Trapping of *Drosophila suzukii*

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Abstract

*The spotted wing drosophila (*Drosophila suzukii*) is a newly introduced pest of soft fruits, stone fruits and grapes in Europe. Various trap types are used for monitoring and mass trapping of this pest. In Switzerland, "Gasser-Becherfalle" with a white lid and a liquid wine-vinegar based attractant is the most widely used trap type for both purposes. In order to improve efficiency of monitoring and mass trapping, two different commercially available trap models (red and white lid), as well as a standard bait supplemented with different acetone concentrations were compared in laboratory and field experiments. In addition,* D. suzukii *populations were monitored in different habitats in order to understand annual migration patterns and assess optimal trapping sites. The results indicate that the two trap types were equivalent. Bait attractiveness can be increased by the addition of acetone, but is highly dosage dependent. Monitoring of* D. suzukii *in different habitats showed that host plants are preferred habitats during summer. In November, a shift of populations towards non-host plants takes place: foliated, evergreen plants are preferred as winter habitats.*

Keywords: Attractant, bait, monitoring, spotted wing drosophila

Introduction

The spotted wing drosophila *Drosophila suzukii* Matsumura (Diptera: Drosophilidae), a devastating pest of soft-skinned fruit crops (such as cherries, grapes and various berries), is originally native to Southeast Asia (Kanzawa, 1939), but has been introduced into Europe (Cini *et al.*, 2012) and America (Walsh *et al.*, 2011; Beers *et al.*, 2011). Female *D. suzukii* possess a serrated ovipositor to cut through the epicarp of their hosts and thus can feed and oviposit on ripening fruit, unlike other Drosophilid flies (Kaneshiro, 1983). Soft-skinned fruits of various non-crop plants serve as alternative hosts, particularly when crop hosts are not available, but also provide source populations and potentially increase pest pressure during crop growing season (Lee *et al.*, 2015). Combined with rapidly increasing populations due to short reproduction cycles of only about 10 days, *D. suzukii* monitoring and management strategies are challenging (Harris *et al.*, 2014). Early detection of *D. suzukii*, mainly by indirect methods such as trapping, are therefore crucial for farmers to prepare and initiate accurate management programs (Beers *et al.*, 2011).

Drosophilid flies use colors (Menne & Spatz, 1977) and fruit volatiles to find their hosts (Lebreton *et al.*, 2012; Faucher *et al.*, 2013). *Drosophila suzukii* trap baits are usually based on fermentation products such as apple cider vinegar, wine, or yeast, since these ingredients are long-lasting and low-priced (Beers *et al.*, 2011; Lee *et al.*, 2011). The flies are attracted by the acetic acid and ethanol, but including further volatile ingredients in baits such as acetoin, ethyl lactate and methionol increase *D. suzukii* captures in traps (Cha *et al.*, 2014). Ketones, such as acetone (2-propanone), have a discrete role in the aroma of some of the most relevant cultivars of sweet cherries for example (Girard & Kopp, 1998), and acetone is formed abundantly during apple ripening (Belitz *et al.*, 2014).

However, previous studies testing for suitable supplements to increase attractiveness of *D. suzukii* baits did not include the cheap compound acetone.

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Since high trap efficiency is crucial for a reliable management program preparation and efficient mass trapping to protect crop plants, we tested two different commercially available trap types, acetone as a supplement to increase attractiveness of a standard bait and monitored various trap sites to improve season-dependent trap placement.

Material and Methods

The effect of different trap types was assessed by comparing non-refillable Gasser-Becherfalle (Biologische Essigfliegenfalle, Riga AG, Switzerland) with white lids to refillable Profatec traps (Profatec AG, Switzerland) with red lids. Both traps were filled with 85 ml of standard liquid wine-vinegar based attractant (Riga AG) installed with 1 m distance to each other in a wild berry hedge for two weeks (5 replicates). The number of captured flies per trap was analysed with a generalized linear model with negative binomial errors, with the fixed factor trap type and the random factor replicate.

The effect of acetone addition to the standard bait was assessed by placing approximately 60 flies for 24 h in nylon mesh cages (45 x 90 x 45 cm), each cage containing a control trap filled with 20 ml standard bait (Riga AG) and an acetone-supplemented trap (20 ml standard bait + acetone 0.0005 %, 0.005 %, 0.05 %, 0.5 % or 5 % v/v; 12 replicates). The number of flies per sex and trap was analysed with a generalized linear model with binomial errors corrected for overdispersion, with the fixed factors sex and trap (acetone, control, non-captured flies) and the random factor cage.

To assess population dynamics of the *D. suzukii* in the field, Gasser-Becherfalle traps were placed in different potential host plants within 150 m in Frick (64°39' N, 26°19' E). Traps were replaced every 7, respectively 14 days. During summer 2014, only males were assessed, from December 2014 onwards also females.

Results

Trap type ($z = 1.00$, $P = 0.32$) had no significant effect on the number of captured flies, whereas there was a marginal effect of sex ($z = 1.76$, $P = 0.08$): the trap with the red lid tended to capture more males than the trap with the white lid.

Bait type ($z = 3.73$, $P = 0.001$) and the acetone concentration ($z = 4.50$, $P < 0.001$) had a significant effect on the number of captured flies ($z = 3.73$, $P = 0.001$), whereas sex ($z = 0.55$, $P = 0.58$) had no significant effect. There was a significant interaction between the concentration and bait type ($z = 7.94$, $P < 0.001$).

There were no flies captured from 16th January to 24th April 2015 (figure 1). The number of captured *D. suzukii* varied over the year and differed between summer 2014 and 2015.

Discussion

The two commercially available trap models were equivalent in catching *D. suzukii*, despite the different lid color. In other studies, red traps were superior to traps with bright colors (Basoalto *et al.*, 2013). However, since the Profatec model is refillable, it might be favorable for economic and ecological reasons.

The addition of acetone to the standard wine-vinegar based attractants clearly increased attractiveness. There is an optimal range of acetone concentration in the standard bait between 0.005 % and 0.05 % (figure 2). At higher concentrations (5 %) acetone was repellent for the flies. However, accurate acetone concentration in the field and over time needs to be determined.

During the hot and dry summer 2015, less *D. suzukii* were captured compared to the mild and wet summer 2014 (figure 1). However, after the hot summer, the *D. suzukii* population recovered quickly and increased again in fall 2015. This is in accordance to the results of Harris *et al.* (2014), who also recorded less *D. suzukii* in traps during hot summer months. At 31 °C for 4 days, mated *D. suzukii* females produce infertile eggs (Kinjo *et al.*, 2014). During the summer, host plants such as *Sambucus nigra* L., *Prunus avium* L. and *Rubus* Sectio *Rubus* are favoured. During the leaf fall, number of captured *D. suzukii* decline and only remain constant in foliated plants such as Rubus, *Hedera helix* L. and *Fagus sylvatica* L. Foliated plants may provide better microclimate and shelter for overwintering than non-foliated plants (Harris *et al.*, 2014).

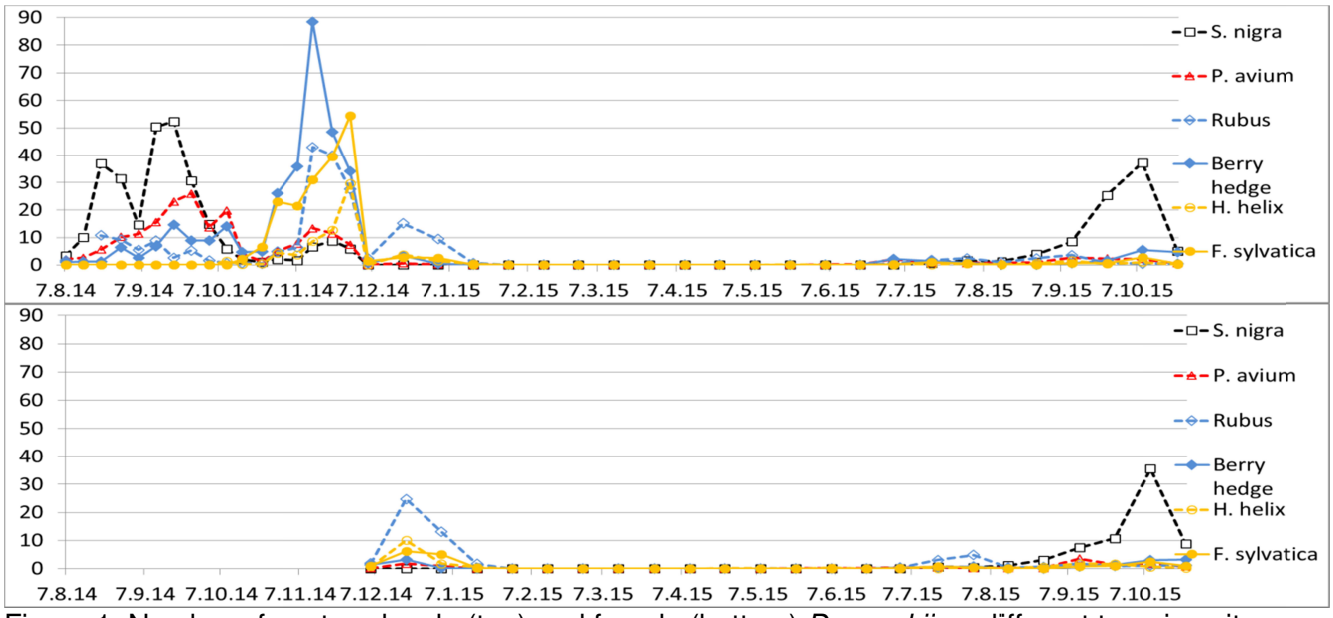

Figure 1: Number of captured male (top) and female (bottom) *D. suzukii* on different trapping sites.

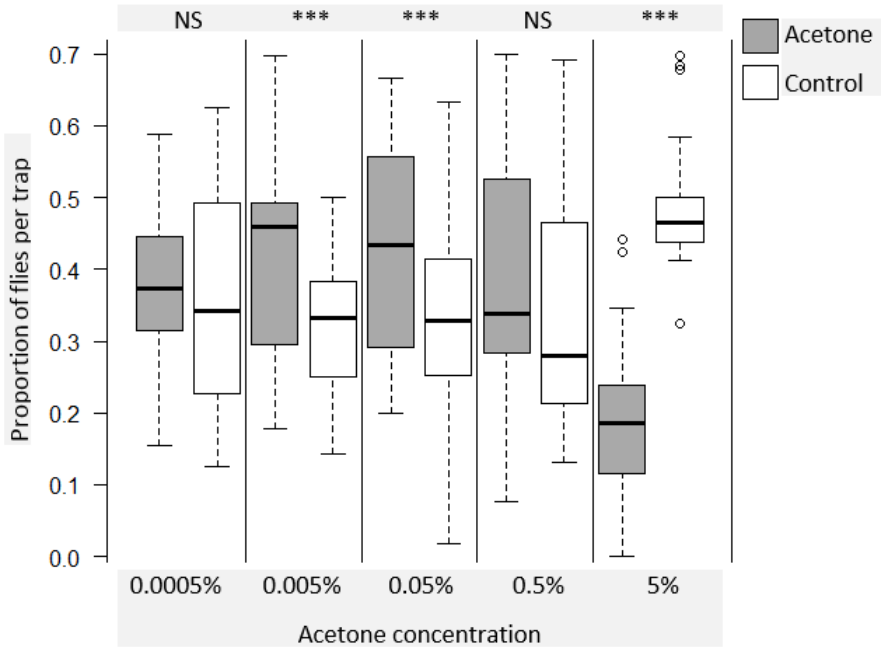

Figure 2: Proportion of *D. suzukii* captured in control traps filled with a standard bait (Riga) versus traps with standard bait supplemented with different acetone concentrations.

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References

Basoalto, E., Hilton, R. & Knight, A. (2013). Factors affecting the efficacy of a vinegar trap for *Drosophila suzukii* (Diptera: Drosophilidae). *Journal of Applied Entomology* **137**: 561-570.

Beers, E.H., Van Steenwyk, R.A., Shearer, P.W., Coates, W.W. & Grant, J.A. (2011). Developing *Drosophila suzukii* management programs for sweet cherry in the western United States. *Pest Management Science* **67**: 1386-1395.

Belitz, H.-D., Grosch, W., Schieberle, P. (2004). Food Chemistry. 3rd edition. Berlin Heidelberg, Deutschland: Springer-Verlag.

Cha, D.H., Adams, T., Werle, C.T., Sampson, B.J., Adamczyk Jr, J.J., Rogg, H. & Landolt, P.J. (2014). A four component synthetic attractant for *Drosophila suzukii* (Diptera: Drosophilidae) isolated from fermented bait headspace. *Pest Management Science* **70**: 324-331.

Cini, A., Ioriatti, C. & Anfora, G. (2012). A review of the invasion of *Drosophila suzukii* in Europe and a draft research agenda for integrated pest management. *Bulletin of Insectology* **65**: 149-160.

Cornelius, M. & Kanzawa, T. (1939). Studies on *Drosophila suzukii* Mats. *Yamanashi Prefecture Agricultural Experimental Station, Kofu, Japan.*

Girard, B. & Kopp, T.G. (1998). Physiochemical characteristics of selected sweet cherry cultivars. *Journal of Agricultural and Food Chemistry* **46**: 471-476.

Faucher, C.P., Hilker, M. & de Bruyne, M. (2013). Interactions of carbon dioxide and food odours in *Drosophila*: Olfactory hedonics and sensory neuron properties. PLoS ONE **8**: e56361.

Harris, D.W., Hamby, K.A., Wilson, H.E. & Zalom, F.G. (2014). Seasonal monitoring of *Drosophila suzukii* (Diptera: Drosophilidae) in a mixed fruit production system. *Journal of Asia-Pacific Entomology* **17**: 857-864.

Kaneshiro, K.Y. (1983). *Drosophila* (*Sophophora*) *suzukii* (Matsumura). *Proceedings of the Hawaiian Entomological Society* **24**: 179.

Kinjo, H., Kunimi, Y. & Nakai, M. (2014). Effects of temperature on the reproduction and development of *Drosophila suzukii* (Diptera: Drosophilidae). *Applied Entomology and Zoology* **49**: 297-304.

Landolt, P.J., Adams, T., Davis, T. & Rogg, H. (2012).Spotted wing drosophila, *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), trapped with combinations of wines and vinegars. *Florida Entomologist* **95**: 326-332.

Lebreton, S., Becher, P.G., Hansson, B.S. & Witzgall, P. (2012). Attraction of *Drosophila melanogaster* males to food-related and fly odours. *Journal of Insect Physiology* **58**: 125-129.

Lee, J.C., Bruck, D.J., Dreves, A.J., Ioratti, C., Vost, H. & Baufield, P. (2011). In focus: spotted wing Drosophila, *Drosophila suzukii*, across perspectives. *Pest Management Science* **67**: 1349-1351.

Lee, J.C., Dreves, A.J., Cave, A.M., Kawai, S., Isaacs, R., Miller, J.C., Van Timmern, S. & Bruck, D.J. (2015). Infestation of wild and ornamental noncrop fruits by *Drosophila suzukii* (Diptera: Drosophilidae). *Annals of the Entomological Society of America* **108**: 117-129.

Menne, D. & Spatz, H.C. (1977). Colour vision in *Drosophila melanogaster*. *Journal of comparative Physiology* **11**: 301-312.

Walsh, D.B., Bolda, M.P., Goodhue, R.E., Dreves, A.J., Lee, J., Bruck, D.J., Walton, V.M., O'Neal, S.D. & Zalom, F.G. (2011). *Drosophila suzukii* (Diptera: Drosophilidae): Invasive pest of ripening soft fruit expanding its geographic range and damage potential. *Journal of Integrated Pest Management* **2**: G1-G7.