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HARMFUL IMPACT OF BROWN MARMORATED STINK BUGS IN AGRICULTURAL AND HORTICULTURAL CROPS IN TIMIS COUNTY AND ATTEMPTS TO CONTROL THEM

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Abstract

Brown marmorated stink bugs (Halyomorpha halys) (Hemiptera: Pentatomidae) is a harmful insect that entered Romania for several years. Its polyphagous is accentuated and in the continuous expansion of the host plants, whether agricultural or horticultural and deciduous forest. Through the present work we have proposed to see what is the current state of the pest in 5 OPs in Timis County related to density, updated range of host plants but also to try to keep populations under control so as to avoid damage. So, for 4 years (2020-2023) from May to October we made observations in various types of areas (field crops, private gardens, parks and fruit orchards). As results, we found high and medium frequency in private gardens with mixed plants but also in orchards, while in field crops, they had a lower frequency. In August, the most specimens were seen. After testing 2 products (a classic insecticide and an bio-insecticide), the classic one proved to be more effective, but taking into account the effects of pollution environment, it is recommended to apply the bio-insecticide first, however both must be used to maximize effectiveness.

Key words*: Brown Marmorated Stink Bugs, pest, polyphagous, control.*

INTRODUCTION

This species is an insect called a stink bug from the family Pentatomidae, which belongs to the order Hemiptera (suborder Heteroptera). It has recently been found almost everywhere in areas where plants are grown, either near houses or in large crops.

The origin is not certain, mentions are attributed to several countries such as China, Taiwan, Japan and China (after Josifov & Kerzhner, 1978), from where it has been spreading since the 70s and 80s, so that it is present in all the main continents (McPherson & McPherson, 2000; Leskey et al., 2012; Callot & Brua, 2013). In Europe, it appeared at the beginning of the 2000s and quickly spread in the southern and central areas from east to west and vice versa (Cesari et al., 2015; Gaspar et al., 2023), so that in 2015 it was observed for the first time in Romania (Macavei et al., 2015). After this date, new appearances of the various stages of the pest were recorded (Ciceoi et al., 2017; DeMichele and Grozea, 2018; Gyawali et al., 2019; Looney et al., 2019; EPPO, 2023).

In western area, where the observations of this work are made, it was subjected to behavioural and host-plant assessments, in the period 2019-2022 (Neacsu & Grozea, 2019; Grozea & Stan Costea, 2020; Vîrteiu et al., 2022; Grozea et al, 2023).

The management of this pest is done by various methods, either biological or synthetic or chemical.

Previous research has demonstrated the effectiveness of acetamiprid, permethrin, insecticidal soap, and petroleum oil in controlling adults as it increased mortality (Bergmann & Raupp, 2014; Sabbatini et al. 2018). Foliar insecticides are also effective in controlling the species as mentioned Kuhar et al. (2012). Among the synthetic products, those based on Lambda-cyhalothrin and thiamethoxam or other categories have been tested and considered performing (Walgenbach & Schoof, 2015), of course some have been withdrawn or have restrictions on use and they must be adapted before use regardless of the culture or the subject addressed (Stef et al., 2020) with the national legislation in force.

Bioinsecticides have proven effective in several applications, such as the one based on spinosad (Morehead & Kuhar, 2017).
Taking into account the agricultural crops involved (cereals), a series of natural enemies can be considered for the control of shield bugs in general (Grozea et al., 2008).
The efficiency of the of parasitoid wasps in the family Platygastridae belonging *Trissolcus* genus is also mentioned in the specialized literature, as a biological solution of the pest under control (Laznik & Trdan, 2021).
In this context, given the lack of a control strategy, including the lack of natural enemies at the Romanian level, we proposed to test 2 products, one chemical and the other biological, in different types of areas where we had previously observed a high presence of the pest.

MATERIALS AND METHODS

Organisation of the activities

In order to find out the number of *H. halys* in the nymph and adult stages, we organised observations in 5 sites ready to be cultivated with different types of solitary or mixed plants (agricultural, vegetable, ornamental, fruit trees, deciduous trees).
The sites were chosen in 5 different localities and I tried to keep a distance of at least 2-3 km between them. As the pest is extremely polyphagous, we opted for a wide variety of available plant species, mostly plants known from literature as good host plants (Table 1).

Phytosanitary products used

We used 2 control products (from the stores of pesticide companies), 1 chemical insecticide based on cypermethrin (Faster 10 CE), in a dose of 200 ml/ha conditioned in the form of an emulsifiable concentrate, with contact and ingestion action as well as 1 bioinsecticide based on spinosad (Laser 240 SC) which has the action of paralyzing the nervous system, is actually a soil bacterium in the component.

Monitoring observations

In every first decade of the month, from May to October, in the 2020-2023 period we carried out numerical level and dynamic evaluations of nymphs and adults. Direct observations on the aerial part of the plants were made by allocating 8 hours in the time interval 10-18 for each place (Figure 1).
The large (woody) plants once subjected to the first observation were marked with a yellow marking tape to be able to identify them at the second reading.

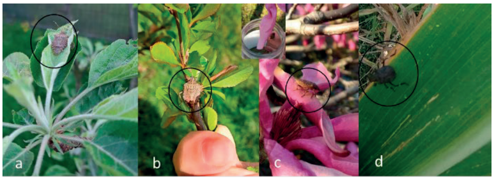

Figure 1. The *H. halys* pest in the adult and nymph stages, in the monitored POs: a. adult on apple tree; b. adult on Japanese quince; c. adult on ornamental tree (magnolia) and collecting samples to establish the effectiveness of the treatments; d. nymph on corn leaf

Evaluation of the effectiveness of phytosanitary products

The 2 phytosanitary products available on the market (Laser 240 SC and Faster 10 CE) were tested under laboratory conditions (Laboratory of Phytosanitary Diagnosis and Expertise of the ULST) in terrariums with a glass base and plastic film with very small holes.
Thus, host plants (wheat) or parts of host plants (green cobs of maize, lilac flowers, magnolia, fruits in the laboratory in 2 replicates - R1, R2).
From each PO (observation point), 20 adults and nymphs (live) were collected (Figure 1) and placed in these terrariums in July-August.
For 2 weeks (at 3, 7 and 10 days), observations were made on the insects remaining alive after the application of the phytosanitary products. The maintenance of the insects was done by feeding them once a day with fresh plant material and ensuring the necessary humidity by sprinkling the food with cold water. Also, the terrariums were placed near the window to ensure adequate light.

Statistical data analysis

In order to evaluate the numerical level existing in the 5 OPs, the raw data obtained at the monthly reading were considered adequate descriptive statistics, and for the evaluation of the effectiveness of the phytosanitary products applied, we resorted to the Duncan Test.
The monthly dynamics and of the individuals attack percent was done through descriptive and graphic evaluation.

Table 1. Technical characteristics of the study sites

Place code	Locality	Area type	Plant category	Covered surface/analised	Placing
PO1PK-TM	Timisoara	Park	Ornamental trees and shrubs	5 plants/50 m^2	Near the houses
PO2FCW-GI	Jumbolia	Field (large) crop	Wheat	300 m^2	Far from houses
PO3GA-DU	Dumbravita	Private garden	Vegetables and ornamental shrubs	300 m^2	Near the houses
PO4MZ-GR	Grabat	Field crop	Maize	300 m^2	Far from houses
PO5FTA-PE	Pesac	Fruit trees(orchard)	Apple trees	5 plants/50 m^2	Near the houses

RESULTS AND DISCUSSIONS

Monitoring results and monthly evolution

The results show that the pest *Halyomorpha halys* is present in all types of areas analysed, both in large arable crops, vegetable or mixed gardens and in parks. By far the largest number of individuals were observed on vegetable and ornamental crops in the PO3GA-DU and the urban park (PO1PK-TM), where 173 and 170 individuals were quantified respectively. There were also enough adults and nymphs in the maize crop in the field (PO4MZ-GR), with 48 individuals, and in the apple orchard in PO5FTA-PE (46 individuals). The fewest individuals (4) were found in the wheat crop of (PO2FCW-GI) (Figure 2).

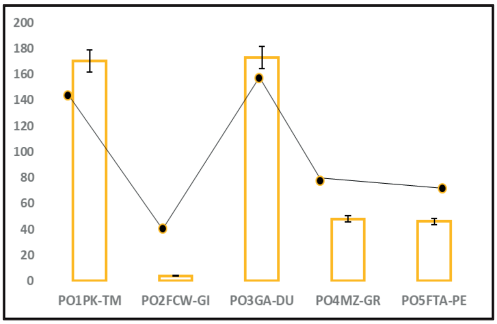

Figure 2. The level of *H. halys* populations quantified comparatively during the entire observation period in the 5 monitored POs

In each year of the study, positive values were recorded, where at least one individual was present. Thus, the highest values were quantified in the last year analysed (2023) (172 individuals), then in 2021, 106 individuals were present. In 2022 there were fewer (85), perhaps due to the drought, although the species is known to be thermophilic, and the lowest number was still in the first year (2021) with 74 individuals. This trend actually shows a gradual increase from year to year (Figure 3).

The monthly evolution of the pest between May and October shows approximately the same trend regardless of the OPs, i.e. with a maximum of 1 in August. The flight curve shows a gradual increase starting in May, a peak in August and a slow decrease towards October for the PO1PK-TM, PO3GA-DU and PO5FTA-PE observations in vegetables and ornamental plants. Exceptions are agricultural crops at PO2FCW-GI where the peak was in June, and PO4MZ-GR with a slight increase from May to October (peak in October) (Figure 4).

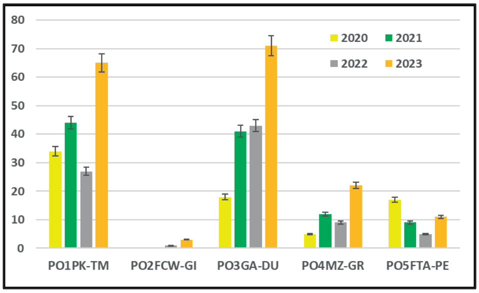

Figure 3. Annual values recorded for study years, taking into account each monitored OP

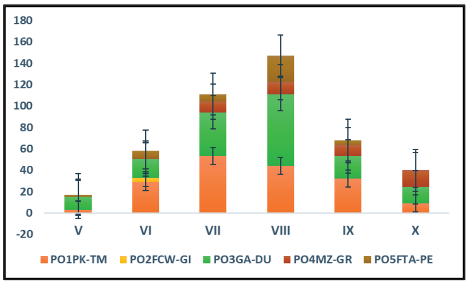

Figure 4. Monthly evolution of adult individuals and nymphs between May and October in the 5 monitored POs

After evaluating the numerical level, we found through the descriptive analysis (Table 2) that in PO1PK-TM x=28.3333 ind., in PO2FCW-GI x=0.6666 ind., in PO3GA-DU x=28.8333 ind. PO4MZ-GR x=8.0000 ind. and in PO5FTA-PE x=7.6666 ind.

Symptomatology and affected plants

Adults and nymphs of *H halys* were most often observed on leaves, but as different host plants were analysed the mode of action was different. In the park, they were observed more on leaves and flowers, in the garden they were seen consuming tomatoes and peppers (leaves and fruits), on ornamental plants they were most often on leaves and inflorescences and in the orchard on fruit and leaves (Figure 1). In agricultural crops, corn has stagnated on cobs and wheat has leaves. All the attacked organs showed small brown spots and a strong smell of stinky bugs. The fruits were most affected by deformation and subsequent cracking or rotting.

The cobs remained undeveloped with a heavy smell, due to the concentration of individuals on a single cob.

The percentage of attacks recorded in the 5 OPs analysed varied from one point to another. Thus, the plants of PO3GA-DU were most affected with 60% of the plants affected, followed by PO1PK-TM (56%), PO5FTA-PE (45%), PO4MZ-GR (41%) and PO2FCW-GI with only 1% of the plants affected (Figure 5).

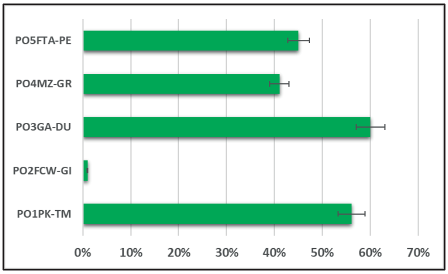

Figure 5. The attack percentage of affected plants in the 5 POs

Results of effectiveness of phytosanitary products

Following the application of the 2 phytosanitary products (Cypermethrin and Spinosad) in 2023 (July-August) addressing the chemical and biological category, we found that there were differences between the average values recorded in the 3 repetitions (Table 3). Thus, in the variant treated with cypermethrin (3rd day) the average value of the surviving individuals was x=13.6666, at 7 days it was x= 6.3333, at 10 days x= 0.3333, it is observed the drastic decrease of the values to almost zero, which is a good result. Regarding the individuals remaining after the application of Spinosad, this determined a slower decrease from x=15.6666ind./3rd day to x=9.6666ind./7th day and to x=5.3333ind./10th day.

Statistical comparisons between the treated and control variants (Table 4) showed significant differences between the variant with cypermethrin on the 7th day and Control (7th day and 10th day) where $p<0.05$ ($p=0.038$; $p=0.045$) but also between the variant with cypermethrin on the 10th day ($p=0.008$; $p=0.002$; $p=0.006$). There were also statistical differences between Spinosad on the 10th day and all Control variants with $p=0.034$; $p=0.02$; $p=0.039$). Among the treated variants (Table 3) there were differences between cypermethrin (7th day) and all variants with Spinosad ($p=0.042$; $p=0.040$; $p=0.029$) but also between Spinosad at 3 days and Spinosad at 7 days ($p=0.009$ and $p=0.018$) or between cypermethrin (10th day) and Spinosad (10th day) with $p=0.008$ and $p=0.034$.

Table 2. Descriptive statistical elements for the numerical level values from the 5 OPs for the entire monitored period

Study sites	[1]Descriptive items for no. of adults and nymphs of *H. halys* in the 5 OPs monitored Period of 2020-2023							
	Mean	Min.	Max.	Low.Q.	Up. Q	R	Var.	SD
PO1PK-TM	28.3333	3.00	53.00	3.00	53.00	90.000	68.50	19.41
PO2FCW-GI	0.6666	0.00	4.00	0.000	4.00	10.000	244,95	1.63
PO3GA-DU	28.8333	12.00	67.00	12.00	67.00	121.000	74.07	21.36
PO4MZ-GR	8.0000	0.00	16.00	0.000	16.00	23.000	77.86	6.23
PO5FTA-PE	7.6666	0.00	25.00	0.000	25.00	51.000	116.57	8.94

[1]minimum, maximum, quartiles (lower and upper), range, variance standard deviation

Table 3. Descriptive statistical elements for evaluating the effectiveness of treatments by the number of marmorated stink bugs (*H. halys*) alive at different day intervals (at 3,7 and 10 days) in July-August 2023

Variants	[1]Descriptive items for evaluating the effectiveness of treatments by the number of marmorated stink bugs alive at different day intervals (at 3,7 and 10 days)/July-August 2023							
	Mean	Min.	Max.	Low. Q.	Up. Q	R	Var.	SD
Control (3rd day)	20.0000	10.00	20.00	10.00	20.00	15.00	200.00	7.35
Control (7th day)	20.0000	10.00	20.00	10.00	20.00	15.00	200.00	7.35
Control (10th day)	20.0000	10.00	20.00	10.00	20.00	15.00	200.00	7.35
Cypermethrin (3rd day)	13,6666	13.00	14.00	13.00	14.00	21.00	5.24	0.71
Cypermethrin (7th day)	6,3333	6.00	7.00	6.00	7.00	13.00	57.56	2.83
Cypermethrin (10th day)	0,3333	0.00	1.00	0.00	1.00	2.00	141,42	0.41
Spinosad (3rd day)	15,6666	15.00	16.00	15.00	16.00	32.00	4.56	0.71
Spinosad (7th day)	9,6666	9.00	11.00	9.00	11.00	22.00	14.14	1.41
Spinosad (10th day)	5,3333	5.00	6.00	5.00	6.00	12.00	12.86	0.71

[1]minimum, maximum, quartiles (lower and upper), range, variance standard deviation

Table 4. Approximate probabilities by Duncan's Test for evaluating the effectiveness of treatments according to the number of marmorated stink bugs (*H. halys*) at different day intervals

Study sites	The Duncan test for evaluating the effectiveness of treatments by the number of marmorated stink bugs (*H. halys*) alive at different day intervals (at 3,7,10 days) Approximate Probabilities for Post Hoc Test/ *p								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Control (3rd day) (1)	1.000	1.000	1.000	0.450	0.008	0.006	0.505	0.110	0.034
Control (7th day) (2)	1.000		1.00	0.470	0.038	0.002	0.64	0.120	0.027
Control (10th day) (3)	1.000	1.000		0.560	0.045	0.006	0.785	0.11	0.039
Cypermethrin (3rd day) (4)	0.350	0.470	0.560		0.250	0.498	0.075	0.150	0.400
Cypermethrin (7th day) (5)	0.450	0.038	0.045	0.250		0.032	0.042	0.040	0.029
Cypermethrin (10th day) (6)	0.008	0.002	0.006	0.498	0.032		0.009	0.018	0.200
Spinosad (3rd day) (7)	0.890	0.640	0.785	0.075	0.042	0.009		0.310	0.180
Spinosad (7th day) (8)	0.110	0.120	0.110	0.150	0.040	0.018	0.310		0.060
Spinosad (10th day) (9)	0.034	0.027	0.039	0.400	0.029	0.200	0.180	0.060	

(1)-Control variant after 3 days; (2)-Control variant after 7 days; (3)-Control variant after 10 days; (4)-treated variant with Cypermethrin after 3days; (5)-treated variant with Cypermethrin after 7 days; (6)-variant with Cypermethrin after 10 days; (7)-variant with Spinosad after 3 days; 8)-variant with Spinosad after 7 days; 9)-variant with Spinosad after 10 days; *the significance test ($p<0.05$, $p>0.05$)

CONCLUSIONS

The results show that the pest *Halyomorpha halys* continues to be active in different crops and plants in different areas. Numbers are quite high and are increasing from year to year. They are more harmful to plants and mixed crops, preferring vegetables and ornamentals, but also maize grown in large crops.
To control them, we have found the insecticide cypermethrin to be extremely effective and the bio-insecticide Spinosad to be moderately effective. As the insecticide has the disadvantage of being polluting and the bio-insecticide has the disadvantage of being highly effective, we thought it appropriate to propose a combination of these two phytosanitary products by alternating applications.

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REFERENCES

Bergmann, E.J., Raupp, M.J. (2014). Efficacies of common ready to use insecticides against *Halyomorpha halys* (Hemiptera: Pentatomidae). *Florida Entomologist, 97*, 791-800.https://doi.org/10.1653/024.097.0262

Callot, H., Brua, C. (2013). Halyomorpha halys (Stal, 1855), la Punaise diabolique, nouvelle espece pour la faune de France (Heteroptera, Pentatomidae). *Entomologiste, 69*:69–71.

Cesari, M., Maistrello, L., Ganzerli, F. (2015). A pest alien invasion in progress: potential pathways of origin of the brown marmorated stink bug Halyomorpha halys populations in Italy. *Journal of Pest Science, 88,* 1-7. doi.org/10.1007/s10340-014-0634-y

Ciceoi, R., Bolocan, I.G., Dobrin, I. (2017). The spread of brown marmorated stink bug, Halyomorpha halys, in Romania. *Journal of Horticulture, Forestry and Biotechnology, 21*(3), 15-20.

De Michele A., Grozea I. (2018). Review of the spreading of *Halyomorpha halys* in Italy and confirmation of presence in Romania. *Research Journal of Agricultural Science,50* (4), 111-115.

EPPO (2023). EPPO Global database. In: EPPO Global database, Paris, France.

Eppo Bulletin, 2023, available on: https://onlinelibrary.wiley.com/journal/13652338

Gaspar H., Castro S., Grosso-Silva J.M., Van Der Heyden T., Loureiro J. (2023). Exponential outspread of *Halyomorpha halys* (Sal, 1855) (Hemiptera: Pentatomidae) in Portugal. *Arquivos Entomolóxicos 22*, 373-376.

Grozea, I., Carabet, A., Chirita, R., Badea, A.M. (2008). Natural enemies in control of invasive species Diabrotica virgifera virgifera from maize crops. *Communications in Agricultural and Applied Biological Sciences 73* (3), 501-508

Grozea I., Stan Costea, A. (2020). Apricot Trees, A new attraction for the Brown Marmorated Stink Bug. *Research Journal of Agricultural Science, 52*, 1, 122-127.

Grozea, I., Dahbi, M., Sidhoum, M. (2023). Brown marmorated stink bug (BMCB) in the conditions of Romania vs Algeria. *Research Journal of Agricultural Science, 55* (1), 98-104

Gyawali A., Regmi B., Pudasaini R., Acharya N. (2019). Diversity and abundance of insect pest of low land rice field in Lamahi, Dang district of Nepal. *Journal of Agriculture and Natural Resources, 2* (1), 238-243.

Josifov M.V., Kerzhner I.M. (1978). Heteroptera aus Korea. Teil (Aradidae, Berytidae, Lygaeidae, Pyrrhocoridae, Rhopalidae, Alydidae, Coreidae, Urostylidae, Acanthosomatidae, Scutelleridae, Pentatomidae, Cydnidae, Plataspidae). *Fragmenta Faunistica, 23,* 137-196.

Kuhar, T.P., Doughty, H., Kamminga, K. (2012). Evaluation of foliar insecticides for the control of brown marmorated stink bug in tomatoes in Virginia, 2011. *Arthropod Management Tests, 37,* E72. doi.org/10.4182/amt.2012.E72.

Laznik, Z., Trdan, S. (2021). Management methods for marmorated stink bug (*Halyomorpha halys* [Stål, 1855], Hemiptera, Pentatomidae). *Acta Agriculture Slovenica, 117* (1). doi:10.14720/aas.2021.117.1.2106

Leskey, T.C., Hamilton, G.C., Nielsen, A.L. (2012). Pest status of the brown marmorated stink bug, *Halyomorpha halys* in the USA. *Outlook Pest Management, 23,* 218-226.

Macavei L. I., Baetan R., Oltean I., Florian T., Varga M., Costi E., Maistrello L. (2015). First detection of *Halyomorpha halys* Stal, a new invasive species with a high potential of damage on agricultural crops in Romania. *Lucrari Stiintifice seria Agronomie 58*, (1), 105-108.

McPherson, J. E., McPherson, R. M. (2000). Stink bugs of economic importance in America North of Mexico. CRC Press, Boca Raton, FL. 272 pp.

Morehead J.A., Kuhar T.P. (2017). Efficacy of organically approved insecticides against brown marmorated stink bug, *Halyomorpha halys* and other stink bugs. *Journal of Pest Science 90*(4), 1277–1285. doi: 10.1007/s10340-017-0879-3

Sabbatini, P., G., Binazzi, F., Marianelli, L. (2018). Lethal and sublethal effects of long-lasting insecticide-treated nets on the invasive bug *Halyomorpha halys*. Journal of Applied Entomology, 142, 141-148.

Sparks, M.E., Bansal, R., Benoit, J.B. (2020). Brown marmorated stink bug, *Halyomorpha halys* (Stal), genome: putative underpinnings of polyphagy, insecticide resistance potential and biology of a top worldwide pest. *BMC Genomics 21,* 227. doi.org/10.1186/s12864-020-6510-7

Ștef, R., Carabet, A., Grozea, I., Chifan, R., Ștef, R., Florian, T. (2020). Efficacy Assessment of synthesis pyrethroids on Ostrinia nubilalis (Hübner) population reduction from corn agro-ecosystem. *Scientific Papers, Series A, Agronomy, 63*(1): 554-561.

Virteiu, A.M., Jiogolea, D., Pistol, A., Seibert, Am., Grozea, I. (2022). Invasive insect species on woody ornamental plants in Life Science University Park (Timișoara: Timiș County) -current status. *Research Journal of Agricultural Science, 54*, 149-158.

Vlad, M., Grozea, I. (2016). Host Plant Species of the Cicada Metcalfa Pruinosa in Romania. *Bulletin UASVM series Agriculture 7*3(1), 131-137. DOI 10.15835/buasvmcn-agr: 11383

Walgenbach, J.F., Schoof, S.C. (2015). Peach insecticide trial, 2013. Arthropod Management Tests, 39, B10. doi.org/10.4182/amt.2014.B10