Exclusion barriers as a sustainable strategy for management of Spotted Wing Drosophila

By: Alina Avanesyan and Christelle Guédot

Using ***exclusion barriers*** is a mechanical control strategy which prevents insect pests from getting into the enclosed area. Over the past decade, the use of exclusion barriers in berry crops has been gradually increased and, in some states, such as in California, exclusion barriers are used for almost all raspberries (Hanson et al., 2013).

There are many types of exclusion barriers, but the main idea is to cover crop plants either from all sides (called ***complete exclusion***) or from the top (called ***incomplete exclusion***); such barriers can be made from plastic or netting materials of different colors (Chouinard et al., 2016; Fig. 1-3).

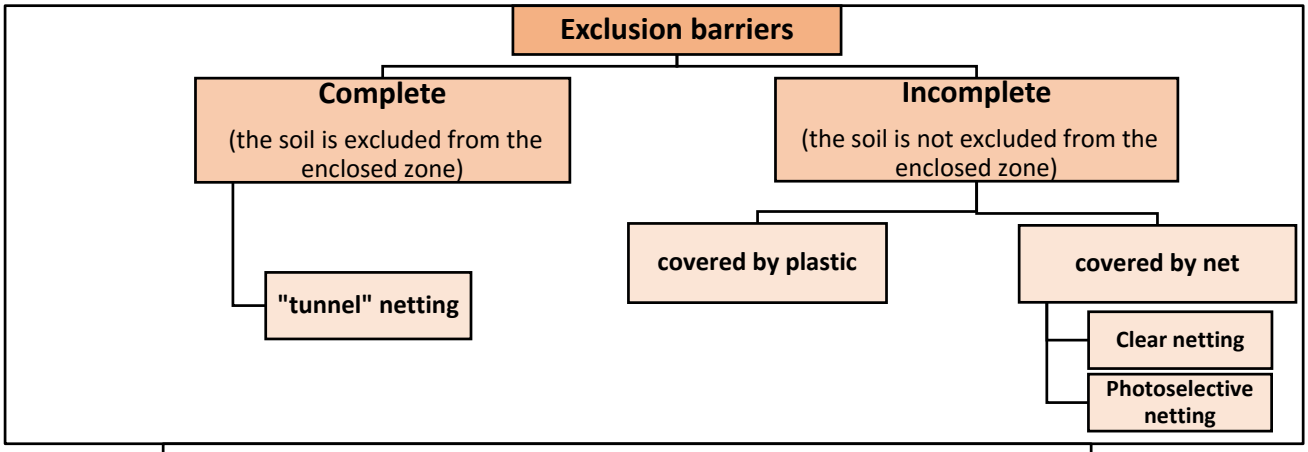

Fig.1. Types of exclusion barriers *(based on Chouinard et al., 2016).*

Fig.2. Incomplete (A, B) and complete (C, D) net exclusion systems *(from Chouinard et al., 2016).*

Fig.3. Plastic high tunnel (A, B) with raspberry plants (C) at Hoch Orchard & Gardens farm (La Crescent, MN)

Such exclusion barriers can protect crop plants not only by physical exclusion of insect pests but also by providing the microclimate which is unsuitable for developing pests (but favorable for plant growth and fruiting) (Table 1). Particularly, plastic cover in high tunnels can alter the solar radiation which may disrupt insect orientation and host location; this happens, for example, with Japanese beetle's movement (Hanson et al., 2013) and behavior of thrips and whiteflies (Burrack et al., 2013). On the other hand, enclosing the plot may cause potential problems with temperature management for plants or development of secondary pests (Chouinard et al., 2016).

Table 1. Advantages and disadvantages of using exclusion barriers

(based on Demchak et al., 2013; Hanson et al., 2013; Rogers et al., 2015; and Chouinard et al., 2016).

Advantages	Disadvantages
• Protection from animals, wind, frost, sunburn damage, etc. • Increased crop yields and fruit marketability • Physical exclusion of insect pests (e.g. *Drosophila suzukii*) • Unsuitable climate for pest development (e.g., increased temperature, altered solar radiation) • Decreased pressure from diseases • Advancement of the harvest season for early-season crops • Lengthening of the fall harvest season for late-season crops • Lengthening of shelf-life of crops • Significant reduction of the number of pesticide applications • Increased opportunities for organic control methods	• Additional costs for the tunnels and their management • Not easy to move • Potential problems with temperature management • Occurrence of disease and pests which are more problematic in the exclusions (e.g., powdery mildew, two-spotted spider mites, etc.) • Development of secondary pests (e.g., woolly apple aphid, the summer fruit tortrix moth, etc.) • Soil quality issues

It has been demonstrated recently that exclusion barriers could be effective strategies for the management of the invasive spotted wing drosophila, *Drosophila suzukii*, one of the main insect pests which attack berries. The studies which compared infestation of berries by *D. suzukii* inside and outside of the exclusion barriers showed that overall the exclusion barriers significantly decreased larval infestation rates.

Particularly, Burrack et al. (2013) showed that blackberries and raspberries had lower infestation rate by *D. suzukii* under high tunnels than outside (Table 2). Similarly, Rogers et al. (2015) found that covered raspberry plots (both plastic and netting) had more marketable fruit than open plots. Interestingly, plastic high tunnels had the lowest percentage of infested berries compared to netting and uncovered plots (Table 3). In another study on blueberry, Cormier et al. (2015) trapped almost no adult *D. suzukii* inside net exclusions (Fig. 4).

Table 2. Mean *D. suzukii* larvae (+/- SEM) per blackberry and raspberry inside and outside high tunnels; pooled 2010–2012 data *(from Burrack et al., 2013).*

Plants	Inside tunnel	Outside tunnel
Blackberry	0.34 ± 0.11	1.17 ± 0.14
Raspberry	0.56 ± 0.09	2.90 ± 0.34

Table 3. Mean *D. suzukii* larval infestation (+/- SEM) of 'Heritage' raspberry grown in high tunnels and open plots
(from Rogers et al., 2015).

Treatment	Percentage of infested berries
Netting high tunnel—untreated	34.58 ± 7.59
Plastic high tunnel—untreated	2.08 ± 1.34
Open plot—insecticide application	60.20 ± 6.53
Open plot—untreated	80.93 ± 5.17

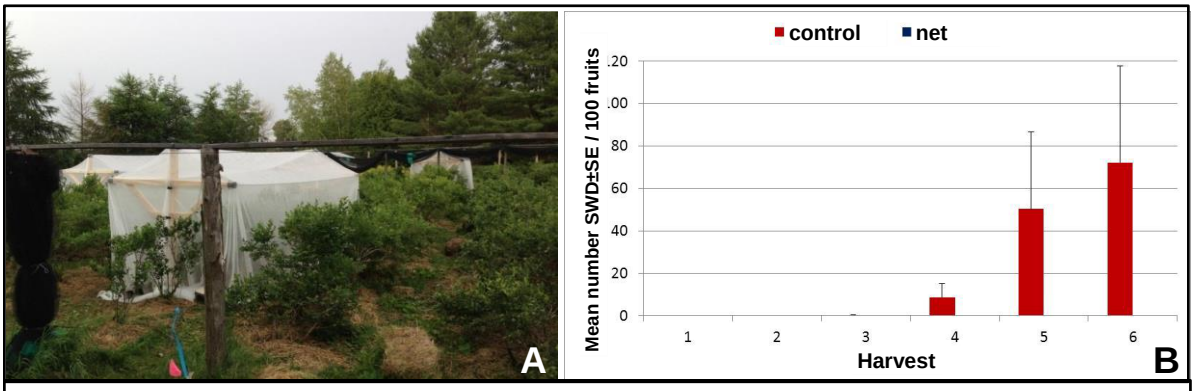

Fig. 4. Net exclusions in blueberry (A) and mean number of D. suzukii adults (B) emerged from berries inside (blue, note bar not visible due to extremely low numbers caught) and outside (red) the exclusion (from Cormier et al., 2015) on May 31, 2016.

Although the exclusion barriers can protect berries from *D. suzukii*, this strategy can be less effective if used, for example, during pollination, or if the mesh size of net cover is too large and flies still penetrate the enclosed area. For successful control of *D. suzukii*, **it is critical to use exclusion barriers at the right time and to follow several recommendations:**

1) Plants should not be covered during pollination, in order to allow pollinators (e.g., bees) access to the flowers. The exclusion covers (plastic or net) should be placed over plants right after pollination is complete (Liburd and Iglesias, 2013).
2) If netting is used, the recommended mesh size is 0.98 mm or less. It has been shown on blueberries that such mesh size can provide 100% protection from *D. suzukii* (Cormier et al., 2015).
3) If plastic exclusion (e.g. a high tunnel) is used, we recommend to use it as a complimentary strategy to netting and to leave entrances of the tunnel covered by a net. This will minimize the number of *D. suzukii* adults entering the tunnel.
4) Since some plant varieties (e.g., summer-bearing and fall-bearing raspberries) have different flowering and fruiting time, exclusions can be applied in sections: the varieties which have begun to ripen can be covered, whereas flowering varieties can be uncovered for pollination. This strategy can be helpful for small or organic growers. (Liburd and Iglesias, 2013).
5) Traps should be placed inside the netting to monitor for the presence of flies. It is important to not trap flies within the barrier. If flies are trapped inside the barrier, they should be controlled using an effective insecticide to eliminate the population before it builds up.

References:

Burrack, H. J., Fernandez, G. E., Spivey, T., & Kraus, D. A. (2013). Variation in selection and utilization of host crops in the field and laboratory by *Drosophila suzukii* Matsumara (Diptera: Drosophilidae), an invasive frugivore. *Pest management science*, *69*(10), 1173-1180.

Chouinard, G., Firlej, A., & Cormier, D. (2016). Going beyond sprays and killing agents: Exclusion, sterilization and disruption for insect pest control in pome and stone fruit orchards. *Scientia Horticulturae*.

Cormier, D., Veilleux, J., & Firlej, A. (2015). Exclusion net to control spotted wing Drosophila in blueberry fields. *IOBC-WPRS Bull*, *109*, 181-184.

Demchak, K. (2009). Small fruit production in high tunnels. *HortTechnology*,*19*(1), 44-49.

Hanson, E. J., Gluck, B. I., & Schilder, A. (2012, June). High Tunnels for Organic Raspberry Production in the Midwestern US. In *II International Organic Fruit Symposium 1001* (pp. 73-77).

Liburd, O. E., & Iglesias, L. E. (2013). Spotted Wing Drosophila: Pest Management Recommendations for Florida Blueberries. *Gainsville, FL: University of Florida*.

Rogers, M. A., Burkness, E. C., & Hutchison, W. D. (2016). Evaluation of high tunnels for management of *Drosophila suzukii* in fall-bearing red raspberries: potential for reducing insecticide use. *Journal of Pest Science*, 1-7.