ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 62 22 Number 1, 2014
http://dx.doi.org/10.11118/actaun201462010201

THE INTENSITY OF INFESTATION OF GARLIC BY *LILIOCERIS MERDIGERA* AND *OPROHINUS SUTURALIS*

Eva Sapáková[1], Hana Šefrová[2], Luděk Hřivna[3], Lea Hasíková[1]

[1]Department of Languages, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[2]Department of Crop Science, Breeding and Plant Medicine, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[3]Department of Food Technology, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract

SAPÁKOVÁ EVA, ŠEFROVÁ HANA, HŘIVNA LUDĚK, HASÍKOVÁ LEA. 2014. The Intensity of Infestation of Garlic by *Lilioceris merdigera* and *Oprohinus suturalis*. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 62(1): 201–211.

Garlic pests have been observed on the following five study plots named Nedakonice (178 m), Olomouc (241 m), Dolní Němčí (256 m), Suchá Loz (306 m) and Vápenky (484 m) in 2010–2012. The occurrence of pests has been found out on winter varieties Dukat and Blanin using various monitoring methods during the vegetation. Most adults *Oprohinus suturalis* (Fabricius, 1775) have been monitored on a variety Blanin (43.1 imagines/m^2) in Dolní Němčí study plot. The adults were first detected in 2011 on 10.4. at 17.4 °C and on 19.5. at 20.7 °C in 2012. The first presence of *O. suturalis* adults did not correlate with altitude. The highest abundance of adults *Lilioceris merdigera* (Linnaeus, 1758) was at temperatures 18–24 °C in dry and sunny weather. The females begin to lay at temperatures above 20 °C, 6–12 days after the first occurrence.

Keywords: *Allium sativum*, Coleoptera, Chrysomelidae, *Lilioceris merdigera,* Curculionidae, *Oprohinus suturalis*, abundance, temperature, yellow bowl

INTRODUCTION

Neither *Lilioceris merdigera* (Linnaeus, 1758) nor *Oprohinus suturalis* (Fabricius, 1775) belong to the major garlic pests. Recently, both species have occured on garlic in higher quantities in Moravia. The adults of *L. merdigera* are bright red with a red head and legs around 8 mm long. The eggs vary in size from 1 to 1.5 mm, they are oval, deep orange getting dark later. The larva is oligopod and brown-yellow with brown head, covered with grey-green excrements, reaching the length of 10 mm (Miller, 1956; Strand *et al.*, 1996). The adults hibernate in leftover plant matter, beginning to be active in the early spring. The eggs are laid from late April to early May on the lower side of leaves from 2 to 11 eggs, each of females can put up to 250 ones. The stage of egg lasts from 6 to 7 days at 22 °C. The larvae pass through four instars. The age can be determined according to the width of the head capsule. When the development is completed, the larvae pupate in a white cocoon in the soil. The pupa stage lasts for about 9 days at 22 °C. New imagines hatch in late July remaining for about 20 days in the soil (Haye & Kenis, 2004). *L. merdigera* is widespread throughout all Europe, Asia, North America and north Africa (White, 1993). The spectrum of parasitoids was studied by Haye & Kenis (2004). The above mentioned ones develop on plants of the genus *Lillium, Allium, Polygonum* and *Convalaria* (Strand *et al.* 1996).

The larvae initially damage in upper mesh leaves, later nibble away irregular holes in the leaves. During feeding they proceed from the tip to the base of the leaves. Also leaf feeding can be caused by imagines (Brown, 1946; Federici *et al.*, 1996). In our area they are widely spread mainly as a pest of onions (1923, 1924 Mělník, 1930–1932 Bzenec, 1968 Jičín, 1970 Brno, 1971 Znojmo, 1973 Zlín, 1985 Brno, Olomouc, 1994, 1995 Uherské Hradiště) (Ústav

fytopathologický, 1924; Baudyš, 1935; ÚKZÚZ, 1955–2000). There are no registered insecticides against *L. merdigera*. It is highly recommended to cover the vegetation by a soft non-woven or hand-picking adults and larvae.

The adults of *O. suturalis* are black 2.5–3 mm long with longitudinal white stripe on the shield and the seam of wing-case. The antennae and legs are reddish brown (Sionek, 1998). The egg is white varying around 0.6 to 0.7 mm in the length and from 0.3 to 0.4 mm wide. The larvae are legless, yellowish or yellowish green with head (Miller, 1956). The white pupa has two short curved clawish spines on the last part of the buttocks. Imagines hibernate, usually leaving the wintering grounds in early May. Females lay one or two eggs into capsules or leaves (Szwejda, 2006). The larval development usually lasts from 5 to 6 weeks, after which the larvae pupate in the soil from 1.5 to 4.5 cm deep in a clay cocoon. After 30 days the imagines hatch and hibernate in the soil around plants in a short period of feeding. One generation per year is mostly common (Clements, 1984; Richter *et al*., 1997). It is widespread in North America, west Asia, Europe, Poland, Germany, Netherlands, Belgium, Estonia, Latvia, Lithuania, France, Italy and Greece, preferring hot and dry habitats. It is developed on plants of the genus *Allium*. The adults nibble away holes in the top of the leave. The larvae nibble away parenchyma inside the leaves. Grub holes externally look like elongated, narrow corridors (Rogowska *et al*., 2006). Leaves deform and crack as a result of feeding larvae (Studzinski *et al*., 1987). In the Czech Republic the damages have been registered in onions (1964 Kolín, Litoměřice, 1965 Kutná Hora, 1966 Mladá Boleslav, Kolín, Nymburk, 1968 Kolín, Kutná Hora, 1970 Mladá Boleslav, Kolín, Kutná Hora, 1993 Olomouc, 1994 Břeclav, 1997 Kroměříž, 1999 Břeclav) (ÚKZÚZ, 1955–2000). There has not been processed any garlic protection against *O. suturalis*. The disposal and removal of leaves is therefore highly recommended (Mesic *et al*., 2004).

The aim of this work was to verify the monitoring of individual species, to clarify their bionomics and to assess the influence of selected factors on the intensity of their occurrence.

MATERIAL AND METHODS

Lilioceris merdigera and *Ophroninus suturalis* were observed on the central and south-eastern Moravia in 2010–2012 on five study plots at different altitudes – Nedakonice (178 m, a warm region with an average annual air temperature of 8.5 °C with an annual rainfall of 550 mm, expanse of 200 m^2), Olomouc (241 m, a slightly warm area with an average annual temperature of 8.5 °C and an average total annual rainfall of 583 mm, expanse of 10,000 m^2), Dolní Němčí (256 m, a slightly warm area with an average annual temperature of 8.1 °C with an average total annual rainfall of 752 mm, expanse of 500 m^2), Suchá Loz (306 m, a slightly warm area with an average annual temperature of 7.6 ° C with an average total annual rainfall of 650 mm, expanse of 200 m^2) and Vápenky (484 m, a slightly warm area with an average annual temperature of 6.1 °C with an average total annual rainfall of 750 mm, expanse of 100 m^2).

The cloves were planted manually in 0.15 × 0.20 m, depth 0.08 m depending on the weather from mid-September to late October. Two winter varieties of garlic Blanin and Dukat were planted on the study plots. The Blanin variety is with medium-sized bulb and 6–12 medium-sized cloves arranged irregularly. The leaves are short, half-upright, dark green, reaching high crop with a very long storage life. The Dukat variety is a medium-sized bulb, with 5–7 medium-sized cloves arranged regularly. The leaves are long, half-upright, dark green. High yields can be obtained and its storage life is long. The cloves of both varieties were stained in fungicide 0.4% Rovral Aquaflo (active ingredient: iprodione) for 20 minutes before planting. During the growing season any insecticide has not been applied. In the course of the vegetation the manual cultivation and weeding out have been provided. The harvest was carried out manually at the beginning of July. The health status of garlic was assessed visually on individual study plots from the end of February at regular weekly intervals and from March to July twice a week. The occurrence of pests and symptoms have been monitored in plants per 1 m^2 on 10 randomly selected locations in the periphery and central parts of the crop.

The presence of adults has been determined by using coloured PVC bowls (yellow, red, green and blue). Five pieces of each bowl with 4% formalin have been placed 1 m from each other across the plot. The caught pests have been processed by conventional entomological methods, the adults were dissected and dried. The larvae have been preserved in 70% ethanol. The final determination of pests was carried in the entomological laboratory. The abundance of pests has been evaluated using a four-point scale (Tab. I). In all study plots the temperature was measured for 24 hours on the surface of the soil using datalogger (GAR 195). The highest values have been recorded in the afternoon and the lowest ones at night on the soil surface from February to July.

The relationship between the abundance of the species and the temperature have been expressed by linear regression. The results have been processed by analysis of variance followed by Tukey test, testing at $\alpha = 0.05$, Statistica 10.

RESULTS AND DISCUSSION

1. *Lilioceris merdigera* (Linnaeus, 1758)

The first occurrence of adults *Lilioceris merdigera* and the current temperature (° C) for individual study plots are shown in Tab. II. The number of individuals of *L. merdigera*/m^2 is recorded in Tab. III.

I: *The scale for determining the abundance of garlic pests by the number of individuals per 1 m² / in 1 bowl*

Level of Occurrence	Abundance per 1 m² / in 1 bowl
1 – zero level of occurrence	0
2 – low level of occurrence	less than 10
3 – medium level of occurrence	10–20
4 – high level of occurrence	more than 20

II: *The first occurrence of L. merdigera and the current temperature on individual study plots*

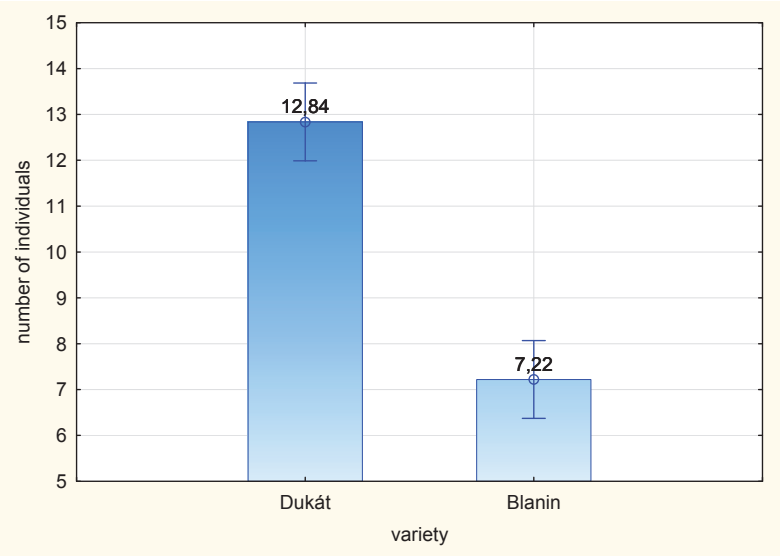
Year/Study plot	Nedakonice		Olomouc		Dolní Němčí		Suchá Loz		Vápenky	
2010	20. 4.	17.3 °C	28. 4.	19.2 °C	29. 4.	19.5 °C	29. 4.	18.4 °C	22. 4.	17.5 °C
2011	23. 4.	18.4 °C	26. 4.	17.9 °C	21. 4.	15.6 °C	28. 4.	18.2 °C	18. 4.	13.9 °C
2012	10. 5.	19.2 °C	9. 5.	19.6 °C	7. 5.	19.5 °C	5. 5.	18.9 °C	8. 5.	18.3 °C

III: *The number of individuals of L. merdigera/m²*

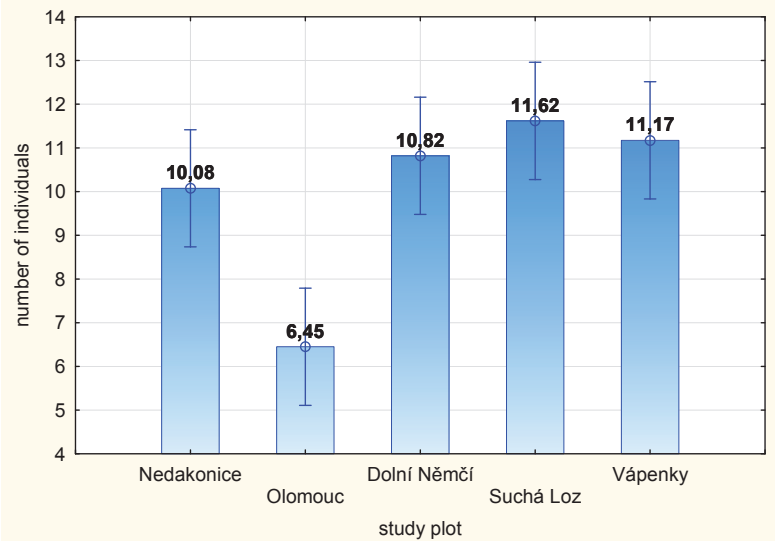
Study plot	Year	Variety Dukát	Variety Blanin	Ø	Level of occurrence
Nedakonice	2010	14.7	7.6	11.2	3 – medium
	2011	12.6	6.5	9.6	2 – low
	2012	13.5	7.5	10.5	3 – medium
	Ø	**13.6**	**7.2**	**10.4**	**3 – medium**
Olomouc	2010	8.6	5.2	6.9	2 – low
	2011	8.4	4.4	6.4	2 – low
	2012	8	3.8	5.9	2 – low
	Ø	**8.3**	**4.5**	**6.4**	**2 – low**
Dolní Němčí	2010	15.2	6.7	11.0	3 – medium
	2011	13.6	8	10.8	3 – medium
	2012	15.2	8.4	11.8	3 – medium
	Ø	**14.7**	**7.7**	**11.2**	**3 – medium**
Suchá Loz	2010	16.2	8.6	12.4	3 – medium
	2011	15.4	8.8	12.1	3 – medium
	2012	17	6.2	11.6	3 – medium
	Ø	**16.2**	**7.9**	**12**	**3 – medium**
Vápenky	2010	11.7	5.4	17.1	3 – medium
	2011	11.7	7.2	18.9	3 – medium
	2012	10.8	6.2	17.0	3 – medium
	Ø	**11.4**	**6.3**	**8.9**	**2 – low**

Among the experimental years there was no significant difference. Overall the Dukat variety (12.8 individuals/m²) was significantly infested more than the Blanin variety (7.2 individuals/m²) (Fig. 1). Among the plots Nedakonice (10.1 individuals/m²), Dolní Němčí (10.8 individuals/m²), Suchá Loz (11.6 individuals/m²) and Vápenky (11.2 individuals/m²) there were significant differences in the intensity of infestation garlic by *L. merdigera* (Fig. 2). At the study plot in Olomouc (6.5 individuals/m²) there was registered the lowest abundance of *L. merdigera*.

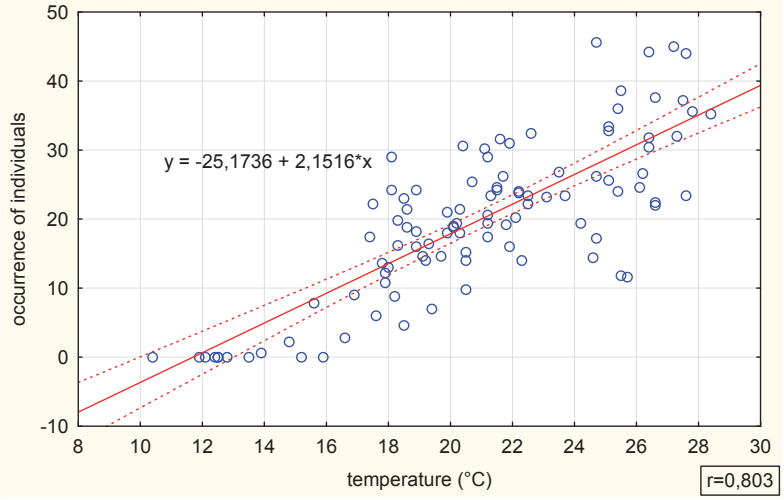
In our experiment, we have found out that the imago of *L. merdigera* begins to appear in late April and early May at temperatures ranging from 13.9 to 19.2 °C. The females began to lay eggs for 6–12 days after the first occurrence at temperatures above 20 °C. Hay & Kenis (2004) and Salisbury *et al.* (2012) have reported that one female lays from 2–16 eggs. According to our findings, one female laid in a number of 6 to 14 eggs on the leaf surface. The highest intensity of onion beelte occurrence has been registered at temperatures of 18–24 °C in dry and sunny weather (Fig. 3). Müller & Rosenberger (2006) have reported that the optimal temperature for the development of *L. merdigera* is 22 °C. The highest number of individuals (eggs, larvae and adults) has been found on the Dukat variety (36 individuals/m²) at 18.8 °C. On the Blanin variety there has been reported the highest number of 24 individuals/m² at 27.9 °C (Fig. 4, 5, 6). Damage symptoms of *Lilioceris merdigera* are shown on Fig. 7. According to the observations of Wilson (1943) and



1: *The effect of variety on the abundance of Lilioceris merdigera in the years 2010–2012*



2: *The effect of locality on the intensity of Lilioceris merdigera in the years 2010–2012*



3: *The effect of temperature on the occurrence of Lilioceris merdigera in the years 2010–2012*

4: *The eggs of Lilioceris merdigera*

5: *The larvae of Lilioceris merdigera*

Halstead (1990) the diapause is a necessity between coupling and laying eggs. When they are disturbed or threatened *L. merdigera* makes a typical rattling sound. According to Emmel (1936), the vibration of the antennae releases a pheromone that attracts the opposite sex of the individual. According to Livingstone (1996) the process of mating is full of ambiguousness that needs to be explored in detail.

2. *Oprohinus suturalis* (Fabricius, 1775)

The first occurrence of adults of *Oprohinus suturalis* and the current temperature (°C) for individual study plots are shown in Tab. IV. In 2010, the plots of Nedakonice, Olomouc, Dolní Němčí and Suchá Loz reported less than 0.5% occurrence of *O. suturalis*. In 2011, *O. suturalis* was monitored in higher abundance on the study plots of Nedakonice, Olomouc, Dolní Němčí and Suchá Loz. In Vápenky was detected no trace of *O. suturalis* at all. The number of individuals of *O. suturalis* /m^2 is recorded in Tab. V.

On the study plots Nedakonice, Olomouc and Dolní Němčí there was a significant difference between 2011 and 2012 (Fig. 8). On the study plot in Suchá Loz the important difference between 2011 and 2012 was observed on the varieties Blanin. Between Dukat varieties there was not any significant difference. Overall, in 2011 the variety Blanin (23.3 imagines/m^2) was significantly infested more than the Dukat variety (19.6 imagines/m^2). In 2012, the difference was no significant between the varieties Dukat (14.3 imagines/m^2) and Blanin (15.5 imagines/m^2) (Fig. 9). The highest intensity of *O. suturalis* was on the study plot in Dolní Němčí (24.3 imagines/m^2) (Fig. 10).

Luczak & Wiewiora (2004) tested 19 kinds of onions and their susceptibility to infest by *O. suturalis*. The results of the experiment have showed the significant differences among the varieties and their predisposition to infest by *O. suturalis*. The varieties Rawska, Wolski and Efekt have been most

6: *The imago of Lilioceris merdigera*

7: *Damage symptoms of Lilioceris merdigera*

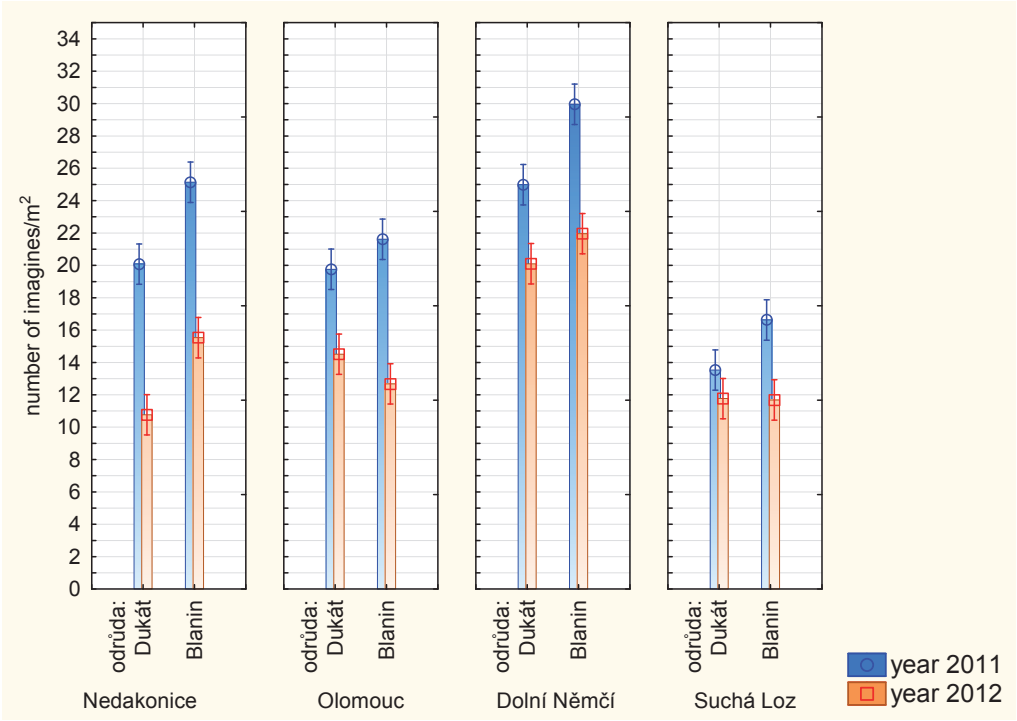
IV: *The first occurrence of O. suturalis and the current temperature on individual study plots*

Year/Study plot	Nedakonice		Olomouc		Dolní Němčí		Suchá Loz	
2011	10. 5.	17.4 °C	31. 4.	14.8 °C	1. 5.	15.6 °C	30. 4.	10.4 °C
2012	1. 5.	19.5 °C	10. 5.	20.5 °C	12. 5.	20.7 °C	14. 5.	20.5 °C

infested at all. The varieties Lagerdold, Spirit and Robusta have not been infested at all or only slightly. In our experiment we have found out that only in 2011 the Blanin variety has been infested in a more significant way than the Dukat variety. In addition to preference of the variety the intensity of infestation of *O. suturalis* plays an important role weather and altitude. The yellow bowl filled with 4% formalin proved to be a particularly suitable attractant for the imagines of *O. suturalis* (Fig. 12). Most adults have been caught in a yellow bowl in the Blanin variety (43.1 imagines) and the Dukat one (29.4 imagines)

V: *The number of individuals of Oprohinus suturalis /m²*

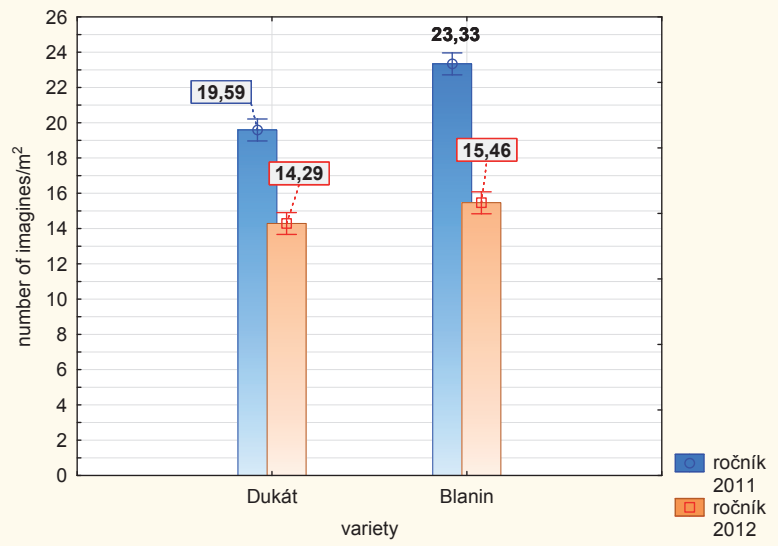
Study plot	Year	Variety Dukát	Variety Blanin	Ø	Level of occurrence
Nedakonice	2011	20.1	20.1	20.1	4 – high
	2012	10.8	15.5	13.15	3 – medium
	Ø	**15.45**	**17.8**	**16.6**	**3 – medium**
Olomouc	2011	19.8	20.6	20.2	4 – high
	2012	14.5	12.7	13.6	3 – medium
	Ø	**17.1**	**16.7**	**16.9**	**3 – medium**
Dolní Němčí	2011	25.0	30.0	27.5	4 – high
	2012	20.1	22.0	21.0	4 – high
	Ø	**22.6**	**26.0**	**24.3**	**4 – high**
Suchá Loz	2011	13.5	16.6	15.1	3 – medium
	2012	11.8	11.7	11.8	3 – medium
	Ø	**12.7**	**14.2**	**13.5**	**3 – medium**



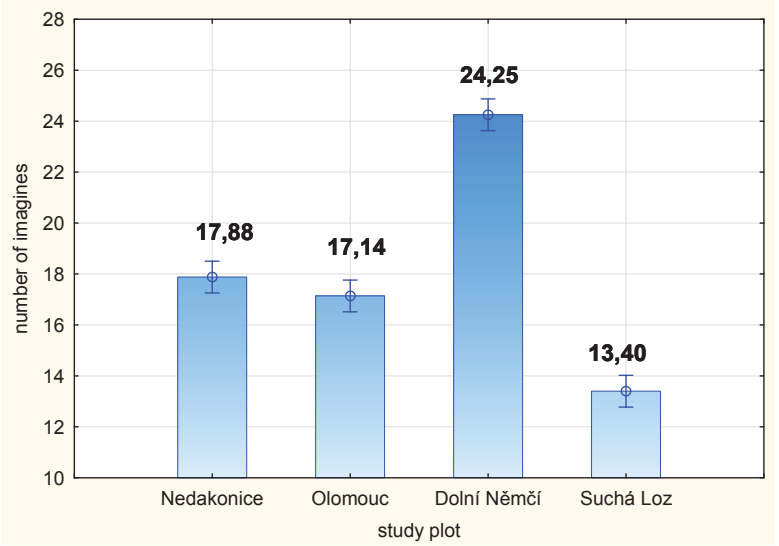
8: *The abundance of the imagines of Oprohinus suturalis on individual study plots in the years 2011–2012*

on the study plot in Dolní Němčí (Fig. 11). Damage symptoms of Oprohinus suturalis are shown on Fig. 13. The lowest abundance has been identified on the study plot in Olomouc on the Dukat variety (15.6 imagines). A similar finding has been reported by Clements (1984) and Đurić (2011), who also appeared to use a yellow bowl to determine the abundance of the *O. suturalis*. In their experiment, the highest abundance has been observed in a yellow bowl with 56 imagines. According to Szwejdy (2005) and Szwejdy *et al.* (2009) *O. suturalis* is the most serious pest of bulb vegetables in Poland. The range of the first occurrence among study areas in 2011 was 11 days (30. 4.–10. 5.) and in 2012 was 13 days (1. 5.–14. 5.). The adults were first detected in 2011 on 10. 4. at 17.4 °C and in 2012 on 19. 5. at 20.7 °C. The first presence of *O. suturalis* adults did not correlate with altitude.

The highest occurrence of *O. suturalis* adults was detected at 20–24 °C in Nedakonice. In Olomouc, the biggest number of *O. suturalis* adults was at the temperature of 18–23 °C, in Dolní Němčí at the temperature of 18–22 °C and in Suchá Loz at the temperature of 18–22 °C. According to Szwejdy (2006) and Ruszowske (1952), the imago of *O. suturalis* begin to appear with regard to temperatures by early May. From our observation results we can conclude that temperature plays a fundamental role in the occurrence of *O. suturalis*. The highest intensity of *O. suturalis* was registered at temperatures of 18–22 °C in dry and sunny weather.



9: *The influence of the variety on abundance of Oprohinus suturalis in the years 2011–2012*



10: *The effect of locality on the intensity of Oprohinus suturalis in the years 2011–2012*

CONCLUSIONS

1. *Lilioceris merdigera* (Linnaeus, 1758)

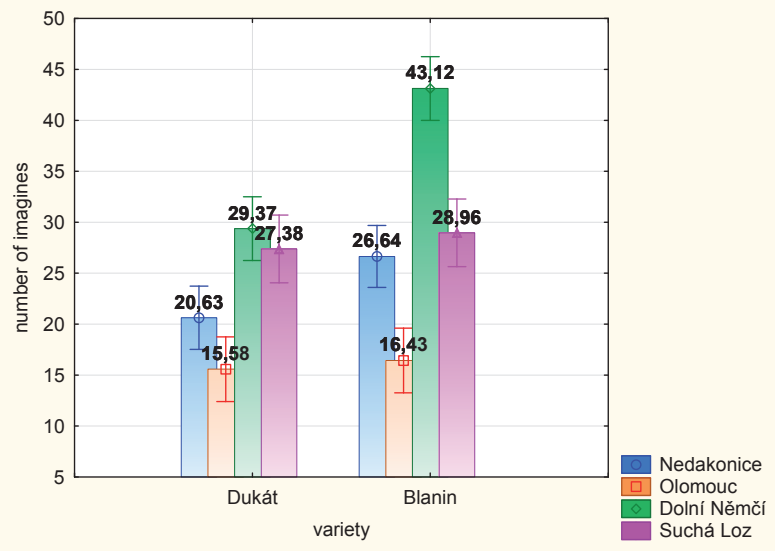
L. merdigera occurred in the years 2010–2012 on all study plots in low to medium abundance in Nedakonice (10.1 individuals/m²), Olomouc (6.5 individuals/m²), Dolní Němčí (10.8 individuals/m²), Suchá Loz (11.6 individuals/m²) and Vápenky (11.2 individuals/m²). The first occurrence of *L. merdigera* was observed on 20. 4. in Nedakonice (17.3 °C) in 2010. In 2011, the first imago appeared on 18. 4. in Vápenky (13.9 °C). In 2012, the first appearance of adults was monitored on 5.v. in Suchá Loz (18.9 °C).

The Dukat variety (12.8 individuals/m²) was significantly more infested than the Blanin variety (7.2 individuals/m²).

The highest abundance of adults comes at temperatures 18–24 °C in dry and sunny weather. The highest number of individuals (eggs, larvae, adults) was seen on the Dukat variety (36 individuals/m²) at 18.8 °C and on the Blanin variety with the highest number of 24 individuals/m² at 27.9 °C. The females begin to lay at temperatures above 20 °C, 6–12 days after the first occurrence.

2. *Oprohinus suturalis* (Fabricius, 1775)

In 2010, the occurrence of *O. suturalis* was found less than 0.5% in the localities Nedakonice, Olomouc, Dolní Němčí and Suchá Loz. In 2011 and 2012, *O. suturalis* in medium to high abundance was registered on the study plots Nedakonice (17.9 imagines/m²), Olomouc (17.1 imagines/m²), Dolní Němčí (24.3 imagines/m²) and Suchá Loz (13.40 imagines/m²). On the study plot Vápenky *O. suturalis* was not observed in either year.



11: *Number of imagines of Oprohinus suturalis in yellow bowls on the individual study plots*

12: *The imago of Oprohinus suturalis*

The first occurrence of *O. suturalis* was found on 30. 4. in Suchá Loz (10.4 °C), on 31. 4. in Olomouc (14.8 °C), on 1. 5. in Dolní Němčí (15.6 °C) and on 10. 5. in Nedakonice (17.4 °C). In 2012, *O. suturalis* first appeared on 1.5. in Nedakonice (19.5 °C), on 10. 5. in Olomouc (20.5 °C), on 12. 5. in Dolní Němčí (20.7 °C) and on 14. 5. in Suchá Loz (20.5 °C).

The highest abundance of *O. suturalis* was recorded on the study plot in Dolní Němčí (24.3 imagines/m^2). In 2011 the Blanin variety (23.3 imagines/m^2) was significantly infested more than the Dukat variety (19.6 imagines/m^2). In 2012, there was no difference in infection between varieties Dukat (14.3 imagines/m^2) and Blanin (15.5 imagines/m^2).

The temperature plays a fundamental role in the occurrence of *O. suturalis*. The highest abundance of *O. suturalis* adults was at temperatures of 18–22 °C in dry and sunny weather.

The yellow bowl filled with 4% formalin proved to be suitable attractant for the imagines of *O. suturalis*. Most adults have been found on the study plot in Dolní Němčí in the Blanin variety (43.2 imagines/m^2). The lowest abundance has been monitored on the study plot in Olomouc in the Dukat variety (15.6 imagines/m^2).

13: *Damage symptoms of Oprohinus suturalis*

SUMMARY

Neither *Lilioceris merdigera* nor *Ophroninus suturalis* belong to the major garlic pests. Recently, both species have occured on garlic in higher quantities in Moravia. In our experiment, we have found out that the imago of *L. merdigera* begins to appear in late April and early May at temperatures ranging from 13.9 to 19.2 °C. The females began to lay eggs for 6–12 days after the first occurrence at temperatures above 20° C. The highest intensity of occurrence has been registered at temperatures of 18–24 °C in dry and sunny weather. The Dukat variety (12.8 individuals/m^2) was significantly more infested than the Blanin variety (7.2 individuals/m^2). The highest number of individuals (eggs, larvae and adults) of *L. merdigera* has been found on the Dukat variety (36 individuals/m^2) at 18.8 °C. On the Blanin variety there has been reported the highest number of 24 individuals/m^2 at 27.9 °C.

In 2010, the plots of Nedakonice, Olomouc, Dolní Němčí and Suchá Loz reported less than 0.5% occurrence of *O. suturalis*. In 2011 and 2012, *O. suturalis* was monitored in higher abundance on the study plots of Nedakonice, Olomouc, Dolní Němčí and Suchá Loz. In Vápenky was detected no trace of *O. suturalis* at all. Overall, in 2011 the Blanin variety (23.3 imagines/m^2) was significantly infested more than the Dukat variety (19.6 imagines/m^2). In 2012, the difference was no significant between the varieties Dukat (14.3 imagines/m^2) and Blanin (15.5 imagines/m^2). The yellow bowl filled with 4% formalin proved to be a particularly suitable attractant for the imagines of *O. suturalis*. Most adults have been caught in a yellow bowl in the Blanin variety (43.1 imagos) and the Dukat one (29.4 imagines) on the study plot in Dolní Němčí. The lowest abundance has been identified on the study plot in Olomouc on the Dukat variety (15.6 adults).

REFERENCES

BAUDYŠ, E., 1935: *Hospodářská fytopathologie II: hubení škůdců živočišných*. Spolek posluchačů na VŠZ, Brno, 630 pp.

BROWN, W. J., 1946: Some new Chrysomelidae, with notes on other species (*Coleoptera*). *The Canadian Entomologist,* 28: 47–48.

CLEMENTS, R. O., 1984: Control of insect pests in Grassland. *Span,* 27, 2: 77–79.

ĐURIĆ, Z., 2011: *Harmfulness of onion weevil (Ceuthorrhynchus suturalis F. Coleoptera: Curculionidae) in the onion production.* Savetovanje o biotehnologiji sa međunarodnim učešćem, Agronomski fakultet, Čačak (Serbia), 16: 4–5.

EMMEL, L., 1936: Aus dem leben des Lilenhahnchens (*Crioceris lilii*). *Natur und Volk,* 66: 424–428.

FEDERICI, B. A. & MADDOX, J. V., 1996: Host specificity in microbe-insect interactions. *Bioscience,* 46: 410–421.

HALSTEAD, A. J., 1990: Lily beetle survey. *The Garden,* 115: 439 pp.

HAYE, T. & KENIS, M., 2004: Biology of Lilioceris spp. (*Coleoptera: Chrysomelidae*) and their parasitoids in Europe. *Biological Control,* 29: 399–408.

LIVINGSTON, S. B., 1996: *Biology, control and host range of Lilioceris lilli: a new ornamental pest in the USA.* Kingston: University of Rhode Island, 78 pp.

LUCZAK, I. & WIEWIÓRA, I., 2004: On possibilities of nonchemical protection of onion against insect pests. *Acta fytechnnica et zootechnica,* 7: 179–181.

MESIC, A. & BARCIC, J., 2004: Diptera pests on onion vegetables in Croatia. *Entomol. Croat,* 8, 1–2: 45–56.

MILLER, F., 1956: *Zemědělská entomologie*. Praha: Československá akademie věd, 1057 s.

MÜLLER, C. & ROSENBERGER, C., 2006: Different oviposition behaviour in Chrysomelid beetles: Characterisation of the interface between oviposition secretion and the plant surface. *Arthropod Structure and Development*, 35: 197–205.

RICHTER, E., HAGNER, S., KRAUTHAUSEN, H. J. & HOMMES, M., 1997: Use of threshold levels in leeks and onions. *Gemuse Munchen*, 33, 4: 249–251.

ROGOWSKA, M. & WRZODAK, R., 2006: Nowe feromony do stosowania w ochronie roślin warzywnych przed szkodnikami. *Ochr. Roślin, Poznań*, 46, 2: 363–366.

RUSZKOWSKA, I., 1952: Biologia szkodnika cebuli chowacza szczypiorowego *Ceut-horrhynchus suturalis* Fabr. (Col., Curculionidae). *Ann. Univ. M. Skłodowska-Curie, Lublin,* 7, 14: 417–471.

SALISBURY, A., COOK, S. M., POWELL, W. & HARDIE, J., 2012: Odourmediated orientation behaviour of the lily beetle *Lilioceris lilii. Physiological Entomology,* 37: 97–102.

SIONEK, R., 1998: *Napomyza gymnostoma* Loew (Diptera, Agromyzidae) and *Oprohinus suturalis* F. (*Coleoptera, Curculionidae*) the important pest of onion in south-eastern Poland. *Annals of Agricultural Sciences-series E - Plant Protection,* 27, 1/2: 73–80.

STRAND, M. R. & OBRYCKI, J. J., 1996: Host specificity of insect parasitoids and predators. *Bioscience,* 46: 422–429.

STUDZIŃSKI, A., KAGAN, F. & SOSKA, Z., 1987: *Atlas chorob a škodcov zeleniny*. Bratislava: Priroda, 327 pp.

SZWEJDA, J., 2005: Szkodniki zagrazajace cebuli ozimej. *Ochrona roślin,* 11: 23–25.

SZWEJDA, J., 2006: Pest management in ecological production of vegetables in Poland. *Ann. Warshaw Agriculture University Horticulture and Landscape Architecture,* 27: 5–15.

SZWEJDA, J. & WRZODAK, R., 2009: Phytophagous entomofauna occuring on onion plantations in Poland in years 1919–2007. *Acta fytechnnica et zootechnica,* 71: 5–14.

ÚKZÚZ, 1955–2000: *Přehled výskytu některých škodlivých činitelů rostlin na území* ČSSR/ČR. ÚKZÚZ, Bratislava-Brno-Praha.

ÚSTAV FYTOPATHOLOGICKÝ, 1924: Nejdůležitější choroby a škůdcové kulturních rostlin v Čechách r. 1923. Zpráva stát. výzkumných ústavů pro výrobu rostlinnou (ústavu fytopathologického) v Praze. *Ochrana rostlin*, 4, 2–3: 44–45.

WHITE, R. E., 1993: A revision of the subfamily Criocerinae (Chrysomelidae) of North America North of Mexico. United States Department of Agriculture. *Technical Bulletin 1805*: 1–158.

WILSON, F. G., 1943: The lily beetle, *Crioceris lilii* Scopoli: Its distribution in Britain (Coleoptera). *Proceedings of the Royal Entomological Society of London. (A),* 18, 10–12: 85–86.

Contact information

Eva Sapáková: eva.sapakova@ mendelu.cz
Hana Šefrová: hana.sefrova@mendelu.cz
Luděk Hřivna: ludek.hrivna@mendelu.cz
Lea Hasíková: lea.hasikova@mendelu.cz