Control of *Drosophila suzukii* with DS-Lime in black berries

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Abstract

DS-lime was applied against Drosophila suzukii *alone or in different combinations with leaf fertilizer (Cuprum and ManZincum) or with the surface-active agent (Proagro surface-active agent) in a field trial in black berries in 2017. DS-lime applications were compared with an untreated control and the application of insecticides (Karate Zeon; lambda-Cyhalothrine and Spintor; spinosad) as a negative and a positive control, respectively. Fruit samples (50 black berries in each) were taken two days before first application, one day before every following treatment and 3 days after the last treatment. The harvest of all ripe fruits as a hygenic measure after sampling should decrease pest pressure. Infestation per fruit sample was counted with number of larvae/50 fruits.* D. suzukii *infestation increased after 3rd sampling in all variants including insecticide control. Application with DS lime resulted in medium efficacies, but with very inhomogeneous results. The combination of DS lime with leaf fertilizers or the surface-active agent did not result in higher efficacies. Obvious blotch were found after lime application to a low extend and no complaints were recorded in the market. The study was done by the associated project partner Landratsamt Karlsruhe, Landwirtschaftsamt Bruchsal on the experimental field of the Centre for Agricultural Technology (LTZ) within the INTERREG V-Upper Rhine Valley-project InvaProtect.*

Keywords: Spotted Wing Drosophila, *Drosophila suzukii*, control

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 (e.g. Asplen *et al*., 2015, Baroffio & Fischer, 2011, Rauleder & Köppler, 2015). Infestation of fruits starts in ivy berries from the previous year after overwintering of the pest and takes until late fall in November e.g. in late raspberry varieties in Southern Germany (see list of host plants on www.ltz-bw.de > ueber uns > InvaProtect). According of population growth with several generations within the season, the broad host spectrum in fruit crops as well as the ongoing infestation in ripening fruits, control of *D. suzukii* is very difficult. Particularly with regard to fruit crops with a long harvesting period for several weeks, the infestation risk is higher, e.g. blackberries or raspberries. Chemical control is restricted to the registration of active ingredients and to the number of applications as well as in organic as in integrated fruit production. According to several experiences, chemical control can only be one part of a strategy (e.g. Hensel & Dahlbender,

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2015, Köppler, 2017). Beside insecticide efficacy, residual activity has also to be taken into account. For organic farming spinosyn class of insecticides is effective. Additionally, azadirachtin and organic pyrethrins only show poor efficacy, resulting in a challenge for organic growers to avoid resistance problems (Bruck *et al*., 2011, Asplen *et al*., 2015). Following, for both, integrated and organic fruit production, additional or alternative measures have to be found, which can be combined with other treatments, e.g. like netting, hygenic measures or short harvest intervals. To develop a combined strategy for *D. suzukii* control is part of the INTERREG-project InvaProtect. One of these measures could be the application of lime, which is registered as a fertilizer. It is required to increase the pH (Baroffio *et al*., 2017). This high pH up to 12 can results in various physical changes in the plant that repel insects.

Material and Methods

The study was done by the associated project partner Landratsamt Karlsruhe, Landwirtschaftsamt Bruchsal on the experimental blackberry orchard (variety Loch Ness) of the Centre for Agricultural Technology (LTZ) in Karlsruhe. Following treatments were made with intervals of 3 to 4 days (7th, 11th, 14th, 18th and 21st July 2017):

DS-lime (($Ca(OH)_2$); PlantoSys, Lochem, NL) 1.5 kg/1000 l water (= DS-lime 1),

DS-lime 1.5 kg/1000 l water with Proagro surface-active agent (0.03 %) (= DS-lime 2),

DS-lime 1.5 kg/1000 l water with the leaf fertilizers Cuprum (0.35 l) and ManZincum (0.35 l) (= DS-lime 3)

DS-lime 1.5 kg/1000 l water with Cuprum (0.35 l) and ManZincum (1.0 l) (= DS-lime 4)

Positive control: alternating application of Karate Zeon (3x; lambda-Cyhalothrine) with Spintor (2x, spinosad) (insecticide control)

Negative control: untreated

Each treatment was applied in 4 replicates, each replicate with 8 to 10 black berry plants. Samples of 50 berries were taken two days before the 1st treatment, one day before every following treatment and 3 days after the last treatment. A complete hygienic harvest was made after each sampling, i.e. the complete harvest of all ripe fruits to reduce infestation pressure. Black berries samples were incubated in net-protected boxes for 24 hours at room temperature and put in water for 3 hours. Emerged larvae were sieved with different sieve sizes (stepwise 2.0 mm, 0.5 mm, and 0.1 mm) and counted under the microscope.

Results

Figure 1 shows the average number of larvae/50 fruits per treatment and sampling date. Before 17th July, fruit infestation did not seem to be influenced by different treatments very much. Even the untreated control plots did not show a high infestation rate. In spite of the 3rd treatment (14th July) infestation increased in all plots, but less in the insecticide and lime treated plots compared to the untreated control. The application of Karate Zeon and Spintor could hold infestation on a lower level with less than 10 larvae/50 fruits. All DS-lime variants reached a medium efficacies and infestation levels from 20 to less than 40 larvae/50 fruits. There could not be found a clear variability between the different DS-lime treatments with or without leaf fertilizer in different concentrations or with the surface-active agent. The maximum average infestation rate in the untreated control plots was about 50 larvae/50 fruits. But, even in the untreated control, infestation decreased at the end of the field trial (24th July).

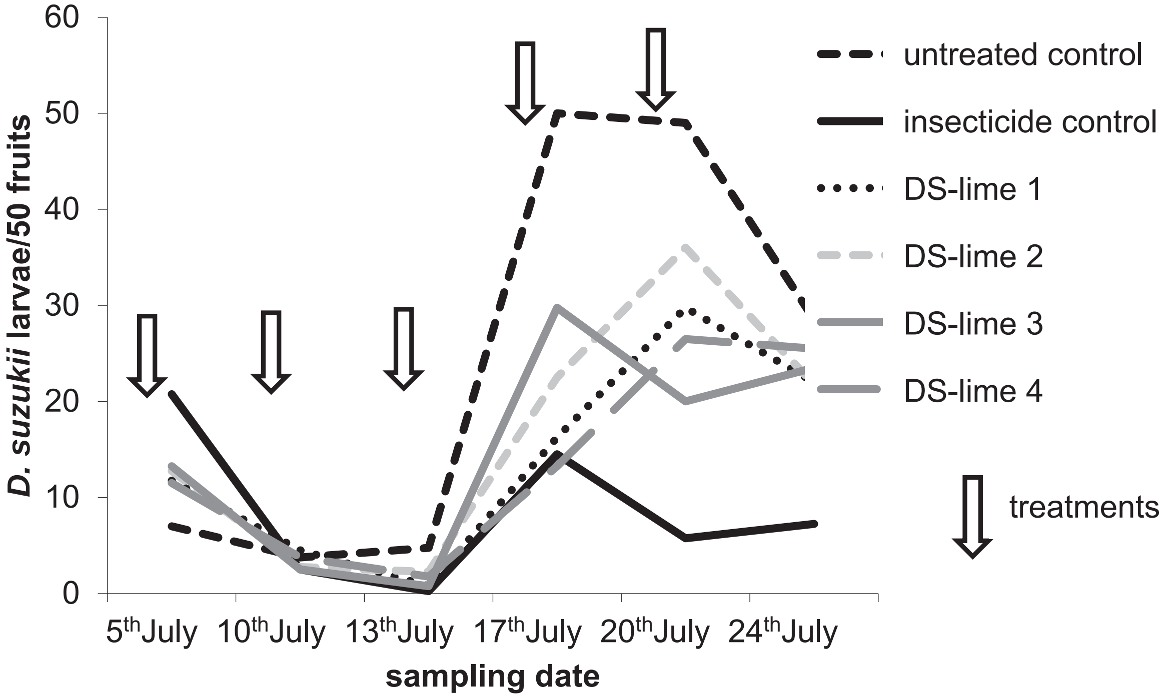

Figure 1: *D. suzukii* infestation depending on sampling date and treatment.

Lime treatments can cause white blotches. Figure 2 illustrate black berry fruits immediately after the 4th application of DS-lime and Proagro surface-active agent (DS-lime 2) in the field. Figure 3 show the fruits after 4 treatments with insecticides and the different DS-lime variants in the market. No complaints were recorded in there.

Figure 2: Black berries with white blotches after 4 applications of DS-lime 2.

Figure 3: Black berries in the market: Insecticide control, DS-lime 1, DS-lime 2, DS-lime 3 and DS-lime 4.

Discussion

The results show a reduction of *D. suzukii*-infestation after DS-lime application in different combinations with fertilizers and a surface-active agent, but with no increasing effects of one of these components compared to DS-lime alone. The reduction was not as obvious as with the insecticide treatment (Karate Zeon and Spintor). According to these results, lime application can be an additional measure to reduce eggs and larvae in the fruits. But only lime applications are not expected to decrease infestation to a satisfying level for fruit marketing. Also Baroffio *et al.* (2017) and Dorsaz *et al.* (2017) have shown the effects of lime on pH and on the number of eggs and larvae in berry crops. Corresponding to the infestation decrease at the end of the field trial, other factors also influence the fruit infestation by *D. suzukii*. At the beginning and in the middle of July maximum temperatures have been about 35 °C. Because of the preference of *D. suzukii* for temperate climate, this heat might have had a negative effect on activity and reproduction of the pest, which got obvious some days later. For this reason, climatic conditions have to be taken into account for the estimation of the infestation risk.

In the presented results, infestation in untreated black berries was low (max. 1 larva/fruit) in comparison to the maximum infestation level of up to 90 larvae/fruit, which was found in 2014 (Köppler, unpublished data). Accordingly, the efficacy of lime products could vary depending on population and infestation pressure. For this reason, other measures than spraying have to be taken in to account to protect berry crops. Netting can be a measure, but also with nets monitoring of fly population and infestation is essential (Köppler, 2017). Further studies have to be done to develop the right strategies for *D. suzukii* control.

Acknowledgements

We thank for funding by the European Regional Development Fund (ERDF).

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