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Monitoring of the Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Banja Luka, Bosnia and Herzegovina

Vesna Vidović[1], Petar Nikolić[1], Snježana Hrnčić[2], Branimir Nježić[1]

[1]University of Banja Luka, Faculty of Agriculture, Banja Luka, Bosnia and Herzegovina
2 University of Montenegro, Biotechnical Faculty, Podgorica, Montenegro

Abstract

Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) is an invasive and polyphagous stink bug native to Asia. It has recently invaded Europe and Bosnia and Herzegovina. It is highly polyphagous pest of many economically important commodities including tree fruit, nut crops, field crops, vegetables and ornamentals. Moreover, it is an important nuisance pest because large numbers of adults seek out artificial structures for overwintering. Monitoring of population dynamics of *H. halys* during two years (2020 and 2021) was performed in Banja Luka, Bosnia and Herzegovina. The pest was present through monitoring period April–October with the highest abundance in the third decade of July when all life stages were present. More individuals were caught on pyramid trap (845) compared to sticky trap (156) favoring pyramid trap for future monitoring. Total number of caught individuals was 6.5 folds higher in the second year of the monitoring indicating population increase that presents threat to agricultural production.

Key words: invasive pest, population dynamics, pyramid and sticky traps, surveillance

Introduction

Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) is an invasive and polyphagous pest in the family Pentatomidae, native to China,

Japan, Korea and Taiwan (Hoebeke and Carter, 2003; Lee et al., 2013). It is a serious agricultural pest of many economically important commodities including tree fruit, nut crops, field crops, vegetables and ornamentals (Rice et al., 2014). The pest harms plants by piercing the surface of the plant and fruit tissues, which has negative effect on its comercial value. Feeding can cause deformation fruit, seeds or pods, white spongy surfaces on the fruit, and tissue damage that is visible inside as discolored flesh of the fruit (Leskey et al., 2014; Nielsen and Hamilton, 2009). This invasive species is considered also as a nuisance problem because it enters homes and other artificial structures during the fall in search of a warm and dry place to hibernate.

Outside its native area the pest has been first recorded in the United States in 1996 in or near Allentown,Pennsylvania (Hoebeke and Carter, 2003) and then spread to most of the United States, as well as to southern Canada (Leskey and Nielsen, 2018). In 2004, the first appearance of *H. halys* in Europe was recorded from Liechtenstein, Switzerland (Arnold, 2009). In Balkans H. halys was first noticed in Greece in 2011 (Milonas and Partsinevelos, 2014), 2015 in Serbia (Šeat, 2015) and 2017 in Croatia (Šapina and Šerić Jelaska, 2018). In the fall of 2018, the species was identified in the area of Mostar, which is the first finding of this species in Bosnia and Herzegovina (Zovko et al., 2019).

Depending on the climatic conditions *H. halys* can have one or two generations per year. Development from egg to adult takes approximately 40 to 60 days, depending on temperature (optimum 25°C) (Lee et al., 2013), and an estimated critical photoperiod for diapause induction is 15,5 h for population from Sochi, Russia (Musolin et al., 2019). It overwinters as an adult in some sheltered places. Overwintering induction starts in September, and reaches its peak from mid-October until November (Lee et al., 2013). Adults leave their overwintering habitats in spring, from the end of March to the middle of May when the temperature is above 10°C. Overwintered adults are observed first on forest woody crops, and later on cultivated plant (Hoebeke and Carter, 2003).

Management of the brown marmorated stink bug in agricultural settings has primarily relied on the use of broad-spectrum insecticides. Excessive chemical control has interrupted established IPM programs for several crops (Blaauw et al., 2015). The discovery of the aggregation pheromone has allowed researchers to design lures which attract *H. halys* bug to the vicinity of the lure location. When combined with traps, including pyramid traps and sticky traps, the lures can allow growers to determine when stink bug populations are at levels that warrant pesticide applications (Aldrich et al., 2009). While *H. halys* can be easily found during the day, some reports suggest that its activity increases at dusk and during the evening (Leskey and Hamilton, 2010). Therefore, a monitoring tool is needed to take advantage of these behaviors.

The aim of this study was to monitore population dynamics of *H. halys* in 2020 and 2021 to determine the density of the population and understand behavior under our climatic conditions. Moreover, in 2021 two different comercial types of traps were tested to determine which trap is more relevant for monitoring.

Material and Methods

In this research, green pyramid traps of the Italian company "Serbios s.r.l." were used, as well as sticky trap Trécé, Pherocon® StinkBug STKY™ Dual Panel Adhesive Trap with pheromones (3S, 6S, 7R, 10S)-10,11-epoxide-1-bisabolen-3-ol and (3R, 6S, 7R, 10S)-10,11-epoxide-1-bisabolen-3-ol (Khrimian et al., 2014) in combination with a synergist, methyl (2E, 4E, 6Z) decatrienoate (MDT) (Weber et al. 2014). Pheromones were changed every 12 weeks according to producers instructions.

During 2020 and 2021 traps were set in the apple orchard (four and five years old, 0.8 ha) in the Botanical Garden of the Institute of Genetic Resources in Banja Luka (N 44º46'35"; E 17º12'50"). In 2020 only a pyramid trap was installed, from 04th of April untill 28th of October. In 2021 both pyramid and sticky trap were installed from 15th of July untill 10th of November, 200 m from each other. We compared total number of *H. halys* caught in the pyramid trap during 2020 and 2021. Also, the number of *H. halys* caught in the pyramid trap and the sticky trap during 2021 was compared.

Traps were inspected three to five times per month for stink bug captures. Each inspection of the trap was accompanied by a visual inspection of the orchard, in order to determine possible damage from the *H. halys*. All trapped individuals were transferred to the laboratory in plastic cups with lids, on which the location and time of sampling were written, in order to identify and further observe the individuals. The identification of adults was performed using the key (Wyniger and Kment, 2010), while the identification of nymphs was done according to a detailed description of individual stages (Hoebeke and Carter, 2003).

Results and Discussion

In figures 1, 2 and 3 are shown abundance of Brown marmorated stink bug captured on pyramid and sticky traps during study in Banja Luka, Bosnia and Herzegovina.

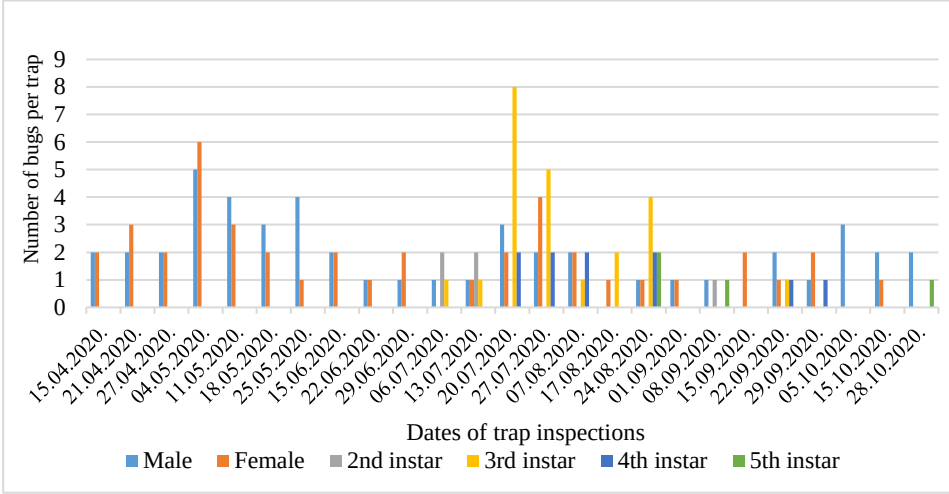

Figure 1. The abundance of Brown marmorated stink bug captured on pyramid trap located in the Botanical Garden of the Institute of Genetic Resources in Banja Luka in 2020.

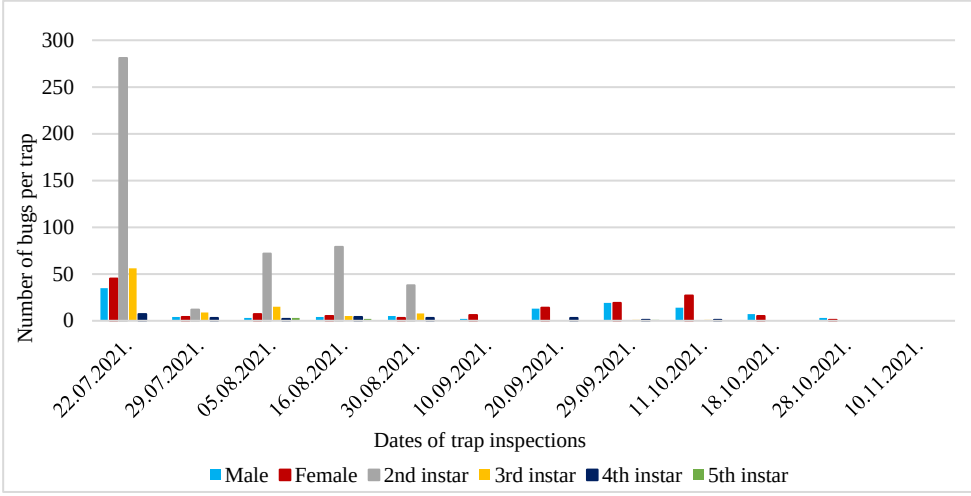

Figure 2. The abundance of Brown marmorated stink bug captured on pyramid trap located in the Botanical Garden of the Institute of Genetic Resources in Banja Luka in 2021.

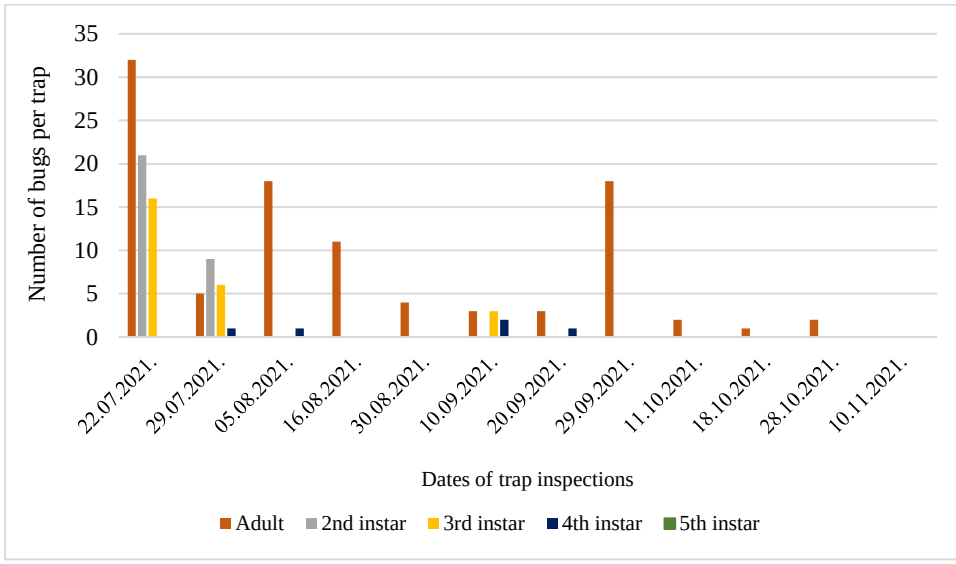

Figure 3. The abundance of Brown marmorated stink bug captured on sticky trap located in the Botanical Garden of the Institute of Genetic Resources in Banja Luka in 2021.

On sticky trap, a large number of adults were damaged, while the nymphs were undamaged. It is assumed that the birds ate them, because from many *H. halys* only the wings are left, with which they are usually glued to the trap.

The highest population density in both years was detected in the third decade of July. On the pyramid trap the most abundant life stage was second stage nymph in both years, while on the sticky trap adult stage was the most numerous. According to Akotsen-Mensah et al. (2018), during 2016, the highest number of adults was in the first half of June, after which the number dropped in the second half of July, then the number began to increase again in late July and early August, while nymphs reached their highest number in July. According to Bosco et al. (2020), depending on weather conditions, the population grew due to a gradual increase in the number of nymphs usually from the beginning of July, and reached its highest level in the second half of July, when wintering adults and first-generation individuals overlapped. In our study the highest number of adults was in the first half of May, then declined during summer months and again raised in autumn.

The total number of *H. halys* in the pyramid trap during 2020 was 132, while in 2021 the number was 852 even the monitoring period was shorter indicating an 6.5 fold increase. Nielsen et al. (2013) conducted an eight-year (2004–2011) study across New Jersey (United States) based on monitoring the

H. halys using black light traps and found that the population density increases by 75% per year.

Our research shows that sticky traps are effective, but less reliable than pyramid ones when it comes to population density. Both traps were set at the same locations and at the same time, but the total number of *H. halys* was much higher in the pyramid trap. Although the number of nymphs on the sticky trap was small, there were always nymphs around the trap on the branch where the trap was hanged. Visual inspection revealed that some nymphs move along the edge of the trap avoiding trapping, while adult individuals usually stick to their wings, making it impossible for them to escape. Acebes-Doria et al. (2018) found that a sticky trap attached to the top of a wooden pole, with commercial lures containing *H. halys* pheromones and a pheromone synergist is cheaper, easier to use, and a reliable replacement for pyramid traps. Their results have shown that sticky traps can reliably detect and track adult and nymph populations at different population densities and geographic locations.

Our results suggest that there is one generation of *H. halys* in area of Banja Luka. Different life stages of the pest are present through period April–October. First nymphs were recorded in July indicating that oviposition starts in July. Understanding behavior of the pest in the local conditions, monitoring of its populations dynamics are prerequisite for implementation of effective control measures.

Conclusion

Halyomorpha halys is present in Bosnia and Herzegovina since 2018. Our monitoring reveals that its population increases yearly, since 6.5 fold increase of specimens was found in the second year of the monitoring. The highest number of individuals was recorded in the third decade of July, when all life stages were present on the traps. Comparison of two types of traps revealed that pyramid trap caught more individuals compared to sticky traps. Monitoring of this pest will be necessary in the future since it has wide host range and potential to make significant economical losses. Monitoring should give information to farmers that will help them to apply appropriate control measures.

References

Acebes-Doria, A., Morrison, W., Short, B., Rice, K., Bush, H., Kuhar, T., Duthie, C., & Leskey, T. (2018). Monitoring and biosurveillance tools for the brown

marmorated stink bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae). *Insects*, 9(3), 82. https://doi.org/10.3390/insects9030082

Akotsen-Mensah, C., Kaser, J. M, Leskey, T. C., & Nielsen, A. L. (2018). *Halyomorpha halys* (Hemiptera: Pentatomidae) responses to traps baited with pheromones in peach and apple orchards. *Journal of Economic Entomology*, 111(5), 2153-2162. https://doi.org/10.1093/jee/toy200

Aldrich, J. R., Khrimian, A., Chen, X., & Camp, M.J. (2009). Semiochemically based monitoring of the invasion of the brown marmorated stink bug and unexpected attraction of the native green stink bug (Heteroptera: Pentatomidae) in Maryland. *Florida Entomologist*, 92(3), 483-491. https://doi.org/10.1653/024.092.0310

Arnold, K. (2009). *Halyomorpha halys* (Stål, 1855), eine für die europäische Fauna neu nachgewiesene Wanzenart (Insecta: Heteroptera, Pentatomidae, Pentatominae, Cappaeini). *Mitteilungen des Thüringer Entomologenverbandes* e.V., 16 (1), 19.

Blaauw, B. R., Polk, D., & Nielsen, A. L. (2015). IPM-CPR for peaches: Incorporating behaviorally-based methods to manage *Halyomorpha halys* and key pests in peach. *Pest Management Science*, 71(11), 1513-1522. https://doi.org/10.1002/ps.3955

Bosco, L., Nardelli, M., & Tavella, L. (2020). First Insights on Early Host Plants and Dispersal Behavior of *Halyomorpha halys* (Hemiptera: Pentatomidae) from Overwintering to Crop Colonization. *Insects*, 11(12), 866. https://doi.org/10.3390/insects11120866

Hoebeke, E. R., & Carter, M. E., (2003). *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae): a polyphagous plant pest from Asia newly detected in North America. *Proceedings- Entomological Society of Washington*, 105(1), 225–237.

Khrimian, A., Zhang, A., Weber, D. C., Ho, H. Y., Aldrich, J. R., Vermillion, K. E., Siegler, M. A., Shirali, S., Guzman, F., & Leskey, T. C. (2014). Discovery of the aggregation pheromone of the brown marmorated stink bug (*Halyomorpha halys*) through the creation of stereoisomeric libraries of 1-bisabolen-3-ols. *Journal of Natural Products*, 77(7), 1708–1717. https://doi.org/10.1021/np5003753

Lee, D., Short, B., Joseph, S., Bergh, J., & Leskey, T. (2013). Review of the Biology, Ecology, and Management of *Halyomorpha halys* (Hemiptera: Pentatomidae) in China, Japan, and the Republic of Korea. *Environmental entomology*, 42(4), 627-41. https://doi.org/10.1603/en13006

Leskey, T. C., & Hamilton, G. C. (2010). *Brown Marmorated Stink Bug IPM Working Group Meeting Report*. Northeastern IPM Center. https://projects.ipmcenters.org/Northeastern/FundedProjects/ReportFiles/Pship2010/Pship2010-Leskey-ProgressReport-237195.pdf

Leskey, T. C., Hamilton, G. C., Biddinger, D. J., Buffington, M. L., Dieckhoff, C., Dively, G. P., Fraser, H., Gariepy, T., Hedstrom, C., Herbert, D. A.,

Hoelmer, K. A., Hooks, C. R. R., Inkley, D., Krawczyk, G., Kuhar, T. P., Lee, D.-H., Nielsen, A. L., Pfeiffer, D. G., Rodriguez-Saona, C., … Wiman, N. (2014). Halyomorpha halys *(brown marmorated stink bug)*. CABI Compendium. https://doi.org/10.1079/cabicompendium.27377

Leskey, T.C., & Nielsen, A.L. (2018). Impact of the Invasive Brown Marmorated Stink Bug in North America and Europe: History, Biology, Ecology, and Management. *Annual Review of Entomology*, 63(1), 599–618. https://doi.org/10.1146/annurev-ento-020117-043226

Milonas, P. G., & Partsinevelos, G. K. (2014). First report of brown marmorated stink bug *Halyomorpha halys* Stål (Hemiptera: Pentatomidae) in Greece. *EPPO Bulletin*, 44(2), 183-186. https://doi.org/10.1111/epp.12129

Musolin, D. L., Dolgovskaya, M. Y., Protsenko, V. Y., Karpun, N. N., Reznik, S. Y., & Saulich, A. K. (2019). Photoperiodic and temperature control of nymphal growth and adult diapause induction in the invasive Caucasian population of the brown marmorated stink bug, *Halyomorpha halys*. *Journal of Pest Science* 92(2), 621–631. https://doi.org/10.1007/s10340-019-01080-1

Nielsen, A. L., & Hamilton, G.,C. (2009). Seasonal occurrence and impact of *Halyomorpha halys* (Hemiptera: Pentatomidae) in tree fruit. *Journal of Economic Entomology*, 102(3), 1133-1140. https://doi.org/10.1603/029.102.0335

Nielsen, A. L., Holmstrom, K., Hamilton, G. C., Cambridge, J., & Ingerson-Mahar, J. (2013). Use of Black Light Traps to Monitor the Abundance, Spread, and Flight Behavior of Halyomorpha halys (Hemiptera: Pentatomidae). *Journal of Economic Entomology*, 106(3), 1495–1502. https://doi.org/10.1603/ec12472

Rice, K. B., Bergh, C. J., Bergmann, E. J., Biddinger, D. J., Dieckhoff, C., Dively, G., Fraser, H., Gariepy, T., Hamilton, G., Haye, T., Herbert, A., Hoelmer, K., Hooks, C. R., Jones, A., Krawczyk, G., Kuhar, T., Martinson, H., Mitchell, W., Nielsen, A. L., … Tooker, J. F. (2014). Biology, Ecology, and Management of Brown Marmorated Stink Bug (Hemiptera: Pentatomidae). *Journal of Integrated Pest Management*, 5(3), 1–13. https://doi.org/10.1603/ipm14002

Šapina, I., & Šerić Jelaska, L. (2018). First report of invasive brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Croatia. *EPPO Bulletin*, 48(1), 138-143. https://doi.org/10.1111/epp.12449

Šeat, J. (2015). *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) a new invasive species in Serbia. *Acta entomologica serbica, 20*, 167-171. https://aes.bio.bg.ac.rs/index.php/aes/article/view/63

Weber, D. C., Leskey, T. C., Walsh, G. C., & Khrimian, A. (2014). Synergy of aggregation pheromone with methyl (E,E,Z)-2,4,6-decatrienoate in attraction of *Halyomorpha halys* (Hemiptera: Pentatomidae). *Journal of Economic Entomology*, 107(3), 1061-1068. https://doi.org/10.1603/ec13502

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(1-2), 1-8. https://www.e-periodica.ch/cntmng?pid=seg-001%3A2008%3A81%3A%3A10

Wyniger, D., & Kment, P. (2010). Key for the separation of *Halyomorpha halys* (Stål) from similarappearing pentatomids (Insecta: Heteroptera: Pentatomidae) occurring in Central Europe, with new Swiss records. *Journal of the Swiss Entomological Society*, 83(3/4), 261-270. https://www.e-periodica.ch/digbib/view?pid=seg-001:2010:83::338

Zovko, M., Ostojić, I., Jurković, D., & Karić, N. (2019). First report of the brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) in Bosnia and Herzegovina. *Radovi Poljoprivredno Prehrambenog Fakulteta Univerziteta u Sarajevu\Works of the Faculty of Agricultural and Food Sciences University of Sarajevo*, 64(69), 68-78.

Праћење популације смеђе мраморасте стјенице *Halyomorpha halys* (Stål, 1855) у Бањој Луци, Босна и Херцеговина

Весна Видовић[1], Петар Николић[1], Сњежана Хрнчић[2], Бранимир Њежић[1]

[1] *Универзитет у Бањој Луци, Пољопривредни факултет, Бања Лука, Босна и Херцеговина*
[2]*Универзитет Црне Горе, Биотехнички факултет, Подгорица, Црна Гора*

Сажетак

Смеђа мрамораста стјеница *Halyomorpha halys* (Stål, 1855) је инвазивна полифагна стјеница поријеклом из Азије. Однедавно је присутна у Европи и Босни и Херцеговини, као веома опасна полифагна штеточина многих економски важних култура, укључујући воће, орашасте плодове, пољске усјеве, поврће и украсно биље. Поред тога, она иритира и становништво јер често презимљава у стамбеним објектима. Праћење популационе динамике H. halys обављено је у Бањој Луци, Босна и Херцеговина током двије узастопне године (2020. и 2021.). Штеточина је била присутна током цијелог периода праћења од априла до октобра, са највећом бројношћу у трећој декади јула када су били присутни сви животни стадијуми. Више јединки ухваћено је пирамидалном замком (845) у поређењу са љепљивом плочом (156), што даје предност пирамидалној замци за будуће праћење. Укупан број уловљених јединки у другој години праћења био је 6,5 пута већи, што указује на повећање популације која представља опасност за пољопривредну производњу.

Кључне ријечи: инвазивне штеточине, популациона динамика, пирамидалне и љепљиве клопке, надзор

Corresponding author: Бранимир Њежић
E–mail: branimir.njezic@agro.unibl.org

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