BIOLOGIJA. 2007. Vol. 53. No 3. P. 59–62

The effect of alien translocations on winter wheat resistance to *Tilletia tritici* (DC.) Tul.

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Alien translocations in wheat have been exhaustively investigated relative to various diseases, except for common bunt. During the period 2005–2006, an experiment was carried out at the Lithuanian Institute of Agriculture (LIA) in an artificially inoculated nursery. The test cultivars represented the latest Western European winter wheat genotypes. The total mean winter wheat infection in the common bunt nursery was 80.9% and the mean for the selected 36 cultivars 76.2%. The high infection level enabled us to screen the cultivars for the level of partial resistance. Of the selected 36 cultivars with or without various alien translocations, only 'Quebon' was found to be resistant. The least infected cultivars 'Tommi' and 'Bill', can be classified as medium susceptible – 15.0% and 17.2%, respectively. The rest of the cultivars were very susceptible, the mean infection level ranging from 53.5% to 98.8%. Cultivars with *Aegilops ventricosa* translocation were the least infected of the selected genotypes. The mean infection of eight cultivars was 74.9%, and the mean for the rest of the cultivars was 81.2%. As a result, this translocation could additionally possess some barely effective genes of partial resistance. Complex translocation from *Secale cereale* did not possess effective partial resistance. The mean infection of cultivars with other translocations was not really different from that of the selected cultivars. Cultivars with translocation from *A. tauschii* were infected more than the mean 87.4%, whereas cultivars with translocation from *Triticum dicoccum* were infected less than the mean 75.4%.

Key words: alien translocations, winter wheat, resistance, common bunt

INTRODUCTION

Common bunt (*Tilletia tritici* (DC.) Tul.) is potentially one of the most devastating plant diseases and occurs in all the wheat-growing regions of the world. Due to the perfect efficiency of synthetic pesticides, breeding for resistance to this disease has been very limited [1]. The area under organic agriculture has been steadily increasing recently [2]. Common bunt is the main constraint for successful growing of organic winter wheat due to the very limited number of resistant cultivars [3, 4]. According to the EU regulations, seed used in organic agriculture after the year 2005 must be produced organically. Consequently, due to the high deficiency of certified organic seed in Europe, repeated cultivation of winter wheat with farm-saved seeds may in the short term lead to a high infection with common bunt. Wheat breeding for common bunt resistance is one of the most important tasks which requires adequate genetic resources [5, 6].

Alien translocations in wheat have been investigated exhaustively relative to various diseases, except for common bunt [7, 8]. Most European winter wheat cultivars possess the translocations described below. Translocation from *Aegilops ventricosa* (*T2A/2AS-2M#1*) is one of the most successful in wheat breeding; it possesses a complex of resistance genes to three rusts and eyespot: *Lr37/Sr38/Yr17/Pch1* [7, 9]. Translocation from *Triticum timopheevii* (*T2B/2G#*1) is very common in the grown wheat cultivars, although the resistance genes *Sr36/Pm6* are no longer valuable [9]. Translocation from *Secale cereale* (*T1BL/1RS*) with the resistance genes *Pm8/Sr31/Lr26/Yr9* additionally confers a better yielding capacity but a lower grain quality [10]. Some powdery mildew resistance genes from alien derivatives were introduced alone with shorter alien chromosome segments: *Pm2* (*5D*) from *A. tauschii*, *Pm4b* (*2AL*) from *T. carthlicum, Pm5a* (*7BL*) from *T. dicoccum* [11]. All these translocations have not been investigated comprehensively in relation to resistance to *Tilletia tritici*. There is a lack of information in the scientific press about monogenes (*Bt*) or polygenes conferring resistance to this pathogen in the mentioned translocations. Considering the situation when genes of partial resistance to common bunt are investigated very poorly [12], there are possibilities to find some partial resistance in cultivars with the above-mentioned translocations. The main objective of this study was to test resistance to common bunt in winter wheat varieties with various alien translocations.

MATERIALS AND METHODS

During the period 2005–2006, experiments were carried out at the Lithuanian Institute of Agriculture (LIA) in an artificially inoculated nursery. The material subjected to bunt resistance tests included cultivars of Western European origin used as the initial breeding material. Inoculation was carried out by shaking seeds with teliospores (5 g spores / 1000 g seed) in a flask for 5 min. In October, when the soil temperature had dropped below 7 °C, the inoculated seeds were sown 15 g per genotype per a 3-m-long row at a depth of 10 cm in four replications arranged in different parts of the field. The disease incidence was measured after harvesting 100 heads at the medium milk development stage (BBCH 75) as the number of infected ears from the total ears harvested. The following scale was used to estimate varietal resistance: infected ears 0.0 = very resistant, 0.1–5.0 = resistant, 5.1–10.0 = moderately resistant, 10.1–30.0 = moderately susceptible, 30.1–50.0 = susceptible, 50.1–100.0 = very susceptible [13, 14]. Statistical analysis included calculation of the mean and its standard devastation (SD); the means were compared with Duncan's Multiple Range test at the level of significance p = 0.01.

RESULTS AND DISCUSSION

Cultivars tested during the 2005 / 2006 season represent the latest Western European winter wheat genotypes [9]. The total mean winter wheat infection in the common bunt nursery was 80.9% and the mean for the selected 36 cultivars was 76.2% (Table). It shows that during the experimental period infection was exceptionally high, which is important for testing effectiveness. Our previous long-term testing of winter wheat cultivars' resistance to common bunt revealed a high variation of disease incidence between years. This result is the best dur-

Table. **Resistance of winter wheat cultivars with alien translocations to common bunt**

Cultivar	Source of known translocations *	Range of infection, %	Average of infection ±SD	Duncan, 01**
Quebon	*A. ventricosa, A. tauschii*	2–8	5.0 ± 2.6	a
Tommi	*A. ventricosa, T. timopheevii*	3–25	15.0 ± 9.6	a
Bill	*A. ventricosa, T. timopheevii T. carthlicum*	10–22	17.2 ± 2.5	a
Hermann	*A. ventricosa, T. timopheevii T. dicoccum*	28–92	53.5 ± 30.2	b
Briliant	*S. cereale*	41–94	62.1 ± 22.5	bc
Lars	Unknown***	49–91	63.8 ± 18.9	bc
Hattrick	*S. cereale*	53–81	65.2 ± 12.4	bc
Milvus	*A. ventricosa, T. carthlicum, T. dicoccum, T. timopheevii*	36–84	65.3 ± 21.0	bc
Privileg	*A. ventricosa, T. timopheevii T. dicoccum, T. carthlicum*	14–97	68.7 ± 37.4	b-d
Sobi	*A. ventricosa, A. tauschii, T. carthlicum*	47–94	69.3 ± 20.1	b-e
Toras	*A. tauschii*	52–94	70.3 ± 17.5	b-f
Altos	*T. dicoccum*	58–84	75.0 ± 11.7	b-h
Anthus	*T. timopheevii, T. dicoccum T. carthlicum,*	67–82	75.8 ± 6.8	b-h
Solitar	*T. timopheevii,*	69–82	75.9 ± 6.3	c-h
Cetus	*A. ventricosa, T. carthlicum,*	71–85	76.0 ± 6.2	c-h
Širvinta1	Unknown	51–92	77.1 ± 19.5	c-h
Cardos	*A. ventricosa*	70–91	79.2 ± 9.2	c-h
Zentos	Unknown	66–88	79.8 ± 9.7	c-h
Paroli	Unknown	60–97	80.6 ± 15.4	c-h
Opus	Unknown	74–94	83.0 ± 10.0	c-h
SW Topper	Unknown	83–86	84.8 ± 1.3	c-h
SW Maxi	*T. dicoccum*	76–90	84.8 ± 6.2	c-h
Tiger	Unknown	85–91	88.8 ± 2.6	d-h
Tuareg	*T. carthlicum., T. dicoccum, T. timopheevii*	89–93	91.0 ± 1.8	d-h
Campari	*S. cereale, A. tauschii,*	82–97	91.2 ± 6.4	d-h
Heroldo	*T. timopheevii*	90–95	93.0 ± 2.2	e-h
Champion	*S. cereale, A. tauschii, T. carthlicum,*	86–97	93.0 ± 4.8	e-h
Empire	*A. ventricosa, T. carthlicum, T. timopheevii,*	87–99	93.3 ± 5.3	f-h
Striker	*A.ventricosa, T. timopheevii*	88–97	93.5 ± 4.0	f-h
Olivin	*A. tauschii, T. dicoccum*	90–98	94.0 ± 3.4	f-h
Skater	*T. carthlicum*	91–97	94.5 ± 2.5	gh
Idol	*A. tauschii, T. dicoccum*	92–97	95.3 ± 2.2	gh
Marshal	*S. cereale*	90–98	95.8 ± 3.9	gh
Buteo	*T. timopheevii, T. carthlicum, T. dicoccum*	92–98	96.0 ± 2.7	gh
Grommit	Unknown	93–100	97.0 ± 2.9	gh
Alitis	*A. tauschii*	98–100	98.8 ± 1.0	h

* Sources: [7, 8, 9, 11, 17].

** Means followed by the same letters do not differ at 1% of significance.

*** Unknown; possibly without translocations.

ing the 13 years' testing in LIA, because the highest mean infection (46.9%) in this nursery was observed in 1994. During our testing, there were no high infections in two and especially in three consecutive years. Anyway, the probability, that the infection level will be the same or higher is low. Therefore, due to the unstable and unpredictable infection level, we may rely on the results from a one-year testing [15, 16]. The high rate of infection provided a possibility to screen the cultivars for the level of partial resistance. Of the 36 selected cultivars, with or without alien translocations, only 'Quebon' was found to be resistant. But as regards infection variability among replications, this cultivar with the highest infection of 8.0% could be classified as medium resistant. The other two, the least infected cultivars 'Tommi' and 'Bill', can be classified as medium susceptible – 15.0% and 17.2%, respectively. All the other cultivars were very susceptible: mean infection ranged from 53.5% to 98.8%. In any way, none of the cultivars could pass field inspection for the incidence level of this disease (7 infected ears / 150 m^2) [18]. Resistance of the three cultivars mentioned could not be influenced by partial resistance at such a high level [3]. It was the effect of resistance to common bunt genes *Bt* [13]. We had no possibility to identify *Bt* genes in these cultivars by comparing their efficiency or pedigree due to the very limited research on the identification of *Bt* genes in European wheat cultivars [3, 9, 17]. Cultivars with *Aegilops ventricosa* translocation were the least infected of the selected genotypes. Excluding the three most resistant cultivars with *Bt* genes, the mean infection of the rest of the 8 cultivars was 74.9% and the mean of the selected cultivars 81.2%. These cultivars were infected slightly less than the rest ones, but their mean was similar to the total mean (81.2%) of the 33 cultivars. Therefore, this translocation could additionally possess some barely effective genes of partial resistance. To validate this result, we should test the cultivars for another 2–3 years and include more cultivars. But it is difficult to obtain a desirable infection level due to the limited possibility to control environmental conditions in the field. Therefore, successful screening of partial resistance to common bunt under field conditions is hardly possible, because it requires precise control of conditions.

The second most promising translocation is from *S. cereale*. It was present in five cultivars, and their mean infection level was 81.5%. This result shows that this complex translocation did not possess effective partial resistance genes. Analysis of a possible effect of translocations was complicated due to their complex distribution in the cultivars tested. The number of known translocations fluctuated from 0 to 4. The mean infection of cultivars with other translocations was not really different from the mean of the 33 cultivars. The most similar to the total mean were cultivars with translocations from *T. carthlicum*, *T. timopheevii* and cultivars possibly without translocations, 82.3, 80.6 and 81.9%, respectively. The cultivars with translocation from *A. tauschii* the rate of infection was higher than average – 87.4%. Conversely, cultivars with translocation from *T. dicoccum* were infected less than average – 75.4 %. In the case of cultivars with translocation from *A. tauschii,* it is clear that this translocation does not possess any effective partial resistance genes. It is likely that translocation from *T. dicoccum* could induce some slight effect of partial resistance in the cultivars as in the case of translocation from *A. ventricosa.*

Summarizing the obtained effect of alien translocations on winter wheat resistance to common bunt, it is possible to conclude that the translocations studied practically did not contribute to partial resistance.

Selection for partial resistance to the most devastating diseases has been performed for over a hundred years. It has been done purposely for the last 5–6 decades and for about one decade with the help of molecular techniques [7, 11]. In terms of common bunt, the breeding level over the last decades has been very low in Europe, except for Sweden; some work has also been done in Czech Republic and Hungary. However, all research efforts have been actually focused on inducing monogenic resistance. Accumulation of partial resistance was a complete coincidence without purposive action of breeders [3, 15]. Resistance to diseases is costly, reducing the fitness of the host in the absence of disease [19]. Therefore, we could state that the breeding material possessing partial resistance or even monogenes should be eliminated due to a lower yield of quality traits. Given the difficulties with accumulation of polygenes in new breeding material, it is possible that polygenes responsible for resistance to common bunt in winter wheat are present in low concentrations and maybe show a low variability. Accumulation of polygenes that are responsible for disease resistance in winter wheat, for example, to powdery mildew, has been lasting for about 50–60 years. The latest cultivars are so resistant that chemical control of the disease does not offer any economic benefit [9, 11, 17]. Conversely, in the case of bunt, such accumulation has not been done because there was no need due to the perfect effect of chemical seed dressers. Therefore, to detect even partial resistance is a great achievement. There is some promising research on the other bunt species. Partial resistance was detected in the case of Karnal bunt. This disease causes huge complications in the areas of its distribution, and therefore intensive research is in progress. Several quantitative trait loci responsible for partial resistance have been identified recently [20]. The situation could be the same with common bunt if research has been boosted.

Received 7 February 2007
Accepted 20 June 2007

References

1. Mamluk OF, Cetin L, Braun HJ et al. Phytopath Medit 1997; 6(3): 167–81.
2. Vasiliauskienė V, Jukna Č, Krikščiūnienė I ir kt. Lietuvos mokslas 2002; 41: 487–560.
3. Dumulasova V, Bartoš P. J Plant Dis Protect 2006; 4: 159–63.
4. Liatukas Ž, Ruzgas V. Biologija 2005; 3: 62–4.
5. Bonman JM, Bockelman HE, Goates BJ et al. Crop Sci 2006; 46: 1622–9.
6. Borgen A, Davanlou M. J Crop Production 2000; (3)1: 157–71.
7. Bartoš P, Ovesna J, Hanzalova A. Czech J Genet Plant Breed 2004; 40(2): 31–5.
8. Friebe B, Raupp WJ, Gill BS. Wheat in a Global Environment. KAP, Dordrecht, The Netherlands, 2001: 709–20.

9. Bundessortenamt. Beschreibende Sortenliste 2005. Hannover GmbH, 2005: 72–85.
10. Villareal L, Rajaram S, Mujeeb-Kazi A et al. Plant Breed 1991; 106(1): 77–81.
11. Hsam SLK, Zeller FJ. The Powdery Mildews. A Comprehensive Treatise. St. Paul, Minnesota, USA, 2002: 219–38.
12. Cao W, Fox S, Knox R. Abstracts, The Canadian Phytopathological Society annual meeting. London, Ontario, 2001: 195.
13. Veisz O, Szunics L, Szunics L. Euphytica 2000; 114: 159–64.
14. Bänziger I., Forrer HR., Schachermayr G et al. Agrarforschung 2003; 10: 328–33.
15. Pospisil A, Benada J, Nedomova L et al. J Plant Dis Protect 2000; 107: 74–80.
16. Ruzgas V, Liatukas Ž. Agronomy Res 2006; 4: 257–61.
17. Sortsforsøg 2005, Korn, bælgsæd og olieplanter, Ministeriet for Fødevarer, Landbrug og Fiskeri, Danmarks JordbrugsForskning, 2005: 19–31.
18. Lietuvos respublikos žemės ūkio ministerija. Valstybinė sėklos inspekcija. Sėklinių veislinių pasėlių ir veislinių sodo augalų aprobavimo metodiniai nurodymai 1999: 1–85.
19. Brown JKM. Tr Genet 19(12): 667–70.
20. Singh S, Brown-Guedira GL, Grewal TS et al. Theor Appl Genet 106: 287–92.

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GIMININGŲ RŪŠIŲ TRANSLOKACIJŲ POVEIKIS ŽIEMINIŲ KVIEČIŲ *Tilletia tritici* (DC.) TUL. ATSPARUMUI

Santrauka

Svetimos translokacijos kviečiuose yra labai išsamiai ištirtos įvairių ligų atveju, išskyrus kietąsias kūles. Eksperimentas buvo atliktas Lietuvos žemdirbystės institute 2005–2006 m. sezoną dirbtinės infekcijos augyne. Tirtos veislės buvo tipiški Vakarų Europos žieminių kviečių genotipai. Vidutinis žieminių kviečių pažeidimas kietųjų kūlių augyne buvo 81,9%, o vidutinis 36 atrinktų veislių pažeidimas – 76,2%. Dėl labai didelio pažeidimo mes turėjome galimybę ištirti veisles pagal dalinio atsparumo lygį. Nustatyta, kad tarp atrinktų 36 veislių su įvairiomis translokacijomis ar be jų atspari buvo tik veislė 'Quebon'. Kitos dvi mažiausiai pažeistos veislės 'Tommi' ir 'Bill' gali būti klasifikuojamos kaip vidutiniškai jautrios – atitinkamai 15,0 ir 17,2%. Visos kitos veislės buvo labai jautrios – vidutinis pažeidimas nuo 53,5 iki 98,9%. Veislės su *Aegilops ventricosa* translokacija buvo mažiausiai pažeistos iš visų kitų genotipų. Vidutinis 8 veislių pažeidimas buvo 74,9%, o vidutinis visų kitų veislių – 81,2%. Taigi ši translokacija gali turėti papildomus menkai efektyvius dalinio atsparumo genus. Kompleksinė translokacija iš *Secale cereale* neteikė jokio atsparumo. Vidutinis veislių su kitomis translokacijomis pažeidimas buvo artimas visų veislių vidurkiui. Veislės su translokacija iš *A. tauschii* buvo pažeistos daugiau nei vidutiniškai – 87,4%. Tuo tarpu veislių su translokacija iš *Triticum dicoccum* pažeidimas buvo mažesnis už vidurkį – 75,4%.

Raktažodžiai: gimining̨ų rūšių translokacijos, žieminiai kviečiai, atsparumas, kietosios kūlės