

Demonstration project “Exclusion netting for managing Spotted Wing *Drosophila* in fruit crops” – Results 2017 – 2019

C. Augel¹, B. Boehnke², A. Wichura³, J. Lindstaedt⁴, J.-H. Wiebusch⁴,
A. Engel⁵, S. Benz⁵, J. Saltzmann⁶, G. Eberhardt⁶, H. Vogt², K. Köppler¹

Abstract

*Exclusion netting is a technical option to contribute to the control the invasive Spotted Wing *Drosophila* (*Drosophila suzukii* (Matsumura 1931), which has become a huge threat for European fruit crops, i. e. stone and berry fruits, since several years. Up to 22 producers of cherry, raspberry, blackberry and blueberry take part in the demonstration project, funded by the Federal Ministry of Food and Agriculture (BMEL), administrated by the Federal Office for Agriculture and Food (BLE) and coordinated by the Julius Kuehn-Institute (JKI), Institute for Plant Protection in Fruit Crops and Viticulture. Mesh sizes of the used nets varied between 0.8 x 0.8 mm and 1.3 x 1.3 mm. The various exclusion netting systems showed an overall successful reduction of fruit infestation by SWD. In orchards fully protected by netting or netting in combination with foliage a distinct reduction of the use of insecticides against SWD was possible when regular SWD monitoring and harvest sanitation procedures were conducted. There was no noticeable increase in occurrence of other pests and pathogens attributed to the nettings. However, in combination with foil tunnels, in some netted orchards an increase in spider mites and caterpillar infestation was observed. In any case, monitoring of the plants on a regular basis is advised due to exclusion of beneficial insects. Costs for the additional exclusion netting were highly variable and depended on various operational factors.*

Keywords: Exclusion netting (Exnet), net, *Drosophila suzukii*, Spotted Wing *Drosophila*

Introduction

The invasive Spotted Wing *Drosophila suzukii* (Matsumura 1931) was first recorded in Germany in 2011 (Vogt *et al.* 2012). Chemical control of the pest is problematic, due to the high number of host plants, the short generation cycle and the high reproduction rate as well as insufficient efficacies of insecticides. Exclusion netting (Exnet) is an alternative technical measure in a plant protection strategy against SWD. On the base of the information and methods by the participating growers the aim of the demonstration project is to describe practical and economic feasible technical solutions and spread this method to protect the fruit crops into the practice. The process is reviewed and evaluated by accompanying studies, listed below, in all participating farms over five growing seasons. After reporting about the first project year (Boehnke *et al.* 2018) we present our experience

¹ K. Köppler & C. Augel, Landwirtschaftliches Technologiezentrum Augustenberg, Nesslerstraße 25, 76227 Karlsruhe, kirsten.koeppler@ltz.bwl.de, clemens.augel@ltz.bwl.de

² H. Vogt & B. Boehnke, Julius Kuehn-Institute, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Schwabenheimer Str. 101, 69221 Dossenheim, heidrun.vogt@julius-kuehn.de, bianca.boehnke@julius-kuehn.de

³ A. Wichura, Landwirtschaftskammer Niedersachsen, Pflanzenschutzamt, Wunstorfer Landstraße 9, 30453 Hannover, alexandra.wichura@lwk-niedersachsen.de

⁴ J. Lindstaedt & J.-H. Wiebusch, Landwirtschaftskammer Niedersachsen, Moorende 53, 21635 Jork, julian.lindstaedt@lwk-niedersachsen.de, jan-henrik.wiebusch@lwk-niedersachsen.de

⁵ A. Engel & S. Benz, Landwirtschaftskammer Nordrhein-Westfalen, Pflanzenschutzdienst, Gartenstraße 11, 50765 Köln-Auweiler, adrian.engel@lwk.nrw.de, silke.benz@lwk.nrw.de

⁶ J. Saltzmann & G. Eberhardt, Julius Kuehn-Institute, Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Stahnsdorfer Damm 81, 14532 Kleinmachnow, jovanka.saltzmann@julius-kuehn.de, gerd.eberhardt@julius-kuehn.de

over three years. Further information on the project and Exnet can be found at “<https://drosodemo-netz.julius-kuehn.de/>”.

Material and Methods

The number of fruit growers participating in the project in 2017, 2018 and 2019 were 19, 20 and 22 respectively. The investigated orchards were located in Baden-Wuerttemberg, Lower Saxony and North Rhine-Westphalia and comprised the highly vulnerable cultures cherries, raspberries, blackberries and blueberries. All cherry orchards were protected by foil canopies and surrounded by laterally netting (Fig. 1A). Berry crops were equipped with either a) foil tunnels and lateral nettings, b) foil tunnels completely covered with net (Fig. 1B), c) nets completely covering the cultures (Fig. 1C) or d) lateral netting only (Fig. 1D). Mesh sizes of the used nets varied from 0.8 x 0.8 mm to 1.3 x 1.3 mm. Presence of SWD was monitored by bait traps. Traps were prepared with 20 holes (2 mm in diameter) in the upper half. As bait, 200 ml of naturally clouded apple cider vinegar mixed with water (ratio 1:1) and 0.025 % detergent was used. Minimum one bait trap within and outside of Exnet were positioned in 1.50 m height in the crop. The traps were changed weekly and number and sex of SWD were determined in each trap. Fruit infestation was controlled on a weekly basis by fruit examination. At least 30 fruits were randomly picked from within and from outside the nettings respectively. Fruit examination was done by visual check of eggs and pupae, by expelling larvae using the water method (emerging fruits at least 1 h in 10 % saltwater) or by emergence of adults. Microclimate data within and outside the Exnet were measured in a height of 2 m using data loggers (Tinytag Plus 2, Gemini Data Loggers). Temperature (temp), relative humidity (rH) and dew point were recorded every 10 minutes. The occurrence of other pests and pathogens as well as beneficial insects was examined at least biweekly by visual checks of shoots supplemented by leaf examinations and insect collections with beating trays. Economic data (costs, additional expenditure of time, yield and quality) were gained by questionnaires as well as on-site measurements and observations and evaluated by the Julius Kuehn-Institute (JKI), Institute for Strategies and Technology Assessment.

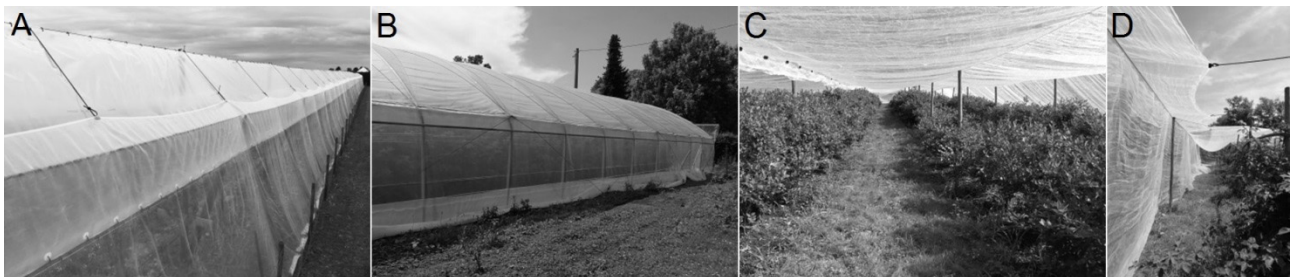


Figure 1: A) cherry orchard protected by foil canopy and lateral netting (G. Eberhardt) B) raspberry orchard with completely netted foil tunnel C) blueberry orchard protected by self-made Exnet system D) blackberry orchard with lateral netting only

Results

The various Exnet systems showed an overall successful reduction or even prevention of fruit infestation by SWD. The total number of insecticide applications against SWD was reduced in comparison to corresponding conventional fruit production without Exnet. The number of saved treatments was generally two to three per investigated orchard, varying between the different fruit crops and varieties as well as the grower. The decision for or against conducting insecticide applications were made by the growers themselves, based

on SWD monitoring results and personal estimate of fruit quality. Exnet in combination with weekly monitoring and fruit sanitation procedures reduced insecticide spraying against SWD. Sanitation procedures included the removal of overripe or unmarketable fruits and close harvesting dates, i.e. in berry crops every two to three days. When SWD was found within an orchard or its proximity, usually a single treatment was conducted about one to two days before or after installation of Exnet. When no trap catches or no infestation was detected throughout the harvest or just marginal infestation at the end of the harvesting period, widely no treatment against SWD was made in Exnet. Blackberry orchards with lateral nets only, lacking an additional horizontal covering system, showed no sufficient reduction of SWD, delaying infestation only for a short period of time.

A tight connection between lateral nets and the ground reduced portals of entry for SWD as well as repair work after strong wind gusts. Many growers used bricks and roof tiles as weighting agents as they were ready at hand or inexpensive. Friction between those weights and lateral nets damaged the Exnet over the years, resulting in multiple minor holes. Sandbags or water-filled hoses as weighting agents caused fewer damages to the nets (Fig. 2A & 2B). One of the growers connected the lateral nettings with clips and expansion ropes to a steel wire close to the ground, which enabled the net to return to its original position after wind gusts (Fig. 2C).



Figure 2: Different types of weighting agents for the ground connection of lateral nettings A) sandbags B) water-filled hose (J.-H. Wiebusch) and C) lateral netting connected with clips and expansion ropes to a steel wire close to the ground (J.-H. Wiebusch)

There was no noticeable increase in occurrence of other pests and pathogens attributed to the nettings. However, in cherry and raspberry orchards spider mites (*Tetranychus viennensis* (Zacher 1920), *Bryobia rubrioculus* (Scheuten 1857), *Panonychus ulmi* (Koch 1836) and *Tetranychus urticae* (Koch 1836)) occurred several times in high numbers when cultivated under Exnet in combination with foil canopies or foil tunnels. Under the same conditions, tortricids (*Adoxophyes orana* (Fischer v. Röslerstamm 1834) and noctuids (*Mamestra brassicae* (Linné 1758)) increased in a few cases. Occurrence of beneficial insects was at a low level and comparable between orchards with and without Exnet.

Five out of six raspberry growers participating in the project experienced at least one fruit season with pollination problems. The exclusion of pollinators by the Exnet was counteracted by placing bumblebees *Bombus terrestris* (Linné 1758) and/or honeybees *Apis mellifera* (Linné 1758) within the Exnet. However, partial pollinated raspberries were assessed multiple times resulting in lower yield under Exnet, but mainly in small and narrow units with angled corners.

Installation of Exnet provoked investments which were determined by various factors: a) possible implementation into a present fruit covering/securing system b) price and quality of the netting c) geometry of the orchard (side length – area relation) d) complete or partly netting of the orchard and headland e) wind susceptibility of the orchard f) own contribution of the growers. Additional costs for harvest were determined by the individual harvest and

warehouse logistics including the accessibility of the Exnet system. Annual costs for additional netting of an already present canopy system were 410 to 1,620 €/ha. Complete net-coverage of a blueberry crop with net only (Fig. 1C) provoked costs of 3,140 €/ha and year. For the complete netting of a foil tunnel the costs aggregated to 2,886 €/ha and year. Cost for the net itself accounted for the greatest amount in capital expenditures for the first-time installment of an Exnet. The calculated increase in unit costs for the additional nettings was 3 – 13 €/ct/kg for cherry and 3 – 15 €/ct/kg for blackberry and raspberry. The complete net-only coverage of a blueberry culture increased the unit costs by 30 €/ct/kg.

Discussion

The first three years of the demonstration project showed that exclusion nettings are a crucial component in a plant protection strategy against SWD. Cherry orchards which are already protected by foil canopies and lateral netting against birds can be equipped with SWD secure nets with only low additional costs. Already present foil canopies and foil tunnels often lack connection points for additional nettings. Transition zones between foil and net must be closed or narrowed down by a sufficient amount of clamps or clips. Eaves area in foil canopies may be an opening for SWD especially in wind-exposed and near SWD-promoting habitats such as early ripening host plants.

Immediate closing of the Exnet after entering the protected orchards must be a routine as well as hygienic measures with the removal of SWD infested or overripe fruits. Close examination for other pests should be implemented in netted fruit crops due to the exclusion of beneficial insects.

Additional costs for the Exnet have to be added to the unit costs irrespectively of fruit infestation presence. However, when SWD infestation occurs, yield losses quickly exceed the additional costs for Exnet. Cherry growers may also benefit from protection against the cherry fruit fly *Rhagoletis cerasi* (Linné 1758). Additionally, exclusion netting may be an effective way to protect fruit orchards against the invasive Brown Marmorated Stink bug *Halyomorpha halys* (Stål 1855).

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