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Seasonal abundance of *Brevicoryne brassicae* L. and *Diaeretiella rapae* (M'Intosh) under different cabbage growing systems

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In 2003–2004, the occurrence of cabbage aphid (*Brevicoryne brassicae* L.) and its main parasite *Diaeretiella rapae* (M'Intosh) was studied on ecologically growing white cabbage versus non manure fertilized and fertilized plots. During the observations, naturally occurring aphids and mummies were counted. *D. rapae* reduced the populations of cabbage aphid by 23.9–26.2% during both experimental years. The abundance of aphids and parasites was highest (p = 0.05) on fertilized cabbage. The highest parasitation was observed in the periods when the number of aphids on the plants was the lowest, at the end of July (2003) and at the beginning of August (2004) at the end of their occurrence on the plants.

Key words: *Brevicoryne brassicae*, cabbage, growing systems, *Diaeretiella rapae*, parasitation

INTRODUCTION

The cabbage aphid *Brevicoryne brassicae* L. causes serious losses of yield in *Brasica* crops and reduces its marketable value (Liu et al., 1994; Costello, Altieri, 1995). *B. brassicae* is one of the most common pests of cabbage crops in Lithuania (Survilienė, 2002). Aphid parasitoids are very important control agents for aphid pest in a variety of agricultural and horticultural crops (Hagvar, Hofsvang, 1991). *D. rapae* is described as the most important factor for natural control of cabbage aphid (Read et al., 1970; Mackauer, Kambhampati, 1984; Elliot et al., 1994; Pike et al., 1999; Jankowska, Wiech, 2003). On the other hand, *D. rapae* females are more attracted by crucifer plants than by other types of plants (Sheehan, Shelton, 1989; Vaughn et al., 1996). Furthermore, parasites and prey prefer the same host plat possibly because aphids and *D. rapae* positively respond to the volatile compounds produced by the plants (Bundemberg, 1990) and honeydew emitted by aphids and used by its natural enemies as kairomones (Brown et al., 1970; Dicke, Sabelis, 1988).

The aim of the investigation was to examine the population dynamics of *Brevicoryne brassicae* and the relationship between aphids and the parasite *Diaeretiella rapae* (M'Intosh) in different ecologicall white cabbage growing systems.

MATERIALS AND METHODS

Investigations were carried out in the experimental fields of Lithuanian Institute of Horticulture in ecologically grown white cabbages 'Bielorusiška Dotnuvos' in 2003–2004. Investigations were conducted according to EPPO standards (Anon, 1997). Each replicate consisted of 12 m^2, and the treatment was repeated five times at a random plot distribution.

Artificial fertilizers and pesticides were not used for ecologically grown cabbages. The trial consisted of two growing systems. There were no fertilizers used in one plot, meanwhile in the other plot organic manure (60 t ha^{-1}) was applied before planting. Observations were started when first winged forms of *B. brassicae* appeared, and were repeated every 4–7 days. Ten plants per plot were inspected, and winged, non-winged forms of the aphids and the mummies of parasitized aphids were counted. The visual method was used for the estimation of parasitation level. Parasited aphids were left on vegetables to allow the emergence of the next generations of the parasite; after that empty mummies usually fell down. The identification of adult *Brevicoryne brassicae* and *Diaeretiella rapae* was based on the identification key (Копанева, 1982).

The number of aphids, their parasites and the percentage of parasitation were compared among treatments in this study by a single factor analysis of variance (ANOVA). Specific differences were identified with Duncan's multiple range test (p = 0.05).

RESULTS

In 2004, as compared with 2003, the number of aphids was higher, especially in manure-fertilized cabbage (Figs. 1–4). The first aphids were observed in the beginning of July in both experimental years. At the beginning, the number of aphids was low, but in fertilized cabbages the abundance of aphids was 1.3 times

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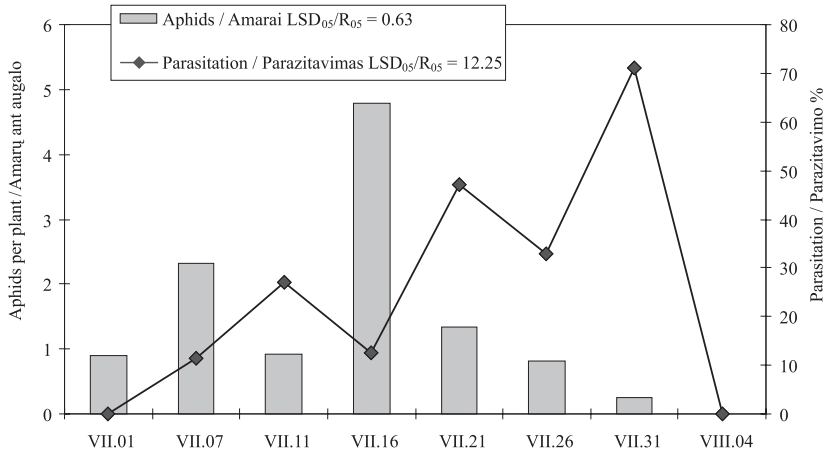

Fig. 1. Dynamics of cabbage aphids and their parasitation by *Diaeretiella rapae* on non-fertilized cabbage plants, 2003

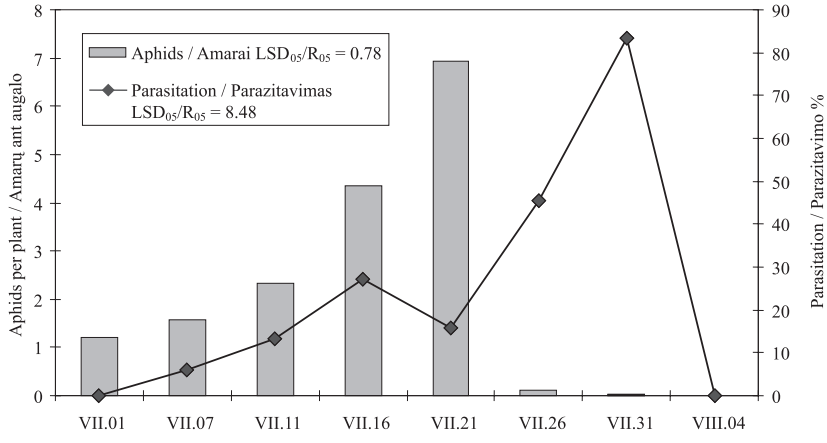

Fig. 2. Dynamics of cabbage aphids and their parasitation by *Diaeretiella rapae* on fertilized cabbage plants, 2003

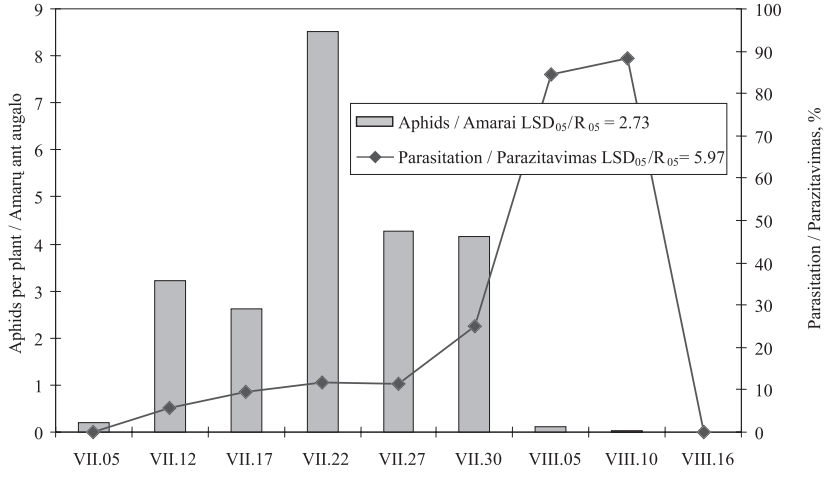

Fig. 3. Dynamics of cabbage aphids and their parasitation by *Diaeretiella rapae* on non-fertilized cabbage plants, 2004

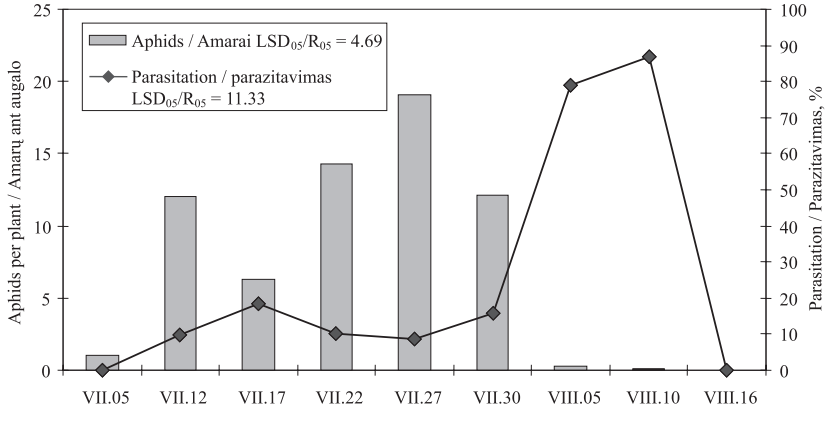

Fig. 4. Dynamics of cabbage aphids and their parasitation by *Diaeretiella rapae* on fertilized cabbage plants in 2004

Table 1. **Mean number of *Brevicoryne brassicae* L. and the percentage of its parasitation by *Diaeretiella rapae* (M'Intosh), 2003–2004**

Parameter	2003			2004		
	Non-fertilised	Fertilized	P = 0.05	Non-fertilised	Fertilized	P = 0.05
Mean number per plant:	1.41	2.07	0.62	2.57	7.24	3.83
Aphids, unt. *Diaeretiella rapae*, unt.	0.32	0.46	0.11	0.51	1.10	0.40
Parasitation, %	25.25	23.88	9.90	26.21	24.23	3.96

Table 2. **Relation between the number of aphids (*Brevicoryne brassicae* L.) and the parasite *Diaeretiella rapae* (M'Intosh) on different growntly cabbage**

Treatments	Correlation coefficient	Equation of regression line y = a + bx	Regression coefficient b
Cabbage non-fertilised	0.7636*	y = 2.5319 + 0.1454x	0.1454
Cabbage fertilised with manure	0.8407**	y = 2.7943 + 0.1244x	0.1244

** Coefficient of correlation significant at the probability level p = 0.01.

* Coefficient of correlation significant at the probability level p = 0.05.

in 2003 and 5 times in 2004 higher than in non-fertilized plots. Later we observed an increase of the aphid population. First mummies of *D. rapae* were found in the beginning of July in 2003 and in the mid of July in 2004. Figs. 1–4 show the dynamic of the number of aphids and the percent of its parasitation. At the beginning, aphid parasitation was low. In 2003, in non-fertilized cabbages, the percentage of parasitation was about two times higher than in fertilized, but in 2004 in fertilized plots it was about two times higher than in non-fertilized plots. Higher parasitation was found mostly in periods when the abundance of aphids was lower. The highest parasitation of aphids (71–88%) was observed at the end of July in 2003 and in the beginning of August in 2004. At this time, the number of aphids was the lowest, and it was also the end of their occurrence on the plants.

Significant differences were found in the mean number of aphids and their parasites between the treatments (Table 1). In 2003 and 2004, the abundance of aphids was respectively 1.5 and 2.8 and of parasites 1.4 and 2.2 times higher in the fertilized treatment. In order to assess the relation between the number of cabbage aphids and *D. rapae* parasites, their correlation and regression was calculated (Table 2). The regression showed a positive relation between the increase of the number of aphids and *D. rapae.*

DISCUSSION

Air temperature, leaf temperature and soluble nitrogen are important factors influencing aphid growth and reproduction (Burgess et al., 1996). We may suggest that in our study, in the fertilized treatment, the level of soluble nitrogen was higher and the abundance of aphids was higher, too. The abundance of aphids depends also on migration. When a colony increases, winged morphs, which are produced in higher proportions, fly and infest new plants (Way, Cammell, 1970) and all the time winged aphids can immigrate into the field (Zhang, Hassan, 2003). Predators in cabbage fields are important for the natural control of cabbage aphid, but their low role early in the season was recorded (Nunnenmacher, Goldbach, 1996). In 2003–2004, in the beginning of July, parasitation by *D. rapae* was low (on average 8%). This study shows that the increase of the number of *D. rapae* is related with the increase of aphid populations. Other study shows similar patterns (Ayal, 1987). According to other studies, the size of the aphid colonies and the substances from their droppings play a key role in finding the host. The wasp *D. rapae* uses honeydew emitted by its host cabbage aphid as a kairomone. These results suggest that honeydew level is used by *D. rapae* as a cue for assessment of the number of aphids in the colony (Shaltiel, Ayal, 1998). In our study, in fertilized cabbage there were more aphids and more parasites. It could be suggested that a higher honeydew level was obtained when aphid populations are more abundant. Other studies show no significant difference in the effect of fertilizer (compost or synthetic fertilizer) on *B. brassicae* and *D. rapae* population growth (Costello, Altieri; 1995). No effect of plant cultivation and the environment (intercropping system, emergence of weeds) on the occurrence of *D. rapae* was found, either (Vidal, Bohlsen, 1994; Horn, 1988). In our study, in fertilized cabbage there was a significant (p = 0.05) difference in the amount of *B. brassicae* and *D. rapae* as compared with unfertilized cabbage. According to Jankowska and Wiech (2003), the highest parasitation was observed in the periods when the amount of aphids on the cruciferous vegetables was the lowest. This is in agreement with our results. According to Zhang and Hassan (2003), the parasitoid *D. rapae* at a wasp: aphid ratio 1.2 : 1 resulted in a successful control of aphids by the second generation of the parasitoid. This might suggest that in 2003–2004 the highest parasitation of aphids was the result of the second generation of *D. rapae* parasitation when the number of aphids was the lowest and rated at 1.2 : 1. Zhang and Hassan (2003) found that parasitation by *D. rapae* reduced the number of offspring of cabbage aphid and shortened its reproduction period. In 2003–2004, *D. rapae* reduced the population of cabbage aphid by 23.9–26.2%. These results demonstrate a significant role of *D. rapae* in limiting the aphid population. Thus, when applying insecticides against aphids, one should take into account also their influence on the parasite population. Many insecticides used for controlling pests in cabbage have a negative effect (Nunnenmacher, Goldbach, 1996; Ellis et al., 1996). A potential consequence within integrated crop management systems might be that aphicides take out susceptible genotypes and thereby reduce the population sufficiently to allow biological control of the resistant individuals by surviving natural enemies (Umoru, Powell, 2002).

CONCLUSIONS

1. The highest parasitation was observed when the number of aphids on the plants was the lowest, i. e. at the end of their occurrence on the plants.

2. When the abundance of cabbage aphids increases, the abundance of *D. rapae* increases, too.

3. *D. rapae* reduced the populations of cabbage aphid by 23.9–26.2%.

4. A statistically significantly ($p = 0.05$) higher number of aphids and *D. rapae* was recorded in manure-fertilized cabbage as compared with non-fertilized cabbage plants.

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BREVICORYNE BRASSICAE L. IR *DIAERETIELLA RAPAE* (M'INTOSH) PAPLITIMAS SKIRTINGAI AUGINAMUOSE KOPŪSTUOSE

S a n t r a u k a

2003–2004 m. stebėtas *Diaeretiella rapae* (M'Intosh) svarbiausio (*Brevicoryne brassicae* L.) parazito paplitimas ant ekologiškai auginamų mėšlu tręštų ir netręštų *Dotnuvos baltarusiškų* baltagūžių kopūstų. Abiem tyrimo metais *D. rapae* sumažino amarų populiaciją vidutiniškai 23,9–26,2%. Amarų ir parazitų buvo patikimai (p = 0,05) daugiau tręštuose kopūstuose. Didžiausias parazitavimas nustatytas liepos pabaigoje (2003 m.) ir rugpjūčio pradžioje (2004 m.), sumažėjus amarų gausumui, jų plitimo pabaigoje.

Raktažodžiai: Brevicoryne brassicae, Diaeretiella rapae, kopūstai, parazitavimas