

Research article

First record of *Drosophila suzukii* (Diptera: Drosophilidae) on the fruits of *Viscum album* spp. *album* in Bulgaria

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Abstract: The invasive fly *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) was recorded for the first time as a pest on the fruit of European mistletoe (*Viscum album* ssp. *album* Linnaeus) in Bulgaria. Fruits were collected in April 2023 from seven sites, located in the region of Nesebar Town. In three of them, the mistletoe grows on false acacia (black locust) tree (*Robinia pseudoacacia* Linnaeus) and in four sites – on Canadian poplar (*Populus × canadensis* Moench). It found that, the infestation rate of mistletoe fruits by *D. suzukii* was influenced by the host species of mistletoe. It is 10 times higher in false acacia (black locust) tree than in Canadian poplar.

Keywords: European mistletoe, fruit infestation rate, invasive fly, new record

Introduction

Drosophila suzukii (Matsumura, 1931) (Diptera: Drosophilidae), also known as “spotted wing drosophila”, is a polyphagous invasive pest of berries and stone fruits from the genera *Vaccinium*, *Rubus*, *Prunus*, *Vitis*, *Ficus*, *Actinidia*, *Rhamnus*, *Lonicera* and many others (Grassi et al., 2012; Seljak, 2011; Walsh et al., 2011; Poyet et al., 2015). It originates and is widely distributed in the south-eastern Palaearctic region, and has recently expanded its range to wider areas of the world. It has been found in Europe, North America, Central and South America, Africa (Morocco), Middle East, Caucasus, Oceania (Hawaii) (Hauser, 2011; Cini et al., 2012; Japoshvili et al., 2018), and recently, it has also been found in Bulgaria. In the country, *D. suzukii* was observed for the first time in 2014 in cherry plantation in the Blagoevgrad region (Karadjova et al., 2016; Minkov et al., 2017). In a decade, the invasive pest has

expanded both its distribution range within the country and its host range. The known hosts of this invasive fly in Bulgaria are various fruit (e.g., cherries, plums) and berry crops (e.g., raspberries, blackberries) (Karadjova et al., 2016; Minkov et al., 2017; Minkov et al., 2018; Petrova et al., 2020). However, the data on wild hosts of *D. suzukii* in the country remain limited. Such a potential host could be the European mistletoe (*Viscum album* L.), whose fruits are known to be attacked by the pest (Thomas et al., 2023; Deconninck et al., 2024a, b). The purpose of the present study is to investigate the potential infestation of mistletoe by *D. suzukii* in the region of the town of Nesebar.

Material and methods

Fruits of the European mistletoe were collected in April 2023 from seven sites (50×50 m) located in the

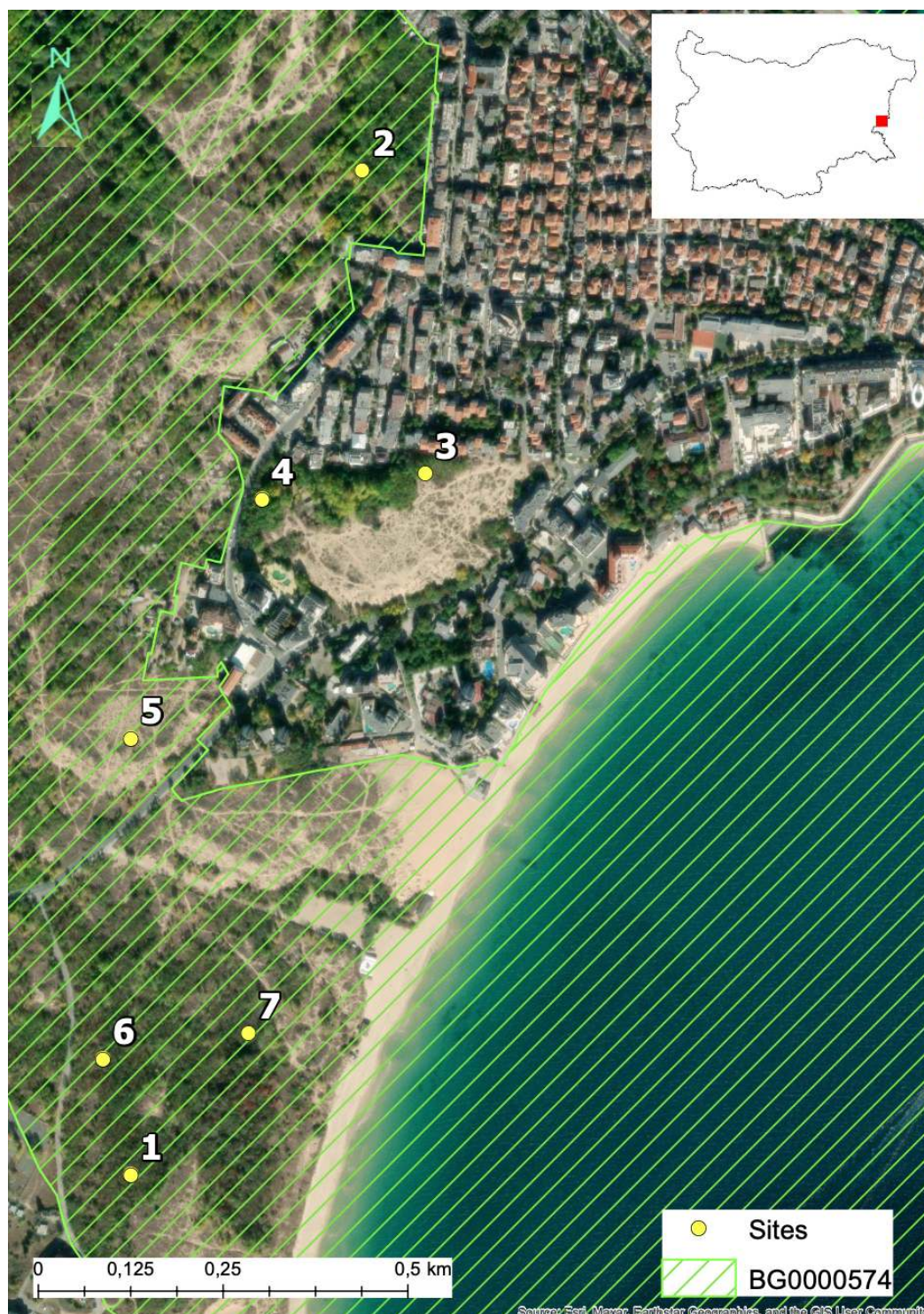


Fig. 1. Map of the studied area.

sand dunes of Nesebar Town (Black Sea Region). In three sites, the European mistletoe (*Viscum album* spp. *album* L.) parasitises false acacia (black locust) tree (*Robinia pseudoacacia* L.) (age between 10 and 25 years), and in the others it grown on Canadian

poplar (*Populus × canadensis* M.) (age 10-50 years). The study area is part of the Natura 2000 site BG0000574 Aheloy-Ravda-Nesebar, with the exception of sites 3 and 4 (Fig. 1). The main characteristics of the sites are presented in Table 1.

Table 1. Main characteristics of the studied sites.

Site, N	Geographical coordinates	Altitude, m a.s.l.	Host tree species	Collected fruits, N	Sampling date
1	N42.6497° E27.7090°	16	<i>R. pseudoacacia</i>	123	09.04.2023
2	N42.6620° E27.7130°	11	<i>P. canadensis</i>	65	10.04.2023
3	N42.6583° E27.7140°	12	<i>R. pseudoacacia</i>	93	12.04.2023
4	N42.6580° E27.7113°	10	<i>P. canadensis</i>	88	13.04.2023
5	N42.6551° E27.7091°	4	<i>P. canadensis</i>	79	15.04.2023
6	N42.6512° E27.7086°	17	<i>R. pseudoacacia</i>	30	16.04.2023
7	N42.6515° E27.7110°	12	<i>P. canadensis</i>	49	19.04.2023

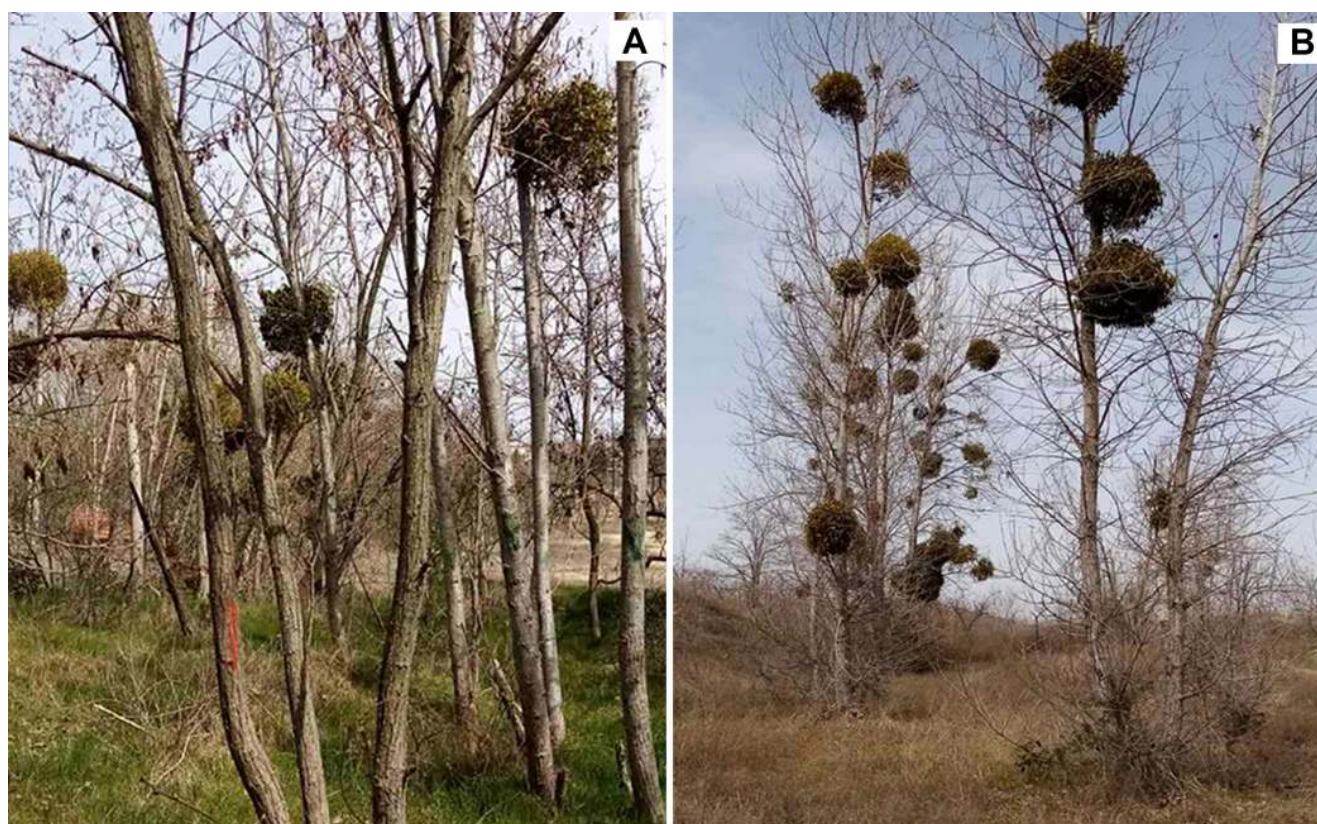


Fig. 2. (A) *Viscum album* ssp. *album* on *Robinia pseudoacacia* – site 1; (B) *Viscum album* ssp. *album* on *Populus* × *canadensis* – site 5.

The European mistletoe fruits were collected in April 2023 from seven sites in the region of Nesebar Town. In three of them, the *V. album* parasitises false acacia (black locust), and in four Canadian poplar. A total of 527 mistletoe fruits were collected, 246 from false acacia (black locust) tree and 281 from Canadian poplar (Fig. 2). The fruit samples were collected from 1 to 3 individuals (clusters) of mistletoe per tree (de-

pending on the rate of infestation of the host tree) at a maximum crown height of 3 m. A maximum of 5 fruits were taken from each cluster without disturbing their integrity. The collected fruits were transported to the laboratory of the Forest Research Institute at the Bulgarian Academy of Sciences, where they were placed together in plastic boxes with filter paper on the base (the slimy texture of the fruits did not allow

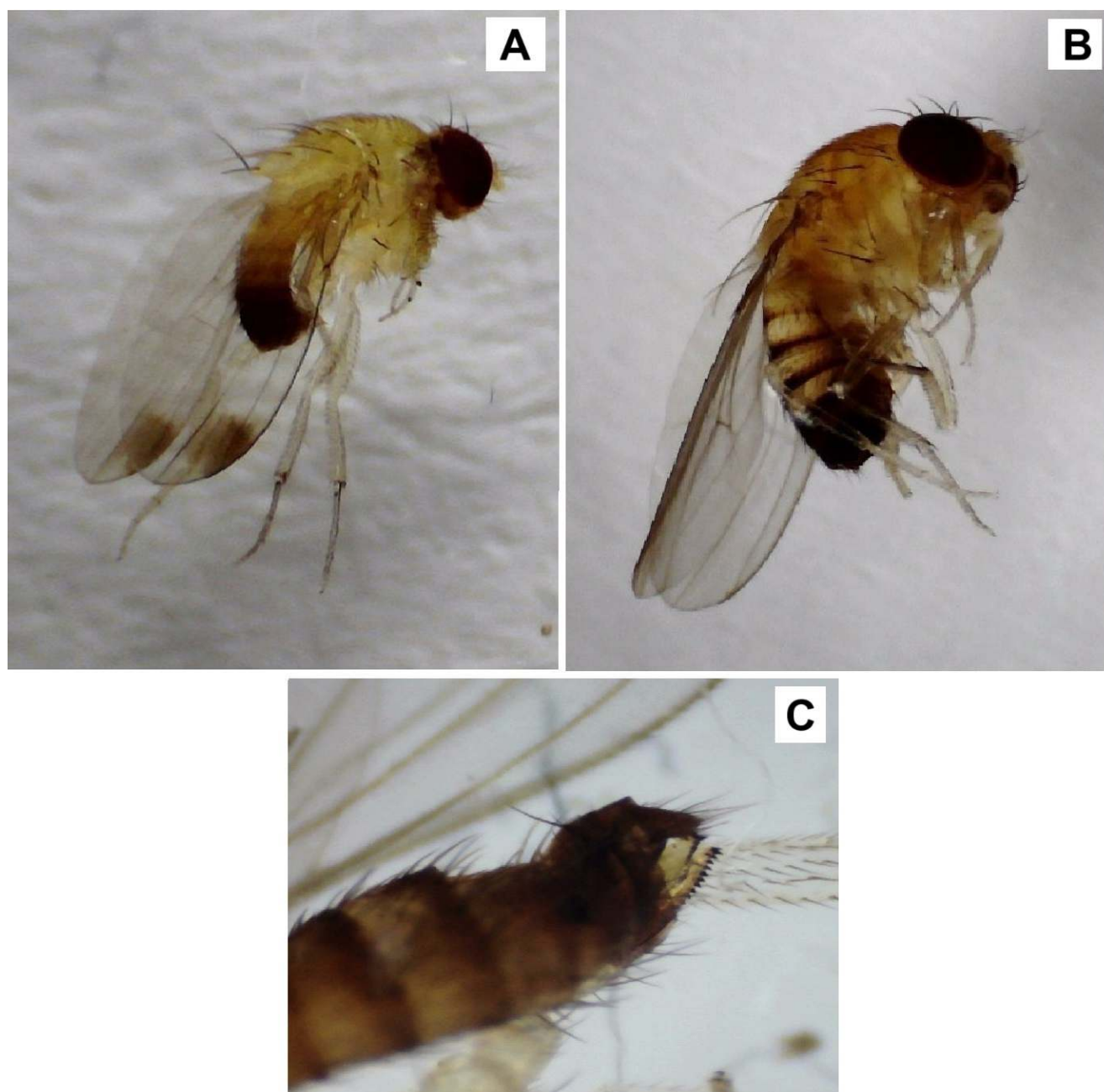


Fig. 3. *Drosophila suzukii* Matsumura. (A) habitus of male specimen; (B) habitus of female specimen; (C) ovipositor.

us to separate them for individual observations). The fruit samples, labeled according to the site number, were stored at room temperature (18–20°C) and natural light. For one year after the date of collection of the samples, the samples were checked daily for the emergence of insect adults and pupae. All emerged adults were put individually in tubs with 95% ethanol. The identification of *D. suzukii* adults was based on external sexual dimorphic characteristics: males by the dark spot on the distal part of wings and females

by the distinctive large serrated oviscapt in their terminalia observed in a stereomicroscope (Hauser, 2011; Yuzuki & Tidon, 2020) (Fig. 3).

The Wilcoxon statistic method was used to construct a confidence interval (CI) for the difference between the mean of infestation rates of mistletoe fruit in black locus tree and Canadian poplar (Hollander & Wolfe, 1973). The infestation rate was calculated as the number of insects emerged from 100 mistletoe fruits.

Table 2. Observations of collected samples.

Site (Sample), N	Host tree species	Collected fruits, N	<i>Drosophila suzukii</i>		Pupation period	Emergence period	Emerged adults, N	Infestation rate, %
			female	male				
1	<i>R. pseudoacacia</i>	123	1	1	18.04.2023–19.04.2023	05.05.2023	2	1.6
2	<i>P. canadensis</i>	65	—	1	19.04.2023	04.05.2023	1	1.5
3	<i>R. pseudoacacia</i>	93	15	6	22.04.2023–28.04.2023	05.05.2023–11.05.2023	21	22.6
4	<i>P. canadensis</i>	88	0	0	—	—	0	0
5	<i>P. canadensis</i>	79	2	—	23.04.2023	06.05.2023	2	2.5
6	<i>R. pseudoacacia</i>	30	2	1	25.04.2023–30.04.2023	06.05.2023–11.05.2023	3	10
7	<i>P. canadensis</i>	49	—	—	—	—	—	—
Total		527	20	9	—	—	29	av. 5

Results and discussion

Trophic connection: *Drosophila suzukii* is reported for the first time as a pest on *Viscum album* in Bulgaria. Given the high polyphagy of the spotted wing drosophila (Kirschbaum et al., 2020), it is not surprising that non-crop plants such as *V. album* have already been identified as early spring host plant for this invasive fly (Poyet et al., 2015; Panel et al., 2018; Thomas et al., 2023; Deconninck et al., 2024a, b). The European mistletoe is widespread in Bulgaria from 0 to 2000 m. a.s.l. (Assyov et al., 2012). Therefore, its fruits are a possible vector, favoring development of spring generations of *D. suzukii* (Deconninck et al. 2024a). In continental Europe, about 80 insect species have been recorded on European mistletoe (Thomas et al., 2023). In the country, only four species have been reported on fruits of *V. album* so far – *Dienerella filiformis* (Gyllenhal, 1827), *Melanophthalma rhenana* Rücker et Johnson, 2007, *M. taurica* (Mannerheim, 1844) (Coleoptera: Latridiidae), *Berginus tamarisci* Wollaston, 1854 (Coleoptera: Mycetophagidae) (Guéorguiev et al., 2023).

Infestation rate in the study zone: The infestation rate of mistletoe fruits by *D. suzukii* in the region of Nesebar Town was low – av. 5%. The pest infestation ranged from 0 to 22.6% by sites (Table 2). It is

observed that the sex ratio is 2:1 with a predominance of females. Under laboratory conditions, the pupation began in mid-April and adult emergence was first observed in the first ten days of May. *D. suzukii* females can lay 350–400 eggs over their lifetime and may deposit several eggs in a single fruit (Kanzawa, 1939). Due to the specificity of fruit texture, which did not allow individual observation, we cannot provide information on the amount of oviposition in one fruit as well as on the number of infested fruits. Information on mistletoe host tree species, number of collected fruits, infestation rate of fruits, and phenology is provided in Table 2.

Infestation rate by mistletoe host species: In similar fruit sample sizes collected from the two mistletoe host species (Table 2), the rate of fruit infestation by the invasive pest was found to be almost 10 times higher in the false acacia (black locust) compared to the Canadian poplar (Fig. 4). The difference in the mean infestation rates was large, 11.4% for false acacia (black locust) vs. 1.0% for Canadian poplar, with an 89% CI of the difference [0.1, 22.6]. The absence of a relationship between sample size (number of collected fruits) and infection rate was investigated to eliminate it as a random factor influencing the relationship found in Fig. 4. The absence of relationship is shown in Fig. 5.

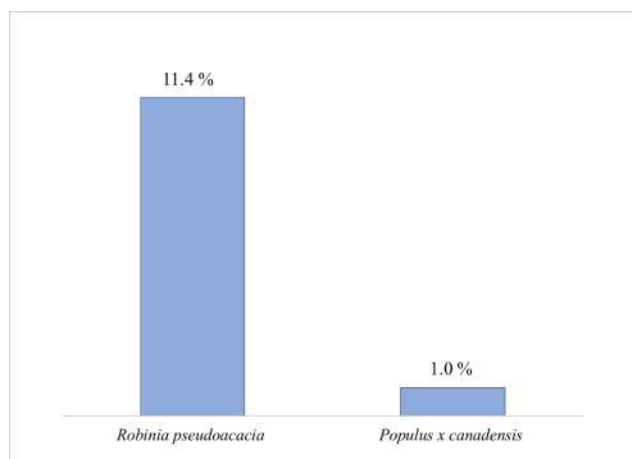


Fig. 4. Infestation rate according to host tree of European mistletoe.

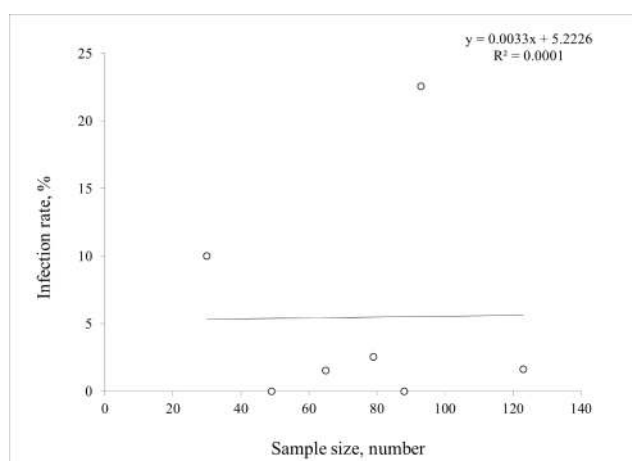


Fig. 5. Relationship between sample size and fruit infestation rate.

Winter fleshy-fruited plants are the catalyst for spring populations of an invasive fruit fly (Deconninck et al., 2024a). The spring generation of the multivoltine species *D. suzukii*, seems to benefit both from the early flowering of false acacia (black locust) in April–May which attracts large numbers of insect visitors (Fleming et al., 2007) and by the presence of the semiparasitic plant *Viscum album* on it. By the contrast to our results, Deconninck et al. (2024a) found that mistletoe fruits on *Populus nigra* (L.) were the most heavily infested compared to those on hawthorn, apple trees or false acacia (black locust). Different infestation may be explained with different biologically active phenolic compounds in mistletoe fruits depending on the host tree species (Pietrzak et al., 2017), which may act as repellents or attractants

for insects, including *D. suzukii* (Hussain et al., 2023). The mistletoe growing on *Populus nigra* (L.) trees are known to be particularly rich in phenolic acids (Pietrzak et al., 2017; Pratyusha 2022). Our contrasting results might be due to the difference in the involved poplar species – it was *P. canadensis*. In any case, the further research is needed to better understand differences in *D. suzukii* infestation between the various mistletoe host tree species.

Conclusion

The data obtained in this study indicate that European mistletoe fruits can catalyse the increase in *D. suzukii* spring generation in the country. In this regard, the mistletoe host tree species appears to be an important ecological factor that affects the numbers of the pest. *V. album* is an important trophic resource for various animal species and it is not viable to eradicate it generally. Therefore, the further pest management strategies should focus on control of mistletoe populations and their host trees, with priority on those trees near to fruit producing areas.

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