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Results of monitoring spotted wing drosophila (*Drosophila suzukii*, Matzumura) in the Republic of Srpska (Bosnia and Herzegovina) for the 2017-2021 period with reference to seasonal population movement

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Abstract

Spotted wing drosophila (SWD) - *Drosophila suzukii*, Matzumura is an important pest of soft and pome fruits. It originates from Asia, now spread throughout Europe, North, and South America. High reproductive potential, many generations per year, and their overlapping have made this pest hard to control. In Bosnia and Herzegovina, SWD has been present at least eight years and for that time little data has been collected on how it spreads and behaves in the agroecological conditions of the Republic of Srpska. Monitoring was conducted in the 2017-2021 period in orchards of different plant hosts. SWD was found in all agriculture regions of the Republic of Srpska with difference in population number. SWD adults are most active from the end of August and are most harmful for grape, blackberry, and late raspberry varieties. Considering climate conditions, population movement was most influenced by precipitation and air temperature.

Key words: spotted wing drosophila, pome fruit, berries, monitoring, Republic of Srpska

Introduction

Spotted wing drosophila (SWD) - *Drosophila suzukii*, Matzumura (Diptera: Drosophilidae) is an invasive pest of many agricultural plants. It originates from

East Asia, but it has recently become widespread throughout Europe, North, and South America (Kinjo et al., 2014).

SWD overwinters as an adult in protected locations, but in favourable conditions it is active all year round. A female lays eggs in ripening fruit of raspberry, strawberry, blueberry, peach, plum, grape, and other agricultural and native plants (Bellamy et al., 2013). One female can lay up to 200 eggs. In a single fruit up to 70 larvae can be found which cause total destruction of fruit tissues. Depending on environmental conditions, SWD can complete up to 13 generations per year (Tochen et al., 2014). Many reports record 100% damage in orchards of susceptible plant hosts (Cini et al., 2012; Weydert & Mandrin, 2013). High reproduction rates, up to a dozen generations per year, a wide host range, and ability to survive long-lasting unfavourable conditions enable SWD to successfully develop and reproduce in non-native regions.

SWD adults are around 3 mm long with yellowish colour of the body and red eyes. Main identification characteristics of the male are dark spots on the edge of the wing and black bristles on the front legs while the female is identified based on axe-shaped, serrated ovipositor (Cini et al., 2012).

Population dynamics of SWD depends on agroecological characteristics of the region and is mostly influenced by temperature. Adults become mobile at air temperature above 5℃, while they become active when the average air temperature exceeds 10℃. The temperature range between 20-25℃ is optimal for SWD activity, while higher temperatures have the worst influence on SWD since they are very sensitive to desiccation (Hamby et al., 2013).

The first report about the presence of SWD in Bosnia and Herzegovina (B&H) was published by Ostojić et al. (2014). Economical threat, expansion, and management of SWD have already been covered by numerous papers published worldwide. However, data on distribution and population movements of SWD in B&H are scarce, although the pest has been present in B&H for eight years.

Raspberry and other soft fruits are of strategic importance for the economy of the Republic of Srpska with annual production of 8000 t of raspberry on nearly 1200 ha harvested area (Institute of Statistics, 2019). Therefore, the Ministry of Agriculture, Forestry, and Water Management of the Government of the Republic of Srpska decided to finance the Program of special surveillance of SWD in the country. The main goal of the research was to determine (i) distribution of SWD across the Republic of Srpska; (ii) presence of SWD in the fruiting stage of pome and stone fruit in different regions of the RS, and (iii) seasonal population movements in different agroecological conditions.

Material and Methods

Monitoring in the field

Monitoring of SWD in the Republic of Srpska was conducted using PET bottles (0.5 l) with 120 ml of apple cider vinegar as a bait attractant. Every bottle was drilled with eight holes 4 mm in diameter. The holes were made on one half of the bottle to make it possible to pour out the attractant with captured specimens without spilling. The traps were set in the centre of orchard in the canopy. They were checked once per week when the attractant was changed.

All samples were sent to the Laboratory of Entomology at the Faculty of Agriculture, University of Banja Luka, where identification of males and females was done. The attractant with captured specimens was poured out on the filter paper placed in a funnel. When the attractant flowed out identification of specimens was done on a binocular microscope. Identification was based on morphological features of males and females.

In the first three years of the monitoring period, 2017-2019, the traps were set in 49-53 orchards in all regions of the Republic of Srpska (Picture 1). Due to covid-19 pandemic, in 2020 and 2021, the number of monitored orchards was 18 and 26, respectively, while the traps were active only in the period of fruit ripening. Monitoring was conducted in orchards of susceptible hosts (Table 1. in Appendix). In 2017, survey started at the beginning of August and lasted for 10-12 week, while in 2018 and 2019 the traps were set in different periods depending on the fruiting stage of different plant hosts.

Fig. 1. Agricultural regions of the Republic of Srpska named by the main city centre: 1. Prijedor, 2. Banja Luka, 3. Gradiška, 4. Doboj, 5. Bijeljina, 6. East New Sarajevo, and 7. Trebinje

Monitoring on the border

In 2017 traps with apple cider vinegar were placed in cargo space of five trucks importing fruits into Bosnia and Herzegovina. The traps were set in two shipments of pear, two shipments of apple, and a shipment of grapes. Four open glasses with 120 ml of attractant were set up in every surveyed shipment for three hours. After that time glasses were closed and sent to the Laboratory of Entomology to check the presence of SWD.

Identification

SWD adults were identified based on morphological characteristics according to a diagnostic protocol (EPPO, 2013). Two main characteristics of males were recorded: a dark spot on the wings and black bristles on the front legs, while females were identified by axe-shaped ovipositor with sclerotized spikes (Figure 2.).

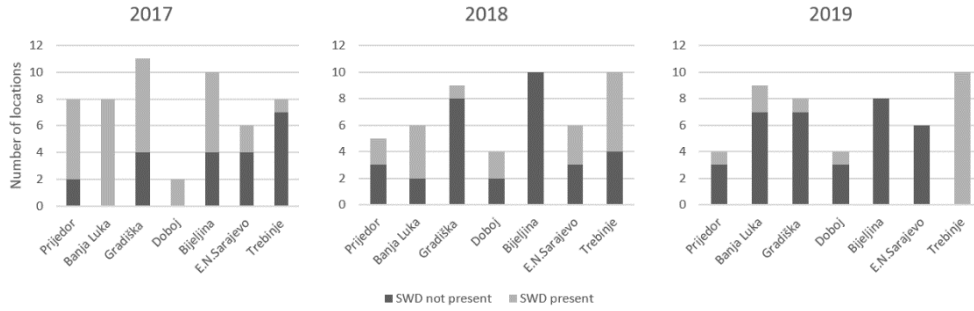
Fig. 2. Identification of SWD adults was based on the following morphological characteristics: (a) dark spots on the wing, (b) black bristles on the front legs, and (c) axe-shaped ovipositor

Climate gradients

Climate parameters were taken from the Carpo forecast reporting system (www.carpo.farm). The Carpo system established and maintained by the Ministry of Agriculture, Forestry, and Water management of the Government of the Republic of Srpska provides a set of data taken from forecast stations located in orchards over the country. Stations collect data in time and those values are available on www.carpo.farm. In this paper we exported minimum, maximum, and average daily air temperature (℃), as well as daily amount of precipitation (mm).

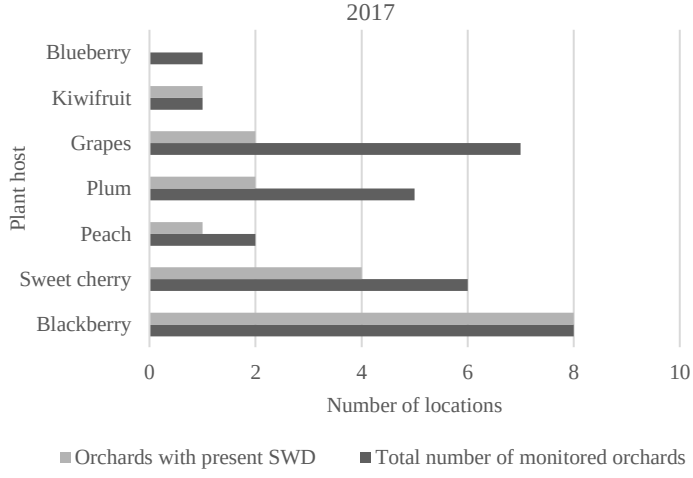
Results and discussion

In the year 2017, SWD was found in 25 orchards, representing 47% of surveyed orchards. Distribution of SWD in the Republic of Srpska was uneven with most numerous populations in the regions of Prijedor and Bijeljina, while in some regions as East New Sarajevo and Trebinje there were two and one positive sample, respectively (Graph 1). Population dynamics was similar between regions with very few catches at the beginning of August and dramatic increase from the middle of September (Graph 5.)

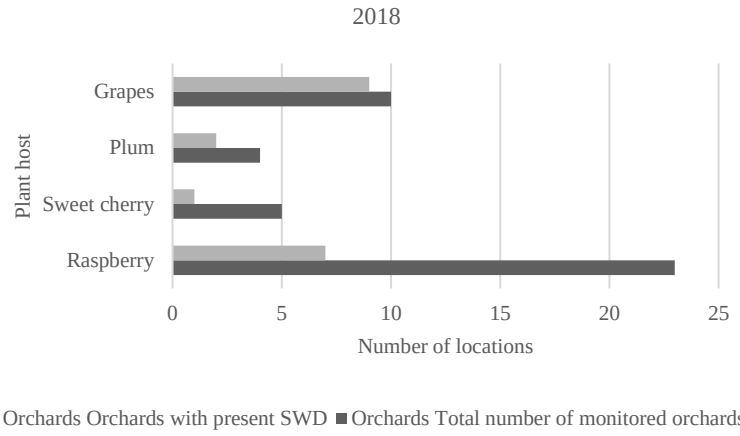


Graph 1. Locations with/ without confirmed presence of SWD

The highest number of locations with confirmed presence of SWD was in the regions of Banja Luka and Prijedor, while in the region of Trebinje SWD was found only on one location. In 2017, SWD was found in raspberry, blackberry, sweet cherry, peach, plum, and kiwifruit orchards, as well as in vineyards (Graph 2.), while in 2018 SWD was found in vineyards and plum, sweet cherry, and raspberry orchards (Graph 3.).

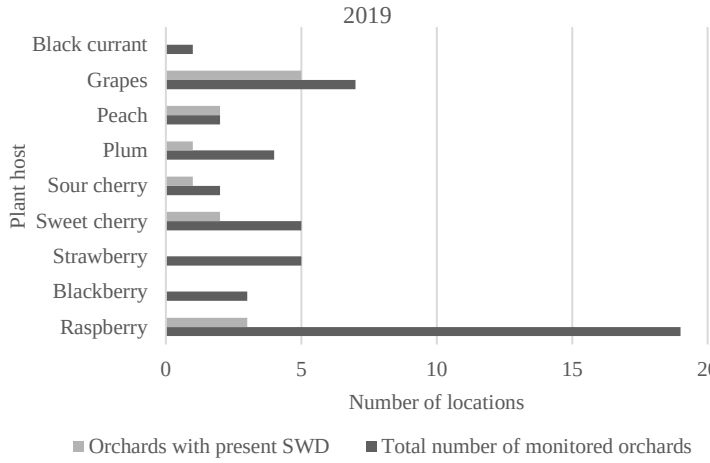


Graph 2. Orchards with confirmed presence of SWD in 2017.



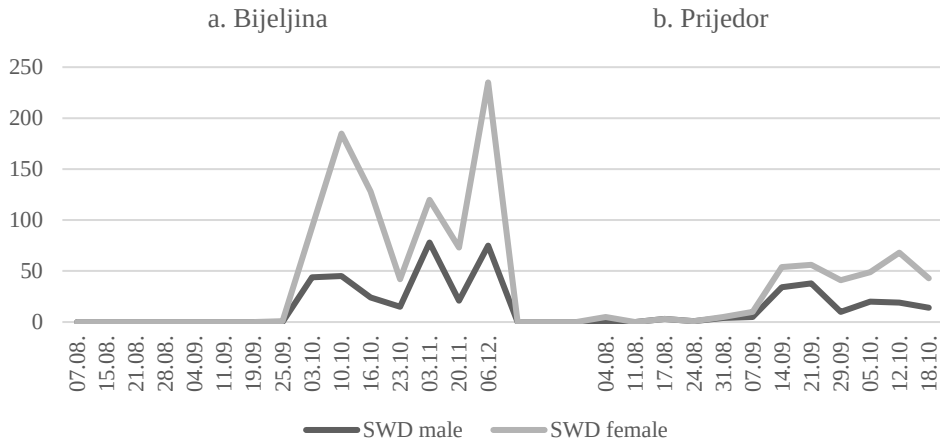
Graph 3. Orchards with confirmed presence of SWD in 2018.

In the year 2019, SWD was detected in 15 out of 49 surveyed orchards, representing 31%. SWD was found in of raspberry, sweet and sour cherry, peach, and plum orchards, and vineyards (Graph 4.).

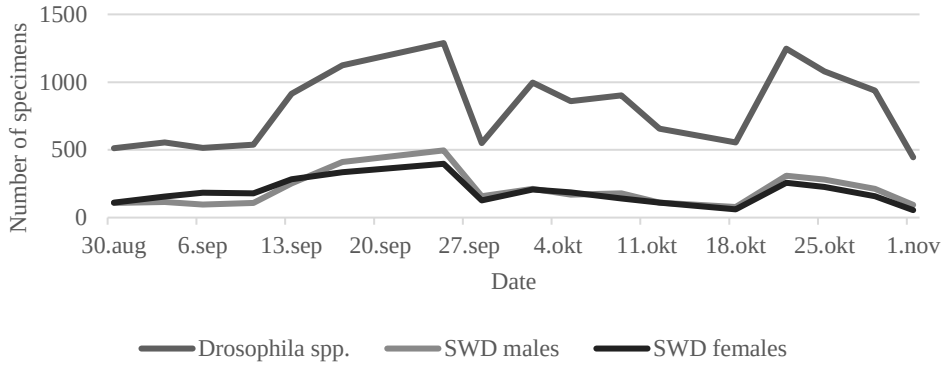


Graph 4. Orchards with confirmed presence of SWD in 2019.

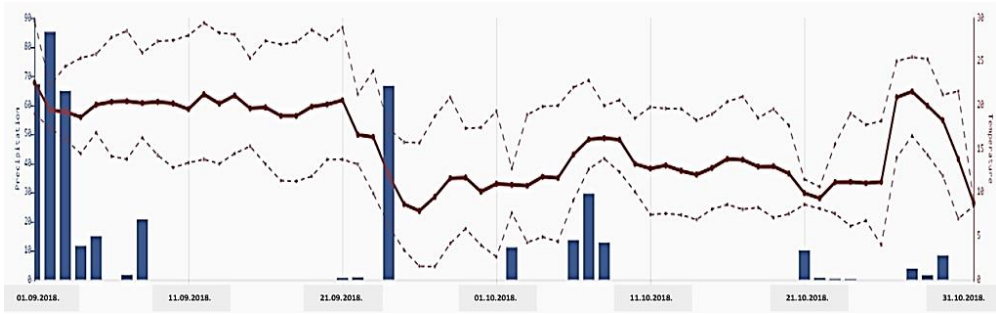
In the years 2020 and 2021, samples were taken in the orchards of various hosts as shown in Appendix 1, but SWD was found only in five orchards each year. In 2020, SWD was found in raspberry orchards, as well as in two blackberry orchards and two vineyards. Similar situation was in 2021 when SWD was confirmed in one orchard of sweet cherry and two orchards of blackberry and two vineyards.



Graph 5. Population dynamics of SWD adults in the 2017 season for Bijeljina (a) and Prijedor (b)



Graph 6. Population dynamics of SWD adults from 1 September to 31 October 2018 for the locality at the University Campus, Banja Luka



Graph 7. Air temperature flow and precipitation from 1 September to 31 October 2018.

Comparing climate conditions with population dynamics of SWD in the location in the Banja Luka region, it is obvious that the activity of SWD depends on the air temperature. At the beginning of monitoring, air temperature exceeded 34℃ when population observed was low. Population of SWD slowly started to grow as temperature fell to 30℃ and stood still. After temperature dropped to 18℃, the number of caught adults of SWD also dropped. This trend was observed at the end of September and October.

SWD was also found in one out of five inspected shipments in the process of import. One female specimen was found in the truck transporting apples from Croatia at the Gradiška border crossing.

This study reveals that SWD is present in all agriculture regions of the Republic of Srpska. In the first year of monitoring (2017) it was obvious that SWD was spread throughout the country. In the first year of monitoring, which started in August and lasted two and a half months, SWD was found in almost 50% of surveyed orchards on the following hosts: raspberry, blackberry, cherry, plum, peach, grape, and kiwifruit. These fruit species are main hosts of SWD (Mitsui et al., 2010). Although the monitoring began late in the season, when most of the fruits were harvested, the post-harvest capture rates of adults were very high. This finding suggests that the alternate hosts also play an important role in the SWD survival until it discovers another suitable host or passes into the next season.

In 2018, monitoring covered the period of fruiting of the main host plants to reveal whether the pest was present in the fruiting stage. SWD was detected in 36% of orchards. Endangered species were raspberry, cherry, plum, and grape. However, there was little damage in soft skinned varieties of grape, while only in blackberry the damage exceeded economic threshold.

Population dynamics of SWD through the season is characterized by almost absence in orchards through the summer period in most of the regions, while the peak was achieved aggressively in September and October. High population numbers were present in November and December as it was in case of Bijeljina. Until the next peak only few specimens were captured between January and July. Similar population dynamics was reported in other regions, such as Italy (Baser et al., 2015), Mediterranean countries (Weydert and Mandrin, 2013), and Germany (Bleyer and Breuer, 2013). For example, in South Korea, SWD has two peaks in the season, in June and October. Therefore, the economic threshold can be expected to be exceeded in the whole period between June and November (Kim et al., 2014).

Inspection of shipments in the process of import showed that SWD can be introduced to the trading plant material. A special concern is that we have found SWD in the apple shipment, while the apple is considered to be a minor host. These findings emphasize the importance of monitoring trade commodities as

they are the main way of introduction of different pests to new areas. The efforts and funds invested in prevention are always more effective than the management of the pests already present.

Conclusions

In all regions of the Republic of Srpska, SWD is widely distributed. SWD presence has been confirmed in raspberry, blackberry, sweet and sour cherry, peach, plum, kiwifruit, and grapevine orchards. However, there has been early population dynamics in the season that most host species such as cherry, raspberry, strawberry, and peach have avoided damage because they ripen before the pest population increases. However, hosts like grapes and blackberries might be highly affected by numerous populations in the late summer and early autumn. Based on this research, in the agro-ecological conditions of the Republic of Srpska SWD is a potentially harmful pest for late raspberry varieties, blackberry, and soft skinned varieties of grape. Based on population densities and overall distribution, there is a need for further monitoring of SWD, especially in regions with dense production of berries and grapes.

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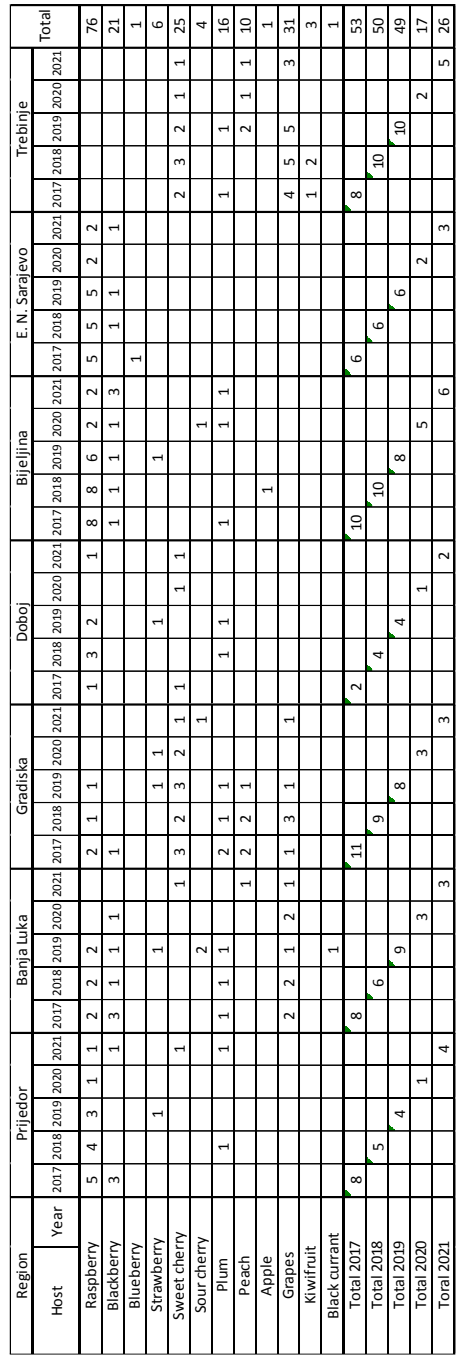
Appendix

Tab. 1. Traps distribution in the period 2017-2021.



Region		Prijedor					Banja Luka					Gradiska					Doboj					Bijeljina					E. N. Sarajevo					Trebinje					Total
Host	Year	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	
Raspberry		5	4	3	1	1	2	2	2			2	1	1			1	3	2		1	8	8	6	2	2	5	5	5	2	2						76
Blackberry		3				1	3	1	1	1		1										1	1	1	1	3		1	1		1						21
Blueberry																											1										1
Strawberry				1					1				1	1					1					1								2	3	2	1	1	6
Sweet cherry						1					1	3	2	3	2	1	1			1	1																25
Sour cherry									2							1									1												4
Plum		1			1	1	1	1	1			2	1	1				1	1			1			1	1						1		1			16
Peach											1	2	2	1																			2	1	1	10
Apple																							1														1
Grapes						2	2	1	2	1	1	1	3	1		1																4	5	5		3	31
Kiwifruit																																1	2				3
Black currant									1																												1
Total 2017		8					8					11					2					10					6				8					53
Total 2018			5					6					9					4					10					6				10					50
Total 2019				4					9					8					4					8					6					10			49
Total 2020					1					3					3					1					5					2					2		17
Toral 2021						4					3					3					2					6					3					5	26

Резултати мониторинга азијске воћне мушице (*Drosophila suzukii*, Matzumura) на подручју Републике Српске (Босна и Херцеговина) у периоду 2017-2021 са освртом на сезонско кретање популације

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Сажетак

Азијска воћна мушица (ABM) - *Drosophila suzukii*, Matzumura је значајна штеточина бобичастог и коштичавог воћа. Поријеклом је из Азије, а тренутно је распрострањена широм Европе, Сјеверне и Јужне Америке. Висок репродуктивни потенцијал, бројне генерације у току године и њихово преклапање чине контролу ове штеточине веома тешком. У Босни и Херцеговини, ABM је присутна најмање осам година, а за то вријеме веома мало података је прикупљено о њеној распрострањености и понашању у различиним агроеколошким условима Републике Српске. Мониторинг је спроведен у периоду од 2017. до 2021. године у засадима различитих воћних врста. ABM је пронађена у свим пољопривредним регионима Републике Српске са различитом густином популације. Одрасле јединке ABM су најактивније од краја августа и највише угрожавају винову лозу, купину и касне сорте малине. Од климатских услова, највећи утицај на бројност популације имају падавине и температура ваздуха.

Кључне ријечи: азијска воћна мушица, коштичаво воће, бобичасто воће, мониторинг, Република Српска

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