

The impact of plant water extracts from  
*Calendula officinalis* L. and *Euphorbia cyparissias* L.  
on the occurrence of *Brevicoryne brassicae* Linnaeus, 1758  
/Hemiptera, Aphidoidea/ and its parasitoid *Diaeretiella*  
*rapae* (M'Intosh, 1855) /Hymenoptera, Ichneumonoidea/

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### Abstract

In years 2007-2008 the impact of water extracts from pot marigold (*Calendula officinalis* L.) and cypress spurge (*Euphorbia cyparissias* L.) on *Brevicoryne brassicae* aphids settling white cabbage as well as the activity of *Diaeretiella rapae* parasitoid was researched. The spraying of plants with water extracts caused a decrease in the number of winged aphids settling the plants, as well as in the number of aphids on plants during the entire season. Pot marigold extract proved to be the most effective in this respect. The number of aphids on plants which were sprayed with it was significantly lower not only in comparison with plants not sprayed but also in comparison with plants sprayed with cypress spurge extract. *D. rapae* parasitoid also had a large impact in the control of aphid number. The degree of parasitisation ranged from 21%-62% depending on the year of research and combination. The highest level of parasitisation (%) was recorded in aphid colonies feeding on plants which were sprayed with pot marigold extract, and the lowest (%) on plants sprayed with cypress spurge extract. Both extracts lowered the number of parasitized aphids on plants.

### Introduction

The application of chemical pesticides causes irrevocable changes in biocenose and has a negative influence on the quality of agricultural products. The

methods of agricultural production which limit their usage and enhance ecological cultivation are becoming more and more popular. In recent years the interest in the possibilities of natural substances application to plant protection against pests has been growing. Plants have long been considered to be the sources of natural substances which can be used for plant protection. They contain a number of compounds (usually secondary substances) which have a repulsive effect on insects by acting as repellents, antifidants, toxins, and have an antibacterial and fungistatic impact (Nawrot, 1984; Burgiel, 2005). Cabbage aphid *Brevicoryne brassicae* is considered to be one of the species that attacks cabbage plant crops every year (Szwejda, 2004; Jankowska & Wiech, 2004). In Poland research on the usefulness of substances obtained from plants in limiting the number of aphids was carried out by Puszkar *et al.* (1994), Achremowicz (1995), Achremowicz & Cież (1998), Barczak & Gulewicz (1998), Ksieżak *et al.* (2008).

The aim of the research was to assess the influence of water extracts from pot marigold (*Calendula officinalis* L.) and cypress spurge (*Euphorbia cyparissias* L.) on the settling of white cabbage by *B. brassicae* and the activity of parasitoid *Diaeretiella rapae* which is significant in limiting its numbers (MacKauer & Kambhampati, 1984; Jankowska & Wiech, 2003).

## Material and methods

The research was carried out in 2007-2008 in a farm at Tropiszowo (2007) and the experimental station of Plant Protection Department in Mydlniki near the city of Kraków, the central-south town in Poland (2008). Middle-early season white cabbage 'Tucana F1' was used in the experiment. Seedlings were transplanted in the first decade of June on 12 plots (4 plots repetition for each combination). On each plot there were 40 plants transplanted at a 40x50 cm spacing. The experiment was launched with a method of blocks selected at random.

Nearby there were cauliflowers, followed by Chinese cabbage and tunnels with parsley on tuft crop in 2007, and sorrel and cereals aimed at in 2008. No chemical treatment was applied throughout while all the necessary work was done by hand.

To prepare extracts from pot marigold 'Promyk' cv. (from the author's own cultivation) was used along with cypress spurge (*Euphorbia cyparissias* L.) obtained from its natural habitats. The plants were picked in full-inflorescence time and then dried in an airy room with no access of sunlight. In the period of inflorescence spurge contained 0.5% of alkaloids (Mowszowicz, 1982). The extracts were made by pouring 100 ml water over 50 g of ground dried herbs on 24 hours (Wawrzyniak, 1996). Plants were sprayed weekly, in the evenings. Cabbage that was not sprayed constituted the control.

The analyses were carried out once a week. Each time 5 select plants from each plot were examined and winged and wingless aphids present singly or in colonies were counted. In order to assess the degree of parasitisation, the method of direct observation was applied which was based on the counting of mummies in aphid colonies. The number of mummies informs about the activity of parasitoids and about their so-called real field effectiveness (BARCZAK, 1992). The mummies were left on plants to facilitate the flight away of subsequent generations of the parasitoid. In order to compare the significance of differences the Duncan's test was used ( $\alpha < 0.05$ ).

## Results and discussion

During both years of research on plants which were treated with pot marigold and spurge extracts fewer *B. brassicae* aphids were registered. Significant differences were seen both in the number of winged aphids settling plants and in the number of aphids on plants during the entire season (Tab. 1). Pot marigold extract proved to have a better activity in this respect.

Table 1. Selected information on *Brevicoryne brassicae* occurrence on plants not sprayed and sprayed with *Calendula officinalis* L. and *Euphorbia cyparissias* L. extracts.

Selected information	Variants		
	Not sprayed plants	Plants sprayed with <i>Calendula officinalis</i> extract	Plants sprayed with <i>Euphorbia cyparissias</i> extract
2007			
Mean number of winged aphids on plant	17.8 c	7.87 a	14.5 b
Mean number of aphids on plant	56.1 c	22.7 a	36.8 b
Mean number of aphids on plant in the period of highest intensity (20.07)	124.5 c	40.5 a	76 b
Parasitation %	32.3 b	37.7 b	21.5 a
2008			
Mean number of winged aphids on plant	4 b	0.2 a	3 b
Mean number of aphids on plant	10.42 b	3.08 a	6.9 b
Mean number of aphids on plant in the period of highest intensity (27.08)	45 b	9 a	30 b
Parasitation %	60 a	62 a	57 a

Mean numbers identified in rows with the same letters do not significantly differ statistically ( $\alpha < 0.05$ )

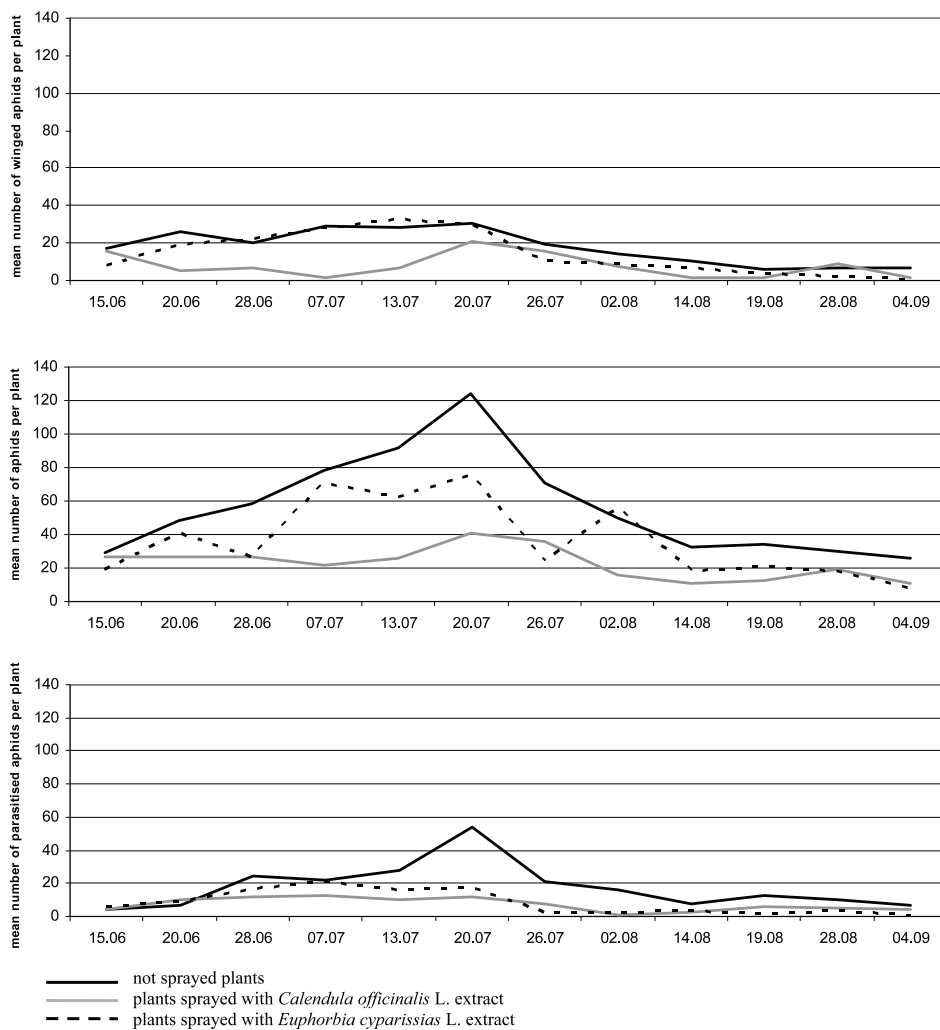


Figure 1. *Brevicoryne brassicae* and its parasitoid *Diaeretiella rapae* number dynamics on plants not sprayed and sprayed with plant water extracts.

In 2007 the number of aphids was significantly lower on plants that were sprayed with it, not only in comparison with plants not sprayed at all but also in relation to plants sprayed with spurge extract (Fig. 1). During the period of the most numerous occurrence of aphids (20 July) on the not sprayed plants their number was almost twice as high as on the plants sprayed with spurge extract, and almost three times as many as on plants sprayed with marigold extract (Fig. 1). Aphid number dynamics on plants not sprayed and sprayed with plant

extracts in 2007 is presented in Fig. 1. In 2008 aphids appeared late on plants (19 June) and they were small in number. As soon as 23 June strong rainfall followed by hail which totally washed first aphid colonies off plants. For the second time aphids were observed only at the end of July, and the most numerous appearance was recorded on 28 August on plants that were not sprayed (Tab. 1).

In the process of host plant finding, glucosinolanes present in all brassiceae plants are important phagostymulants for the cabbage aphid (OSTROUMOW, 1992; GABRYŚ, 1992). Their content may be different in different species. Even particular brassiceae vegetables differ in this respect, which may also be the reason of their different attractiveness level for aphids (JANKOWSKA & WIECH, 2004). The spraying of cabbage with extracts of plants which were not host plants may mask their proper scent, especially if these are plants of as strong a scent as pot marigold. Similar effect was achieved by spraying plants with the French marigold (*Tagetes patula*) extract (JANKOWSKA, 2008). Also, the introduction of pot marigold and French marigold as intercropping plants for cabbage caused a significant increase in the number of aphids settling plants (JANKOWSKA, 2007). The intercropping with pot marigold had a significant influence on the decrease in the number of other phytophags which fed on cabbage (JANKOWSKA *et al.*, 2009).

Plant extracts may also cause mortality of aphids which are already on the plants (ACHREMOWICZ, 1995; ACHREMOWICZ & CIEŻ, 1998). ACHREMOWICZ (1995) studied in a laboratory the effectiveness of plant extracts taken out of 37 plant species of 17 botanical families, using *Myzus persicae* and *Aphis fabae* as test insects. The greatest effectiveness (ranging from 81.3-80.2%) was shown by sage extract (*Salvia officinalis*), garlic (*Pallium sativum*) and lavender (*Lavendula angustifolia*). Many authors have pointed out to antifidant activity of plant extracts in relation to aphids and other phytophags associated with cabbage (ENDERSBY & MORGAN, 1991). KSIĘŻAK *et al.* (2008) recorded a decrease in the number of black bean aphids on faba bean (*Vicia faba minor*) using saponines from alpha-alpha but a significant decrease in the aphid number was observed only in the third week after spraying. Alpha-alpha saponines were also used by PUSZKAR *et al.* (1994) to limit the number of damson-hop aphid (*Phorodon humuli* Schrank, 1801) on hops. To limit the number of aphids BARCZAK & GULEWICZ (1998) used lupin (*Lupinus* spp.) extracts.

In both years the number of aphids on plants was extensively reduced by parasitoid *Diaeretiella rapae* M'Intosh. *D. rapae* is the most common parasitoid of cabbage aphid and the fact that it feeds on a dozen of other aphid species favours the maintenance of this hymenopteron in agroecosystems when there is a lack of most favourite host plant, i.e. cabbage aphid (NEMEC & STARY, 1984).

As stated by WILSON & LAMBDIN (1987), the development of *D. rapae* runs best when *B. brassicae* aphid is its host. Then females lay daily 10.3 eggs on average, mean development time is 15 days, and the ratio of sex in next generation is 73.5 females). The fact that the parasitoid accepts all developmental stages of *B. brassicae* is also relevant (HANG & HASSAN, 2002).

The dynamics of parasitisation was alike in all combinations (Fig. 2). Depending on the combination the degree of parasitisation ranged from 21.1-62% (Tab.1). JANKOWSKA & WIECH (2003) observed the degree of parasitisation of aphids feeding on white cabbage to range between 14.2-17.6%, while DUCHOVSKIENĖ & RAUDONIS (2008) in Lithuania to range between 23.9-26.2%, CHUA (1977) in England – 22.7-26.6%. In both years the highest parasitisation (%) was observed in colonies of aphids feeding on plants sprayed with pot marigold extract, and the lowest (%) on plants sprayed with cypress spurge extract (Tab. 1). While analyzing the number of mummies in aphid colonies (Fig. 1) it was concluded that both extracts influenced the decrease in the number of parasitized aphids.

Many authors highlight that the same signals which attract herbivorous insects are also attractive to predators and parasitoids (HARMATHA & NAWROT, 1985). Allyl isothiocyanate attracts parasitoids (and aphids too) (READ *et al.*, 1970; TITAYAVAN & ALTIERI, 1990; OSTROUMOW, 1992; GABRYŚ, 1999). The size of aphid colonies (AYAL 1987), and substances derivative of their excrements can be significant (AYAL, 1987; BROWN *et al.*, 1970; BUNDEMBERG, 1990). The coverage of plants with extracts may disorientate not only aphids but also parasitoids. Many authors observed different reactions of parasitoids to extract which was applied to treat aphids which were their host. BARCZAK (1994) observed that the application of napery from plants of the *Polygonaceae* family caused not only a gradual fall in the number of *Aphis fabae* number but also a decrease in the number of primary parasitoids that hatched. Also, extracts from lupin had a negative impact on parasitoids of *A. fabae* (WYROSTKIEWICZ *et al.*, 1996).

Although the cypress spurge extract contains cyanogenous compounds (BLAIM, 1965), it is the pot marigold extract that seems to be more useful to control cabbage aphid numbers. Its application led to a significant reduction of *B. brassicae* population on plants in the experiment. Pot marigold extract may also lower the number of other agrophagous species feeding on brassiceae. WAWRZYNIAK (1996) recorded its antifidant activity in relation to caterpillars of large white butterfly (*Pieris brassicae*) in laboratory conditions. In field conditions the spraying of plants with pot marigold extract protected it from eggs being laid by females of this butterfly (WAWRZYNIAK, 1996).

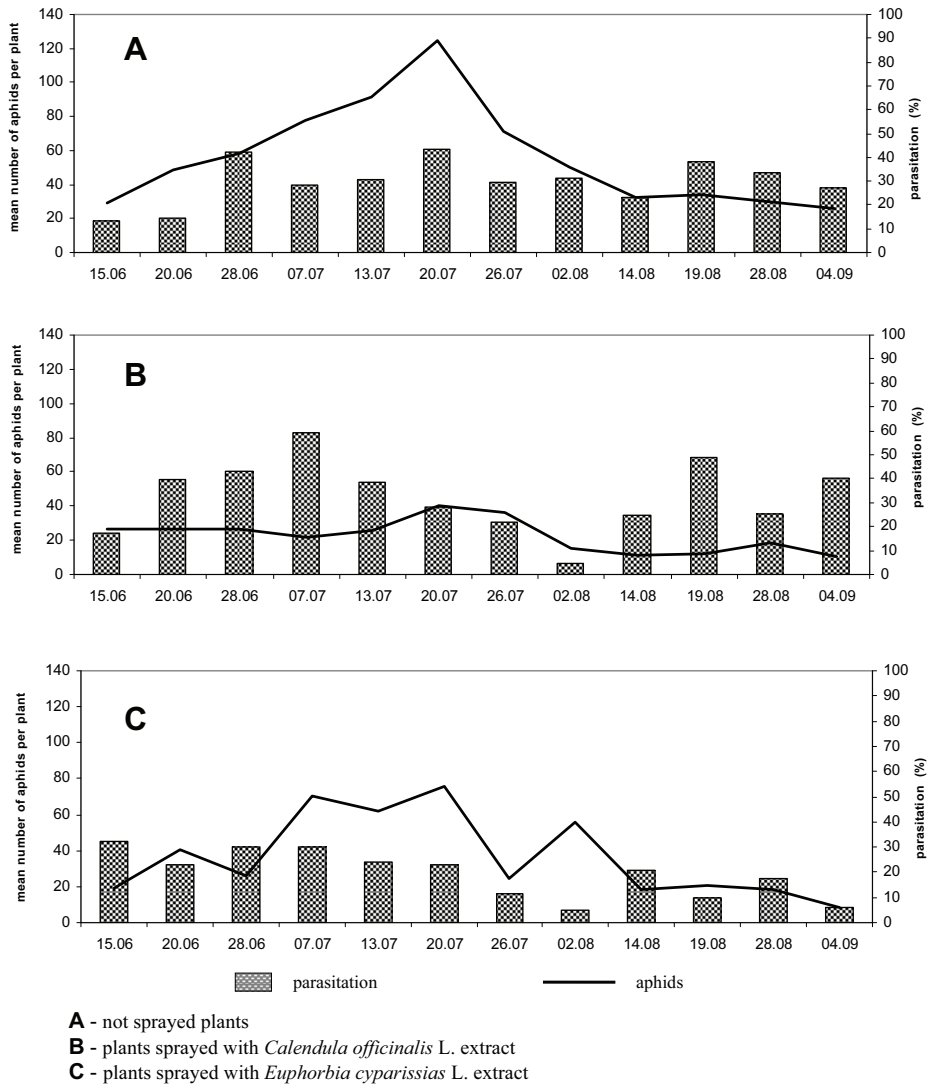


Figure 2. Comparison of parasitization level of *Brevicoryne brassicae* by *Diaeretiella rapae*

## Conclusions

1. Water extracts from pot marigold and cypress spurge lowered the number of aphids on plants. *Calendula officinalis* extract proved to have a better effect.

2. Both extracts lowered the number of parasitized aphids (mummies), though the highest level of parasitation (%) was recorded in aphid colonies feeding on plants sprayed with pot marigold extract.

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- rence of cabbage aphid (*Brevicoryne brassicae* L.), its parasitoid *Diaeretiella rapae* M'Intosh and predatory Syrphidae. Aphids and Other Hemipterous Insects, 13: 199-209.
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**Wpływ wodnych wyciągów z nagietka (*Calendula officinalis* L.) i wilczomlecza sosnki (*Euphorbia cyparissias* L.) na występowanie mszycy kapuścianej (*Brevicoryne brassicae* (Linnaeus, 1758)) /Hemiptera, Aphidoidea/ i jej parazytoida *Diaeretiella rapae* (McIntosh, 1855) /Hymenoptera, Ichneumonoidea/**

**Streszczenie**

W latach 2007-2008 badano wpływ wodnych wyciągów z nagietka lekarskiego (*Calendula officinalis* L.) oraz wilczomlecza sosnki (*Euphorbia cyparissias* L.) na zasiedlenie roślin kapusty białej przez mszycę kapuścianą *Brevicoryne brassicae* oraz aktywność parazytoida *Diaeretiella rapae* McIntosh. Opryskiwanie wyciągami spowodowało zmniejszenie liczby mszyc uskrzydłych zasiedlających rośliny, jak też liczebności mszyc na roślinach w ciągu całego sezonu. Najskuteczniejszy pod tym względem okazał się wyciąg z nagietka. Na roślinach opryskiwanych nim mszyc było istotnie mniej nie tylko w porównaniu do roślin nie opryskiwanych, ale też w porównaniu do roślin opryskiwanych wyciągiem z wilczomlecza. Duże znaczenie w ograniczaniu liczebności mszyc miał parazytoid *D. rapae*. Spasożytność wahała się od 21% – 62% w zależności od roku i kombinacji. Najwyższe spasożytność (%) obserwowano w koloniach mszyc zerujących na roślinach opryskiwanych wyciągiem z nagietka, a najniższe (%), na roślinach opryskiwanych wyciągiem z wilczomlecza. Oba wyciągi wpłynęły na zmniejszenie liczby mszyc spasożytność na roślinach.