Resistance to *Rhopalosiphum padi* (Homoptera: Aphididae) in Triticale and Triticale-Derived Wheat Lines Resistant to *Diuraphis noxia* (Homoptera: Aphididae)[1]

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Abstract *Rhopalosiphum padi* (L.) (bird cherry-oat aphid) and *Diuraphis noxia* (Mordvilko) (Russian wheat aphid) are common aphid pests of wheat and can cooccur at relatively high levels within wheat fields. Resistance to both aphids has been identified in several triticale accessions. We conducted experiments to identify and characterize antibiosis-type resistance to *R. padi* in additional triticale lines and to test *R. padi*-resistance levels in several backcrossed, triticale-derived lines of *D. noxia*-resistant wheat. Triticale accessions '6A-558', 'H85-734' and 'M86-6174' were identified with moderate levels of antibiosis to *R. padi*. All three accessions limited *R. padi* population growth relative to 'Arapahoe' over 13 d. 6A-558 increased development time of *R. padi* compared to that on Arapahoe, and 6A-558, H85-734 and M86-6174 each decreased the number of nymphs produced by *R. padi* over 7 d. Additional tests confirmed 'N1185' triticale as a strong source of resistance to *R. padi*, and showed that 'Lamar' wheat was not resistant to *R. padi*. Tests of wheat lines derived from crosses between N1185 and Lamar and then selected for resistance to *D. noxia* showed that three of 13 lines reduced the number of *R. padi* per plant, with resistance levels comparable to N1185 in two lines. Nymphiposition by *R. padi* measured over a 24-h period did not differ among any lines in no-choice tests. The results provide further support that triticale is a significant source of resistance to *R. padi*, but further work is needed to understand transference of *R. padi*-resistance from triticale to wheat.

Key Words *Rhopalosiphum padi*, bird cherry-oat aphid, triticale, host-plant resistance

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Rhopalosiphum padi (L.) (bird cherry-oat aphid; Homoptera: Aphididae) is a nearly worldwide aphid pest of small grains (Elliott et al. 1994, Blackman and Eastop 2000). Infestations of *R. padi* cause yield loss to small grains by reducing yield components such as kernel mass and the numbers of spikelets and seeds (Pike and Schaffner 1985, Kieckhefer and Gellner 1992, Riedell et al. 1999). *Rhopalosiphum padi* vectors *Barley yellow dwarf virus* (BYDV) to small-grain plants, which can cause further yield loss (McGrath and Bale 1990, Riedell et al. 1999, Chapin et al. 2001, Thackray et al. 2005).

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Limiting cereal-aphid infestations can prevent damage, reduce incidence of BYDV, and sustain yield of small grains (Wiktelius and Pettersson 1985, Power and Gray 1995). Host-plant resistance is a desirable strategy for limiting aphid infestations because it is economical and environmentally sound (Panda and Khush 1995, Webster and Kenkel 1999). Part of a program of genetic wheat improvement consists of identifying aphid resistance in wheat or closely related species, and then incorporating the resistance into agronomic cultivars (Webster and Kenkel 1999).

We have identified resistance to *R. padi* in several triticale (X*Triticosecale* Wittmack) accessions (Hesler 2005, Hesler and Tharp 2005), including plant introductions (e.g., PI 386148, PI 386150 and PI 386156) that also have resistance to the Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Nkongolo et al. 1989, Webster 1990). *Rhopalosiphum padi* and *D. noxia* can cooccur at relatively high levels within wheat fields in several regions (Hammon et al. 1996, Schotzko and Bosque-Pérez 2000), and host-plant resistance to both aphid species may be an advantageous strategy for wheat pest management (Hesler and Tharp 2005).

Hesler (2005) and Hesler and Tharp (2005) suggested screening additional triticale lines for resistance to *R. padi* and performing experiments to test the transferability of resistance from triticale to wheat. To test transferability, wheat lines crossed with PI 386148 and other resistant triticale accessions and selected for aphid resistance are needed. We were unaware of the availability of wheat lines derived from crosses with triticale specifically selected for *R. padi*-resistance, but we had access to wheat lines derived from PI 386148 selected for resistance to *D. noxia* (Nkongolo et al. 1996; S.D.H., unpubl. data). Because several of the triticale lines that we identified as resistant to *R. padi* are also resistant to *D. noxia*, we hypothesized that triticale-derived wheat lines with resistance to *D. noxia* may similarly confer resistance to *R. padi*. Herein, we report on tests that identify and characterize *R. padi*-resistance in additional triticale lines and tests of *R. padi* resistance in several backcrossed, triticale-derived lines of *D. noxia*-resistant wheat.

Materials and Methods

Two separate groups of experiments were conducted with one group involving tests of triticale lines against *R. padi* and the other testing triticale-derived wheat lines. All experiments were conducted at the North Central Agricultural Research Laboratory (NCARL), Brookings, SD. The wheat, triticale, and triticale-derived wheat lines used in the experiments are listed in Table 1, and individual experiments were limited to a maximum of 6 entries due to space and labor constraints.

All experimental plants were prepared by germinating seeds between layers of moist paper towels held in plastic containers in the dark (Hesler et al. 1999). After 24-48 h at 20°C, individual seedlings exhibiting uniform root and coleoptile growth were planted into a 2:1:1 mixture of Vienna soil (fine-loamy, mixed Calcic Hapludolls), perlite and coarsely ground coconut shells (Coir®, J. R. Johnson Supply Inc., Roseville, MN, USA). Seven-day-old seedlings were used at the start of each experiment; these seedlings had one fully extended leaf and a second leaf emerging from the whorl.

Seedlings were infested with winged *R. padi* obtained from a virus-free, multiclonal stock colony maintained on 'Hazen' barley (PI 483238) plants in growth chambers (Controlled Environments Inc., Pembina, ND, USA) at NCARL (Hesler 2005). Infestation by winged viviparae simulates aphid colonization of seedlings in the field

Table 1. Small-grain accessions used in host-plant-resistance experiments with *Rhopalosiphum padi*

Accession	Comments
	Triticum aestivum L. (wheat)
Arapahoe (PI 518591)	Susceptible to *Diuraphis noxia* biotype 1 (Hein 1992) and to *R. padi* (Hesler et al. 1999)
KS92WGRC24 (PI 574479)	Tolerance resistance to *D. noxia* biotype 1 (Martin and Harvey 1995) and to *R. padi* (Hesler 2005)
Lamar (PI 559719)	Susceptible to *D. noxia* biotype 1 (Nkongolo et al. 1996)
Prowers (PI 605389)	Resistant to *D. noxia* biotype 1 (Quick et al. 2001)
	X *Triticosecale* (triticale)
N1185 (PI 386148)	Resistant to *R. padi* (Hesler and Tharp 2005) and *D. noxia* biotype 1 (Nkongolo et al. 1996). Pedigree: *Triticum durum* Desf./*Secale strictum* C. Presl (NGRP 2006a)
Okto Derzhavina (PI 386150)	Resistant to *R. padi* (Hesler and Tharp 2005) and *D. noxia* biotype 1 (Nkongolo et al. 1996). Pedigree: Hostianum 237/*Secale xderzhavinii* Tzvelev (NGRP 2006a)
6A-558 (PI 428993)	Susceptible to *D. noxia* biotype 1 (NGRP 2006b). Pedigree: 4B59/UC-90 (NGRP 2006a)
M86-6174 (PI 542551)	Resistance unknown. Pedigree: Stephen/Turkey rye (NGRP 2006a)
H85-743 (PI 542560)	Resistance unknown. Pedigree: Chinese Spring Wheat/ unknown rye (NGRP 2006a)
H7089-52 (PI 611811)	Resistant to *R. padi* (Hesler 2005)
	Lamar × N1185 (wheat × triticale) lines
CO03751 through CO03764 (minus CO03756 and CO03762)	Resistance to *D. noxia* biotype 1 (unpubl. screening data, S.D.H. and F.B.P.)

(Kieckhefer 1975, Araya et al. 1987). During a test period, populations initially founded by winged aphids would likely produce only nonwinged offspring (Dixon 1998). This eliminates differential developmental and reproductive rates due to aphid morphs and limits variation in aphid population growth to test lines.

Tests of triticale lines. Resistance to *R. padi* among three triticale accessions was compared by using a no-choice test that measured nymphiposition by winged *R. padi* during the initial 24 h of infestation and subsequent population growth of *R. padi* among accessions over a 13-d infestation period (Hesler 2005). This test was followed by an experiment that measured the development time and reproduction of *R. padi* among triticale accessions. 'Arapahoe' wheat (Baenziger et al. 1989) was formerly one of the most widely grown varieties in South Dakota (SDASS 1998) and the northern Great Plains. It is susceptible to *R. padi* (Hesler et al. 1999) and *D. noxia* (Hein 1992). Arapahoe has been used as a control in previous resistance studies with *R. padi* (Hesler 2005, Hesler and Tharp 2005), and served as an aphid-susceptible control in the present study. The triticale line 'Okto Derzhavina' was used as an *R. padi*-resistant check (Hesler and Tharp 2005) in the tests.

Nymphiposition and population growth. Test plants were planted into cylindrical tubes (D40 Deepot Cell, 6.4 cm diam, 25.0 cm ht; Stuewe and Sons, Corvalis, OR) filled with soil, which was then covered with 2.5 cm of 40-mesh sand. Plants were randomized by accession within 8-12 replicate blocks and transferred to environmental chambers (18-20°C, approx. 50% RH, and 13:11 L:D photoperiod) for the tests.

To start each test, plants were infested with three winged *R. padi* and covered with vented, clear plastic cylinders (3.5 cm diam, 35 cm ht). The winged *R. padi* were not necessarily uniform in age. Twenty-four hours after infesting, winged *R. padi* were removed and the numbers of nymphs deposited per plant were counted (day-1 counts). Nymphs were thinned to 5 per plant, and plants were then recaged and returned to the test chamber. Twelve days later, the numbers of aphids per plant were counted (day-13 counts). For each test, day-1 and day-13 counts were each subjected to a respective analysis of variance (ANOVA). Counts from the two tests, which were identical, were subjected to mixed model ANOVA appropriate for repeated tests (PROC MIXED program; Littell et al. 1996; SAS Institute 2002). Means were separated using the LSMEANS feature that incorporated a Tukey-Kramer adjustment to control experimentwise error rate ($\alpha = 0.10$). A level of statistical significance set at $\alpha = 0.10$ is useful to detect meaningful resistance to *R. padi*, and this level of significance was used in other experiments for consistency.

Development time and reproduction. The effect of accessions on number of days from birth to onset of reproduction by *R. padi* and the number of nymphs produced by each *R. padi* in the first 7 days of adulthood were determined. Seedlings exhibiting uniform root and coleoptile growth were planted individually into 10-cm diam clay pots filled with soil mix, and the mix was covered with about 2.5 cm of 40-mesh sand. Each pot contained one seedling of a single accession. Seven days after planting, 8 pots of each accession were selected for uniform seedling growth. Each plant was then infested with a winged *R. padi*, and covered with vented, plastic, tubular cages (7 cm diam, 35 cm tall) pushed into the soil. After 24 h, winged aphids were removed, and neonates thinned to one per seedling. Each nymph-plant pair represented one replication. Pots were arranged in a randomized complete block design within a growth chamber (18-20°C, photoperiod of 13:11 [L:D] h). Beginning 6 days after initial infestation, experimental plants were examined daily for nymphiposition as aphids matured. The date when nymphiposition began was recorded for each aphid, and neonates were counted and removed every 1-2 d over the next 7 d. The number of nymphs deposited by each aphid was summed over its first 7 days of reproduction. This experiment was performed twice. Data on time to reproductive maturity from the two trials were combined in one analysis, and data on the number of progeny were combined in a separate analysis. For each analysis, a mixed model ANOVA (PROC MIXED) was used, with line as a fixed factor, trial and block as random factors, and block nested within trial. Means were separated using the LSMEANS feature that incorporated a Tukey-Kramer adjustment to control experimentwise error rate ($\alpha = 0.10$).

Triticale-derived wheat lines. Wheat lines were tested for resistance to *R. padi* following crosses between a susceptible wheat accession and an aphid-resistant triticale accession. Two sets of experiments were conducted. The first set was performed to confirm susceptibility to *R. padi* in a parental wheat accession, and the second set of experiments compared levels of resistance among triticale-derived wheat lines to that of their resistant triticale parent. Experiments were conducted by using the nymphiposition-population growth test as described earlier.

Tests of Lamar wheat as a susceptible parent for triticale-derived wheat lines. The performance of *R. padi* on wheat cultivar 'Lamar,' triticale accession PI 386148 (also known as 'Spontany Kanova N1185,' hereafter 'N1185'), and other aphid-resistant wheat and triticale lines were specifically included to confirm Lamar as susceptible and N1185 as resistant to *R. padi* (Hesler and Tharp 2005). This test was conducted twice, with Arapahoe wheat as the susceptible check. Counts from the two tests were subjected to mixed model ANOVA appropriate for repeated tests (PROC MIXED), with mean separation by LSMEANS incorporating a Tukey-Kramer adjustment ($\alpha = 0.10$).

Tests of triticale-derived wheat lines. The second set of tests (denoted A, B, C, and D) was conducted to compare *R. padi* performance on the various wheat-x-triticale lines, with Lamar wheat as the susceptible check. The first three tests in this group were conducted to identify resistant lines, and the final test was conducted to retest performance against *R. padi* of the three most promising wheat-x-triticale lines for which sufficient seed remained and to directly compare the performance of those lines against N1185. Counts from each of these tests were subjected to separate ANOVA (PROC GLM; SAS Institute 2002), with accession means separated by Tukey's HSD test ($\alpha = 0.10$).

The wheat-x-triticale lines used for testing the transfer of *R. padi*–resistance were the backcross progeny derived from crosses between Lamar wheat and N1185 triticale. N1185 was initially used as the male parent and Lamar wheat as the female parent. Backcross progenies were evaluated for resistance to *D. noxia* biotype 1 after each of the first two, backcross generations, and the resistant progeny were used as male parents with each subsequent backcross to Lamar as the female parent. Pollen from resistant plants of the second backcross progeny was irradiated at 1 kR using a ^{60}Co source as described by Nkongolo et al. (1993). The third backcross was made with the irradiated pollen, also using Lamar as the recurrent wheat parent. After this last backcross, the derived progenies that were resistant to *D. noxia* biotype 1 were self-pollinated for more than seven generations. Only individual plants that showed high-level resistance to *D. noxia* biotype 1 were selected for self-pollination at each generation. These crossings and screenings produced 13 lines that were tested for resistance against *R. padi* in our experiments.

Results and Discussion

Tests of triticale lines. *Nymphiposition and population growth.* Nymphiposition by winged *R. padi* during the initial 24 h of infestation did not differ among accessions ($\bar{X} \pm SE = 8.8 \pm 0.5$ nymphs per plant, $F = 0.98$; df = 4, 74.9; $P = 0.42$), consistent with results of previous no-choice nymphiposition tests with winged *R. padi* (Hesler 2005, Hesler and Tharp 2005). Population growth of *R. padi* over 13 d differed among entries ($F = 7.11$; df = 4, 56.1; $P < 0.001$), with each triticale accession having less *R. padi* per plant compared with Arapahoe wheat (Table 2, Set 1).

Table 2. Number of *Rhopalosiphum padi* on Arapahoe wheat and four triticale accessions after 13 d of infestation

Accession	Mean per plant ± SE
Set 1	
Arapahoe wheat	118.8 ± 5.1 a
6A-558 triticale	91.0 ± 8.5 b
H85-743 triticale	84.7 ± 5.6 b
M86-6174 triticale	80.2 ± 8.4 b
Okto Derzhavina triticale	72.8 ± 9.6 b
Set 2	
Arapahoe wheat	170.0 ± 7.2 a
KS92WGRC24 wheat	152.5 ± 11.2 a
Lamar wheat	161.6 ± 5.3 a
Prowers wheat	170.9 ± 5.4 a
H7089-52 triticale	163.6 ± 8.6 a
N1185 triticale	79.4 ± 6.4 b

Means ± SE not followed by the same letter are significantly different (LSMEANS method, Littell et al. 1996; $\alpha = 0.10$). Means in each set are for two trials of identical tests (Set 1: $n = 9$, first trial; $n = 12$, second trial. Set 2: $n = 10$, first trial; $n = 12$, second trial).

Development time and reproduction. Both number of days to reproduction ($F = 2.19$; df = 4, 89.9; $P = 0.076$) and number of progeny produced by *R. padi* in the first 7d of adulthood differed by accession ($F = 12.41$; df = 4, 90; $P < 0.001$). The number of days to reproduction by *R. padi* ($\bar{x}$ ± SE) was greater on 6A-558 triticale (8.5 ± 0.1 d) than on Arapahoe wheat (8.0 ± 0.1 d), but days to *R. padi* reproduction did not differ among other triticale accessions (each 8.2 ± 0.1 d) or between them and Arapahoe wheat. Fewer progeny were produced by *R. padi* on triticale accessions than on Arapahoe wheat (Fig. 1). There were also fewer *R. padi* nymphs on accessions 6A-558 and Okto Derzhavina than on M86-6174, whereas the number of nymphs on H85-743 did not differ from that on other triticale accessions.

Triticale-derived wheat lines. *Tests of Lamar wheat as a susceptible parent for triticale-derived wheat lines.* Nymphiposition by winged *R. padi* during the initial 24 h of infestation did not differ among wheat and triticale accessions ($\bar{x}$ ± SE = 9.2 ± 1.0 nymphs per plant, $F = 0.71$; df = 5, 99.7; $P = 0.62$), consistent with results of previous no-choice nymphiposition tests with winged *R. padi* (Hesler and Tharp 2005). Population growth of *R. padi* over 13 d differed among entries ($F = 26.40$; df = 5, 80.4; $P < 0.001$), with N1185 triticale having less *R. padi* per plant compared with other accessions (Table 2, Set 2). This result was consistent with an earlier study (Hesler and Tharp 2005) that showed N1185 limits the number of *R. padi* per plant relative to Arapahoe wheat. Lamar wheat did not differ from Arapahoe in numbers of *R. padi* per plant, indicating Lamar was a suitable susceptible check for subsequent tests. Wheat lines 'KS92WGRC24' and 'Prowers' and triticale line 'H7089-52' did not differ from Arapahoe in the number of *R. padi* per plant. The lack of difference in *R. padi*-population growth between Arapahoe, KS92WGRC24, and H7089-52 is consistent with previous results (Hesler 2005). Of the three *D. noxia*-resistant lines in this test (KS92WGRC24, Prowers and N1185), only N1185 limited population growth of *R.*

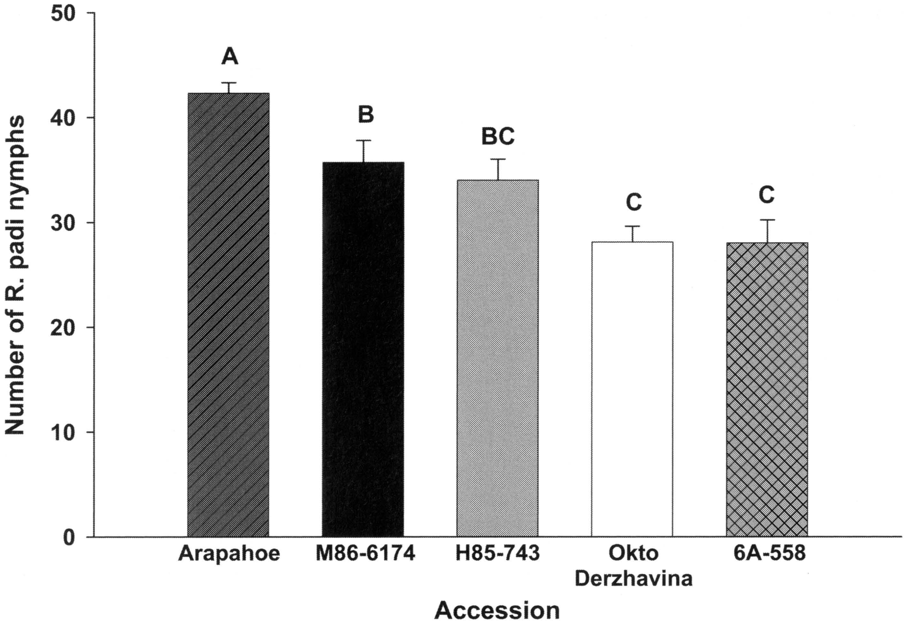

Fig. 1. Number of *Rhopalosiphum padi* nymphs produced over 7 d on Arapahoe wheat and four triticale accessions. Means ± SE are for two identical trials of testing (*n* = 12, each trial).

padi. N1185 possesses antibiosis/antixenosis type resistance to *D. noxia* (Nkongolo et al. 1996), whereas tolerance is the primary mode of resistance to *D. noxia* in KS92WGRC24 and Prowers (Martin and Harvey 1995, Quick et al. 2001).

Tests of triticale-derived wheat lines. Nymphiposition by winged *R. padi* during the initial 24 h of infestation did not differ ($P > 0.10$) among accessions in this group (test A: $X \pm$ SE = 5.3 ± 0.4 nymphs per plant, $F = 0.34$, df = 4, 44; test B: $X \pm$ SE = 13.4 ± 0.5 nymphs per plant, $F = 0.61$, df = 5, 54; test C: $\bar{x} \pm$ SE 8.5 ± 0.5 nymphs per plant, $F = 1.15$, df = 4, 42; test D: $\bar{x} \pm$ SE = 8.9 ± 0.5 nymphs per plant, $F = 0.46$, df = 4, 44). Population growth results are given in Table 3. Wheat-x-triticale lines did not reduce *R. padi* population growth relative to Lamar wheat in test A ($F = 2.15$; df = 4, 17; $P = 0.12$) and test B ($F = 1.93$; df = 5, 38; $P = 0.11$), although line CO03757 had <50% of the number of *R. padi* per plant as Lamar in test B. In test C, line CO03752 had fewer *R. padi* per plant than Lamar did ($F = 2.33$; df = 5, 35; $P = 0.07$), but three other wheat-x-triticale lines did not differ from Lamar in the number of *R. padi* per plant. In test D, lines CO03757 and CO03763 and N1185 triticale had fewer *R. padi* per plant than Lamar wheat ($F = 13.15$; df = 4, 37; $P < 0.001$). Lines CO03757 and CO03763 did not differ from each other or from N1185 in the number of *R. padi* per plant.

To summarize, our results identified three additional triticale accessions with resistance to *R. padi,* and we demonstrated limited success in transference of *R. padi*-resistance from N1185 triticale to wheat. Accessions 6A-558, H85-734 and M86-6174 are further examples of triticale with low to moderate levels of antibiosis

Table 3. Number of *Rhopalosiphum padi* on wheat and triticale, and wheat-x-triticale lines after 13 d

Accession	Mean per plant ± SE
Test A	
Lamar wheat	154.1 ± 10.1 a
CO03755	119.8 ± 9.1 a
CO03757	97.3 ± 17.4 a
CO03761	121.8 ± 13.9 a
CO03763	129.2 ± 14.6 a
Test B	
Lamar wheat	214.9 ± 14.5 a
CO03753	178.5 ± 8.6 a
CO03758	177.4 ± 11.4 a
CO03759	207.7 ± 12.5 a
CO03760	205.6 ± 10.5 a
CO03764	213.1 ± 10.7 a
Test C	
Lamar wheat	107.6 ± 8.6 a
CO03751	84.9 ± 10.3 ab
CO03752	81.2 ± 8.9 b
CO03754	99.3 ± 7.9 ab
CO03765	101.3 ± 4.7 ab
Test D	
Lamar wheat	155.5 ± 7.5 a
CO03752	127.4 ± 7.9 ab
CO03757	89.7 ± 9.1 c
CO03763	100.5 ± 8.9 bc
N1185 triticale	74.7 ± 9.7 c

For each test, means ± SE not followed by the same letter are significantly different (Tukey's HSD test; $\alpha = 0.10$).

resistance to *R. padi* (Neil et al. 1997, Hesler 2005, Hesler and Tharp 2005). Antibiosis resistance can be effective in preventing aphids from reaching economic damage levels (Dreyer and Campbell 1987, Kennedy et al. 1987, Wiktelius and Pettersson, 1985), and is an especially favored modality for limiting spread of aphid-vectored plant viruses, such as BYDV (Gibson and Plumb 1977, Kennedy 1976, Power and Gray 1995). Tests for additional modalities of resistance (i.e., antixenosis and tolerance) and particular resistance mechanisms (e.g., plant defense compounds) should be conducted.

The pedigrees of 6A-558, H85-734, M86-6174, N1185 and Okto Derzhavina differ from one another (Table 1). Future studies are needed to compare the genetics of these accessions and determine if they have different genes for resistance to *R. padi*. Having a relatively large repertoire of resistance genes may be valuable for utilizing and managing host-plant resistance to *R. padi*.

With more triticale accessions identified with resistance to *R. padi*, there is increasing need to determine the transferability of this trait to cultivated wheat. We tested for transference of *R. padi*-resistance into wheat lines derived from crosses between Lamar wheat and N1185 triticale, but found resistance to *R. padi* in only 3 of the 13 derived lines, although resistance in the lines was comparable to that in N1185. We expected a greater proportion of *R. padi*-resistance in the triticale-derived wheat lines, given the high frequency of *R. padi*-resistance in N1185 plants tested in the present study (23 of 27 replicate plants with low to intermediate numbers of *R. padi*) and similarly high frequencies of resistance observed among N1185 plants in previous tests (Hesler and Tharp 2005). As all N1185 seeds and plants used for crossing were checked for purity (Nkongolo et al. 1996), it is unlikely that extraneous genotypes were included in the crosses. Rather, the limited success in transference of *R. padi*-resistance may have been due to selection during backcrossing for *D. noxia*-resistance that precluded resistance to *R. padi*, and indicates that genes for resistance to *D. noxia* differ from those for *R. padi*. Future studies are needed to test triticale accessions for the independence of resistance to each aphid species and to test transferability of *R. padi*-resistance in triticale-derived wheat lines selected specifically against that aphid species.

Triticale is a valuable genetic resource for wheat improvement, as it may be a vehicle to transfer desirable characteristics of rye, such as insect and disease resistance, into wheat (Furman et al. 1997). Our identification of three more triticale accessions with resistance to *R. padi* further emphasizes its value. However, the introgression of genes directly from rye or indirectly via triticale may negatively affect the yield, quality, and agronomic adaptation of wheat (Furman et al. 1997), and wheat with undesirable characteristics derived from rye or triticale may require additional mating and selection before aphid resistance can be deployed in finished cultivars (Souza 1998). Nonetheless, advances in molecular genetic techniques, which have the potential to facilitate introgression of insect resistance genes between cereals (Quisenberry and Clement 2002), may improve the probability of successful transfer from triticale to wheat of desirable traits, such as aphid resistance, while precluding undesirable ones. Further research should determine expedient ways of transferring resistant traits from triticale into wheat.

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