Effectiveness of Aphid Parasitoids (Hymenoptera: Aphidiidae) on Winter Wheat in Two Agricultural Systems*

SHOKI AL DOBAI and JÁN PRASLIČKA

Slovak Agricultural University Nitra – Department of Plant Protection, Nitra, Slovak Republic

Abstract

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From the obtained results we can note that the parasitoids in our experiments in 1997 and 1998 had considerable influence on decline of aphids population density, at which the percent of parasitization in milk maturity stage of wheat was from 2.7 to 35%. The culmination of parasitization was recorded in our experiments about 7–10 days after the culmination of population density of aphids. The obtained results did not confirm the definite influence of different growing systems on parasitization of aphids, because in 1997 the parasitization was very high in integrated growing system and in 1998 in ecological growing system. The influence of different growing systems on aphids parasitization appeared during a given year and within an growing system. It also appeared between different years and it was found that these differences were significant. The parasitoids found were: *Aphidius ervi* Haliday, *A. rhopalosiphi* De Stefani-Perez, *A. uzbekistanicus* Luzhetzki, *Praon volucre* (Haliday), *Ephedrus plagiator* (Nees), *Diaeretiella rapae* (M'Intosh). In 1997, the most abundant species were *Aphidius ervi* and *A. rhopalosiphi* and in 1998 *A. uzbekistanicus* and *Aphidius ervi*.

Key words: winter wheat; cereal aphids; Aphididae; parasitoids; Aphidiidae; *Aphidius*

In Slovakia, the cereal aphids *Metopolophium dirhodum* (WALKER), *Rhopalosiphum padi* (LINNAEUS) and *Sitobion avenae* (FABRICIUS) were found to be most abundant (PRASLIČKA *et al.* 1997; CAGÁŇ & KMEC 1991). The same aphid species were recorded in various species of wheat in the Czech republic (HAVLÍČKOVÁ & HOLUBEC 1999). Parasitoids of the family Aphidiidae are the important limiting factor of aphid's occurrence (WETZEL *et al.* 1981; STARÝ 1981). HÖLLER (1990) stated that the parasitoids were mostly the main factor causing mortality of aphids in cereals in the Kiel area in Germany. Parasitoids appear in fields of cereals shortly after the migration of aphids. They have small rate of population growth, and its peak happen about one week after culmination of aphid population density (JONES 1972; RAUTAPÄÄ 1976; STARÝ 1978). ANKERSMIT (1982) stated that the adults of parasitoids emerge in field conditions about three or four weeks after parasitization. The second generation appears in time of maximum population density of aphids. Recently a more attention has been given to the support and protection of aphid natural enemies, which commonly occur in natural and cultivated ecosystems. Factors increasing the effectiveness of natural enemies are known, including the suitable wintering sites, access to food of mature individuals, care about forest and artificial meadows in the vicinity, selective regulation of weeds in margins of fields, appropriate crop rotation. In addition to the previous mentioned factors the neighbouring crops of cereals have an important role in parasitization, and may be a source of parasitoids also for cereals. Ecological agriculture is one of alternatives, which has a positive influence on the occurrence and development of natural enemies (VICKERMAN 1977; STARÝ 1978, 1981; POWELL 1986; LACKO-BARTOŠOVÁ *et al.* 1995).

The aim of this study was determination of effectiveness of cereal aphid parasitoids on aphid's populations in winter wheat in two growing systems.

MATERIAL AND METHODS

Effectiveness of parasitoids on decrease of cereal aphids population density in winter wheat was studied in 1996–1998 in SBER Slovak agricultural university in Nitra Dolna Malanta in two growing systems: (a) ecological system under which we use two alternatives (i) plots with organic fertilizer, (ii) plots without fertilizer, with the same crop rotation (bean + alfalfa, alfalfa, winter wheat [intercrop], maize for silage, winter rape [intercrop], common

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pea [intercrop], maize for silage, winter wheat). Ecological system wasn't chemical treated; (b) integrated system with organic fertilizer and commercial fertilizer, with crop rotation (alfalfa, maize, maize for silage, winter wheat, sugar beet, spring barley [intercrop], common pea, winter wheat). Integrated system was treated only by herbicide. In both systems two different basic soil cultivation are used: conventional with ploughing to the depth of 0.24 m and minimum with shallow cultivation to the depth of 0.12–15 m. Population density was observed from flowering growth stage of wheat to soft dough stage of wheat, in 7–10 days intervals. For determination of the degree of parasitization we evaluated randomly 100 plants (4 × 25 plants) from the crop margin and at 5 m depth inside crop, in fields. On each plant we counted the number of all aphids (alive non-parasitized and parasitized or mummified aphids from each site). For identification of species composition of cereal aphid parasitoids, we collected samples from aphid colonies of plants in each system. Samples were obtained from all parts of the selected plants with aphid colonies (leaves, blades, ears). This way of collecting samples according to STARÝ (1970) is most suitable. Obtained material was transported to laboratory in plastic boxes and kept 1–2 days in refrigerator at 8 ± 2°C. The mummified aphids were directly collected and kept in glasses, which were covered by nylon mesh and stored in the laboratory at 18 ± 2°C. The emerged parasitoids were directly catched and killed by ethyl acetate.

The rest of samples were also stored in laboratory and the emerged parasitoids were directly catched and killed by ethyl acetate too. The obtained material (parasitoids) was stored in closed test tubes, which were marked (number of the sample, site, and date of emergence, number of individuals). Parasitoid genera were determined according to the colour and the shape of the mummy. Parasitoids were identified after emerging according to the keys designed by STARÝ (1981) and POWELL (1982).

Percent of parasitization was calculated by the following equation:

$$\% \text{ parasitization} = 100\ (b/a + b)$$

a – alive non-parasitized aphid
b – parasitized and dead mummified aphids

Results were analysed by Tukeys test.

Table 1. Population density and parasitization of cereal aphids during 1996–1998

			Total number of aphids*		Number of aphids* from unparasitized		Number of aphids* from parasitized		% parasitism	
Year	Date	Growth stage	EK	IN	EK	IN	EK	IN	EK	IN
1996	26.5.	flowering 61 DC	15	41	15	41	0	0	0	0
	3.6.	flowering 65 DC	37	48	37	48	0	0	0	0
	11.6.	flowering 69 DC	318	395	316	392	2	3	0.6	0.7
	18.6.	milk maturity 73 DC	387	229	386	228	1	1	**0.2**	**0.4**
	25.6.	milk maturity 75 DC	111	148	111	148	0	0	0	0
	4.7.	Milk maturity 79 DC	175	77	175	77	0	0	0	0
1997	3.6.	flowering 65 DC	130	134	130	133	0	0	0	0
	10.6.	flowering 69 DC	679	802	676	799	3	3	0.4	0.3
	17.6.	milk maturity 75 DC	4036	2570	3923	2475	113	95	**2.7 Ab**	**3.6 Bb**
	27.6.	milk maturity 77 DC	1336	1945	1179	1524	157	421	**11.7 Aa**	**21.6 Bb**
	3.7.	soft dough 85 DC	389	401	123	110	266	291	68.3	72.5
	10.7.	caryopsis hard 91 DC	102	105	0	0	102	105	100	100
1998	26.5.	flowering 61 DC	24	91	24	91	0	0	0	0
	3.6.	flowering 65 DC	245	255	245	255	0	0	0	0
	10.6.	milk maturity 71 DC	1638	1186	1638	1183	0	3	0	0.2
	17.6.	milk maturity 75 DC	1380	2364	1354	2308	26	56	**1.8 Aa**	**2.3 Ba**
	25.6.	milk maturity 77 DC	419	463	271	398	148	65	**35.3 Bb**	**14.0 Aa**
	30.6.	soft dough 85 DC	77	11	61	0	16	0	20.7	–

*Number of aphids on 100 plants
EK – Ecological agricultural system
IN – Integrated agricultural system

Significance of values of parasitization, in 1997 and 1998 in growth stage milky maturity of wheat is marked by capitals letters during a given year between systems and between years is marked by small letters within a system.
Values bearing identical letters show statistical differences ($P = 0.05$)

RESULTS

The obtained results are listed in Table 1. In 1996, the occurrence of aphids was relatively low, and so the percentage parasitization. The highest occurrence of aphids was recorded in the integrated growing system in flowering stage of wheat – 69 DC (395 individuals) and in the ecological growing system in milk maturity stage of wheat – 73 DC (387 individuals). The first occurrence of parasitized aphids was recorded in the end of flowering stage of wheat – 69 DC in both growing systems. Percent of aphid parasitization ranged between 0.2 and 0.7%. In 1997, the highest occurrence of aphids through three years of observations was recorded in the middle of maturity stage of wheat – 75 DC. This was found in the ecological growing system (4036 individuals) and in the integrated growing system (2570 individuals). The first occurrence of parasitized aphids was recorded in both growing systems in the end of flowering stage of wheat – 69 DC (0.3–0.4%). Percent of aphid parasitization in milk maturity stage of wheat was in ecological agricultural system and in the integrated growing system ranged between 2.7–11.7% and 3.6-21.6%, respectively, at which the differences with different systems were significant. The very high percent of parasitization was recorded in the soft dough stage of wheat in the integrated growing system 75.5% and in the ecological growing system 68.5%. In 1998, the highest occurrence of aphids was also recorded in milk maturity stage of wheat in the integrated growing system and in the ecological growing system from 419 to 1638 individuals and from 463 to 2364 individuals, respectively. The first parasitized aphids were recorded in the milk maturity stage of wheat, although in the end of this stage was found 35.3% parasitized aphids in the ecological growing system and 14.0% in the integrated growing system, with the significant differences between systems.

The obtained results did not confirm the definite influence of different growing systems on parasitization of aphids, because in 1997 the parasitization was very high in integrated growing system and in 1998 in ecological growing system. The influence of different growing systems on aphids parasitization appeared during a given year and within an growing system. It also appeared between different years and it was found that these differences were significant. From the obtained results we can note that the parasitoids in our experiments in 1997 and 1998 had considerable influence on decline of aphids population density, at which the percent of parasitization in milk maturity stage was from 2.7 to 35.3%.

DISCUSSION

Similar results were presented by the following authors (WETZEL *et al.* 1981; PRASLIČKA & AL DOBAI 1997), which also recorded the considerable decline of the aphids population density at 10% parasitism and more in the end of the flowering stage and in begining of milk maturity stage of cereals. On the other hand BORGEMEISTER (1992) recorded maximum of aphid parasitism 20%, although he did not record an important effect on the decrease of aphid population density. The peak of parasitization was recorded in our experiments about 7–10 days after the culmination of population density of aphids. The results of this study is confirmed by the results of many authors (RAUTAPÄÄ 1976; STARÝ 1978). KOROTOVA (1993) recorded the culmination of parasitization of aphids in the Novosibirsk area of Siberia till after 2-3 weeks after culmination of population density of aphids.

Species composition of found parasitoids and their relatively representation during 1997–1998, is listed in Fig. 1. Six species of parasitoids were recorded: *Aphidius ervi, A. rhopalosiphi, A. uzbekistanicus, Praon volucre, Ephedrus plagiator, Diaeretiella rapae.* In 1997, *Aphidius ervi* and *A. rhopalosiphi*, were most abundant species of parasitoids and in 1998, *A. uzbekistanicus* a *Aphidius ervi.* BORGEMEISTER (1992) studied the interaction between cereal aphids *Sitbion avenae*, *Rhopalosiphum padi* and *Metopolophium dirhodum* and nine species of parasitoids in Germany. The most dominant parasitoids were *A. rhopalosiphi* a *A. picipes* (Nees).

PANKANIN-FRANCZYK and SOBOTA (1998) found nine species of parasitoids attacked cereal aphids on winter

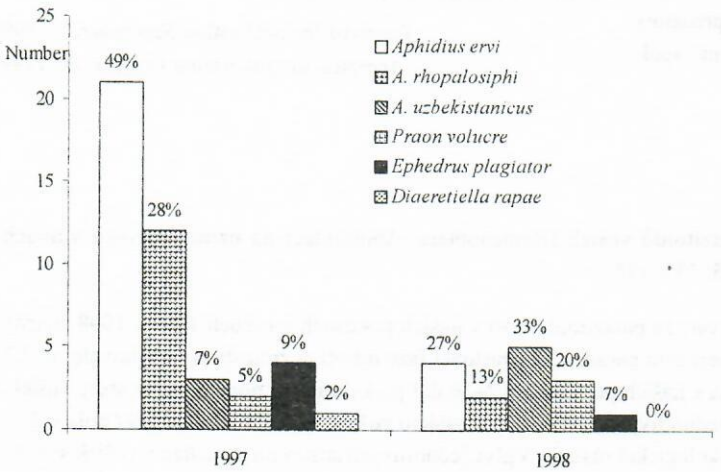

Fig. 1. Species composition of cereal aphid parasitoids in 1997–1998

and spring crops in two sites in region near Warsaw and Wroclaw in Poland. At which the dominant presentation had *A. uzbekistanicus*. GRUBER *et al.* (1994) recorded in fields of sorghum in region Drome in France in aphid *Schizaphis graminum* (Rondani) ten species of parasitoids: *Aphidius ervi, A. matricariae* HALIDAY, *A. picipes* (Nees), *A. rhopalosiphi, A. uzbekistanicus, Ephedrus plagiator, Praon gallicum* Starý, *P. volucre, Aphelinus asychis* Walker and *A. varipes* (Foerster). The most abundant species belonged to genera *Praon* and *Aphelinus*.

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References

ANKERSMIT G. W. (1982): *Aphidiidae* as parasites of the cereal aphids *Sitobion avenae* and *Metopolophium dirhodum*. In: Proc. EC Experts Meet., Portici: 42–49.

BORGEMEISTER CH. (1992): Primary and hyperparasitoids of cereal aphids: interactions and interference from insecticides. Agrarökologie, **3**: 18.

CAGÁŇ L., KMEC P. (1991): The occurrence of aphids on maize grown under different ecological conditions. In: Proc. 4th ECE/XIII. SIEEC, Gödöllö: 432–435.

CARTER N., MCLEAN I. F. G., WATT A. D., DIXON A. F. G. (1980): Cereal aphids: a case study and review: In: COAKER T. H. (Ed.). Applied Biology. Academic Press, London: 271–348.

GRUBER F., POPRAWSKI T. J., COUTINOT D. (1994): Hymenopterous parasites and hyperparasites of *Schizaphis graminum* (Rondani) (Homoptera: Aphididae) on Sorghum, in the Drome, France. J. Appl. Ent., **117**: 477–490.

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.

HÖLLER C. (1990): Overwintering and hymenopterous parasitism in autumn of cereal aphid *Sitobion avenae* (F.) in northen FR Germany. J. Appl. Ent., **109**: 21–28.

JONES M. G. (1972): Cereal aphid, their parasites and predators caught in cages over oat and winter wheat crops. Ann. appl. Biol., **72**: 13–25.

KROTOVA I. G. (1993): Hymenopteran parasitoids and their role in reducing the abundace of grain aphids in west Siberian forest-steppe of the Ob.-Region. Zool. Zhur., **72**: 51–57.

LACKO-BARTOŠOVÁ M. *et al.* (1995): Ekologické poľnohospodárstvo. EKO, Nitra.

PANKANIN-FRANCZYK M., SOBOTA G. (1998): Relationship between primary and secondary parasitoids of cereal aphids. J. Appl. Ent., **122**: 389–395.

POWELL W. (1982): The identification of hymenopterous parasitoids attacking cereal aphids in Britain. Systém. Ent., **7**: 465–473.

POWELL W. (1986): Enhancing parasitoid activity in crops. In: WAAGE J., GREATHEAD D. (Ed): Insect Parasitoids. Acad. Press, London: 319–335.

PRASLIČKA J., AL DOBAI S. (1997): Výskyt a parazitácia obilných vošiek na ozimnej pšenici na EXBA SPU Nitra. In: Zbor. Ref. XIV. Slov. a Čes. Konf. Ochr. Rastl., Nitra: 196–197.

PRASLIČKA J., BOKOROVÁ M., AL DOBAI S. (1997): Výskyt obilných vošiek na ozimnej pšenici v rôznych sústavách poľnohospodárstva. Acta phytotechn. Univ. Agric. (Nitra) **52**: 91–96.

RAUTAPÄÄ J. (1976): Population dynamics of cereal aphids and method of predicting population trends. Ann. Agric. Fenn., **15**: 272–293.

STARÝ P. (1970): Biology of Aphid Parasites (Hymenoptera: Aphidiidae) with Respect to Integrated Control. Series entomologica, 6. Dr W. Junk, The Hague.

STARÝ P. (1978): Seasonal relations between lucerne, red clover, wheat and barley agroecosystems through the aphids and parasitoids. Acta Ent. Bohemoslov, **75**: 296–311.

STARÝ P. (1981): Biosystematic synopsis of parasitoids on cereal aphids in the western palearctic (Hymenoptera: Aphidiidae, Homoptera: Aphididae). Acta Ent. Bohemoslov. **78**: 382–396.

VICKERMAN G. P. (1977): Monitoring and forecasting insect pests of cereals. In: Proc. 1977 Brit. Crop Prot. Conf. Pests and Dis., **1**: 227–234.

WETZEL TH., GNAHIM A., FREIR B. (1981): Zum Bedeutung von Predatoren und Parasiten für die überwachung und Bekämpfung von Blattäusen in Getreidebestanden. Nachr.-Bl. Pfl.-Schutz DDR, **35**: 239–244.

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Súhrn

AL DOBAI S., PRASLIČKA J. (1999): **Vplyv parazitoidů vošiek** (Hymenoptera: Aphidiidae) **na ozimú pšenicu v dvoch poľnohospodárskych systemov.** Pl. Protect. Sci., **35**: 131–135.

Na základe dosiahnutých výsledkov možno konštatovať, že parazitoidy mali v našich pokusoch v rokoch 1997 a 1998 značný vplyv na pokles populačnej hustoty vošiek, pričom percento parazitácie v rastovej fáze mliečnej zrelosti sa pohybovalo od 2,7 do 35,3 %. Kulminácia parazitácie bola zaznamenaná v našich pokusoch o 7–10 dni po kulminácii populačnej hustoty vošiek. Dosiahnuté výsledky nepotvrdili jednoznačne vplyv jednotlivých sústav na parazitáciu vošiek, nakoľko v roku 1997 bola vyššia parazitácia na integrovanej sústave a v roku 1998 na ekologickej sústave. Vplyv jednotlivých sústav na parazitáciu vošiek sa však

prejavil v rámci roka a v rámci sústav aj medzi jednotlivými rokmi, so štatisticky preukaznými rozdielmi. Z parazitoidov boli zistené druhy: *Aphidius ervi* Haliday, *A. rhopalosiphi* De Stefani-Perez, *A. uzbekistanicus* Luzhetzki, *Praon volucre* (Haliday), *Ephedrus plagiator* (Nees), *Diaeretiella rapae* (M'Intosh). V roku 1997 boli najpočetnejšie zastúpené druhy *Aphidius ervi* a *A. rhopalosiphi* a v roku 1998 *A. uzbekistanicus* a *Aphidius ervi*.

Kľúčové slová: pšenica ozimná; obilné vošky; Aphididae; parazitoidy; Aphidiidae; *Aphidius*

Corresponding author:

Prof. Ing. JÁN PRASLIČKA, CSc., Slovenská poľnohospodárska univerzita Nitra, Katedra ochrany rastlín, Tr. A. Hlinku 2, 949 76 Nitra, Slovenská republika, tel.: + 421 87 60 12 52, fax: + 421 87 41 14 51, e-mail: al-dobai@afnet.uniag.sk