Study on stem pests of elm tree in Uzbekistan

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Abstract. Forest stem pests are of great interest as permanent components of forest biocenosis. In the forest they perform different roles; in a healthy forest they participate in the process of thinning and recycling the wood of naturally dying trees. In turn, they serve as food for other forest inhabitants. When the biological stability of plantings is violated, they act as pests and cause the death of still living trees. Many of them cause great physiological and technical harm. Stem pests constitute a large ecological group of insects that feed on the bark and wood of trunks and branches and have varied economic significance. Some colonize trees without visible signs of weakening, others are very weakened and even felled trees. Trees infested with stem pests die differently, this is due to the nature of the weakening of the tree and the infestation by pests. One of the main factors for the mass reproduction of stem pests is the physiological weakening of plantings, which provides food for pests. And the reasons that ensure the weakening of plantings are environmental factors: climatic (drought, excessive moisture, saline groundwater, windbreaks, snow banks, fires and others), and biotic (leaf-eating pests, tree diseases and human economic activity).

1. Introduction

Elm trees (*Ulmus* spp.) hold a special place in the hearts and landscapes of Uzbekistan, where they have been cultivated for centuries for their shade, beauty, and wood [1]. These majestic trees line streets, grace parks, and stand tall in forests, providing numerous benefits to both humans and the environment. However, the health and vitality of these trees are under constant threat from various pests, with stem pests being of particular concern [2].

Stem pests are insects that primarily target the stems, branches, and trunks of elm trees, causing damage that can range from aesthetic to severe, affecting the tree's overall health and longevity [3]. In Uzbekistan, several stem pests pose a threat to elm trees, with notable species including the elm leaf beetle (*Xanthogaleruca luteola*), the elm zigzag sawfly (*Aproceros leucopoda*), and the elm spanworm (*Ennomos subsignarius*). These pests have the potential to defoliate entire trees, leading to weakened defenses, increased susceptibility to diseases, and even tree mortality [4].

Understanding the biology, behavior, and ecology of these stem pests is crucial for developing effective management strategies. The elm leaf beetle, for example, is a voracious feeder that can quickly defoliate an entire tree if left unchecked [5]. This beetle typically lays eggs on the underside of elm leaves in the spring, and the larvae that hatch feed on the leaves, skeletonizing them and reducing the tree's ability to photosynthesize. Mature larvae drop to the ground and pupate, emerging as adult beetles to continue the cycle [6].

The elm zigzag sawfly, on the other hand, is a relatively new pest in Uzbekistan, having been first reported in the country in recent years. This sawfly has a distinctive zigzag pattern on its wings and lays eggs on elm leaves. The larvae that hatch feed on the leaves, causing damage similar to that of the elm leaf beetle [7]. However, the sawfly larvae can also defoliate entire branches, leading to more localized damage but still posing a significant threat to tree health.

The elm spanworm, also known as the cankerworm, is another pest that can defoliate elm trees. This moth lays eggs on twigs and branches, and the larvae that hatch feed on the leaves, often creating silken shelters where they can hide and feed protected from predators [8]. While the damage caused by elm spanworms is typically less severe than that caused by the elm leaf beetle or zigzag sawfly, repeated defoliation over several years can weaken the tree and make it more susceptible to other pests and diseases [9].

Managing stem pests of elm trees requires a multifaceted approach that includes cultural, mechanical, biological, and chemical methods. Cultural methods, such as planting elm species that are less susceptible to pests or avoiding planting

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elm trees in areas where pests are prevalent, can help reduce pest pressure [10]. Mechanical methods, such as pruning out and destroying infested branches or using barriers to prevent adult beetles from laying eggs, can also be effective. Biological control, which involves using natural enemies of the pests to control their populations, is another important strategy [11]. Several natural enemies of elm pests, including parasitic wasps and predatory beetles, can help keep pest populations in check. Introducing these natural enemies into affected areas can help reduce the need for chemical pesticides, which can have negative impacts on the environment and non-target species [12].
Chemical control, while effective, should be used judiciously and as a last resort [13]. When using chemical pesticides, it is important to select products that are specifically labeled for use on elm trees and to follow all label instructions carefully to minimize the risk to beneficial insects, wildlife, and the environment.

2. Materials and Methods

A comprehensive review of existing literature was conducted to compile information on the stem pests of elm trees in Uzbekistan. Online databases, scientific journals, and relevant books were searched using keywords such as "elm tree pests," "stem pests," "Uzbekistan," and specific pest names including "Scolyhis scolytur Febr.", "Scolytus orientalis EG", "Alolesthes savia Sol" and other types. The search was limited to articles published in English, Russian, and Uzbek languages.
The review focused on identifying the key stem pests of elm trees in Uzbekistan, including their taxonomy, biology, distribution, host range, damage symptoms, and management strategies. Information on the life cycle of each pest, including egg-laying behavior, larval development, pupation, and adult feeding habits, was also compiled.
Data on the occurrence and distribution of stem pests of elm trees in Uzbekistan were compiled from various sources, including scientific studies, government reports, and local observations. Information on the prevalence of each pest in different regions of Uzbekistan, as well as the impact of pest infestations on elm tree populations, was recorded.
The compiled data were analyzed to identify patterns in pest occurrence and distribution, as well as trends in pest damage and management practices [14]. The effectiveness of current management strategies, including cultural, mechanical, biological, and chemical control methods, was assessed based on available literature.

3. Results and Discussion

3.1. Scolyhis scolytur Febr.

The large elm sapwood (Figure 1) is widespread in the republics of Central Asia, the European part of Russia, the Crimea and the Caucasus. It is the main pest of elm, inhabiting the trunks of both weakened and healthy-looking elms. Great damage is caused both in valleys and in the mountains, in the zone of distribution of fodder trees.

Fig. 1. *Scolyhis scolytur* Febr.

The beetles of the large elm sapwood are dense, stocky, shiny, black or dark brown in color. The antennae and tarsi are reddish-brown and the body length is 3.5-5.5 mm. The forehead is compacted, with small wrinkles and tubercles, covered with dense short, reddish-brown hairs. The female's is convex, the male's is depressed. The elytra taper towards the apex, the end of the elytra is smooth, without denticles. The abdomen is slanted upward, sharply curved. In the

middle of the posterior edge of the 3rd and 4th abdominal segments along a sharp tubercle. On the posterior edge of the last abdominal segment there is a brush of golden hairs.

The uterine tract is longitudinal, 30-50 mm long, more than 2 mm wide, lies deep in the bark, slightly touching the sapwood. The larval passages run perpendicular to the uterine passage.

The large elm sapwood prefers to settle in more moist and moderately lit areas, i.e., it settles more often in dense plantings. In addition to elms, it damages poplar, grass, walnut, willow and ash. In Central Asia, it settles exclusively on elm and other elm species, mainly on the trunk and thick branches. The larvae mainly feed on bast and lightly sapwood.

The large elm sapwood overwinters in the larval stage in feeding areas. In valley conditions, in the spring, in the first ten days of March, the larvae pupate and after 9-12 days, in the third ten days of March - early April, the flight of beetles of the overwintered generation begins. In mountainous conditions (Su-Kok), beetle flights occur at the end of April and beginning of May, almost a month later. The emerging beetles provide additional nutrition by gnawing short canals on the shoots near the buds, and often introduce infection with the causative agent of Dutch disease (Figure 2). During the summer, females lay eggs, while they gnaw out the uterine passage in the bark and lay up to 60 eggs on its sides. Females lay their entire supply of eggs within 6-12 days. After 7-10 days, the laid eggs hatch into larvae, which, while feeding, gnaw out the larval tunnels perpendicular to the uterine tunnel. The passages of the larvae do not intersect, they diverge fan-shaped, individual passages reach up to 70 mm in length. The larvae feed for 18-20 days, and in mountain conditions up to 1 month. At the end of the course, the larvae gnaw out the cradle and pupate. At the beginning of the third ten days of May, beetles of the first generation appear. The development of the first generation is completed within 39-43 days, beetles appear in the third ten days of May: the second 31-37 days, beetles appear in the second ten days of July; the third is 39-45 days, beetles appear at the end of August. The fourth generation develops within 20-32 days, then the larvae go into diapause, which overwinter for 160-170 days. Thus, in valley conditions it develops in four generations, and in mountain conditions (Su-Kok) - three generations [15].

Fig. 2. Damaged tree

3.2. Scolytus orientalis EG.

Eastern sapwood (Figure 3) causes great harm in old elm plantations, primarily colonizing overmature trees. In field protective plantings it inhabits relatively young trees, especially in rainfed protective plantings, where the infestation of elms reaches up to 70%. Widely distributed in Uzbekistan, Turkmenistan, Crimea and the Caucasus, Bulgaria, Romania and northern Iraq.

The beetles are pitch-brown, shiny, with an almost black head, red-brown elytra, and yellow-red legs and antennae. The male has straight hair on the forehead, not curved inward, while the female has thick and long hair. At the end of the elytra there is a brush of hairs, and also at the end of the abdomen of the male there are protruding long hairs and a body length of 2.5-3.8 mm.

Fig. 3. *Scolytus orientalis* EG.

The uterine tract is laid along the inner surface of the bark, not always touching the sapwood. The length of the uterine tract is 20-70 mm, most often up to 50 mm. The larval passages are long.
The sapwood overwinters in the larval stage, which has finished feeding. In the spring, the larvae pupate and after 7-10 days, at the beginning of the third ten days of April (in the valley) and in the first half of May (in the mountains), the beetle year begins. Females lay their entire supply of eggs within 7-13 days. Embryonic development ends within 7-13 days, the hatched larvae feed for 23-34 days, after which they gnaw out a cradle in the thickness of the bark and pupate. The pupal stage lasts 7-10 days.
The full development cycle of the first generation is completed in 38-49 days, the second in 40-50 days. The third generation completes its development in the spring of next year, as the larvae go to winter, which lasts 190-200 days. It develops in three generations per year.

3.3. Alolesthes savia Sol.

Alolesthes savia Sol (Figure 4) is widely distributed in the Republic of Uzbekistan and other countries of Central Asia, as well as in Afghanistan, Pakistan, and Iran.
Being a polyphage, it damages poplars, willows, elms, plane trees, walnuts, ash, oaks, maples and almost all fruit crops. One of the most dangerous pests of ornamental forest plantings in populated areas. In the process of feeding, the larvae gnaw out quite large areas under the bark, and also make deep passages into the wood and riddled it so much that the trees dry out.

Fig. 4. *Alolesthes savia* Sol.

At the same time, mechanical strength is often lost in places where larvae are massively populated and trees easily break off in light winds. Trees damaged by urban longhorn beetle are not suitable for construction and ornamental work. Therefore, this pest is also called a technical pest [13].
The beetles are quite large, 28-47 mm long, the body is elongated, from reddish-brown to brown, covered with short, gray, tightly fitting hairs that hide the main color of the body. This hairline gives the body a velvety appearance with a silvery tint. The eyes are large and deeply notched.
The antennae of the male are 1.5 times longer than the body, eleven-segmented, the latter much longer than the others. The female's antennae are slightly shorter than the body, the eleventh segment is not prominent, and it is almost the same in length as the 10th or 9th segments.
The pronotum has coarse transverse wrinkles and is covered with short yellowish-grayish hairs. The first beetles appear at 21-22 hours (Figure 5); before exiting, the beetles gnaw a flight hole in the bark (3-3.5 cm x 1.2-1.5 cm).

Fig. 5. Urban longhorned beetle larva (*Alolesthes savia* Sol.)

3.4. Cratomerus intermedius Oben.

The elm borer (Figure 6) is widespread in the sovereign states of Central Asia and southern Kazakhstan, and is found in all areas where elm forage plants grow. However, there is evidence that the elm borer damages pear and apple trees. At the same time, the borer colonizes weakened and dying trees, the larvae flutter on the trunk and thin branches. The pest is ecologically flexible, found in equal numbers in the valley and in urban plantings, as well as in the mountains, up to the upper limit of elm growth. The population of elms with this pest reaches 25-76% [4].
Beetles, like most borers, have an elongated flat body, the ventral side is copper-red, golden and shiny. The elytra are bronze-brown, the edges are bordered by a narrow red stripe. The entire body is covered with sparse whitish hairs and the body length of the beetle is 7-12 mm.
The larval passages pass along the inner surface of the bark and only slightly touch the sapwood, up to 8 cm long at the end of the passage - the pupal cradle.

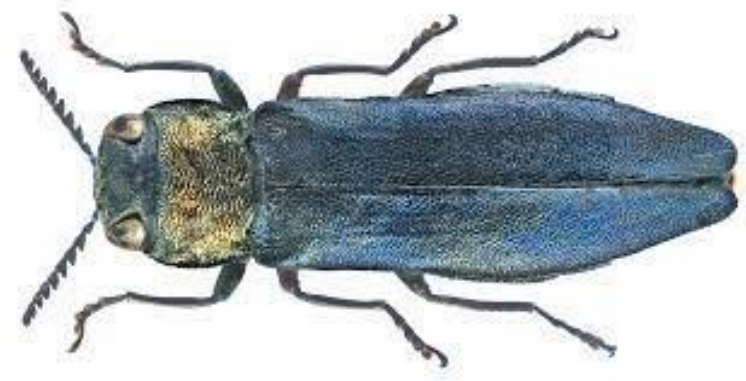

Fig. 6. *Cratomerus intermedius* Oben.

The elm borer overwinters in the larval stage, which has finished feeding in wood, in a prepared pupal cradle. In the spring of next year, in the valley at the end of March-April, and in the mountains at the end of April-May, the beetle

flight begins and lasts about two months. The mass flight of beetles is observed from mid-May to the end of June. The beetles emerge from the wood through the entrance hole of the larva into the pupal cradle, then gnaws a flight hole in the bark. During the summer, females lay eggs on the trunk and branches of varying thickness. However, they prefer weakened ones and do not colonize completely healthy trees. During the oviposition period, the female crawls along the trunk and branches with the ovipositor released and lays one egg at a time in cracks and depressions in the bark [14].

After 10-15 days, larvae hatch from the laid eggs, which gnaw into the bark and feed on the phloem. The passages of the larvae are longitudinal, winding, gradually widening as the larvae grow; the width of the passage sometimes reaches 4-5 mm and a length of 8 cm. The larval passages are clogged with drill flour. In August-September the larvae finish feeding, gnaw out a cradle in the wood and overwinter there. Due to the length of the beetles' summer, some of the larvae have time to finish feeding and pupate in the fall. In this case, the newly formed beetles go to winter. In the spring of next year, these beetles fly out in April-May, and the overwintered larvae pupate in the spring and the beetles fly in June. The full development cycle is completed within a year.

3.5. Analysis part

The head is equipped with highly developed jaws. The larva is whitish-cream in color, up to 6.5 cm long, with a well-developed chest, on which there are three pairs of barely noticeable legs. The head is flat, pulled into the body. The eggs are whitish, oval in shape, the shell is dotted with high tubercles (Table 1).

The longhorned beetle overwinters in the larval and beetle stages under the bark and in the wood of the fodder tree. The longhorned beetle inhabits more than 35 tree species, both forest and fruit. Fruit crops are especially dangerous; if the drying out of poplar or elm requires the feeding of several dozen or even hundreds of larvae, then for an apple or pear tree one larva is enough, since under the thin bark of fruit trees the larva gnaws out a spiral or ring passage around the trunk and the tree dries out.

Table 1. Distinctive features of beetles with a one-year and two-year development cycle

Beetles	Number of observations P	Average N	Standard deviation $\mp\sigma$	Average error $\mp M$	Dispersion V%	Accuracy rate, P %	T
Body length, mm							
Biennial generation	50	41.3	2.635	0.372	6.4	0.9	4.9
One-year generation	50	23.1	2.659	0.376	4.5	1.6	
Fertility, pcs. eggs							
Biennial generation	15	93.6	5.819	1.499	6.3	1.5	8.7
One-year generation	15	31.3	4.119	1.062	13.2	3.4	

The beetle season begins at the end of April, beginning of May; the last beetles are observed even in mid-July. The mass flight of beetles lasts about a month. Beetles fly at night and lead a crepuscular lifestyle. They have little or no flight, but quickly crawl along the trunk and branches of a tree.

Table 2. Biological effectiveness of pesticides against urban longhorned beetle larvae

Pesticide	Consumption rate, kg/ha	Number of trees processed	Number of counting trees	Number of counting eggs	Number of larvae	Biological efficiency, %
Barley 100 g/l (P1)	0.15	112	3	171	164	61.58+1.54
Bi-58 new 40%	1.2	87	3	163	151	58.28+5.0
Dimychyn 48%	0.3	56	3	199	158	89.87+3.10
Control	No treatment	3	3	199	146	-

Males appear first on the surface of the tree; at the beginning of the summer of beetles, males predominate, in the middle the ratio equalizes, and at the end of summer females predominate. The beetles do not feed, although they excrete eco-crements; they live for about a month due to the fatty deposits of the larvae. From dawn, all the beetles

again climb into the flight holes, with their bellies first, so early in the morning you can still see the antennae or tips of the antennae of the beetles from the flight holes (Table 2, Figure 7).
During the summer, females lay eggs in cracks and depressions in the bark, while the female slowly crawls with the ovipositor released. Eggs are always laid on areas with living bark; egg laying in one place lasts 10-15 minutes.

Fig. 7. Efficiency of pesticides for urban longhorned beetle

The fertility of the female is quite varied from 80-120 to 260-340 eggs. After 8-10 days, larvae hatch from the laid eggs and bite into the bark of the food tree. In the process of feeding, the larvae gnaw out entire areas in the sapwood bark (Table 3).

Table 3. Biological effectiveness of dimilin against urban longhorn beetle larvae on various tree species

Wood species	Consumption rate, kg/ha	Number of processed trees	Number of frozen eggs	Number of eggs viewed	Number of hatched larvae	Biological effectiveness
Experimental station						
Poplar Bolle	0.3	18	4	263	197	90.86±2.67
Elm	0.3	13	4	224	186	92.47±2.98
Control			4	229	121	-
Botanical garden, Tashkent region, Uzbekistan						
Apple tree (Razmari variety)	0.3	16	4	89	64	95.31±1.77
Control	-	-	4	1	17	-

4. Conclusions

The entrance hole of the larva gradually rots at the edges and it expands, through which the larvae throws out drilling flour and excrement. Flight holes of beetles on the bark and the accumulation of drilling flour at the base of the trunk are unmistakable signs of the colonization of a tree by an urban longhorned beetle. By autumn, the larvae reach 5-6 cm in length, some of them overwinter under the bark, and some bite into the wood. In the spring of next year, the larvae continue feeding. By the end of July, the larvae reach 6-7 cm in length. At the end of their passage in the wood, they gnaw out an oval cradle and pupate, and at the end of August young beetles begin to appear, they overwinter in the cradle and fly out in the spring of next year.
The full development cycle of the urban barbel ends within two years. However, the urban longhorned beetle can develop at a more accelerated pace, especially when the larva feeds on dry bark and wood. In this case, the larvae pupate in August and young beetles appear, which fly out in the spring of next year. These beetles are distinguished by their significantly smaller size and the fertility of females is 3-4 times less than normal.

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