Frequency of occurrence of field bugs-mirids on the cotton–alfalfa agrocenosis in the Tashkent oasis

Abdivohid Kuchkarov[1], *Adamboy* Boltaboev[1], *Qahramon* Ibragimov[1], *Olimaxon* Ergasheva[1*], *Mamlakat* Makhmudov[1]

[1]National University of Uzbekistan, University street 4, 100174 Tashkent, Uzbekistan

Abstract. On the basis of the collections and observations conducted by the authors in 2016–2021, various points within the Tashkent region. The observations on cotton crops and weeds were conducted in the spring and summer seasons. The counts were performed on wild plants and plants surrounded by cotton crops. The seasonal dynamics was studied and the time when the maximum number of field bugs were observed on cotton plants, were identified.

1. Introduction

Due to their wide geographic range, rich species variety, and abundant populations, plant bugs are environmentally successful. The distributions of some mirids line up with long-established biogeographic zones and transcontinental trends. Centers of endemism, linkages between species, and areas of species richness connected with high endemism have all been found through biogeographic investigations.

Mirids are widespread in a wide range of environments, from salt marshes and coastal dunes to the summits of mountains. Numerous species focus on glandular-hairy or even carnivorous plants, and Ranzovius Reuter species are some of the rare heteropterans that coexist with spider webs as commensals. As natural adversaries as well as pests, the Miridae family, the largest of the *Heteroptera*, has a significant economic impact on the entire planet [1, 2, 3]. Herbivorous and omnivorous mirid bugs, in contrast to the majority of Hemiptera, are lacerate/macerate and flush feeders rather than phloem feeders. This means that instead of using the salicylic acid pathway, plants respond to harm from arthropods in this feeding guild through the jasmonic acid or ethylene signaling pathways [4]. Additionally, mirids deposit their eggs in plant tissues, causing oviposition harm, in contrast to the majority of other *Heteroptera* that lay their eggs on the plant's surface [5, 6]. There are more than 650 species (170 genera) of the gadfly (*Miridae*) family in the territory of the CIS, and only approximately 1% of them, to one degree or another, damage cultivated plants [7].

This group is widespread and occurs in a wide variety of biotopes on herbaceous, shrub and woody vegetation, mainly in the upper and middle tiers. These bugs do not live in the litter, but often take refuge in it from danger or adverse weather.

Based on the study of morphological and metabolic parameters of plants, a number of studies were conducted to determine the degree and mechanism of harmfulness of bugs–mirids [8]. The research materials of these authors made it possible to establish violations of the fertile organs of plants, as well as to give preliminary chemical, biological and physiological characteristics of the negative effect on cotton when infected with bugs – *miradae*. According to the results of a number of previous studies, it was found that the alfalfa bug is the main factor of "sticky bacteriosis" of cotton plants [9].

The intensification of agricultural production caused a change in the level of the negative impact of a number of known faunistic components of agrocenoses and the emergence of new ones. So, on cotton, the expansion of habitats, as well as the harmful activity of alfalfa and field bugs, whiteflies, leafhoppers, and other groups of arthropods was noted [8].

2. Materials and Methods

The number of field bugs was established by mowing with an entomological net (50 double sweeps from each field) along two diagonals of the field. Plants were examined in 10 samples per hectare measuring 25x25 cm after the sums of effective temperatures required for larval development were established. The actual data were compared with the

*Corresponding author: o.ergasheva@nuu.uz

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calculated ones. Determination of the duration of development from the egg to an adult bug and the timing of the appearance of individual stages of larvae were conducted in field and laboratory conditions using special cages – insulators.
To determine the hatching of the larvae from the wintering eggs, in each five–day period, the stubble of alfalfa from the plots 25x25 cm was taken. From the developing eggs, the larvae hatched after a few days, depending on the temperature.

3. Results

In view of this, this issue becomes quite relevant. Among the Hemiptera, the *Miridae* family occupies a special place; it is ecologically associated with various biotopes and plays an important role in bio- and agrocenoses. Most of the species of this family, being phytophages, are serious pests of cotton, forage grasses, vegetables, medicinal plants, and tree and shrub species [7]. As a result of feeding the bugs, the condition and further development of plants are disturbed, accompanied by various deformations and death of individual parts of the plants. An example of this is the destruction of the generative organs of cotton by a field bug: buds, flowers, ovaries, and bolls (Fig. 1).

Fig. 1. Organs of cotton damaged by field bugs – *Lygus pratensis, L*

An important role in negative consequences in such plants is exerted by both mechanical damage to tissues by field bugs and the toxic effect of their saliva. The toxic effect of bug saliva on plants has been studied for a long time [10]. Direct experiments have proven the poisoning of mice (up to death), attacked by a large number of field bugs. The rapid paralysis that occurs in insects after being pricked by predatory bugs *Micromerus, Rhinocoris,* and others is also well known. Acute burning pain in humans is caused by injections of not only zoophagous bugs but also phytophages [11]. However, the role of the dominant harmful species of mirids in biocenotic processes has not been sufficiently studied.
In Uzbekistan, such pests as field and alfalfa bugs affect industrial, forage, oilseeds, medicinal and other crops. The harmfulness and bioecological characteristics of alfalfa bugs *(Adelphocoris lineolatus and A. jakovlevi)* in Uzbekistan have been studied by a number of researchers [12**]**.
As for the issue of biology and ecology of field bugs, which are the most serious pests affecting the cotton, alfalfa and other crops, there are limited data in the literature. Taking this into account, we have conducted special studies on field bugs of the *Lygus* genus.
The route studies conducted in 2017 in 5 farms in the Urta–Chirchik region showed that field bugs were dominant. On the territory of the Tashkent oasis, cotton occupies an important place among agricultural crops. As a result of the research, 10 species of field bugs (mirids) were identified; of these, *Lygus pratensis, L. gemellatus, L. rugulipennis. and A. lineolatus* annually cause great damage to cotton crops (Table 1).
Observations showed that in 2020, the spring revival of overwintered field bugs began very early. Already in the first warm days of the first decade of February at a temperature of 12□C on the southern slopes of ravines and hills, among the bushes of last year's grass, single crawling bugs were found.
Somewhat later (after February, 12), in more open places, when the air temperature in the middle of the day rose to 16□C, bugs were observed in search of plants for food. Field bugs flew at a height of 0.5 – 1.5 m, populating plants, and in a weak wind, they were found up to 7 – 8 m. In the third decade of February, with a decrease in temperature and strong wind, the bugs stopped and hid among the remains of plants.
Observations conducted in the recreation area located on the territory of the "Haqiqat" farm covered with dense tree species showed that the flight of field bugs begins a little later, from March 17 to March 22. The bugs that flew out began to feed on the swollen buds of various tree species and often basked motionlessly in the sun. The main mass of

bugs in these places remained in winter shelters for a long time until the beginning of April, although by this time, the litter was drying up and its temperature in the middle of the day reached 22 – 25□C, their emergence took place gradually, sometimes stretching until April 10.

Table 1. Frequency of occurrence of field bugs – mirids on the cotton–alfalfa agrocenosis of the Tashkent oasis

Family	Genus and species	Cotton	Alfalfa	Weed plants surrounded by a cotton field
Miridae	*Lygus pratensis* L.	+++	+++	+++
	L.gemellatus H.–S.	++	++	++
	L.rugulipennis Popp.	++	++	++
	Adelphocoris lineolatus Goeze	++	+++	++
	A. jakovlevi Reut.	+	++	+
	Campylomma verbasci M.–D.	+++	++	+
	C. diversicornis Reut.	+++	++	+
	Camptobrochis punctulatus Schill.	++	++	+
	Poeciloscytus (Polymerus) cognatus Fieb.	+	+++	++
	P.(Polymerus) vulneratus Panz.	+	+++	++

Symbols: + + + – massive, + + – common, + – rare

In early March (March 7, 2017, March 11, 2018), field bugs left open wintering sites (roadsides, shallow ditches overgrown with weeds, fallow lands, perennial grasses). In search of food, they accumulated on the seedlings of winter crops. For example, in the early and warm spring of 2017, in the "Istiqbol" and "Haqiqat" collective farms, the first flights of bugs from their wintering sites were observed on March 9, and already on March 20, their number per 1 m^2 ranged from 1 to 16 specimens on alfalfa and on flowering shepherd's bag (*Capsella bursa pastoris.*). After 7 – 10 days, female bugs with ripening eggs were the first to leave the fields of winter wheat and move to alfalfa crops, where at this time a massive flowering of shepherd's purse, rape and other crucifers was observed. A week later, males flew from winter crops, the number of which in spring is less than females.

During the period of spring migrations, some of the populations of field bugs also flew to the seedlings of various field and garden crops, in particular, sugar beet, where the growth points were damaged.

The process of maturation of gonads in females began immediately after resumption of feeding and at average daily temperatures of 11–12°C in late March (2020) and early April (2021) and lasted for 9–12 days. Even at the beginning of the first decade of April, females with immature eggs could be found at the field bug wintering sites.

To determine the presence of mature eggs in field bugs, on April 10, 2018, the abdomens of 50 females were opened, and from 14 to 37 mature eggs were found.

We found the first oviposition of field bugs on a shepherd's purse and rape in the second decade of April 2018. Sometimes laid eggs protrude to the surface of the stem. If the place of laying is soft and juicy, then the eggs are completely immersed in the stem, the puncture sites for laying eggs are whitish, stoma–shaped.

Massive clutches of eggs were found at the end of the second and third decades of April, and the term of its completion generally depended on the timing of the emergence of overwintered bugs and the length of the period of their settling on flowering plants (herring bursa, rape, sorrel and testes of cruciferous crops).

In publications of some researchers [13, 14], it is indicated that the field bug develops on alfalfa from the moment of its regrowth until the end of the season. Our surveys conducted in 2017 – 2018 showed that on alfalfa the pest is colonized only after the plant has formed buds. Prior to that, it feeds on flowering plants: shepherd's bag, rape, sorrel, etc.

Oviposition of a field bug on alfalfa is noted on lateral stems and in places closer to the growing point.

Eggs on cotton were laid in a softer and more succulent stem, where they plunge into it; this makes them difficult to see. In this case, they can only be viewed under a magnifying glass or binoculars. The place of deposition is elliptical, 0.3 – 0.4 mm long, 0.1 – 0.2 mm wide. It looks like the stomata of a leaf, framed by a thin white border, and the middle is similar to the color of the stem.

It should be noted that the females of the overwintered generation of field bugs placed their eggs mainly in the vegetative parts of weeds (stipules, petioles, leaves, stem nodes and, less often, in the branches and pre–apical parts of the stems). In the stems and leaf stalks of plants, eggs were usually placed one at a time, without preserving any order, less often random clusters of eggs were observed in groups, when there were many bugs and different females laid eggs in one stem.

Single individuals of the 2nd generation field bugs appeared on May 15, and their large concentration was noted in the 3rd decade of May (05.24.2017) on the rape. In cotton, they were also registered in the 3rd decade (26.05.2019). A mass clutch of eggs on seed alfalfa of 3 – 4 years of standing was noted in the sixth five–day period of May. It should be noted

that on alfalfa of the 1st year of standing, in comparison with subsequent years, bug oviposition was not observed. It was seen mainly on weeds: swan and others growing in alfalfa fields. This can be explained, apparently, by the fact that the stalk of 1–year alfalfa is still very thin and is not suitable for oviposition [15].
Field bug eggs were also seen on melilot, mustard, sugar beet, sesame, kenaf and jute, and among wild plants, on various types of wormwood *(Artemisia sieversiana, A. annua, A. vulgarus)*, common yarrow *(Achillea millefolium)*, wild plant *(Senecio subdentatus)*, white marie *(Chenopodium album)*, etc.
Sometimes, different females laid eggs in one stem, in this case, they were observed randomly accumulating in groups. Above the punctures, a frozen liquid was noticed, which the female released from the gonads. The eggs were immersed in the substrate or laid perpendicularly under the peel of the stem and deciduous scales. On cotton plants, eggs were laid in the leaf stalks and in the stem, closer to the growing point (Fig. 2)

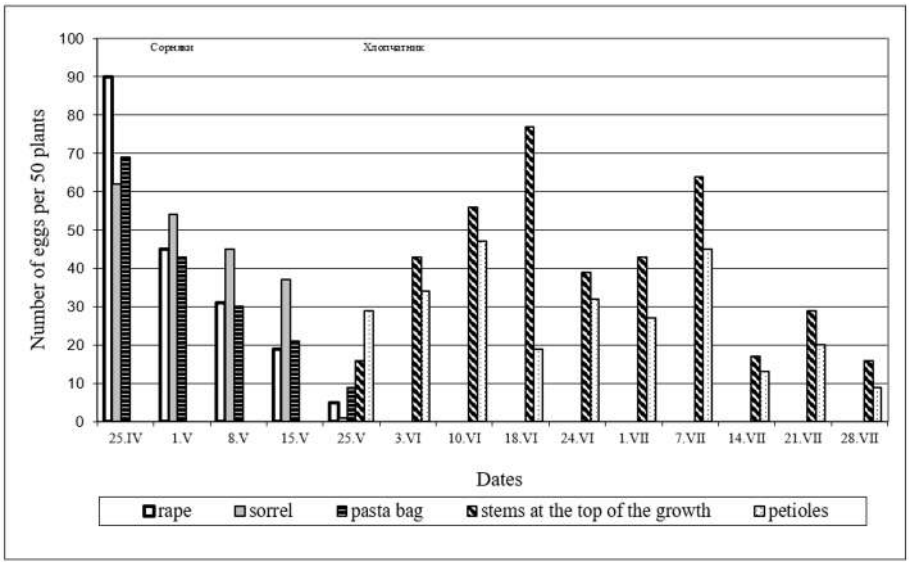

Fig. 2. The degree of occurrence of field bug eggs in weed stems of plants and cotton (on 50 stems)

Field bugs prefer to lay their eggs in plants that retain the softness and juiciness of tissues, which is of great importance for the amicable release of larvae. It should be emphasized that the eggs of field bugs continue to develop in dried plant stems. According to our assumptions, the stem tissue, when dried, should have crushed the eggs, or deprived the larvae of the opportunity to get out of the shell. When inspecting the cotton plant, we noticed that its stems were expanded in those places where field bug eggs were located. In the opened stems, around the eggs, a dense mass was found created by the plant as a result of its irritation to the substances secreted by the female during the laying of eggs. Undoubtedly, this mass protected the egg from mechanical compression when the stem dries up and, as a consequence, ensured the successful emergence of the larvae from the dried stems.
The natural dying off of the wintering generation of field bugs began at the end of the first decade of May, and first of all, it affected males, and the mass character was noted in mid–May, although some females of this generation were found later (in the middle of the third decade.)
We noted a mass hatching of the 2nd generation bug larvae on alfalfa in the 2nd decade of June (June 17, 2021), which is about 5 – 7 days ahead of its occurrence on cotton. Single hatching of field bug larvae on cotton of the 3rd generation took place in the middle of the 2nd decade of July (July 13, 2020), and massive hatching – on July 18.
To clarify the timing of the development of individual ages of the 2nd generation larvae (first on cotton) in the second decade of June 2021. observed in vivo at average daily temperatures of 23–27°C. They ranged from the first and second ages –3–5, the third –4–6, the fourth –5–6, and the fifth –6–7 days. Development of all larval stages lasted for 21–29 days. The development of the third and fourth generations lasted for approximately three weeks on average.
Larvae of the first and second instars feed on the succulent parts and generative organs (buds, flowers, ovaries) of cotton, and older instars and adult bugs, in addition, were found on capsules. At night, they were in the lower and middle tiers of cotton.
The movement of larvae to the upper layer was noted shortly after sunrise. From 10–12 o'clock they began to descend into the middle layer of cotton and here, under the leaves, they sheltered from the sun's rays. The evening rise began at 4 pm and the larvae remained in the upper tier until dusk, and again descended after complete darkening. In cloudy weather, the larvae fed in the middle of the day. The effectiveness of measures against pests of bedbugs on cotton, to a

large extent, depends on the knowledge of their number and phenology. For this purpose, in 2020 – 2021, we performed counts of the number of field bugs on the above-mentioned crops.
The observations were conducted in the spring and summer seasons on cotton crops and on weeds. The counts were performed on wild plants and plants surrounded by cotton crops. The seasonal dynamics was studied and the terms of the maximum number of field bugs on cotton were revealed.
According to our observations, in 2020, the first adult specimens of field bugs were found on alfalfa on April 24, on cotton (without replanting) in brigade No. 5 of the "Haqiqat" farm – on June 17 – 8 specimens. per 100 plants, grade C 6524 in brigade No. 3 of the farm named after A. Ikromov – June 22 (sowing in the 1st decade of April) on cotton (reseeding on May 10), in brigade No. 4 of the Istiqbol farm – June 30, 1997, 20 specimens each per 100 plants.
Due to weather conditions, the period for the transition of field bugs to cotton crops, respectively, was postponed. In 2021 (brigades No. 6 and No. 7 of the “Istiqbol” farm) bugs were found on cotton on 26 May. The larvae of *Lygus pratensis, L. gemellatus and L. rugulipennis* could not be distinguished from each other. Therefore, in the dynamics of the number of bugs and their larvae, the figures are general.
To establish the dynamics of the number of field bugs, 4 stationary plots (No. 6 – 9) of cotton were studied (Fig. 3).

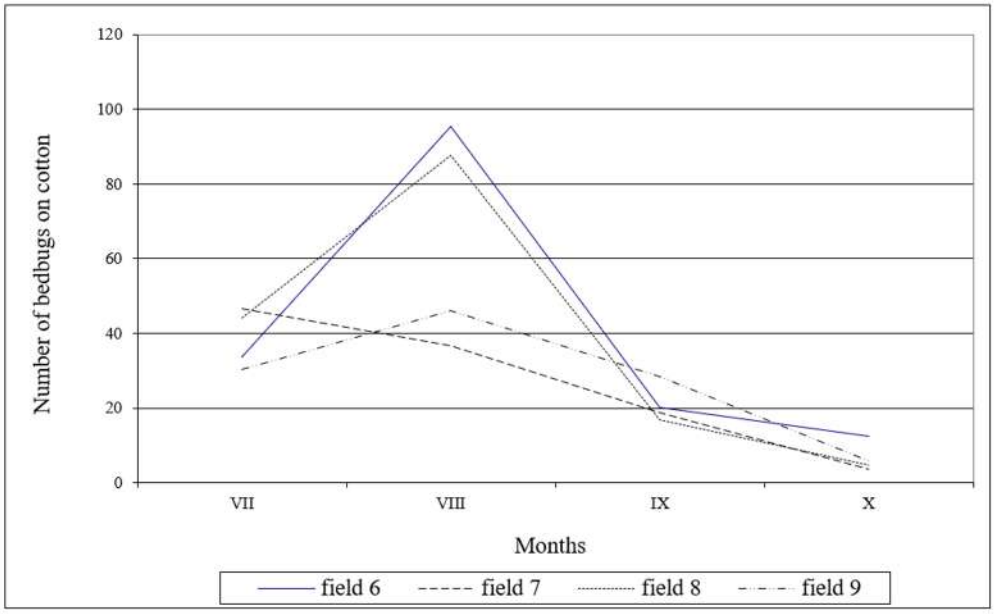

Fig. 3. Dynamics of the number of field bugs in stationary cotton plots of the farm "Haqiqat" of the Urta–Chirchik district of Tashkent region

Cotton field no. 6 is located next to the alfalfa seed; Cotton field no. 7 - next to the forage alfalfa planting 3 years old; cotton field no. 8 – at a distance of about 1.5 km from alfalfa; cotton field no. 9 is located next to the crops of melons and fodder beets.
As can be seen from the census data, the period of the maximum increase in the number of adult bugs and their larvae coincides with the period of mass flowering and the formation of bolls. Observations showed that the location of cotton fields on the border with alfalfa or at a distance from them did not have a significant effect on the number of field bugs.
The analysis of observations on the stationary plots of the "Khakikat" farm in the Urta–Chirchik region confirms that field bugs can be attributed to serious pests of alfalfa. This is consistent with the data obtained by other researchers [16].
With regard to alfalfa, the leading factor determining the level of the number of field bugs can be the sown area and the age of crops since with an increase in the number of years of cultivation of this crop, a gradual accumulation of pests occurs. A particularly large number of adult insects was observed during net mowing on seed alfalfa (in June – August 2017 with 50 mowing pairs of 250 – 262 individuals), and larvae in late June – early August (250 – 270). In mid – July 2016, on seed alfalfa, the number of field bugs reached 1000 individuals with 50 pairs of butterfly net mowing.
We tried to find out the development cycle of the field bug on cotton. On cotton bushes, females laid eggs in the tissue of young stems and leaf stalks. Although the bugs make several injections, the number of eggs, with rare exceptions, ranges from 1 to 3 eggs. The timing of the development of the stages of the field bug was determined (Table 2) depending on the average ten–day air temperature and humidity.

Table 2. The timing of the development of individual stages of the field bug on cotton (2020)

Stage development	Observation time	Duration of development(day)	Air temperature,°C	Relative humidity, %
Egg	from 12.07. to 19.07	8	26.9	38.7
Larva	from 19.07 to 9.08	22	28.3	42.4
From egg to imago	from 12.07 to 10.08	30	26.9 – 28.3	38.7 – 42.4

The larvae hatching from eggs usually lead an active lifestyle. A large accumulation of field bugs on cotton was noted in mid–August in some fields, their number reached 320 – 380 individuals per 100 plants. Since the end of August, cotton plants become coarse and unsuitable for feeding insects, although usually by autumn the population of field bugs increases everywhere. During this period, bugs mainly concentrate on alfalfa and wild plants (wormwood, water pepper, etc.).

As we have observed, the beginning of the flight to the wintering grounds, in the conditions of the Tashkent oasis was from the end of the first decade of October and the flight lasted until the third decade of November. During this period, bugs flew from open biotopes to deposits with high vegetation (thickets of shrubs, gardens, shelterbelts and other sheltered places), where they continued to feed on the contents of seeds of various plants. Most often, bugs were located in large groups under shrubs, between dry leaves, in the upper layer of the litter, less often in the middle and even less often in the lower layers.

Counts conducted from November to February 2020 – 2021 showed that the density of wintering bugs was – 0.9 – 20 individuals per 1m^2 of area. A particularly high density was noted under dense vegetation (water pepper, adjerik, etc.).

Females of field bugs lay down for the winter with undeveloped ovaries, which looked like almost completely transparent, glassy tubules, whereas in males in autumn, the gonads were bright green, not differing in appearance from mature ones.

The field bug numbness in winter came gradually. At first, even with a cold snap in the middle of the day to + 2°C, they did not become numb and, disturbed, slowly crawled, and at + 5°C they tried to fly. Subsequently, when warm weather returned, even after severe frosts reaching –10 –12°C, the numb bugs revived again, sometimes slowly crawling.

The period of winter dormancy is a weak point in the life cycle of field bugs. Usually, the number of their populations greatly decreases by the spring. For example, in the wet winters of 2020 – 2021 in the Tashkent region, the death of field bugs in wintering places reached 69 – 74%.

Largely, the survival of field bugs, like other insects hibernating in the adult phase, depends on the conditions of autumn fat feeding. Field bugs that managed to accumulate a sufficient supply of fatty body before the onset of frost, other things being equal, endure wintering more easily. Whereas those lagging behind in development, poorly fed species die. Therefore, the warm and long autumn of the Tashkent oasis contributes to the successful wintering of bugs and an increase in the threat from them in the next year's spring.

Unlike species wintering in the egg phase, the harmful activity of field bugs begins already in early spring and can, as mentioned above, manifest itself on the seedlings of crops sown even in very well cultivated fields and vegetable gardens, completely free from plant residues. Very destructive for a number of crops especially the ones cultivated for fiber, field bugs cause damage to the vegetative parts of plants not only in the germination phase, but also in subsequent phases of the growing season, when, for example, in kenaf, they lead to a sharp decrease in fiber yield in qualitative and quantitative terms.

4. Conclusion

Bolls damaged by bugs can be divided into two rather pronounced types. An outward sign of damage of the first type is the formation on the fiber of an open or incompletely opened capsule of brown lumps, representing a glued mass. There are up to three to four such brown lumps on one lobule, but most often one or two. Healthy and slightly damaged lobules bloom normally, and more severely damaged lobules, finally, with severe damage, the lobules remain poorly developed, and their fibers turn yellow or brown. Sometimes the entire lobule is a brown lump.

In the second type of damage, young and sometimes large ripening capsules crack along one of the outer seams. Moreover, the crack, in most cases, does not extend over the entire seam, but captures only a part of it.

References

1. Pérez-Hedo M, Bouagga S, Zhang NX et al., Induction of plant defenses: the added value of zoophytophagous predators, *J Pest Sci* **95**, 1501–1517 (2022)
2. Sequeira RV, Integrated pest management of plant sucking bugs (Hemiptera: Miridae) in Australian cotton: back to the future, *Bulletin of Entomological Research* **109**(5),1-13 (2018)

3. Piemontese L, Giovannini I, Guidetti R, Pellegri G, Dioli P, Maistrello L, Rebecchi L, Cesari M, The species identification problem in mirids (Hemiptera: Heteroptera) highlighted by DNA barcoding and species delimitation studies, *The European Zoological Journal* **87**(1), 310-324 (2020)
4. Pérez-Hedo M, Riahi C, Urbaneja A, Use of zoophytophagous mirid bugs in horticultural crops: Current challenges and future perspectives, *Pest Manag Sci*. **77**(1), 33-42 (2021)
5. Cooper WR, Spurgeon DW, Oviposition behaviors and ontogenetic embryonic characteristics of the western tarnished plant bug, Lygus hesperus, *Journal of Insect Science* **12**, 36 (2012)
6. Dumont F, Lucas E, Alomar O, Oviposition behavior of the mirid Macrolophus pygmaeus under risk of intraguild predation and cannibalism, *Insect Science* **28**(1), 1-7 (2020)
7. Vanyants GM, Muminov NN, Madaminov VS, Hemiptera in cotton – alfalfa agrocenosis, *Plant Protection* **10**, 37–39, (1990)
8. Koravyansky NM, Protection of alfalfa from pests and diseases, Rosagropromizdat, Moscow (1990)
9. Alimukhammedov SN, Adashkevich B, Aylov Z, Khodzhaev Sh, Biological method of combating the main pests of cotton, Mekhnat, Tashkent (1986)
10. Khamraev Ash, Seasonal distribution of field bugs in agrobiocenoses, *Plant Protection and Quarantine* **9**, 31 (1999)
11. Perdikis D, Favas C, Lykouressis D, Fantinou A, Ecological relationships between non–cultivated plants and insect predators in groecosystems: the case of *Dittrichia viscosa* (Asteraceae) and *Macrolophus melanotoma* (Hemiptera: Miridae), *Acta Oecologica* **31**, 299 – 306 (2007)
12. Musaev DM, Khojaev ShT, Sattarov NR, Musaeva MK, Distribution, ecology and damage to cotton crop of (Creontiades pallidus) in Surkhandarya region, *Agrochemical Protection and Plant Quarantine* **5**, 5–8 (2019)
13. Khodzhaev ShT, Integrated plant protection systems successes and tasks, *Uzbek Biological Journal* **5**, 36–38 (2012)
14. Musaev DM, Kholmatov BR, Sattarov NR, Amirov IB, Musaeva MK, Mamatmurotov Ash, Cotton shredder bug Creontiades pallidus (Rambur, 1839) damage to cotton crop in Surkhandarya region of South Uzbekistan, *EurAsian Journal of BioSciences* **14**, 4683–4687 (2020)
15. Gafurova L, Ergasheva O, Bioindication in ecological assessment of eroded soils in mountain areas, *Journal of Critical Reviews* 7(2), 288-291 (2020)
16. Khamraev ASh, Kuchkarov A, Trophic relationships of the field bug *Lygys patensis* L. Zhur, *Plant Protection and Quarantine* **11**, 35–36 (2000)