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INFESTATION OF DIFFERENT GARLIC VARIETIES BY DRY BULB MITE *ACERIA TULIPAE* (KEIFER) (ACARI: ERIOPHYIDAE)

E. Sapáková, L. Hasíková, L. Hřivna, H. Stavělíková, H. Šefrová

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Abstract

SAPÁKOVÁ, E., HASÍKOVÁ, L., HŘIVNA, L., STAVĚLÍKOVÁ, H., ŠEFROVÁ, H.: *Infestation of different garlic varieties by dry bulb mite Aceria tulipae (Keifer) (Acari: Eriophyidae).* Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 6, pp. 293–302

The intensity of garlic infestation by dry bulb mite *Aceria tulipae* (Keifer, 1938) was observed on different garlic varieties in central Moravia. The aim of this study was to determine infestation of different garlic varieties during storage in the winter period 2011–2012. Current studies on 11 garlic varieties from the Centre of the Region Haná at an altitude of 210 m showed high abundance of *Aceria tulipae* on 10 varieties. Bolting garlic varieties (Bzenecky Mutant VF, Sochi 25, Tiraspol, Zailijskij) were highly infested, non-bolting varieties (Czerga, SIR 10 new breeding, Gjirokaster) were infested weakly or not at all (Kelcyre). The highest abundance of mite was found out in semi-bolting garlic variety (Plovdiv Rogosh) with total number up to 1 500 individuals in one clove. Significant differences in infestation between external and internal part of the clove were observed in 4 of 11 evaluated varieties. Root segment was significantly the most infested part of the clove. The most resistant kinds to mite infestation were the Kelcyre, Gjirokaster and SIR 10 new breeding varieties. The highest mite introduction to inside cloves was observed in the Plovdiv Rogosh variety. The choice of suitable varieties can significantly eliminate occurrence of *A. tulipae* and their infestation.

abundance, clove, garlic variety, infestation, pest, plant protection

Garlic is a popular vegetable kind for its high content of vitamins, enzymes and bactericidal effect. It is frequently attacked on a relatively broad spectrum of pathogens and pests during vegetation and storage. *Aceria tulipae* (Keifer, 1938) is known as the main pest on garlic in all production areas all around the world. It thrives on the plants during the growing season and in cloves during storage condition.

The mite *Aceria tulipae* has been known since 1938 from tulip bulbs collected in Sacramento, California originating from the Netherlands (Keifer, 1938). Fifteen years later, an eriophyid species infesting North American wheat and suspected to be vector of the wheat streak mosaic virus was identified as *A. tulipae* by Slykhuis (1953). The last investigations show, that the species on wheat is not conspecific with *A. tulipae* and that the last taxon represented really a complex of species (Perring, 1996).

Kasetsart (1986) describes the morphology of this species in details. Various aspects of biology were studied by numerous authors, e.g. Slykhuis (1953), Sill *et al.* (1959), Rosario *et al.* (1965), Manson (1970), Scalopi *et al.* (1971), Jeppson *et al.* (1975), Wahba *et al.* (1984), Courtin *et al.* (2000), (MacLeod, 2007). Lindquist *et al.* (1996) discuss possibilities of its dispersal. *Aceria tulipae* has been reported from all continents except Antarctica. In Europe its occurrence was registered in Bulgaria, Denmark, Great Britain, Finland, Germany, Hungary, Italy, Holland, Poland, Spain, Yugoslavia (Magowski, 2004). From the Czech Republic it is given as pest of tulips by Dušek (1985), as pest of garlic by Rod (1997).

Symptoms of host plants infestation and caused damage were evaluated by e.g. Lange (1955), Smalley (1956), Lesna *et al.* (2004) and Leeuwen *et al.* (2010). Several authors investigated the species as vector of

viral pathogens (Ostoja-Strazewski & Mattews, 2009, Van Dijk *et al*., 1991). Lesna *et al*. (2004) and Aratchige *et al*. (2007) deal with possible protection from *Aceria tulipae* by predatory mites.

The subject of the study was to evaluate the abundance of mites namely *Aceria tulipae* in 11 garlic varieties during storage condition.

MATERIALS AND METHODS

The garlic varieties analysed in the present experiment were taken from the Centre of the Region Haná for Biotechnological and Agricultural Research, Department of Genetic Resources for Vegetables, Medicinal and Special Plants, Crop Research Institute in Olomouc. The review with geographic origin of evaluated varieties is given in Tab. I. As shown in Tab. I, six varieties (Bzenecky Mutant VF, Sochi 24/1, Sochi 25, Tiraspol, Dushanbijskij 125 and Zailijskij) belong to bolting garlics, four varieties (Czerga, SIR 10new breeding, Gjirokaster and Kelcyre) are non-bolting and the only one Plovdiv-Rogosh is semi-bolting one. The cloves of each variety were taken by camera Canon EOS 50D (Figs. 9–19). The garlic started to be planted in the field conditions of Crop Research Institute in Olomouc-Holice at an altitude of 210 m in the autumn time, 14th and 15th October 2010. The soil was prepared by usual procedures. The manual cleaning of weeds was made during all vegetative period. The insecticide chlorpyriphos-methyl (0.125% Reldan 40 EC) was used for the pest control on 3rd and 4th March 2011 and it was repeated in the course of 14 days again. The harvest time was from 28th–30th June and from 1st–3rd July. The harvest was made manually. Garlic bulbs were cleaned and stems were cut to a length of 10 cm. Then they were put in storage room. The harvesting plants were dried in a special room at 20 °C with suitable air circulation for 30 days. After 150 days of storage at 15 °C and 80% relative humidity mite infestation started to be done. At the beginning the plants were divided into three main morphological groups according to the ability to produce the scape: the first group with the scape (bolting), the second part without the scape (non-bolting garlic) and the third part presents semi-bolting one. The last morphological type has bulbils in the different parts of the pseudostem. According to MacLeod (2007) and Wahba *et al*. (1984) all garlic varieties were kept in chamber at 4 °C to prevent further development of mite cycles. This temperature also slows down migration activity of mites which is necessary for the assessment of mites. From each variety five samples were evaluated. Seven cloves were assessed from each sample. External packagings were carefully removed using laboratory pincette and scalpel. Immediately after taking out from the chamber the mites were counted on the outside and inside of the clove (Fig. 8). Each clove was cut longitudinally, perpendicular to the surface. Subsequently, it was done counting mites on cut surface around the root (root segment), central part (central segment) and stem (peak segment). Mites were counted using microscope Olympus SZX9. The abundance of mites was also evaluated using four classes (Tab. II), as follows: 1st class – 0 abundance, 2nd – 1–100, 3rd – 101–1 000 and 4th > 1 001 individuals. It was carried out by one responsible person to avoid error. The results were processed using analysis of variance followed by Tukey testing, statistics 8 (Figs. 1–7).

RESULTS AND DISCUSSION

Host plants and symptoms

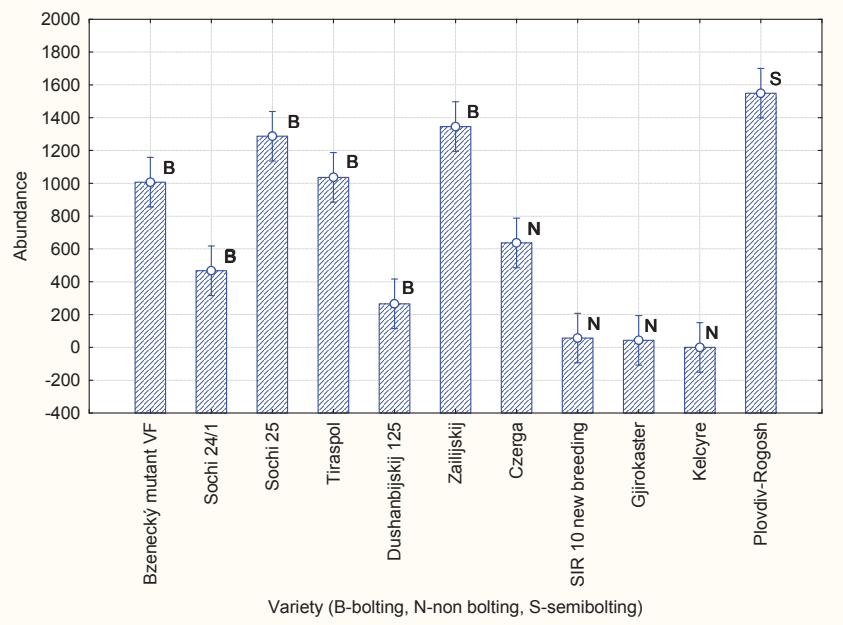
The symptoms on cloves of each variety of our monitoring are shown in Figs. 9–19. The Figs. 9–14 show evident signs of mite damage in bolting garlic varieties. In these photographs drying of clove tissue can also be seen. Symptoms of mite damage

II: *Density classes of Aceria tulipae on a clove*

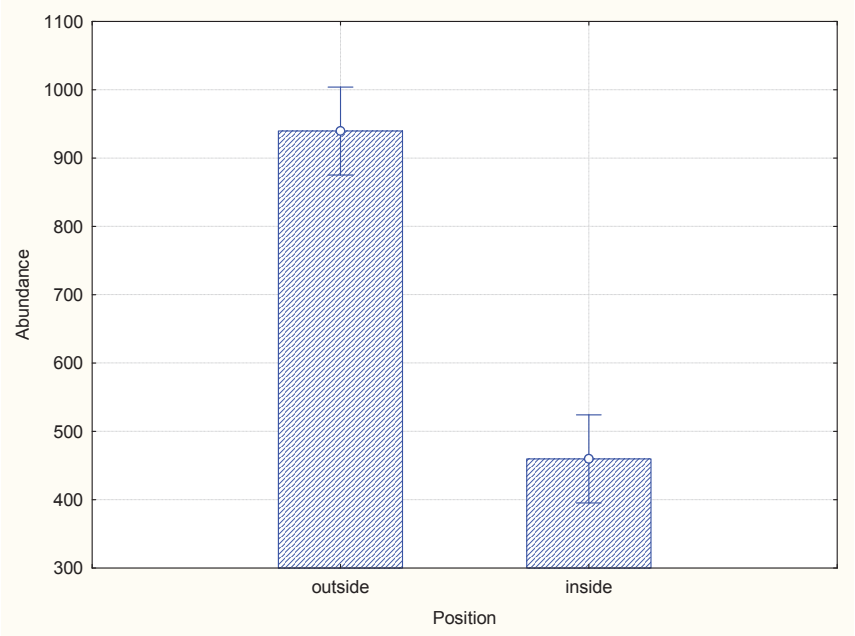
Density	Class	
0	1	zero
1–100	2	low
101–1 000	3	mean
> 1 001	4	strong

I: *The set of garlic varieties*

Type	Name	Country of origin	Figure
bolting	Bzenecky Mutant VF	Czech Republic	9
bolting	Sochi 24\1	Russia	10
bolting	Sochi 25	Russia	11
bolting	Tiraspol	Moldova	12
bolting	Dushanbijskij 125	Tajikistan	13
bolting	Zailijskij	Tajikistan	14
non-bolting	Czerga	Soviet Union	15
non-bolting	SIR 10 new breeding	Soviet Union	16
non-bolting	Gjirokaster	Albania	17
non-bolting	Kelcyre	Albania	18
semi-bolting	Plovdiv-Rogosh	Bulgaria	19



1: *The total number of Aceria tulipae on clove in each variety*

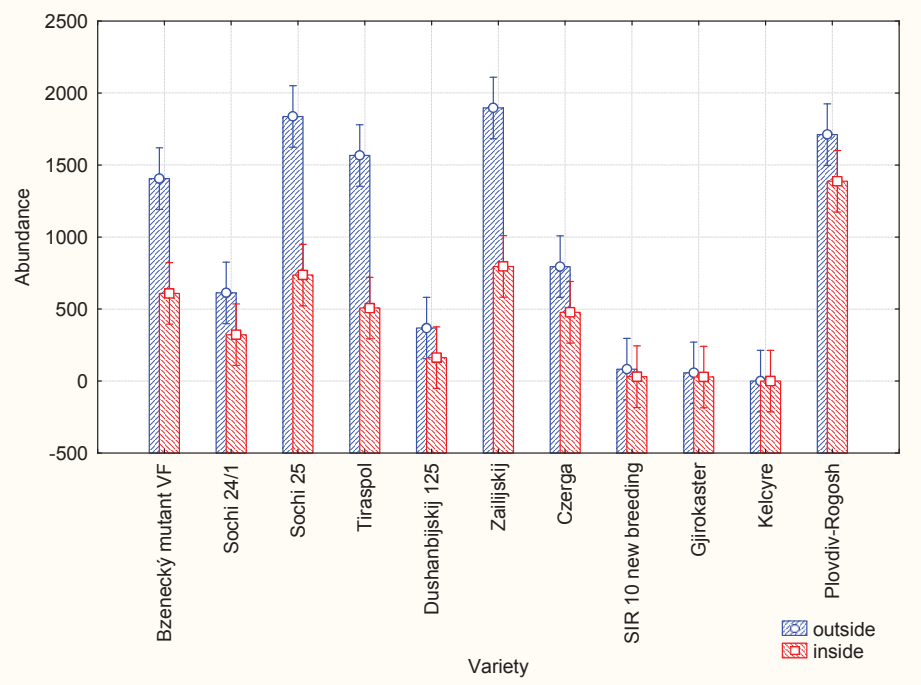


2: *Abundance of Aceria tulipae inside and outside clove*

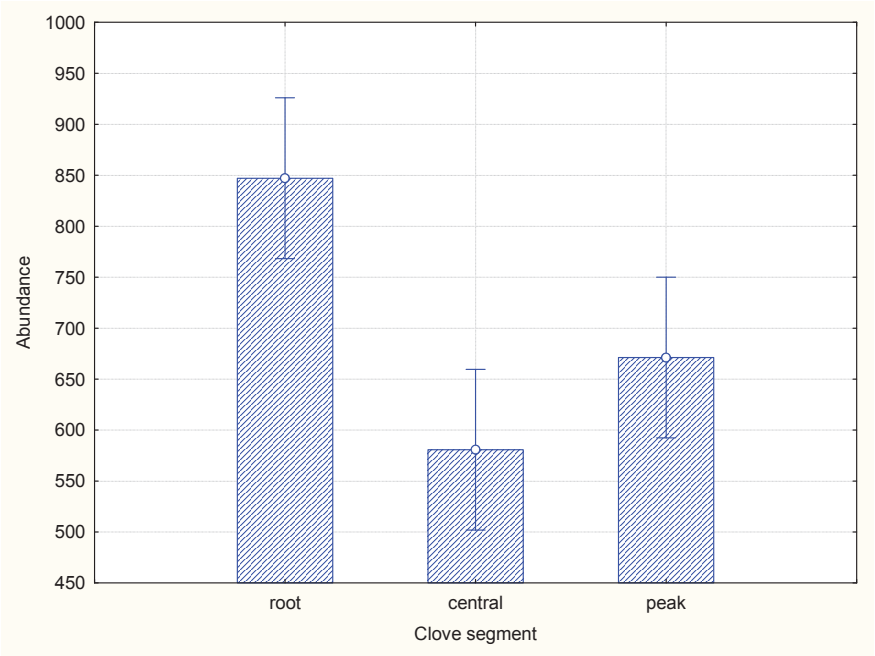
are smaller in non-bolting garlic varieties (Figs. 15–18). In the root segment of the clove dense mite population in semi-bolting garlic variety (Plovdiv-Rogosh) (Fig. 19) can be seen.

Infestation of garlic varieties

The mite *Aceria tulipae* was detected in 10 of 11 evaluated varieties. Bolting garlic varieties (Bzenecky Mutant VF, Sochi 25, Tiraspol, Zailijskij) were highly infested by mite (Fig. 1). Non-bolting garlic varieties (Czerga, SIR 10 new breeding, Gjirokaster) were mite infested weakly or not at all (Kelcyre) (Fig. 1). The highest abundance of mite was in semi-bolting garlic variety (Plovdiv Rogosh) with total number up to 1 500 individuals in a clove (Fig. 1). In 4 of 11 varieties were observed significant differences in infestation between external and internal part of the clove (Fig. 2). The differences were no significant for the other varieties. The biggest difference was observed in the varieties: Sochi 25, Zailijskij and Tiraspol between internal and external part of clove (Fig. 3). For all varieties infestation was higher outside clove except the Kelcyre variety (Fig. 3). Occurrence of mites on clove

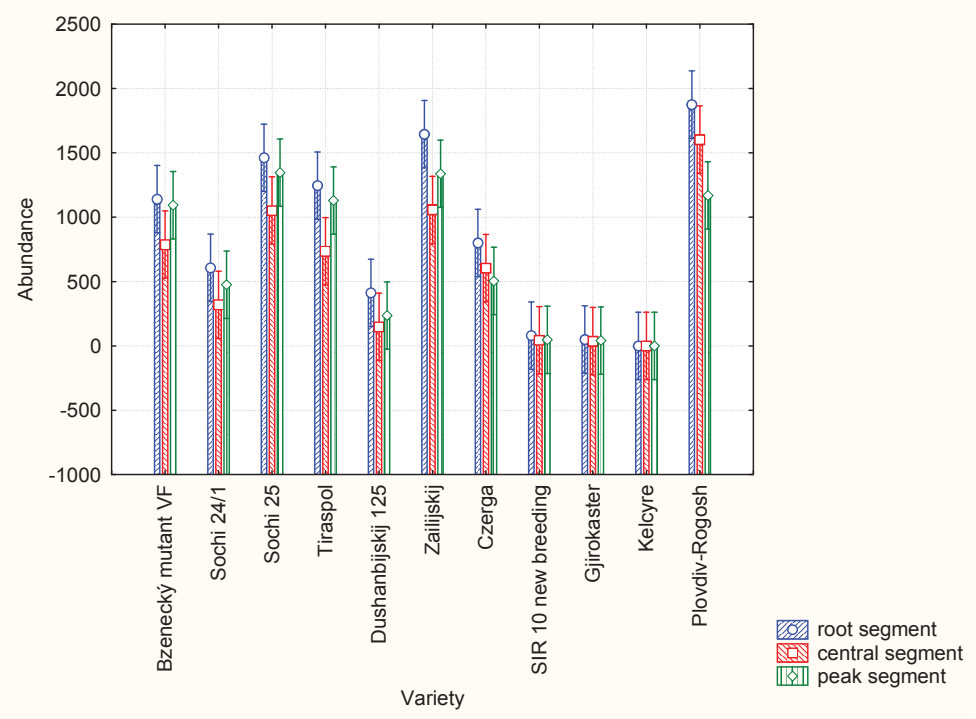


3: *Occurrence of Aceria tulipae inside and outside clove of each variety*

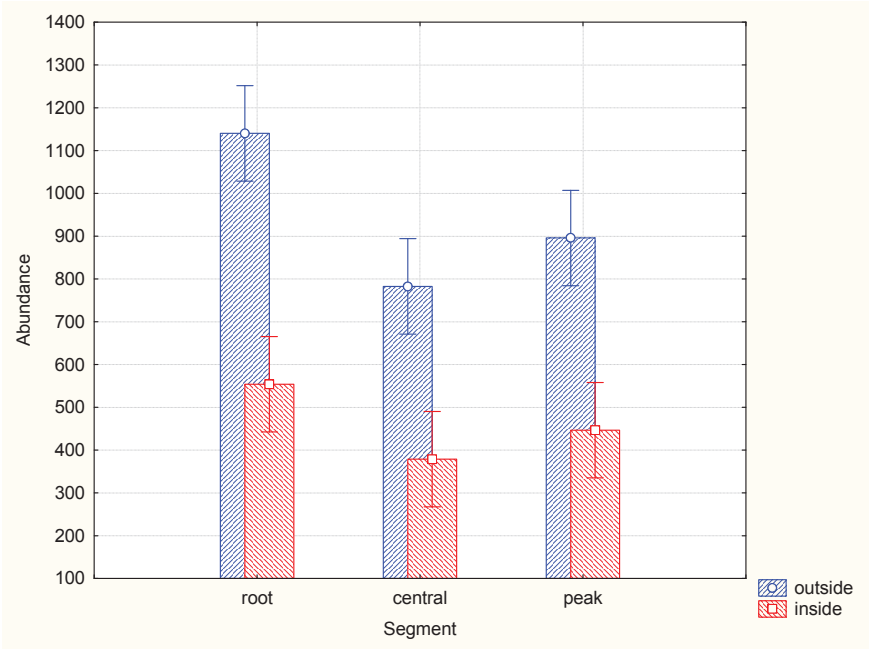


4: *Distribution of Aceria tulipae on clove*

was not homogeneous. Significantly root segment was the most infested part of the clove (Fig. 4). The lowest occurrence of mites was in the middle segment (Fig. 4). The variability of occurrence was not as significant as in the evaluation of the whole set of outside and inside cloves (Fig. 5). Significant differences in the occurrence were observed on a single clove segment only in the varieties Zailiskij and Plovdiv Rogosh. Generally, occurrence of mites on all segments of the clove was lower inside than on the outside part of clove (Fig. 6). The root segment was the most attacked by mites and the central segment was the least attacked (Fig. 6). The biggest difference between the level of infestation outside and inside the clove was observed in the root segment (Fig. 6). Fig. 7 shows that the most resistant kinds to mite infestation were the Kelcyre, Gjirokaster and SIR 10 new breeding varieties. In

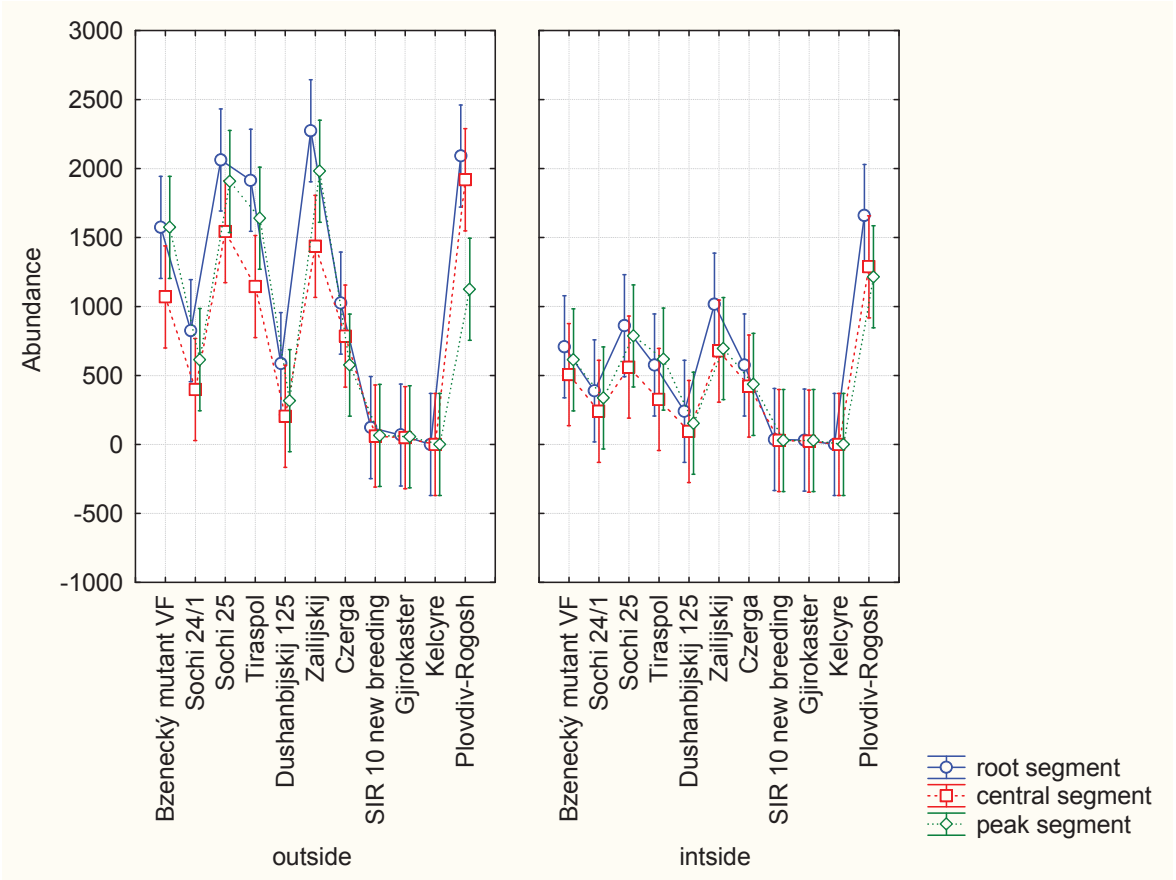


5: *Occurrence of Aceria tulipae on segments of the varieties*



6: *Occurrence of Aceria tulipae on inside and outside individual segment cloves*

these varieties, occurrence of mites was zero or very low. On the contrary, high infestation on the inside clove showed the varieties Zailiskij, Sochi 25 and Tiraspol (Fig. 7). These varieties have originated in eastern Eurasian countries. The average to higher values were observed in the Czech Bzenecky Mutant VF variety. The highest mite introduction to inside cloves was observed in the Plovdiv Rogosh variety. The highest mite infestation was in the direction from root in all infested varieties. Kelcyre variety belongs to the 1st class of abundance, varieties (Sir 10 new breeding, Gjirokaster) to the 2nd class, Bzenecky Mutant VF, Tiraspol, Sochi 24/1, Dushanbijskij 125 and Czerga varieties to the 3rd class and Sochi 25, Zailijskij and Plovdiv-Rogosh varieties to the 4th class (Tab. III).



7: *Occurrence of Aceria tulipae (interaction among variety × segment × position)*

III: *Density of Aceria tulipae in individual varieties of garlic*

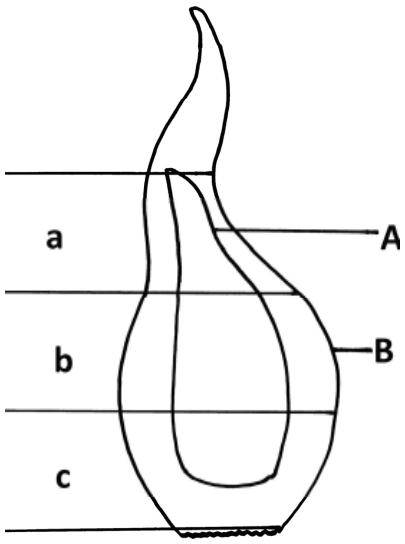
Class	Variety
1	Kelcyre
2	Sir 10 new breeding, Gjirokaster
3	Bzenecky Mutant VF, Tiraspol, Sochi24/1, Dushanbijskij 125, Czerga
4	Sochi 25, Zailijskij, Plovdiv-Rogosh

Scalopi *et al.* (1971) evaluated 5 garlic varieties and observed similar damage. They coined a new term, "whip-tailed" leaves, to describe this damage. In our research, we observed similar symptoms above mentioned on the leaves during vegetation. We can also confirm drying of bulb tissue during storage condition.

Host plant protection possibilities

Our experiments proved that the choice of suitable varieties can significantly eliminate occurrence of mites and their infestation. From this viewpoint the Kelcyre variety seems to be the best one, which was inert to the infestation. The resistance of this variety is probably caused by the formation of compact bulbs. The individual cloves are protected by close fitting packagings. These packagings prevent the entry of pests on the outside or inside part of the clove. On the other hand, the Zailiskij and Plovdiv Rogosh varieties are less suitable for storage. Possible solutions of resistance of some varieties are very limited.

MacLeod (2007) mentions the development of *A. tulipae*, some individuals can survive in condition



8: *Longitudinal section of clove (a – root segment, b – central segment, c – peak segment, A – inside, B – outside)*

9–19: *Garlic cloves infested by Aceria tulipae (9 – Bzenecky Mutant VF, 10 – Sochi 24/1, 11 – Sochi 25, 12 – Tiraspol, 13 – Dushanbijskij 125, 14 – Zailijskij, 15 – Czerga, 16 – SIR 10 new breeding, 17 – Gjirokaster, 18 – Kelcyre, 19 – Plovdiv-Rogosh)*

at –25 °C. Such cold tolerance does not allow the use of refrigeration as a control method because garlic bulbs do not withstand temperature below –4 °C. Wahba *et al.* (1984) discusses about cool temperatures that prevent population growth during the winter although eggs, nymphs and adults are able to survive in the bulbs for extended periods either in storage or in bulbs left in the soil during winter. Although hosts are only grown outdoors, this pest could establish in the protected environments of *Allium* storage facilities. MacLeod (2007) recommends before planting hot water treatment of bulbs (55 °C for 10–20 min, or 60 °C for 10–15 min). This treatment can reduce mite populations, but such temperatures also reduce bulb germination. Soaking garlic for 24 hours in 2% soap (not detergent) and 2% mineral oil has been reported to provide good mite control. Therefore *Aceria tulipae* requires high humidity to thrive, so following harvest, infestations can be controlled with the normal drying process prior to bulb storage. Measures to prevent the movement of infested bulbs, soil or foliage between growing sites and storage facilities would inhibit spread. Thus, a moderate cold only postpones problems, because it stops population development, but not their survival.

Understanding ecological and genetic aspects of eriophyid invasions could help to defuse mitigation measures and management strategies. Knowledge of host specificity and adaptation to new host plants of eriophyid species could be useful in risk evaluation and in guiding the adoption of control measures (Michalska *et al.*, 2009).

CONCLUSIONS

We have reached the following conclusions from the attack of *Aceria tulipae*:

The different resistance to mite infestation was proved:

- The Kelcyre variety was not attacked by mites.
- The highest abundance of mites was in Plovdiv Rogosh variety with total number up to 1500 mites (adults, nymphs, eggs) in one clove.

- Significantly the external clove part was the most infested.
- Significantly the internal clove part was the least infested.
- Generally, the highest abundance of mites was significantly higher on the root segment of external than on internal clove part.
- The eliminating the occurrence of mites on garlic cloves results from resistance to attack individual varieties.
- The assessment, the suitability of varieties considered in the specific economic characteristics: yield and resistance to pests and pathogens.

SUMMARY

Aceria tulipae (Keifer, 1938) is known as the main pest on garlic in all production areas around the world. It thrives on the plants during the growing season and in cloves during storage conditions. It has been known since 1938 from tulip bulbs collected in California originating from the Netherlands. It is reported from all continents except Antarctica.

Current studies on 11 garlic varieties from the Centre of the Region Haná at an altitude of 210 m showed high abundance of *Aceria tulipae* on 10 of them. The aim of this study was to determine infestation of different garlic varieties during storage. Bolting garlic varieties (Bzenecky Mutant VF, Sochi 25, Tiraspol, Zailijskij) were highly infested. Non-bolting garlic varieties (Czerga, SIR 10 new breeding, Gjirokaster) were infested weakly or not at all (Kelcyre). The highest abundance of mite was in semi-bolting garlic variety (Plovdiv Rogosh) with total number up to 1 500 individuals in one bulb. Kelcyre variety belongs to the 1st class of abundance, varieties (Sir 10 new breeding, Gjirokaster) to the 2nd class, Bzenecky Mutant VF, Tiraspol, Sochi 24/1, Dushanbijskij 125 and Czerga varieties to the 3rd class and Sochi 25, Zailijskij and Plovdiv-Rogosh ones to the 4th class (Tab. III). In 4 of 11 evaluated varieties were observed significant difference in infestation between external and internal part of the clove. Significantly root segment was the most infested part of the clove. The most resistant kind to mite infestation were the Kelcyre, Gjirokaster and SIR 10 new breeding varieties. The highest mite introduction to inside cloves was observed in the Plovdiv Rogosh variety. The highest mite infestation was proved in the direction from root in all infested varieties. The choice of suitable varieties can significantly eliminate occurrence of *A. tulipae* and their infestation.

The resistance of varieties is probably caused by the formation of compact bulbs. Hot water treatment of bulbs before planting (55 °C for 10–20 min, or 60 °C for 10–15 min) can reduce mite populations, but also reduce bulb germination. Soaking garlic for 24 hours in 2% soap (not detergent) and 2% mineral oil has been reported to provide suitable mite control. Infestation can be controlled with the normal drying process prior to bulb storage. Measures to prevent the movement of infested bulbs, soil or foliage between growing sites and storage facilities would inhibit spreading.

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Address

Ing. Eva Sapáková, Ústav pěstování, šlechtění rostlin a rostlinolékařství, Mgr. Lea Hasíková, Ústav jazykových a kulturních studií, doc. Ing. Dr. Luděk Hřivna, Ústav technologie potravin, Mendelova univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika, Ing. Helena Stavělíková, Ph.D., Výzkumný ústav rostlinné výroby, v.v.i, Centrum regionu Haná pro zemědělský a biotechnologický a zemědělský výzkum Šlechtitelů 813/21, 783 71 Olomouc, Česká republika, doc. Ing. Hana Šefrová, Ph.D., Ústav pěstování, šlechtění rostlin a rostlinolékařství, Mendelova univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika, e-mail: xsapako0@node.mendelu.cz, lea.hasikova@ mendelu.cz, ludek.hrivna@ mendelu.cz, stavelikova@ genobanka.cz, sefrova@mendelu.cz