PERIODICUM BIOLOGORUM
VOL. 119, No 2, 131–135, 2017
DOI: 10.18054/pb.v119i2.4935

UDC 57:61
CODEN PDBIAD
ISSN 0031-5362

short communication

Severe damage to vegetables by the invasive brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae), in Hungary

GÁBOR VÉTEK[1]
DÁVID KORÁNYI[1,2]

[1] Szent István University, Department of Entomology, Villányi út 29–43, H-1118 Budapest, Hungary

[2] University of Pannonia, Department of Animal Science, Deák Ferenc utca 16, H-8361 Keszthely, Hungary

Correspondence:
Gábor Vétek
E-mail: Vetek.Gabor@kertk.szie.hu

Abbreviations:
BMSB – brown marmorated stink bug

Keywords: alien pest; BMSB; dry bean; green hot pepper

Abstract

Background and purpose: *The brown marmorated stink bug (BMSB),* Halyomorpha halys, *is native to East Asia and has recently become an invasive pest in North America and Europe. It is considered a nuisance pest as well as a significant economic pest causing damage to a wide range of crops. Following its first record in Budapest, Hungary, in 2013, repeated reports confirmed its establishment in the country. In late summer 2016, growers began to complain about stink bug damage to dry bean and forced green hot pepper, both grown in the vicinity of a site in Budapest where BMSB had been present for at least the past three years. The aims of our study were to identify if the damage in green hot pepper and dry bean has been caused by BMSB and to estimate the level of the damage.*

Materials and methods: *We collected 50 dry bean pods ('Etna') randomly from a 0.1 ha large plot on 2 September, and we checked the seeds in each pod for the symptoms of feeding in the laboratory. To assess the rate of damaged hybrid green hot pepper ('Daras') fruits, 100 fruits picked by the grower in a greenhouse were studied in situ on 8 September for damage from stink bugs. A vacuum device was used to collect stink bug samples from both sites.*

Results: *We found damaged seeds in 47 dry bean pods (94%), and all the green hot pepper fruits (100%) were affected. We identified BMSB as the causal organism in both cases.*

Conclusions: *Our results call the attention to the severe threat posed by BMSB to the European crop production.*

Received January 30, 2017.
Revised May 22, 2017.
Accepted July 03, 2017.

INTRODUCTION

The invasive alien brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) is native to China, Korea, Taiwan, Japan, and northern Vietnam (*1, 2*), and has been introduced in the USA as well as in Europe, where it was first recorded in Switzerland in 2004 (*3, 4, 5*). Soon afterwards, it has also been recorded in Liechtenstein, Greece, Germany, France, Italy and Hungary (*6*). Recent records include Austria (*7*), Romania (*8*), Serbia (*9*), Russia (*10, 13*), Spain (*11*), Bulgaria (*12*), Abkhazia, Georgia (*13*) and Slovakia (*14*). In the UK, BMSB was first intercepted in passenger luggage arriving from the USA in 2010, and then later, in 2013, in a consignment of stone imported from China (*15*).

Figure 1. *Stink bug damage symptoms on an 'Etna' dry bean seed (Photo: D. Korányi)*

The first records of BMSB in Hungary date back to 2013, when a few individuals were found at two locations in Budapest, and one specimen was photographed at Ócsa. In 2014, many detections were reported from different parts of the capital (*16*, *17*, *18*). In 2015, BMSB was found at further locations, namely Budakalász and Martonvásár (*19*). As a result of a public survey initiated in autumn 2016, the species was soon reported as present at additional sites in various parts of Hungary, however, mass occurrence (out of Budapest and its close region) was observed only at Pécs (South Hungary) (*20*).

Brown marmorated stink bug has been documented feeding on a wide range of plant species worldwide, including economically important plants, with many of them reported as having suffered major damage (e.g. *3*, *21*, *22*, *23*, *24*, *25*, *26*, *27*). Several vegetables have already been identified as being at a risk of heavy infestation by the pest, but the significance of BMSB in this group of crops seems to have been studied less so far (e.g. *28*, *29*, *30*, *31*, *32*, *33*). Beans (in particular *Phaseolus vulgaris* L.) and peppers (*Capsicum annuum* L.), the plants being in the focus of our survey, have been shown to be attractive hosts of the stink bug species (*23*, *25*, *29*, *30*, *31*, *32*, *33*). Symptoms of damage differ according to the plant species affected, and these have been described and illustrated by Kuhar et al. (*29*) and Rice et al. (*25*).

The objective of our study was to reveal if BMSB has caused the damage on dry bean and forced green hot pepper. We have also tried to estimate the level of BMSB damage in these crops.

MATERIALS AND METHODS

We conducted the study in the area of the Experimental and Research Farm of the Szent István University, Budapest, Hungary, in September 2016. Neither the dry bean ('Etna') nor the forced hybrid green hot pepper ('Daras') were sprayed with any insecticides prior to the survey.

For the dry bean 'Etna' we collected 50 pods randomly on a 0.1 ha large dry bean field (6 rows of 100 m length each, 2 m row spacing) (47.4033°N, 19.1498°E), on 2 September. We used a vacuum device (McCulloch BVM 250) to collect 6 insect samples, each from a separate row, along a diagonal transect of the plot. The No. 1–6 samples contained the stink bugs which were present on bean plants growing between the 7–8th, 25–26th, 42–43rd, 59–60th, 76–77th, and 93–94th metres of the row. We checked all the seeds in each collected pod for the symptoms of feeding, and determined the stink bug species and their numbers present in the samples in the laboratory of the Department of Entomology, Szent István University.

The studied hybrid green hot pepper 'Daras' was grown together with other 48 pepper cultivars and candidate varieties in a 0.15 ha large Filclair plastic greenhouse (47.3973°N, 19.1519°E). We checked *in situ* 100 'Daras' fruits chosen randomly from the items just harvested by the grower on 8 September. The number of fruits showing stink bug damage symptoms was recorded. We collected 5 insect samples from 2 parallel 'Daras' rows (50 m long each, 0.9 m row spacing) by using the aforementioned vacuum device on 9 September. Sample No. 1 was taken at the 5th metre of the adjacent rows, and the samples No. 2–5 were collected at the 15th, 25th, 35th, and 45th metres, respectively, of both rows. Each sample included insects present on 8 (4–4 opposing) plants of ca. 2.8 m height.

Figure 2. *Mass occurrence of BMSB nymphs in the studied 'Etna' dry bean plot at Budapest, 2 September 2016 (Photo: G. Vétek)*

Figure 3. *Stink bug damage symptoms on green hot pepper (Photo: G. Vétek)*

RESULTS

In the case of the 'Etna' dry bean samples, we found at least one damaged seed (Fig. 1) in 47 pods (94%), and in 20 pods (40%) all the seeds were damaged. This means that less than 10% of the pods could be estimated as having remained unaffected by stink bugs by early September, close to harvest. Only two phytophagous stink bug species, *Halyomorpha halys* and *Nezara viridula* (L.) were present in the samples collected with the vacuum device, with total numbers of 176 and 19, respectively. Regarding BMSB, each sample was largely dominated by nymphs (Fig. 2). Their rate in the 6 samples as a total was 98.9%. We found the largest numbers of BMSB individuals in samples No. 1 (62 nymphs, 0 adult) and 6 (57 nymphs, 1 adult female), representing the two opposite corners along the diagonal transect of the dry bean plot. We recorded the smallest numbers of specimens (4 nymphs in sample No. 3, and 13 nymphs and 1 adult female in sample No. 4) in the middle of the plot.

In the forced hybrid green hot pepper ('Daras'), we could identify stink bug damage symptoms (Fig. 3) on each fruit of the collected sample, which means 100% damage. BMSB was the only stink bug species collected (6 nymphs) with the vacuum device. We could also find exuviae of BMSB nymphs in samples No. 2–5.

DISCUSSION

Our results show that following the first detection of BMSB at Péterimajor (also within the territory of the Experimental and Research Farm), Budapest, in autumn 2013 (*16*), populations of the pest reached densities within a couple of years that could cause significant damage to the studied crops. Although we do not have season-long data on the occurrence of stink bug species either in the dry bean or the forced green hot pepper, we have been informed by the growers that prior to the (mass) occurrence of the „brown stink bugs", identified as *H. halys* during this study, only a few individuals of *N. viridula* could be observed in both crops. Moreover, populations of *N. viridula*, the only phytophagous stink bug species found besides BMSB, remained insignificant also in early September. The clear dominance and high abundance of BMSB nymphs (and exuviae) present and the severe feeding damage recorded in the two crops confirm the results of previous studies (e.g. *25*, *29*, *31*, *32*) that bean and pepper are major hosts of BMSB.

The high abundance of specimens found close to the borders of the bean field seems to indicate the edge effect described by Venugopal et al. (*34*). In our case, the bean was surrounded on three sides by wooded areas, which might be the sources of invasion. The strong dispersal capacity of BMSB nymphs (*35*) might also lead to the heavy infestation of the bean field.

Compared to the high level of damage, the relatively small number of BMSB specimens collected from the pepper on 9 September might be explained partly by that the individuals might be present on comparatively small numbers on the plants during the morning hours when the samples were taken. The growers here experienced higher activity of BMSB specimens during the sunny daylight hours. Furthermore, previous plant manipulations (regular pruning in the growing period; the latest one was carried out a week before the sampling) resulting in less dense foliage the specimens could rest on and be concealed in (*36*) might also lead to moderate catches. Symptoms on fruits, however, could develop due to feeding at any time during fruit development and ripening. Nevertheless, this phenomenon requires further investigations.

As the Extra class and Class I green hot pepper is sold by the piece, even some minor aesthetic feeding damage caused by stink bugs and noticed by the customer may result in a price drop. Although the exact economic loss due to the stink bug damage alone would be difficult to calculate, we could see that many of the affected peppers had to be categorized into a lower class, depending on the severity of the symptoms, meaning a reduced price. Furthermore, the need for an intervention with a combination of broad-spectrum insecticides (with the active substances thiamethoxam and deltamethrin) in September so as to moderate damage by BMSB caused not only extra costs but also led to the disruption of the biological pest management program conducted successfully prior to the occurrence of the stink bug species in the greenhouse.

This is an early report of damage to vegetables by BMSB in Europe. Scientific reports on damage to any crops by BMSB all over the continent are still rather limited, and are concentrated to the regions of Switzerland and Italy (*6*, *36*, *37*, *38*, *39*), although there is a recent report also from Romania (*40*). Hopefully, the results of our survey can call the attention to the rapidly increasing threat posed by this pest to the European plant production, including the vegetable-growing sector, and may

facilitate a rapid response to prevent or at least to moderate the number of major damage events in the future.

Acknowledgements: *We are grateful to the management, especially Zsuzsanna Julianna Helfné Szabó and Krisztiánné Kis, and staff of the Experimental and Research Farm of the Szent István University for their assistance during our work.*

This paper was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences, and by the COST Action TD1209, European Information System for Alien Species.

REFERENCES

1. JOSIFOV MV, KERZHNER IM 1978 Heteroptera aus Korea. II. Teil (Aradidae, Berytidae, Lygaeidae, Pyrrhocoridae, Rhopalidae, Alydidae, Coreidae, Urostylidae, Acanthosomatidae, Scutelleridae, Pentatomidae, Cydnidae, Plataspidae). [Heteroptera from Korea. II. Part (Aradidae, Berytidae, Lygaeidae, Pyrrhocoridae, Rhopalidae, Alydidae, Coreidae, Urostylidae, Acanthosomatidae, Scutelleridae, Pentatomidae, Cydnidae, Plataspidae).] Fragm Faun 23 (9): 137–196 [in German]
2. RIDER DA, ZHENG LY, KERZHNER IM 2002 Checklist and nomenclatural notes on the Chinese Pentatomidae (Heteroptera). II. Pentatominae. Zoosystematica Rossica 11 (1): 135–153
3. HOEBEKE ER, CARTER ME 2003 *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae): a polyphagous plant pest from Asia newly detected in North America. P Entomol Soc Wash 105: 225–237
4. WERMELINGER B, WYNIGER D, FORSTER B 2008 First records of an invasive bug in Europe: *Halyomorpha halys* Stål (Heteroptera: Pentatomidae), a new pest on woody ornamentals and fruit trees? Mitteilungen der Schweizerischen entomologischen Gesellschaft 81: 1–8
5. HAYE T, ABDALLAH S, GARIEPY T, WYNIGER D 2014 Phenology, life table analysis, and temperature requirements of the invasive brown marmorated stink bug, *Halyomorpha halys*, in Europe. J Pest Sci 87: 407–418. https://doi.org/10.1007/s10340-014-0560-z
6. HAYE T, GARIEPY T, HOELMER K, ROSSI J-P, STREITO J-C, TASSUS X, DESNEUX N 2015 Range expansion of the invasive brown marmorated stinkbug, *Halyomorpha halys*: an increasing threat to field, fruit and vegetable crops worldwide. J Pest Sci 88: 665–673. https://doi.org/10.1007/s10340-015-0670-2
7. RABITSCH W, FRIEBE GJ 2015 From the west and from the east? First records of *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) in Vorarlberg and Vienna, Austria. Beiträge zur Entomofaunistik 16: 126–129
8. MACAVEI LI, BÂEȚAN R, OLTEAN I, FLORIAN T, VARGA M, COSTI E, MAISTRELLO L 2015 First detection of *Halyomorpha halys* Stål, a new invasive species with a high potential of damage on agricultural crops in Romania. Lucrări Ştiinţifice, Universitatea de Ştiinţe Agricole şi Medicină Veterinară Iaşi, seria Agronomie 58 (1): 105–108
9. ŠEAT J 2015 *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) a new invasive species in Serbia. Acta entomologica serbica 20: 167–171
10. MITYUSHEV IM 2016 First record of marmorated bug detection in Russia. Zashchita i karantin rasteniy 3: 48 [in Russian]
11. DIOLI P, LEO P, MAISTRELLO L 2016 Prime segnalazioni in Spagna e in Sardegna della specie aliena *Halyomorpha halys* (Stål, 1855) e note sulla sua distribuzione in Europa (Hemiptera, Pentatomidae). [First records in Spain and Sardinia of the alien species *Halyomorpha halys* (Stål, 1855), with notes on its distribution in Europe (Hemiptera, Pentatomidae).] Revista gaditana de Entomología 7 (1): 539–548 [in Italian and Spanish]
12. SIMOV N 2016 The invasive brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) already in Bulgaria. Ecol Mont 9: 51–53
13. GAPON DA 2016 First records of the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera, Pentatomidae) in Russia, Abkhazia, and Georgia. Entomological Review 96 (8): 1086–1088. https://doi.org/10.1134/S001387381608011X
14. HEMALA V, KMENT P 2017 First record of *Halyomorpha halys* and mass occurrence of *Nezara viridula* in Slovakia (Hemiptera: Heteroptera: Pentatomidae). Plant Protect Sci doi: 10.17221/166/2016-PPS
15. MALUMPHY C 2014 Second interception of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) in Britain. Het News 21: 4–5
16. VÉTEK G, PAPP V, HALTRICH A, RÉDEI D 2014 First record of the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Heteroptera: Pentatomidae), in Hungary, with description of the genitalia of both sexes. Zootaxa 3780 (1): 194–200. https://doi.org/10.11646/zootaxa.3780.1.8
17. PAPP V, RÉDEI D, HALTRICH A, VÉTEK G 2014 Az ázsiai márványospoloska [*Halyomorpha halys* (Stål, 1855)] (Heteroptera: Pentatomidae) Magyarországon. [Brown marmorated stink bug [*Halyomorpha halys* (Stål, 1855)] (Heteroptera: Pentatomidae) in Hungary.] Növényvédelem 50 (11): 489–495 [in Hungarian]
18. KORÁNYI D, HALTRICH A, MARKÓ V, VARGA Á 2015 Városi környezetbe ültetett juharfajok Heteroptera együttese. [Heteroptera community of urban maple trees.] Növényvédelem 51 (8): 363–370 [in Hungarian]
19. VÉTEK G 2016 Az ázsiai márványospoloska (*Halyomorpha halys*). [The brown marmorated stink bug (*Halyomorpha halys*).] Agrofórum 27 (8): 42–47 [in Hungarian]
20. MÉSZÁROS Á 2016 Az ázsiai márványospoloska [*Halyomorpha halys* (Stål,1855)] első észlelése Nyugat-Magyarországon. [First data of the brown marmorated stink bug [*Halyomorpha halys* (Stål,1855)] from West-Hungary.] Cinege 21: 52–54 [in Hungarian]
21. BERNON G 2004 Biology of *Halyomorpha halys*, the brown marmorated stink bug (BMSB). USDA APHIS CPHST, 17. Final Report – USDA APHIS CPHST 2004 T3P01.
22. NIELSEN AL, HAMILTON GC 2009 Life history of the invasive species *Halyomorpha halys* (Hemiptera: Pentatomidae) in northeastern United States. Ann Entomol Soc Am 102 (4): 608–616. https://doi.org/10.1603/008.102.0405
23. LESKEY TC, HAMILTON GC, NIELSEN AL, POLK DF, RODRIGUEZ-SAONA C, BERGH JC, HERBERT DA, KUHAR TP, PFEIFFER D, DIVELY GP, HOOKS CRR, RAUPP MJ, SHREWSBURY PM, KRAWCZYK G, SHEARER PW, WHALEN J, KOPLINKA-LOEHR C, MYERS E, INKLEY D, HOELMER KA, LEE D-H, WRIGHT SE 2012 Pest status of the brown marmorated stink bug, *Halyomorpha halys* in the USA. Outlooks on Pest Management 23 (5): 218–226. https://doi.org/10.1564/23oct07
24. LEE D-H, SHORT BD, JOSEPH SV, BERGH JC, LESKEY TC 2013 Review of the biology, ecology, and management of *Halyomorpha halys* (Hemiptera: Pentatomidae) in China, Japan, and the Republic of Korea. Environ Entomol 42 (4): 627–641. https://doi.org/10.1603/EN13006
25. RICE KB, BERGH CJ, BERGMANN EJ, BIDDINGER DJ, DIECKHOFF C, DIVELY G, FRASER H, GARIEPY T, HAMILTON G, HAYE T, HERBERT A, HOELMER K, HOOKS CR, JONES A, KRAWCZYK G, KUHAR T, MARTINSON H, MITCHELL W, NIELSEN AL, PFEIFFER DG, RAUPP MJ, RODRIGUEZ-SAONA C, SHEARER P, SHREWSBURY P,

VENUGOPAL PD, WHALEN J, WIMAN NG, LESKEY TC, TOOKER JF 2014 Biology, ecology, and management of brown marmorated stink bug (Hemiptera: Pentatomidae). J Integ Pest Mngmt 5 (3): 1–13. https://doi.org/10.1603/IPM14002

26. BAKKEN AJ, SCHOOF SC, BICKERTON M, KAMMINGA KL, JENRETTE JC, MALONE S, ABNEY MA, HERBERT DA, REISIG D, KUHAR TP, WALGENBACH JF 2015 Occurrence of brown marmorated stink bug (Hemiptera: Pentatomidae) on wild hosts in nonmanaged woodlands and soybean fields in North Carolina and Virginia. Environ Entomol 44 (4): 1011–1021. https://doi.org/10.1093/ee/nvv092

27. BERGMANN EJ, VENUGOPAL PD, MARTINSON HM, RAUPP MJ, SHREWSBURY PM 2016 Host plant use by the invasive *Halyomorpha halys* (Stål) on woody ornamental trees and shrubs. PLoS ONE 11 (2): e0149975. https://doi.org/10.1371/journal.pone.0149975

28. FUKUOKA T, YAMAKAGE H, NIIYAMA T 2002 Damage to vegetables by the brown marmorated stink bug. Ann Rept Plant Prot North Japan 53: 229–231

29. KUHAR TP, KAMMINGA KL, WHALEN J, DIVELY GP, BRUST G, HOOKS CRR, HAMILTON G, HERBERT DA 2012 The pest potential of brown marmorated stink bug on vegetable crops. Plant Health Progress doi:10.1094/PHP-2012-0523-01-BR

30. KUHAR T, MOREHEAD A, DIMEGLIO T 2015 Diagnosing stink bug injury to vegetables. Virginia Tech. ENTO-173NP

31. KUHAR T, MORRISON R, LESKEY T, AIGNER J, DIVELY G, ZOBEL E, BRUST J, WHALEN J, CISSEL B, WALGENBACH J, RICE K, FLEISCHER S, RONDON S 2016 Integrated pest management for brown marmorated stink bug in vegetables. Brown Marmorated Stink Bug SCRI CAP Vegetable Commodity Team in conjunction with the Northeastern IPM Center

32. ZOBEL ES, HOOKS CRR, DIVELY GP 2016 Seasonal abundance, host suitability, and feeding injury of the brown marmorated stink bug, *Halyomorpha halys* (Heteroptera: Penatomidae), in selected vegetables. J Econ Entomol 109: 1289–1302. https://doi.org/10.1093/jee/tow055

33. PHILIPS CR, KUHAR TP, DIVELY GP, HAMILTON G, WHALEN J, KAMMINGA K 2017 Seasonal abundance and phenology of *Halyomorpha halys* (Hemiptera: Pentatomidae) on different pepper cultivars in the mid-Atlantic (United States). J Econ Entomol 110 (1): 192–200 https://doi.org/10.1093/jee/tow256

34. VENUGOPAL PD, COFFEY PL, DIVELY GP, LAMP WO 2014 Adjacent habitat influence on stink bug (Hemiptera: Pentatomidae) densities and the associated damage at field corn and soybean edges. PLoS ONE 9 (10): e109917. https://doi.org/10.1371/journal.pone.0109917

35. LEE D-H, NIELSEN AL, LESKEY TC 2014 Dispersal capacity and behavior of nymphal stages of *Halyomorpha halys* (Hemiptera: Pentatomidae) evaluated under laboratory and field conditions. J Insect Behav 27 (5): 639–651. https://doi.org/10.1007/s10905-014-9456-2

36. SAUER C 2012 Die Marmorierte Baumwanze tritt neu im Deutschschweizer Gemüsebau auf. [New occurrence of the brown marmorated stink bug in Swiss German vegetable production.] Extension Gemüsebau, Gemüsebau Info 28/12: 4–5 [in German]

37. PANSA MG, ASTEGGIANO L, COSTAMAGNA C, VITTONE G, TAVELLA L 2013 Primo ritrovamento di *Halyomorpha halys* nei pescheti piemontesi [First record of *Halyomorpha halys* on nectarine fruits in NW-Italy.] Informatore Agrario 37: 60–62 [in Italian]

38. BARISELLI M, BUGIANI R, MAISTRELLO L 2016 Distribution and damage caused by *Halyomorpha halys* in Italy. Bulletin OEPP/EPPO Bulletin 46 (2): 332–334. https://doi.org/10.1111/epp.12289

39. MAISTRELLO L, COSTI E, CARUSO S, VACCARI G, BORTOLOTTI P, NANNINI R, CASOLI L, MONTERMINI A, BARISELLI M, GUIDETTI R 2016 *Halyomorpha halys* in Italy: first results of field monitoring in fruit orchards. IOBC-WPRS Bulletin 112: 1–5

40. CICEOI R, MARDARE E, TEODORESCU E, DOBRIN I 2016 The status of brown marmorated stink bug, *Halyomorpha halys*, in Bucharest area. Journal of Horticulture, Forestry and Biotechnology 20 (4): 18–25