Abundance of Cereal Aphids (Hemiptera: Aphididae) within Wild *Triticum* and *Aegilops* spp., and Cultivated Wheat*

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Abstract

HAVLÍČKOVÁ H., HOLUBEC V. (1999): **Abundance of cereal aphids (**Hemiptera: Aphididae**) within wild** *Triticum* **and** *Aegilops* spp.**, and cultivated wheat**. Plant Protect. Sci., **35**: 67–70.

Accessions of the wild *Triticum* species: *T. boeticum, T. dicoccoides, T. urartu,* and the *Aegilops* species: *Ae. columnaris, Ae. geniculata, Ae. markgrafii, Ae. neglecta* and *Ae. triuncialis* in the collection of the Gene Bank of RICP Prague-Ruzyně, with *T. aestivum* cv. Sandra as control, were evaluated for cereal aphid occurrence in the open during 1995–1998 period. The cereal aphid species *Rhopalosiphum padi* (*RP*), *Metopolophium dirhodum* (*MD*) and *Sitobion avenae* (*SA*) were predominant on the plants. Variations in the abundance of individual aphid species in each year were found. The results from 1997, the optimal year for aphid occurrence, showed differences between both aphid and plant species. *RP* significantly dominated in *Triticum* species, while *SA* preferred *Aegilops* accessions. A significant negative correlation was found between *RP* and *MD* densities in the *Triticum* spp., while *MD* and *SA* occurrence showed a negative relation to that of *RP* and *SA* in the *Aegilops* accessions. The individual aphid species showed a similar pattern of infestation in several genomically close accessions.

Key words: cereal aphids; abundance; *Metopolophium dirhodum*; *Rhopalosiphum padi*; *Sitobion avenae*; wild *Triticum* spp.; *Aegilops* spp.

Wherever cereals are grown aphids attack them, each species feeding on different parts of the plants and varying in their abundance from year to year (DIXON 1987; KÖRBER & CARL 1991). Many authors documented great differences in aphid infestations of various cereal species and cultivars, as well as different species of wild *Triticeae* grasses. Much attention has been devoted to the study of aphid behaviour on hosts in relation to plant resistance against aphids. In this respect, wild plants and primitive ancestors of the cultivated plants in current use are very important sources of resistance genes for cereal breeding against aphids (TREMBLAY *et al.* 1989; BURTON *et al.* 1990; KINDLER 1991).

A relatively large number of wild *Triticeae* grasses including wheat ancestors has been assembled in the Gene Bank of the Research Institute of Crop Production in Prague-Ruzyně. A major part of this material was tested for the resistance to diseases (HOLUBEC *et al.* 1992). Since 1987 a number of accessions, mainly from the *Aegilops* genus has been tested for resistance to cereal aphids (HAVLÍČKOVÁ & HOLUBEC 1995). In these tests remarkable differences in abundance of individual aphid species on *Aegilops*, wild *Triticum* species and winter wheat cultivars were observed. Several representatives of these plant species were selected and used for evaluation of occurrence and behavior of individual aphid species on different host plants.

MATERIAL AND METHODS

Five *Aegilops* spp.: *Ae. columnaris, Ae. geniculata, Ae. markgrafii, Ae. neglecta, Ae. triuncialis* and four *Triticum* spp.: *T. boeticum, T. dicoccoides, T. urartu*, as well as winter wheat species *T. aestivum* cv. Sandra as control, were cultivated on experimental plots (0.8 m × 0.8 m) in Prague-Ruzyně, from 1995 to 1998. One accession of one provenience from each species selected in Prague-Ruzyně in previous years was used. The 40 seeds of all tested species were sown in four replications in autumn of each year. The experimental field was surrounded by a strip of winter wheat cv. Regina. In each experimental plot the number of aphids present on 20 tillers were counted at the end of plant anthesis.

Aphid abundance and occurrence of individual aphid species on the tested accessions were recorded during all years under study. Aphid abundance was evaluated according to the total number of aphid individuals per tiller. The percentage or proportion of each aphid species in the total aphid population number per tiller on individual ac-

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cessions, served as a criterion of host suitability for individual aphid species. Because of the great variability of aphid occurrence from one year to the next, the data obtained in 1997 were used as a standard for the determination of the differences in aphid abundance on the tested accessions. In this particular year the main aphid species occurred at sufficient population densities and the experimental plants were at the end of anthesis before the incidence of natural enemies. Simple statistical analysis were used: *t*-test for differences in aphid abundance on individual accessions and the linear regression for relations between proportions of individual aphid species on accessions.

RESULTS

Three cereal aphid species, *Metopolophium dirhodum* Walk. (*MD*), *Rhopalosiphum padi* L. (*RP*) and *Sitobion avenae* Fabr. (*SA*) occurred on the experimental plants each year. In 1995 a large number of *Sipha elegans* Guercio (*SE*) was observed in *T. boeticum*. However, no individuals of this aphid species were found in the following years. At the time of aphid evaluation the largest colonies of *MD* were found on the abaxial sites of the flag and the second leaves, while the tips of these leaves were preferred by *SE*. *RP* mostly occupied the sheaths of lower leaves and *SA* was concentrated in the young ears. According to the visual observations, the aphids occurring on *Aegilops* and wild *Triticum* species were considerably smaller than those feeding on plants of the wheat cv. Sandra. The population density of individual aphid species varied considerably during experimental years. With the exception of 1997 one or two aphid species were either present in very low numbers or were completely absent (*SE* in 1996–1998, Table1).

The data from 1997 provided the best information, since the results from this year showed great differences in infestation by aphids on individual accessions. Except for *T. boeticum*, the total number of aphids per tiller was higher in *Triticum* than in *Aegilops* species. Infestation of *T. aestivum* and *T. dicoccoides* was significantly higher ($P < 0.01$) than that of the other tested accessions. By contrast, in *Ae. geniculata* and *Ae. neglecta* the total number of aphids per tiller was significantly lower ($P < 0.01$) when compared with the rest of the accessions (Fig. 1).

Table. 1 Abundance and relative density [%] of *M. dirhodum* (*MD*), *R. padi* (*RP*), *S. avenae* (*SA*) and *S. elegans* (*SE*) on plants of *Triticum* and *Aegilos* spp. in the individual years. Presented values are the means of 720 evaluated tillers, 80 from each tested accession, at the end of anthesis

Year	Individuals per tiller	*MD*	*RP*	*SA*	*SE*
1995	2.90	14.2	3.4	19.7	62.7
1996	0.34	3.8	92.4	3.8	0.0
1997	10.00	40.4	44.6	15.0	0.0
1998	0.41	12.8	9.3	77.9	0.0

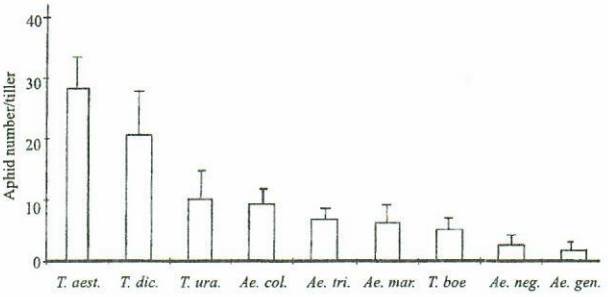

Fig. 1. Average abundance of cereal aphids on plants of the tested accessions (*Triticum aestivum, T. boeticum, T. dicoccoides, T. urartu, Aegilops columnaris, Ae. geniculata, Ae. markgrafii, Ae. neglecta* and *Ae. triuncialis*) in 1997. Presented values are the means (± SD) from 80 tillers of each accession

The population densities of individual aphid species on the tested plants differed in relation to both aphid and plant species. Similar aphid species proportions were found in genomically related accessions. Infestation in *T. aestivum* and *T. dicoccoides* was high, while in *Ae. neglecta* and *Ae. geniculata* it was low (Fig. 1 and 2). Opposite values of *RP* and *SA* densities were found in *Triticum* and *Aegilops* spp., respectively. In *Triticum* species *RP* dominated significantly ($P < 0.01$), while in *Aegilops SA* numbers were significantly ($P < 0.01$) higher. No significant differences in *MD* proportions were found between *Triticum* and *Aegilops* spp. (Fig. 2).

In wheat plants the proportions of *SA* were generally lower than those of other aphid species and the increase in *RP* infestation of the accessions correlated to a decrease in *MD* incidence ($P < 0.01$). With the exception of *T. urartu*, where *RP* largely prevailed, a higher level of *RP* in the accessions was accompanied by an increased *SA* density.

The results received for *Aegilops* varied to a larger extent than those for *Triticum*. In *Aegilops SA* comprised more than one third of the total aphid count, while *RP* was present in smaller quantities than *SA* (*Ae. columnaris, Ae. geniculata, Ae. neglecta*) or *MD* (*Ae. triuncialis, Ae. markgrafii*). A negative correlation between *MD* and *SA*, *RP* and *SA* occurrence on the tested accessions ($P < 0.01$ and $P < 0.1$, respectively) was shown to exist, while the correlation between *MD* and *RP* proportions was mostly positive.

The high attractiveness of *Triticum* spp. for *RP* was frequently apparent in *T. urartu* (86.7% of total aphids/tiller). *M. dirhodum* generally preferred *T. aestivum* (65.2% of aphids/tiller) and also dominated in *T. boeticum, Ae. triuncialis* and *Ae. markgrafii*. All these accessions were weakly infested with *SA* in all our experiments. *T. aestivum* had the lowest attractiveness for *SA* (4.1% of total aphids/tiller). By contrast, *SA* represented more than 60% of total aphids number counted in *Ae. columnaris* (Fig. 1 and 2).

DISCUSSION

Different levels of abundance of each aphid species were observed on the tested plants in different experimental years. It is well known that occurrence of individual aphid

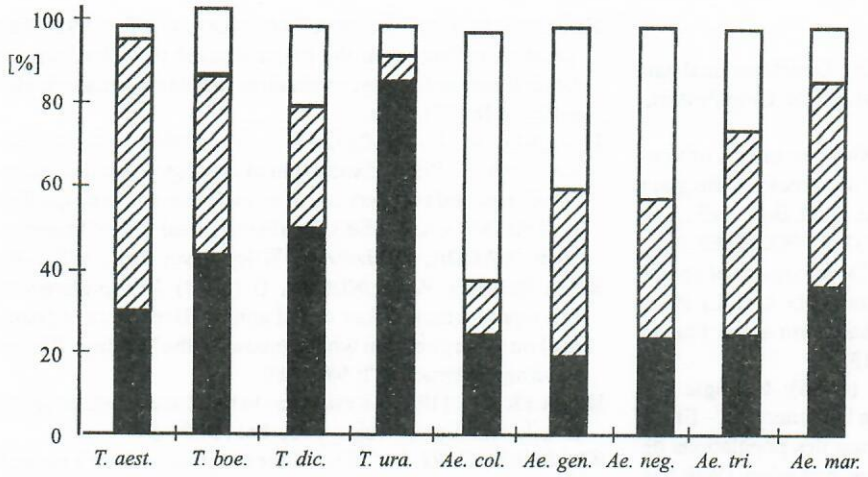

Fig. 2. Relative density (%) of individual aphid species on plants of tested at the end of anthesis in 1997. Presented values are the means of 80 tillers of each accession

species varies in relation to climatic and weather conditions from year to year (DEDRYVER & GILLE 1982; ACREMAN & DIXON 1989). In 1995, *S. elegans* predominated and was also present in wild *Triticum* in the 1993–1995 period (HAVLÍČKOVÁ *et al.* 1996), while no individuals of this aphid species were found on the tested plants in the following years.

A very low aphid occurrence or population density of one or two aphid species in 1996, did not allow us to obtain a complete set of data for each of the four experimental years. However, in 1997 the plants' condition and densities of all main aphid species were optimal for the tests. Even though the aphids feeding on plants of winter wheat cultivar were considerably bigger, wild *Triticum* and *Aegilops* species were preferred. *SA* preference for several *Aegilops* accessions might be attributed to their quicker development when compared with that on wheat. According to DEDRYVER and DIPIETRO (1986), a moderate precocity of the plants could result in their higher attractiveness for *SA*.

All wild *Triticum* species were probably very good hosts for *RP*. It would appear that their wide host–plant spectrum of *RP* (KIECKHEFER & LUNDEN 1983) does not exclude specific patterns of discrimination to its host choice in regard to *Triticum: T. boeticum, T. dicoccoides, T. urartu,* and *Aegilops: Ae. columnaris, Ae. geniculata, Ae. markgrafii, Ae. neglecta* and *Ae. triuncialis* (WEIBULL 1990). This assumption could also be supported by a very late observation (6 Nov. 1998, the daily temperature not exceeding 10 °C) of the large colonies of *RP* on seedlings of *T. araraticum* growing on the experimental fields in Prague-Ruzyně (our observation). The high ability of this aphid species to select wild *Triticum* spp. – also manifested by a significant preference for *T. urartu* – might increase its dangerous effects through virus transmission from wild to cultivated plants (MASTERMAN *et al.* 1994). Generally, suitable nutritive quality for aphids of several *Aegilops* and wild *Triticum* species was confirmed by chemical analyses of their seeds (HOLUBEC *et al.* 1992, 1993).

Unlike *R. padi*, *S. avenae* mainly infested *Aegilops* accessions despite its usual preference for winter wheat (WRATTEN 1978). The dominance of one aphid species over another depends on many factors and the developmental patterns of wheat were shown to affect *SA* behavior on plants (ACREMAN & DIXON 1985). A negative correlation between the population proportions of *RP* and *MD* found in primitive *Triticum* was also observed in several winter wheat cultivars (HAVLÍČKOVÁ 1989). An increase in *RP* infestation frequently accompanied by an increase in *MD* densities in *Aegilops* was found not only in this study but also in previous experiments (HAVLÍČKOVÁ & HOLUBEC 1995).

In general, genetically close accessions were similarly attractive or not attractive for aphids. The very low infestation of genomically close *Ae. neglecta* and *Ae. geniculata*, corresponds with the results of the earlier tests (HAVLÍČKOVÁ & HOLUBEC 1995), and thus supports this conclusion. The leaf waxiness of these two species may play an important role in the plant deterrence for aphids (TSUMUKI *et al.* 1989; ACREMAN & DIXON 1989). By contrast, genomically close *T. aestivum, T. dicoccoides and T. urartu* were suitable for aphids. A smaller genetic similarity of *T. boeticum* to cultivated wheats could be the cause of its lower average infestation despite its high attractiveness for *S. elegans* (HAVLÍČKOVÁ *et al.* 1996).

Our results indicate that several *Aegilops* species were nonpreferred by all aphid species and thus might serve as genetic resources in breeding programs for wheat improvement. On the other hand, several accessions of wild *Triticum* and *Aegilops* were preferred as good hosts by one or two aphid species. Differences among individual aphid species in host selection have to be therefore taken into account when searching for resistance sources against cereal aphids.

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Souhrn

HAVLÍČKOVÁ H., HOLUBEC V. (1999): **Abundance mšic na planých travách rodů *Triticum, Aegilops* a pšenici ozimé**. Pl. Protect. Sci., **35**: 67–70.

V letech 1995–1998 byl v Praze-Ruzyni testován soubor ozimých trav rodů *Triticum* – *T. boeticum, T. dicoccoides, T. urartu* a *Aegilops* – *Ae. columnaris, Ae. geniculata, Ae. markgrafii, Ae. neglecta* a *Ae. triuncialis* a jedné odrůdy pšenice ozimé Sandra na výskyt mšic. Ve všech letech byly zjištěny na rostlinách tři druhy mšic – *M. dirhodum* (*MD*), *R. padi* (*RP*) a *S. avenae* (*SA*). Četnost i zastoupení jednotlivých druhů mšic v jednotlivých letech kolísalo. Výsledky z roku 1997, kdy byly všechny druhy mšic přítomny v dostatečné hustotě, ukázaly průkazně vyšší podíl *R. padi* na zástupcích rodu *Triticum* a vyšší procento *SA* na zástupcích rodu *Aegilops*. U zástupců rodu *Triticum* byla zjištěna negativní korelace mezi četností *RP* a *MD*. Na travách rodu *Aegilops* byla negativní korelace stanovena mezi zastoupením *MD* a *SA* a *RP* a *SA*. Genomově blízké druhy vykázaly podobný stupeň infestace jednotlivými druhy mšic.

Klíčová slova: plané druhy rodu *Triticum*; *Aegilops* spp.; obilní mšice; *Metopolophium dirhodum*; *Rhopalosiphum padi*; *Sitobion avenae*; abundance

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