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# *PLODIA INTERPUNCTELLA* (HÜBNER, 1813) AND *NEMAPOGON GRANELLUS* (LINNAEUS, 1758) – UNCOMMON PESTS ON STORED GARLIC (*ALLIUM SATIVUM* L.) IN THE CZECH REPUBLIC

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## Abstract

HRUDOVÁ EVA, ŠAFRÁNKOVÁ IVANA. 2017. *Plodia interpunctella* (Hübner, 1813) and *Nemapogon granellus* (Linnaeus, 1758) – uncommon pests on stored garlic (*Allium sativum* L.) in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65(4): 1167–1173.

Garlic is one of several important vegetable species grown in the Czech Republic. *Ditylenchus dipsaci* (Kühn, 1857) (Tylenchida: Anguinidae), *Aceria tulipae* (Keifer, 1938) (Acari: Eriophyidae), *Rhizoglyphus echinopus* (Fumouze & Robin, 1868) (Acari: Acaridae) and *R. robinii* Claparède, 1869 (Acari: Acaridae), *Suillia lurida* (Meigen, 1830) (Diptera: Heleomyzidae) are common pest species found on garlic plants in the Czech Republic. Nowadays *Aceria tulipae* (Keifer, 1938) is beginning to be considered as the one causing damage. *Plodia interpunctella* (Hübner, 1813) (Lepidoptera: Pyralidae) and *Nemapogon granellus* (Linnaeus, 1758) (Lepidoptera: Tineidae) are small moths which are common pests usually found on stored products. Both of these species larvae were found as the uncommon pests of stored garlic in the Czech Republic in January 2016. Until now, their harmfulness on stored garlic has been reported only from Central America.

Keywords: garlic, *Plodia interpunctella*, *Nemapogon granellus*, stored garlic pests

## INTRODUCTION

Garlic is one of the oldest known horticultural crops. It was used thousands of years ago. Ancient medical texts from Egypt, Greece, Rome, China and India recommended it for treatment of disease (Rivlin, 2001). Its benefits for human health are well known (Bordia *et al.*, 1975, Lanzotti, 2006). Garlic bulbs contain crude protein, crude fat, crude fiber, ash, minerals – K, P, Mg, Na, CA, Fe, dimethyl sulfite and essentials oils (Hacıseferoğulları *et al.*, 2005). It is used in gastronomy for its typical flavour. Garlic pesticidal activity is known, it has insecticidal, nematocidal, rhodenticidal and molluscicidal effect (Singh and Singh, 2008). As state Mason and Linz (1997) the garlic oil may be used to repel European starlings (*Sturnus vulgaris* Linnaeus 1758).

Garlic (*Allium sativum* L.) is very important commercial crop grown all over the world and consumed in various forms, usually as vegetable, spice and herbal remedy nowadays. China has the largest acreage of this crop and dominates the world market (Mishra *et al.*, 2014). Spanish garlic is gaining a dominant position in Europe (Medina and García, 2007). In the former Czechoslovakia the largest acreage of garlic was in the fifth decade of 20th century, then it decreased and, in 2002 there were only 41 ha in the Czech Republic. After this decrease, gradual acreage increase followed and in 2015 the garlic acreage at professional growers accounted for 236 hectares (Buchtová, 2015). Garlic is becoming one of the few important vegetable species grown in the Czech Republic.

Environmental conditions, agrotechnical measures and presence of pathogens and pests are the key factors affecting the yield. *Ditylenchus dipsaci* (Kühn, 1857) (Tylenchida: Anguinidae), potato tuber nematode *D. destructor* Thorne 1945 (Tylenchida: Anguinidae), *Aceria tulipae* (Keifer, 1938) (Prostigmata: Eriophyidae), *Rhizoglyphus echinopus*

(Fumouze & Robin, 1868) (Acari: Acaridae) and *R. robinii* Claparède, 1869 (Acari: Acaridae), *Suillia lurida* (Meigen, 1830) (Diptera: Heleomyzidae) are common pest species found on garlic plants in the Czech Republic. *Aceria tulipae* seems to be the most important pest nowadays (Sapáková *et al.*, 2012). All of the species mentioned above are key garlic pests in other countries as well.

Predominantly dry bulb mite (*A. tulipae*), bulb mite (*R. echinopus*) and *R. robinii* are pests of stored garlic bulbs. However, other pest species are present as well – Indian meal moth [*Plodia interpunctella* (Hübner, 1813); Lepidoptera: Pyralidae] (Mandelli and Almeida, 1984) and European grain moth [*Nemapogon granellus* (Linnaeus, 1758); Lepidoptera: Tineidae] (Espinoza and Sannino, 2004).

Neither Indian meal moth nor European grain moth were reported as pests of stored garlic bulb from the Czech Republic until now. Larvae of Indian meal moth are general feeders, they feed on surface of the stored product such as grain, seeds, dry fruit, dog food, spices and processed food as well.

The uncommon symptoms of damage were found on stored garlic bulbs of the cultivar 'Dukát'. The symptoms included galleries and bitten out surface, the caterpillars were found on damaged bulbs. The larvae under garlic bulb's surface and causing damages were hardly visible at the first sight. Infested garlic bulbs were stored in a warehouse where the temperature oscillated between 15–22 °C and relative humidity was about 60 %.

## MATERIAL AND METHODS

The infested garlic bulbs were isolated and kept in laboratory conditions to cultivate founding caterpillars. The infested bulbs were isolated and larvae were kept in room temperature (21–23 °C) in dishes covered by mesh in order to acquire adults for confirmation of determination. Pupating and adults hatching took place in these dishes too. The determination was confirmed based on the hatched adults' morphology and morphology of their reproductive organs according to Carter (1984) and Slamka (2010).

These adults were determined as used for laboratory experiments:

a) determination of hatching adults
b) assessment of *Plodia interpunctella* length development cycle

The infestation of garlic sample of cultivars 'Dukát', 'Havran' and 'Vekan' by Indian meal moth was initiated in order to determine these pests life cycle length on garlic bulbs as the feed. The eggs of offspring of *Plodia interpunctella* larvae found on stored garlic mentioned above were used for experiment. A hundred eggs were placed into one dish. Garlic samples – 3 × 33 cloves of each cultivar was placed into dishes (500 ml volume) and covered by technical screen UHELON 18S. Infested garlic was placed into an environmental chamber. Temperature values of 18 °C, 21 °C and 25 °C were chosen for our experiment. Relative humidity 60 % and light-dark cycle 16:8 were used. Temperature 10 °C was not used because it is very low and is suggested to prevent development of most of the storage insects. The first observation of infested garlic was made two weeks after infestation, then every other day. When the first pupae were found, the observation was recorded daily. Newly hatching adults were taken away from the dishes and their total number was assessed. Individual larval instar periods were not estimated to avoid the disturbance of larvae.

c) assessment of *Nemapogon granellus* length development cycle

There were only seven individuals hatched from the infested garlic bulbs. However, this number proved utterly insufficient for further experiments.

## RESULTS AND DISCUSSION

Caterpillars feeding on garlic bulbs and making galleries (Fig. 1) were found under bulbs surface, while on grain they feed on surface. Based on these symptoms it is not quite possible to clearly determine which species caterpillars caused damage on the garlic bulbs and state their contribution. The exact identification of caterpillars is possible according to morphometric characters and chaetotaxy and/or according to adults' sexual organs morphology. The pupating of caterpillars takes place there or nearby the infested garlic (Fig. 2). The larvae were determined as Indian meal moth (*Plodia interpunctella*) and European grain moth (*Nemapogon granellus*). This determination was confirmed after adults' emerging (Fig. 3 and Fig. 4). The Indian meal moth adults isolated from larvae found on infested garlic were used to obtain the offspring for the experiments.

Complete development cycle's duration of Indian meal moth on garlic was assessed during laboratory experiments. Development cycle of European grain moth was not observed because of lack of individuals for egg production and therefore the garlic infestation was impossible to deploy.

The different length of their development cycle was found in this experiment which has been done on garlic bulbs. Three varieties of garlic 'Dukát', 'Havran' and 'Vekan' were infested by Indian meal moth eggs and cultivated in temperatures 18 °C, 21 °C and 25 °C. Temperatures lower than 17 °C and higher than 35 °C were not used because the lower development threshold stated by Arbogast (2007) is 15 °C and the upper limit for development is greater than 35 °C. Mohandass *et al.* (2007) state that lower limit of development may vary from 16–20 °C. Lower developmental threshold temperature estimated by Johnson *et al.* (1995) is 14 °C, and 13.5 °C and 15.2 °C by Na and Ryoo (2000).

Number of emerged adults, number of days from infestation to emerging adults and adults number during emerging process is shown in Figs. 5–7.


1: *Indian meal moth - caterpillar feeding in garlic clove*


2: *Indian meal moth - pupa on infested garlic clove*


3: *Indian meal moth - adult*


4: *European meal moth - adult hatched from infested garlic*

In our experiment, the average development period from egg to adult takes 40.5 days at the temperature 25 °C, at 21 °C it was 72.5 days in average and the adults hatching period was six days longer, at 18 °C development takes in average 112.5 days and was four days longer than at 25 °C. First adult emerged at 25 °C variation was observed after 34 days, at 21 °C after 64 days and at 18 °C 104 days after infestation. The total number of emerged Indian meal moth adults was 26 on 'Dukát' variety, 27 on 'Havran' and 30 on 'Vekan' at 18 °C, 46 adults on 'Dukát', 49 on 'Havran' and 48 on 'Vekan' at 21 °C and 59 on 'Dukát', 70 on 'Havran' and 65 individuals on 'Vekan' at temperature 25 °C.

Most studies of the Indian meal moth biology were done on cereals (Arbogast, 2007, Mohandass *et al.*, 2007), some authors realized the experiment on other crops e.g. dried vegetables (Na and Ryoo, 2000), groundnuts (Mbata and Osuji, 1983) or dates (Pourbehi *et al.*, 2013). There are only few studies dealing with Indian meal moth as a garlic pest.

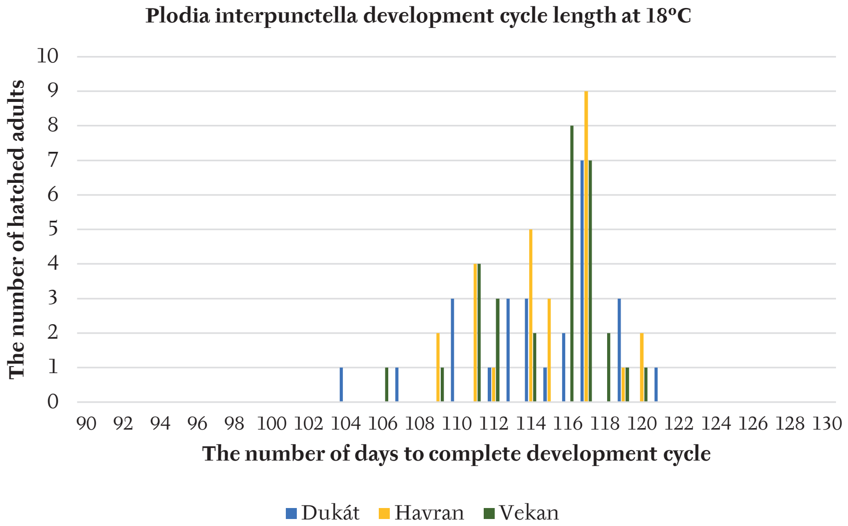
The Indian meal moth life cycle can take 27 to 305 days. Very detailed description of Indian meal moth biology provide Mohandass *et al.* (2007). Williams (1964) states that complete life cycle lasts 63 days. As Mohandass *et al.* (2007) show, the development time of Indian meal moth depends on the conditions (temperature, humidity, diet) and geographic differences among populations. Fontenot *et al.* (2012) state the grain as optimal diet for this pest. Arbogast (2007) shows the complete life cycle at 30 °C and 60 % r.h. on maize grain lasts 20 days. Detailed study of Indian meal moth biology on garlic give Perez-Mendoza and Aguilera-Peña (2004). They state development time from egg hatching to adult emergence on garlic ranges between 42 and 47 days; their experiment was conducted at unregulated conditions, average daily maximum temperature was 25–27 °C, minimum 11–20 °C, relative humidity ranged from 40 to 83 %.

European grain moth development cycle from egg to adult takes from 56 to 180–210 days (Espinoza and Sannino, 2004). As show Trematerra and Lucchi (2014) *N. granellus* can develop at temperature as low as 6.4 °C, physical limits for complete development are 7–27 °C at 65–95 % relative humidity; optimum conditions for complete development are 25 °C and 90 % r.h. These authors state that in the US and Canada the complete life cycle of *N. granellus* lasts about 10 weeks. According to Trematerra and Lucchi (2014) this species produces 1–4 generations per year.

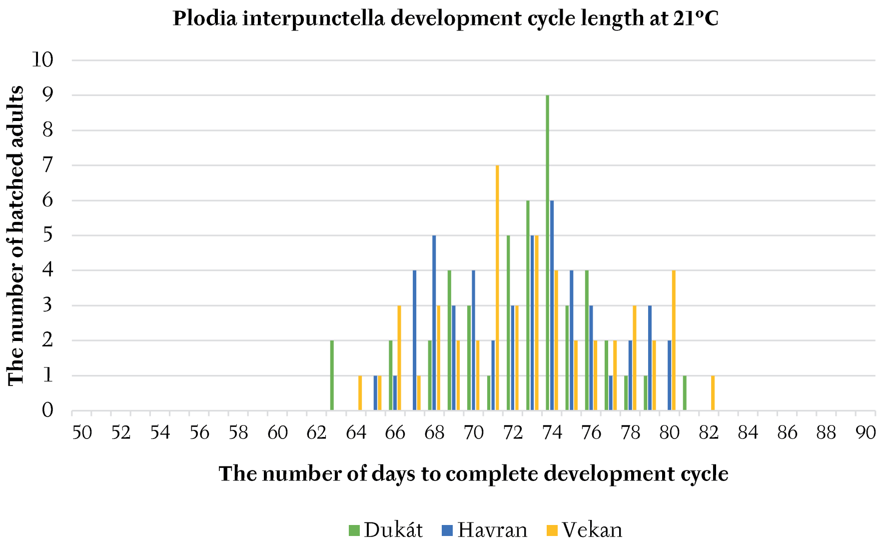
Indian meal moth is a common and very important pest of stored products all over the world, while the European grain moth is common, however it is considered to be an insignificant pest (Rees and Rangsi, 2004). Both of these pests usually feed on stored grain, dried products such as vegetables, fruits and drugs, stored nuts as well as processed food.

Neither *Plodia interpunctella* nor *Nemapogon granellus* have been known as the pests of stored garlic in the Czech Republic until January 2016. Indian meal moth is known and very important pest of stored garlic bulb in Mexico (Perez-Mendoza and Aguilera-Peña, 2004). These authors showed Indian meal moth causes about 30 % of loses on stored garlic.

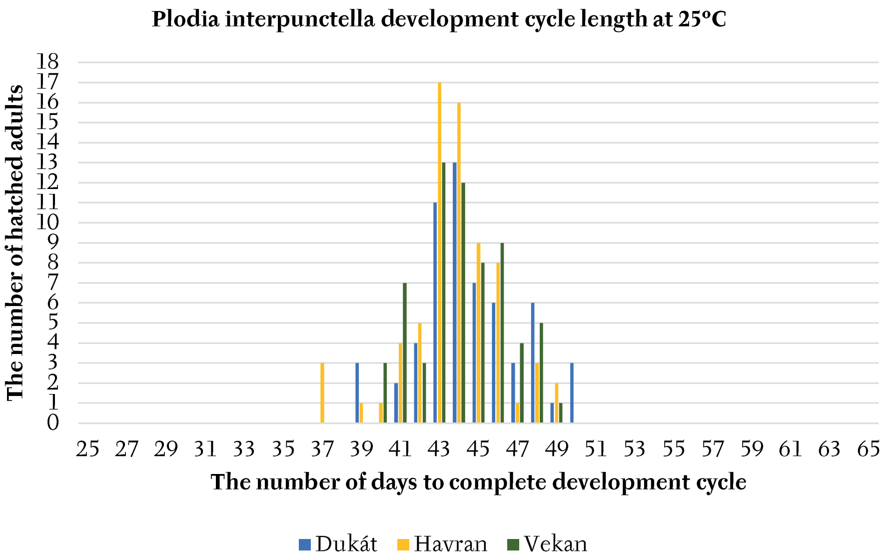
European grain moth was detected as a pest of stored garlic bulb in Italy by Espinosa and Sannino (2004). As show Trematerra and Lucchi (2014) European grain moth is a garlic pest and they found them as an unusual pest on and in corks in a wine cellar.




5: *Indian meal moth development cycle length at 18 °C*




6: *Indian meal moth development cycle length at 21 °C*




7: *Indian meal moth development cycle length at 25 °C*

## CONCLUSION

Indian meal moth (*Plodia interpunctella*) and European grain moth *(Nemapogon granellus)* are common pests of stored product, especially of cereals and processed plants, but they are uncommon pests of stored garlic bulb in the Czech Republic. Due to this fact, the special protection methods are not established yet. We suggest using prevention methods – cleaning, spraying of insecticides or gassed storage before storing new produce. Control measures against these pests are based on monitoring by sexual pheromones or the light traps are necessary. Maintaining storage temperature under the lower threshold (see above) prevents development of these species and seems to be the most suitable method.

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