2007 vol. 67, 95-102
DOI: 10.2478/v10032-007-0034-4

# PHYTOPHAGOUS ENTOMOFAUNA OCCURRING ON CARROT AND PLANT PROTECTION METHODS

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Received: July 25, 2007; Accepted: September 11, 2007

Summary

Over 34 phytophagous species were noted on carrot plantations in Poland. Most of them are oligo- and polyphagous species, occurring in populations, which pose permanent threat for carrot plantations.

Basing on occurrence frequency and quantity, the identified species were classified into 3 groups.

I group. Species causing significant economic losses: carrot fly (*Chamaepsila rosae* Fabr.), root aphids (*Pemphigus phenax* B&B), cutworm (*Agrotis* spp.), *Semiaphis dauci*, hawthorn carrot aphid (*Dysaphis crataegi* Kalt.), lygus bug (*Lygus* spp.).

II group. Species infesting plantations in cyclic intervals of several years: black been aphid (*Aphis fabae* Scop.), psyllid (*Trioza viridula* Zett.), *Depressaria nervosa* Haw., *D. depresella* Hb., *D. heracliana* DeGeer, wireworms (*Agriotes* spp.), white grubs (*Melolonthinae*)

III group. Species occurring sporadically in numbers, which may pose a threat to plants: knot grass (*Acronicta rumicis* L.), *Mamestra dissimilis* Knoch., *M. persicariae* L., *Autographa gamma* L.

Monitoring of pests presence and threats caused by them is conducted by constantly developed system of short- and long-term forecasting. It includes the species harmful to plantations every year or cyclically, which need to be controlled. Treatment times are established based on signalisation of pest presence on plantation, using yellow sticky cards (*Chamapsila rosae*), pheromone traps (*Agrotis segetum*) or periodic inspection of plantation to evaluate threshold value (other species).

key words: carrot, phytophagous entomofauna, monitoring, harmfulness

## INTRODUCTION

Carrot has been grown for many years in different regions of Poland. Therefore, it became a natural habitat for a lot of insect species. Many of them are phytophagous species, occurring in populations, which pose permanent

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threat for plantations. This great diversity of entomofauna has been a subject of numerous researches for many years (Crüger 1991, Ravn & Esbjerg 1994, Tiilikkala *et al*. 1996). Only the species, which were observed as pests on Polish plantations in the years 1919-2006, were described (Ruszkowski 1933, 1935, Szwejda 2006 a,b).

## METHODS OF INSECTS' COLLECTION

Presented insect species were collected from fields during vegetation period, from injured parts, under- or above-soil, of carrot in the first or second cultivation year. The insects were collected in different developmental stages: pre-imaginal stage and imaginal stage. To monitor flights of adults of cutworm (*Agrotis segetum*) pheromone traps and for carrot fly (*Chamaepsila rosae*) yellow sticky cards were used. Root aphids (*Pemphigus phenax*) were collected directly from carrot roots.

## RESULTS

**Phytophagous entomofauna noted as pests of carrot grown in Poland**

During last 80 years, over 34 taxa, belonging to species, genus or family, were observed on Polish plantations. According to quantity and frequency of occurrence on plantations, the collected species were divided into 3 groups.

Group I. The species causing significant economic losses, which yearly pose a threat to carrot plantations.

Just like in many other European countries, carrot fly (*Chamaepsila rosae*) is major carrot pest in Poland, having been noted on plantations since mid-fifties of XIXth century (Belke 1861). It occurs in numerous populations, irrespective of diverse climatic and soil conditions of carrot cultivation. Its mass occurrence is favoured by the fact that this species not always migrates obligatorily, and in the regions of production of carrot or other *Umbelliferae* (parsley, parsnip, or celeriac) its pre-imaginal stage cycle, including overwintering, is connected to host plant. In turn, adults spend their whole lives in groups of perennial plants surrounding plantations (Ellis & Ester 1999).

Another commonly occurring species is aphid (*Pemphigus phenax*). It is a heteroecious species and its numerous occurrence in all regions of carrot production is related to common occurrence of poplar in Poland. On poplar, this species overwinters and develops spring generations (Goszczyński & Cichocka 1986, Szwejda 1999). Carrot is also commonly infested by other oligophagous species: willow carrot aphid (*Cavariella aegopodii*), hawthorn carrot aphid (*Dysaphis crataegi*) and *Semiaphis dauci.* Similarly to poplar, in Polish agricultural landscape many hawthorns and willows exist being primary host for, respectively, *D. crataegi* and *C. aegopodii*. The latter species infests carrot plants very early, already during plant emergence. In later stages its population is strongly reduced by a parasitoid from family *Aphidiidae* (*Hymenoptera*), to the level harmless for further development of plants. Other permanent elements of phytophagous entomofauna are cutworms from genus *Agrotis.* Cutworms

have been noted in carrot cultures already since 20-ties of previous century (Ruszkowski 1933), always occurring in cyclic intervals of several years (Napiórkowska-Kowalik 1996, Walczak *et al*. 2004). The research conducted in the years 2000-2006 in Institute of Vegetable Crops revealed strong domination of *Agrotis segetum*, which constituted over 96% of all larvae collected from root zone of carrot grown in the regions of Central Poland. On seed plantations, developing seeds are each year damaged by lygus bugs (*Lygus* spp.), with major species *Lygus rugulipennis* (Korcz 1987).

Group II. The species infesting plantations in cyclic intervals of several years.

In forested regions, an aphid *Trioza apicalis* is a problem. This is a heteroecious species, which overwinters on conifers (Tiilikkala *et al*. 1996, IOBC, Fischer & Terrattlaz 2003). For many years, it used to be noted as important pest in our country (Ruszkowski 1933), but since the sixties of previous century this species has occurred only sporadically and in restricted areas. On above-ground plant parts, black bean aphids (*Aphis fabae)* develop seasonally in high numbers. As a typically polyphagous species, it simultaneously infests other crops surrounding the plantation. Also, leaf mines caused by pea leaf miner (*Phytomyza atricornis)* are often visible. The latter species is common on plantations of plants from *Papillionaceae*, *Cucurbitaceae* and *Solanaceae* families.

On seed plantations, caterpillars (*Depressaria nervosa*, *D. depresella*, *D. heracliana*) and midge flies (*Kiefferia pimpinellae*) occur in commonly. They damage above-ground parts of carrot. Out of other species, mainly on organic soils, on carrot roots the following species feed: wireworms (*Agriotes*), larvae of crane flies (*Tipulidae: Tipula paludosa*, *Tipula oleracea*) and march flies (*Bibionidae*: *Bibio marci*, *B. hotulanus*). For many years, two species of white grubs (*Melolontha melolonta* and *M. hippocastani*) have been recorded. Their populations build-up in 3-5 years cycles, just like cutworms.

Group III. Species occurring sporadically in numbers that may pose a threat to plants.

Increasing monocultural production in agriculture regions attracts many polyphagous species, which may present a threat to plantations of carrot. They comprise mainly caterpillars (*Lepidoptera*) damaging above-ground parts of carrot: *Acronicta rumicis*, *Autographa gamma*, *Mamestra brassicae*, *M. persicariae*, *M. pisi*, *Phlyctaenodes sticticalis* and *P. palealis*. These species were recorded as pests on carrot already in previous century (Ruszkowski 1933, Ruszkowski *et al*. 1935). Presently, no reports are available on phytophagous *Hymenoptera* from the genus *Tenthradella*, though they were noted as pests by Ruszkowski *et al*. (1935).

The role of two species from *Jassidae* family (*Empoasca pteridis* Dahlb. and *Edwardsiana flavenescens* is not explained yet. They are present in great numbers on plantations of carrot during whole vegetation period, sucking leaves, which results in numerous, minute dots. However, negative effects of their feeding were not confirmed, except for the fact that they may transmit virus diseases (Soika & Kamińska 2000).

Table 1. Phytophagous entomofauna occurring on carrot in Poland

| Order | Species | Quantity* |
|---|---|---|
| Diptera | *Chamaepsila (Psila) rosae* Fabr. | I* |
| | *Phytomyza atricornis* Meig. | II* |
| | *Kiefferia pimpinellae* F. Loew | II |
| | Tipulidae: | III* |
| | *Tipula paludosa* Meig. | |
| | *T. oleracea* L. | |
| | Bibionidae: | III* |
| | *Bibio marci* L. | |
| | *B. hortulans* L. | |
| Homoptera | *Pemphigus phenax* B&B | I |
| | *P. lactucarius* Pass. | III |
| | *Semiaphis dauci* Fabr. | I |
| | *Cavariella aegopodii* Scop. | I |
| | *Dysaphis crataegi* Kalt. | I |
| | *Aphis fabae* Scop. | II |
| | *Trioza apicalis* Fuerst. | II |
| Heteroptera | *Empoasca pteridis* Dahlb. | III |
| | *Edwardsiana flavenescens* Fabr. | III |
| | *Lygus rugulipennis* Popp. | I |
| | *L. campestris* L. | I |
| | *Orthops kalmi* L. | I |
| Lepidoptera | *Acronicta rumicis* | III |
| | *Depressaria nervosa* Haw. | II |
| | *D. depresella* Hb. | II |
| | *D. heracliana* DeGeer | II |
| | *Phlyctaenodes (Pyrausta) sticticalis* L. | II |
| | *P. palealis* Schiff. | II |
| | *Autographa gamma* L. | III |
| | *Papilio machaon* L. | III |
| | *Mamestra dissimilis* Knoch. | III |
| | *M. persicariae* L. | III |
| | *M. pisi* L. | III |
| | Noctuidae – Agrotis spp. | I |
| | - *Agrotis segetum* Schiff. | |
| | - *A. exclamationis* L. | |
| | - *Graphiphora c-nigrum* L. | |
| Coleoptera | Agriotes spp. | II |
| | - *Agriotes obscurus* L. | |
| | - *A. lineatus* L. | |
| | - *A. sputator* L. | |
| | - *Athous niger* L. | |
| | Melolonthinae | II |
| | - *Melolontha melolontha* L. | |
| | - *M. hippocastani* F. | |
| Hymenoptera | *Tenthradella* sp. | III |

Explanation: I* - numerous occurring, II* - periodical occurring, III* - sporadic occurring

**Protection methods and threshold values**

Species and population variation of the presented species, occurring in agrocenosis, is characterized by great fluctuation range, due to natural or induced migrations of insects in a search for host plants as well as population build-up under conditions more favourable for their development. Such a great diversity of phytophagous species infesting carrots from sawing to harvest makes protection treatments an integral part of production cycle of this vegetable.

Monitoring of pests occurrence and risks caused by them is conducted basing on continuously updated short- and long-term forecast system. Precise prediction of risk dates enables effective protection of monitored area and at the same time minimalization of impact on environment when plant protection chemicals are used. In our country, damages caused to crops, including carrot, were recorded already in the twenties and thirties of previous century (Ruszkowski 1933,1935). Permanent monitoring of losses caused by pests was started at the end of the fifties and it is systemically carried out at the area of the entire country (Walczak 1999). It includes phytosanitary condition of crops based on periodic inspections and assessment of extent of losses.

The greatest threat has been imposed for years by carrot fly (*Chamaepsila rosae*) (Szwejda & Narkiewicz 1970), root aphid (*Pemphigus phenax*) (Szwejda 1999) and cutworms (*Agrotis* spp.), with dominating species *A. segetum* (Walczak *et al*. 2004). Various methods of pests monitoring are used in order to establish threshold values. For carrot fly, a threshold value for the first generation of the pest (May) when using yellow sticky cards was catching 2 adults during 3 consecutive days, while for the second generation (from mid-July to mid-August) a threshold value is on average 0.75-1 adult. For root aphid (*Pemphigus phenax*), the basis for determination of threshold value is a presence of one colony of aphids on carrot roots within the row of 0.5 meter in 3 spots on 1 ha field. The periods of initial colonization of carrot roots by root aphids are presented in the Table 3. A basis for risk signalisation for cutworm (*Agrotis* spp.) infestation is catching males into pheromone traps. The studies conducted in Research Institute of Vegetable Crops in 2005-2006, revealed two peak periods of *A. segetum* occurrence (Fig. 1). It is necessary to continue monitoring every year because of significant differences in time of flight and infestation of plantations by adults in particular years, depending mainly on weather conditions (Ravn & Esbjerg 1994, Collier & Phelps 1996, Walczak & Jakubowska 2001, Szwejda 2006b).

Effective control of phytophags still based on plant protection chemicals, mainly synthetic, used preventively as seed treatments or after pest occurrence e.g. by spraying or soil drench. More and more often biological substances of natural origin are used. In the experiments conducted in the Research Institute of Vegetable Crops in Skierniewice, during the years 2000-2003, promising results against carrot fly (*Chamaepsila rosae*) and aphid (*Semiaphis dauci*) were obtained with the application of azadirachtin, an extract from seeds of a neem tree (*Azadirachta indica*) (Szwejda 2006a). In many research centres studies on

other protection methods are also carried out, e.g. breeding of carrot cultivars tolerant or resistant to pests.

Table 2. Dates of flight of carrot fly (*Chamaepsila rosae*) on carrot. Yellow traps. Field observations, Skierniewice 2004-2006

| Dates od flight | | | | | |
|---|---|---|---|---|---|
| 2004 | | 2005 | | 2006 | |
| First generation | | | | | |
| Beginning | End | Beginning | End | Beginning | End |
| 05.05. | 18.05. | 30.05. | 16.06. | 30.05. | 18.05. |
| Second generation | | | | | |
| 29.07. | 10.08. | 22.07. | 08.08. | 02.08. | 15.08. |

Table 3. Dates of carrot colonisation by summer generations of wingless root aphids (*Pemphigus phenax*). Field observations. Skierniewice 2004-2006.

| Beginnig of colonisation date | | |
|---|---|---|
| 2004 | 2005 | 2006 |
| from 02.08. | from 15.07. | from 30.07. |

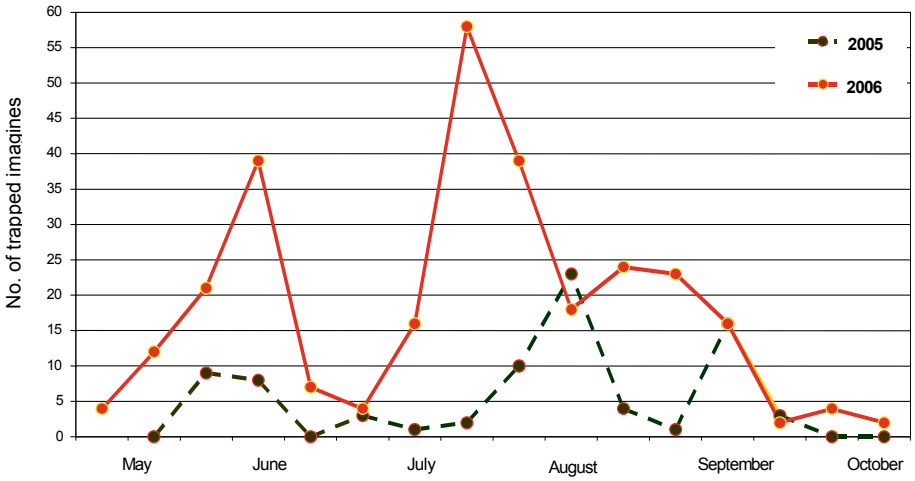



Fig. 1. Monitoring of adults flight of *Agrotis segetum* on carrot using pheromone traps. Field observations, Skierniewice 2005 and 2006.

## CONCLUSION

Keeping phytosanitary conditions of crops on the level preventing from significant injuries of plants during growing period and after harvest is an indispensable element of a technology of vegetable production. Therefore, the basic activity is permanent monitoring of the fields with appropriate warning systems (traps, periodical inspection of a plantation). A constant threat is posed by natural or forced migration of many phytophagous species to new areas, resulting mainly from changing crops structure, increasing urbanisation of agricultural areas, international exchange of agricultural products and climate changes.

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## FITOFAGICZNA ENTOMOFAUNA WYSTĘPUJĄCA NA MARCHWI I METODY OCHRONY

Streszczenie

Na krajowych plantacjach marchwi, stwierdzono dotychczas ponad 34 fitofagicznych gatunków. Większość z nich to gatunki oligo- i polifagiczne, występujące w populacjach stwarzających permanentne zagrożenia na plantacjach marchwi.

Z uwagi na powszechność i częstotliwość występowania, zidentyfikowane gatunki podzielono na 3 grupy.

I grupa. Gatunki wyrządzające istotne szkody ekonomiczne: połyśnica marchwianka (*Chamaepsila rosae*), bawełnica topolowo-marchwiowa (*Pemphigus phenax*), rolnice (*Agrotis* spp.), mszyca marchwiowa ondulująca (*Semiaphis dauci*), mszyca głogowo-marchwiowa (*Dysaphis crataegi*), zmieniki (*Lygus* spp.).

II grupa. Gatunki zasiedlające plantacje w powtarzających się cyklicznie kilkuletnich odstępach: mszyca burakowa (*Aphis fabae*), golanica zielonka (*Trioza viridula*), płożek kminiaczek (*Depressaria nervosa*), płożek obłączkowiaczek (*D. depresella*), płożek marchwiaczek (*D. heracliana*), drutowce (wireworms) (*Agriotes* spp.), pędraki (armyworms) (*Melolonthinae*)

III grupa. Gatunki sporadycznie występujące w liczebności mogącej stanowić zagrożenia dla roślin: wieczernica szczawiówka (*Acronicta rumicis*), piętnówka zmienna (*Mamestra dissimilis*), piętnówka rdestówka (*M. persicariae*), błyszczka jarzynówka (*Autographa gamma*).

Monitorowanie obecności agrofagów i powodowanych przez nie zagrożeń, prowadzi się w oparciu o stale unowocześniany system prognozowania krótko- i długoterminowego. Objęto nim gatunki corocznie lub cyklicznie zagrażające plantacjom, wymagające zwalczania. Terminy zwalczania są ustalane w oparciu o sygnalizację obecności szkodnika na plantacji, stosując żółte tablice lepowe (połysnica marchwianka - *Chamaepsila rosae*), pułapki feromonowe (rolnice - *Agrotis segetum*) lub okresową lustrację plantacji określającą próg zagrożenia (threshold value) - (pozostałe gatunki).