APHIDS AND OTHER HEMIPTEROUS INSECTS	VOL. 13 219-226

Correlation between the settling of cereals by grain aphid (*Sitobion avenae* F.) and the number of parasitic *Hymenoptera*

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Introduction

On grasses, including cereals, the presence of several dozens of aphid species is observed, among which: *Rhopalosiphum padi* L., *Sitobion avenae* F. and *Metopolophium dirhodum* (Wlk.) are registered to occur in great numbers in Europe (Abo Kaf & Moczulski, 1991a; Cocker, 1980; Pankanin-Franczyk, 1982; 1990; Ruszkowska, 2002; Stary, 1976). One of the most important factors which limit the numerous spreading of these insects is a rational and systematic weed control. Weeds, which grow in greater numbers and are settled by aphids much earlier than crops, may therefore, lead to serious dispersion of these aphids on crop plants (Achremowicz *et al.*, 1968). The presence of weeds may, however, at times prove to be desired because they constitute a specific reservoir for populations of aphids' natural enemies such as primary parasitoids (Barczak, 1991).

The structure of crop environment in Poland in combination with a less intensive as yet treatment of chemicals on the fields, favours the occurrence of natural enemies of cereal pest insects and their greater effectiveness (Miczulski, 1978). The effectiveness of aphidophagous organisms in controlling aphid populations, including the prevention of their gradation is also dependent on factors such as e.g. relevant technologies of crops, size of field and diversification of agricultural landscape (Kroeber & Carl, 1991).

This research attempted to determine the dependence between the degree of settling winter wheat and rye plantations by the grain aphid (*Sitobion avenae* (F.)) colonies and the number of associated parasitic hymenopterans.

Material and methods

Material concerned with the settling of cereals by the grain aphid and the number of its parasitoids was collected in the north of Poland on winter rye and winter wheat crops, located in the Kujawy-Pomerania region (Mochełek large scale farm area and Żędowo individual farm) in 1996-1997.

Colonies of grain aphid (*S. avenae*) and associated parasitic hymenopterans were the object of research. All the insects that were isolated in the course of rearing were primary parasitoids from the Ichneumoridea: *Aphidiidae* and *Chalcidoidea: Aphelinidae* families as well as hiperparasitoids (total).

Samples were collected yearly on crops, the size of which ranged from 6 to 8 ha. On the fields no aphid or other agrophagous organism chemical control was applied. The material for research on aphids and parasitic hymenopterans was collected every 4 – 7 days, from the moment when aphids migrating on crop field gave birth to its first offspring until the full maturity of cereals.

In order to determine the number of aphids and the degree of plants colonised by them each time on the edge and in the centre of the field, 50 leaves were collected at random.

The parasitoid rearing in laboratory conditions was carried out in the following way: on particular observation days different parts of plants with aphids on them were collected from all the sites. Initially the plants were collected together with leaves of bottom internodes, later with flag leaves, and finally with ears. Depending on the year of research from 50 to 100 plant parts with aphid colonies were collected from each research area. A plant part settled by one aphid colony constituted a single sample. In a laboratory aphids along with mummies were counted and then the parts settled by them were placed in jars protected from the top by bolting-cloth. To rear the maximum number of hymenopterans the jars were kept until the spring of the following year in glass cases of room temperature.

In order to directly assess the interdependence between the settling of plantation by aphids (taking into account their number) and the number of hymenopterans (along with the mummies), the value of linear correlation coefficient r was calculated and the equation of the type of first degree regression: $y = bx + a$.

Results and discussion

The presence of a strong linear correlation between the degree of settlement of rye and wheat crops by grain aphid, *S. avenae*, and the number of associated parasitic *Hymenoptera* were recorded (Tab. 1.). Significant differences and averagely greater values of the linear correlation of coefficient r for both cereal species were obtained in 1997, in both sites, Mochełek (large scale farm area) and in Żędowo (individual farm). Such interdependence was often stronger in case of wheat rather than rye, and especially large difference was recorded in 1996. It has to be mentioned that in that year the number of aphids on rye was much lower. On the other hand, in 1997, in Mochełek the correlation was greater on rye (Tab. 1.). This may suggest that these interdependencies should depend to a lesser extent on the cereal species or crop area, land usage and probably more on different environmental factors.

Table 1. Linear correlation coefficient value r calculated for determination of interdependence of plant settlement by aphids and parasitic *Hymenoptera* on winter wheat and winter rye crops

Year	1996		1997	
	Winter wheat	**Winter rye**	**Winter wheat**	**Winter rye**
Mochełek	0.913**	0.516	0.791*	0.926**
Żędowo			0.791*	0.773*

* - significant at p = 0.05
** - significant at p = 0.01

The calculated high values of simple correlation coefficient provided basis to carry out an analysis of linear regression. On the basis of such equations as y = bx+a linear regressions were drawn and illustrated the course of changeability in the hymenopterans number, depending on the degree of aphid settlement of the plants (Fig. 1.). For all the experimental objects the presence of a clear linear trend was recorded which allowed one to conclude that there was a high probability of a strong linear dependence between the two analysed features in the case of winter wheat and winter rye in both years of research.

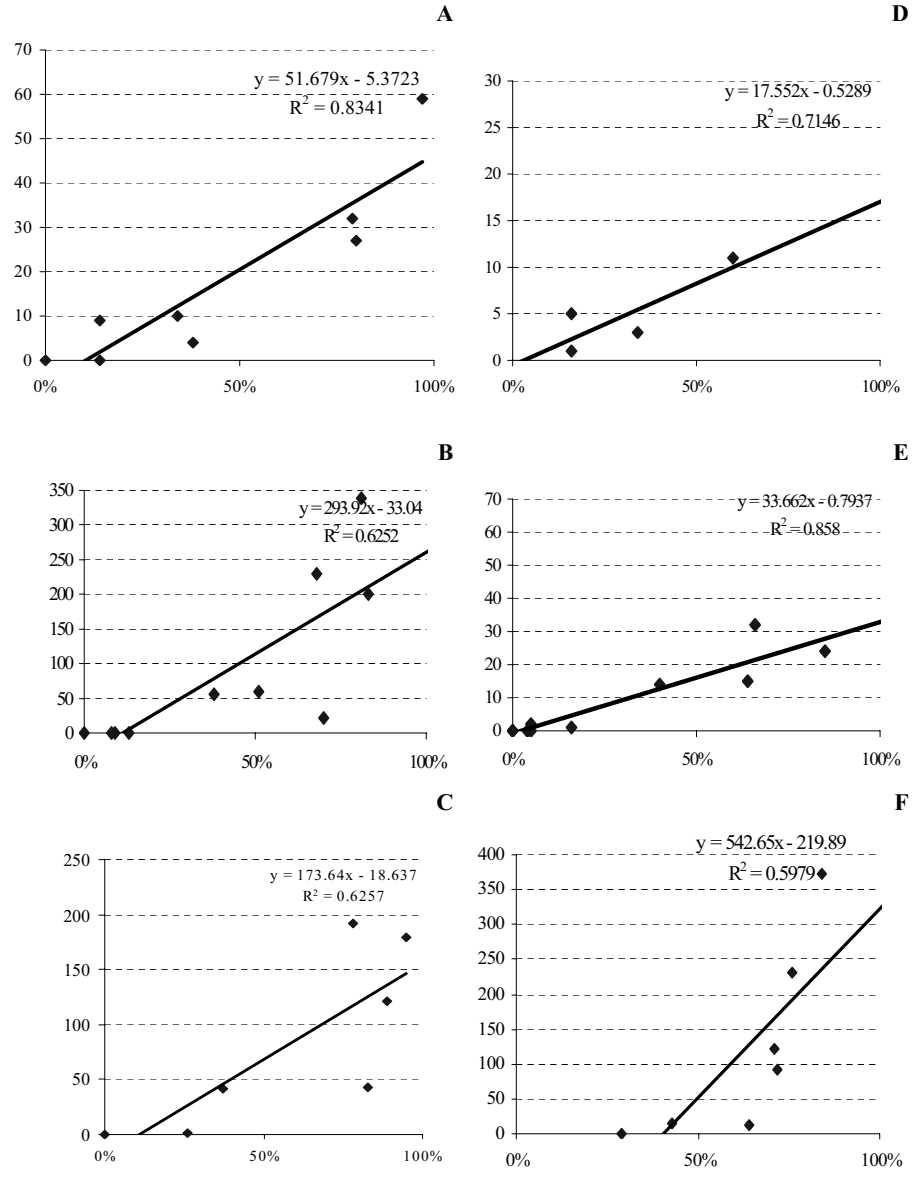

Fig.1. Equations and simple lineal regressions calculated to the relation of aphid (X axis) settlement of wheat (A, B, C) and rye (D, E, F) to numbers of parasitic *Hymenoptera* with mummies (Y axis) A, D – Mochełek 1996; B, E – Mochełek 1997; C, F – Żędowo 1997

The period when aphid feeding may cause serious economic losses lasts from the blooming phase, through the formation and ear fulfilment until the end of milky maturity, when ears cease to be proper food for aphids

(Łęski, 1991). In all the research seasons most rye plants settled by aphids were recorded in the blooming phase – up to 60%, relatively high number – in milky maturity of potatoes (up to 70%) when at the same time the number of aphids in colonies was the highest – up to 170 specimens in Żędowo (Dębek-Jankowska, 2004). In the same developmental phases of cereals it was usually *S. avenae*, which formed much larger colonies than on rye which was well seen in Mochełek (Tab. 2.). During the period of sudden decline in aphid number usually in the phase of waxy maturity of kernels, the greatest number of parasitized aphids was found (Dąbek-Jankowska, 2004). This accordance was confirmed previously by Abo Kaf & Miczulski (1991b); Chambers *et al.* (1986); Kąkol & Miętkiewski (2001) and Pankanin-Franczyk (1982); Chambers *et al.* (1986) who pay attention to the fact that plants' developmental phase, migration, weather conditions and presence of natural enemies are the cause for decline in aphid number on cereal plantations.

Ruszkowska (2001) claims that parasitoids do not play a vital role in limiting aphid populations on cereals during the spring and summer in Poland. This may be testified by e.g. their number, effectiveness and a small number of species especially in 1996 (Tab. 2.). However, not to overestimate the role as played by parasitoids in regulating the number of aphids, one may claim that their presence on crops, with moderate intensity of aphid presence may be important as one of the factors to decrease the harmfulness of phytophagous organisms up to the tolerance level (Bogucka, 1983; Chambers *et al.* 1986; Miczulski, 1980). This may be confirmed by e.g. a relatively high parasitizing of aphids on rye and wheat in 1997 (Tab. 2.). Moreover, the *Aphidiidae*, by cooperating with predators in a given biocenosis may increase the general effectiveness of aphidophagous organisms (Ruszkowska, 2001; Sobota, 1992).

Table 2. Ratio of aphid hosts to parasitic *Hymenoptera*

	Mochełek				**Żędowo**	
		1996		**1997**		**1997**
Numbers of:	rye	wheat	rye	wheat	rye	wheat
aphids	885	2759	862	6115	8059	6754
parasitoids	5	82	32	307	128	195
hiperparasitoids	14	46	48	194	493	108
Mean range of parasitisation*	3.4%	8.1%	9.7%	19%	12.%	19.6%
Species in numbers						
Aphidiidae	1	3	2	4	4	3
Aphelinidae		1		1	1	1
Hyperparasitoids	3	4	5	5	7	5

* together with mummies

Conclusions

1. The analysis of correlation between the settling of plants by aphids and the number of parasitic *Hymenoptera* points out to a strong positive interdependence between these features for all the objects in the experiment.
2. On the basis of the calculated equations of regression, the presence of a clear linear trend between the degree of cereal plantation settlement by *S. avenae* and the accompanying parasitoids was confirmed.

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Korelacja między zasiedleniem zbóż przez mszycę zbożową (*Sitobion avenae* F.) a liczebnością pasożytniczych błonkówek (*Hymenoptera parasitica*)

Streszczenie

Celem podjętych badań była próba określenia zależności między stopniem zasiedlenia plantacji pszenicy ozimej i żyta przez mszycę zbożową (*Sitobion avenae* F.), a liczebnością stowarzyszonych z jej koloniami pasożytniczych błonkówek (*Hymenoptera parasitica*). Materiał dotyczący występowania i liczebności mszycy zbożowej oraz jej parazytoidów zbierano w latach 1996-1997, na plantacjach żyta i pszenicy ozimej zlokalizowanych w woje-

wództwie kujawsko-pomorskim (Mochełek i Żędowo). W celu określenia zasiedlenia roślin przez mszyce, każdorazowo, na obrzeżu i w środkowej części pola, w sumie, losowo pobierano 50 źdźbeł. Dla wszystkich obiektów doświadczalnych stwierdzono występowanie wyraźnego trendu liniowego, co pozwala z dużym prawdopodobieństwem wnioskować o istnieniu silnej zależności liniowej między dwiema analizowanymi cechami, zarówno w przypadku pszenicy, jak i żyta, w obu latach badań. Potwierdzają to również na ogół wysokie wartości wskaźnika korelacji prostej.

Acknowledgment

The authors wish to thank Prof. M. Wiwart from the Warmia Mazurian University for the help in statistic assessment of data.