INVESTIGATION OF THE LUSITANIAN SLUG (*ARION LUSITANICUS* MABILLE) DAMAGE

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Abstract. The Lusitanian slugs (*Arion lusitanicus Mabille*) is one of the species of invasive animals originated from Spain and Portugal, Lusitania region in particular. The slugs were first detected in 2008 in Kaunas, Lithuania. The spread of this species is rapidly increasing, which creates unfavourable conditions for growing plants in gardens, orchards, and other areas. The study was carried out in the orchard of Vytautas Magnus University Botanical Garden by controlling their damage by applying mulch of buckwheat husks. The aim of the research was to identify the effectiveness of buckwheat husks as a natural plant waste in protecting garden plants from damage caused by the Lusitanian slugs. In 2021, the study was carried out in the training garden, the collection department of VMU Botanical Garden. The benefits of mulching lettuce with buckwheat husks to protect them from invasive slug damage have been analysed. The lettuce examined were grown in 1.2 m width beds, where the gaps between vegetable beds were surrounded by a well-maintained lawn. There were four replicates of the study, when the area of 1 m^2 was investigated. At the investigated sites, plants were mulched with a dry, loose, and clean buckwheat husk layer of 5 cm thickness. The damage caused by the Lusitanian slugs was recorded by measuring damage on plant leaves and converting the damage into the percentage expression. The phytofixation method was used. Damage was assessed on a five-point scale, where 0 points - plants undamaged, 1 point - damaged up to 15%, 2 points - damaged from 15 to 30 per cent 3 points - damaged from 30 to 50 per cent, 4 points - damaged from 50 to 75 per cent, 5 points - damaged (destroyed) from 75 to 100 per cent of leaves of the investigated plants. The results of the research showed that the use of special partitions made from buckwheat husks and mulching of vegetables can control the damage of invasive slugs. Minor damage was found in vegetables mulched with buckwheat husks: damage from 1 to 2 points. In the control site, where the plants were not mulched with buckwheat husks, the damage was 3 points. Having assessed the damage, it can be stated that the activity of Lusitanian slugs was affected by less favourable environmental conditions: sunny days, high ambient air temperature, limited level of precipitation and a well-maintained environment, as there were no shady places and high grasslands or other common shelters for slugs.

Keywords: invasive slugs, mulch, buckwheat husks.

Introduction

There have been estimated over 130000 species of molluscs (Mollusca). In Lithuania, there are approximately 150 different species of mollusks in natural habitats, of which almost 80 species inhabit on land (Kazlauskaitė, Klimavičius, Petrauskaitė, 2020). The species of molluscs common in the territory of Lithuania was first studied and described by prof. P. Šivičkis. German diplomat O. Mollendorf examined the species of common mollusks in Vilnius and Kaunas districts in 1898. Researchers Dybowski, W. and Godlewski, O. (1885), Hilbert. R (1912), Polinski, W. (1917), Jacckel, S. (1926), Liacharriov, I. (1962) who worked in the neighbouring countries also described species of molluscs in their works (Gaidienė, 1997). At that period, invasive slug species posing a threat to native flora and fauna were not analysed. Seven genera of arthropods of the family Arionidae are included in the systematic list of Lithuanian land snails (Gaidienė, 1997). In 2020, the large black slug (Arion ater L) was included in the list of protected species of animals, plants and fungi of the Republic of Lithuania. The Lusitanian slug (Arion lusitanicus Mabille) is only one species of invasive animal native to Spain and Portuguese region of Lusitania (Fig. 1). It is thought that the slugs could enter Lithuania via Poland with vegetables, from Germany with seedlings or from the Netherlands with flowers. The slugs were first detected in 2008, in Kaunas (Lithuania). This species is spreading rapidly in gardens, parks, and homesteads. Presently, it is found in almost the entire territory of Lithuania (Skujienė, Adomaitis, 2021). An adult Lusitanian slug (Arion lusitanicus) is about 15 cm long, its skin colour can range from orange to brown, and its development cycle takes one year. In the course of a day, the slug eats a large amount of greenery, which on average can reach about half the body weight of the pest. Under favourable conditions, in the presence of adequate amounts of feed, the slugs reproduce fast and they mate in late summer. Female slugs lay their eggs in the soil in piles of 25-70 in one place. One female can lay about 250 white 4 mm diameter oval eggs. Slugs grow and mature very quickly in just two or three months and survive for 6-7 months. Under favourable conditions (long, warm and wet autumn), up to two generations of slugs can develop in a year. It is estimated that over 20 individuals can be detected in the areas favourable for reproduction.

Fig. 1. Eggs of the Lusitanian slug (Arion lusitanicus)

Recently, when winters are getting warmer in Lithuania, juveniles may overwinter, although slug eggs usually overwinter. They can be distinguished by the colour of the tentacles, which are black in Lusitanian slugs. Juveniles of the Lusitanian slugs with their characteristic streaks are usually found only in late April, when they begin to feed.

Fig.2. Lusitanian slug (Arion lusitanicus)

Table 1. Recommended measures for plant protection

No.	Type of measures	Author	Measures
1.	Preventive	Kazlauskaitė, Klimavičius, Petrauskaitė, 2020.	Buckwheat husk mulch
		Tamošiūnas, 2021, Ragickaitė, 2017	Installation of barriers using copper foil, creation of favourable conditions for natural predators of slugs
		Skujienė, 2018	Quarantine of imported plants
		Vaidelys. 2013	Barriers of annual plants (dragon flower (Antirrhinum), Mexican aster (Cosmos bipinnatus), cornflower (Centaurea cyanus), zinnia (zinnia elegans) , etc.
		Sajenkienė, 2019,	Keeping environment clean
2.	Mechanical	Skujienė, 2018	Manual collection of slugs
		Čepulis, 2020, Tamošiūnas, 2021	Installation of traps
3.	Chemical	Fedotovas, 2020	Registered products: *Feramol, Gusto, Lima Oro, Sluxx, Meridian, Ironmax Pro*. Low-risk products that can be used on organic farms *Sluxx, Ironmax Pro*.

The polyphagous pest eats beans, lettuce, spinach, carrots, beets, potatoes or other vegetables, flower foliage. The damage done by these slugs is visible such as foliage veins and glossy mucous paths. The slug actively feeds in the dark during the day, late in the evening or early in the morning when there is little sun or weather is rainy. During the day, they hide under fallen foliage or other shady shelters because their body cover lacks a protective layer and their long stay in a sunny environment kills them. Slug control measures applied by homestead owners can vary from mechanical, preventive and chemical measures. In Lithuania, no studies have been performed to assess the traits of these varieties, this is the first research to assess the control of invasive Lusitanian slugs using buckwheat husks. The results of the study are relevant and important for tree nurseries, botanical gardens and homesteads where the use of chemicals is restricted. The aim of the study was to evaluate the effect of buckwheat husks in controlling the damage done by the Lusitanian slugs depending on environmental conditions.

The object of research is the Lusitanian slug.

Methodology of the research

The research was carried out in 2021 in the training garden, a collection department of VMU Botanical Garden. The benefits of using buckwheat husks for mulching of lettuce to protect them from damage done by invasive Lusitanian slugs were analysed. Vegetables in 1.2 m width beds were examined. Plant seedlings were planted in the spring of 2021 in accordance with technological requirements. The beds are formed in a north-south direction, with a well-maintained lawn in the gaps. There were four replicates of the study, when the area of 1 m^2 was investigated. At the investigated sites, plants were mulched with a dry, loose, and clean buckwheat husks layer of 5 cm thickness. During the study period, the harmful activity of the Lusitanian slugs was observed in the study objects.

Fig.3. Training garden

The study was carried out in June, July, and August, when slugs are most active. Safe beddings were arranged at the investigated sites where slugs could safely hide during the day. Damage done by the Lusitanian slugs was recorded by measuring damage on plant leaves and converting their damage in percentage expression. The phytofixation method was used. Damage was assessed on a five-point scale, where 0 points - plants undamaged, 1 point - damaged up to 15%, 2 points – from 15 to 30 per cent, 3 points - damaged from 30 to 50 per cent, 4 points - damaged from 50 to 75 per cent, 5 points - damaged (destroyed) from 75 to 100 per cent leaves of the studied plants.

Table 2. Meteorological conditions

Month	Decade	Ambient air temperature	Precipitation mm	Duration of sunlight in hours	Soil temperature at a 10 cm depth
June	I	16	60	85	18
	II	20	21	77	22
	III	21	51	99	24
July	[	17	28	65	20
	II	18	5	112	22
	III	17	30	85	21
August	I	19	20	103	23
	II	19	17	105	24
	III	17	80	57	25

Results

During the study, conventional plant care techniques were applied to vegetable plants. In the absence of moisture, the plants are watered by pouring about 10-15 l of water into 1m². Lettuce was grown according to the general methodology of intensive garden and orchard plant cultivation developed by LAMMC SDI (Lithuanian Research Centre for Agriculture and Forestry, Institute of Horticulture) researchers (2013). Ambient weather conditions were not very favourable to assess the effects of pests on plants during the study period. The recorded meteorological data are presented in Table 2.

Excessive or optimal humidity and higher ambient temperatures in June provided favourable conditions for slug feeding, although sufficiently warm soil and lack of shelter for pests limited their ability to move. Similar conditions were observed in July and August, only at the end of September, low precipitation created less favourable conditions for the development of the Lusitanian slugs. The damage of slugs depending on weather conditions is shown in Figure 4.

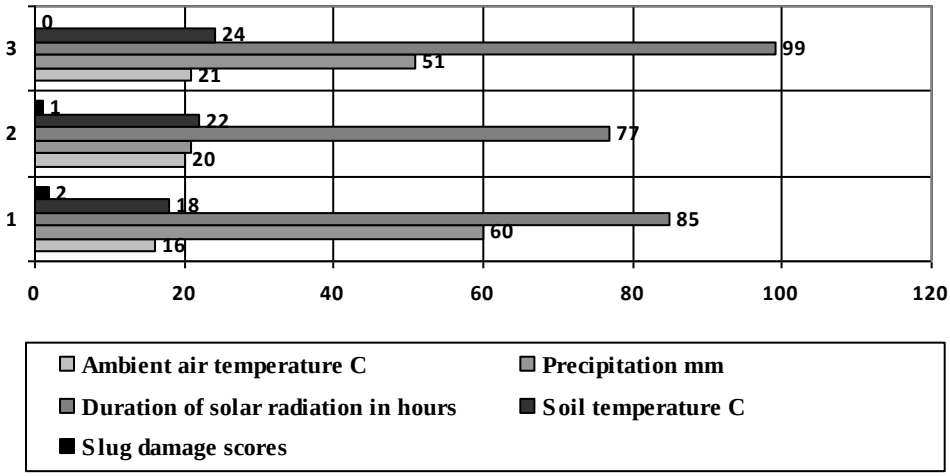

Fig.4. Damage of slugs depending on environmental conditions (1-2-3 decade of June)

Assessing the activity of the Lusitanian slugs in June, it is observed that in the first decade their activity (damage 2 points) was determined by higher precipitation and a sufficiently favourable ambient air temperature. In the following decades, with increasing soil temperature, decreasing precipitation and an increasing number of sunny hours (Decade 3), the damage decreased and there was no significant damage in the third decade. In July, minor damage was observed in the first and second decades (Fig. 5).

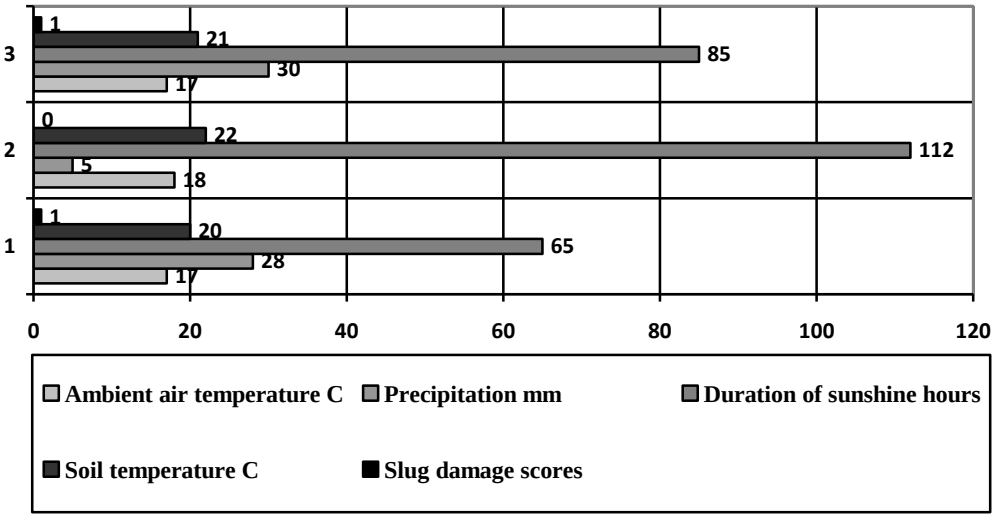

Fig.5. Damage of slugs depending on environmental conditions (1-2-3 decade of July)

In the second decade of July, in the presence of light rainfall and long duration of sunshine and high soil temperature, the activity of the Lusitanian slugs was not observed. The first decade of August was marked by slightly cooler weather, more rainfall and reduced duration of sunshine. This had a significant impact on damage to plants (Fig. 6).

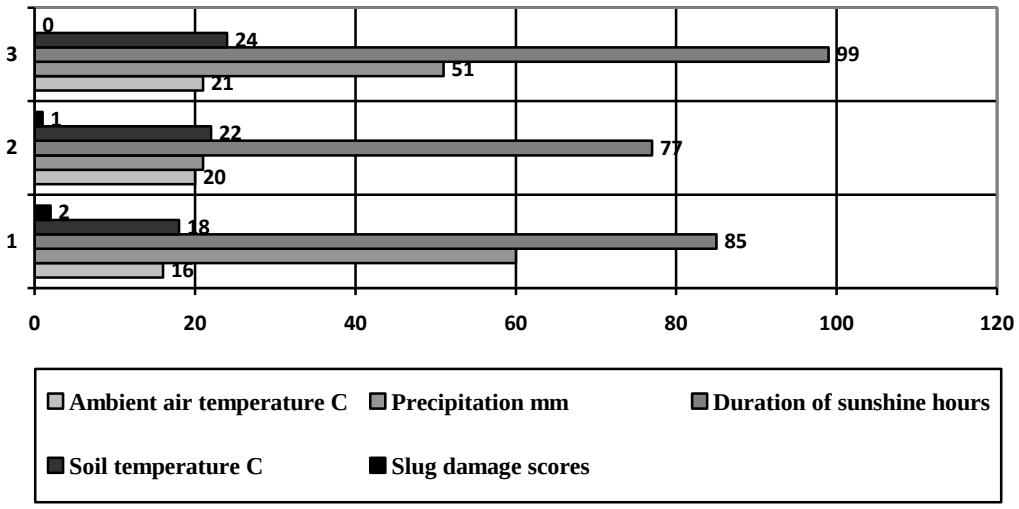

Fig.6. Damage of slugs depending on environmental conditions (1-2-3 decade of August)

In the second half of the month, higher ambient air temperatures and duration of sunshine slowed the damage done by pests in the investigated plants.

Assessing the damage caused by the Lusitanian slugs, it was found that plants were not significantly damaged, when the plants were mulched with buckwheat husks. The data are presented in Table 3.

Table 3. Damage (1 – 5 points)

Plants	Control	Replicates of the study				Average
		I	II	III	IV	
Lettuce	3	1	2	1	2	1,5

Minor damage was detected in vegetables mulched with buckwheat husks: damage from 1 to 2 points. In the control vegetable bed, where the plants were not mulched with buckwheat husks, the damage was measured to 3 points. Assessing the damage, it can be stated that the activity of the Lusitanian slugs could also be determined by less favourable environmental conditions: a number of sunny days, high ambient air temperature, limited rainfall and well-managed environment, as there were no shady places and high grasslands or other shelters.

Conclusions

1. During the study, the meteorological conditions were partially similar to those of perennial ones, which were moderately or slightly favourable to the activity and harm done by Lusitanian slugs. The damage of slugs in individual periods of the study was determined by sufficiently high ambient air temperature, long duration of sunshine, increasing soil temperature and a limited precipitation level.

2. It has been identified that damage in lettuce ranged from 1 to 2 points in the period of the investigation.

3. A well-managed environment for growing vegetables, a sunny habitat, and a regular mulching of the soil with buckwheat husks can reduce the harmfulness of slugs.

4. Based on the results of the study, it can be stated that the spread and harmfulness of the Lusitanian slugs can be reduced by applying several control measures and complying with agricultural technical requirements.

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