Are there preferences of *Drosophila suzukii* for cherry and plum varieties?

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Abstract

Within the INTERREG V-Upper Rhine Valley-project InvaProtect different cherry and plum varieties were screened for the number of Drosophila suzukii *eggs in the field and in the laboratory. Field screening of plums were made with 12 different varieties, 4 different ripening stages per variety and 30 fruits per sample collected 1-2 times a week from August until October in 2016. Laboratory trials were conducted as choice and no-choice tests in cages with female flies and certain numbers of fruits depending on ripeness and size (T 23 °C, RH > 65 %). Female flies were allowed to lay eggs for 24 h. For plums, preferences in egg laying were found in the field screening as well in the laboratory tests. The varieties Topfive, Haroma and variety No. 4834 were most susceptible compared to the varieties Tophit plus, Jojo, Presenta, Hauszwetschge and Mirabelle with 0 or very few eggs layed, respectively. For cherries, in all varieties eggs were laid from 9.4 per fruit in Samba and Vanda to 1.9 per fruit in the variety Tamara in no-choice tests. In choice tests the differences were not as obvious as in the no-choice tests. Only the yellow-reddish variety Stardust was significantly less susceptible as Kordia. Further studies have to be made to give recommendations to the growers.*

Keywords: Spotted Wing Drosophila, *Drosophila suzukii*, host fruits, preferences.

Introduction

The spotted wing drosophila, *D. suzukii* (Diptera: Drosophilidae), is native to South-East Asia (Walsh *et al*., 2011). In Europe, it was first recorded in Spain in 2008 (Calabria *et al*., 2012) and within a few successive years in many European countries. According to the EPPO PQR database on quarantine pests and CABI, Invasive Species Compendium (EPPO, 2016, CABI, 2016), *D. suzukii* was recorded in Europe with a wide-spread distribution in the Mediterranean, Western and central European regions. *D. suzukii* is a highly polyphagous species infesting fruits from many different plant genera and families including commercial crops, as well as ornamental and wild growing species, especially small berries, other soft and stone fruits including sweet and sour cherries or plums (e.g. Asplen *et al*., 2015, Baroffio & Fischer, 2011, Rauleder & Köppler, 2015). Lists of *D. suzukii* hosts can be found on *www.ltz-bw.de* or www.cabi.org. Cherries (*P. avium*) are one of the most susceptible hosts with a very high reproduction potential for *D. suzukii*. Plums (*P. domestica*) are further stone fruit hosts later in the season. The host status of fruits depends on *D. suzukii* phenology, population development, climatical conditions and for early hosts on the occurrence of fertile adults early in spring (Zerulla *et al*. 2015; K. Köppler, 2015 unpublished results). To adapt plant protection measures or to find fruit characteristics which influences egg laying or larval development, different cherry and plum varieties were investigated for number of eggs within the INTERREG-project InvaProtect.

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Material and Methods

Field trials with plums in 2016

In 2016 12 different plum varieties with 4 ripening stages as long as available (unripe - green and hard, unripe - market quality but hard, ripe and soft, overripe) were screened for *D. suzukii* eggs from 18th August until 19th October once to twice per week. Plum trees were not treated with insecticides during fruit growing and fruit ripening phase. Eggs were counted under the microscope. Following plum varieties from the LTZ-experimental field were investigated: variety No. 4834, Haroma, Topfive, Hanita, Toptaste, Presenta, Topend plus, Mirabelle, House Plum (`Hauszwetschge`), Tophit plus, Mirabelle plum, Jojo.

Because of frost losses, plum screening could not be repeated in 2017.

Laboratory trials

Laboratory trials were performed with plums in 2016 and in 2017 as well as with cherries in 2017. Because of the above mentioned frost losses at LTZ in 2017, plumes were provided from other regions (see acknowledgements). All tests were performed in plastic insect cages (BugDorm-42222) with 10 D. suzukii-females (in 2017 with 20 females in some plum trials), 4 replicates and controlled conditions (T 23 °C, RH > 65 %). Female flies were allowed to lay eggs for 24 h.

No-choice plum laboratory trials (2016 and 2017): tests with 10 (2016) or 4 (2017) fruits of the same variety in one cage, tested varieties Topfive, Haroma, Hanita, Hanka, Aprimira, Mirabelle, Tophit plus, Jojo, House plum, Presenta and President.

Choice plum laboratory trials (2016 and 2017): tests with two plum varieties (N = 5 in 2016, N = 2 in 2017 for each variety) in each cage, tested pairs House plum vs. Tophit plus, Topfive vs. Hanita, Haroma vs. Jojo and variety No. 4834 vs. Presenta.

No-choice cherry laboratory trial (2017): tests with 5 cherries of one variety/cage, tested varieties Sweet Early, Earlise, Burlat, Bellise, Titan, Vanda, Satin, Grace Star, Samba, Early Korvic, Carmen, Stardust, Kordia, Oktavia, Tamara, Regina, Skeena, Habunt, Verdell.

Choice cherry laboratory trial (2017): tests with two cherry varieties (N = 3 for each variety) in each cage, tested pairs Grace Star vs. Carmen, Oktavia vs. Tamara and Stardust vs. Kordia.

Results

Field trials with plums in 2016

Results of the different ripening stages were summarized for plum field trials because of similar tendencies, that unripe plums were not susceptible compared to an increasing ripening stage. Only overripe plums were not as attractive as ripe fruits.

Table 1: *D. suzukii* oviposition in different plum varieties in the field: No. of eggs/fruit and percentage of infested fruits, LTZ 2016.

Plum variety (N analysed fruits)	No. of eggs/fruit (% infested fruits)		Plum variety (N analysed fruits)	No. of eggs/fruit (% infested fruits)
variety No. 4834 (746)	0.8 (15.0)		Topend plus (150)	0.007 (0.7)
Haroma (563)	0.2 (7.1)		Mirabelle (630)	0.002 (0.2)
Topfive (244)	0.06 (3.3)		House plum (567)	0.002 (0.2)
Hanita (358)	0.03 (2.0)		Tophit plus (110)	0 (0)
Toptaste (240)	0.03 (0.8)		Mirabelle plum (289)	0 (0)
Presenta (539)	0.03 (1.3)		Jojo (524)	0 (0)

Table 1 shows the number of eggs/fruit and percentage of infested fruits for each variety collected in the field in 2016. It shows a clear difference between varieties. The most susceptible varieties were no. 4834, Haroma, Topfive, Hanita, Toptaste and Presenta, the last three varieties with the same rate for eggs/fruit. In contrast, no eggs were found in the varieties Tophit plus, Mirabelle plum and Jojo.

Laboratory trials

No-choice and choice plum laboratory trials: To give a better overview, results of plum laboratory trials were also summarized for 2016 and 2017. Table 2 represents the no-choice results and table 3 the choice results for plum varieties. The no-choice tests resulted in similar tendencies as in the field. The highest numbers of eggs/fruit were found in the variety No. 4834, Haroma, Topfive and Hanita. This result could also be confirmed in the choice tests, where Topfive, Haroma and variety No. 4834 were more susceptible compared to their compared variety in each case. The combination of House plum and Tophit plus in one cage did not result in egg laying in one of the fruits. This corresponds also with the former results in the field as well as in no-choice laboratory tests.

Table 2: *D. suzukii* oviposition in different plum varieties in no-choice laboratory trials: average No. of eggs/fruit 2016/2017.

Plum variety	No. of eggs/fruit		Plum variety	No. of eggs/fruit
Topfive	3.1		Tophit plus	0
Haroma	1.1		Jojo	0
Hanita	0.9		House plum	0
Hanka	0.4		Presenta	0
Aprimira	0.2		President	0
Mirabelle	0			

Table 3: *D. suzukii* oviposition in combinations of different plum varieties in choice laboratory trials: average No. of eggs/fruit 2016/2017.

Plum variety 1 vs. 2	No. of eggs/fruit variety 1vs. 2
Variety No. 4834 vs. Presenta	6.2 vs. 0.4
Topfive vs. Hanita	2.5 vs. 0.5
Haroma vs. Jojo	0.92 vs. 0
House plum vs. Tophit plus	0 vs. 0

Table 4: *D. suzukii* oviposition in different cherry varieties in no-choice laboratory trials: average No. of eggs/fruit, 2017.

Cherry variety	No. of eggs/fruit		Cherry variety	No. of eggs/fruit		Cherry variety	No. of eggs/fruit
Samba	9.4		Harbunt	6.0		Kordia	3.5
Vanda	9.4		Bellise	5.2		Verdell	3.4
Sweet Early	9.3		Stardust	4.8		Oktavia	3.3
Satin	8.9		Grace Star	4.4		Carmen	2.6
Titan	7.7		Skeena	4.1		Tamara	1.9
Burlat	6.7		Regina	4.1			
Earlise	6.6		Early Korvic	3.7			

No-choice cherry laboratory trial (2017): *D. suzukii* oviposition rate per fruit is shown in table 4. All cherry varieties were susceptible. The highest rates were found in the varieties Samba, Vanda, Sweet Early or Satin with 8.9 to 9.4 eggs. The lowest rate occurred in Early Korvic, Kordia, Verdell, Octavia, Carmen and Tamara with 3.7 to 1.9 eggs.

Choice cherry laboratory trial: Three cherry combinations were screened, in which differences between varieties were not as obvious as in plums. Only the combination Stardust vs. Kordia showed a higher difference in oviposition with a lower number of eggs in Stardust (tab.5).

Table 5: *D. suzukii* oviposition in different cherry varieties in choice laboratory trials: average No. of eggs/fruit, 2017.

Cherry variety 1 vs. 2	No. of eggs/fruit variety 1vs. 2
Grace Star vs. Carmen	2.6 vs. 2.9
Oktavia vs. Tamara	5.3 vs. 3.8
Stardust vs. Kordia	7.0 vs. 23.9

Discussion

Both, in the field and in the laboratory clear differences in the oviposition rate could be shown for plums. Varieties No. 4834, Topfive and Haroma had the highest No. of eggs in all experiments. Ripening time cannot be taken as a factor for differences in infestation rates, because the mentioned varieties get ripe during different periods of the season (August-September). *D. suzukii* population increases within the season until autumn, hence the infestation risk is higher for late varieties. Population growth and infestation risk depends on temperature as well as humidity. Hot and dry conditions are not favourable for *D. suzukii*. Following, infestation level can vary between different years, between regions and within a season (Köppler & Rauleder, 2015, Köppler, 2017). Additionally, field experiences made by growers in different regions did not confirm some of these findings for certain plum varieties (growers, personal communications). During the ripening process of the fruits, susceptibility increases. Lee *et al.* (2011) showed for different soft fruits and cherries a higher egg rate as the brix level increased. For investigated plum varieties ripe and softer fruits number of eggs was higher compared to unripe fruits, but overripe fruits had not been as attractive as ripe plums. Thickness of fruit skin and penetration force can also play a role in oviposition ability for *D. suzukii* as well as fruit components for larval hatch and development.

According to the results plums are much less susceptible to *D. suzukii* as cherries. Cherries are in general highly infested fruits compared to other stone fruits (Harzer & Köppler, 2015). The maximum oviposition rate in plums was 3.1 eggs/fruit (variety Topfive) in no-choice laboratory trials. In the field this number only reached 0.8 eggs/fruit in the variety No. 4834 in 2016. The highest number was found in the cherry varieties Samba and Vanda in no-choice trials (9.4 eggs/fruit). There was no cherry variety without eggs. Highest difference in the egg rate was about 7.5 eggs/fruit in no-choice tests and 17 eggs/fruit in choice tests. Following, cherry varieties can also differ in susceptibility in laboratory trials. The yellow-reddish variety Stardust was significantly less susceptible as Kordia. Although color affects oviposition is not clear. According to the broad host range, *D. suzukii* is able to infest fruits of very different colors.

Whether these findings may influence the infestation in the field, is not clear. Again, abundance of the pest and population growth influences the infestation risk as well as abiotic conditions. Furthermore, site factors, like combination or number of different cherry varieties

and other attractive host fruits nearby can be a factor for infestation (Tochen *et al*., 2014, 2015).

The results of the presented study have to be seen as a first indication for the influence of fruit varieties on *D. suzukii* infestation level. Further studies have to be done. Nevertheless, precise monitoring of flies and the beginning of oviposition in fruits are important measures every year to make the right decision for pest control.

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