MINUTES COST863 WG2 + WG3 Joint Meeting

Biotic and abiotic stress prevention in integrated berry fruit production

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Päivi Parikka, Rolf Nestby and Gijs van Kruistum

The Joint Meeting was held in the frame of the EU-COST Action 863 “Euroberry Research: from Genomics to Sustainable Production, Quality and Health”. In total 21 researchers from 12 countries (Europe and Canada) attended the meeting, which was organised by Violeta Kondakova and her team at the AgroBioInstitute of the University of Sofia, Bulgaria from 9th until 11th March 2009.

The objective of the joint meeting was to discuss developments in the field of biotic and abiotic stress prevention incl. biological pest and disease control and pesticide residue management. Different aspects were treated such as:

- abiotic stress;
- biotic stress prevention;
- biological pest and disease control;
- pesticide residue management

To have a general international overview on the impact of stress factors on berry physiology and disease development the following expert was invited to give a presentation:
Dr. Jean-Pierre Privé, Agriculture and Agri-Food, Boctouche, New Brunswick, Canada. Understanding and reducing environmental stress in sustainable berry fruit production.

The outcome of the Joint Meeting was focused on the identification of the present knowledge on biotic and abiotic stress factors and the future requirements in the area of research to guarantee a sustainable berry production with high quality fruits. Definition of major themes and strategies for further research and collaborations in these fields are important.

Main achievements

1. Abiotic stress

Understanding and reducing environmental stresses in sustainable berry fruit prodution, The interesting presentation of the invited speaker from Canada stressed that χ2 indices of daily weather can describe the effect of climatic parameters on berry development. To achieve this, data for long periods are needed for good analyses of the effect of weather events on growth and quality parameters.

Tensiometers do not show plant drought fluctuations in the plant! Just the soil status. The growers do not like to use them. Other means of describing the water situation in soil are examined. Normally water is given constantly to prevent drought. However, it is a question at what critical point is water necessary? A small plant is not necessary negative! If we are concerned about fruit quality, size and yield in a best possible combination. These aspects should be more closely looked into. To achieve this use of intelligent irrigation systems (Like: ESI) would be important not only for water control, but also for frost protection; e.g. in blueberries where -3°C is critical for injury in the flower.
Low mid-winter injury is a problem both as long term LTS, but also due to stress created by alternate freezing and thawing events, which are becoming more frequent at a climate change with milder winters. Electrical impedance spectroscopy is a good approach for estimation of multiple freeze-thaw cycling injury. It was shown that a controlled freezing protocol to facilitate the rapid screening of large populations of seedlings of apples was useful **(Jean-Pierre Privé)**
It could be shown abiotic effects by using the PGPR (Plant growth promoting *Rhizobacteria*), *Bacillus subtilis* M3, *Bacillus subtilus* OSU-142 and *Pseudomonas putida* BA-8 + control, in the field. PGPR produced IAA, fixed N influenced cytokinin producing capacity. BA-8 controlled *B. cinerea* better than the other. Inoculation of bacteria increased plant growth and productivity. All bacteria had effect on abiotic stresses and initiated an increased plant nutrient element uptake from soil (large increases in NPK Fe), **(Sezai Ercisli et al).**
Flower induction is mainly controlled by temperature and light. However, it can also be influenced by stress manipulation. By example will drought (reduced soil volume) and lack of nutrients stop growth and start f**lower** initiation production. However, a too long period in these pots would reduce inflorescence quality! A similar effect is achieved by growing the plants at low temperature. These stresses could be used to start flower initiation, and subsequently to improve the growth conditions, a proper plant development would be achieved. By example 400 chilling hours are enough to initiate flower induction in strawberries. But to improve flower and inflorescence development the plant has to be removed to a warmer environment. **(Davide Neri and Gianluca Savini, Delm et al, Klamkowski et al).**
Growing strawberries in modern production systems like polyethylene tunnels, gave a negative correlation between soluble solids, firmness and dry matter % and temperature. pH was inversely related to daily global radiation, and T and total water input affected fruit colour in some cvs. Using black or brown polyethylene mulch, showed that black mulch vs white mulch lowered carbohydrate reserves and decreased chlorophyll content (Comment Rolf Nestby: Under Norwegian conditions black or brown mulch normally produce higher yield than white mulch). Black mulch decreased fruit size in the first harvest year and decreased soluble solids in both trial years. A north east position decreased growth vs a south-west row position (**Saila.T. Karhu).**
Hungary is situated at 46-48° latitude North, and due to a climatic change, strawberry suffers more frost in the flower, almost every year, and blackberry suffers winter freezing to the ground every 3-5 year due to temperatures of – 20°C for long periods, alternating with mild periods during winter. Lack of Chilling is also a problem and **r**aspberry and currant have reduced sprouting because of milder winters and lack of chilling. Pathogenes in the buds have continued to multiply during dormancy, increasing the injury! Also high temperatures may be a problem, and while black currant no longer suffer from frost in the flower, it suffers of hot spells with green fruit drop! Raspberries and blackberries suffer from sunburn on fruits and leaves, which induces earlier leaf fall, and poorer flower development. The hotter summers induces soil warming which inhibits root growth, giving problems in nurseries **(Denes Ferenc).**
The periods without snow cover during winter have increased the last two decades, the spring has become milder and earlier and the winter arrives at a later date. Examinations of strawberry cvs grown in Norway shoved that they had a critical freezing temperature close to -8 C. Stable Long term freezing is worse for coastal plants than continental plants, while alternate freezing and thawing is worse for continental plants than for coastal plants, and the injury increases as number of freezing/thawing cycles increases. Covering from autumn to April/May gave good protection either with straw or fleece, but straw had to be removed in April. The cover reduced both mild and freezing temperatures in mid winter **(Rolf Nestby).**

2. Insects pests, viruses and residue management

In this session four oral presentations were given on a wide range of subjects. Also two posters were connected to this topic. Research on insect pests is primarily directed on replacement of chemical use to more integrated control methods or even biological control by use of a wide range of tools. By using a sex pheromone the population dynamics of raspberry cane midge (*Resseliella theobaldi)* in Switzerland was studied. This pheromone trap allows to estimate the midge populations and to decide if it is necessary to use an insecticide and at which moment. With a semiochemical trap and a floral attractant raspberry beetles (*Byturus tomentosus)* can be caught and damage of the fruits was decreased. In Finland a study is running on biological pest control in remontant strawberry under

plastic tunnels. Two spotted spider mites (*Tetranychus urticae)* and thrips were controlled by releases of different natural enemies. By monitoring of these pests and the effect of natural enemies a system of biological control will be developed for these types of strawberries. The monoculture practice of strawberry production in Portugal is not sustainable and leads to a high pressure of diseases and pests and a high use of chemical soil fumigants. After the phase out of methyl bromide, the search for alternative soil disinfestation methods in combination with integrated pest management (IPM) is intensified. In the Netherlands an alternative for methyl bromide fumigation of mother planting stock was found in form of a controlled atmosphere temperature treatment (CATT). With this non-chemical treatment a durable solution for methyl bromide was found. Beside the strawberry tarsonemid mite (*Phytonemus pallidus)* also the two spotted spider mite (*Tetranychus urticae)* is eliminated by CATT. New viruses are transported to Europe with plant material and they can be an increasing problem in the future. Blueberry red ringspot virus (BRRSV) is present in USA and it has now been identified also in Slovenia from symptomatous plants.

3. Fungal diseases

The session for plant diseases contained four oral presentations. One of the posters presented was also of disease problems. Plant diseases are often enhanced by environmental conditions. Abiotic stresses that affect plants can also make them more susceptible to pathogens. Disease resistance is a good tool in disease control but the resistant cultivars may be less productive. The major fruit rots are very difficult to control without chemicals and control of soil-borne pathogens need different approaches in fruit production.

Pesticide residues are an increasing issue among consumers. However, fruit rots like *Botrytis* cause major reduction in fruit quality and yields and they are controlled with fungicide sprays. To achieve an adequate control, several treatments during flowering and fruit development are needed. More strict demands are set to fruit production by supermarkets to lower pesticide residues.

Decision support systems can offer a solution for disease control based on infection risk and with less fungicide applications. Biological control is an opportunity to reduce pesticide use and environmental effects of fruit production. To have a good effect with biological products is a more complicated than with chemicals. *Ulocladium atrum* has been successfully used to control Botrytis fruit rot with sprays timed using decision support system. Different spray schedules have resulted up to 67% reduction in *Botrytis* infection in fruit. To combine use of a fungicide and biological products can be a good solution when infection pressure is high. Hypobaric treatments after harvest have reduced *Botrytis* and *Rhizopus* spoilage of fruit. Also chitosan has shown effect on post-harvest decay of strawberries.

Soil-borne pathogens can be controlled with crop rotation and soil treatments. Biofumigation with glucosinolate containing plants such as *Brassicas* have proved to be effective in disease control. They have been more effective on heavy than porous soils. The green mass used in biofumigation has to be incorporated to the whole root layer to have a good effect. It can reduce *Verticillium* microsclerotia and increase yield. However, timing of green mass incorporation still needs investigation. Also the effects on soil microflora have to be studied as well as the effect on several other diseases on soft fruit.

Phytophthora cactorum is a widespread and economically important disease on several fruit species. Especially, it has spread with infected strawberry planting material. Most of the strawberry cultivars are susceptible to the pathogen and even those that have some resistance may have damages under environmental stresses. Other soil microbes can affect soil-borne *Phytophthora* and possibly inhibit infection. Some indication of this was achieved with compost amendments. Commercial composts made of municipal wastes and biowaste have shown suppressiveness in greenhouse trials on strawberry plants.

Progress and discussions

In the final discussion the needs for further research was highlighted in the FP7 proposition:

Improving European berries production, quality and nutritional value (Strawberries, Currents, Blackberries, Blueberries and Raspberries) Call: FP7-KBBE-2010-4

Proposed topics for aspects on abiotic stress:

Title suggestions (short and long)

a. ***Cresh Berries (Chemical reduction strategy in berries)*** *(chemical reduction has to be described).*

b. ***Sustainable resource strategy in berries under a climate change.***

Suggestion: Based on case studies and *IFP (integrated fruit production). This will allow different groups/disciplines to interact.*

Thematic suggestions are:
Genetics
Plant physiology
Pest and diseases
There is a connection between abiotic and biotic stresses and with genetics (cvs).

General

Stop or stress plant growth. This will initiate flower induction, (well known in strawberries).
Strawberries, raspberries, blueberries, blackberries,currants

a. Beneficial results of timing and amount of stress (especially: nutrient, drought and temperature).

b. Description of flower (inflorescence quality and number yield potential).

c. Suggesting a system based on this idea for European plant production of the most important cvs grown in European regions.

The specific stresses (not all should necessarily be included in a FP7 project):

LTS (Low temperature stress) and avoidance in winter

a. Strawberries , raspberries, blueberries (also lowbush, V. myrtillus), black currants.

b. Cultivars.

c. Management methods for tolerance and avoidance (covering, heating, watering (drought), fertilization etc)

Suggesting methods for European growers based on specific region. How can management methods and cultivar interact to reduce LTS injury.

Chilling
Lack of chilling has appeared as a problem in central and south Europe. To solve this will be a question of breeding, but also management technique. Methods to add chilling conditions in controlled production could be an option.

Heat stress
Also this has appeared as a problem in central Europe and it may happen even in Scandinavia.
Frequently seen in blackberries and raspberries.
This can be solved by joint effort of breeding and management.
Are there any positive effects of heat stress? (Diseases, pests?)

Drought
To be concerned about under protected cultivation, but also more frequently in the open field according to climate scenarios. This do not has to be a problem as long as there is water available, but more knowledge is necessary to understand the reactions of plants. It is possible that a certain drought stress could be beneficial at certain growth and development stages. (e.g. to stop growth in strawberries and initiate flower production).

Wind
This is a stress of its own, and may destroy leaves and fruits and reduce growth. It is also a factor increasing the injury of drought, and can as so increase LTS since these two stresses partly have the same effect on plant cells.

Salt stress
In areas with saline soil this is a problem, but it may also be a problem due to incorrect fertilization.

Waterlogging
A problem connected to poor drainage. Drought and water logging are two counterparts and should be handled in experiments as one topic.

Excess light stress (Photo inhibition)

Because of climate change the autumns are becoming milder. It is a question if plants can benefit of this. At late autumn there will be at least in central and northern Europe, a lack of light. This will influence plant growth and development, and it is observed that the fruit quality of berries may be intermediate or poor. There is a lack of knowledge around this, and the question is if breeding and management could invent cvs and management methods making it possible to stretch the fruit production beyond the limits of today?

Extras
It is already known that biotic stresses are affected by abiotic stresses. In a FP7 project it would be a very good idea to make connections between these disciplines. The abiotic group is convinced that the cooperation in two COST actions (COST 836 and COST 863) already has created a good network and cooperation, and a project within the stress topics and breeding would certainly benefit of that! These suggestions of topics that could be incorporated into a FP7 project are the result of a group work within the abiotic stress- group at the Sofia work shop March 2009, and the planetary discussion of the whole stress group.

Proposed topics for aspects on pest prevention and integrated pest control:

1. Improving of plant resistance in open field production of berries
Key words: plant condition, cultivating techniques, mulching, use of compost, manure

2. Protected cultivation techniques in integrated pest control
Key words: rain cover methods, use of plastic tunnels, biological control methods, economics

3. Climate change and prevention of new pests and viruses
Key words: diagnostic methods, monitoring, host range, natural enemies, pheromones, introducing exotic predators and the relation to domestic fauna, improving biodiversity

Overall important is to improve the integration of knowledge and to promote ‘chain thinking’in this FP7 call.

Proposed topics for aspects on disease control

Sustainable management of plant diseases in berry production:
- description of the production chain of sustainable berry production regarding plant diseases and their control
- integrated disease control, biocontrol and alternative control methods
- enhancing plant resistance and resistant plant material
- cultivation methods to reduce disease pressure
- managing new disease risks in berry production

The European knowledge of disease management:
- disseminating results
- filling in the gaps of knowledge in the European level

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