

Identification of the major insect pests and their biological characteristics in apple orchards (Uzbekistan)

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Abstract. The study presents biological characteristics of the major apple pests in Uzbekistan. For evaluating the key insects, field observation has been conducted. The in-situ results have identified six major apple pests in three selected research areas of the province. Thus, in this study, the biological behavior and potential harm of the determined pests on apple trees are provided. This field-based investigation helps to establish an integrated method to fight against those harmful pests and their devastating influence.

1 Introduction

National food security is significantly boosted by the agricultural industry in many nations, which also creates jobs for locals and maintains economic equilibrium [1]. However, it has become more difficult to manage agriculture effectively in recent years due to factors such as worldwide changes, unprecedented environmental and human impacts on the environment, and fast population expansion [2-3]. Significant losses in agricultural output have been attributed to environmental difficulties, such as salinization of irrigated land, excessive use of pesticides and fertilizers, and the fast proliferation of many harmful insects in apple orchards [4]. The detrimental effects of dangerous insects are becoming more prevalent, especially in horticulture, which lowers the quality of popular fresh products like apples [5].

Uzbekistan is one of the major apple importers in Central Asia. FAO data indicates that Uzbekistan exported 18,827 tons of apples in total in 2022 [6]. The Uzbek Statistics Agency (SA) reports that during the first consecutive five months in 2023 (from January to May), Uzbekistan exported 4,400 tons of apples worth \$1.8 million to seven different nations. When compared to the same time in 2022, this trend indicates a reduction of 702 tons [7].

Uzbekistan primarily cultivates the major agricultural fruits, including apple, in mountainous areas. However, due to harsh environments, unpredictable weather conditions, and destructive insect impacts, the apple orchards are in serious trouble [8-10]. Harmful insects and their unfavorable influences pose significant challenges to apple orchards [11].

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Currently, in the context of Uzbekistan, more than 300 arthropods could be found, and they feed on fruit trees, eating and harming the leaves of the trees [5].

Depending on the type of nutrition they consume, we can divide the major agricultural insects that cause great damage to seedy fruit trees (including apple, pear, and quince) and trees with kernels (apricot, peach, plum, and cherry) into sucking and chewing groups [12, 13]. Numerous diseases and insects negatively impact apple trees [13]. Year by year, especially dangerous insects cause severe damage to apple harvest quality. This causes the overall quality of the product to deteriorate, resulting in a decrease in export volume [14].

Therefore, a thorough study of their biological characteristics is necessary to resolve the issue. However, without specific experience and without sufficient groundwork, eliminating the problem may prove challenging. Therefore, scientific and field-based investigations devoted to understanding their biological characteristics are increasingly important in the case of Uzbekistan for implementing preventive measures. The study aims to identify the major insect pests in Uzbekistan's apple orchards, particularly in the major apple-producing districts of the Jizzakh region.

2 Materials and methods

2.1 Site description

We conducted this study in the Jizzakh Province, one of the largest regions in the eastern half of Uzbekistan. It is bordered by Tajikistan in the south and southeast, Samarqand Province in the west, Navoi Province in the north-west, Kazakhstan in the north, and Sirdaryo Province in the east (Figure 1). The province has an area of over $21.179 \times 10^5 \text{ m}^2$ ha, of which arable land is $3.049 \times 10^5 \text{ m}^2$ ha (or 14.4% of the total land area).

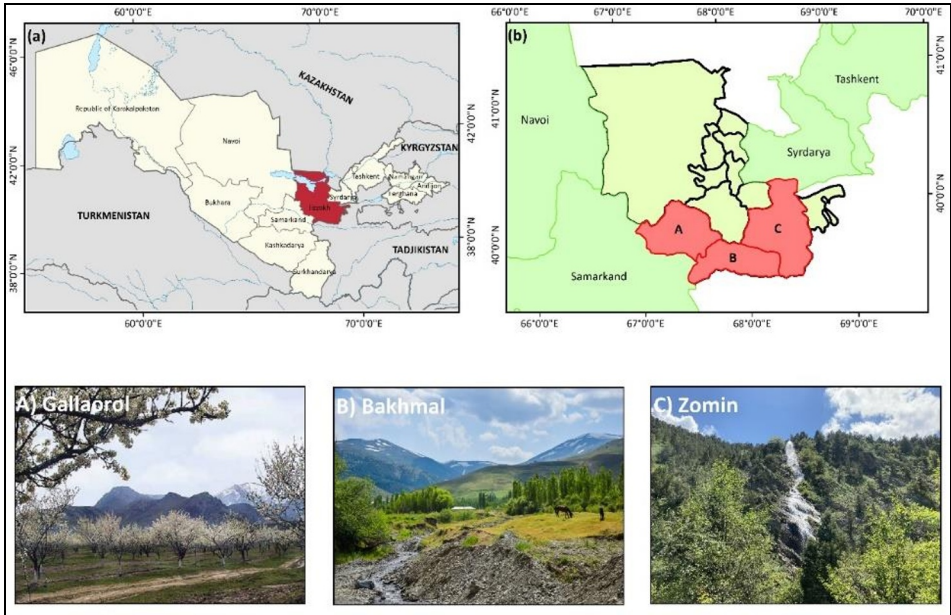


Fig. 1. Study area description: (a) Jizzakh province in the map of Uzbekistan; (b) location of the selected districts in the map of Jizzakh Province (base maps: www.commonswikimedia.org).

The main agricultural crops cultivated in the irrigated lands of the region are as follows: cotton, wheat, berries, fruit, grapes, melons, and gourds. Jizzakh's climatic characteristics

are characterized by dry and hot summers and mild, cold winters [15, 16]. The average annual temperature is 15.6 °C, and the annual precipitation ranges from 100 to 300 mm, with most of the rainfall occurring in the winter and early spring. July primarily sees the highest air temperature, ranging from 36 to 37 °C. Although the summer season is dry, the air humidity reaches 70%–80% in winter [17]. The administrative division of the study area includes twelve districts (Arnasoy, Baxmal, Dostlik, Forish, Gallaorol, Sharof Rashidov, Mirzachul, Paxtakor, Yangiobod, Zomin, Zafarobod, and Zarbdor) and one district-level city, Jizzakh. In this study, we chose Bakhmal, Gallaorol, and Zomin districts because they are well-known areas for cultivating and growing apples and have apple production potential.

2.2 Catching insects

In order to capture the apple insect pests, we used pheromone traps in our three chosen districts to capture those pests. In this regard, odor hormones extracted from the gonads of butterflies were utilized. The female butterfly's gonad releases a smell that travels a considerable distance. The male butterfly, sensing the smell, flies from 6–15 km to mate with the female butterfly. The female butterfly extracts hormone from its gonad and mixes it with a special yellow glue. As a result, the flying male butterfly sticks to the sticky substrate. We hung these pheromone traps 1.5–2 m above the upper branches of the apple tree. It was monitored every 3–4 days. We removed the old pheromone traps and replaced them with new ones. We utilized these pheromone traps throughout the vegetation period.

3 Results and Discussion

Evaluation of the biological characteristics of apple insect pests.

We captured the following apple insect pests in the selected districts:

- Apple aphid.
- Woolly apple aphid.
- San Jose scale.
- European red mite.
- Two-spotted spider mite. and
- Codling moth.

These insect pests, in turn, represent a significant threat to apple yield, and orchards and their biological characteristics are as follows:

Apple aphid – its mature imago or larva feeds by sucking the sap on the apple tree twigs, leaves, flowers, and buds (Figure 2). High levels of infestation by the aphids can cause stunted shoots, disfigured fruit, and premature leaf fall, especially in young trees. Overwintering eggs hatch in spring, and the aphids colonize the growing tips of the shoots, causing the edges of the leaves to curl [18]. Aside from that, apple fruits become tasteless or unpalatable.



Fig. 2. The attack of apple aphid bug on apple tree twigs.

Wooly apple aphid – It is a true bug and sucks sap from plants. [19-20]. The colonies feed on twigs and roots, causing the tree to form galls. These galls, initially small but gradually growing in size, cause the most damage when they form among the roots (Figure 3). Continued feeding into the roots can destroy them, reduce tree growth, or kill them. As the aphids feed, they produce honeydew, which drips onto the fruit, allowing for the growth of sooty mold, which impacts the fruit's saleability. The honeydew can also create unpleasant conditions for orchard workers to work in due to the high levels of sticky honeydew excreted. The honeydew can also cover the leaves, allowing mold to grow there. The aphids can also infest the apples, especially on varieties with an open calyx, when the aphids can feed on the apple core [21].



Fig. 3. Wooly apple aphids on tree twigs.

The San Jose scale – primarily infests the bark on the tree's stem and branches (Figure 4). On the fruits, it occasionally appears as a red spot. A heavy infestation will result in the loss of branches. The red spots on the fruits and leaves do not cause great damage; however, they can cause problems in quarantine inspection because the species (a quarantine insect) is widespread in parts of the world. Grayish scales appear on the tree bark when a heavy infestation emerges [22]. Laboratory examination with stereomicroscope analyses of the branches can detect lighter infestations. The red spots on the fruits can also indicate an infestation [23].



Fig. 4. The infestation of the apple tree stem with San Jose scale.

The European red mite – is a species of mite that is one of the major agricultural pests of many deciduous fruit crops and trees, including apple, pear, peach, and plum [24]. *Artocarpus heterophyllus*, *Citrus aurantiifolia*, *Citrus aurantium*, *Citrus grandis*, *Cucumis*, *Pyrus pyrifolia*, *Pyrus communis*, *Vitis vinifera*, *Vitis labrusca*, *Zea mays*, *Prunus avium*, *Prunus persica*, *Pyrus baccate*, and *Pyrus communis* are among the plants (excluding fruit trees) on which *P. ulmi* has a cosmopolitan distribution and a very wide host range [25]. This species clearly causes damage when the infected leaves first turn yellow, then turn brown, and ultimately fall off the foliage (Figure 5). Serious damage to the tree results in a relatively small yield form and poor quality. This, in turn, leads to a decrease in yield to 35–70%.



Fig. 5. The damage caused by The European red mite.

The two-spotted spider mite – is vastly polyphagous and can feed on hundreds of plants, particularly vegetables and food crops such as peppers, tomatoes, potatoes, pepinos, beans, maize, and strawberries, as well as some ornamental plants such as roses [26].



Fig. 6. The removal of the sap by two-spotted spider mites.

Additionally, research indicates that it is the most prevalent pest of *Withania somnifera* in India [27]. Basically, it lays its eggs on the leaves, and it poses a threat to host plants by sucking cell contents from the leaves cell by cell, leaving tiny pale spots or scars where the green epidermal cells have been destroyed. Although individual lesions are very small, attacks by hundreds or thousands of spider mites can cause thousands of lesions, reducing plants' photosynthetic capability. Spider mites primarily feed on the underside of the leaf, penetrating the plant tissue with their mouthparts. All spider mites spin fine strands of webbing on the host plant. The feeding of the mites causes the leaves to turn gray or yellow. Necrotic spots appear in the advanced stages of leaf damage. Mite damage to the open flower causes the petals to brown and wither, resembling a spray burn. When two-spotted spider mites remove the sap, the mesophyll tissue collapses and a small chlorotic spot forms at each feeding site (Figure 6). Estimates suggest that the mites destroy 18 to 22 cells per minute. Continued feeding causes a stippled-bleached effect, and later, the leaves turn yellow, gray, or bronze. If the mites remain uncontrolled, they may cause complete defoliation [26].

The codling moth – is one of the major pests in fruit production and apple orchards worldwide because the larvae directly feed on fruits [28]. People often refer to a codling moth larva as an "apple worm." Since the larvae are not able to feed on leaves, they are highly dependent on fruits as a food source and thus have a significant impact on crops (Figure 7).



Fig. 7. The impact of the codling moth on apple yield.

After becoming visible in April and May, *C. pomonella* adults lay their eggs on the surface of apple fruits. The hatching larvae start feeding by boring into fruits and forming galleries towards the fruit's seed chamber [29]. As a result, the larvae's internal feeding damage renders fruits unmarketable [30].

4 Conclusion

Although fresh fruit production is an essential tool for Uzbekistan's economic growth, the devastating impact of insect pests on apple orchards is becoming more significant. This, in turn, requires pest management strategies. However, the lack of data to combat apple pests makes it challenging to find sound solutions and avoid product deterioration and yield loss. Without certain knowledge of the biological characteristics of the insect pests and how destructive their impact on apple production is, it is far more difficult to be able to fight against the major fruit pests. Thus, in this investigative analysis, we provided some practical data based on our in-situ experiments and existing studies. *Aphis pomi* (apple aphid), *Eriosoma lanigerum* Hausm (woolly apple aphid), *Diaspidiotus perniciosus* Comst (San Jose scale), *Pannychos ulmi* (European red mite), *Tetranychus urticae* Koch (two-spotted spider mite), and *C. pomonella* L. (codling moth) were the main apple pests that were observed in the selected areas. We made an effort to elucidate their potential impact on apple trees, twigs, stems, leaves, and trunks. Without a doubt, this paper serves as a data provider or a basis for governmental bodies responsible for apple production to implement preventive measures and pest management strategies in apple orchards to avoid the negative impacts of insect pests.

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