Biology, behaviour and control of Drosophila suzukii in Trentino region, Northern Italy

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Exp. Station of Vigalzano – loc. Costa di Casalino, via della Val 2, Pergine Valsugana

’s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
- Quite a small region: the territory surface is about 6,207 sq.km
- A mountainous region: 77% of the territory is above 1,000 m a.s.l
- A complex orographic structure: extremely variable climatic and environmental conditions
Agriculture is very important and widespread, it uses about 147,000 hectares:

- Around 10,000 hectares of vineyards
- 875,000 hectolitres of wine (1.8% of national production)
- 14 million bottles of spumante

- Around 10,000 hectares of apple orchards
- 460,000 tons of apples (21% of national production)
Estimated economic losses caused by Drosophila suzukii infestations: about 500,000 euros in 2010, 3 million euros in 2011 !!

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Surface (hectares)</th>
<th>Production (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet cherry</td>
<td>180</td>
<td>1,211</td>
</tr>
<tr>
<td>Strawberry</td>
<td>110</td>
<td>4,700</td>
</tr>
<tr>
<td>H.Blueberry</td>
<td>84</td>
<td>700</td>
</tr>
<tr>
<td>Raspberry</td>
<td>53</td>
<td>650</td>
</tr>
<tr>
<td>Blackberry</td>
<td>24</td>
<td>370</td>
</tr>
<tr>
<td>Wild strawberry</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>488</strong></td>
<td><strong>7,947</strong></td>
</tr>
</tbody>
</table>

Gross Marketable Production value

30 million € (19% of GMP value from the whole regional fruit production)
LIST OF RESEARCH AND EXPERIMENTAL ACTIVITIES ON Drosophila suzukii AT FEM

- **Territorial monitoring**: adult flight and fruits infestation, alert service
- **Traps and baits**: development and comparison of different models, studies on volatiles emitted by fruits and lures
- **Behavioural studies**: the overwintering, validation of Oregon State University (USA) phenological model, the spreading of the adults on the territory, factors promoting the infestations
- **Parasitoids**: rearing and evaluation in open field trials of resident and commercial species
- **Morphology and genetic**: studies on the populations
- **Wolbachia bacteria**: studies on the presence and role in the local SWD populations
- **Insecticides**: evaluation of registered and new compounds in lab and open field trials
- **Alternative control methods**: sanitation procedures, mass trapping, habitat manipulation techniques, anti-insect nets, attract and kill, alternative insecticide distribution systems, organic compounds, repellents
- **Wine grape**: monitoring, cultivar susceptibility, possibilities of infestation control
Territorial monitoring

**SWD catches with Droskidrink baited traps in Trentino**

- **Graph:**
  - Mean weekly max temp. (°C) - Pergine
  - Max temp. 2015

- **Legend:**
  - 2013
  - 2014
  - 2015

- **X-axis:**
  - Week 1 to Week 49

- **Y-axis:**
  - Mean n° of adults/trap/week
  - 0 to 2000

- **Month Legend:**
  - J F M A M J J A S O N D

**% of samples infested by SWD eggs/larvae**

- **Graph:**
  - % of samples infested by SWD eggs/larvae

**Notes:**

- ‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
- CENTRO TRASFERIMENTO TECNOLOGICO
Biology and behaviour

One of the key moments of the biology of *D. suzukii* is the overwintering phase. To better understand its reproductive behaviour during the whole season and particularly during the winter time, we dissected one by one about 63,000 females caught from 2012 to 2015 during the territorial monitoring, to analyse their ovaries. These females were classified according to a scheme of 5 reproductive conditions we can recognize.
First females with mature eggs:

- **Week 16** (15-21/4)
- **Week 11** (10-16/3)
- **Week 13** (23-29/3)

In °C:

- 3.13
- 0.52
- 1.14

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Biology and behaviour

Output of the phenological model developed by Oregon State University, USA

data from Pergine weather station (Trentino, Italy - 458 m a.s.l)

1\(^{st}\) egg laying date estimated by the phenological model

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>11 April (week 15)</td>
</tr>
<tr>
<td>2014</td>
<td>18 March (week 12)</td>
</tr>
<tr>
<td>2015</td>
<td>29 March (week 13)</td>
</tr>
</tbody>
</table>

1\(^{st}\) females with mature eggs caught in the territorial monitoring (ovarian matur.analysis)

<table>
<thead>
<tr>
<th>Year</th>
<th>Caught Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>15-21 April (week 16)</td>
</tr>
<tr>
<td>2014</td>
<td>10-16 March (week 11)</td>
</tr>
<tr>
<td>2015</td>
<td>23-29 March (week 13)</td>
</tr>
</tbody>
</table>
The control of *Drosophila suzukii* on soft fruits in Trentino still relies on the combination within an Integrated Pest Management plan of:

- Area-wide application of preventative and sanitation measures
- Habitat manipulation
- Mass trapping
- Anti-insect nets
- Insecticides applications
Effect on the control of *D.suzukii* damage of a short harvest interval on primocane-fruiting red raspberry

- **% of fruits with *D.suzukii* eggs/larvae**
  - 2-days harvest interval
  - 4-days harvest interval

### Graph Details:
- **Sampling date**:
  - 16-8 to 10-9
- **X-axis**: Sampling date
- **Y-axis**: % of fruits with *D.suzukii* eggs/larvae

---

Control
Preventative and sanitation measures
The black plastic mulching promotes a hot/dry microclimate, that is negative for *Drosophila suzukii* development.
In 2011 we also formulated Droskidrink, a mixture of

- 75% pure apple cider vinegar
- 25% red wine
- 20 grams/liter of unrefined sugarcane

This bait showed to be very effective in preliminary mass trapping and attract and kill open field trials carried out in that season.

% of the adults caught during the whole trial, from week 19 to 37

Field trial to compare the efficacy of apple cider vinegar traps of different colour
Control

Mass trapping

2012

mean n° of D. suzuki adults (square root transf)

1. ACV
2. Red wine vinegar
3. Drosophila+unref sugarcane
4. Drosophila+unref sugarcane
5. Drosophila+unref sugarcane
6. Drosophila+unref sugarcane
7. Drosophila+unref sugarcane
8. Cera Trap
9. Protein bait
10. Drosophila+unref sugarcane
11. Water and brewer yeast
12. Drosophila+unref sugarcane
13. Drosophila+unref sugarcane

* error bar is LSD p 0.05

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CENTRO TRASFERIMENTO TECNOLOGICO
Control

2013

Mass trapping

mean nº D. suzukii adults (square root transformed)

1_Droskidrink  2_ACV  3_Droskidrink+unref sugarcane  4_Droskidrink  5_ACV  6_Droskidrink+unref sugarcane  7_Droskidrink+unref sugarcane  8_Droskidrink+unref sugarcane  9_Droskidrink+unref sugarcane

* error bar is LSD p 0.05

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
ANOVA and Tukey’s test p<0.01

2014

Control

Mean n° of D. suzukii adults (log transformed)

1. Drostdrink+unref sugarcane
2. ACV (low filtration and pasteur.)
3. ShinEtsu DSX 111
4. ACV (commercial brand)
5. RIGA AG liquid bait
6. ShinEtsu DSX 112
7. ShinEtsu DSX 113
8. ACV (low filtration and pasteur.)

ANOVA and Tukey’s test p<0.01

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)

CENTRO TRASFERIMENTO TECNOLOGICO
ANOVA and Tukey’s test p<0.01
Currently, according with the results of our experiences, this is the best trap we have

<table>
<thead>
<tr>
<th>Trap</th>
<th>Bait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droso Trap® (Biobest)</td>
<td>• 200 ml Droskidrink</td>
</tr>
<tr>
<td></td>
<td>• 20 g/liter unrefined sugarcane</td>
</tr>
<tr>
<td></td>
<td>• 1 drop of surfactant agent</td>
</tr>
</tbody>
</table>
3 years experience of *D.suzukii* infestation control with a combination of mass trapping and insecticides in highbush blueberry fields (var.Brigitta) in Samone (Valsugana, Trentino)

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>1 trap/12 m²</th>
<th>2014</th>
<th>1 trap/10 m²</th>
<th>2015</th>
<th>1 trap/16 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>control 600 m²</td>
<td></td>
<td>control 300 m²</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>900 m²</td>
<td></td>
<td>600 m²</td>
<td></td>
</tr>
</tbody>
</table>

's-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
- **2014**: about 32,000 adults in a single trap along the wood margin at week 31

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg. % Efficacy</th>
<th>Max % Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>38.4</td>
<td>72</td>
</tr>
<tr>
<td>2014</td>
<td>0.5</td>
<td>5.8</td>
</tr>
<tr>
<td>2015</td>
<td>32</td>
<td>72.6</td>
</tr>
</tbody>
</table>
COMMENTS

- Efficacy extremely variable: better results where *(environment)* and when *(season, period)* the pest has a low-medium demographic pressure

- More traps = higher efficacy (but it’s also more time consuming)

- This is currently the best trap we have, but it may improve: many adults are attracted, but not finally caught (increase of the damage on nearby fruits). To investigate the possibility to kill them covering the outer trap surface with insecticides

- An early spring mass trapping of the first mature females on a wide area may be more effective and have a detrimental effect on the pest population development. A late fall/winter mass trapping may also contribute to reduce the overwintering population
LABORATORY TRIALS TO ASSESS THE EFFICACY OF INSECT PROOF NETS OF DIFFERENT MESH SIZE

- Clear plexiglass cylinders closed on both sides with screens of different mesh size
- 5 males + 5 females from local rearing were inserted in each cylinder and re-counted 1-2 days later
- Blotting paper soaked with apple cider vinegar or Droskidrink was used to force the adults escape
Control

<table>
<thead>
<tr>
<th>grid</th>
<th>hole size (mm)</th>
<th>hole area (mm²)</th>
<th>% D. suzukii adults escaped</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/10</td>
<td>0.27 x 0.77</td>
<td>0.21</td>
<td>0</td>
</tr>
<tr>
<td>16/10</td>
<td>0.49 x 0.77</td>
<td>0.38</td>
<td>0</td>
</tr>
<tr>
<td>10/7</td>
<td>0.84 x 1.17</td>
<td>0.98</td>
<td>0</td>
</tr>
<tr>
<td>8/8</td>
<td>1 x 1</td>
<td>1</td>
<td>80</td>
</tr>
<tr>
<td>8/5.5</td>
<td>0.97 x 1.54</td>
<td>1.49</td>
<td>30</td>
</tr>
<tr>
<td>8/6</td>
<td>1 x 1.6</td>
<td>1.6</td>
<td>25</td>
</tr>
<tr>
<td>Anti-hail</td>
<td>7 x 3</td>
<td>21</td>
<td>100</td>
</tr>
</tbody>
</table>

Results indicate that the hole area must be ≤ 1 mm². If equal, it must not be square shaped.

Consider that in field conditions adults can vary considerably in their size.
Preliminary open field trials with nets of the grid 16/10 on sweet cherry and h. blueberry gave satisfying results.

<table>
<thead>
<tr>
<th></th>
<th>% infested fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>90</td>
</tr>
<tr>
<td>net</td>
<td>0</td>
</tr>
</tbody>
</table>

These tests increased the interest for the evaluation of these nets on wider surfaces and with more applicable covering methods.
Valsugana/Spera: organic H.blueberry plantation of cv.Brigitta. No insecticides for the control of *D.suzukii*

- 2 hectares surface completely covered and surrounded with anti-insect net of 1x1 mm hole size, from week 24-25 (middle of June, just before the fruits reddening), till the end of harvest (week 33, middle of August)
D. suzukii infestation in an organic H. blueberry field (cv Brigitta) protected with exclusion net (1x1 mm hole size) - Valsugana, Trentino

\[ n^\circ \text{of SWD adults (m+f)} \]

\[ \% \text{inf.fruits}_\text{net} \]
\[ \% \text{inf.fruits}_\text{control} \]
\[ \text{SWD catches}_\text{net} \]
\[ \text{SWD catches}_\text{control} \]

2012

\begin{align*}
\text{5/7} & : 27 \\
\text{10/7} & : 28 \\
\text{18/7} & : 29 \\
\text{25/7} & : 30 \\
\text{31/7} & : 31 \\
\text{6/8} & : 32 \\
\text{13/8} & : 1.49 \\
\end{align*}

\begin{align*}
\text{0} & : 0 \\
\text{50} & : 0 \\
\text{100} & : 0 \\
\text{150} & : 0 \\
\text{200} & : 0 \\
\text{250} & : 0 \\
\text{300} & : 0 \\
\text{350} & : 0 \\
\text{400} & : 0 \\
\end{align*}

\begin{align*}
\text{date and week} \\
\text{0} & \quad \text{100} \\
\text{50} & \quad \text{90} \\
\text{100} & \quad \text{80} \\
\text{150} & \quad \text{70} \\
\text{200} & \quad \text{60} \\
\text{250} & \quad \text{50} \\
\text{300} & \quad \text{40} \\
\text{350} & \quad \text{30} \\
\text{400} & \quad \text{20} \\
\text{450} & \quad \text{10} \\
\text{500} & \quad \text{0} \\
\end{align*}
Daily air temperature (°C)

- Maximum
- Mean
- Minimum

Date:
- 30-6
- 7-7
- 14-7
- 21-7
- 28-7
- 4-8
- 11-8

Control Anti-insect nets

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CENTRO TRASFERIMENTO TECNOLOGICO
Control Anti-insect nets

Daily air RH (%)

Date: 30-6, 7-7, 14-7, 21-7, 28-7, 4-8, 11-8

Legend:
- Red: Control
- Blue: Net

Location: s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
Control Anti-insect nets

ANOVA p < 0.05

Fruit firmness

Kg/cm²

- control
- net

Fruit sugar content

°Brix

- control
- net

Fruit colour lightness

L*

- control
- net

Fruit colour Chroma

C*

- control
- net

ANOVA p < 0.05

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CENTRO TRASFERIMENTO TECNOLOGICO
Valsugana/Telve: conventionally managed H.blueberry plantation of cv.Brigitta. No insecticides for the control of D.suzukii

Row-by-row protection with anti-insect net of 1x1.6 mm hole size from week 24-25 (middle of June – just before the fruits reddening), till the end of harvest (week 35 – end of August)
D. suzukii infestation in a H. blueberry field (cv. Brigitta) row-by-row protected with exclusion net (1x1.6 mm hole size) - Valsugana, Trentino

D. suzukii infestation in a H. blueberry field (cv. Brigitta) row-by-row protected with exclusion net (1x1.6 mm hole size) - Valsugana, Trentino

% infested fruits

n° of SWD adults (m+f)

% inf.fruits_net
% inf.fruits_control
SWD catches_net
SWD catches_control

0 10 20 30 40 50 60 70 80 90 100

27 28 29 30 31 32 33 34 35

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
Daily air temperature (°C)

- Red line: control
- Blue line: net

Date range: 28-6 to 13-9

Control Anti-insect nets

2014

's-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)

CENTRO TRASFERIMENTO TECNOLOGICO
Daily air RH (%)
Control

Anti-insect nets

2014

ANOVA and linear mixed-effects model p<0.01

'Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
ANOVA and linear mixed-effects model $p<0.01$

*s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
Valsugana/Villa Agnedo: conventionally managed summer fruiting raspberry (var. Tulameen)

A block of 3 high tunnels was completely surrounded with a 350 cm high band of anti-insect net of 0.49x0.77 mm hole size. An opening of about 50 cm was left between the nylon covering and the net band on the end wall, to allow hot air to escape.

The other high tunnels, without net, were used as a control plot.

A micro sprinkler cooling irrigation system was active separately in both the experimental plots.
D. suzukii infestation in a red raspberry field (cv. Tulameen) protected with exclusion net (0.49x0.77 mm hole size) – Valsugana, Trentino
Daily air temperature (°C)

- Control
- Anti-insect nets

Date:
- 25-7
- 1-8
- 8-8
- 15-8
- 22-8
- 29-8

Temperature:
- 0
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45

Weather station_max T
Daily air RH (%)

- Red line: control
- Blue line: net
- Dotted line: weather station_max RH

Date: 25-7 to 29-8

Control Anti-insect nets
Control Anti-insect nets

ANOVA p<0.05

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)

CENTRO TRASFERIMENTO TECNOLOGICO
Anti-insect nets

Control

2015

ANOVA p<0.05

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
COMMENTS

- The anti-insect nets are the most effective control method we tested: they also allow a pesticides input reduction, the effectiveness of which increases in crops protected with nets.

- Satisfying results were obtained in open field applicative situations also with nets with holes slightly larger than 1mm² (better air circulation).

- In high tunnel crops, partial protection systems in combination with a micro-irrigation cooling system may significantly reduce the damage, limiting also the side effects on the microclimate we can have with an integral protection systems.

- Be extremely careful to evaluate the type of covering system to adopt and ensure that the protection with net is always active: regular examinations (especially after important weather events), to avoid holes especially close to the soil level, correct management every time you need to access to the crop.
## Insecticides registered in Italy against *Drosophila suzukii* on strawberry and soft fruits in 2015

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Commercial formulations</th>
<th>Crops</th>
<th>PHI (days)</th>
<th>Notes, restrictions</th>
<th>Derogation license</th>
</tr>
</thead>
<tbody>
<tr>
<td>pyrethrins</td>
<td>Asset, Biopiren Plus, Piretro Verde</td>
<td>strawberry, raspberry, blackberry</td>
<td>2</td>
<td>-</td>
<td><strong>Ministerial Decree 12/6/2015</strong>: from 12/6 to 09/10/2015</td>
</tr>
<tr>
<td>spinetoram</td>
<td>Delegate™ 2015</td>
<td>strawberry, raspberry, blueberry, red currant</td>
<td>7</td>
<td>max 2 sprays at 15 days min. interval</td>
<td><strong>Ministerial Decree 05/5/2015</strong>: from 15/7 to 10/11/2015</td>
</tr>
<tr>
<td>deltamethrin</td>
<td>Decis Evo</td>
<td>raspberry, blackberry</td>
<td>7</td>
<td>max 3 sprays at 7 days min. interval</td>
<td><strong>Ministerial Decree 23/4/2015</strong>: from 15/6 to 12/10/2015</td>
</tr>
<tr>
<td>fosmet</td>
<td>Spada 200 EC</td>
<td>blueberry</td>
<td>5</td>
<td>max 1 spray/year</td>
<td><strong>Ministerial Decree 26/3/2015</strong>: from 01/6 to 28/09/2015</td>
</tr>
</tbody>
</table>
## Insecticides applications

Other insecticides already registered on strawberry and soft fruits in Italy against other pests with possible side-effects against *Drosophila suzukii*

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Crop/target</th>
<th>Commercial formulations (examples)</th>
<th>PHI (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>deltamethrin</td>
<td><strong>Strawberry</strong> (aphids, thrips, bugs)</td>
<td>Decis, Bitam EC,</td>
<td>3</td>
</tr>
<tr>
<td>etofenprox</td>
<td><strong>Strawberry</strong> (aphids, leafhoppers), <strong>Raspberry</strong>, <strong>H.blueberry</strong>, <strong>Red currant</strong>, <strong>Blackberry</strong> (aphids, leafhoppers, thrips)</td>
<td>Treboil 30, Trebon UP,</td>
<td>7</td>
</tr>
<tr>
<td>lambda cyhalothrin</td>
<td><strong>Strawberry</strong> (aphids), <strong>Raspberry</strong> (aphids, caterpillars)</td>
<td>Karate Zeon, Forza,</td>
<td>7</td>
</tr>
<tr>
<td>pyrethrum with piperonyl butoxide</td>
<td><strong>Strawberry</strong> (aphids, thrips, bugs, caterpillars, beetles)</td>
<td>Piresan Plus, Piretrum 40,</td>
<td>2</td>
</tr>
</tbody>
</table>
In this open field conditions, phosmet showed to completely devitalize *D. suzukii* eggs for a period after the treatment of 4-4.5 days on average.
The efficacy level of these insecticides in field situations is always questionable and extremely variable (low reliability !)
The female of D. suzukii inserts its eggs under the skin of healthy fruits during ripening.

**Pest biology**
- Eggs and larvae are well protected
- Different life stages at the same time
- Adults easily escape during sprays
- Rapid life cycle, more generations per year, seasonal fluctuations
- Continuous adults immigrations in the fields from external sources
- Behaviour still unclear

**Small fruits crop features**
- High susceptibility close to full ripening
- Very long harvest, with very short intervals between pickings
- Few insecticides registered in Italy (no or low systemic activity)
- For fresh market (zero tolerance !)

**Insecticides applications**

- Necessity of repeated applications during the harvest, using insecticides with as long as possible residual activity, but as short as possible PHI !!

**GROWERS**
- Health
- Costs increase
- Risk of residues on fruits

**CONSUMERS**
- Health
- Prices increase

**AGRO-ECOSYSTEMS/ENVIRONMENT**
- No biological control of other pests
- Effects on pollinators, beneficials
- Resurgence of old pests (e.g. TSSM)
- Resistance development in SWD pop.
- Pollution

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CENTRO TRASFERIMENTO TECNOLOGICO
COMMENTS

- In our field situations, and particularly in seasons with high pest pressure, the insecticides give a very limited contribution to the *D.suzukii* infestations control.

- Their use within an integrated pest management plan must be justified and well-reasoned, is still necessary at this stage, but is unsustainable over a medium-long period. We must provide our growers with alternative control methods.
Aim of the trial: to reduce susceptibility to oviposition on h.blueberry increasing fruit skin hardness by means of Calcium fertilisers foliar applications

Product: Micrap Calcio (Hydro Fert s.r.l) – 15% water solution of Calcium oxide

Rate: 300 ml.hl

Applications: with microsprinkler irrigation system – a double weekly application from week 25 (19/6) to 27, then a weekly application till the end of harvest
Two «home made» attract and kill baits were evaluated in two separate primocane fruiting raspberry fields (cv Heritage) - two other raspberry fields in the same area served as a control plots

1. Droskidrink (DD) + SpintorFly® (DowAgroscience – spinosad 0.024%) + unrefined sugarcane + 2% glycerol
2. Droskidrink (DD) + z-cypermethrin + unrefined sugarcane + 3% glycerol

A total of 33 daily applications (07:30-08:00 a.m) from the fruit reddening (13 August) till almost the end of harvest (14 September)

At each application, 1200-1500 ml of the bait were distributed by means of a hand sprayer along the field edges, on alternate rows inside the plantation (on basal leaves of the canes, on the grass along the rows) and on wild trees and shrubs next to the field
Open field trial to evaluate the efficacy of two A&K baits on primocane fruiting red raspberry

*site: Canezza/Valle dei Mocheni/2014*

<table>
<thead>
<tr>
<th>% fruits with eggs/larvae</th>
<th>Compared to control 1</th>
<th>Compared to control 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mean of the harvest</strong></td>
<td><strong>DD+Spintor Fly</strong></td>
<td><strong>DD+z-cypermethrin</strong></td>
</tr>
<tr>
<td>Fruits sampled along the edges and inside the plot</td>
<td>43.7</td>
<td>61.6</td>
</tr>
<tr>
<td>Fruits sampled inside the plots</td>
<td>59.2</td>
<td>70.4</td>
</tr>
</tbody>
</table>
Control

Parasitoids – semi field trial

- Control (50m²)
- Treatment (50m²)
- Treatment + Augmentorium (50m²)

**D. suzukii infestation:** 50 females + 25 males in each section (first 2 weeks)

**Leptopilina heterotoma releases:** 50 females + 50 males in T and T+A sections (first 4 weeks)

**Trichopria drosophilae releases:** 50 females + 50 males in T and T+A sections (first 4 weeks)

**Sampling:** 10 berries/week from each section
Results

Control Parasitoids – semi field trial

Leptopilina heterotoma  Trichopria drosophilae

Tot # of SWD eggs on sampled berries

<table>
<thead>
<tr>
<th>Date</th>
<th>Control</th>
<th>Treatment</th>
<th>Treatment+Augment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-okt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08-okt</td>
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<td>15-okt</td>
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<td>22-okt</td>
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<tr>
<td>29-okt</td>
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<td></td>
</tr>
<tr>
<td>05-nov</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Tot # of eclosions

<table>
<thead>
<tr>
<th>Parasitoid</th>
<th>Control</th>
<th>Treatment</th>
<th>Treatment+Augm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichopria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leptopilina</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. suzukii</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‘s-Hertogenbosch (NL), 07 January 2016 – International Soft Fruit Conference (ISFC)
We still have to learn a lot about the biology and behaviour of this pest.

A better knowledge will allow us to develop more effective and sustainable control techniques.
ACKNOWLEDGEMENTS

We are very grateful also to our colleagues Linda Carlin, Manuel Failo, Massimo Pezzè, Luisa Mattedi, Flavia Forno, Romano Maines, Gaja Boscheri, Marino Gobber, to Lorenzo Tonina (University of Padova), Gianluca Groff, to LEXEM project and to all the growers of Sant’Orsola Soft Fruit Growers Association who supplied us with the orchards for our trials.