Outbreak of Mirid Bugs (Heteroptera: Miridae) on Hop*

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Abstract

ŠEDIVÝ J., ŘEHÁK V. (2000): **Outbreak of Mirid Bugs** (Heteroptera: Miridae) **on hops.** Plant Protect. Sci., **36**: 150–155.

Outbreaks of mirid-bugs on hop in Czech hop region recurred in 1875, 1928/29, 1947/48 and 1998/99. The spectrum and importance of specific harmful mirid species varied with the type of hop-garden. *Calocoris fulvomaculatus* was a dominant species in pole hop-gardens. *Lygus rugulipennis* was a dominant pest in trellises in 1998/99, when it locally damaged more than 50% of bines. Mirid-bugs migrate to hops at temperatures over 10°C, and stay there over the growing season. Bine tops are damaged by sucking, drying back later. Bines that grow from under the sites of injury are distorted and cease twining. This damage is caused before and after the training, up to 2.5 m of the bines height. An economic threshold is at 10% of damaged bine tops and more in the period after training. Years with warm, dry autumn, mild winter and warm, dry spring provide favourable conditions for outbreaks of the mirid-bugs and their spring activities.

Key words: hop; mirid-bugs; monitoring; damage; economic threshold; weather factors

Outbreaks of bugs from the family Miridae occur on hop at irregular cycles of many years. Events of harmful abundance of bugs has been known in the Czech hop region since 1875. *Calocoris fulvomaculatus* Deg. was a dominant pest at that time; it recurrently caused areal damage to pole hop-gardens, totally destroying hop plants and was a reason for the destruction of heavily infested hop-gardens. A similar area outbreak recurred in 1928–1929. The build-up of bug populations was encouraged by the earlier method of training hop bines on poles since the bugs over-wintered as eggs in the pole bark and emerged nymphs found food at the sites of their eclosion. Another outbreak in 1947–1948 was localised, occurring mainly in regions with floodplain forests. Commercially significant losses caused by bugs were observed in June and July: shot-holing necroses on leaf blades, wilting and drying of bine tops, dieback of flowers and burrs. Some of the heavily damaged hop-gardens had to be destroyed again. Estimated losses of hop yields caused by mirid-bugs amounted to 8–10 million Kč (Czech crown) for the years concerned. The following harmful polyphagous species were present: *Lygus kalmi* L., *Lygus rugulipennis* Popp., *Pseudoloxops coccineus* M.D., *Liocoris tripustulatus* F., *Calocoris fulvomaculatus* Deg. and *C. norvegicus* Gmel. (BLATTNÝ *et al.* 1950). The last outbreak of bugs on hop occurred in 1998. It was detected in May, when losses had already been incurred, resulting in stunted growth of hop plants. More than 50% of trained hop bines were damaged locally in 1998, cone weight on damaged bines decreased by 50% (ŠEDIVÝ & FRIC 1999). Higher abun-dance of bugs causing damage to hop plants persisted in 1999 as well.

Nevertheless, mirid-bug outbreaks on hop crops tend to be unexpected because the population densities of bugs and spectrum of harmful species are not monitored during the intervals between the years of harmful abundance. This was one of the reasons why the goals of this study involved methods of determining the abundance of mirid-bugs and their species spectrum, describing species-specific symptoms of injury, and identification of localities with recurring harmful abundance on hop. Evaluation of the weather factors that support harmful abundance of mirid bugs was also a part of this project.

MATERIALS AND METHODS

Experiments of 1998. Mirid-bugs abundance was monitored in 35 hop-gardens in the Czech hop region from June to late August in 1998. The mirid-bugs species were collected by sweeping: 3×25 sweeps were carried out on

*This study was carried out under Project E-99-2021-0001 funded by the Ministry of Agriculture of the Czech Republic in 1999.

hop plants and weeds in hop-gardens and their nearest vicinity. Additionally, mirid-bugs were obtained by shaking 3×20 plants onto a shaker 1 m^2 in size.

The number of damaged bines was determined on 3×10 plots 8×8 m in size that were demarcated by four posts. Twenty-one plants were set out in each plot and a total of 630 plants was evaluated in each hop-garden. The number of trained bines in field conditions of hop-gardens was variable. Variability of the number of trained bines was evaluated in 10 hop-gardens, on four plots demarcated by four posts in each case. Two bines were trained to one stringing in 53%, 3 bines in 27% and one bine in 20%. In 1998, differences in the length of laterals were assessed on 40 plants damaged by sucking and on 40 plants free of damage by sucking, to the height of 2.5 m. The method and height of measuring the lengths of laterals were identical in both groups of plants.

Experiments of 1999. In 1999, mirid-bugs abundance was detected in 42 hop-gardens. Variability of the number of trained bines was the same as in 1998. Bugs species were detected in 3×50 sweeps on hop plants and weeds in hop-gardens and on their fringes.

Monitoring of the number of damaged bines before training was carried out in three hop-gardens, on 100 plants in each. The number of tops with bracteole clusters and distorted leaves was assessed on each plant. After the bines were trained to the height of 2.5 m, damage was assessed from the number of plants with distorted or wilting and drying bine tops. As the growing season proceeded, bine damage was determined on the basis of bine top dieback, distorted bines under sites of injury and growth of long pendent laterals with single cones. Assessments were made on 4×10 plots demarcated by four posts, with a total of 840 plants being evaluated in each hop-garden.

Weather Data. The effect of weather factors on mirid bug outbreak was evaluated on the basis of data from meteorological stations of the Czech Hydrometeorological Institute at Prague-Klementinum, Kadaň and Žatec. Weather conditions were evaluated from Walter's climatograms for the years of outbreaks: 1875, 1927/28, 1947/48 and 1998/99, in order to determine favourable conditions for hibernation of *L. rugulipennis* and its injuriousness in spring months of the next year. Walter's climatogram as a hydrothermic diagram helps define the periods of arid drought favourable for the bugs development. Since the major part of the Czech hop region lies in a sugar beet area, average monthly temperatures, precipitation amounts and sunshine hours recorded at meteorological stations in a sugar beet region in the autumn, winter and spring seasons of 1997/98 were also used to characterise a mild winter.

RESULTS

Mirid Communities of Hop-Gardens. Local harmful abundance of mirid-bugs was concentrated in regions with a higher percentage of coniferous or mixed forests and dense shrubbery in the vicinity of hop-gardens. In general, weed infested hop-gardens and their environs were suitable sites for the bugs presence and hibernation.

Lygus rugulipennis was a dominant bug species in both years of observation. Infestation rates in 1998 ranged from 0.3% of damaged bines (Stekník) to 52.3% (Třeboc) (Fig. 1). Total number of damaged bines was 2651: the group of plants with 1 damaged bine was largest (2213), while the group with two damaged bines had 401 plants and with 3 damaged bines 37 plants. Hop damage decreased in 1999. The highest degree of damage (23.7%) was recorded in a hop-garden in Ročov cadastre (Fig. 2). The number of damaged bines per hop plant decreased. Total number of damaged bines was 2686: 2092 plants had one damaged bine per plant and 594 plants had two

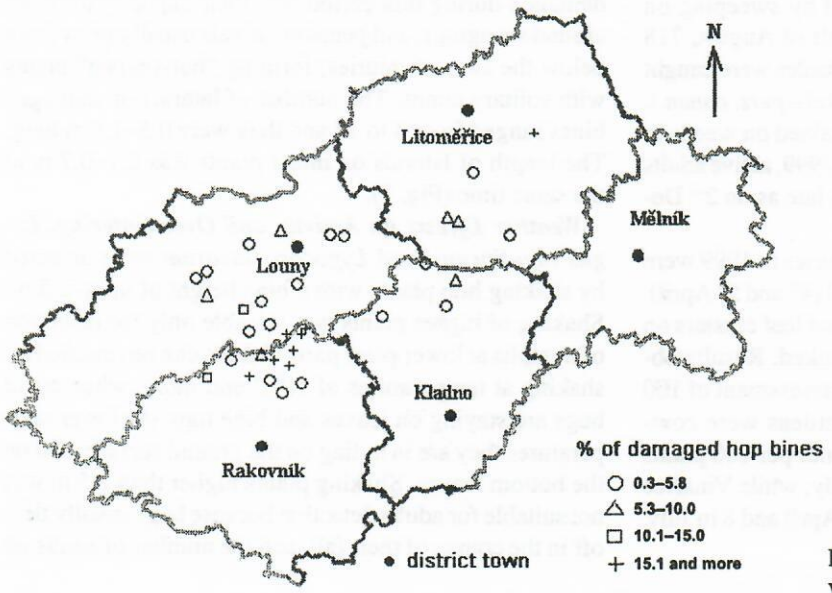

Fig. 1. Monitoring of hop-gardens infested with mirid-bugs in 1998

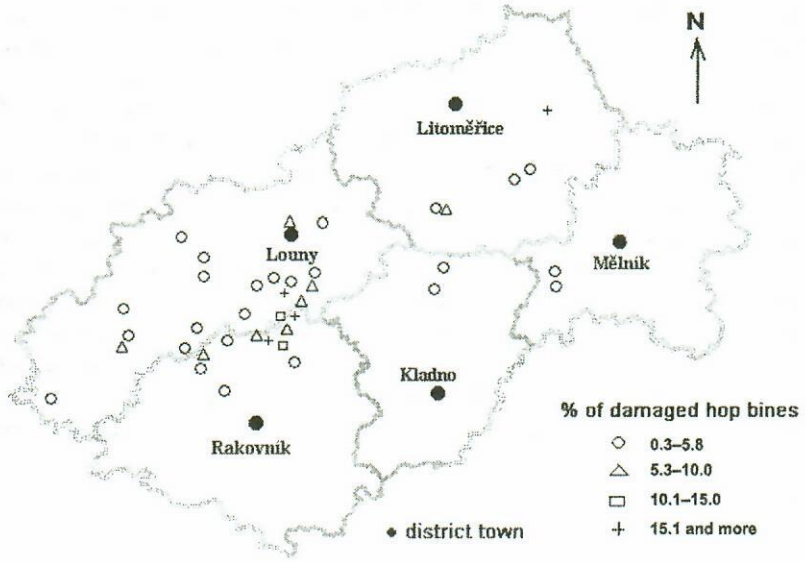

Fig. 2. Monitoring of hop-gardens infested with mirid-bugs in 1999

damaged bines per plant. No plants with three damaged bines were observed. The number of hop-gardens infested with mirid-bugs differed, depending on the year of observation. Damaged plants were discovered in 34 out of 35 hop-gardens examined in 1998. Three out of 42 hop-gardens were free of any damaged plants in 1999. Injuries were greatest in hop-gardens with areal infestation of plants. Infestation on the fringes of the crop, or clumps of infestation, were observed in hop-gardens with medium- and low-degree of damage. The outbreaks recurred in identical areas in both years.

Populations Dynamics of L. rugulipennis. In 1999, *L. rugulipennis* density was highly variable. A maximum of 11 imagos was caught by sweeping in April and May. In June, at the 1st generation maturation, 20 nymphs in the 4th instar and 24 adults were intercepted by sweeping. Sweeping in the 2nd generation (27th July) yielded 16 nymphs in the 2nd or 3rd instars and 45 adults. 52 nymphs of 3rd and 4th instar and 334 adults were obtained by sweeping on weeds in late August. In the second half of August, 718 adults with sex index 1.2 in favour of females were caught on a stationary picking machine (J. Vostřel – *pers. comm.*). After hop picking, *L. rugulipennis* remained on weeds in hop-gardens as well as in the vicinity. In 1999, active adults were found on *Atriplex nitens* plants as late as on 2nd December, at temperature of 4°C

Plant Damage. Symptoms of hop injuries in 1999 were detected on untrained bines in early April (4th and 5th April). Injuries occurred inside the bracteole and leaf clusters on bine tops, or sometimes bines were hooked. Results obtained before hop training and by final assessment of 100 plants in July in three selected hop-gardens were compared. At Dobroměřice locality, five bines per 100 plants were infested in April and 7 bines in July; while Vinařice locality recorded 13 damaged bines in April and 8 in July, and Ročov locality found 25 damaged bines per 100 plants in April and 24 of trained bines in July.

After the training of hop bines in 1999, plant injuries were concentrated on bine tops and parts of bines under the very top. The abundance of *L. rugulipennis* in hop bine tops was highest in mid-April. This mirid species caused wilting of the tops and their mortality. Plants were damaged to the bine height of 2.5 m (Table 1). Plants damaged during this period lost their capacity to twine around stringings, and pendent laterals usually grew from below the sites of injuries, forming "hut-shaped" plants with solitary cones. The number of laterals on damaged bines ranged from 4 to 12 and they were 0.5–1.6 m long. The length of laterals on intact plants was 0.1–0.7 m at the same time (Fig. 3).

Table 1. Height of damaged hop bines in July 1998 (n = 200)

Bine height	Number of bines
To 1 m	80
To 1.5 m	30
To 2 m	75
To 2.5 m	15

Weather Effects on Activity and Overwintering. *Lygus rugulipennis* and *Lygocoris lucorum* were detected by shaking hop plants with a bine height of up to 2.5 m. Shaking of higher plants was suitable only for detection of nymphs at lower plant parts. Adults can be revealed by shaking at temperatures of 10°C and more, when mirid bugs are staying on leaves and bine tops. At lower temperatures they are in hiding on the ground surface, and on the bottom leaves. Shaking plants higher than 2.5 m was not suitable for adults detection because bugs usually flew off in the course of their fall, and the number of adults on

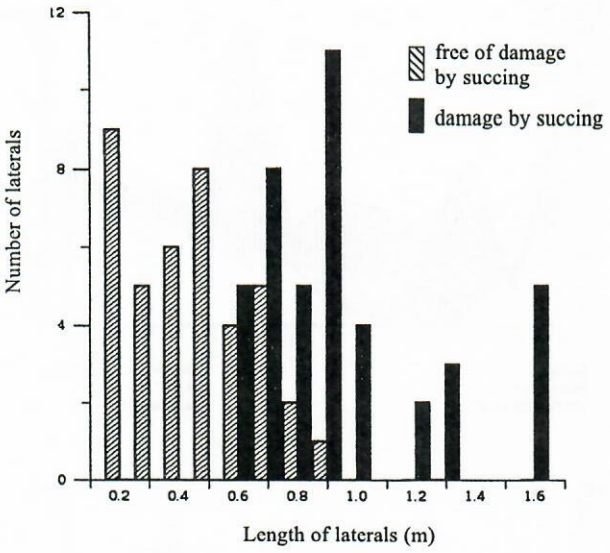

Fig. 3. The length of laterals on measured hop plants

a shaker rapidly decreased at temperatures above 15°C. Seven bug species were caught by sweeping at the bases of hop and weed plants in 1998. They included six species that cause damage to cultivated crops, including hop. *L. rugulipennis* (42.35%) and *Lygocoris lucorum* (39.8%) were dominant species on hop plants from June to August. Accessory species involved *Liocoris tripustulatus, Lygus kalmi, Pseudoloxops coccineus, Calocoris fulvomaculatus* and *Calocoris norvegicus* (17.85%) (ŠEDIVÝ & FRIC 1999). In 1999 hop plants and weeds *Chenopodium album* L., *Atriplex nitens* Schkuhr., *Urtica dioica* L. and *Artemisia vulgaris* L. harbored solely *Lygus rugulipennis* and *Lygocoris lucorum.* As indicated by catches of *L. rugulipennis* from sweepings in 1999, its population density increases as the growing season proceeds in relation to harvest dates of surrounding field crops.

Average daily air temperatures higher than the long-term normal values characterised weather conditions in 1997/98 from December 1997 to May 1998. Precipitations from January to May 1998 was lower than normal, and there were evidently more sunshine hours in the same period than is the long-term normal. The gaps between the meteorological factors in our study and their long-term normal values describe favourable conditions for the hibernation and spring activity of mirid-bugs (Table 2). Walter's climatograms for the years of outbreaks: 1928/29, 1947/48 and 1998/99, drawn up for the same periods on the basis of data from Žatec and Kadaň stations, illustrate favourable conditions of extreme drought from September to October and from April to May. A favourable period of arid spring in April is also documented by a climatogram from Prague meteorological station (Klementinum) referring to the first record of a mirid-bug outbreak on hop in 1875 (Fig. 4). Extreme drought in March and April, when hop bines are fixed to stringings, is obviously one of the main factors, which increase the bugs' injuriousness to hop.

DISCUSSION AND SUMMARY

Important Species. Mirid-bugs have been hop pests in Czech Republic since the times when hops were grown in pole hop-gardens. *Calocoris fulvomaculatus* was a dominant pest in the past, and its eggs overwintered in pole bark. Nymphs infested hop plants at earlier stages, and by imagos in June and July. Symptoms of injuries were shot-holing of leaf blades, unnatural leaf clustering, distorted bine tops, drying of laterals, dieback and necroses of bine tops and infertility of plants. In the trellises, mirid-bug outbreaks were localised and changes in the spectrum of injurious bug species occurred. Injuries to inflorescence and flower bases and burrs became the new symptoms of hop damage. BLATTNÝ *et al.* (1950) identified 11 herbivorous bug species as potential hop pests. However, their harmfulness was not defined. Consequently, the data on the damage caused by some species to hop are not correct because they include predacious species of the genera *Orius, Nabis* and *Anthocoris*. After our observations early spring damages are caused solely by species overwintering as adults. Among the species mentioned

Table. 2. Weather conditions from November to May in 1997/1998 in a sugar beet region of the Czech Republic in comparison with normal average values

Month	Average air temperature [°C]		Precipitation amount [mm]		Sunshine amount [hrs]	
	actual	normal	actual	normal	actual	normal
November	3.5	3.5	44.6	38.9	**48.5**	45.3
December	**1.5**	–0.1	36.3	32.4	25.8	34.8
January	**1.0**	–2.1	**14.9**	28.6	**59.5**	41.0
February	**3.3**	–0.3	**6.3**	26.6	**99.5**	64.5
March	3.7	3.7	**26.5**	29.9	**142.9**	113.4
April	**10.6**	8.5	**28.3**	39.8	**167.0**	160.0
May	**14.6**	13.6	**30.7**	67.7	**249.1**	206.1

actual – monthly temperature average; normal – long-term average as normal values

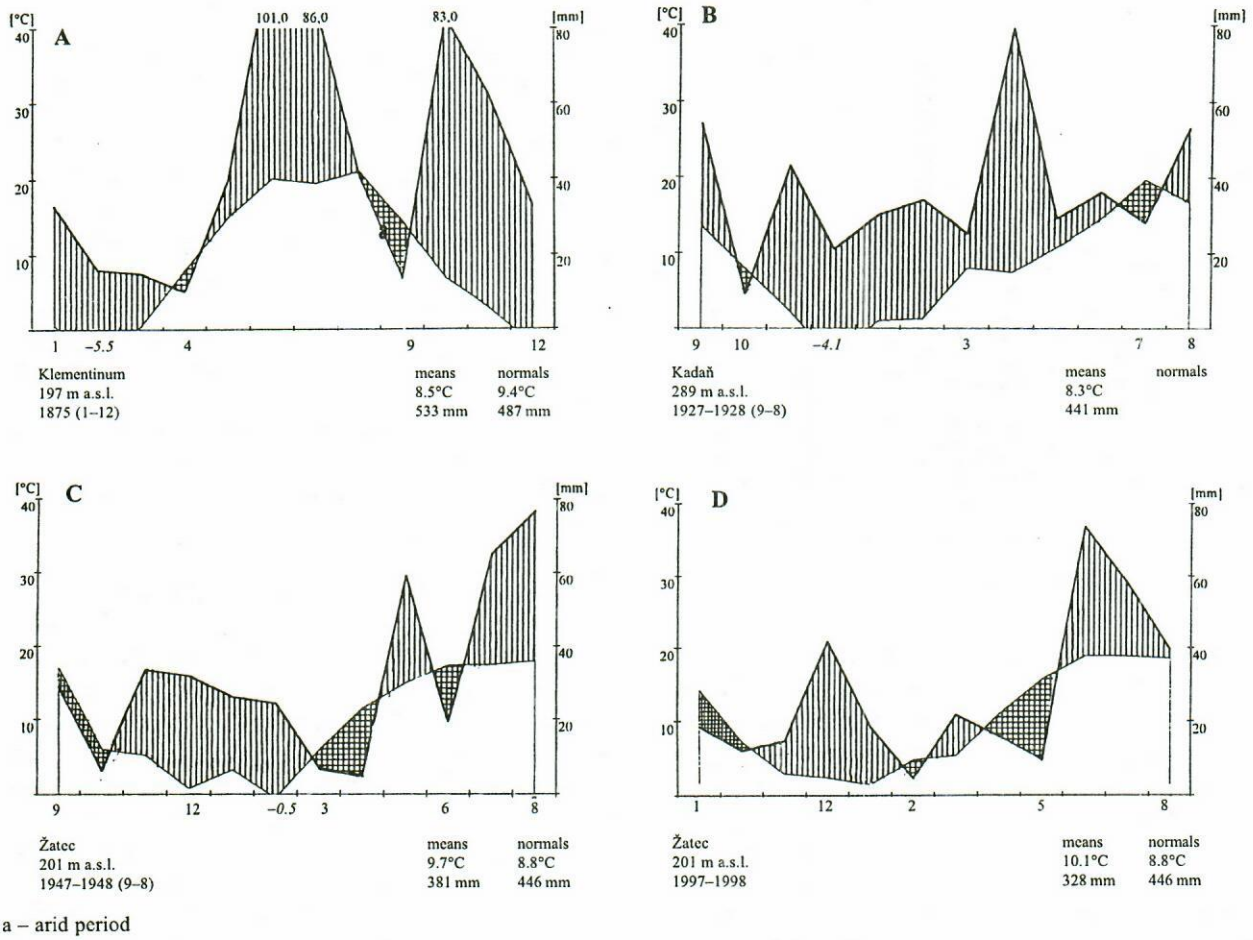

Fig. 4. Walter's climatograms for the years of mirid-bugs outbreaks in the Czech Republic: A – Prague-Klementinum, B – Kadaň, C – Žatec, D – Žatec

by BLATTNÝ *et al.* (l.c.) these are *Lygus rugulipennis, Lygus kalmi, Liocoris tripustulatus* and *Pseudoloxops coccineus*.

Outbreaks on hop in 1998–1999 were dominated by *L. rugulipennis* and *Lygocoris lucorum*. The species *Liocoris tripustulatus*, *Lygus kalmi*, *Calocoris norvegicus* and *C. fulvomaculatus* were accessory species which survived exclusively on weeds in hop-gardens.

***Damage by** L. rugulipennis.* The only harmful species was *L. rugulipennis*. It occurs on hop during the growing season. A part of the population was found to overwinter on weeds in hop gardens and their vicinity. They migrate to hop at temperatures of 10°C and more. Adults attack leaves and bine tops by sucking. Damaged bine tops are distorted, with clusters of bracteoles and leaves. Bug sucking is concentrated mainly to bine tops after training. Tops damaged by sucking wilt and die back. Damaged plants lose their apical dominance. Distorted laterals grow from leaf axillae under the sites of injury, losing their twining quality. Later on, a higher number of long, lateral bines with solitary cones grows from under sites of injury. Symptoms of such damage are found up to the 2.5m height of bines. If the infestation rate of plants is higher than 10% before training, an identical or higher infestation rate is to be expected after training. No drying or rusting of hop flowers and cones caused by bug sucking was observed in the two years of observation. *L. rugulipennis* abundance on hop showed seasonal variations. The density after hop training was very different and the number of females was higher than that of males. As indicated by the presence of nymphs and adults on a shaker and in sweeps, *L. rugulipennis* has two generations on hop. Its population density largely increases after field crops harvest when *L. rugulipennis* adults disperse to crops including hop that has not been harvested yet (BONESS 1963; ŠEDIVÝ & KODYS 1973). Flights of *L. rugulipennis* by night were also intensive in the same period as demonstrated by its high abundance in a light trap (ŠEDIVÝ & HONĚK 1983). The abundance of *L. rugulipennis* also increases in plant residues on ventilator frames of pesticide applicators. A proportion of migrating bugs contributes to a higher population density of the second generation. This is evidenced by nymphs still present in mid-September. Active adults were detected on weed plants in hop-gardens and their

nearest environs in December, at the temperature of 4 °C. Suitable conditions for *L. rugulipennis* hibernation exist due to infestation of hop-gardens and their environs with weeds from the genera of *Chenopodium* and *Atriplex*. In accordance with assesment of weather conditions in the years of mirid-bugs outbreaks on hop, warm autumn, mild winter are favourable for the hibernation of adults. The warm, arid period in March and April benifits the spring activities of bugs and the injuriousness of adults.

Recomendations. To make decisions on reasonable control measures, the date of *L. rugulipennis* appearance on hop should be determined after hop training. Damage to 10% of bines and more is an economic threshold for control. If the measures are taken later, economic losses cannot be avoided.

References

BLATTNÝ C., HOBERLAND L., OSVALD V. (1950): Ploštice žijící na chmelu a boj proti nim. Brázda, Praha.

BONESS H. (1963): Bilogisch-ökologische Untersuchungen an *Exolygus* Wagner (Heteroptera, Miridae). Ein Beitrag zur Agrarökologie. Z. wissenschaftl. Zool., **168**: 376–420.

ŠEDIVÝ J., KODYS F. (1973): Přezimování *Lygus rugulipennis* Popp. a její sezonní výskyt na polních plodinách. Ochr. Rostl., **9**: 61–66.

ŠEDIVÝ J., HONĚK A. (1983): Flight of *Lygus rugulipennis* (Heteroptera, Miridae) to a light trap. Z. Pfl.-Schutz Pfl.-Krankh., **90**: 238–243.

ŠEDIVÝ J., FRIC V. (1999): Harmfulness of mirid bugs (Heteroptera Miridae) on hop Rostl. Výr., **45**: 255–257.

Received for publication October 2, 2000
Accepted for publication November 24, 2000

Souhrn

ŠEDIVÝ J., ŘEHÁK V. (2000): **Přemnožení klopušek** (Heteroptera: Miridae) **na chmelu**. Plant Protect. Sci., **36**: 128–133.

Klopušky na chmelu se přemnožily v české chmelařské oblasti opakovaně v letech 1875, 1928/29, 1947/48 a 1998/99. Zastoupení a ekonomický význam jednotlivých škodlivých druhů se měnil v závislosti na způsobu pěstování chmele. V tyčkových chmelnicích byla dominantním druhem klopuška chmelová *Calocoris fulvomaculatus*. V roce 1998/1999 byla dominantním škodlivým druhem klopuškla chlupatá *Lygus rugulipennis*, která lokálně poškodila více než 50 % rév. Na chmel klopuška přeletuje při teplotách nad 10 °C a zdržuje se na něm po celou vegetační sezonu. Sáním poškozuje vegetační vrcholy, které po poškození odumírají. Réva vyrůstající pod místem poškození se kroutí a ztrácí schopnost dalšího vývinu. Poškozené révy později nasazují pouze ojedinělé hlávky. K tomuto poškození dochází v období před zavedením chmele i po něm až do výšky rév 2,5 m. Ekonomický práh pro ošetření je 10 % a více poškozených vegetačních vrcholů v období po zavedení. Roky s teplým, suchým podzimem, mírnou zimou a teplým suchým jarem jsou příznivé pro přemnožení klopušky na jaře a její škodlivost.

Klíčová slova: chmel; *Lygus rugulipennis*; monitoring; škody; ekonomický práh škod; faktory počasí

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