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DOI: 10.2478/ahr-2018-0012

Acta Horticulturae et Regiotecturae 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2018, pp. 54–57

MONITORING OF MOTH PESTS IN APPLE TREE ORCHARD

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The work suggests importance of monitoring apple tree pests from moth group in growing conditions of Nitra, Slovakia. In 2014 there was observed occurrence of moths e.g. Codling moth (*Cydia pomonella* L.), Appleseed moth (*Grapholita lobarzewskii* Now.), Hawthorn berry moth (*G. janthinana* Dup.), and Summer fruit tortrix moth (*Adoxophyes orana* Fish. v. Roesl.) in the apple tree orchard located in the Botanical Garden of SUA in Nitra with help of pheromone traps. The date of first generation occurrence of Codling moth, Appleseed moth and Summer fruit tortrix moth was recorded on April 23. All the pests showed two peaks of flight activity, but with Hawthorn berry moth three periods of higher occurrence were recorded. The course of temperatures influenced number of pests trapped in traps remarkably. The number of pest individuals was highly influenced by rainy weather and lower temperatures in months when there was expected their highest harmfulness. The recorded values might be influenced by plant species diversity of the experimental orchard as well as that of the surrounding area.

Keywords: moths, apple tree, integrated pest management, automated meteorological station, pheromone traps

There is a wide range of insect pests in the orchards in the Slovak territory which cause remarkable damages from the aspect of fruit yield as well as fruit quality every year. Besides that they influence vitality of fruit trees and life period of orchards negatively. Apple trees produce one of the most important fruit species grown in Slovakia. The productive area of apple tree in Slovakia was 3,074.1 ha in 2016, which was 48.2% of all fruit orchards in the Slovak territory (Meravá, 2017). Moths are the most dangerous pests of apple trees. These are lepidopterans with harmful caterpillar stage. The larvae cause damages by feeding on leaves and fruits. Their development starts from mid-May and their damaging activity continues until fruit harvest (Tancik, 2013). During the last decade of 20th century, appearing and spreading of insect species was observed that had not presented serious or any problem to fruit production previously, while in others, increase of number of generations within a season was recorded. These phenomena are attributed to climatic change generally. Global warming contributed to successful spreading of new pest species from warmer regions and enabled their acclimatization in the Slovak territory. This situation calls for changes in the system of plant pest control, increases its complexity; period of pesticide application is changing, importance of pest signalization is increasing as well as the use of non-chemical pest control methods.

Several monitoring techniques have been developed and applied to monitoring moth pests in fruit orchards. The most effective approach involves sex-pheromone-baited traps (Davis, French and Venette, 2005).

Temperature is among decisive environmental factors influencing the rate of development and activity of pests. Graf et al. (1999) established thermal thresholds for *Grapholita lobarzewskii* and found them more or less the same as for the codling moth *Cydia pomonella* and *Adoxophyes orana* established previously by various authors.

Material and methods

The experiment was conducted in the fruit orchard located in the Botanical garden of the Slovak University of Agriculturein Nitra in 2014. There was observed occurrence of pests of moth group in the apple orchard with lower level of orchard management.

Climatic characteristics of the site are as follows: mean annual temperature 9.6 °C, sum of active daily temperatures 2,880 °C, annual sum of precipitation 595 mm, altitude 130 m, sunshine duration 1550 hours a year, average number of days with snow cover 50, maximum snow cover depth 70 cm (Year-book of Slovak Hydrometeorological institute, 1991) – values for 1951–1980 period.

The orchard is a part of demonstrational, educational and pomological collections of different fruit species, and only a small portion of yield is used commercially. The total area of the orchard is approximately 4 ha. Chemical pest and disease control corresponds with the lower production intensity (2 to 6 chemical treatments within a season depending on fruit species) and pesticides are used only in a part of the orchard area. Age of apple trees within the orchard is diverse, with youngest trees being 8 years old, and the oldest ones even 25 years old. Apple trees are planted in blocks alternated with blocks planted with other fruit

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species. Soil management system is natural sod, and soil surface is mulched with moved grass (obviously 4 times a season) and shoot grinding on spot after pruning. Prevailing portion of young orchard is planted with Braeburn cv. and few other cultivars as supplemental. In older part of the orchards Golden Delicious, Idared and Šampion are prevalent, however cultivar assortment is very broad. Various rootstocks were used, from dwarfing (mostly M9) for trees formed as slender spindle on wire support to medium vigorous and vigorous for bush trees and semi-standards with natural crown.

In the experiment there were monitored various moth species e.g. *Cydia pomonella* L., *Grapholita lobarzewskii* Now., *G. janthinana* Dup., *Adoxophyes orana* Fish. v. Roesl., via number of individuals caught in pheromone traps placed in the apple orchard. The experiment was conducted during the 2014 season.

Prior to placing pheromone traps in the orchard the bionomies of individual pest species were studied thoroughly as well as the principles of proper use of pheromone traps. Special pen-register was created afterwards for recording the number of pest individuals captured in pheromone traps. To gather meteorological data – temperature, precipitation – an automated meteorological station (AMS) installed in the orchard was used. Temperatures were used to determine the sums of effective temperatures (SET) necessary for peaks of pest flight activity and periods between them.

The pheromone traps were distributed in the orchard during green leaf tip stage (BBCH 09) which was on April 4, 2014. Placing of individual pheromone traps respected the producer installation guides. Traps were hanged on central leader or scaffold branches or on wire support sparsely, at the height of minimum 1.5 m above soil surface in inner parts of the apple tree block. Due to a relatively small orchard area, 1 pheromone trap with specific pheromone was installed for each the monitored moth pest.

Number of individuals caught in pheromone traps was observed and recorded regularly 3 times a week (Monday, Tuesday, Friday) starting from their placing into the orchard until the end of the season. Numbers of captured individuals were recorded in a special pen register. After the captured pest counting sticky boards of traps were cleaned to remove any rests of pest individuals which could distort results in the next checking term. After finishing of the observation period the data were processed, and expressed via flight curves to identify peaks of pest flight activity.

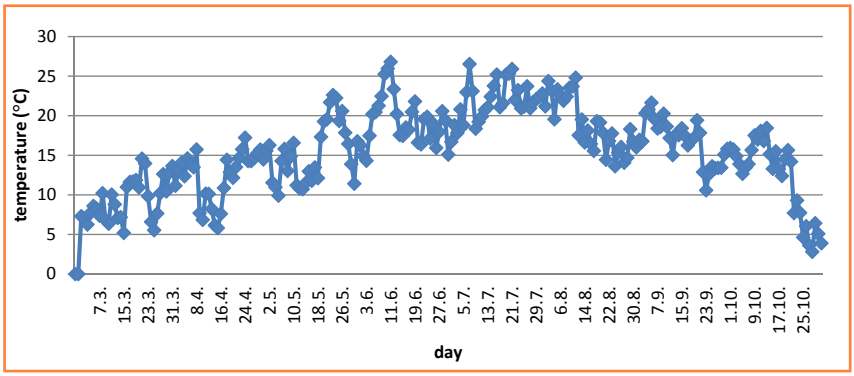

Figure 1 Mean daily air temperatures in March – October 2014

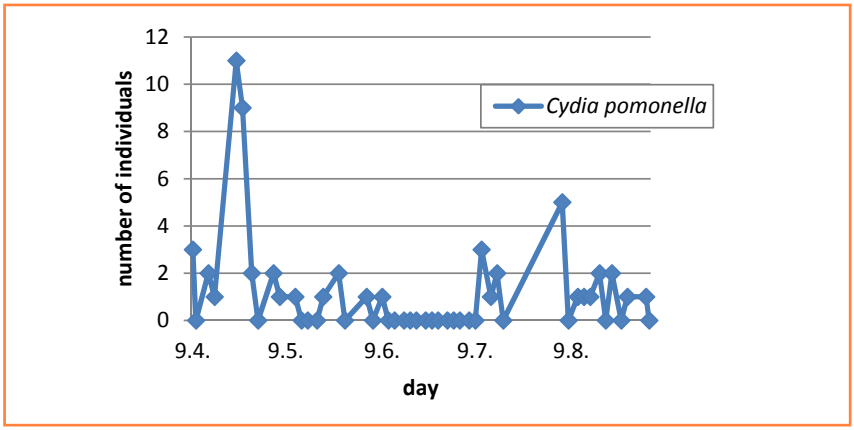

Figure 2 Flight curve of Codling moth (*Cydia pomonella* L.) in 2014

Results and discussion

There are presented the processed data obtained in the locality of the Botanical garden of SUA in Nitra in the 2014 season. The figure 1 shows the course of mean daily temperatures prior to and during the observation period of pest flight activity in the 2014 season. Mean daily air temperature of the observed period (March – October 2014) was 14.9 °C.

The observed period was typical with frequent precipitation. Within March – October period there were 52 days with precipitation above 1 mm and 22 days with precipitation above 5 mm. This fact remarkably influenced pest flight activity.

Figures 2–5 present numbers of pest individuals captured in traps within the observed period. For better clarity the graphs are customized – only periods with nonzero values of captured pests are presented; however, the observation period was longer (from April 9 to October 31, 2014).

First adults of Codling moth were recorded on April 4 (3 adults). Peak of the first generation flight was on April 23. The flight activity during the following period was low. The second generation of the pest was recorded with the peak on August 6.

The greatest number of Hawthorn berry moth adults was recorded on May 26. The course of flight activity was remarkably influenced by weather conditions. Based on the numbers of individuals captured in traps we assume that

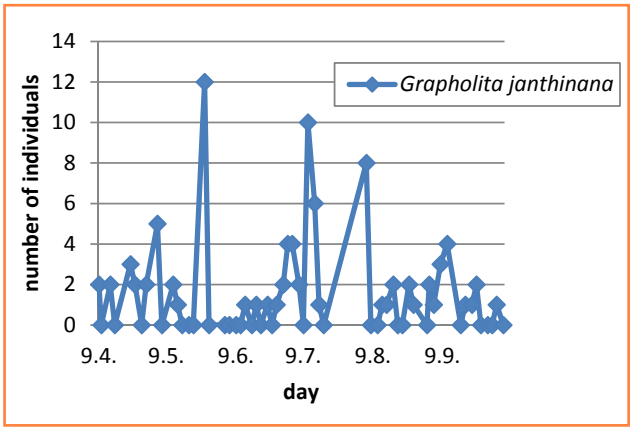

Figure 3 Flight curve of Hawthorn berry moth (*G. janthinana* Dup.) in 2014

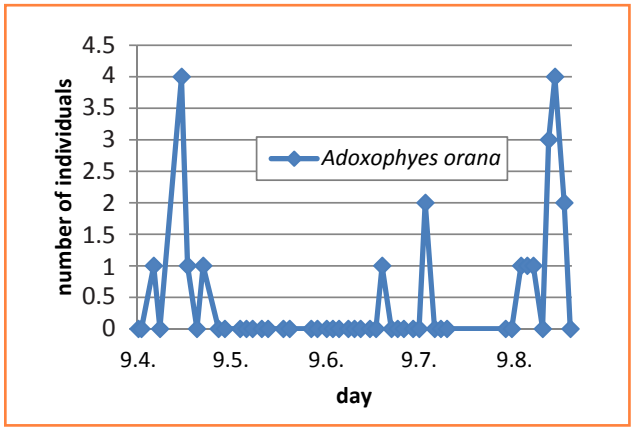

Figure 5 Flight curve of Summer fruit tortrix moth (*Adoxophyes orana* Fish. v. Roesl.) in 2014

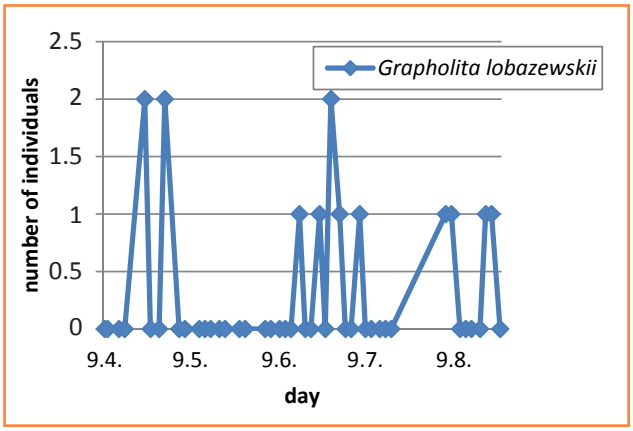

Figure 4 Flight curve of Appleseed moth (*Grapholita lobarzewskii* Now.) in 2014

the peak of the second generation of the pest was on July 11.

There was low occurrence of Appleseed moth in the 2014 season in the experimental locality as shown in the figure 4. Greater number of adults captured in the traps was found on April 23, April 30 and June 27 (2 adults per observation).

Two generations of Summer fruit tortrix moth were observed within the 2014 season, first with the peak on April 23, second on August 22, both with 4 adults captured in the traps.

The obtained data are related to the locality of the Botanical garden of SUA in Nitra and as we suppose they may be influenced with species diversity and distribution of plots planted with various fruit species within the area of the orchard, and long term low level of pest management programme in part of the orchard which is in coincidence with assertions of Joshi et al. (2016) about differences of Codling moth populations and flight patterns in abandoned and commercially managed orchards.

According to Praslička et al. (1997), the flight activity of Codling moth starts in the end of May and the peak of flight activity is in June. The maximum oviposition is reported in the second half of June. Our records set the beginning of flight activity of the pest on April 23, which is in concidence with the results of Fadamiro (2004) of experiments conducted at different locations in Minnesota (USA) where he found the first capture of *C. pomonella* males at ≈110 DD base 10°C, which corresponded to apple bloom at the experimental locations. In our experiment, the maximum oviposition was in the second half of May due to the fact that 2014 was the year with an early onset of spring. The same date of the first flight was found with Hawthorn berry moth in 2014 by Juračková (2014) in the region of Louny, while with Codling moth on April 22, 2014 in the region of Litoměřice (Northeastern Bohemia). Cigániková (2011) reported the beginning of Appleseed moth flight activity in 2008 on June 18 at SET 424 °C and the peak of the first generation June 25. Our observations showed the greatest number of adults caught in pheromone traps on April 23, April 30 and June 27, however, their number was lower. Different peaks of second generations of the pests indicate various thermal requirements.

Out of the observed moth pests, the most numerous ones were Codling moth and Hawthorn berry moth followed by Summer fruit tortrix moth and Appleseed moth, though the flight activity patterns were different in individual pests. Belo (2011) obtained similar results in commercial apple tree orchard in Ostratice (approximately 40 km from our experimental site).

Conclusions

The aim of the work was to gather information on flight activity of selected significant pests of moth group in the apple tree orchard which was used for modelling of activity of the observed pests and predicting their occurrence regarding the meteorological factors in the specific production region. At the experimental site there were observed meteorological data (temperature, precipitation) with the use of an automated meteorological station installed in the experimental orchard. The occurrence of the selected moth species was monitored, e.g. Codling moth (*Cydia pomonella* L.), Appleseed moth (*G. lobarzewskii* Now.), Hawthorn berry moth (*G. janthinana* Dup.), and Summer fruit tortrix moth (*Adoxophyes orana* Fish. v. Roesl.) with the use of pheromone traps. Flight curves were created which indicated different flight activities. With some of the observed pests, the same term of the first generation was found – April 23, with Summer fruit tortrix moth, Codling moth, and Appleseed moth. With the mentioned species,

2 periods of high flight activity were recorded with exception of Appleseed moth with 3 periods of higher numbers. Dynamics of temperature indicated the influence on second generation massiveness (low temperature caused smaller numerousness of pests; however, activity was recorded during longer period). Frequent precipitation and low temperatures in June and August which corresponded with periods of pest harmful activity influenced its flight activity greatly. The results might be distorted due to fruit species diversity in orchard, and proximity of gardens with great plant diversity.

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