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MONITORING OF CODLING MOTH (*CYDIA POMONELLA* L.) IN APPLE ORCHARDS USING TWO METHODS

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Abstract: The present studies were conducted in 1999–2001 in three apple orchards differing from each other by the system of cultivation, the type of agricultural treatments and chemical control of pests. Their purpose was to monitor codling moth (*Cydia pomonella* L.) in different types of apple orchards using pheromone traps, finding out the relation between the occurrence of moths and the sum of effective temperatures as well as determining the number of wintering caterpillars of this species with the use of bands of corrugated paper. The analysis of male flight of codling moth on the basis of pheromone traps makes it possible to state the occurrence of two generations in each studied year. The maximum population of the first generation was observed in the second or third ten days of June, while that of the second generation in the first ten days of August. The moths flight began when the sum of effective temperatures was 109.2–145.2°C, and the mean diurnal temperature was 12.3–17.2°C.

Key words: *Cydia pomonella* L., codling moth, apple orchards, monitoring, pheromone traps, sum of effective temperatures

INTRODUCTION

Long term of observations point out that the population of codling moth (*Cydia pomonella* L.) and the done damage by this pest undergo considerable changes (Suski and Niemczyk 1985). It is a species characterized by a very wide range of occurrence, which results in its development and biology varying in particular habitats.

In recent years the population of codling moth increased in particular orchards. This is a consequence of a limited use of insecticides against this species as well as insecticides with a wide spectrum of efficacy. This also resulted from meteorological conditions, namely fairly mild winters favouring overwintering of caterpillars (Płuciennik and Olszak 1996; Płuciennik 2000), and warm summers (when the temperature in the evening and at night during the moths' flight was lower than 15°C) which made the development of the second generation of this species possible (Kozłowski 1993).

The purpose of the present paper was to monitor *C. pomonella* in different types of apple orchards using pheromone traps, settling the relation between the occurrence of moths and the sum of effective temperatures as well as determining the population of wintering forms of this species with the use of bands of corrugated paper.

MATERIALS AND METHODS

The studies were conducted in three apple orchards in the vicinity of Lublin in 1999–2001. The fact that particular objects were not too distant from each other ensured comparability of meteorological conditions occurring in the area of the studied orchards. Particular apple orchards differed from each other by the system of cultivation, the type of agricultural treatments and chemical control of pests.

The orchard in Leonów (site 1), which was not chemically protected and its area was about 5 ha, a commercial orchard with semi-dwarf plantings till 1993. Since then, no plant protection treatments or fertilization were there appued. Cultivated fields are situated around this orchard.

The orchard in Motycz (site 2), which had a limited program of protection and the area of about 2 ha, included semi-dwarf trees with a double row system. In this object chemical protection was applied at the moment when the population of the pest increased to the harmfulness threshold. In each year, 2–3 treatments using insecticides were applied [Owadofos 540 EC (fenitrotion 540 g/l), Decis 2.5 EC (deltametryna 2.5%), Zolone 35 EC (fosalon)]. This orchard borders with fallow land and another apple orchard.

An intensively protected orchard in Jastków (site 3), of the area about 2 ha, includes plantings arranged vertically as spindle bushes and attached to an individual post. In each year, 5–6 treatments of plant protection using insecticides were applied [Sumithion 500 EC (fenitrotion 500 g/l), Zolone 350 EC (fosalon), Owadofos 540 EC (fenitrotion 540 g/l), Karate 0.25 EC (lambda-cyhalotryna 25 g/l), Bulldock 0.25 EC (beta-cyflutryna 25 g/l)]. This orchard borders with a cultivated field, a hop plantation and a pond.

Aiming at determining the population of overwintering caterpillars of codling moth, in June in each of the examined orchards bands of corrugated paper were at-

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tached around the trunks of 45 randomly chosen trees. Those bands were then taken off in September. The overwintering larvae found in the bands were placed in isolators for winter and were kept in studied orchards. In the spring moths' flights were observed.

The dynamics of the *C. pomonella* flight was determined on the basis of catches into pheromone traps of Delta type produced by PPH "MEDCHEM". In particular objects, one trap was hanged in the outside part of the tree crown at height of about 1.5 m above the ground. They were placed in the examined orchards just after blooming period, and next the number of caught males was checked three times a week.

On the basis of male flights observed checking pheromone traps, an attempt was made to establish the relation between their flight dynamics and the sum of effective temperatures. The sum of effective temperatures was calculated according to the formula included in Alford's *et al.* (1979) study:

$$S = (T - t_0)\, d$$

where:
T – diurnal temperature
t_0 – physiological zero for given species
d – number of development days of stage or generation.

The value of 10°C was adopted as the physiological zero (Kagan 1976). The temperatures above the physiological zero were added since 1st January of each studied year.

The results obtained from caught males to pheromone traps were submitted to a statistical analysis using the sign test for dependent observations (Stanisz 1999).

RESULTS

Observations carried out in 1999–2001 in different types of apple orchards made it possible to state that the most *C. pomonella* larvae in trap bands made of corrugated paper were found in the orchard with a limited program of plant protection in Motycz (Table 1). There, the tree trunks had bark with numerous cracks, which created good environment for overwintering larvae of this species. Nearly half as many larvae were observed in trap bands in the orchard without any chemical protection in Leonów. On the other hand, no larvae of this species were found in the intensively protected orchard in Jastków during the three years of observations.

It can be seen from table 2 that during the three years of observations in all examined orchards, the codling moth flight usually began in the third ten days of May. The end of moth flight was found out in the second or third ten days of August although in 2000 in the orchard with a limited program of plant protection and in 2001 in the orchard without any plant protection treatment, the last moths were still observed in the first days of September.

In 1999, the maximum number of the first generation in all studied experimental objects was found in the first and second ten days of June (Fig. 1). The maximum flight of the second generation of this species was observed in

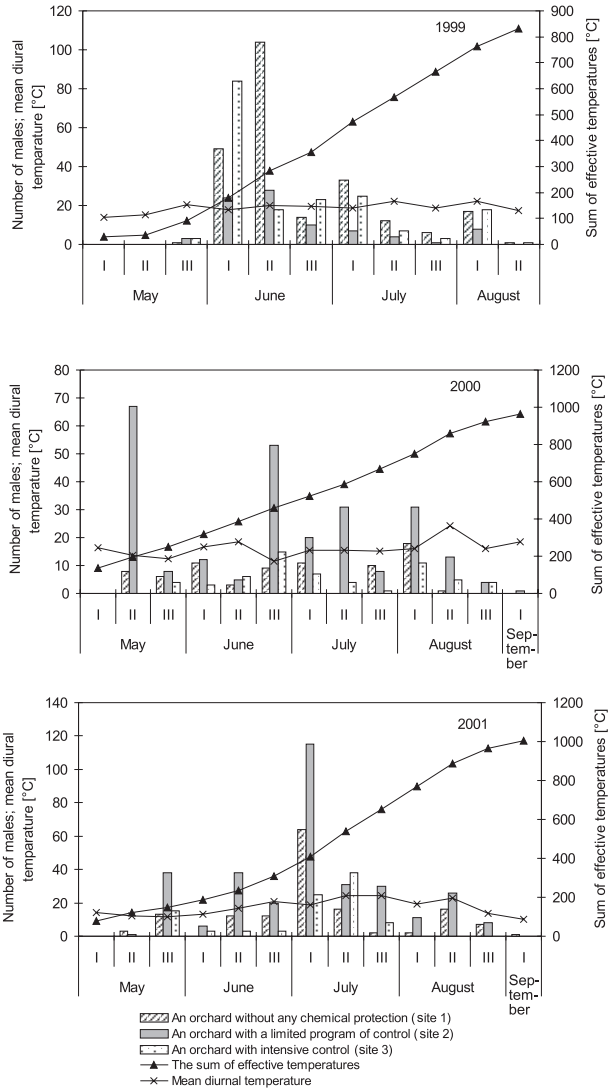

Fig. 1. The flight dynamics of *C. pomonella* males in particular apple orchards in 1999–2001

the first ten days of August, and its number was remarkably smaller than that of the first generation.

In 2000, codling moth occurred in small numbers in the orchard without any chemical protection in Leonów. It was found out that the second generation was more numerous than the first one and its maximum occurred during the first ten days of August. In the orchard with a limited program of plant protection in Motycz, two peaks of the maximum male of *C. pomonella* were observed and they occurred in the second and third ten days of June. The highest number of the second generation in that orchard occurred in the first ten days of August. In the intensively protected orchard in Jastków, the first generation of codling moth was the highest in the third ten days of June, while the second one in the first ten days of August.

In 2001, the maximum male number of *C. pomonella* in the orchard without any chemical protection and in the orchard with a limited protection scheme was observed in the first ten days of August, whereas in the intensively protected orchard in the second ten days of July. The second generation male flight was observed only in the orchard without chemical protection and in the orchard

Table 1. Number of hibernating larvae of *C. pomonella* in trap bands of corrugated paper in apple orchards in 1999–2001

Year	Site		
	orchard without chemical protection (site 1)	orchard with a limited program of control (site 2)	orchard with intensive control (site 3)
1999	12	14	0
2000	8	5	0
2001	21	62	0
Total	41	81	0

Table 2. Number of *C. pomonella* males caught to pheromone traps in apple orchards in 1999–2001

Site	Year	Number of males in trap	First caught moths	Last caught moths	Percentage of males in particular months				
					V	VI	VII	VIII	IX
Orchard without any chemical protection (site 1)	1999	182	29 V	14 VIII	1.7	68.7	19.2	10.4	–
	2000	77	13 V	19 VIII	18.1	29.9	27.3	24.7	–
	2001	148	19 V	6 IX	10.8	16.2	55.4	16.9	0.7
Orchard with a limited program of control (site 2)	1999	237	31 V	17 VIII	0.4	70.5	21.5	7.6	–
	2000	253	13 V	4 IX	29.6	27.7	23.3	19.0	0.4
	2001	324	19 V	27 VIII	12.0	19.8	54.3	13.9	–
Orchard with intensive control (site 3)	1999	85	29 V	8 VIII	3.5	73.0	14.1	9.4	–
	2000	60	24 V	24 VIII	6.7	40.0	20.0	33.3	–
	2001	95	23 V	30 VII	15.8	9.5	74.7	–	–

with a limited protection program and its maximum was stated in the second ten days of August.

It can be seen from the data in figure 1 that the flight of codling moth began when the sum of effective temperatures was 109.2°C in 1999. In the other two years of studies, the sum of effective temperatures in the period when the moths flight began was higher and it was 145.2°C in 2000, and 118.3°C in 2001. Within the three years of studies, the mean diurnal temperature during the flight of the first moths was 12.3–17.2°C.

The statistical analysis (using the sign test for dependent observations) showed that three compared apple orchards significantly differed with respect of the number of codling moth males.

DISCUSSION

The bark of trees and shrubs is place where a lot of insect species from various trophic groups overwinter. One of the phytopagous species that go through winter diapause in cracks of bark is *C. pomonella*. The highest number of dormant caterpillars of this species within the three years of studies was observed in the orchard with a limited program of plant protection (81 specimens), where the trees had bark with numerous cracks, which creates favourable conditions for overwintering. An equally high number of diapausing larvae of *C. pomonella* in the orchard with a limited protection scheme was pointed at in the studies by Jeanneret and Charmillot (1997). In the intensively protected orchard did not occur larvae of this species in the bands of corrugated paper, which, however, does not exclude the possibility that codling moth occured in this orchard because male individuals were found in pheromone traps. Due to the occurrence of smooth-bark trees, larvae probably could have overwintered in the mulch (Razowski 1991).

The analysis of flight dynamics of codling moth on the basis of catches in pheromone traps indicated the occurrence of this species in two generations. Most frequently, the male flight of this species began in the third ten days of May, while Stamenković *et al.* (1999) reported that in the area of Serbia the moths flight mostly began in the first half of May. The maximum number of the first generation usually fell into the second or third ten days of June, while that of the second generation into the first ten days of August. In other regions of the country, the flight dynamics of codling moth occurs at similar dates (Płuciennik 1999, 2000).

Air temperature is an important abiotic factor directly or indirectly influencing the development, survival, number and spread of insects (Szujecki 1980). Knowledge of the sum of effective temperatures during the first moths flight of particular species enables prognosing the dates of their occurrence in a given year.

The flight of *C. pomonella* males began with the sum of effective temperatures ranging from 109.2°C to 145.2°C, depending on the year of studies. In England, with the sum of effective temperatures of 150°C, about 24% were caught, and in certain cases even 50% of all males of the first generation (Cranham 1974; Alford *et al.* 1979). During the three years of studies, the mean diurnal temperature during the occurrence of the first moths ranged from 12.3 to 17.2°C. The results obtained in the studies on the sum of effective temperatures and the mean diurnal temperature during the flight of the first males are similar to the data presented by Bulyginskaja and Emeljanov (1997).

REFERENCES

Alford D.V., Carden P.W., Dennis E.B., Gould H.J., Vernon J.D.R. 1979. Monitoring codling and tortrix moths in United Kingdom apple orchards using pheromone traps. Ann. Appl. Biol. 91: 165–178.

Bulyginskaja M.A., Emeljanov V.A. 1997. Dinamika liota samcov jablonnoj plodožorki *Laspeyresia pomonella* L. (*Lepidoptera, Tortricidae*) na sintetičeskie polovye feromony v sadach severo-zapada Rossii i opredeljajuščie ee faktory. Entomlogičeskoe Obozrenie LXXVI (2): 290–296.

Cranham J.E. 1974. Studies with sex pheromones. Codling moth, *Laspeyresia pomonella*. p. 161–162. In: East Malling Research Station Annual Report for 1973.

Jeanneret Ph., Charmillot P.J. 1997. Populations de tordeuses dans les vergers d'arbres à haute tige et risque de colonisation pour les cultures commerciales de pommieres. Revue Suisse Vitic. Arboric. Hortic. 29 (4): 219–227.

Kagan F. 1976. Metody prognozowania i sygnalizacji występowania szkodników drzew i krzewów owocowych. p. 169–220. In: „Instrukcja dla służb ochrony roślin z zakresu prognoz sygnalizacji i rejestracji, cz. II". Instytut Ochrony Roślin, Poznań.

Kozłowski J. 1993. Prognoza występowania i ustalenie terminu zwalczania owocówki jabłkóweczki (*Carpocapsa pomonella* L.) w latach 1981–1992 w Wielkopolsce. Prace Nauk. Inst. Ochr. Roślin 35 (1/2): 43–47.

Płuciennik Z. 1999. Wykorzystanie pułapek feromonowych i selektywnych insektycydów do zwalczania owocówki jabłkóweczki. p. 31–34. In: Proc. Ogólnopol. Nauk. Konf. Ochr. Roślin Sad. 16–17 lutego 1999, Skierniewice.

Płuciennik Z. 2000. Problemy ze zwalczaniem owocówki jabłkóweczki w 1999 roku. p. 107–110. In: Proc. Ogólnopol. Nauk. Konf. Ochr. Roślin Sad. 15–16 lutego 1999, Skierniewice.

Płuciennik Z., Olszak R.W. 1996. Owocówka jabłkóweczka – stan zagrożenia, zwalczanie. p. 55–57. In: Proc. Ogólnopol. Konf. Ochr. Roślin Sad. 20–21 lutego 1999, Skierniewice.

Razowski J. 1991. Motyle (*Lepidoptera*) Polski. Cz. VIII – Grapholitini. Monografie Fauny Polski, T. 19. PWN, Warszawa – Kraków, 187 pp.

Stamenkovič S., Milenkovič S., Stamenkovič T., Polesny F. 1999. Population dynamics of summer fruit tortrix moth *Adoxophyes orana* F.v.R. (*Lepidoptera, Tortricidae*) in Western Serbia. p. 177–181. In: Proc. Workshop on Arthropod Pest Problems in Pome Fruit Production at Einsiedeln, Switzerland. November 30 – December 3 1999. Bull. OILBSROP, 1999.

Stanisz A. 1999. Podstawy statystyki dla prowadzących badania naukowe. Testy nieparametryczne – cz. II. Medycyna Praktyczna 10: 167–169.

Suski Z., Niemczyk E. 1985. Uwagi nad integrowanym zwalczaniem szkodników sadów w Polsce. Wiad. Entomol. 5 (3–4): 99–108.

Szujecki A. 1980. Ekologia Owadów Leśnych. PWN, Warszawa, 603 pp.

POLISH SUMMARY

MONITORING OWOCÓWKI JABŁKÓWECZKI (*CYDIA POMONELLA* L.) W SADACH JABŁONIOWYCH Z WYKORZYSTANIEM DWÓCH METOD

W latach 1999–2001 prowadzono badania w trzech sadach jabłoniowych różniących się między sobą systemem uprawy, ochrony roślin oraz zabiegami agrotechnicznymi. Ich celem był monitoring owocówki jabłkóweczki (*Cydia pomonella* L.) w różnych typach sadów jabłoniowych z wykorzystaniem pułapek feromonowych, ustalenie związku pomiędzy pojawem motyli a sumą efektywnych temperatur oraz określenie liczebności zimujących gąsienic tego gatunku z wykorzystaniem opasek z papieru falistego. Analizując dynamikę lotu owocówki jabłkóweczki na podstawie odłowów do pułapek feromonowych stwierdzono występowanie tego gatunku w dwóch pokoleniach, w każdym roku badań. Maksimum liczebności pierwszego pokolenia odnotowano w II lub III dekadzie czerwca, a drugiego pokolenia w I dekadzie sierpnia. Lot motyli rozpoczynał się przy sumie efektywnych temperatur wynoszącej 109,2–145,2°C i średniej dobowej temperaturze 12,3–17,2°C.