Synthesis report
[WP5- sustainable fruit production]

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Document overview

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Synthesis findings

This work package, sustainable fruit production, has three focus themes:

- fruitthinning,
- water/nutrients
- organic fruitgrowing

During the meeting of the group, 31 May/! June 2017, scanning reports of 2016-2017 were presented, as well as the expectation of the impact of the springfrost in each region discussed. In 2016, the first year of the project, each partner described the GAP on the focus themes as far as his/her organization could deliver input on. Pitfruit is a perennial crop with a culture for 15-25 years. Changes go slowly and research has to be done multiple years to validate the new insights. Therefor the GAP descriped in year 1 (Y1) has not altered substantial to the GAP described in 2016-2017. Each groupmember gave an overview of the scanning report describing the present GAP, new experiences, new insights/knowledge and problems.

The meain developments for the future are:

Thinning: most countries are focusing on the development of decision support models (DSS) as a tool that can help growers to make the right decisions about chemical and manual thinning, through measuring or prediction of the physiological reaction of the trees. Can we forecast June drop / fruitset or the reaction to chemicals? A new correction tool ACC -Valente for late thinning as correction has been developed but is still not widely available for testing.

Water/nutrients: Flow of water in the tree, modelling the soilmoisture, sensortesting, plant physiological reaction to different waterstress levels in different stages of the season, usage of waste water, usage of satellite images to estimate dryness, reduced N-programs, buffering more water from spring and -wintertime by increasing organic substance levels in the soil.

IPM/organic: Netting, rain protection, biodiversity, green products, acceptance, registration and development of new products, birdshelters, pre-cultivation

Overview of best practices (summary of GAP from last year + additional info) :

Thinning:

For apple, chemical thinning with various products is used in almost all production areas in Europe. The main products are NAA, NAD, ATS, Brevis, BA-6, Ethrel. The products are used depending on the varieties and the climate. Especially in warm climates the reaction on 6-BA is very good, only some varieties like Red Delicious, Rubens and Fuji react not so well on 6BA. Brevis is used more and more. Varieties with strong problems with biannual bearing like Elstar, Fuji and Red Delicious are treated with blossomthinners like ATS and Ethrel to promote early fruitdrop and initiate return bloom.

In general everybody uses an combination of chemical products depending on variety and weather circumstances.

Mechanical thinning (Darwin machine) is used in organic fruitgrowing on varieties with a good fruitset like Elstar and Gala. In The Netherlands, mechanical thinning is hardly used because its results with, for example, the Darwin thinner, have shown too much fluctuation. Besides that, the often-used spindle shape (80-100 cm trees) is less suitable for this machine. In Italy, for peach no chemical thinning is available and mechanical thinning is used, but still needs improvement.

Brevis (metimitron) is now almost allowed in all European countries. It is a strong thinning agent for pears and apples. Still a lot of research is needed to explain the variation in results. Main research focus is at the temperatures and radiation during the days before, during and after the application.

In Spain, Italy, Belgium and Holland different DSS -models (most depending on estimated carbonhydrate balance) are being tested as a guide to better estimate the result of the chemicals.

Water/nutrients

In The Netherlands the IRRY water model is updated now and tested. This time the model is being adapted to automatic loggers of the watercontent in the soil. In practice most fruitgrowers use Watermarks (tensiometers) to measure the waterstress. The results of long time research to the reaction of the trees to waterstress in different periods of the growing season are well used in the common practice. Most fruitgrowers use the summerperiod to accept guided waterstress (60-70 kPa), depending on growth. In the pre-harvestperiod and cell-division period no waterstress is accepted.

Unlike some other European countries, irrigation is not used in apple growing in Belgium. Yearly around 60 pear growers get orchard specific advice for irrigation and fertigation. Despite the demonstrated positive effects of irrigation on fruit size, this number of supported 'Conference' growers is only increasing slowly. Via soil sample analysis, leaf mineral analysis, fruit set and a soil water balance model a weekly advice is given to pear growers that subscribe to the PWARO service, which tells them how much irrigation should be done (in mm/m^2) in the following week as well as whether fertigation is required. Still leaching of Nitrogen out of the soil in the last part of the season is a major problem. Studies and fieldtrials are being done to evaluate and show the reaction of the tree and fruits to lower N-supply.

Water scarcity in semi arid regions of Europe, like in Spain and Italy, threatens the sustainability of fruit tree orchards unless irrigation water is optimized and scheduled in deficit irrigation strategies. The correct use of the most successful deficit irrigation strategies, such as regulated deficit irrigation requires both a good understanding of demands of the crop at different phenological stages and physiological mechanisms involved in the response of plants to water stress, and the use of reliable and sensitive indicators of water stress. In southern Europe (Spain and Italy) the use of shading nets is mentioned as a method to reduce water needs. In Italy in some parts (ER) the fruitgrowers can use the IRRIFRAME balance model to get better insight on the evaporation of the trees. The DSS is now being optimized to combine this model with PERFRUTTO which works with fruit measurements in the period of 2 months after F2. All other fruitgrowers are working based on their experience. The variation between fruitgrowers is large. In Catalonia sensors which measures soilwatercontent are already connected to internet (IoT) so a continuously measurement combined with evatranspirationmodels can give better info to consultants and individual fruitgrowers how to adapt their watersupply.

In South-Tirol the usage of high amounts (100-150 kg N/year) of Nitrogen were tested for many years, showing no better performance to the quality or production of Red Delicious.

For Switzerland irrigation is less important as for other countries with an exception for some regional cultural-specific expectations, like apricots in the canton of Valais and cherries under rain cover.

For Denmark: in fruit orchards drip irrigation every 50 cm in row or at planting position is normally applied the first 3 years after planting, and thereafter normally very limited only in draught situations. In intensive apple, pear and stone fruit drip irrigation is very common. In strawberries irrigation is necessary in harvest years, both before and after flowering and in autumn to ensure flower bud development. The Danish law sets a maximum for fertilizer application. Typically most tree fruit is fertilized less than the norm to control vegetative growth.

The average Hungarian sweet cherry orchards aren't irrigated, because the natural precipitation (550 to 700 mm annual yearly precipitation) might be enough for growing this crop among extensive conditions. The intensive orchards are irrigated, the growers use drip irrigation or micro sprinklers to water them.

In the south-west part of France, growers who have decided to apply precise irrigation are mainly producers of kiwi, hazelnut, walnut, prune and sometimes, apple, pears, peaches and apricots. The main reason is because they see that a better irrigation will benefit in a better quality of fruits and a longer storage possibility. The other reasons as saving water, fertilizer and energy are known but not the main argument for the decision to invest.

Research in Lithuania: major attention was concentrated for analysis of morphological, biochemical peculiarities of the aboveground part of the trees (apple tree 'Auksis' grafted on MM.106, M.26, B.118, M.9, P 60, P 59, P 2, B.396, P 22 rootstocks) and evaluation of how they are affected by water deficiency. Results showed that the drought evoked photosynthetic pigments system adaptation mechanisms of all apple rootstocks except P 22. Tendency for changes in phytohormones and sugars content under drought stress of various extent was not established. Apple rootstocks M.26, M.9, P 2 and B.396 were the most drought sensitive. P 22, B.118 and P 60 were more resistant to drought.

IPM/organics

In Holland, despite the increasing demand of the consumers, the amount of organic fruitgrowing is not rapidly increasing. This is due to the limited number of allowed organic products for crop health.

Organic production is increasing in Denmark following the large and increasing demand by Danish consumers. For apple 21 % of total area was organic in 2014 but only 4.9 % in pear. Organic treatment strategies for a full season are available for apple, pear, sweet and sour cherry, black and red currant and strawberries outside.

For Germany: Spraying intervals and exact timing of pesticide use in the vegetation periods of berry plants allow the fruit producers to use various pesticides and in the same time prevents detectable residues in the harvested berries. Using the recommended and developed spray schedules insures integrated fruit production and in the same time retailer demands. Holthusen (2016) estimated that 90% of apple growers in northern Germany use this method. Growing berry fruits under cover, (protected production) augments in the last two years in Northern Germany. Advantages: less herbicide use, less insecticide use, less fungicide use, higher yield/m^2 and assured harvests without the influence of rainfall and other weather phenomena's, therefore better quality. Up to 60% of the northern strawberry producers use a reduced spraying sequence of classical fungicides supported by beneficial organisms.

In Romania, the organic agriculture increased the last years. According FAO statistics, of the organic cultivated orchards, approximately 86% are under conversion and only 14% are certified. For the organic fruit growing in Romania, six factors are important:: apple scab resistant varieties; the use of ameliorative plants in soil preparation for planting; almost all organic fruit tree growers use pheromone traps for monitoring and risk assessment of pests; the protection and monitoring of useful orchard fauna; alternative organic pesticides and in many orchards mechanical weed control is used as an alternative for herbicides.

The recent developments per theme:

Thinning:

In research for France, the prediction of flowering time is a new development. From long time series of flowering time observation, models can be inferred and used to predict flowering time in a given year or in climatic scenarios for the future. For thinning, the integration of fruit set capability and self-thinning trait in new varieties and the use of models to predict fruit set depending on fruit load and climatic conditions are new. Making decision tool(s): the goal is to find a simple diagnostic for which the information will directly come from molecular markers and genes expressions (AppleGenie).

In Denmark, mechanical thinning by hand held equipment or tractor driven machines with flower stripper is tested.

In Italy, mechanical thinning is considered a very promising approach for crop load management in peach, where chemical strategies are not available and the hand thinning is very expensive due to the high amount of hours needed. The various benefits obtained (higher fruit quality, lower needs for hand thinning) make this approach extremely convenient for peach growers who can apply it also for organic productions. The reaction of the tree on the application of Brevis and the reaction of the fruitgrowth on the application of Brevis is being evaluated to better understand this product.

The efficacy of the new thinning product Brevis is evaluated in several European countries. Models are tested to better evaluate the effects of the thinningagent and to come to a DSS system.

In Holland a lot of testing is being done with combinations of products which increase the uptake of metamitron. Especially the EC-formulation or products which contain a little mineral oil shows effects on the thinning effect of Brevis.

In Switzerland, experiments on thinning sweet cherries with a high crop load were done in 2004, 2005, 2006 and again in 2015. Besides hand thinning, also chemical products were evaluated (ATS, BA, NAA, Metamitron). So far, thinning of sweet cherries was not successful: either there was no thinning effect, or if the crop load was reduced, the increase in fruit size was not high enough to compensate a smaller harvest.

Water/nutrients:

In Belgium, irrigation and fertigation in soil-grown strawberry is a standard practice, but precise steering of the system is lacking and is based on the grower's experience and interpretation of the plant growth and production, as well as the (predicted) rainfall. Within the framework of an ongoing project at PCfruit guidelines are under development to determine the irrigation and nitrogen thresholds as well as the optimal application strategies with the final aim to minimize water and nitrogen inputs and losses due to drainage and at the same time improve strawberry quality. Satellite images are being tested to see their practical value for monitoring dryness.

Recent developments in France: derive indices of water stress tree status from airborne images. Applied to apple progenies and pre-selected material. Model the impact of water restriction of tree development and fruiting capability. In south-west of France the next step in irrigation is automatization of the irrigation including RDI on light soils (not verified here on clay soils).

In Italy subsurface irrigation is recently implemented. This strategy foresees an underground water distribution tanks to pipelines and irrigators buried slightly under the cultivated row, with a frequent but low irrigation rate lasting during the daily light period. Subsurface irrigation has the clear advantage of reducing evaporative water losses, while increasing the distribution efficiency, allowing a higher volume of wet soil; a reduction in the amount of water used for irrigation; a better management of drought periods; a lower weed growth and, consequently, lower needs for herbicides treatments on the surface.

New research for the usage of waste water is being executed on peach and apples. Different sterilisatortechniques with UV and H2O2 are tested.

For The Netherlands: wireless reading of Watermark: data collection in the field by sensors wired with dataloggers with electrical loading by sun cells and wireless communication to the PC via GSM and an internet based application of IRRY. New soilsensors are evaluated.

In Spain soil water evaporation should be reduced as much as possible in order to achieve high irrigation efficiency. This can be done by mulching, innovative canopy forms or reducing fruit load. DSS models are tested and more integrated in common practice. For the use of sensitive indicators of water stress, special attention has been paid in Spain to plant-based methods, since plant measurements have the advantage of integrating the soil and atmospheric water status, as well as the response of the plant to the surrounding conditions. New methods have been developed for non-destructive, automatic and continuous measurements, such as dendrometers sap flow and turgor-related probes.

IPM/organics

In Denmark, the scientific testing of covering of apple and pear with plastic roofs to avoid direct precipitation on fruit and leaves is ongoing to avoid apple scab attack and several years results seems very promising, almost an on off effect of infection. Dry fruit do not get scab at all or very limited. Challenge are the costs and stability of roofs. Hot water treatment of apples to avoid storage rots has been demonstrated to be efficient and is now slowly moving into industry following development of treatment equipment.

In Germany, the berry fruit research Station northern Germany situated in Langförden (Berry compartment of the ESTEBURG) is working since two years intensely on research in protected production. Key aspects, variety and growing method testing of different species of berry fruits under cover, to find the appropriate varieties and methods for sustainable berry fruit production. An experiment of different growing containers as Air pot, Bato pot, and models from Beekenkamp is set for the next two years to evaluate root growing, plant development and phytosanitary conditions. The experiment takes place in the cultivation of Raspberries, Blueberries. Substrate aggregates and substrates are tested with different varieties to get knowledge about which variety needs which substrate and which nutrition method. Different water storing substrates are tested to avoid drain to reduce water- and fertilizer wastage. (Koschnick 2016)

In Romania, apple scab resistant varieties are tested as well as ameliorative plants in soil preparation before planting, many species of useful orchard fauna, alternatives for organic pesticides and natural compounds to induce plant resistance.

Research in Switzerland showed for hail nets with side nets that concerning pest insects, the codling moth was successfully reduced in plots with side nets compared to control plots without side nets. Effects on beneficial or other pest insects are still evaluated. Meteorological and physiological measurements have only just started. With side-netting, the problems with wooly aphid increased. This effect is also noticed in research in Holland. Not only wooly aphid but also green aphids showed more severe damage in netted orchards.

Summary for EIP dissemination

Project title: **EUFRUIT: European Fruit Network**

Keywords: thinning, water, nutrients, IPM, organic

Summary: This work package, sustainable fruit production, has three focus themes: thinning, water/nutrients and organic. During the meeting of the group, scanning reports were presented, giving an overview on the current status of best practices of sustainable production that growers apply today as well as recent developments in sustainable fruit production that are in the pipeline.

Developments for the future are:

Thinning: most countries are focusing on the development of DSS, decision support models as a tool that can help growers to make the right decisions about chemical and manuel thinning, through measuring or prediction of the the reaction of the trees. Can we forcast junidrop / fruitset or the reaction to chemicals. ACC -Valente for late thinning as correction

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IPM/organic: Netting, rain protection, biodiversity, green products, acceptance, registration and development of new products, birdshelters, pre-cultivation

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Annex: Scanning reports

See pdf