Research Article

Diversity and Abundance of Mite and Moth Pests in Maloideae Orchards with Records of Their Associated Natural Enemies

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Abstract | Uzbekistan is renowned for its fruit production among the Central Asian countries, due to its diverse agro-climatic conditions. Maloideae orchards, which include fruit varieties like apples and pears, are especially prominent throughout the country. The current study was carried out in Maloideae orchards of Tashkent and seven districts of central Fergana. The study was conducted on the mites and moths attacking the orchards in the area during the fruit growing season from 2020-2022. The extent of attack on leaves and damage was also calculated. Among spider mites the two species *Tetranychus viennensis* and *Tetranychus urticae* were found in abundant in all regions infesting the apple and pear orchards. The natural enemies of these mites were also found, which were *Scolothrips acariphagus* and *Stethorus punctillum* in the orchards. A detailed graph of the natural enemies recorded during the studies is also presented in the paper. Two species of moths, *Cydia pomonella* and *Grapholita molesta*, infested the orchards. The infestation of *C. pomonella* was more severe than that of *G. molesta* in quince orchards, while the infestation levels were similar in apple and pear orchards. These natural enemies play a vital role in controlling different stages of the mites. The mass rearing and commercial production of these predators has been started for controlling different insects' pests attacking fruit orchards.

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Introduction

Uzbekistan holds a unique position due to the diversity and richness of its fruit tree species. In recent years, extensive efforts have been made to boost fruit production, create new local and intensive orchards, and enhance the sector. However, pest insects have begun to inflict significant damage on fruit trees in the country. Given this, one of the pressing issues today is to thoroughly examine the species composition

of pests in Uzbekistan's fruit-growing areas, identify their geographical distribution and bioecological characteristics, assess the consequences of large-scale pest outbreaks, and develop a specialized database to organize effective pest control methods. Additionally, recent agricultural reforms, the growing share of fruit and vegetable crops in export markets, and the ongoing implementation of market mechanisms in the sector have made it a priority to address these challenges. The lack of systematic application of effective strategies, particularly in horticulture, viticulture, and vegetable cultivation, coupled with insufficient scientific focus, has resulted in the underutilization of the industry's full potential (Alimukhamedov and Adashkevich, 1983; Ganieva *et al*., 2021; Mirziyoev, 2017).

Recently herbivorous mites and frugivores have become a widespread and significant threat to garden crops across all Central Asian republics. These pests are among the primary culprits causing substantial damage to fruit farming in Uzbekistan. To control them, it is essential to apply various acaricides 3-4 times annually. However, the use of traditionally employed chlorinated organochlorine chemicals is now prohibited in global practice due to their negative impact on ecology and human health. Chemical treatments promote resistance (adaptation) in mites and other pests, while also eliminating beneficial predatory and parasitic species that help control mite and pest populations in orchards. Moreover, the chemical residues contribute to environmental pollution, exacerbating the ecological crisis (Ganieva *et al*., 2021; Mirziyoev; 2017; Yanar and Ecevit, 2008).

Phytophagous mites have caused significant damage to orchards by sucking cell sap and inflicting injury, which also makes the plants more susceptible to diseases. Various control methods are available, and among them, relying on natural predators is an eco-friendly and sustainable option. Biological control is widely regarded as an effective pest management strategy, as it helps maintain a clean environment without disrupting the natural balance (Balykin *et al*., 2021; Yanar and Ecevit, 2008; Bostanian *et al*., 2006). Moths are causing significant harm to orchards, with the codling moth being a particularly harmful pest. This moth goes through five instars and feeds on the fruit, causing extensive damage to orchards (Erler and Tosun 2023). Maloideae orchards are also vulnerable to attacks from the oriental fruit moth (*Grapholita molesta*). The extent of damage and infestation varies depending on the fruit variety and is positively correlated with environmental conditions (Ma *et al*., 2023).

The current study was conducted to assess the infestation of phytophagous mites across different regions and fruit types, as well as to document the natural enemies of these mites in the Maloideae orchards.

Materals and Methods

Location

The studies were conducted in various locations of Tashkent and seven districts of Fergana during the active season from 2020 to 2022. In Tashkent region, the 11 districts studied included Kibray, Tashkent, Yukori Chirchik, Orta Chirchik, Kuyi Chirchik, Zangiota, Okhangaron, Bekobod, Piskent, Boka, and Chinoz. The seven districts of Central Fergana included Uchkuprik, Rishton, Bogdod, Yazyavan, Tashlak, Buvaida, and Oltariq. Generally accepted zoological, entomological, and acorological methods are used during the research. Field research was carried out from early spring to late autumn based on methods of (Dospekhov,1979; Lakin, 1990; Lindit, 1964).

Specimens collection and identification

For the collection of insects and mites standard procedure was used. Entomological nets were used for the collection of insects. Before collecting insects, the behavior was observed for some time. The insects were pinned, preserved and labeled according to the host and date of collection. For mites the leaves were collected and were brought to the labs and mites were collected from the infested leaves. Slides were prepared and were used for identification and were then stored in the laboratory. The collected mites and insects were identified using different taxonomic keys and were labeled accordingly. The specimens were deposited in the museum for records.

Mites and natural enemy population

Mite populations were recorded from infested leaves collected across various localities at different intervals. Similarly, the populations of natural enemies were monitored at these same locations during the same periods, and the data are represented in the tables and graphs. A total of 100 leaves were collected from apple, pear, and quince orchards, and the number

of mites per leaf was calculated. The data were then categorized based on their abundance, including low, average, and high populations, which were indicated using distinct markers.

The collected natural enemies, including mites and moths, were accurately identified using different identification keys. The abundance of the recorded natural enemies was calculated and was organized by taxonomic orders.

Statistical analysis

All the recorded data were subjected to statistical analysis using computer program. MS Excel was used for the analysis. Descriptive Statistics were used for the data analysis. Mean and standard deviation was calculated.

Results

Mite species infestation in maloideae orchards

The primary mites infesting Maloideae orchards belong to the spider mite family (Tetranychidae). Two species of herbivorous mites from the Tetranychidae family were identified: the hawthorn spider mite (*T. viennens* Zacner), a common species, and the two-spotted spider mite (*T. urticae* Koch, 1836). The infestation levels in different locations are presented in Table 1. *T. viennensis* was abundant in all orchards compared to *T. urticae.*

Table 1: *Interdistrict species diversity of mites attacking the Maloideae orchards.*

Species name	Interdistrict spread		
	Bekobod, Bostanlik, Tashkent, Kibray	Zangiota, Tashkent, Okkurgan, Okhangaron	Okhanga-ron, Piskent, Chinoz, Yangiyol
The Hawthorn Spider Mite *Tetranychus viennensis* Zacner	(307±9) ***	(305±8) ***	(312±13) ***
Two-spotted spider mite *Tetranychus urticae* Koch, 1836	(202±7) **	(206±11) **	(201±9) **

** rare species lowest population per 100 leaves, ** common species moderately population per 100 leaves, *** abundant species highest population per 100 leaves.*

Mite infestation in various fruits orchards

The two-spotted spider mite (*T. urticae*) was observed as abundant in common species in apple and quince, while rarely found in pear orchards across nearly all districts of the Tashkent region, including Bekobod, Bostanlik, Kibray, Zangiota, Okkurgan, Okhangaron, Piskent, and Chinoz. *Tetranychus viennensis* infestation was highest in apple followed by quince and lesser infestation was recorded in pear orchards (Table 2).

Table 2: *Mite infestation on various fruits species.*

Species name	Fruit species		
	Apple	Quince	Pear
Tetranychus viennensis Zacner	(317±9) ***	(225±9)**	(78±6)*
Tetranychus urticae Koch, 1836	(310±11)***	(70±4)*	(9±2)*-

** Rare species lowest population per 100 leaves, ** common species moderately population per 100 leaves, *** abundant species highest popoulation per 100 leaves.*

Natural enemies of mites

A total of 17 natural enemies belong to 5 orders and 7 families were recorded that were feeding on mites in both areas. Among them 7 species belonging to *Coccinellidae* family, two species each to *Chrysopidae*, *Surphidae*, *Anthosoridae* and *Miridae* and one each from *Aeolothripidae* and *Thripidae*. Highest number of species 7 were recorded from coleoptera order followed by 4 species from Hemiptera and 2 each from Thysanoptera, Neuroptera and Diptera order. Among the mentioned beneficial insects, Coleoptera consist of 41.2%, Hemiptera 23.5%, and Thysanoptera, Neuroptera and Diptera orders was 12% (Figure 1).

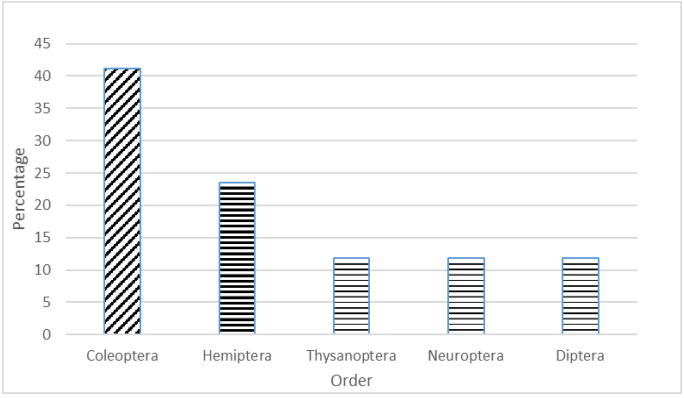

Figure 1: *Percentage composition of natural enemies of mites, by taxonomic order.*

Among the beneficial insects observed in the Maloideae orchards, specialized biocontrol agents like *Scolothrips acariphagus*, *Stethorus punctillum*, *Psyllobora vigintiduopunctata*, *Coccinella septempunctata*, *Chrysopa carnea*, and *Harmonia axyridis* play a crucial role in managing mite infestations within the orchards Figure 2.

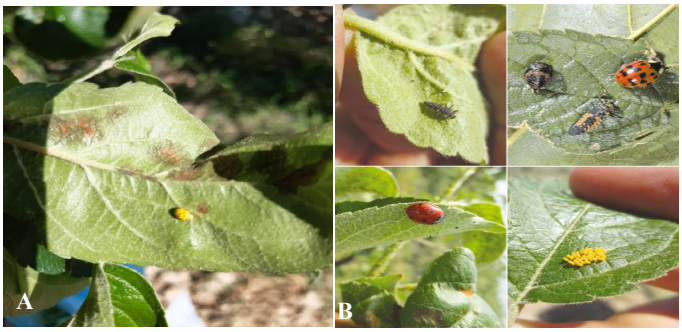

Figure 2: *(A) Spider mite colony and its natural enemy Psyllobora vigintiduopunctata (Linnaeus, 1758); (B) larva and imago of Coccinella septempunctata.*

Moths attacking the maloideae orchards

Two types of moths, *Cydia pomonella* and *Grapholita molesta*, were found to cause serious damage to the orchards. Both pests belong to Tortricidae family, a group of dangerous pests that cause significant damage to the orchards. The pest larval instars were attacking the fruits and causing damage in the orchards. The infestation of *C. pomonella* and *G. molesta* was similar in apple and pear orchards, while *G. molesta* population was lower in quince orchards Table 3.

Table 3: *Distribution of frugivores species by Maloideae tree species.*

Species name	Fruit orchards		
	Apple	Quince	Pear
Cydia pomonella (Linnaeus, 1758)	(326±12)***	(202±9) **	(59±4) *
Grapholita molesta (Busck, 1916)	(318±9) ***	(62±3) *	(55±5) *

** Rare species lowest population per 100 trees, ** common species moderately population per 100 trees, *** abundant species highest popoulation per 100 trees.*

Natural enemies of moths

A total of 23 species belonging to 5 orders, 9 families, and 22 genera were recorded in them as a natural enemy for moths in the orchards. Among the listed beneficial insects, the Hymenoptera order was the most dominant, accounting for 47.83%, followed by Coleoptera at 26.09%, and the Hemiptera 13.04%. Representation from the Neuroptera was 8.70%, while the Diptera contributed 4.35% Figure 3.

Elasmus albipennis of the Eulophidae family, *Dibrachys cavus* of Pteromalidae, *Ageniaspis fuscicollis* of the Encyrtidae family, *Blondelia nigripes* of the Tachinidae family *Campalomma verbaci* and *Deraeocoris punctulatus* from the Miridae family and *Nabis ferus* from the Nabidae family were the prominent biocontrol agents feeding on different stages of moths Figure 4.

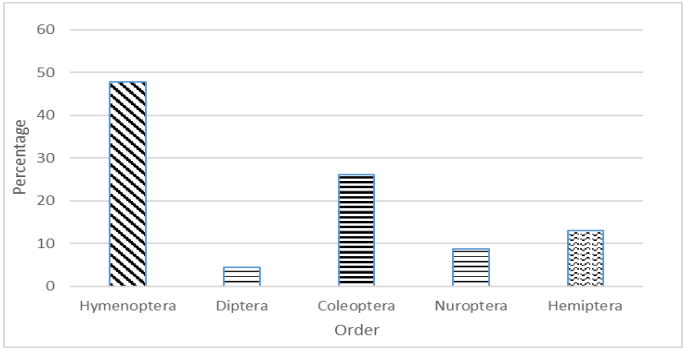

Figure 3: *Relative abundance (%) of moth-associated natural enemies by taxonomic order.*

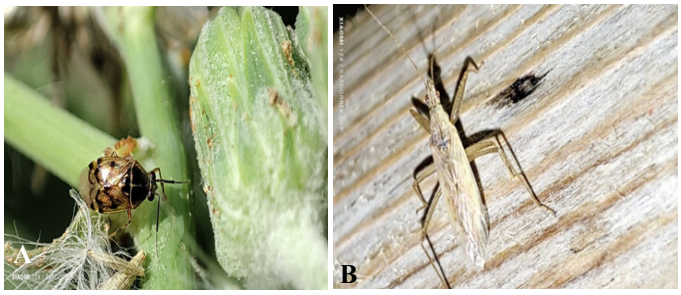

Figure 4: *Natural enemies of moths: A. Deraeocoris punctulatus, B. Nabis ferus.*

Discussion

During the current studies two mite species were found to be abundant in all districts of Tashkent and central fergrana infesting the Maloideae orchards. The two species are *Tetranychus viennensis* Zacner and *Tetranychus urticae*. The infestation of both mite species was high in apple compared to pear and quince. The mites attack the leaves and suck cell sap disturbing photosynthesis and causing weakness in plant which affect quality and quantity of the fruit bearing trees. The current studies are in line with those of Yanar and Ecevit (2008) and Kasap (2003) who reported that the spider mites of Genus *Tetranychus* are severely damaging the fruit orchards and especially the apple orchards and the population fluctuates with season and time. Balykina *et al* (2021) also report high infestation of *T. urticae* high infestation in apple orchard in the neighboring countries of Uzbekistan which are in conformity with our findings.

A total of 17 species of natural enemies of mites were recorded in these studies. Among them seven were from Coccinellidae family, two species each to Chrysopidae, Syrphidae, Anthosoridae and Miridae. Conncinellidae were highest and abundant in number. These findings are in similarity with those of Attia *et*

al. (2013). They studied that the Coccinellidae family is an efficient biological control agent of spider mites in orchards. A few hundred Coccinellidae can control thousands of mites as they have great feeding capacity. Chrysopidae and Syrphidae are also considered good natural enemies for controlling the mites population (Wilson *et al*., 1991).

Two types of moths *Cydia pomonella* and *Grapholita molesta* were causing damage to the Maloideae orchards. The infestation of both moths was high in apples compared to quince and pear in all the localities. Earlier studies of Kamusiime *et al*. (2023) are in conformity that these moths severely damaged the Maloideae orchards. Further they reported that *Cydia pomonella* is a devasting pests in all apple growing areas. The pest affects the production and quality of fruits severely and if not timely managed the loss can be high.

A total of 23 species of biocontrol species belonging to 5 orders, and 9 families were recorded for both moths. Among the biocontrol agents the order Hymenoptera is most dominant, accounting for 47.83%. Hymenopterous wasps are efficient biological control agents in the studies area and help in lowering the population of moths. Lacey and Unruh (2005) also reported that the order Hymenoptera was to be considered as an effective agent for the moth control in orchards. They also studied that the Parasitism of these wasp can reach up to 40% and can significantly reduce the moth population.

Conclusion

Maloideae Orchards are often plagued by infestations of mites and moths, which can severely impact both the quality and quantity of the fruit, leading to significant financial losses for farmers. Fortunately, nature provides several biocontrol agents that can effectively combat these pests. These natural predators, when mass-reared and released into orchards, can significantly reduce the populations of mites and moths, offering a sustainable and eco-friendly solution to pest control. By utilizing biological control methods, farmers can minimize the damage to their crops, ultimately protecting their yield and ensuring long-term productivity in the orchards.

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Novelty Statement

The research identifies the primary insects and pests affecting Maloidae orchards, along with their natural predators. These natural enemies can be utilized to manage pest populations, promoting sustainable agriculture.

Author's Contribution

Z.A. Ganieva, S.Q. Kimyonazarov and M.R. Shermatov: Conducted the experiments and gathered the data.
Hussain Ali, M.A. Embergenov and M. Sh. Akhmedova: Assisted with data analysis and contributed to writing the initial draft.
Hussain Ali: Revised the manuscript and submitted it for publication.

Conflict of interest
The authors have declared no conflict of interest.

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