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THE CONTROL OF *CYDIA POMONELLA L.* IN APPLE ORCHARDS OF FOREST STEPPE OF UKRAINE IN THE CONDITIONS OF CLIMATIC CHANGE

V. M. Chayka, Doctor, Prof.,

I. G. Rubezhniak, PhD., Assoc. Prof.

National University of Life and Environmental Sciences of Ukraine

O. I. Petryk, postgraduate student

Institute of Plant Protection, National Academy of Agrarian Sciences of Ukraine

E-mail: rubezhnyak@yandex.ru, elia-81@list.ru, petryk.olena@gmail.com

Abstract. *The present studies were conducted in 2013 in three apple orchards differing from each other by the age, the apple varieties and system of 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* diapausing *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 three generations. Increase of average annual temperature is directly influence on generation number of codling moth in Ukraine.*

Keywords: *Cydia pomonella L., codling moth, apple orchards, monitoring, pheromone traps, corrugated paper band, sum of effective temperatures*

Introduction. Codling moth, *Cydia pomonella* L. is a major pest of deciduous tree crops in fruit-growing regions throughout the world. In Ukraine Forest steppe, codling moth is considered as an important pest of apple orchards. The losses of apple crop have been from 30% to 70% (Krykunov 2000). Previous researches shown, that climate changes in Ukraine altered the structure of the leafroller complex, the number of generation, duration of imago flight in apple orchards (Chayka *et al.* 2013a).

The aim of experiment, conducted in 2013, was to monitor *C. pomonella* in 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 research was conducted in three commercial apple orchards of Tarasivskii agricultural enterprise, Kiev region. Particular apple orchards differ from each other by the age, the apple varieties and system of chemical control of pests. The nineteen-year-old orchard was not chemically protected and Idared, Spartan, Prima, Reinette and Simirenko cultivars are grown there. The thirteen-year-old orchard was an intensively protected orchard. In each year, 11 treatments of plant protection using insecticides were applied in this orchid. There grown Jonagold, Florina and Champion cvs. In seven-old orchard 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 and Jonagold, Golden Delicious, Golden Delicious cvs are grown there.

The dynamics of *C. pomonella* flight was determined on the basis of catches into pheromone traps of Atracon-A with Pestifix glue and synthetic pheromone produced by "Intervab" (Moldova). The traps were hanged inside the canopy of apple trees in early May. Distance between traps was less than 50 m. The traps were checked one time per 5 days, pheromone capsules were changed every 20 days and glue boxes - every 10 days (Triebel *et al*. 2001).

Aiming at determination the number of diapausing caterpillars of codling moth, in 1 June in each of the exanimated orchards corrugated paper bands (CPBs) 20 cm wide were wrapped around the tree trunk of 10 apple trees (cultivars of winter apple). The bands were checked one time per 7 days, the captured caterpillars and pupae were counted for record and pupae was removed and destroyed. Traps and bands were placed in the orchard before the moths appear (Suskling 2000).

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 *et al.*1979).

Results. Fig. 1 presents the sum of effective temperatures in 2013 in the period when the moth flight began.

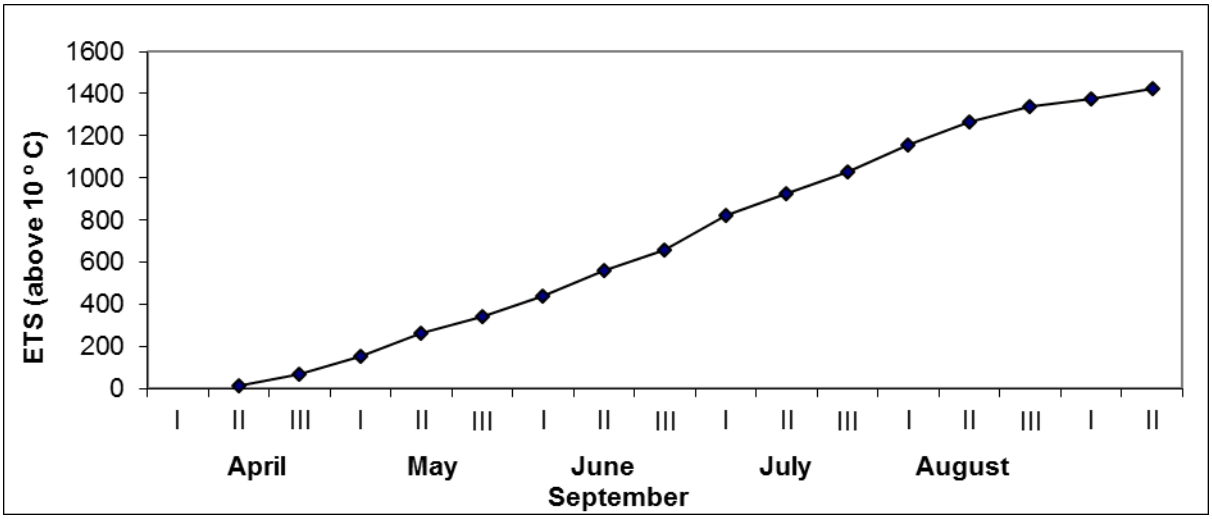

Fig. 1. Effective temperature sums (above 10° C) during the vegetation period in 2013, Kiev

The pheromone traps showed that the flight of codling moth generation in the orchard without any chemical protection was observed on first decade of May and the sum of effective temperatures was 80.4 ºC (Fig.2). Flight of overwintering generation was observed from 1 May to 25 June. The maximum flight activity was recorded on 25 May at 302 degree days. The flight of the secondary moth generations was registered from 3 July to 5 August at 757.5 degree days. The maximum number of codling moth was observed on 15 July and the number of moths captured in the traps was 25 moths per trap.

It was observed the flight of the third moth generation from 10 to 30 August at 1156 degree days. The flight peak of codling moth was noted on 15 August at 1212.5 degree days.

Figure 3 shows that the codling moth flight of overwintering generation in the intensively protected orchard was observed from 1 May to 20 June at 80.4 degree days. The maximum quantity of codling moth was registered on 15 May at 210.5 degree days.

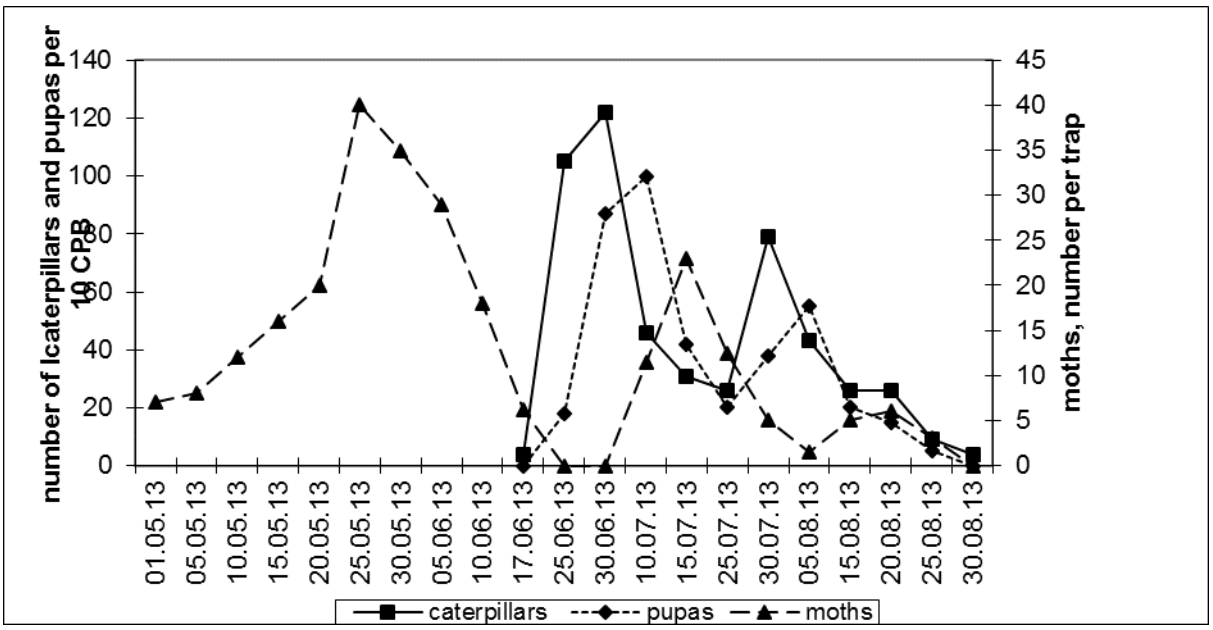

Fig. 2. The flight dynamics of Cydia pomonella L. in 2013, Tarasivskii agricultural enterprise of Kiev region (not chemically protected apple orchard)

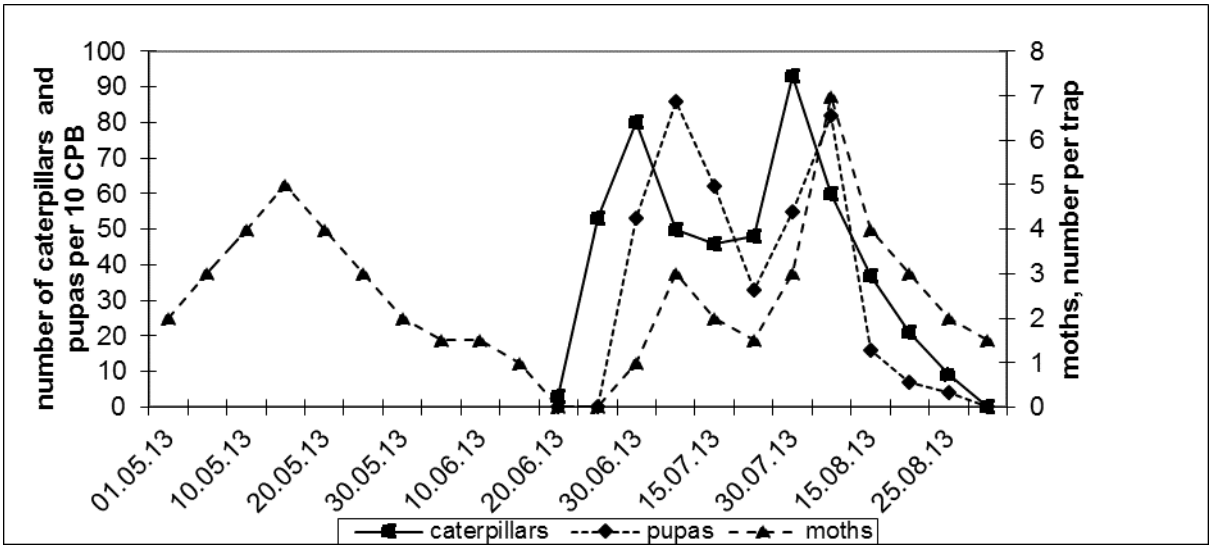

Fig. 3. The flight dynamics of Cydia pomonella L. in 2013, Tarasivskii agricultural enterprise of Kiev region (intensivly protected apple orchard)

The flight of the second and third moth generations were from 30 June to 25 July and from 30 July to 10 September at 695 and 1020.5 degree days respectively. The flight peak of the second and third generations was noted on 5 June and 5-10 August. It was found that the flight of the third generation was more numerous that the first one. In our opinion, such dynamics of codling moth can account for the fact that the orchards in the period of apple vegetation were chemical protected. However

before harvesting the pesticide treatments were finished, as a result the codling moth flight to pheromone traps was resumed.

It can be seen from the data in figure 4 that the flight of codling moth in the apple orchard with a limited protection scheme began when the sum of effective temperatures was 97.2 º C. The flight of moth was observed from 3 May to 15 June. The flight peak of overwintering generation was noted on 25 May at 302 degree days. During the second generation, the appearance, peak and last moth emergence was observed on 25 June, 15 July and 5 August at 629, 972.5 and 1110 degree days, respectively. It was observed some small flight peak of *C. pomonella* from 10 August to 10 September at 1156 degree days with maximum flight peak on 25 August (5 moths per trap).

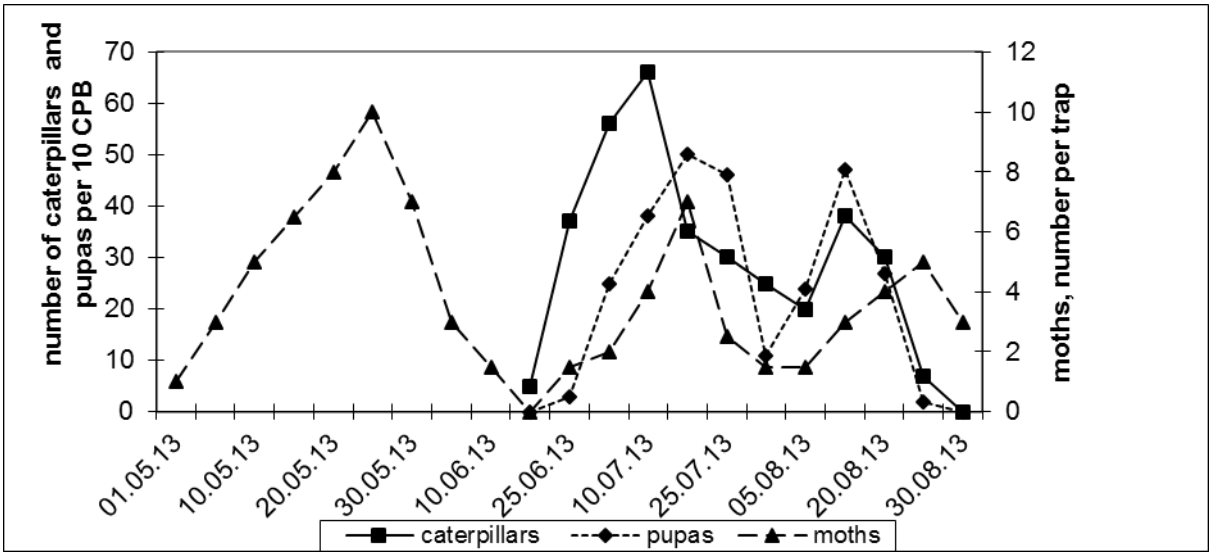

Fig. 4. The flight dynamics of Cydia pomonella L. in 2013, Tarasivskii agricultural enterprise of Kiev region (apple orchard with a limited protection scheme)

The present results shows that start of cocoon process of caterpillars of *C. pomonella* in the unsprayed apple orchard and in the intensively protected orchard were observed on 17 June and 20 June, respectively (Fig.2, 3). The first pupae were removed from CPBs at the end of July at 560 degree days. The highest number of caterpillars in the bands on 1 July and 29 July were the beginning of pupae process of the second and third generations in the both orchards. In orchard with limited

pesticide treatment the height number of caterpillars was observed on 12 July and 12 August (Fig. 4). It was calculated the diapausing caterpillars of the codling moth of two generations (Fig. 5).

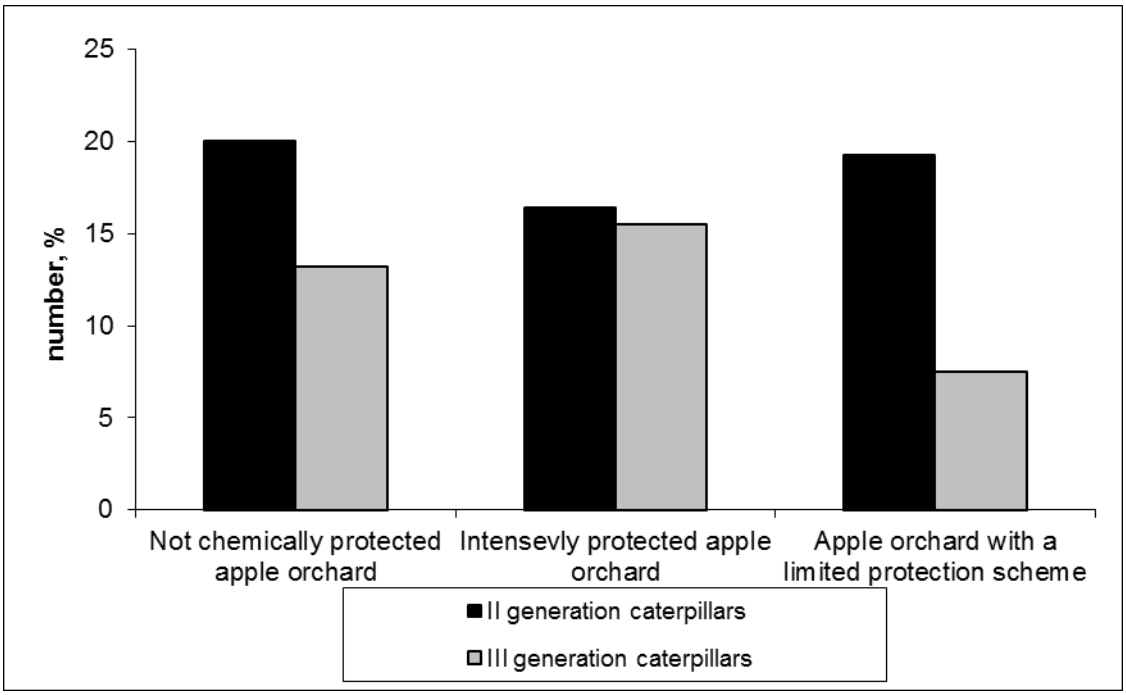

Fig. 5. The formation of diapausing caterpillars of Cydia pomonella L. in 2013, Kiev region

The height number of diapausing caterpillars of *C. pomonella* was in the orchard without chemical protection. There were 20% and 13.2 % diapausing caterpillars of the second and third generations, respectively. In the orchard with a limited protection scheme, 19.3% and 7.5% diapausing caterpillars of the second and third generations were observed. On the other hand, equal number the diapausing caterpillars of the second and third generations of month occurred in the intensively protected orchard (16.4% and 15.5%, respectively).

Discussion. Vasilev *et al.* (1984) demonstrated that pest has two generations in the Ukrainian Forest Steppe. In 2000, the codling moth had only one generation in northern and central regions of Ukraine. The researchers observed a facultative second generation in separate orchards (Braion *et al.* 2003). The monitoring of codling moth in apple orchards of Tarasivskii agricultural enterprise during 2010 - 2012 was shown, that *C. pomonella* has one winter generation and two summer

generations (Chayka *et al.* 2013a). The analysis of flight dynamics of codling moth in 2013 on the basis of catches in pheromone traps and corrugated paper bands indicated the occurrence of this species in three generations also.

The winter generation in the orchard without chemical protection and the orchard with a limited protection scheme was more numerous that the summer generations. It was found that the flight of the second summer generation was more numerous and durational than the winter generation and the first summer generation in orchard with intensive pesticide treatment. In our opinion, that is an impact of the pesticide application on the pest population number.

The long-term observations of climate change in Ukraine indicated that the average annual temperature increased on 0.9 ^{O} C in last century (Adamenko 2014). Since 1989 the average temperature increased by 1^{O} C in summer and by 1.35^{O} C in winter. Positive fluctuation of air temperature in Ukraine from 1989 to 2013 was the highest in the history of climatic monitoring. Rise of the average annual temperature (and sum of effective temperatures) results in expansion of environmental zones of pest optimum, changes of harmfulness zone, increase of the pest generations for season and reorganization of entomological complexes (Fedorenko *et al*. 2011; Chayka *et al*. 2013b). Increase of average annual temperature is directly influence on generation number of codling moth in Ukraine.

Kot (2010) and Pluciennik (2013) reported that in the area of Poland the *C. pomonella* has two generation. On the other hand, numerous researches show that climate changes may affect the development rates and emergence of the codling moth (Juszczak *et al*. 2013). This could increase the emergence probability of the pest third generation that has not currently occurred in Poland in 2020-2040. Under future conditions of increased temperatures (2045–2074), the present risk of below 20% for a pronounced second generation (peak larval emergence) in Switzerland will increase to 70–100%. The risk of an additional third generation will increase from presently 0–2% to 100% (Stoeckli *et al.* 2012). The same changes of number of *C. pomonella* generations are predicted in different countries of the world under climatic change (Sunil *et al.* 2015).

Thus, nowadays the change of number generation of codling moth under climate change in Ukraine is very topical, because the integrate systems of chemical defense of orchard were based on the phenological principles of observations.

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ЦИКЛЫ РАЗВИТИЯ ЯБЛОННОЙ ПЛОДОЖОРКИ CYDIA POMONELLA L. В УСЛОВИЯХ ЛЕСОСТЕПИ УКРАИНЫ ПРИ ИЗМЕНЕНИЯХ КЛИМАТА

В. Н. Чайка, И. Г. Рубежняк, Е. И. Петрик

Анотация. *В Лесостепи Украины при существующих климатических показателях яблоневая плодожорка в цикле развития показывает одну зимнюю и две летних генерации. Таким образом, в условиях потепления яблоневая плодожорка увеличила количество поколений, что необходимо учитывать при планировании мероприятий по защите культуры.*

Ключевые слова: *изменения климата, яблоневая плодожорка, чередование поколений, яблоня*

ЦИКЛИ РОЗВИТКУ ЯБЛУНЕВОЇ ПЛОДОЖЕРКИ CYDIA POMONELLA L. В УМОВАХ ЛІСОСТЕПУ УКРАЇНИ ЗА ЗМІН КЛІМАТУ

В. М. Чайка, І. Г. Рубежняк, О. І. Петрик

Анотація*. В Лісостепу України за поточних показників клімату яблунева плодожерка в циклі розвитку має зимову та дві літні генерації. Таким чином, в умовах потепління яблунева плодожерка збільшила кількість поколінь, що необхідно враховувати під час планування заходів хімічного захисту культури.*

Ключові слова: *зміни клімату, яблунева плодожерка, чергування поколінь, яблуня*