# MORE WEAPONS AVAILABLE

Integrating tools against Drosophila suzukii: mass trapping and application of fruit protectors

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D. suzukii attacking blueberries. Courtesy: Claudia Funes, INTA Argentina

The spotted wing drosophila (Drosophila suzukii Matsumura) is considered an invasive plague, constituting a serious economic threat in diverse fruit trees, as it has begun to occur in Chile. During the 2019/20 agricultural season, losses of US$4,000 to US$17,750 per hectare were reported in some blueberry and cherry orchards in the Ñuble Region ( Buzzetti, 2020 ). This situation could increase and extend to other fruit trees as the pest moves forward in other regions.

The economic losses associated with D. suzukii are mainly due to the damage generated by the oviposturing of fruits, usually done by one or more females in the same substrate since the fruit begins to vary in color thereafter. The female can lay several eggs per fruit and continue to damage, in a larval state, the fruits adjacent to each other.

Unlike other drosophilids, the spotted fly oviposes in healthy fruits, and it can be observed that it prefers to ovipose in fruits with soft and thin skin, close to maturity. It is an extremely polyphagous species, reporting worldwide hosts that vary from berries, pits, grapes, tomatoes, wild species and ornamental plants, among others, also presents a high fertility (can produce up to 600 eggs per female), with an extremely short generational time as it grows from egg to adult in one or two weeks.

Due to the high capacity for the spotted fly to present resistance to insecticides, the need for complementary tools to support its management is foreseen. On this line of investigation, other countries have developed the use of meshes, massive capture traps, fruit protectors based on phospholipids or diatoms, among other tools, with some conclusive results but that still present limits in their applicability or extrapolation due to the lack of local experiences, as it happens in Chile.

In that context, it was raised as objectives of the present study, 1) to investigate the level of effectiveness of the use of traps adapted for massive capture of adults; and 2) to study the predisposition of D. suzukii females to ovipose in fruits treated with a phospholipid-based biofilm under the commercial formulation Parka®.

TABLE 1
**TREATMENTS DESIGNED ACCORDING TO THE COMBINATION OF TRAP AND BAIT TYPE**

| Treatment | Description |
|---|---|
| A: Control | No treatment, only water to rule out the tipping effect |
| B: Parka | Two foliar applications were separated by 10 days, made from pint with 9.5L/ha each. |
| C: Standard | Two applications of insecticide corresponding to Invicto 50 CS 20mL/10OL on cherry trees or Imidan 70 WP 1.6 kg/ha on blueberries, separated by 10 days. |

**MASSIVE CAPTURE**

This trial stage was carried out during the 2019/20 season in a cherry orchard located in the Ñuble Region, in an area registered as positive for the presence of D. suzukii, according to records of the Agriculture and Livestock Service (SAG), and later confirmed by the incidence of fruit damage during the same season. In this study, Flybuster® model traps and homemade red lid traps with 4 mm diameter holes and 2 cm spacing were used (SAG, 2017). For both traps, the volume capacity corresponded to 1 liter (standardized). Treatment combinations and type of bait are summarized in Table 1.

In all treatments, the equivalent of four traps/hectare was used, distributed in a grid format outside the orchard. The location of the treatments was drawn at random, establishing a completely randomized design with four repetitions (of 1 hectare each) and six moments of evaluation (at 4, 6, 9, 10, 14, 20 days after installation, which have been summarized as the sum of adults captured in 20 days after installation). The traps were installed at maturity and post-harvest of the fruit tree (May 20, 2020), and were evaluated independently of each other. The variables evaluated in each measurement were: number of adults of D. suzukii captured per trap (total and separated by sex), and number of other insects (total and by species) captured per trap.


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**FRUIT PROTECTORS**

In two orchards located in the Ñuble region (a cherry orchard and a blueberry orchard), both positive for the presence of the pest and with evident damage from the point of fruit ripening, the treatments proposed in Table 2 were carried out.

Each treatment was drawn at random with 4 repetitions of 20 plants each, with measurements after each application moment to establish, at 9 days after the first application (DDA-I) and at 9, 10, 12, 14 days after the one corresponding to the application (DDA-II), the total of infected fruits and the total of ovipositions of D. suzukii in the fruits.

In all studies, data was analyzed to determine compliance with ANDEVA assumptions and to establish, if necessary, the use of appropriate statistical transformations. Tukey's multiple comparison test (p:0.05) was used to define possible differences between results obtained according to treatments.

Traditional taxonomy techniques supported by molecular identification were used to confirm the specimens involved in all the tests performed.

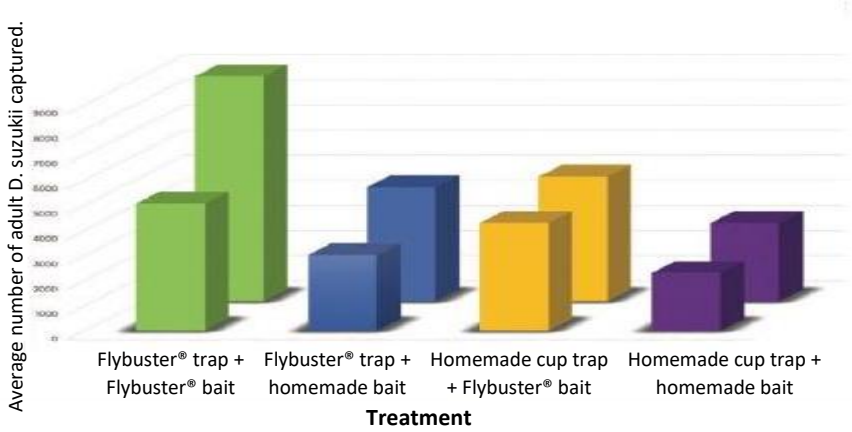
TABLE 2
**VARIABLE FACTORS INVOLVED IN STUDIES OF FRUIT PROTECTORS**

| Treatment | Type of bait |
|---|---|
| 1: Flybuster® Trap | yeast diluted in 50:50 of water and apple cider vinegar. |
| 2: Flybuster® Trap | Formulated as a household attractant (8g of sugar; 1.3g of active bread yeast, 69g of wheat flour, 4ml of apple cider vinegar) in water (up to 1 liter). |
| 3: Homemade glass trap | Flybuster® yeast diluted in 50:50 of water and apple cider vinegar |
| 4: Homemade glass trap | Formulated as a household attractant (8g of sugar: 1.3g of active bread yeast, 69g of wheat flour, 4ml of apple cider vinegar) in water (up to 1 liter). |

## MASS TRAPPING TEST RESULTS

In all treatments evaluated, the highest capture rate occurred in the post-harvest period, which would respond to the lack of competition between food attractants and the presence of fruit. The most efficient combination in capturing adults of D. suzukii was the use of Flybuster® with its own bait (of the same name), followed by the homemade Trap with Flybuster® bait, (always the bait diluted in 50:50 of water and apple cider vinegar). In comparison, combinations with homemade attractants were less efficient in capturing adults (Figure 1).

**FIGURE 1: AVERAGE OF ADULTS OF D. SUZUKII CAPTURED IN 20 DAYS PER TREATMENT AND EVALUATION PERIOD**
**(Columns shown in first row correspond to spring data, rear row, post-harvest data)**




The proportion of Females: Males captured of D. suzukii did not present significant differences between the treatments. As for the selectivity of the treatments, in all the combinations of traps evaluated, contaminating insects were found in equivalent amounts, but of different composition. During the same measurement period, the mosquito trap captured mainly mosquitoes (Diptera: Culicidae) and houseflies (Diptera: Muscidae), while the glass type housefly trap captured other drosophiles (especially D. melanogaster), making it difficult to correctly identify the adults with traditional macroscopic taxonomic techniques, given the degree of similarity with the target species.

In future works and some currently in progress, the proposed evaluations are extended by combining other interactions such as trap color and design and the direct impact of the use of these traps on the parameters to measure direct damage in the fruits. However, a promising development has been established in the level of captures of adult D. suzukii under productive orchard conditions in Chile, which would support a control program with conventional techniques such as pesticide application.

Starting point of highest susceptibility to D. suzukii infection in blueberries at the time the studies were carried out.

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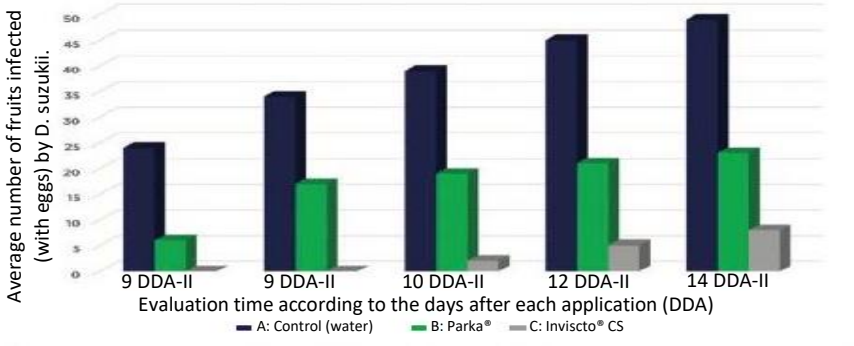
**FRUIT PROTECTORS TEST RESULTS**

The use of Parka on cherries and blueberries resulted in a decrease (expressed as a percentage at the end of the evaluation period) in the mean number of fruit damaged by spotted wing flies' ovipostures by 54-68% respectively, compared to the control; and 59-63% less severity of attack when determining the mean number of ovipostures on cherries and blueberries compared to the control's treatment (data not shown).

In terms of efficacy as a single control, what has been achieved with the use of Parka is evidently surpassed by the use of chemical treatments; however, these are products with different main purposes. On the other hand, it should be noted that, although some insecticides such as Imidan 70WP or Invicto 50CS can report a longer period of protection than others, in the case of D. Suzukii, there is a shorter period of effectiveness due to the rapid reinfestation that occurs with a new population of adults from different origins (high migration rate), that, if they manage to settle and ovipone in the fruit, they quickly produce a new incidence of damage to the crop (Figure 2).

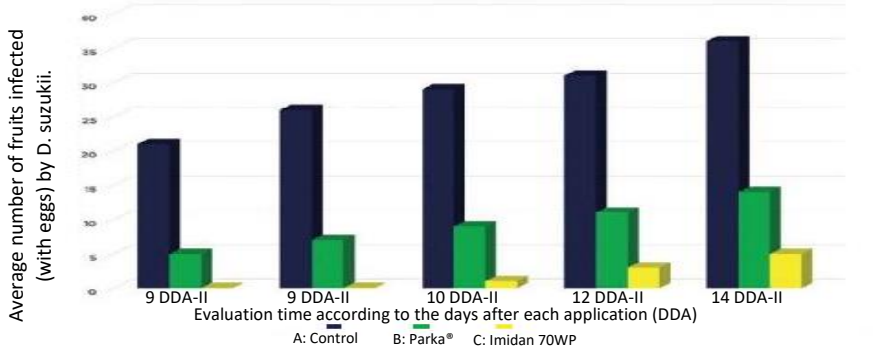
**FIGURE 2: AVERAGE NUMBER OF CHERRIES INFESTED WITH D. SUZUKII OVIPOSTURES ASSOCIATED WITH EACH TREATMENT AND EVALUATED FOR EACH APPLICATION**



Under these conditions, in the case of Invicto 50 CS the control was adequate during at least ten days, similar in behavior to the one observed for the control of D. suzukii achieved with another microencapsulated formulation of l-cyhalothrin previously studied (Karate Zeon) (Buzzetti, 2020). For both l-cyhalothrin formulations, it would be suggested a maximum interval between applications of twelve days, to avoid an infestation rebound.

In the case of Imidan 70 WP, damage control of D. suzukii was appropriate in blueberries, which would allow simultaneous control of several pests of agricultural interest at intervals of 12 to 14 days for the evaluated dose (Figure 3).

**FIGURE 3: AVERAGE NUMBER OF BLUEBERRIES INFESTED WITH D. SUZUKII OVIPOSTURES ASSOCIATED WITH EACH TREATMENT AND EVALUATED FOR EACH APPLICATION**




It is estimated that at least two full generations of D. suzukii were completed by the time these trials were developed. A relevant factor to consider in the quantification of the damages attributable to the attack of the spotted fly is the increase of the expression of latent infections in asymptomatic fruits, due to the fact that it generates wounds in the cuticle of the fruits either by the effective laying of eggs or by the attempt of ovipostures when the fruit receives treatments whose mechanism of action does not affect the adults (by mortality, paralysis, repellence or another route). This increase in the expression of the rots could be masked by attributing it only to the failures in a treatment program of the disease, although it is also related to the attack of the plague.

Considering that each female of the spotted fly has a high reproductive capacity, and that, as already mentioned, this pest can attack several times the same fruit or different females can attack the same fruit, the results obtained in this work are a great opportunity to complement a phytosanitary program, since according to the proposal of the company, the function of "parka" as a phospholipid-based biofilm is not related to pest management or mortality, but to the protection of the fruit against adverse weather effects, such as breakage by rain or sunburn, which would allow, in the search for the main objective for which the product is recommended, an improvement in a phytosanitary program associated with this pest and, collaterally, to the expression of rots.

Therefore, in future works, evaluations of combined treatments between this formula and different insecticide tools are projected, in order to establish possible interactions that favor pest management, and how they are inserted, together with tools such as mass trapping, in an integrated pest management program that does not focus on the excessive use of pesticides.


Model of Flybuster trap used

## References

Buzzetti, 2020. "The spotted Wing Drosophila in the South of the World: Chilean Case and Its First Productive Impacts". Available at: https://api.intechopen.com/chapter/pdf-preview/71435.SAG, 2017. Work plan for surveillance and integrated management of the pest Drosophila suzukii (Matsumura) (Diptera: Drosophilidae) in productive orchards and host fruit processing sites. Available at: http://www.sag.cl/sites/default/files/plan_de_trabajo_para_drosophila_suzukii_huertos_y_otros_julio2017.pdf.

## Declaration of the authors:

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