Estimating Spotted Wing Drosophila Overwintering Mortality

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Abstract

Drosophila suzukii *Matsumura (Spotted wing drosophila SWD) is a global pest attacking ripening small and stone fruits. Preventive plant protection strategies aim at limiting the SWD population build-up early in the year. Estimating overwintering mortality is crucial to anticipate the population dynamics before SWD penetrate the crop and lay eggs and may therefore support us in timing of monitoring and plant protection programs in the spring. The major factors determining survival, development time and fecundity of SWD include temperature, humidity and the availability of food resources. However, winter mortality is mediated by many other factors such as microhabitats, host suitability, natural enemies or population characteristics. The investigation of the relevance of such factors will provide better understanding of its overwintering survival and seasonal population dynamics. Such life history measures are critical for modelling overwinter mortality and population development. We first estimated the number of chilling days as an indirect measure for winter mortality.*

Keywords: Drosophila suzukii, overwintering mortality, modelling, plant protection

Introduction

The spotted wing drosophila (SWD), *Drosophila suzukii* Matsumura (Diptera: Drosophilidae), is an invasive fruit fly native to Southeast Asia and is now established in many production areas of soft-skinned fruit species in North America, Asia, and Europe (e.g. Cini *et al*., 2012). Female SWD oviposit in ripening fruits using a serrated ovipositor, making the fruit unmarketable and frequent insecticide sprays and other cultural control measures to protect crops are necessary (Beers *et al*., 2011). Preventive plant protection strategies aim at limiting the SWD population build-up early in the year. Estimating overwintering mortality is therefore crucial to anticipate the population dynamics before SWD penetrate the crop and lay eggs and may therefore support the timing of monitoring and plant protection programs. The major factors determining survival, development time and fecundity of SWD include temperature, humidity and the availability of food resources (e.g. Kimura 2004). Therefore investigating the dependence of SWD population parameters on temperature and other meteorological variables (e.g. relative humidity, microclimate) will provide a better understanding of its overwintering survival and seasonal population dynamics. Such life history measures are critical for modelling overwinter mortality and population development. In 2014 we simulated 30-40 chilling days less compared to cooler years in Switzerland. A non-linear model for winter mortality will be fitted and validated using chilling days and other environmental and population parameters.

Material and Methods

There is strong indication that long-term survival of SWD is unlikely at temperature below 10 °C (Kimura, 2004; Dalton *et al*., 2011; Jakobs *et al*., 2015). A temperature-based model

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is therefore the basis to predict winter mortality. We first estimated the number of chilling days as an indirect measure for winter mortality. A chilling day is a day with mean temperature < 10 °C. In a second step we will consider different metrics of meteorological parameters (e.g. duration, date, variability) and also interactions among them (e.g. temperature and humidity). However, winter mortality is affected by many other factors such as the availability of overwintering habitats and demographic characteristics of SWD (cold tolerance and plasticity, age, acclimatisation, diapause). The model for overwintering mortality will be adapted based on the relevance of such environmental and population parameters.

Results and Discussion

In summary we estimated 180-225 chilling days per year for Switzerland. In 2014 we simulated 30-40 chilling days less compared to cooler years. This result is in line with higher SWD trap counts in 2014 compared to other years for Switzerland. A non-linear model for winter mortality will be fitted using chilling days and other environmental and population parameters.

There are on-going experiments to measure development, survival, fecundity and hatch rate of a Swiss SWD population at different temperatures and humidity levels. These data will be used to calibrate model parameters (chilling start and threshold temperature) and to adapt the model regionally for Switzerland. Additionally the model will be complemented using other parameters such as the presence overwintering habitats.

Finally, the model will be validated under (semi-)field conditions using cages and traps and data from meteorological stations.

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