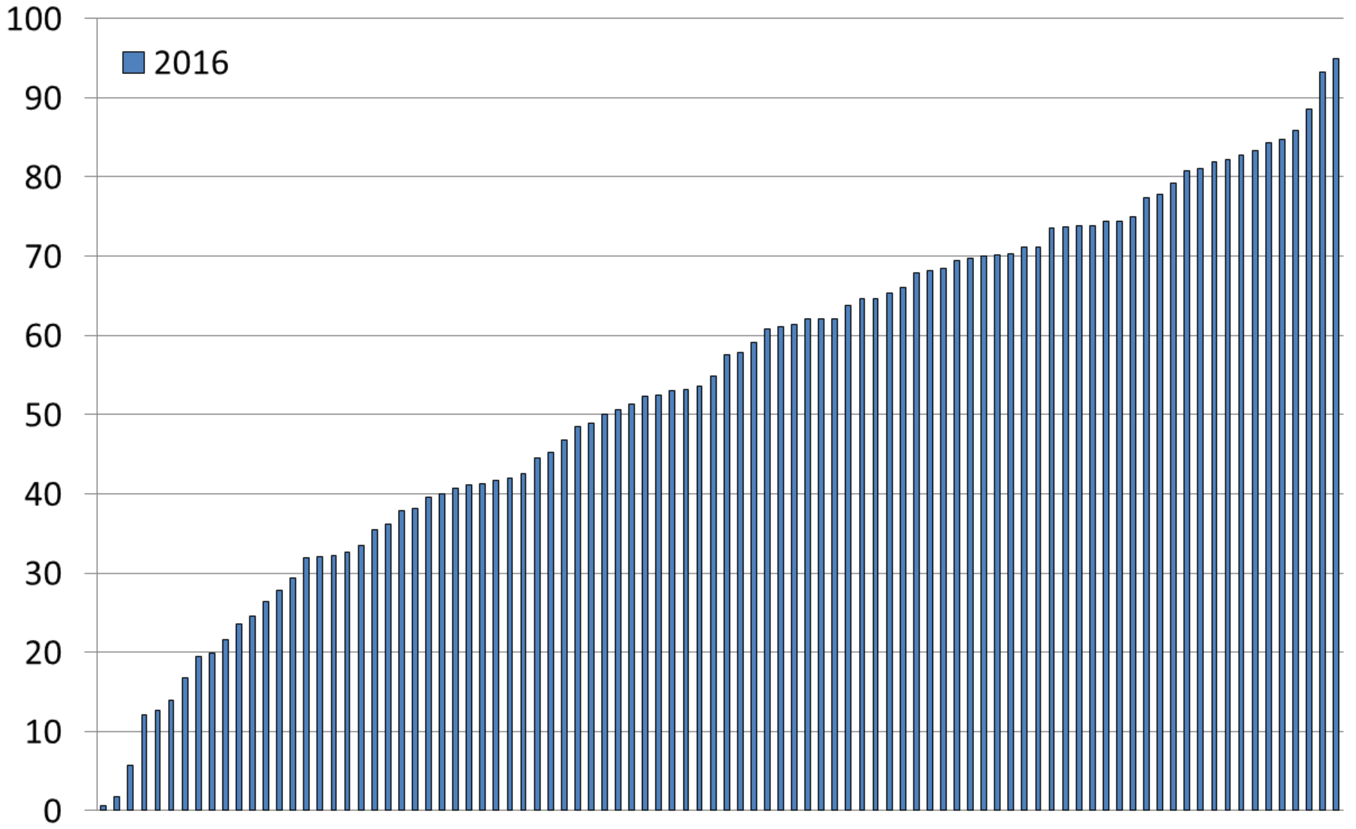

Figure 3: Common bunt infection (% infected spikes) of 80 *Triticum spelta* genotypes in 2016 in Stäfa, Switzerland. Artificial inoculation was carried out on dehulled seeds.

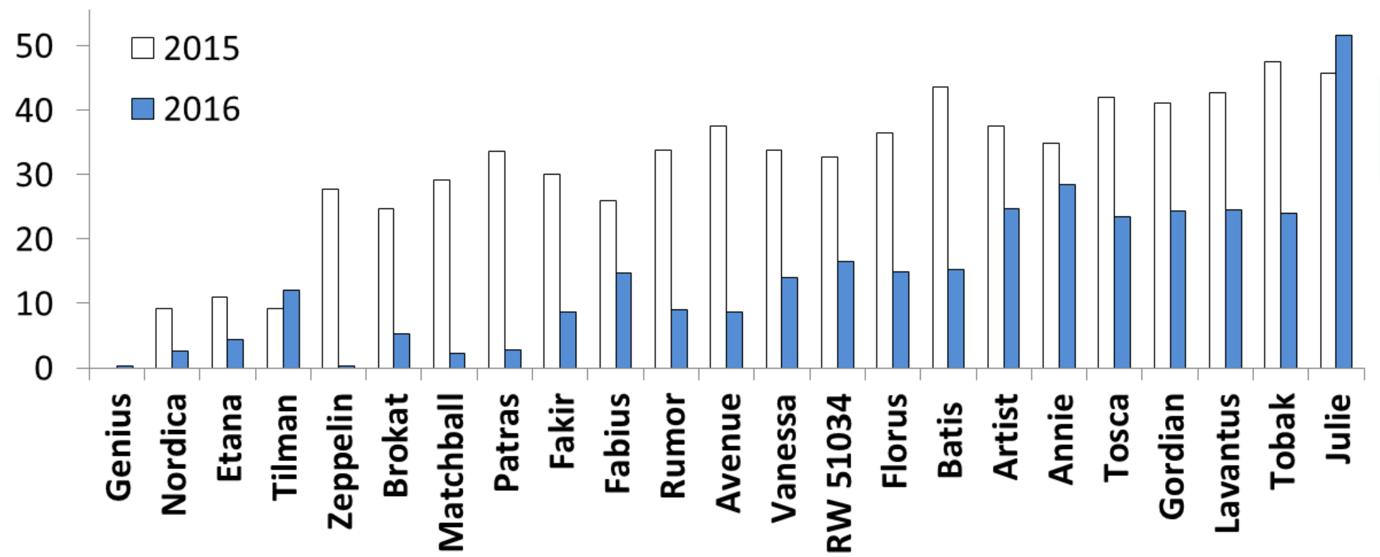

Figure 4: Common bunt infection (% infected spikes) of 23 *Triticum aestivum* cultivars currently registered in the Czech Republic in 2015 and 2016 in Prague, Czech Republic.

Table 2: Mean levels of common bunt infection observed on the most susceptible spelt wheat genotypes in field trials in the Czech Republic, Austria and Switzerland in 2015 and 2016

Genotype	% bunted ears				
	Stäfa 2016	Prague 2015	Prague 2016	Tulln 2015	Tulln 2016
STRICKHOF	83.3	22.1	4.8	9.1	12.0
VÖGELERS	84.3	17.6	1.0	13.8	18.1
VON RECHBERGS FRÜHER WINTERDINKEL	85.8	29.2	6.2	9.2	8.5
BLACK FOREST	68.5	26.9	0.0	14.1	31.9
COSMOS	88.5	19.6	2.2	9.0	28.5
LANTVETE FRAN GOTLAND	80.8	21.4	2.6	27.9	27.5
SAMIR	77.9	35.7	4.9	19.3	34.8
SCHWABENSPELZ	81.9	19.4	15.1	20.8	43.4

Table 3: Mean levels of common bunt infection observed on the most resistant spelt wheat genotypes in field trials in the Czech Republic, Austria and Switzerland in 2015 and 2016

Genotype	% bunted ears				
	Stäfa 2016	Prague 2015	Prague 2016	Tulln 2015	Tulln 2016
SOFIA 1	1.7	0.0	0.0	0.0	0.0
ALBIN	0.6	1.0	1.6	0.0	0.0
T. SPELTA KROMERIZ	12.1	0.8	0.0	1.1	2.1
GUGG 2G	16.8	1.1	2.9	0.0	5.2
OSTRO	5.7	4.1	0.0	0.0	16.5
ALTGOLD	14.0	9.3	3.4	3.1	3.9
CERALIO	24.6	7.1	1.9	0.0	1.7
SPY	19.5	4.6	2.7	0.0	11.5

Conclusion

Based on these results from the Czech Republic, Austria and Switzerland, 'Albin' and 'Sofia 1' can be considered as valuable resistance sources to common bunt. As far as we know, the resistance genes of these two genotypes haven´t been characterized yet.

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