EUFRUIT

SUSTAINABLE FRUIT PRODUCTION TO MINIMIZE RESIDUES

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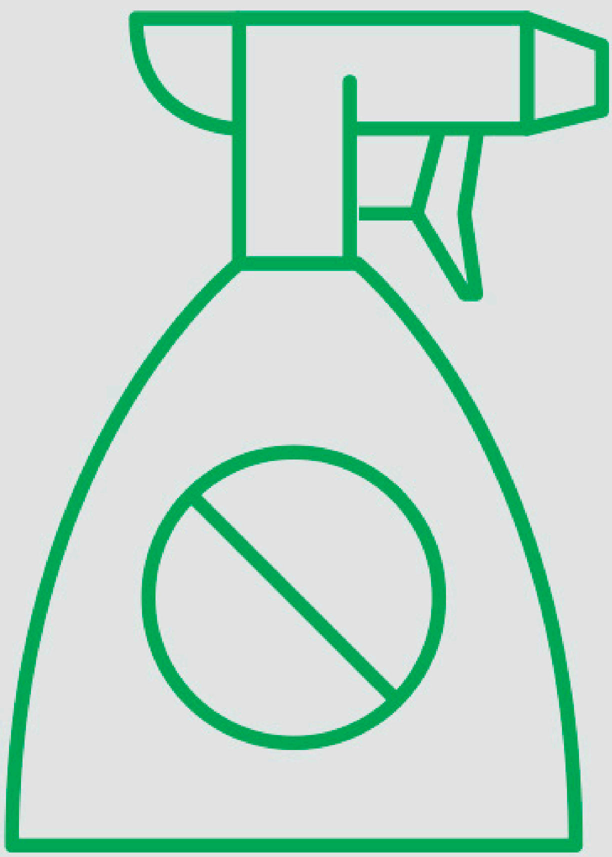

In 2016, an International Expert Group (IEG) including 19 organizations was established and has over three years contributed to scanning and discussing their national best practices and exchanging knowledge on the reduction of pesticide residues on fruit and in the environment by using alternatives to chemical protection against pests and diseases, developing strategies to limit the negative incidences of pesticides and adopting new spraying technologies. This IEG was closely linked to the EUFRIN Working Group called: "Sustainable fruit production to minimize residues". IEG members are also representatives on many national networks allowing the exchange of information between variety testers, which is very useful to increase the knowledge around strategies to produce fruit whilst reducing residues.

The state of the art was evaluated across country partners and a total of 11 strategies were discussed at the IEG meetings. The IEG focused on exchanging information on different alternatives techniques to pesticides, some of these techniques are currently being used by growers and others are very much at the experimental stage. These strategies included:

1) Biodiversity

Orchards offer the opportunity to foster ecosystem services. The principle is to apply soft protection practices and to develop a supervised plant diversity management strategy to enhance conservation biocontrol and limit pest outbreak. Strategies could include:

1. eliminate plants hosting quarantine or key pests and diseases of the orchard,
2. foster plants hosting a rich and/or abundant natural enemy complex,
3. provide natural enemies with habitat and food resources (pollen, nectar, alternative prey) all year round, which can include sowed flower strip in the middle of the tree rows to encourage the establishment of natural enemies,
4. release beneficial insects in orchards to control pests e.g. aphids. However, results depends of various factors, including the climate conditions at the release period, adequate timing between the release and the annual dynamic of the beneficial insects, pest population, balance between prey/predator populations, and the stage of the crop.

Biodiversity is also a central part of the plant health care strategies in organic farming. There is a need to increase biodiversity but this is complex due to the need to have an understanding on the occurrence and biology of many natural predators. Researchers are also considering the use of beneficial insects such as wood ants to reduce pests in apple orchards against winter moths and other caterpillars and the use of introducing predators such as Amblyseius andersoni, against spider mites. Furthermore, it is necessary to adapt practices to avoid negative incidences of the spray application on the beneficial insects.

2) Biological control

Only a few microorganism based products are registered in Europe for fruit production. For example: Bacillus subtilis, Aureobasidium pullulans may be used for the control of some fungal pathogens such as powdery mildew or postharvest diseases (Botrytis cinerea, Monilinia fructigena) or granulovirus preparation against codling moth or fruit tortrix. Further research is needed to identify new "alternative" biological control solutions to replace chemical pesticides.

Alternative strategies currently being tested by research organizations in the EU include production strategies: entomopathogenic fungi products (to control thrips in strawberry), entomovectors (such as use of bumblebees against Fire blight on apple flowers) and application of yeasts (aimed at control of postharvest diseases). Direct postharvest strategies could include biological control products by nebulisation (e.g. to control storage diseases on apples).

Some bacterial antagonists and lytic bacteriophages are already available such as Bacillus spp. against Fire blight, and other are identified but currently being tested (Pseudomonas fluorescens, Pantoea agglomerans, Pantoea vagans). Further experiments are needed to optimize biological control products in practice, including co-formulations to enhance persistence, environmental fitness and shelf-life of the product.

3) Cultural practices

Apple scab usually survives over winter under the trees, in the dead, infected leaves from the previous season. Cultural practices include crushing "infected" leaves fallen on the soil to reduce primary inoculum. Drosophila suzukii is an example of how important cultural practices are in limiting conditions that are favorable for pest population development. The following practices are advised: Canopy management by winter and green pruning in order to create a less humid microclimate in the foliage, improve the insecticide application quality, reducing the harvest period, soil management by frequent grass cutting, in order to reduce the wet and cool microclimate under the canopy, management of neighboring areas to avoid shading, stagnant pools of water, in order to reduce the wet and cool microclimate in the borders and at harvest, it is important to remove infested fruits and to manage the fruit waste.

4) Decision tools

In order to support growers, data need to be analyzed and used to predict the risks. Decision tools require that 'pest and disease models' together with 'predictive models' are developed and are linked to accurate and updated weather data, these include

i. Warning systems for growers and advisory organizations based on observations, and models to predict infection risks of diseases and simulate pest development, but also their predators. The aim is to optimize treatments and apply them at the right moment.
ii. Guidelines to consider side-effects of plant protection products on beneficial insects and
iii. Systems for treatment management, such as a tool which calculates the spray dose by taking into account the tree dimensions and the leaf densit

Improvements are needed in the

i. quality and availability of data for model inputs (more biological data),
ii. quality and availability of data for model evaluation (climate and agronomic data),
iii. integration with crop models,
iv. processes for model validation; and
v. development of a network to share the tools at national and international level. Furthermore, models should be more "site specific", given that pest and diseases pressure and climatic conditions may be very different from one location to another.

5) Detection

Initial evaluations have been carried out to assess the use of drones with spectral sensors for fire blight detection by identification and validation of suitable wavelengths. However, accurate identification of the tree status (healthy or infected) is not yet sufficient for practical implementation and warrants further improvement.

6) Natural substances

These alternative products are to be registered the same as pesticides. Some products contain natural substances coming from plants, animals, or minerals, including pelargonic acid, eugenol, thymol, garlic extracts, clove oil, potassium bicarbonate, laminarin, potassium phosphonates, pyrethrins, sulphur.

More natural solutions are needed, however they must be identified and tested in laboratory and field conditions and registered. To replace the use of copper against apple scab, various alternatives are being tested including potassium bicarbonate and sulphur or potassium bicarbonate and potassium silicate, an ion salt form of pelargonic acid, Equisetum arvense L, Urtica spp., sodium hydrogen carbonate and laminarin.

7) Physical methods (mechanical, thermal, barriers, traps)

Mechanical techniques: Weed control in orchards becomes a major concern, because of the progressive exclusion of the glyphosate herbicide and other herbicides. Mechanical weeding is already practiced in organic production, but new technologies are emerging such as "GrassKiller" with high pressure water (up to 1.250 bar) and "Electroherb" with high-frequency alternating current.

Thermal process: Hot water treatment technologies in the orchards to control weeds are still being developed and tested, including using either hot water or steam, however energy costs, water and time use still need to be optimized. Postharvest hot water treatments aim at controlling storage rots in apples (Gloeosporium) are currently being used commercially. The treatment is applied quickly after harvest, by dipping fruit in 48-50°C water for 2 - 3 minutes prior to cold storage. New products are also being tested for water disinfection and food processing, including Oxone (potassium peroxymonosulfate), ozonated water, and electrolyzed water.

Barriers: Physical barriers are a strategy being tested such as rain covers over the top of the trees that reduce the incidence of rain on the development of fungus and bacteria. In practice, cherries are covered for a short time close to harvest to avoid fruit cracking. In apples and pear trials trees are covered for the whole season for apple scab protection, but also Gloeosporium. Trials are also evaluating the protection of kiwifruit against Pseudomonas syringae pv. actinidae. Further research is needed to understand the mechanism of the protection under plastic tunnels against apple scab and Gloeosporium; the effect of plastic on other pathogens; the productivity and fruit quality under plastic; the long-term sustainability on soil. Other plastic tunnel types have to be investigated, as one of the major limitations for this technology are the costs. Another approach is exclusion netting. For example on apples, nets may be used against codling moth, oriental moth, Mediterranean fruit fly, Halyomorpha halys and in cherries to protect against Drosophila suzukii. To help the pollination, bumblebees and wild bees are placed into the netted orchards.

Traps: Various types of traps are being evaluated, including pheromones traps, alternative traps aim to attract insects with their color or with food attractant such as sugar, vinegar.

8) Plant resistance inducers

Extracts or chemical compounds inducing resistance are often referred to "plant activators", "inducers" or, if derived from micro-organisms, "elicitors". Classical inducers do not have a direct impact on pathogens, which clearly distinguishes them from fungicides. Currently research activities are evaluating the effectiveness, frequency of applications, residues and sustainability of the applications.

9) Semio-chemicals

There are 3 types of semio-chemicals: 1) gustatory stimulants (stimulating feeding, making sprayed surface more preferred); 2) attractants (volatile compounds making olfactory orientation possible) or pheromones are being used as mating disruptors; 3) repellents (volatile compounds to discourage insects to come on the plant). On Drosophila suzukii, the efficiency of insecticides was improved with a feeding enhancer.

10) Spray applications

Orchards are scanned by sensors or even drones to record gaps in the orchard and the surface structure of individual trees. These data provide individual application maps, which can then be combined with computer controlled sprayers. These new technology could reduce the output of pesticides.
Use of tunnel sprayer compared to an axial fan sprayer, reduces the use of pesticides by 20% due to the recycling technique.

Ways to improve the applications of pesticides while reducing the emission of crop protection products and achieving a uniform crop coverage are being investigated. The methods are: i) regulate wind speed and spray direction ii) blow and spray trees from both sides at the same time iii) adjust spraying liquid by nozzle position iv) the nozzle choice v) adapt spraying to crop vi) reduce spray volume. Despite large variation, there are significant differences between techniques and adjustments, but the performances of the sprayers will come from the adaption of our orchards to the sprayers.
To limit the loss of pesticides in the environment during spray application it is essential to annually control the sprayer and the accuracy of the sprayer (e.g. nozzles (orientation, discharge, pressure), and adjustment of the sprayer).

Physical barriers, such as nets or hedges, are used to reduce pesticides drift out of the orchard and protect habitations, water and other crops from spray applications.

11) Talking a 'system approach'

Taking a system approach is needed and involves a combination of techniques no. 1-10 to reduce the use of pesticides. The aim is to evaluate the technical and economic performances by measuring i) the reduction of pesticides, ii) the efficacy level on pest and diseases, iii) the production costs compared to yield and fruit quality.

The IEG on sustainable fruit production to minimize residues has delivered 3 synthesis reports (at EU level) based on 66 scanning reports (at Regional/National level), 65 seminars and workshops, 119 field-based meetings, open days, field visits, grower meetings, 62 participation in industry events, exhibitions, conferences with industry stakeholders and 4 events aimed at the general public.

Outputs, reports & communications see:
http://kp.eufrin.eu/

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