OCCURRENCE AND BIODIVERSITY CHARACTERISATION OF INSECT PESTS FROM AN OLD ALMONDS ORCHARD IN WESTERN ROMANIA

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Abstract. *Almond (Amygdalus communis), is the most produced tree nut crop globally, with total production exceeding 1.3 million metric tons (INC 2020; RIJAL et al., 2021). Being a globally expanding crop lately, due to climate change caused by global warming, but also due to the growing demand for almond kernels (global demand has increased by 220%) - which leads to a potentially high profit, farmers' interest in this walnut, has also taken shape in Romania. In the world, the annual yield losses, in the case of almond orchards, due to the attack of diseases and pests can reach 20-30%. Studies on the taxonomy and diversity of harmful insects in almond orchards obviously have a large number of pests often found in Romania and around the world. Methods of direct observations and colored adhesive traps are used to collect specimens. Insects in the present study were collected from April to September 2021, with a decadal frequency, from an almond orchards located in Lovrin Development Research Station (Timiș, Romania). A number of 324 insect were collected and classified in two different orders (Hemiptera and Lepidoptera). The most abundant were the species belonging to the Aphididae family. Also, a high abundance presented the Diaspididae family.*

Keywords*: occurrence, biodiversity, insects, almonds orchard, western Romania*

INTRODUCTION

Almond is a tree species native to the arid areas of Central Asia, from where it has spread, in the last 50 years, throughout the world (BOLU, 2016; RODRIGUES *et al.*, 2020). It is a typical mediterranean species with a great economic importance, due to its medicinal and nutritional benefits, its seeds being consumed in almost every country in the world (BASPINAR *et al*., 2018).

The key insect pests currently associated with almond include: *Hyalopterus amygdali* (Blanchard), *Hyalopterus pruni* **(**Geoffroy**),** *Myzus persicae* (Sulzer), *Parthenolecanium corni* (Bouchè), or *Anarsia lineatella* (Zeller), *Grapholita molesta* (Busck), which causes important crop losses, reduceing orchard vigor and yield (BOLU & ÖZGEN 2007, BOLU *et al.*,2011).

Two important species of aphids that include *Hyalopterus pruni* **(**Geoffroy**)** and *Hyalopterus amygdali* (Blanchard) can be found in almond orchards (ZALOM *et al.*, 2017 a,b). Before 2000, *Hyalopterus pruni* **(**Geoffroy) was considered one of the most important aphid pests in western Romanian almond orchards. Presence of *Hyalopterus amygdali* (Blanchard) was reported with considerable delay and the studies revealed that this is a newly invasive pest species in our country (FERARU, 2004; TEODORESCU, 2018), but a very common species worldwide (WALTON *et al*., 2009).

Considering the economic importance of these pests and taking into account the fact that in our country there are very few bibliographical references; the aim of this paper is to highlight the diversity and abundance of the most important insect pests associated with almonds and their fluctuations in climatic conditions in western Romania.

MATERIAL AND METHODS

Sampling site

The biological material used in this research was collected from the almonds orchard belonging to the Lovrin Development Research Station, which is located in the north - western part of Timiș County, Romania (45°57′03″N 20°46′32″E). 2021 was a favorable year for almonds in the climatic conditions of Lovrin and its surroundings, due to the prolonged drought and high temperatures in spring, similar conditions to those in the area of origin being created. From the data analysis regarding pluviometric regime, it results that in its ensemble it was an atypical year, the quantities of water from precipitations registering values below the multiannual monthly average in most of the spring months. The drought installed in the spring months, respectively March, amplified by the atmospheric heat, had unfavorable effects on pest insects, especially on aphid species, significantly reducing their population levels. In addition, a second limiting factor was the high temperature difference between day and night, which was around + 27 °C throughout the spring, which led to prolonged delays in Lepidoptera species mating flight and egg - laying. The annual average temperature was 12.3°C, with 1.4°C higher than the 70-year multiannual average (10.9°C). The highest average deviations being reported, as we already have pointed out, in the spring months. The sampling site is characterized by a typical chernozem soil, slightly glazed and weakly alkalized, epicalcaric, medium clay loam, formed on a loessoid bedrock, with pH between 6.9 – 7.2.

Sampling methods

Insects were collected between April and September 2021, with a decadal frequency, using the method of direct observations and colored adhesive traps (GROZEA *et al.*,2009 a,b; VÎRTEIU *et al.*, 2015 a; FERICEAN & CORNEANU, 2017; STEF *et al.*, 2019). The trial was arranged in a completely randomised design with three replications, for each replication selecting 5 trees.

Two differently colored sticky traps, yellow and orange, measuring 10x20 cm, were installed at the base and at the middle and top of the crown. The traps were monitored and replaced at 10 day intervals (i.e. sampling period) from the beginning of flowering period until harvest. Upon the removal of the colored sticky traps, they were wrapped with clear plastic cling film and transferred to the laboratory. After the traps were transferred to the laboratory, each of the colored traps was examined, and all insects species collected were counted using a stereoscopic microscope.

All material was preserved in 70% alcohol (*Homoptera* species), or in paper bags (*Lepidoptera* and *Heteroptera* species) and identified at taxonomic level (order, suborder, infraorder, suprafamily, family, subfamily, tribe, genus and species), using the following keys for species identification: LODOS (1980); BLACKMAN & EASTOP (2000, 2006); VÎRTEIU *et al.* (2015 b); BERGMANN *et al.* (2016); RIJAL & GYAWALY (2018); RIJAL & ZALOM (2020).

RESULTS AND DISCUSSIONS

A list of insect pests present in almond orchards in western Romania (Lovrin Development Research Station) is provided in Table 1.

The sampling revealed that *Hyalopterus pruni*, *Hyalopterus amygdali*, *Myzus persicae* and *Parthenolecanium corni* are common in almond orchards. In additional, a few lepidoptera species: *Anarsia lineatella* and *Grapholita molesta* were collected by direct examination of almond kernels.

Table 1.

Insect species in almond orchards of Western Romania, SCDA Lovrin

Order *Hemiptera* Linnaeus, 1758
- Suborder *Heteroptera* Latreille, 1810
  - Infraorder *Cimicomorpha* Leston, Pendergrast & Southwood, 1954
    - Family *Miridae* Hahn, 1833
      - Genus *Lygus* Hahn, 1833
        - ***Lygus spp.***
  - Infraorder *Pentatomorpha* Leston, Pendergrast & Southwood, 1954
    - Family *Pentatomidae* Leach, 1815
      - Genus *Halyomorpha* Mayr, 1864
        - ***Halyomorpha halys* Stål, 1855**
- Suborder *Sternorrhyncha*
  - Infraorder *Aphidomorpha*
    - Family *Aphididae* Latreille, 1802
      - Genus *Hyalopterus* Koch, 1854
        - ***Hyalopterus pruni*** Geoffroy, 1762
        - ***Hyalopterus amygdali*** Blanchsrd, 1840
      - Genus *Myzus* Passerini, 1860
        - ***Myzus persicae*** Sulzer, 1776
  - Infraorder *Coccomorpha* Heslop – Harrison, 1952
    - Family *Coccidae* Fallen, 1814
      - Genus *Parthenolecanium* Šulc, 1908
        - ***Parthenolecanium corni*** Bouchè, 1844
    - Family *Diaspididae* Targioni Tozzetti, 1868
      - Genus *Diaspidiotus* Berlese & Leonardi, 1896
        - ***Quadraspidiotus perniciosus*** Comstock, 1881

Order *Coleoptera* Fabricius, 1775
- Suborder *Polyphaga* Emery, 1806
  - Infraorder *Cucujiformia* Lameere, 1938
    - Family *Coccinellidae* Latreille, 1807
      - Genus *Coccinella* Linnaeus, 1758
        - ***Coccinella 7 – punctata*** Linnaeus, 1758
      - Genus *Adalia* Mulsant, 1850
        - ***Adalia 2 – punctata*** Linnaeus, 1758
      - Genus *Hippodamia* Dejean, 1837
        - ***Adonia variegata*** Goeze, 1777

Order *Lepidoptera* Linnaeus, 1758
- Suborder *Glossata* Fabricius, 1775
  - Infraorder *Heteroneura* Tillyard, 1918
    - Family *Gelechiidae* Stainton, 1854
      - Genus *Anarsia* Zeller, 1839
        - ***Anarsia lineatella*** Zeller, 1839
    - Family *Tortricidae* Latreille, 1803
      - Genus *Grapholita* Treitschke, 1829
        - ***Grapholita molesta*** Busck, 1916

Halyomorpha halys is a common species on almond trees arround the world (Rijal *el al*., 2018, 2020,2021; Stahl *et al.*, 2021), in Romania being mentionated for the first time in almond orchards.

Most of the species mentionated here (*Hyalopterus pruni*, *Myzus persicae*, *Parthenolecanium corni*, *Quadraspidiotus perniciosus* , *Halyomorpha halys*, *Anarsia lineatella*

and *Grapholita molesta*) were also recorded as pests in sweet cherry, peach, apple, goji and jujube orchards, wich are grown in the same region of Romania.

Three common entomophagous species, belonging to *Coccinallidae* family: *Coccinella 7 – punctata*, *Adalia 2 – punctata*, *Adonia variegata*, have established in almonds trees.

Major pests

***Halyomorpha halys* Stål, 1855**

Order *Hemiptera* Linnaeus, 1758/ Suborder *Heteroptera* Latreille, 1810/ Infraorder *Pentatomorpha* Leston, Pendergrast & Southwood, 1954/ Suprafamily *Pentatomoidea* Leach, 1815/ Family *Pentatomidae* Leach, 1815/ Subfamily *Pentatominae* Amyot and Serville, 1843/ Tribe *Cappaeini* Atkinson, 1888/ Genus *Halyomorpha* Mayr, 1864

*Material examinated:*59 specimen collected with adhesive traps from almond orchards
Description: Adult - approximately 1.7 cm long and about as wide, with a dark brown color on dorsal side and a creamy white-brown on ventral part. Also, presents two white spots on its antennae and alternating dark bands on the thin outer edge of its abdomen. The instar larvae are first red, turning almost black, and then finally becoming brown and have the antennae black with a single white band.
Life cycle: hemimetabolous insect. Development from egg to adult takes approximately 40 to 60 days . Adults emerge from overwintering in April. Eggs are laid from June to August. Nymphus molt as they progress through five different stage, from August to October and some times November, when adults appears.
Distribution and host plants: Invasive species with a global impact. Distribution: Palaeartic and Neartic region; in recent years invading the Neotropical region. The adults and larvae feed on over 100 species of plants, including apples, apricots, plum, pears, cherries, peaches, beans, peppers, tomatoes, cucumber, corn, sunflower, soybeans, rose, lilac, viburnum and grape.

Hyalopterus pruni Geoffroy, 1762

Suborder *Sternorrhyncha*/ Infraorder *Aphidomorpha*/ Suprafamily *Aphidoidea* Geoffroy, 1762/ Family *Aphididae* Latreille, 1802/ Subfamily *Aphidinae* Latreille, 1802/ Tribe *Aphidini* Latreille, 1802/ Genus *Hyalopterus* Koch, 1854

Material examinated: 2149 specimens collected with adhesive traps
Description: The apterous female – with an elongate shape, pale green color, with a darker dorsal band and partially covered by whitish mealy wax. The siphunculi are very short, dark gray towards the apex, the cauda is green and almost 3 time longer than the siphunculi. Body lenght – 1,5 – 2,6 mm. The alate form have the dorsal side of the abdomen with an pale green color, and the head and thorax – blackish.
Life cycle: Viviparous parthenogenesis throughout the year. The species overwinter as eggs on *Prunus* species. The fundatrices hatch in April. In June the alate form appears. This form migrate to the secondary host, between early July and early August. The winged male and winged gynoparae return, in September, to its primary host. The mated oviparae then lay eggs on trunks of the primary host. The pest may annually raise 14 - 18 generations
Distribution and host plant: Almost cosmopolitan. Its list of host plants includes almond, apricot, peach and other *Rosaceae* as primary host.

Hyalopterus amygdali Blanchard, 1840

Material examinated: 1420 specimens collected adhesive traps
Description: Small dioicus aphid with body lenght arround 2 mm and greenish in color. The apterous female with te siphunculi slightly curved and dilated at the tip and cauda presents 3 setae – 2 on lateral side and one on apical part. The alate form
Life cycle: The floury peach aphid winters at the stage of egg on the primary host. In the spring period - the activity originating 4 or 5 generations (founders and fondatrigenie) on almonds and peaches. The migrant forms are seen, in summer on secondary host, and in the autumn period, returns to the primary host to lay the wintering egg.
Distribution and host plant: Is commonly found in Palaeartic regions. The pest attacks almond, sometime apricot and pear. Narrowly oligophagous species found commonly, as primary host, on *Rosaceae*.

Myzus persicae Sulzer, 1776
Tribe *Macrosiphini* Wilson, 1910/ Genus *Myzus* Passerini, 1860

Material examinated: 847 specimens collected also with adhesive traps
Description: The apterous female – are greenish in color. Body lenght - 1.7 to 2.0 mm. The antennae are black, exept the III article that is yellowish at the base. The legs are pale yellow except the tarse, that are black. The siphunculi are yelow – greenish with darker tips. The cauda is short, yellowis, almost 1/3 from siphunculi lenght. The alate forms have a black head and thorax, and a yellowish green abdomen with a large dark patch dorsally. Body lenght - 1.8 to 2.1 mm.
Life cycle: Parthenogenic reproduction. Migratory species, with up to 8 generations that can occur on primary host (*Prunus*) in the spring. After, the winged aphids forms disperse in summer on secundary host (legume, ornamental flowers). In the autumn, winged male and female aphids disperse on primary host. The species overwinter as egg in tree trunks and brunches.
Distribution and host plant: The species posses a wide geographical distribution, and is one of the most widespread pests from many orchards, ornamental and cultivated plants ((more over 40 botanical plant families), such as: peach, almond, apricot and plum; potato, bean, broccoli, Brussels sprouts, cabbage, carrot, cauliflower, celery, cucumber, eggplant, lettuce, parsley, parsnip, pea, pepper, radish, spinach, tomato; corn, tobacco, sugar beet, and sunflower.

Anarsia lineatella Zeller, 1839
Order *Lepidoptera* Linnaeus, 1758/ Suborder *Glossata* Fabricius, 1775/ Infraorder *Heteroneura* Tillyard, 1918/ Superfamily *Gelechioidea* Fracker, 1915/ Family *Gelechiidae* Stainton, 1854/ Subfamily *Anacampsinae* Bruand, 1850/ Tribe *Chelariini* Le Marchand, 1947/ Genus *Anarsia* Zeller, 1839

Material examinated: 23 larvae observed inside the kernels
Description: The adult moths are grey and have grey, fringed with long hairs forewings, and also, with a pattern of darker and lighter spots and lines. The hindwings are lighter in colour than the forewings. The larvae approximately 10 mm long with reddish brown colour at maturity. The head, pronotum and legs are black and the dorsal side of the abdomen covered with numerous hairs.

Life cycle: The species has two generation/ year and overwinters as a young larva in bark of twigs and branche cavity. In spring, the larva feed on flower buds and leaves. After a short, but intense feeding period, mature larvae, forms a cocoon, on the branches, for pupation. The moth appears in early June. After copulation flight, the females deposit their eggs commonly on fruit and foliage. The young larvae, appears, after 5 – 14 days, in mid June. They feed on the kernel or between the hull and the shell. The larval stage takes about 20 – 35 days, after pupation, the second generation moth appears at the end of July.
Distribution and host plant: The distribution map includes Palaeartic and Neartic Regions. The main host plants: apple, almond, peach, apricot, plum.

CONCLUSIONS

From data analysis of the present study it was highlighted that the attack of aphids and lepidoptera species, although they did not present high population densities, caused significant damages.

In the case of *Hyalopterus pruni*, the large number of specimens proves its importance for the almond orchards in the western part of Romania. It is necessary to monitor the future populations of this pest, in order to establish the most appropriate control methods.

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