COST FA1104 Final Conference

Sustainable production of high-quality cherries for the European market

4-8 April 2016
Naoussa, Macedonia, Greece

Scientific Program - Book of Abstracts

Organizing Committee

Nikolaos Papadopoulos, University of Thessaly, Volos, Greece
Athanasios Molassiotis, Aristotle University of Thessaloniki, Thessaloniki, Greece
George Manganaris, Cyprus University of Technology, Lemesos, Cyprus
It is our pleasure to welcome you to the Final Conference of the COST Action FA1104 “Sustainable production of high-quality cherries for the European market” in Naoussa, Macedonia, Greece. The Conference is a joint initiative of the University of Thessaly, the Aristotle University of Thessaloniki and the Cyprus University of Technology.

The program of the conference includes 7 plenary talks, 30 oral presentations and 40 poster presentations that are expected to cover the whole spectrum of cherry cultivation, ranging from basic aspects of the “biology of the cherry orchards” to nutritional aspects of fruit and trading.

We endeavour to offer a high-quality and interesting program with renowned keynote speakers, as well as, an attractive social program during the conference.

Convenors
Nikolaos Papadopoulos
George Manganaris
Athanasios Molassiotis
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**Moderators:** Karoly Hrotko, Daniela Giovannini  

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<td>09:45-10:00</td>
<td><strong>M. Schuster</strong></td>
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<td><strong>M. Jensen</strong></td>
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<td><strong>H. Kaufmann, A. Kunz, E. Luedeling, J. Gebauer, M. Balmer, M. Blanke</strong></td>
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**Morning Tea/Coffee break [Café Neon]**

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**Moderators:** Ana Wünsch, Felicidad Fernandez

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<td><strong>G. Bujdoso, K. Hrotko</strong></td>
<td>Overview on usage of rootstocks and scions in the production in Europe (OP-13)</td>
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<td>12:15-12:30</td>
<td><strong>I. Chatzicharisis, C. Kazantzis, T. Sotiropoulos, P. Drogoudi</strong></td>
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<td>12:30-12:45</td>
<td><strong>F. Stănică, A. Asănică, A. Peticilă</strong></td>
<td>Parallel Trident - a suitable canopy for medium density sweet cherry orchards (OP-15)</td>
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<td><strong>E. Karagiannis, I. Minas, A. Lazaridou, A. Molassiotis</strong></td>
<td>The impact of modified atmosphere and 1-MCP in the quality traits of sweet cherry (OP-16)</td>
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**Lunch, Archochori village**
16:00 - 17:00  Poster session II (21-40)

17:00-18:00  Session VI: Oral presentations
Moderators: Joanna Pulawska, Slawomir Lux

17:00-17:15  S. Lux, A. Wnuk, H. Vogt, T. Belien, A. Spornberger, M. Studnicki
On-farm validation of a ‘virtual cherry farm’ concept based on a stochastic simulation model used as a tool for enhancement of site-specific IPM (OP-17)

17:15-17:30  J. Špak, J. Přibylová, J. Fránová, O. Lenz, I. Koloníuk, F. Paprštein
Analysis of Cherry Virome by Next Generation Sequencing (OP-18)

17:30-17:45  J. Pulawska, M. Cieślińska, M. Kałużna, M. Michalecka, A. Poniatowska, W. Warabieda
Occurrence, identification and characterization of fungi, bacteria, viruses, phytoplasma and pests infesting cherries in Poland – the results of three-year project (OP-19)

17:45-18:00  C. Ioannou, S. Papanastasiou, K. Zarpas, J. Koutsafikis, C. Athanassiou, N. Papadopoulos
Development and implementation of a Location Aware System (LAS) for monitoring and management of the European cherry fruit fly, Rhagoletis Cerasi (Diptera: Tephritidae) in commercial orchards in Greece (OP-20)

18:00-18:45  Evening Tea/Coffee break [Vetlans Culture Center]

18:45-20:30  Management Committee meeting
An EU.Cherry project presentation will be included (M. Delmas)

Thursday, April 7

09:00-12:30  Site visit
- Prototype cherry orchard (Lemonidis farm, Rodochori)
- Winery Kir-Yianni (Gianakochori)
- Cooperative Unit (Naoussa)
- Nursery of cherry cultivars (Veria)
- Light lunch

12:30-15:00  Excursion to Vergina [guided tour]

15:00-17:00  Free time at Veria
18:00  Return to Naoussa
21:00-01:00  Gala dinner [Palea Poli Boutique Hotel]
**Friday, April 8**

**08:30-11:00 Session VII: Plenary lecture & oral presentations**
Moderators: Joël Pothier, Pavlina Drogoudi

08:30-09:00 **M. Bizzarri**
OROPLUS®: beyond rain protection

09:00-09:30 **D. Valero**
Preharvest and postharvest tools to maintain sweet cherry quality at harvest and after storage (PLE-07)

09:30-09:45 **M. Fotirić Akšić, R. Cerović, V. Rakonjac, D. Nikolić, S. Radičević**
Pollen tube growth and early embryogenesis in ‘Oblacinska’ sour cherry (OP-21)

09:45-10:00 **I. Ionescu, G. Ortega, A. Bayo, B. Lindberg Møller, R. Sánchez-Pérez**
Metabolite control of flowering time in sweet cherry (OP-22)

10:00-10:15 **B. Wenden, J. Quero-Garcia, M. Meland, M. Blanke**
A European network for cherry phenology (OP-23)

10:15-10:30 **G. Charlot**
High density training systems (OP-24)

10:30-10:45 **M. Meland, J. Børve, B. Hatteland, O. Frøynes**
Sweet cherry R&D in a Nordic climate (OP-25)

10:45-11:00 **J. Sedlak, F. Paprstein**
Micropropagation of sweet cherry cultivars (OP-26)

**11:00-12:00 Morning Tea/Coffee break [Café Neon]**

**12:00-13:30 Session VIII: Oral presentations & Concluding remarks**
Moderators: Guglielmo Costa, Mathew Whiting

12:00-12:15 **F. Paprstein, J. Sedlak, V. Holubec**
Historic sweet cherry cultivars (OP-27)

12:15-12:30 **D. Gamrasani, A. Weksler, R. Ben-Arie, H. Friedman**
Pitting in cherry can be induced by hitting and is enhanced by low temperature (OP-28)

12:30-12:45 **K. Koumanov**
Intensive cherry production: Bulgarian approaches and implications for further research (OP-29)

12:45-13:00 **S. Lugli, R. Correale, Mi. Grandi, A. Ravaiolli, M. Bertolazzi**
The new “Sweet Series” cherry varieties from the University of Bologna (OP-30)

**13:00-13:30 Official Closure of COST FA1104 action**
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The cherry world production reached about 2.300.000 t mainly distributed in Asia (43%), Europe (37%) and America (18%). Quite interesting to point out that 10 producing countries account for more than 70% of the world production. Important is also the production of the ex URSS that reached that of historical country as Spain. As far as Italy is concerned, cherry is actually cultivated in vocational areas: Apulia (18.500ha), Campania 3.193ha), Emilia-Romagna (2.247ha) and Veneto (2.203ha). The cultivation technique changed thanks to the new genetic material that allow to overcome the size of the tree and the self-incompatibility that characterized the cherry industry in the past. In addition, there are still old problems such as the fruit cracking and some new entry (*Drosophila suzukii*) that have to be possibly solved. To overcome these problems, in Emilia-Romagna in particular, the cultivation under tunnel is becoming extremely important in consideration of the innovation of the plastic films capable of broader functions (able to pass specific wavelengths, light diffusive or heat protective). The innovative films have anti-cracking action, control fruit ripening and improve quality and also might act against the development of pest and plant disease. Also the new training and high density planting system do not represent a limitation to the mechanisation of the orchards grown under tunnel. The tunnel, that was a limitation in the past, turned out into an opportunity of development and testing of new production models.
Limits and challenges of pest control in cherries

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Modern and intense cherry production tries to cover a long period of the season, depending on the climatic region from May/June with early varieties until July. The main cherry pests built up its population in spring before, during and after cherry bloom or when the fruits turn from green to yellow or red. Some pests also cause damage on ripe fruits. Currently, control of main cherry pests is insecticide based in integrated cherry production. The registration of insecticides as all other pesticides in plant protection is regulated by the Regulation (EC) No 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market. This regulation introduces comparative assessment and substitution to the regulatory process for plant protection products (EC DG SANCO, 2013). This has and will have consequences for the availability of effective active ingredients against pests in cherries and other crops. Some examples will be given for future limits of the control of some main pests in cherries: Against *Myzus cerasi* the carbamate pirimicarb can be applied the EU in some member states. It is known to have low effects on beneficial organisms and the approval of the European Commission of it is 30/04/2018. Pirimicarb belongs to the candidates for substitution, i.e. it meets two of the criteria to be considered as a PBT (= persistent, bio accumulative, toxic) substance. Another insecticide thiacloprid with an EU-approval until 30/04/2017 against aphids in cherries belongs to the chemical group of neonicotinoids. Beside the discussion on side effects on honey bees of the whole group, it also belongs to the candidates of substitution, because of endocrine disrupting properties. To control flies, like the European cherry fruit fly and the spotted wing drosophila, broad spectrum insecticides like pyrethroids (e.g. lamda-cyhalothrine, deltamethrine), organophosphates (e.g. dimethoate, phosmet, chlorpyrifos/chlorpyrifos-methyl) and spinosynes (e.g. spinosad, spinetoram) are most effective. Furthermore, the neonicotinoid acetamiprid is applied against fly pests. But, in many European countries, most these insecticides are not registered for the use in cherries any longer or can only be applied with an annual exceptional permit in some of the member states. Furthermore, dimethoate and lamda-cyhalothrin also belong to the candidates for substitution: dimethoate (approval: 31/07/2018) because of low ADI (Acceptable Daily Intake)/ARFD (Acute Reference Dose)/AOEL (Acceptable Operator Exposure Level) and lamda-cyhalothrin (approval: 30/06/2016) because of two of the criteria to be considered as a PBT. The availability of pesticides against cherry pests will become one of the most important challenges for European cherry growers. On one hand side, research to find new compounds for sustainable cherry production, on the other hand side, research for alternative strategies must be intensified. This also includes basic as well as applied research on biology, behaviour and epidemiology of some of the pests as a base for specific biological, biotechnical or other environmental sound control strategies.
Spanish changes in the main species of deciduous fruit species in recent decades, with especial importance to production areas, in particular in cherry are exposed. We describe the situation and trends concerning cultivars, rootstocks, training systems and cost of production. The import-export trade focusing on destination/origin countries is analysed and also the cherry consumption. Spain is, depending on the season, the second/third largest producer and exporter of cherry in the European Union. Poland and Italy play the most important role. In the last two decades the most significant change concerning deciduous fruit production, has been the significant increase of stone fruit species production, in particular peach the leading specie, for their better adaptation to the warm climates that characterize the main producing areas. Cherry occupied in 2015 an area of 33,004 ha, the second in importance after peach, with an average annual production over the period 2005-2015 of 90,400 t of which 27% is exported mainly to several European Union countries as United Kingdom, Italy and Germany. The import is not important compared to export and Chile is the main supplier. The main producing regions are Extremadura, Aragón and Catalonia. The different production areas provide an extended period of supply to markets, ranging from mid-April in early producing areas, to early August in the late areas. Consumption shows a constant increase since 1989. Technological innovation has been very important in particular with regard to new cultivars production and training system development. Over the last two decades the new varieties from Summerland (Canada), California (USA) and more recently Italy, have been planted in the main production regions, complemented in some cases with local varieties as “Tipo Picotas” in Extremadura. ‘Early Bigy’/‘Burlat’, ‘Summit’/‘Lapins’ and ‘SweetHeart’ are the references in early, mid and late season, respectively. The selection of Prunus mahaleb INRA SL-64 has been and still is the most used for its adaptation to calcareous soils. The semi-intensive reduced gobelet, also called “Spanish bush” or “Catalan bush”, with local modifications is the most popular in all the producing areas. The implementation of a modern and innovative post-harvest infrastructure enabled to develop and apply the different protocols of certification required by the destination markets. In addition different Protected Designation of Origin (PDO) and Protected Geographical Indications (PGI) were achieved by the cherry produced in some specific regions.
Selection in cherry is multifactorial and multispacial. Natural populations are facing different selective forces and may have suffered severe selection pressure from bottlenecks. Instead, the genomic region around the S-locus clearly shows balancing selection. Epigenetic variation appears uncoupled from genetic variation in cherry, however the role of heritable, as well as purely stochastic, epigenetic variation in selection and in the evolutionary adaptation of the phenotype is unclear. Breeding populations on the other hand, are the result of clear traditional phenotypic selection, usually directional in genetics terms. Novel approaches in selection come through the association of genetic markers with economically important traits and have recently taken the form of QTL and candidate gene mapping. Marker assisted selection and its variant marker assisted seedling selection bridge quantitative and molecular approaches and may accelerate, intensify and precise breeding applications. Artificial selection has resulted in considerable genetic gains, but on the other hand has reduced the genetic diversity of the germplasm used. In parallel, the availability of novel cultivars leads to orchard expansion potentially able to take advantage of the whole ecological envelop of the species natural distribution. Therefore, in novel metapopulations the question emerges: is the difference in reproductive success driven by naturally occurring processes, or is selection anthropogenically imposed? How the wild-type germplasm feeds back to the breeding populations? Which is the nature of selection in cherry?
FruitBreedomics: a European project to help bridging the gap between basic research and breeding in fruits

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The FP7 European research project FruitBreedomics has come to an end. Started in March 2011, the project officially ended on August 31st, 2015. It has been 52 months of intense research activity by many researchers from 28 research institutes and private companies to fulfill the goal of bridging the gap between genomics and breeding in fruit trees. The approach taken to close this gap has been comprehensive. It has encompassed the generation of new tools for phenotyping, genotyping and transcriptomics; The genomics tools enable the discovery of new associations of markers and traits of commercial interest thanks to different approaches (Pedigree Based Analysis (PBA) and Genome Wide Association studies (GWAS). They also enable to decipher New knowledge about the European apple and peach germplasm structure. FruitBreedomics also helps to develop methods (Molecular Assisted Breeding, Genomic Selection, Fast Breeding) to improve the efficiency of fruit breeding programs and plant material that commercial breeders of fruit varieties can implement and use in their day to day effort to create new cultivars.
Research at the intersection of biology and technology: sweet cherry orchard systems of the future

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Sweet cherry remains among the most labor-intensive temperate tree fruit crops, requiring large crews of skilled labor for harvest and pruning. Indeed, regional growers associations in the U.S. have identified labor shortages as their highest concern. As new sweet cherry orchards are planted, growers must consider the system precocity and productivity, the fundamentals of orchard profitability. Yet equally important is orchard labor efficiency and its potential to incorporate mechanization and/or automation. The tree fruit physiology team at Washington State University has been refining the high efficiency orchard systems that are sustainable, consistently productive, and yield superlative fruit. Clearly, compact, planar architectures will be essential where the entire canopy is readily accessible. There is much interest in the Upright Fruiting Offshoots (UFO) architecture due to its planar nature and the simplicity of pruning and training. In our trials, hand harvest efficiency was 72% greater in the UFO system compared with traditional, multi-leader systems. In addition, we have demonstrated the potential to mechanically prune vertically-trained UFO orchards. Despite requiring three passes per tree (hedging the east and west sides + topping), mechanical pruning was ca. 20 times more efficient (time/tree) than hand pruning. In addition, we have documented no negative effects of full mechanical pruning on fruit yield and quality in the UFO system. Our partnership with agricultural engineers into novel harvest technologies has revealed great potential to harvest stem-free sweet cherries with excellent quality and efficiencies that are 50-fold greater than hand harvest. We are developing fully mechanical harvest systems as well as mechanical-assist systems that function in a variety of architectures. The successful development of any high efficiency orchard system will depend upon addressing the total system with research at the intersection of biology and technology being key. This presentation will describe a more than decade-long collaboration toward the development of high efficiency sweet cherry production systems and the vision we have for orchards of the future.
Preharvest and postharvest tools to maintain sweet cherry quality at harvest and after storage

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Sweet cherry horticultural production chain consists of several parts: production, picking, cooling, selection, grading, packaging, transport, distribution and consumption. Quality after storage is probably the most important factor affecting consumer’s acceptability, especially for overseas marketing. Sweet cherry fruit is a very perishable commodity, since both the edible part and the stem loose water rapidly as well as decay incidence, which constitutes the main problem for successful transport and marketing. The changes in these quality parameters during postharvest storage lead to reduced shelf life. This work aims to give an updated knowledge about some recent developments with the objective of a better control of postharvest deterioration of sweet cherries. The strategies include pre- and post-harvest applications and some innovative treatments including oxalic acid, salicylic acid, acetylsalicylic acid, methyl jasmonate and methyl salicylate. Apart from quality attributes (colour, firmness, acidity, sugars and weight loss) the effect of these treatments on the content of bioactive compounds (anthocyanins, polyphenols, and carotenoids) and antioxidant properties will be evaluated at harvest and during postharvest storage. Some of these treatments are considered as GRAS and then they can be applied without any restriction at appropriate concentration.
Oral Presentations (OP)
**OP-01**

**Testing of sweet cherry cultivars in Belgium**

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The four main cultivars grown in Belgium are ‘Kordia’, ‘Lapins’ ‘Regina’ and ‘Sweetheart’, but these have some disadvantages. Indicatively, ‘Kordia’ is susceptible to frost, the fruit set of ‘Regina’ is not easy, ‘Lapins’ is susceptible to cracking and ‘Sweetheart’ has a tendency to crack and rot and simultaneously a short harvest window. The assortment would be best completed with the addition of a self-fertile cultivar that is not susceptible to frost and/or cracking. The ideal cultivar should be productive, early or late ripening, low in vigour and have a good fruit quality (firm, large and dark). This study provides information over two screenings, held at pcfruit in Sint-Truiden (Belgium). In the first screening, 3 trees per cultivar grafted on ‘Gisela 5’ were planted, with ‘Kordia’ as a standard. The examined cultivars were assessed for at least 4 production years. The best cultivars from the first screening were planted at a larger scale (second screening) as soon as possible, with the intention of finding solutions to their negative qualities. From the cultivars planted in the first screening since 1999, ‘Skeena’, ‘Hertford’, ‘Samba’, ‘Korvik’ and ‘Grace Star’ have been planted in the second screening at present. With the exception of ‘Skeena’, these cultivars are all situated in the 3rd to 6th week of the harvest season (= first and second decade of July). Other interesting cultivars in the first screening are ‘Poisdel’, ‘Rubin’ and ‘Penny’. From these new cultivars ‘Samba’ ‘Korvik’ and ‘Grace Star’ are already grown on a commercial scale in Belgium.

**OP-02**

**Phenotypic characterization and evaluation of European cherry collections: A survey of used descriptors**

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Standardization of descriptors and protocols is a precondition when aiming to harmonize characterization data records from different collections. The harmonized documentation of the accessions maintained in the European *Prunus* collections is among the most important goals of the *Prunus* Working Group of the European Cooperative Programme for Genetic Resources (ECPGR) network. Over the recent years, the *Prunus* WG has embarked on the initiative of selecting, among the crop-specific descriptors published by International organizations as IPGRI (International Plant Genetic Resources Institute, now Bioversity International) and UPOV (International Union for the Protection of New Varieties of Plants), a subset of descriptors (so-called First Priority Descriptors, FPD) considered most informative, hence to prioritize in the characterization of the European *Prunus* accessions. In the framework of the COST Action FA1104 ‘Sustainable production of high-
quality cherries for the European market’ (https://www.bordeaux.inra.fr/cherry/), a questionnaire was circulated to the COST partners and curators of sweet and sour cherry (P. avium and P. cerasus) collections, aimed to ascertain which descriptors, categories and scales were in use for the evaluation and characterization of cherry in Europe. Based on the answers provided by a total of 22 partners for sweet cherry and 13 for sour/duke cherry, 16 descriptors resulted commonly used by 2/3 of the partners (15 and 14 for sweet and sour/duke cherry, respectively), hence deemed as the most useful to characterize cherry by the majority of curators. The 16 descriptors most used could be proposed for inclusion in the list of the FPD recommended for the characterization of the European sweet and sour Cherry collections.

**OP-03**

**Effects of various gaseous treatments on quality retention and decay incidence during storage and transit of sweet cherries**

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Sweet cherries (Prunus avium L.) are non-climacteric fruit which are harvested fully ripe, when fruit have reached eating quality. Soon after harvest degradation process are very fast leading to consistent loss of marketability in relation to environmental conditions. In fact cherry fruits are highly perishable and not suitable for long term storage; their shelf life is shortened by loss of firmness, discoloration and desiccation of the pedicels, and decay. Maintaining fruit at low temperatures immediately after harvest improves firmness and stem color retention, and reduces decay incidence. In the last years a number of gaseous treatments have been proposed in order to extend commercial life of sweet cherries including modified atmosphere packaging, massive CO2 pre-treatments, 1-MCP, and fumigations with ethanol and/or acetaldehyde. While some of them have presented consistent beneficial effects on reducing decay incidence and maintaining fruit quality for longer time during storage and transit, others have showed only limited or no improvement of fruit storability. The present work will summarize main results of innovative gaseous treatments on quality attributes and decay incidence of sweet cherries during storage and transit and will point out possible best practice for postharvest handling.

**OP-04**

**Mechanical properties of sweet cherry fruit skins**

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The skin of developing sweet cherry (Prunus avium) fruit is subjected to considerable stress and strain. Failure of the skin is associated with impaired barrier properties in water transport. The objectives were (1) to establish a standardised, biaxial tensile test of the fruit skin, (2) to locate its load bearing structure, and (3) to characterise and quantify mechanical properties of two cultivars
of contrasting cracking susceptibility. We chose ‘Regina’ as the less-susceptible and ‘Burlat’ as the more-susceptible cultivar. A segment of the exocarp (ES) was mounted in the elastometer such that the in vivo strain was maintained. The ES was pressurised from the inner surface using silicone oil. This caused the ES to bulge outwards, stretching it biaxially and increasing its surface area. Pressure (p) and biaxial strain (ε) due to bulging were quantified and the modulus of elasticity (E) was calculated. Abrading the cuticle decreased the fracture strain but had no effect on fracture pressure. The skin of ‘Regina’ was stiffer as indexed by a higher E, and had a higher $P_{fracture}$ than that of ‘Burlat’. There was little difference in their fracture strains. Differences in E and $P_{fracture}$ between ‘Regina’ and ‘Burlat’ remained even after destroying their plasma membranes by a freeze/thaw cycle. Microscopy of skin cross-sections revealed no differences in cell size between ‘Regina’ and ‘Burlat’ skins. The results demonstrate that epidermis and hypodermis, but not the cuticle, represent the structural ‘backbone’. Furthermore, cell wall physical and possibly chemical properties account for cultivar differences in skin mechanical properties.

**OP-05**

Cryo-scanning electron microscopy and X-ray microanalysis: a powerful research tool to investigate structural and analytical aspects of plant tissues

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The applications of cryo-scanning electron microscopy of frozen-hydrated samples in plant investigation is reviewed to show how this powerful research tool can help to clarify plant functions and interactions with the environment. Its power to arrest and stabilize plant parts in milliseconds, holding water and soluble components in situ, makes possible the analysis of the soluble elements at cell level and the distinction of gas and liquid containing regions, allowing examination at micrometer resolution. The prevention of the cracking of the fruits is a priority for cherry cultivation worldwide and clarifies the causes that determine it as an important issue for scientific researches. To demonstrated how the spraying of silicon (Si) to the foliage can reduce the cracking of the cherry fruits, with similar extent or greater than that of calcium chloride, Cryo-scanning electronic microscopy (Cryo-SEM) and energy-dispersive X-ray microanalysis (EDXRMA) were used in order to deepen understanding the mechanisms of action of this element and to localize the silicon in the tissues of the fruit sprayed.
**OP-06**

**Update on the North American Regional sweet cherry Canopy Architecture x Rootstock Systems Trials**

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Coordinated intensive sweet cherry orchard system trials planted across North America in 2010 are evaluating four high density canopy architectures combined with three precocious rootstocks of varying vigor levels. The canopy architectures are: 1) KGB (Kym Green Bush), a multiple leader bushy canopy with 8 to 15 upright fruiting leaders; 2) TSA (Tall Spindle Axe), a single leader with 15 to 20+ lateral fruiting branches in a conical canopy; 3) UFO (Upright Fruiting Offshoots), an oblique cordon-like horizontal leader with 8 to 12 upright fruiting leaders aligned in a narrow fruiting wall canopy; and 4) SSA (Super Slender Axe), a single leader with 20 to 30+ short lateral fruiting shoots, planted closely, pruned severely, and aligned to form a narrow fruiting wall canopy. The rootstocks are Gisela 3 (Gi3, dwarfing), Gisela 5 (Gi5, semi-dwarfing), and Gisela 6 (Gi6, semi-vigorous). The scion varieties and trial sites are: ‘Benton’ (Michigan, MI), ‘Regina’ (Geneva New York, NY-G, and Hudson Valley New York, NY-HV), and ‘Skeena’ (British Columbia, BC and Nova Scotia, NS). The most vigorous site is MI, and least vigorous site is NS at about 30% the vigor of MI. Across sites, TSA trees have been most vigorous, followed closely by KGB trees, then UFO trees (about 13% less vigorous), and finally SSA trees. The highest cumulative yields (2013-2015, Years 4-6) have been in BC, about 3X higher than in MI, NY-G, and NY-HV, and 10X higher than in NS. When appropriate tree x row spacing is taken into account, estimated cumulative orchard yields per hectare thus far are highest for UFO trees at three of the five sites, followed by TSA trees. In general, neither canopy architecture nor rootstock has significantly influenced fruit size. Successful renewal of fruiting wood has been influenced by the vigor of the canopy x rootstock combinations.

**OP-07**

**Molecular characterization of old Austrian sweet cherry varieties**

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In the course of three projects on survey and conservation of regional Austrian sweet cherry cultivars some rare old cultivars like ‘Joiser Einsiedekirsche’, ‘Schartner Rainkirsche’, or ‘Sämling von Sauerbrunn’ have been found. A number of other cultivars could not be identified, since their morphologic characteristics differed from descriptions indicated in the literature. The implementation of genetic markers such as microsatellites, also called simple sequence repeats (SSRs), which serve to provide a characteristic genetic fingerprint can help accelerate the process...
of cultivar identification. The European Cooperative Programme for Plant Genetic Resources ECPGR emphasizes a standard set of microsatellite markers and reference accessions so that fingerprints of cherry collections can be harmonized. We report on the genetic fingerprints acquired in order to further characterize the local cultivars as well as the accessions of the BOKU germplasm collection. The ultimate goal is to identify unknown varieties, verify the trueness-to-type of those identified, as well as, to avoid duplicates.

### OP-08 Achievements and tendencies in mahaleb cherry rootstock breeding

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Adaptability of mahaleb cherry to continental climate, tolerance to drought, hot summer, pure soils, high pH and lime tolerance are such rootstock traits that could contribute to improvement of the cherry growing adaptability under those environmental conditions that due to the climate changes are usually forecasted. The diverse rootstock usage in vigor control is the actual situation in the sweet and sour cherry growing. This diverse rootstock usage might be expected for the future too, when training system and rootstock are considered together, matched properly with the vigor of orchard site. There are few clonal rootstocks showing some vigor control to 65-70% of seedlings and medium precocity. Further on the potential in compact or spur type mahalebs, genetic dwarf genotypes or inbred lines are still not fully utilized in mahaleb cherry breeding. Possible interspecific crosses between *P. mahaleb* and other cherry species (*P. avium* and *P. fruticosa* crosses are known yet) also could extend the range of desired growth control and precocity. Traditional seed tree selection resulted in seed tree clone, producing high quality seedlings for sweet- and sour cherry growing but their vigor control and precocity doesn’t meet all the requirements of modern pedestrian orchards. Variability of mahaleb cherry manifested in selected genotypes, inbred lines and potential of interspecific crosses promise progress in those directions that are desired rootstock traits in vigor control, precocity and environmental adaptability.

### OP-09 Application of embryoculture in the breeding of early ripening sweet cherry (*Prunus avium* L.)

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One of the main objectives in the sweet cherry breeding programs in the world and in Bulgaria is the release of early ripening cultivars, bearing large-sized fruits. Since 1985, new methods based on technological advances for in vitro cultivation and micropropagation of sweet cherry embryos of early ripening cultivars were developed and introduced in the Fruitgrowing Institute – Plovdiv. Combining conventional breeding methods with the new opportunities provided
by the novel biotechnological tools, contributed to achieving better results in the programme, expressed in accelerating the process of establishing a better quality F1 hybrid collection of early ripening parent combinations. The use of in vitro embryo culture in the early-harvested cultivars is difficult because of the small embryo size (sometimes reaching 50-75% of seed size at the time of isolation). Our previous studies showed that the type and the concentration of the cytokinins and carbohydrates used were of specific importance for the successful cultivation of smaller-size embryos. More than 100 hybrid plants are successfully grown from embryo culture every year. The first successful results of the breeding program developed through embryo culture in vitro are the very early-harvested cultivar ‘Kossara’ and bicolored light ‘Rosita’ fruits, which were officially acknowledged in Bulgaria during 2008 and 2009, respectively.

**Interspecific hybrids in cherry breeding**

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The loss of genetic diversity in new cherry cultivars over the last decades led to a lower adaptability to changes of growing and climatic conditions. In many fruit breeding programs interspecific hybridizations have been used to increase the genetic diversity and to realise new characteristics in fruit crops. First interspecific crosses of sour cherry with Prunus maackii and P. fruticosa were released by I. V. Michurin in Russia and L. Kerr in Canada in order to increase winter hardness of sour cherries. That happened in the first half of the 20th century. Different interspecific hybridizations and backcrosses were realized in the cherry breeding program at Dresden-Pillnitz. In the last 15 years sweet cherries were crossed with *P. canescens*, *P. tomentosa* and sour cherries with *P. maackii*, *P. spinosa*, *P. padus*, *P. serotina*. The goal of this breeding program has been the realization of genotypes with new fruit and tree characteristics and a higher level of resistance to biotic and abiotic stress. During the last years new cherry genotypes were identified with resistance to cherry leaf spot, Blumeriella jaapii, and high anthocyanins content.

**Pollination and germination methods in cherry breeding - a survey**

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Breeding of new sweet and sour cherry cultivars is a process that relies on strong knowledge of parental plant genotype and phenotype to select appropriate crossing partners. The applied methods used in a breeding process also need to be considered to achieve maximum output with minimum effort. Methods chosen on one hand may depend on the number of crossings made and quantity of progeny produced and on the other hand on the value and importance of
each individual crossing. The higher value, the more intensive methods may be applied to secure offspring. In the EU COST project FA-1104 Sustainable production of high-quality cherries for the European market a survey of the state of art of pollination and germination methods used as part of cherry breeding in European breeding programs and breeding projects has been undertaken to highlight the current status of methods used, the obtained success rates obtained and areas where further improvements may still be obtained. The questionnaire contained 125 questions/answer combinations for each cherry species and 13 countries provided data input. The input covered both data from permanent breeding programs and from temporary breeding projects. For sweet cherry breeding activities were found in Germany, Hungary, Romania, Poland, Serbia, France, United Kingdom, Spain, Italy, Turkey, Bulgaria, Greece, Latvia. For sour cherry breeding activities were found in Germany, Hungary, Serbia, Romania, Turkey, Poland and Denmark. Traditional well documented methods play an important role and more intensive methods are only rarely used when high value and difficult crossings are attempted.

OP-12 How climate change and lack of chilling affect cherry growing in the future

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Sweet cherry (Prunus avium L) trees require 400-1,600 chilling hours depending on the variety and the location. Climate change and global warming poses a major problem in cherry growing worldwide. This is because of insufficient chilling during the winter months, which disrupts flowering of sweet cherry trees.

Indigenous fruit trees have adapted to the local weather conditions over a long period of time. With changing weather conditions, also due to the continuously faster advancing climate change, warm winter can lead to problems in the bloom of high chill fruit trees such as sweet cherries with a high chilling demand in winter. In the valleys of the Cape region in South Africa, in Morocco and in the Provence (France), certain high chill sweet cherries are no longer cultivated. A worldwide survey of chilling development in the future has identified an increase in chilling in the North Europe, whereas a dramatic loss of chilling is predicted from the Mediterranean countries. Orchardists need to know the chilling needs of their fruit trees to plant just for the regional temperature conditions adapted varieties to counteract possible failures. Countermeasures include breeding, defoliation in the autumn, evaporative cooling and shading during winter,dormancy breaking agents and moving to higher elevation. The results of the four-year-study at Klein-Altendorf (University of Bonn, Germany 50°N) using 160 potted sweet cherry trees with three different chilling requirements (500-1,500 CH) under natural diurnal light and temperature conditions showed that the dynamic model appears most suited in describing chilling requirements in sweet cherry at this location.
Overview on usage of rootstocks and scions in the production in Europe

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Numerous sweet and sour (tart) cherry cultivars and rootstocks were released over past decades around the world, but there is no reliable data, how many of them are currently in the production. To collect data on usage of rootstocks and cultivars in the global production, trends of the production and the orchard systems, a questionnaire was sent to COST members and the representatives of the most important cherry producing countries. In the sweet cherry production there is a tendency of planting cultivars with large fruit size and ripening at various times. The countries having mild conditions prefer dwarfing or semi-dwarfing rootstocks (GiSelA 6, GiSelA 5, GiSelA 3) under irrigated conditions, while the usage of semi-vigorous or standard vigor rootstocks (MaxMa 14, Weiroot 158, P. mahaleb and P. avium seedlings) is typical in countries with hot and dry conditions without irrigation. Rate of seedling usage is high especially in Eastern Europe. Interestingly, GiSelA series can be found all over the world; the usage of this series seemingly doesn’t depend on the climate conditions. The sour cherry is the fruit species especially predominant in Eastern Europe. German, Hungarian, Serbian, Sowjet, and US–bred cultivars grafted on vigorous rootstocks dominate in the production. Beside the orchards for mechanical harvest the rate of intensive orchards for hand picking is increasing. This research was fulfilled in the frame of COST FA1104 project and presented in the Chapter 1 of the book with title of “Cherries: Botany Production and Uses” will be published at CABI.

The cherry cultivation and genetic resources in Greece

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In Greece cherries are cultivated in about 11,000 ha with a dynamic increase in planting areas and modern cultivation systems such as dense planting systems and rain or hail protection covers. Greece is the fourth largest producer of cherries in EU and the 12th in the world. Exports are limited to only 10-17% of the cherries produced, with an increasing trend during the recent years. Although orchards or isolated trees can be found all around mainland and even in islands, the epicenters of Greek cherry production are the prefectures of Pella and Imathia (75% of the total area), which are areas with favorable cold conditions and irrigated fertile soils. Since 1970, the Department of Deciduous Fruit Trees in Naoussa, formerly known as Pomology Institute, has had a significant input in the expansion of the cherry cultivation in the above areas. Numerous cherry
European sweet cherry production faces many challenges and high-quality fruits, obtained following sustainable technologies, are the main goals. Not always, the use of dwarfing rootstocks and high density plantings are the best solutions for the sweet cherry orchards, taking in consideration the diversity of environmental conditions in the production areas, high investment cost, farmers limited resources, etc. The parallel Trident canopy was recently studied for most of the stone fruit species in Romania, planted as vertical fruiting walls at 4.0 - 4.5 m between rows and 2.5 - 3.0 m within row. The results registered on sweet cherry varieties grafted on semi-vigorous and semi-dwarfing rootstocks indicated that, Trident is a suitable planting system for the medium density orchards. The new canopy showed multiple advantages as simplicity in formation and maintenance, reduction of planting density and initial investment, increase of productive structure per hectare, division of tree vigour on three growing axes, production of high quality fruits and high and constant yield.

The limited storage life of sweet cherry fruits renders necessary the application of novel technologies to extend their postharvest life. Over the last decade, postharvest treatments such as modified atmosphere were applied in order to reduce the respiration rate of the fruits. Additionally, there are conflicting results regarding the efficacy of 1-methylcyclopropene (1-MCP, an inhibitor of ethylene perception) in the postharvest performance of sweet cherries. In the present study,
commercially harvested “Regina” fruits were treated or not with 1-MCP (SmartFreshTM, 0.5 μL L-1, 24 h, 0oC) and cold stored at 0oC and relative humidity > 90% for a period of 30 days in the presence or in the absence of modified atmosphere bags (MABs). Following cold storage and also after 2 days at room temperature (20 oC, shelf life), fruits were analyzed for various quality traits. During cold storage, fruits exposed to MABs environment displayed lower respiration rate and weight loss compared to the control. Physiological disorders, such as pitting and shrivel were significantly reduced in fruits subjected to MABs. Finally, stem browning and fruit firmness were increased in fruits preserved in MABs. The application of 1-MCP did not appear to affect fruit qualitative attributes irrespectively to MABs application.

On-farm validation of a ‘virtual cherry farm’ concept based on a stochasticsimulation model used as a tool for enhancement of site-specific IPM

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Regulatory pressure for implementation of the Integrated Pest Management in spite of the scarcity of robust IPM methods and dwindling lists of the approved pesticides – jointly - make the fresh fruit production challenging. The problem is most severe in small/medium scale farming systems typical for organic and ‘ecologically-conscious’ non-industrial production, which are typically spatiotemporally complex and where generic IPM protocols are seldom effective without site-specific adaptation. As a remedy, application of a ‘virtual cherry farm’ concept is presented, based on Markov-like stochastic emulation of the on-farm behaviour of R. cerasi. The model represents a ‘bottom-up ethological’ approach focused on behaviour of the ‘primary IPM actors’ - large cohorts of individual insects – operating within seasonally changing mosaics of spatiotemporally complex farming landscape, under the challenge of the local IPM actions. Model parametrization was based on compiled published information about R. cerasi and the results of our auxiliary on-farm experiments. The experiments were conducted on sweet cherry farms located in Austria, Germany and Belgium. For each site, a customised ‘virtual cherry farm’ module was prepared, reflecting spatiotemporal features of the particular experimental farm. Historical farm data about pest monitoring, IPM treatments and fruit infestation were used to specify the
model assumptions and calibrate it further. Finally, for each of the farms, virtual IPM experiments were simulated and the model-generated results were compared with the results of the real experiments conducted on the same farms. The potential and broader applicability of the model and the ‘virtual cherry farm’ approach - were discussed.

**OP-18**

**Analysis of Cherry Virome by Next Generation Sequencing**

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Leaf samples of eight selected cherry trees containing mixed infections of several viruses were collected from symptomatic trees in germplasm collection at the Research and Breeding Institute of Pomology Ltd. and analysed by Next Generation Sequencing (NGS) on Illumina HiSeq 2500 after isolation of total RNA and/or dsRNA. Reasonable parts of genomic sequences were obtained for Cherry leaf roll virus (CLRV), Prunus necrotic ring spot virus (PNRSV), Prune dwarf virus (PDV), Apple chlorotic leaf spot virus (ACLSV), Little cherry virus 1 (LChV1) and Cherry virus A (CVA). Similarly, we identified partial sequences of Cherry necrotic rusty mottle virus - CNRMV, Cherry green ring mottle virus - CGRMV and Little cherry virus 2 - LChV2, not recorded previously in cherry and sour cherry in the Czech Republic, and of a possibly new luteovirus, which sequence is currently completed by RT-PCR. This research was supported by grant LD 14004 and by the infrastructure of the programme CZ.1.05/2.1.00/03.01 16. of the Czech Ministry of Education.

**OP-19**

**Occurrence, identification and characterization of fungi, bacteria, viruses, phytoplasma and pests infesting cherries in Poland – the results of three-year project**

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In years 2014-2016 we conducted national project which aim was to recognize the occurrence of the most important pathogens and pests of cherry trees in Poland. Out of fungal diseases, four species of Monilinia were detected as a causal agents of brown rot of cherries, including M. polystroma as a species found on cherries for the first time in the world. *Colletotrichum acutatum* was recognized as a main species responsible for bitter rot on cherries. The analysis of genetic diversity of fungal pathogens showed intra and interspecies diversity. During the course of study, two new species of pathogenic for cherries bacteria were discovered – Agrobacterium arsenijevicii causing crown gall and *Pseudomonas cerasi* responsible for bacterial canker on
cherries. Additionally rapid and sensitive conventional and real-time PCR based quick and sensitive Real-time PCR based method for detection of *Pseudomonas syringae* pv. morsprunorum was developed. Monitoring of orchards revealed ‘Candidatus Phytoplasma prunorum’ presence in sweet cherries, ‘Ca. *P. asteris*’ in sour cherries and PNRSV in sweet and sour cherries. No correlation between the genetic profile of PNRSV strains, geographical region of their origin and host plant species was found. Investigation on the occurrence of Cacopsylla pruni in cherry orchards as a potential vector of ‘Candidatus Phytoplasma prunorum’ showed that this psyllid occurred occasionally in the surveyed orchards, and phytoplasma was not detected in their bodies.

**Development and implementation of a Location Aware System (LAS) for monitoring and management of the European cherry fruit fly, *Rhagoletis Cerasi* (Diptera: Tephritidae) in commercial orchards in Greece**

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A Location Aware System (LAS) for *Rhagoletis cerasi* monitoring and management was developed and implemented in commercial cherry orchards in central Greece. LAS is based on (a) a network of sensors (adults’ electronic traps and weather conditions sensors), (b) the digitalization of several elements of the orchards and (c) data transmission via a 3G mobile phone network and storage in a personal computer. The above system also includes (d) a Decision Support System (DSS) that employing appropriate algorithms, evaluates both density and spatial components of *R. cerasi* populations and in combination with the prevailing weather conditions determines both the necessity and the mode of insecticidal sprays (covering hot spots only or the entire plot), and (e) a detailed recording and evaluation of the spraying data. A pilot application of the above LAS took place in four commercial cherry orchards. Four similar, conventional (Integrated Pest Management regulated) and three organic cherry orchards were used as controls. Results showed that *R. cerasi* populations were low in both LAS and conventional orchards. In contrast, high adult captures were recorded into organic cherry orchards. The implementation of LAS resulted in a four-fold decrease (on average) of the insecticidal applications against the cherry fly relative to the conventional orchards. Fruit infestation rates were zero in both LAS and conventional orchards while reached ≈12% in the organic ones. We discuss the importance of adopting Location Aware Systems for the management of *R. cerasi* considering reduction of sprayings frequency and biodiversity conservation towards a sustainable cherry production.
Pollen tube growth and early embryogenesis in ‘Oblačinska’ sour cherry

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Due to the long-term cultivation in diverse agro-ecologic conditions and the use of both vegetative and sexual propagation ‘Oblačinska’ sour cherry cultivar, which prevails in Serbian commercial sour cherry orchards, became a mixture of numerous genotypes that have different yielding potential. In biology of fertilization besides the pollen tubes and female tissues interaction that affects reduction of pollen tube number, status of embryo sacs during blooming time is considered as a very important prerequisite for successful fertilization. Therefore, the objective of this study was to monitor the dynamics of pollen tube growth in style and functionality of embryo sacs of four ‘Oblacinka’ sour cherry clones in self- and open pollinations during two years. In all clones, in all parts of the pistil (upper third, lower third and locule), average number of pollen tubes was higher in open pollination in the second year of the experiment. Incompatibility signs (‘balloons’, ‘bifurcation’ and ‘loops’) were observed mostly in upper part of the style, rarely in lower part. Normal embryo sacs (43-47%) were determined in all clones, in both experimental years. In addition to that, some sacs with degenerative malformation and sacs with irregular spatial configuration of its individual elements were also noticed. Even the emergence of “twin” nucellus with two embryo sacs within the same integuments (3.9-20.0%) were noticed, but in only two clones. In both experimental years number of formed embryos was higher in open pollination (42.3-64.3% in first and 42.3-67.9% in the second) compared to the self pollination (23.1-27.6% and 26.9-44.0%, respectively).

Metabolite control of flowering time in sweet cherry

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Dormancy is the ability of perennial plants to suspend growth in response to environmental conditions. It is well known how flowering is regulated on the genetic level in annual plants, but the transition from dormancy to flowering in perennial plants like sweet cherry (Prunus avium) is still poorly understood. More than 40 million tons of stone fruit from Prunus spp. are going to be threatened over the next years, as global warming is progressing and the necessary winter chill is decreasing. Hence, the ability to control dormancy release and flowering in perennial plants is
extremely desirable. We aim at elucidating the role of metabolites involved in breaking dormancy and flowering in sweet cherry. In the past, different cyanide-based products (e.g. Dormex®, AlzChem, Germany) have been used in agriculture to compensate for missing winter chill and to advance flowering, suggesting cyanide as a key player in dormancy release. Interestingly, cyanogenic glucosides, which constitute one component in an ancient plant defense system, are also known to release cyanide. The cyanogenic glucoside prunasin is present in flower buds of Prunus plants. Cyanide-based inhibition of antioxidant enzymes like catalase leads to increasing ROS levels, which are known to be important messengers in various cellular processes. When dormant sweet cherry flower buds were treated with Dormex®, dormancy was released in treated buds three days earlier compared to controls. Prunasin levels were analyzed by LC-MS in these samples over the course of 18 days from dormancy to flowering. A differential expression analysis between treated and control samples revealed promising genes candidates for flowering time in fruit trees.

A European network for cherry phenology

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In the context of climate change, interest in phenology studies has been renewed. In particular, shifting phenologies with warming have been widely documented and these data represent a valuable asset for developing predictive models. Phenology data for sweet and sour cherry have been recorded for decades across Europe. Researchers involved in phenology studies within COST Action FA 1104 gathered in April 2014 in Ullensvang (Norway) and a phenology network was initiated to share and exploit existing data. We will present a proposition of homogenized phenology observations across Europe on reference cultivars for future multisites analyses. In addition, in order to better understand flowering response to environmental conditions, a global statistical analysis was conducted on a large dataset for sweet cherry flowering dates collected in the phenology network. Based on PLS (Partial Least Square) regressions, this study allowed the identification of critical times of the year when temperatures have a significant effect on flowering dates. Results should improve the precision of phenological modelling approaches.
High density training systems

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In France, cherry trees are usually trained to an open vase system. Other training systems of cherry are also possible. They allow a more rapid fruit set and make pruning and harvest easier. The arrival of new rootstocks has made these training systems easier, namely, the single axe, biaxe, triaxe, fruiting wall and UFO. The choice between these different systems will depend on the expected development of the soil/cultivar/rootstock combination. The greater the vigour, the more axes are needed to divide the growth and limit the development of the trees as far as height and width are concerned. Protection of the trees from insects and rain can also be considered.

Fruiting wall

We have conducted four trials since 2001. Eight varieties with different growth habits, grafted on Tabel®Edabriz (2001-2014). Four varieties were grafted on Maxma 14 (2007-2014). Two varieties were grafted on two rootstocks (Gisela 6, Weiroot 158). These two last trials are in progress.

Axis, bi and triaxis, palmette

For the past 7 years we have tried these training systems with numerous varieties and rootstocks. The hedgerow is quite flat by removing the branches which are perpendicularly to the row.

UFO

One trial has been set up for 2 years in order to determine the varieties that are well adapted to this training system.

Sweet cherry R&D in a Nordic climate

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Sweet cherries can be grown in Norway in areas with suitable local climatic conditions up to 60°N. High density orchards with rain covers are most common, and are the result of long term research at NIBIO Ullensvang. Numerous projects on all aspects of cherry growing have resulted in an economically viable industry. Rain-induced fruit cracking in cherries remains a problem at an international level. The most common systems in Norway are Haygrove multibay tunnel systems and retractable rain covers that must be drawn over the trees manually before rainfall events. Covered orchard tunnel systems offer not only the advantage of rain exclusion but also allow additional manipulation of the environment, tree growth and fruiting. More than 50 cultivars from different breeding programmes world-wide are currently evaluated under tunnel cover. Bumble bees are tested to increase pollination and fruit set. Tunnel covers with different light spectral transmittance; bioregulators, water and nutrition supply all aiming to produce a large crop of high quality fruits are tested. In general, sweet cherry high tunnel production gives
increased yields of larger fruit than in the open land, but investment costs are higher. As a result the acreage of sweet cherry production in tunnels is increasing in Norway. Postharvest quality and methods to improve fruit quality with different storage methods and packaging are tested in cooperation with the packinghouses. In the northern climate, bacterial canker is an important disease and is currently under research in cooperation with the nurseries and industry.

**OP-26**  
**Micropropagation of sweet cherry cultivars**

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The aim of this study was to identify the possibility of micropropagation of two Czech sweet cherry cultivars ‘Karesova’ and ‘Amid’. The use of tissue culture techniques constitutes an important tool for quick multiplication of requested cultivars and also the opportunity to improve the health status of micropropagated plants by combining in vitro culture with chemo or thermotherapy followed by in vitro rooting. Selected two genotypes were successfully established in vitro using mercuric chloride in a concentration of 0.15% as a sterilization solution. Cytokinin activity of BAP, TDZ (thidiazuron) and 2iP (6-(g,g-dimethylallylamino purine) was tested in the multiplication phase. The following growth regulator concentrations were evaluated for multiple shoot induction: BAP (1, 2 and 4 mg L⁻¹), TDZ (0.5 and 1 mg L⁻¹), 2iP (10 mg L⁻¹). Values of proliferation rate were relatively low and varied between 1.1 and 2.1. BAP at concentration 4 mg L⁻¹ was found to be more effective than TDZ and 2iP for shoot multiplication. Rooting of both cultivars was promoted on MS medium supplied with 1 mg L⁻¹ NAA (naphthaleneacetic acid). Root initiation started within 2 weeks. The root induction was relatively low from 45% for ‘Karesova’ and 28% for ‘Amid’. In conclusion, achieved multiplication and rooting rates were sufficient for in vitro culture establishment, short-term maintenance and in vitro chemotherapy. But these relatively lower rates are not satisfactory for larger in vitro production of plants of studied sweet cherry cultivars in a commercial scale.

**OP-27**  
**Historic sweet cherry cultivars**

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The area of the present Czech Republic was rich in fruit crops in the last centuries. A considerable amount of sweet cherry cultivars had been cultivated until the beginning of the 20th century. There were local cultivars of sweet cherry, which were distributed and typical for certain areas. These landraces were well adapted to the soil-climatic conditions of a particular region. Because of the possible extinction of these indigenous landraces, the programme for collecting and long term conservation of fruit genetic resources on the territory of the Czech Republic has
been carried out. Rescue of sweet cherry landraces, which formed a part of this programme, is described in this presentation. Collecting expeditions were directed to the areas not influenced by the intensive agricultural production and recreational expansion. Important accessions were localized by Global Positioning System (GPS) and in situ registered. Found sweet cherry landraces showed a high variation in tree size, productivity, ripening time, fruit size, fruit quality and disease resistance. The most important sweet cherry landraces are characterised.

OP-28

Pitting in cherry can be induced by hitting and is enhanced by low temperature

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Storage of cherry is necessary to extend the supply period. However, development of pitting in cherry curtails the storage capacity of this high value crop. In this study we characterized pit formation of several commercial cultivars and showed variability in their sensitivity to pitting and that pitting increases during storage in all cultivars. Pitting can be induced by a mild hit that does not damage the skin and it causes a temporary increase in ion leakage. Since storage of cherry is associated with stresses of low temperature exposure and dehydration leading to weight loss, we examined the contribution of these stresses to pit formation. The contribution of weight loss to pit formation is very limited, while, the exposure to low temperature was more prominent in its contribution to pit formation during storage. Our results show that bruising and low temperature are the main stresses that cause pit formation in cherry during storage, nevertheless the underlying process remains obscure.

OP-29

Intensive cherry production: Bulgarian approaches and implications for further research

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There is general agreement on the necessity of intensification in sweet cherry production based on dwarfing and productive rootstocks. On the other side, results of many studies on the today available dwarfing rootstocks point out their poor performance in relatively dry conditions and on poor and light soils. We also have carried out, for 15 years, an experiment with nine cultivars grafted on the ‘Gisela 5’ rootstock and supplied with water and mineral nutrients through a microirrigation system. Our results and the perusal of the available literature cogently show that real intensification of the cherry production is possible right now, provided the extremely
high requirements concerning pruning, water regime and mineral nutrition of intensively grown
trees are properly met. Still, this statement needs to be verified under different and site-specific
ecological conditions, stages of the trees' development, and scion/rootstock combination.
For that purpose our cherry community could organize a common project, in which dwarfing
rootstocks, microirrigation and fertigation will be indispensable. Teams of scientists with diverse,
complementary expertise are preferable as well.

The New “Sweet Series” Cherry Varieties
from the University of Bologna

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The «Sweet Series» is a bundle of new cherry varieties bred by S. Lugli, R. Correale, Mi. Grandi
of the Department of Agricultural Sciences of the University of Bologna (UNIBO). The breeding
process began in 2000 and it was specifically targeted to develop six-seven cultivars capable of
covering a long 30/40-day picking arc and incorporating a ‘maximizing’ common denominator
of high qualitative features: from high field and cropping performances to excellent fruit quality
and appearance. The programme involves a public-private partnership coordinated by CRPV
(Centro Ricerche Produzioni Vegetali) in Cesena with funding provided by UNIBO and the Emilia-
Romagna regional authority in the public sector and in the private by New Plant (grouping Apo
Conerpo, Apofruit and Orogel Fresco) and by the non-profit Vignola Foundation. The breeding
stages of parental selection and initial crosses (Stage 1) were followed by a seedling selection
process (Stage 2) under strict threshold screening parameters, i.e. ≥ 28 mm minimum size, 4-6
CTIFL scale skin colour, ≈ 60 Durofel index, ≈ 18 °Brix sugar content, and 7-8 g/l acidity. In 2004,
from the initial 3000 seedlings 13 candidates were selected to be further tested directly in pre-
commercial test fields (Stage 3) set up in 2008; five best-performing candidates were chosen for
release in 2012 and the last one in 2015. Through the activity of the Knowledge Transfer Office
(KTO) of UNIBO the Sweet Series have been protected at European level by different intellectual
property rights: six applications for the grant of community plant variety rights (*) and six
associated trademarks (®) have been filed as follows: Sweet Aryana® PA1UNIBO*, Sweet Lorenz®
PA2UNIBO*, Sweet Gabriel® PA3UNIBO*, Sweet Valina® PA4UNIBO*, Sweet Saretta® PA5UNIBO*
and Sweet Stephany® PA7UNIBO®. The KTO has been involving in the exploitation of the Sweet
Series, by means of specific license agreements with different European business partners able
to propagate and market these varieties, thus enabling the Sweet Series to reach European final
consumers.
Poster Presentations (PP)
Antioxidant capacity and polyphenol content were quantified in vapour-extracted juice of nine Austrian, partially endemic sweet cherry (Prunus avium) cultivars: ‘Spätbraune von Purbach’, ‘Early Rivers’, ‘Joiser Einsiedekirsche’, ‘Große Schwarze Knorpelkirsche’ and four unidentified local varieties. Additionally, the effect of storage (one month at room temperature in green glass bottles) was evaluated for ‘Early Rivers’, ‘Joiser Einsiedekirsche’, ‘Große Schwarze Knorpelkirsche’ and three local varieties. One unidentified variety showed the highest antioxidant capacity (2,2-Diphenyl-1-pikryl-hydrozyl-assay, 9.64 µmol Trolox equivalents per mL), total polyphenols (HPLC, 2747 mg cyanidin 3-glucoside equivalents per L juice) and total cyanidins (1085 mg cyanidinchloride equivalents per L juice) was suitable for mechanical harvest and its juice did not show any losses of antioxidant capacity and total anthocyanin concentration during storage. The juice of ‘Große Schwarze Knorpelkirsche’ fruits had also high concentrations of total cyanidins (873 mg cyanidin-chloride equivalents per L juice), but showed substantial losses throughout the storage period. Overall, the local Austrian sweet cherry varieties from the Pannonian climate zone appear to be particularly suitable for the production of processed products like cherry juice with high anthocyanins and polyphenols contents.

Impact of Plant distance and Rootstock to Growth and Yield of the Sweet Cherry (Prunus avium L.) cultivar Regina in Eastern Austria

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In a seven year field trial (2006-2012) in the research orchard of the University in Vienna the influence of different planting distance (1.5, 2 and 2.5 m) in the row in combination with the two rootstocks ‘Gisela 3’ and ‘Weiroot 72’ on growth and yield parameters of the sweet cherry cultivar, Regina’ was investigated. The rootstocks as well as the planting affected significantly trees’ performance. After three years the trees on ‘Weiroot 72’ were more vigorous than on ‘Gisela 3’, whereas no differences were observed in regard to the planting distance. The closer planted trees had higher yield per hectare than those planted with wider space. In the total of the studying
experimental period the single tree yield on both rootstocks was similar and it was dependent on the growth being higher at the more dwarf ‘Gisela 3’ rootstock. The fruit weight was not affected by the planting distance, however, the fruits from the more vigorously grown ‘Weiroot 72’ were of higher size than those from ‘Gisela 3’. Calculating yield and price depending on fruit size ‘Weiroot 72’ on 2 and 1.5 m distance were economically the most efficient variants in our trial.

Monitoring adult cherry fruit flight fly in two regions of Bosnia and Herzegovina

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The European cherry fruit fly (Rhagoletis cerasi L.) is among the most important pest of sweet and sour cherries. In most cherry growing regions control is based on insecticides. The successful application of insecticides depends on thorough knowledge of the pest life cycle. To adopt an organic control strategy entomopathogenic nematodes and botanical insecticide azadiractin may be required. High costs of these products require more precise application towards decreasing the number of applications and their cost. To have precise application life cycle characteristics of target pest in production region should be known. The aim of this study was to monitor adult R. cerasi population dynamics in two main cherry production regions in BiH: in the south near the city of Mostar and on the very north of the country near Gradi ka city. Yellow sticky panels, which were checked weekly, have been used. The flight duration in both areas was estimated and a predictive temperature model has been developed. In Gradi ka flight started on 10th of May and lasted until 29th of June. Maximum flight was recorded in week of 8th of June. First adult appeared after accumulated 347 degree days above a threshold of 7 °C starting from 1 January. Results of this study will reveal which cultivars are not or less affected due to their earlier ripening and time of the most successful application of biological control agents.

Morphometric characteristics of sweet cherry grown in the northwest part of Bosnia

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Traditionally sweet cherry production in Bosnia and Herzegovina has the greatest economic importance in the southeastern part of the country. This region is characterized by modified Mediterranean climate that is favorable for sweet cherry cultivation and earlier fruit ripening. Recently, sweet cherry cultivation got increasing importance in fruit production in the north part of B&H. The selection of appropriate cultivar suitable for this growing conditions is a huge
challenge for fruit growers. The aim of this study was to analyze morphometric characteristics of actual sweet cherry cultivars grown in the area of north-west Bosnia. The orchard established in 2007 belongs to private company "Agroimpex". All cultivars were grafted on rootstock Gisela 5 and trained in the Vogel spindle system. Planting distance was 4×2 m. Over a three year period (2010-2012) were analyzed basic morphometric characteristics of sweet cherry fruit (weight and dimension of fruit and stone, stalk length, content of soluble solids). For each variety 30 randomly selected fruit were analyzed. Cultivar Burlat was used as a standard during the research period. The study reveals the significance of the cultivar specificity in the characteristics of the analyzed fruit, with a significant impact of the year during the research period. The smallest fruit weight was observed in Blaze Star cultivar (4.89 g), while the cultivar Samba had the biggest fruit (9.18 g). Favorable and uniform characteristics of fruit during the study were observed for the cultivars Summit, Samba, Van and Regina.

**PP-5 Optimization of rooting of sweet cherry hybrids (Prunus avium L.) in vitro**

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Rooting in vitro is considered the main problem in micropropagation of woody fruit and ornamental species. The aim of the present study was to investigate the possibility to improve the rooting of sweet cherry plantlets by a new plant growth stimulator of natural origin Charkor (Agrobiotech, Ukraina). It is a product of biotechnological cultivation of fungi-epiphytes from ginseng roots and contains a balanced complex of phytohormone analogues of natural auxin and cytokinin, amino acids, carbohydrates, fatty acids, trace substances. The investigation was conducted with micropropagated sweet cherry plantlets. Single elongated microshoots (3 cm) were placed on rooting medium. Three concentrations of Charkor (0.1, 0.3 or 0.5 ml l-1) were tested. The same medium with addition of 1.48 µM IBA and a hormone-free medium served as controls. Plants were kept in growth chamber under 16h photo period (fluorescent tubes OSRAM 40 W, 150 µmol m-2 s-1 PPFD) at 22±2°C. Data on rooting percent, mean number of roots per plant, root length rate were collected after 30 days on the corresponding rooting medium. All treatments with Charkor led to higher rooting percentage with more roots per plant and good acclimatization and survival rate. The highest rooting percent in vitro (88.6%) with more than 6 roots per plant was achieved on the rooting medium with 0.5 ml l-1 Charkor.
Croatia is divided into three Climatic regions: continental (in Pannonian Plains), alpine (mountainous Dinara) and Mediterranean (Adriatic coast). The main region of sweet cherry production in Croatia is placed in Mediterranean part where the most favourable conditions for growth and fruit development exist. In this research four promising cultivars of sweet cherries (‘Van’, ‘Lambert’, ‘Hedelfinger’ and ‘Sunburst’) planted in year 2008 on location Sibinj (155 m.a.s.l.) near Slavonski Brod (Brodsko-posavska County) in continental part of country were included. The sweet cherry fruits were harvested at full maturity stage in year 2013 and were analysed for some physical (dimensions, weights and colour) and chemical (total soluble solid – TSS, titratable acidity – TA and ratio of TSS/TA) fruit properties. In our study, we determined some differences among cultivars regarding their physical and chemical properties. ‘Sunburst’ fruits showed significantly highest values of fruit weight (6.80 g), dimensions (height 20.5 mm, width 23.7 mm and thickness 20.6) and ratio of TSS/TA (34.81). The length of the fruit stalk is an important parameter for determination of sweet cherry fruit quality. The longest fruit stalk value was measured in ‘Hedelfinger’ (38.4 mm). Cultivar ‘Hedelfinger’ had the highest values of TSS (16.25%) and TA (0.82 %). Obtained results point that in our agro-ecological conditions cultivar ‘Sunburst’ showed the most appreciable quality properties.

We give an overview of the first written traces of cherry varieties in the oldest available literature of pomology in Croatia, dating from the period which begins in the first half of 19th century when the cherry varieties are mentioned for the first time, till the recent years. We also connect data from old literature with the results of our recent research on molecular identification of local varieties using microsatellite markers, and detection of their S-allele constitution. We have also found out that several local varieties from the region are synonyms among themselves, and which international varieties might be their synonyms. We explain their economic value, potential and perspective as a traditional agricultural product important for rural sustainability. Several local sweet cherry varieties known in Croatia are produced in limited geographic areas. These varieties, as well as several other varieties from the other countries in the region (Macedonia, Slovenia) are
named according to toponyms of the region of their production (village, mountain or island),
or according to several saint’s days around which their fruits ripen. Such way of naming is, in
linguistic way, a consequence of limiting communication and trading channels through which the
planting material was spread and fruits traded during the last centuries. Such way of spreading
implies the possibility that some of these varieties occurred to be synonyms as a result of non-
controlled introduction a hundred and more years ago.

**PP-8** Identification of phytoplasmas infecting sour and sweet cherry trees in the Czech Republic

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Phytoplasmas, ‘Candidatus Phytoplasma’, are cell-wall-less prokaryotes that parasitize plants and
insects. They are associated with diseases of several hundreds of plant species, including many
economically important food, vegetable, and fruit crops, ornamental plants, timber and shade trees.
Phytoplasmas in fruit trees cause economic losses in many parts of Europe including apples, pears
and various stone fruits. Survey for phytoplasma diseases was conducted in sour and sweet cherry
orchards, germplasm collection as well as in wild growing cherry trees in the Czech Republic during
2014-2015. Samples were collected from trees resembling symptoms of phytoplasma and/or virus
diseases. Phloem tissue and leaf midribs were used for total DNA extraction. Nested PCR assays and
sequence analyses of different genetic loci showed presence of phytoplasmas belonging to two
different ribosomal subgroups: 16SrI-B (‘Candidatus Phytoplasma asteris’) and 16SrX-A (‘Ca. P. mali’).
Various terms of samples collection, DNA isolation methods, numerous combinations of PCR primers
as well as difficulties with phytoplasma detection (presence of non-specific PCR amplifications)
have been evaluated. Sequence variability of phytoplasma strains infecting cherry trees in the
Czech Republic is under investigation. This research was supported by grant LD 14004 and by the
infrastructure of the programme CZ.1.05/2.1.00/03.0116. of the Czech Ministry of Education.

**PP-9** Bakirtzeika cherries: variability due to genetic, climatic and cultivation differences

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Bakirtzeika cherries are a Greek cultivar with high-quality export-oriented fruit cultivated widely
in northern Greece (mainly central Macedonia). In an effort to collect genetic material as elite
propagation material, we studied 4-5 trees per orchard in 6 commercial orchards at different areas, various altitudes and with variable cultural practices, but with similar yield (around 10 tn/ha). At around 250 m altitude three orchards were studied: Rachi (RA), cup-shaped irrigated well-spaced; Giannakochori (GI), slender-spindle irrigated under hail-nets; Filoteia (FI), cup-shaped dense planting. At around 750 m altitude two orchards were studied: Sarkiniotika (SA) and Arhaggeli (AR), both cup-shaped well-spaced dry-cultivated. At around 1000 m altitude one orchard (Soupotar, SO) with large sphere-shaped dry-cultivated trees was studied. The genetic distances between the studied trees and orchards showed that SO and SA orchards formed a cluster, RA orchard was more differentiated from them and the other three orchards (GI, FI and AR) were grouped in a distinct cluster. Based on the UPOV shoot, leaf and fruit analyses, and various other objective leaf and fruit analyses, in some characteristics the grouping of GI and FI orchards compared to the rest were related to their close genetic heritance, but most of the parameters studied must have been influenced from the altitude, shade (due to hail-net and dense planting) and irrigation.

**PP-10**

**Clonal diversity characterization of Latvian sour cherry landrace ‘latvijas zemais’**

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Sour cherry is a traditional crop in Latvia where extensive knowledge exists about cultivation, cultivar introduction and testing as well as collection, characterization and evaluation of genetic resources. The most widely grown and most important sour cherry cultivar in Latvia is landrace ‘Latvijas Zemais’ due to its adaptability to local climate with large fluctuations of air temperature during winter. Typical characteristics of ‘Latvijas Zemais’ are - low or medium vigour, weeping habit, bar wood formation, dark red fruit skin and fruit flesh. However, essential variability of other fruit traits and productivity is observed among the clones. The aim of the investigation was the characterization of genetic diversity of sour cherry ‘Latvijas Zemais’ by genotyping and phenotyping of several fruit traits. The genotyping was performed on 25 clones of the landrace, using 24 SSR (microsatellite) markers, which all generated amplification fragments. The average number of alleles per marker was 5.75, from 2 (UDP96-005) to 9 (BPPCT037, CPPCT6), only locus EMPAO26 locus showed monomorphic band pattern. Results allowed discriminating all tested clones, except for two: ‘Latvijas Zemais’ clone’s No. 22 and 62. The phenotyping was conducted for 24 the most healthy and productive clones. Fruit mass, soluble solid content (SSC), proportion of fruit flesh (PFF) and stem retention force (SRT) was determined. Fruit mass varied from 2.8 to 6.6 g, SSC - from 12.0 to 19.5 Brixo, PFF - from 68.5 to 94.9% and SRT – from 0.7 to 3.4 N.
Monilinia species causing brown rot of cherries in Poland and their phylogenetic relationship

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In order to determine the presence and distribution of Monilinia spp. on sour and sweet cherry fruit in Poland, surveys in 57 commercial orchards, where brown rot was observed, were carried out from 2013 to 2015. Total of 796 isolates were collected. On the basis of morphological characteristics and molecular identification, 409 from them were classified to M. laxa, 306 to M. fructigena, 57 to M. fructicola and 24 to M. polystroma species. M. laxa and M. fructigena were detected in all surveyed orchards. All of M. fructicola and most of M. polystroma isolates were found in central and south-east parts of the country. Additionally, four M. polystroma isolates were derived from sour cherry fruit originating from Wielkopolska region.

In total, 20 isolates representing four Monilinia species were used for phylogenetic analysis. Based on DNA sequences of fragments of genes coding: heat shock protein 60 (HSP60), ß-tubulin (TUB2), zinc finger transcription factor (PAC1) and 14 alpha-demethylase (CYP51) the phylogenetic tree was constructed. Dendrogram obtained on the basis of concatenated sequences of four genes showed that Monilinia spp. isolates were grouped according to their species classification and they formed four distinct monophyletic groups. Groups of M. polystroma, M. fructigena and M. laxa isolates were clustered together in one larger clade, while M. fructicola isolates were clustered separately. Phylogenetic analysis indicated that M. polystroma and M. fructigena isolates were the most similar (sequence similarity > 98%).

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Cherries from Romanian research fruit growing

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In Romania, cherries are grown on an area of 7,761 ha (Statistical Yearbook 2014) of which about 53% is sweet cherry, 45% is sour cherry and about 2% is bitter cherry. However, 58% of orchards’ surface is in decline or over 25 years old. Nowadays, it is ongoing a program for renewing local fruit growing. The Research Station for Fruit Growing, Iasi is located in the North-Eastern part of Romania while Research Institute for Fruit Growing, Pitesti is located in the South part of Romania, both having a major influence in the commercial cherries growing by offering specific research results and providing certified propagating material for farmers. This study presents a synthesized overview of the ten more spread cultivars in the area. Sweet cherry cultivars as
Sour cherry cultivars as ‘Stelar’ (‘Mocanesti 16’ × ‘Anglaise Hative’), ‘Rival’ (‘Griot Moscovski’ × ‘Nana’) and ‘Botoşani’ (local selection) are very spread in Romania. Bitter cherry cultivars are used as an excellent raw material for processing as jam or alcoholic drinks. ‘Amaris’ and ‘Special’ are new cultivars approved by RSFG Iasi and RIFG Pitesti, respectively.

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**Evaluation of fruit mineral content in Oblacinska sour cherry clones**

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Fruits are generally acceptable as good source of nutrients and they are known to be excellent source of minerals. Since Oblacinska sour cherry is well known as a mixture of different clones with large variation in numerous traits, the aim of this study was to analyze fruit mineral content (Al, B, Ca, Cu, Fe, K, Li, Mg, Mn, Mo, Na, P, S, Se and Zn) of 39 ‘Oblacinska’ sour cherry accessions. Samples of frozen fruits were prepared by microwave digestion using an Ethos 1 microwave system. One gram of berry sample, 1.0 mL of 30% H₂O₂, and 7.0 mL of concentrated ultrapure HNO₃ were mixed and transferred into the microwave digestion vessel. After, the sample was cooled and diluted to 25 mL with ultrapure H₂O. All analyses were performed on a Thermo Scientific iCAP 6500 Duo ICP. Among all examined minerals, results showed that potassium was found in large quantity in all clones, which average amount was ~1 g kg⁻¹ of frozen weight. Phosphorus was on the second place with its average of ~0.25 g kg⁻¹ of frozen weight, while calcium was on the third with ca. 0.16 g kg⁻¹ FW. The mineral profile was clone depended and decreased in order: K>P>Ca>Mg>S>Fe>Na>B>Mn>Zn>Cu>Al>Li>Se>Mo. The analyzed elements in sour cherry fruits confirmed its high nutrient storage capacity which pronounces it as fruit species with potentially significant health benefits.
Crown gall caused by tumorigenic agrobacteria is a widespread bacterial disease that may cause significant economic losses in cherry nurseries and orchards worldwide. Plasmids are important genetic elements of agrobacteria that may carry pathogenetically and environmentally relevant traits. We sequenced and characterized plasmids from two tumorigenic and one non-pathogenic *Rhizobium rhizogenes* strains isolated from the same gall on ‘Colt’ cherry rootstock. The strains contained from 4 to 5 circular plasmids whose size and GC content ranged from 33,094 to 218,413 bp, and 55.7% and 59.2%, respectively. Unlike the smallest plasmid whose replication genes were similar to those of pAgK84 of *R. rhizogenes* strain K84, the rest of plasmids belonged to the repABC family. Phylogenetic analysis indicated diversity among repABC proteins that may be due to their different origins. Based on phylogenetic analysis of relaxase proteins, plasmids were grouped in the mobilization (MOB) families MOBQ and MOBP. Majority of plasmids possessed genes encoding type IV secretion system and were grouped into MPFT family based on phylogenetic analysis of VirB4 mating pair formation (MPF) protein. Two tumorigenic strains harbored almost identical tumor-inducing (Ti) plasmid (3 SNPs), which were classified as nopaline-type and showed high similarity to Ti plasmid of strain *Agrobacterium* sp. C58. Non-pathogenic strain harbored plasmid containing genes for opine catabolism similar to pAtK84b of *R. rhizogenes* strain K84. In addition, most of the plasmids analyzed carried genes associated with processing and metabolism of various substrates, which most likely contribute to bacterial fitness and competitiveness. The work was conducted in the frame of STSM of COST FA1104 and financed by National Science Centre, Poland grant No. DEC-2013/08/M/NZ9/00138.
The paper presents the most important results obtained at FRI in the field of pollination and fertilization of cherries – flowering phenology, pollen quality, monitoring the pollen tube growth in vivo (pollen tube number and growth rate through certain pistil parts, pollen-pistil interaction in the style, unusual pollen tube growth in the ovary), cytoembryology (stage of ovule development, viability of ovule and embryo sac, early embryogenesis). Investigations are also focused to specificities of cherry genotypes in their reproductive behaviour as polleniser/pollinated cultivar, and to the adequate choice of domestic and foreign cultivars’ combinations that exhibit the best performance in terms of fruit set and yields. Reproductive behaviour is considered in the context of temperature conditions, bearing in mind incidence of seasons with higher temperatures during the flowering in the main cherry-growing regions in Serbia. Research work on self- and cross-(in)compatibility in cherries has been started several decades ago by monitoring fruit set percentage under field conditions, and was later considerably advanced by observing pollen tube growth in the pistil using fluorescence microscopy. In recent years, S-genotyping of domestic and foreign sweet cherry cultivars using the consensus primers that amplify the two introns of S-RNase and allele-specific primers has been also involved.

**PP-16**

**Discrimination between sweet cherry cultivars based on meteorological data**

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Cherry is a fruit species, where time from flowering until harvest is one of the shortest, but meteorological data is important in cultivars’ evaluation anyway. Fruit weight, crop yield, total soluble solids and total acidity have been monitored on an array of cultivars (‘Biggareau Burlat’, ‘Black star’, ‘Grace Star’, ‘Merchant’, ‘Sweet Early’, ‘Vigred’). Meteorological data (minimal, maximal and average daily temperatures, precipitation, hours of solar irradiation and humidity) were averaged over two periods: differentiation phase (June – April) and fruit phase (April – June). As expected, some cultivars correlated with meteorological data better than others. ‘Biggareau Burlat’, ‘Grace Star’ and ‘Sweet Early’ showed very good correlations of the meteorological data in differentiation phase with fruit weight, total acidity and crop yield. In the case of ‘Black Star’ and ‘Grace Star’, a high correlation was observed also for total soluble solids (0.8 for minimal temperature and 0.92 for humidity), which might be great advantage. On the other hand, for ‘Vigred’ all parameters correlated well with the meteorological data in the fruit phase. Statistical analysis (p < 0.05) of correlations between cultivars in the fruit phase reveals no statistically significant differences between cultivars, but in the differentiation phase it does. ‘Merchant’ showed statistically significant differences from ‘Biggareau Burlat’, ‘Grace
Star’ and ‘Vigred’, but there are also statistically significant differences between ‘Biggareau Burlat’ and ‘Sweet Early’ and between ‘Black Star’ and ‘Grace Star’, so they respond differently to our meteorological conditions. Additional research in this direction is needed, but it seems like it could be a useful tool in discriminating cultivars, maybe even predicting their efficiency in local conditions.

**PP-17**

**Yield efficiency of seven sweet cherry cultivars on gisela 5 growing in Slovenian conditions**

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In Agricultural and Forestry Institute of Nova Gorica, in Fruit growing centre of Bilje, we regularly test sweet cherry cultivars with the aim to select the perspective ones and recommend them to fruit growers. Yield efficiency, expressed as a ratio between cumulative yield and trunk cross section area (TCSA), is one of the main characteristics which shows the production potential of the cultivar. Six sweet cherry cultivars of foreign origin (Early Bigi, Sweet Early, Biggareau Burlat, Merchant, Grace Star, Black Star) and one Slovenian cultivar Vigred, all grafted on Gisela 5, were planted in 2008. Yield per tree and trunk diameter were measured annually. The most vigorous were the trees of Grace Star and Black Star, with more than 100% higher TCSA than trees of other cultivars. They showed also significantly higher cumulative yield. On the other hand, yield efficiency (kg/cm²) was similar to other cultivars with the exception of Early Bigi. In this case also tree vigor is important information that must be considered when deciding on plantation.

**PP-18**

**Identification of sweet cherry (Prunus avium L.) cultivars by the ECPGR molecular markers**

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In order to determine the varieties with a better agronomic performance in the semiarid conditions of the Southeast of Spain, a germplasm collection of sweet cherries was studied for several years. The collections are composed by 77 cultivars with diverse origins: France, USA, Italy, Hungary and Spain. The phenotypic study is crucial to verify the genetic identity to avoid mistakes. The markers selected to develop this study were microsatellites (SSR) because their results could be compared between laboratories. A set of twelve markers recommended by the ECPGR were selected. The DNA was extracted from young leaves taken in spring and two
multiplex-PCRs were made with the Type-it Microsatellite PCR kit (Qiagen), one reaction with four markers and other with eight. The results were analyzed with GeneAlex, Polulations and TreeView to generate a UPGMA dendrogram. The twelve markers were not enough to differ between all the varieties under study. We could not discriminate 14 cultivars. ‘Cristobalina’ was the most different cultivar and appeared separated from the rest. Three additional big groups were created, the first one included the earliest ripening cultivars while the biggest group, had cultivars mainly from the USA. The last group was formed by 8 cultivars, some of them from Hungary. The analysis of the markers revealed that the marker EMPa002 was the less informative whereas the markers EMPaS10 and BPPCT037 amplified eight alleles and generated fifteen and twelve genotypes, respectively. Despite of we could not differ all varieties we need to enlarge the number of markers.

**PP-19**

**S-locus diversity of sweet cherry varieties from Galicia, North Western Spain**

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Prunus avium is a native tree in Europe. Different environmental conditions have allowed the selection of ecotypes adapted to different regions. In Spain marked environmental conditions are found between the eastern regions, under Mediterranean influence, and the north and north Western areas near the Atlantic Ocean coasts. While several works have investigated the genetic diversity and the S-locus of local sweet cherry varieties from different areas from Spain, to our knowledge, no previous work has studied local plant material from Galicia (North Western Spain). In this work, a group of local sweet cherry varieties from Galicia have been initially investigated to study the diversity at the S-locus and to establish their genetic cross-compatibility. S-locus genotyping was carried out by PCR, analysing the S-locus genes, S-RNase and SFB. This information was used to assign each variety to their corresponding incompatibility group (IG). Differences in the identity and frequency of the S-haplotypes identified were observed when compared to most cultivated sweet cherry and local sweet cherry varieties from other regions of Spain. Further studies are in progress to complete their molecular and morphological characterization in order to assess their interest for breeding.
Evaluation of the total phenolic content and total anthocyanins of different sweet cherry breeding progenies

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It is known that sweet cherries are one of the most appreciated fruits by consumers, not only for their good organoleptic characteristics, but also for their functional characteristics. Among the latter, cherries have provided several studies because of the high levels of bioactive compounds present in them such as melatonin, serotonin, phenolic acids and several flavonoid groups including anthocyanins, flavonols and flavan-3-ols. This fact has led breeders to consider bioactive compounds as interesting targets in breeding programs. For this reason, in our sweet cherry breeding program carried out at Scientific and Technological Research Centre of Extremadura (CICYTEX) was established the aim of obtaining new progenies with high functional value. Therefore, this study was designed to screen and compared 76 seedlings coming from the breeding cross between ‘Pico Negro’ × ‘Hudson’ by measuring their content of total phenolics and total anthocyanins. The findings obtained confirmed the importance of genotype on the availability of bioactive compounds of sweet cherry fruits due to a high variability found in the progenies evaluated, ranging from 86.39 mg of gallic acid equivalents (GAE) per 100 g of fresh weight (FW) to 363.61 mg of GAE per 100 g of FW for total phenolics, whilst the content of anthocyanins varied between 1.22 mg of cyanidin-3-O-rutinoside equivalents per 100 g of FW and 263.93 mg of cyanidin-3-O-rutinoside equivalents per 100 g of FW. Finally, we can conclude that new progenies obtained would provide sweet cherries with enhanced bioactive compounds content and consequently, with benefits to health.

The effect of preharvest and postharvest CaCl₂ application on sweet cherry quality

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Crucial factor for the sweet cherry industry and consumer is the maintenance of high quality fruit and stem. Calcium (Ca) plays an important role on fruit cell wall properties and plasma membrane structure and integrity. The objective of this study was to evaluate the effect of two preharvest foliar 0.5% CaCl₂ applications (2 and 1 week before harvest) in sweet cherry ‘Lapins’ trees. In
addition, 0.5% CaCl₂ applied during the hydro-cooling process. Following CaCl₂ treatments, sweet cherry fruits were either maintained at room temperature (20 °C) for 3 days (shelf life) or cold stored for 20 days in plastic bags (0°C, 90% relative humidity (RH) and subsequently maintained at 20°C for 2 days. Subjective quality assessments indicated that preharvest CaCl₂ application reduced fruit cracking, pitting and browning stem. Although fruit penetration and deformation were not affected by the CaCl₂ treatments, stem removal force was higher in fruits subjected to CaCl₂. Significant differences at harvest or during shelf life period were monitored in respiration rate, external color, soluble solids concentration, total phenolic and anthocyanin contents, and antioxidant activity among treatments.

**PP-22** Biology and control of bacterial diseases and drosophila suzukii in cherry growing in the Netherlands

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In the Netherlands, bacterial canker in cherry trees is caused by *Pseudomonas syringae* pathovars. Recently, cherry production in the Netherlands has changed from a relatively extensive into an intensive cultivation. In general nurseries and fruit growers are not familiar with bacterial diseases and lack knowledge in order to prevent infections. Therefore, control strategies to manage cherry decline have to be developed. The Spotted Wing Drosophila (SWD), *Drosophila suzukii*, is a fruit fly of Asian origin that rapidly invaded Europe from 2008 onwards. In contrast to other Drosophila species that develop on overripe or decaying fruits, *D. suzukii* is able to oviposit in undamaged ripe fruits. Since its first notification in the Netherlands in 2012, it has become a major pest of berry and stone fruit crops. Like in many other countries, soft fruit production in the Netherlands is characterised by a large variety in crops and culture methods. For example, cherries are grown in traditional orchards with high trees and a large variety of cultivars, but also in modern plantations under rain cover. The latter enables the growers to leave the fruits on the tree and prolong the harvest season, but it will also increase the risk of SWD infestation. First observations on the SWD biology in the Netherlands will be presented. Part of the research is carried out within the EU-DROPSA project. It has focus on new and emerging threats such as *Drosophila suzukii*, and the bacterial pathogen *X. arboricola* pv. *pruni* (Xap).

**PP-23** S allele diversity in sweet cherries in Turkey

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Turkey is dominated world sweet cherry production and export determination of S-allele combinations of sweet cherry genotypes and cultivars has importance for both growers and
breeders. In this study S-allele combinations of 50 local Turkish sweet cherry genotypes by using a PCR-based method has been determined. Ten different S-alleles were detected. Although the most common S-allele was S3, as also found in Western genotypes and cultivars, there were some differences in the frequencies of some S-alleles between Turkish and Western sweet cherry genotypes. According to their S-allele compositions, 30 local Turkish sweet cherry genotypes were assigned to 10 previously identified incompatibility groups. For the remaining genotypes, whose S-allele combinations did not fit to any previous incompatibility groups, three more incompatibility groups, XLII, XLIII and XLIV, were proposed. Results obtained from this study will help both sweet cherry growers and breeders to better manage these local Turkish sweet cherry genotypes in their orchards.

PP-24  Selecting markers for genetic diversity characterization in sweet cherry

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The use of molecular markers, in particular microsatellites, for characterising germplasm diversity has become very common over the last decade. In December 2006, participants of an ECPGR-sponsored workshop met at East Malling Research (now NIAB EMR) to discuss the ideal characteristics of genotyping marker sets and to set out guidelines on how to best compare results across different germplasm collections and different laboratories. One of the outcomes was a proposed set of SSR markers and control cultivars for sweet cherry (Clarke and Tobutt 2009). Since then, several groups have used (part or all of the markers) in this genotyping set to characterize a range of wild and cultivated germplasm. The performance of this a few of these markers has been found to be less than ideal. Additionally, markers linked to traits of interest for breeders (such as fruit size or flesh colour) have been identified. Validation of those markers in diverse germplasm sets is essential to their deployment for marker-assisted breeding (MAB). The EU.CHERRY project will aim to select a diversity panel for cultivated cherries and landraces across Europe. In addition to phenotypic information provided by the curators in the originating collection, genotypic information will be produced for these accessions at NIAB EMR using a set of SSR markers based on the original ECPGR recommendations. Information on marker performance for various studies as well as potential to inform breeders will be used to select this improved marker set.
Cherry production in Turkey has been threatened by emerging and increasingly severe losses due to bacterial canker caused by *Pseudomonas syringae* pv. *syringae* (Pss) and *Pseudomonas syringae* pv. *morsprunorum* (Psm). Bacterial canker in western Anatolia was mainly caused by Pss whereas Psm was the major causal agent of bacterial canker in Eastern Anatolia depending on the variation of ecological conditions. It was concluded that ecological differences played a major role in the determination of bacterial canker agents. The main purpose of this study was to determine the susceptibility of some common sweet cherry cultivars, grown in Turkey, to bacterial canker by field observations and immature fruitlet test. The most susceptible cherry cultivar both on fruitlet test and orchard observation was cv. Napoleon, which was known as universal susceptible, and it was followed by local cv. Salihli (syn. 0900 Ziraat). Early Burland was the least susceptible cv compared to other tested sweet cherry cvs both on orchard observation and fruitlet test. The other aim of this study was to evaluate the copper resistance level among Pss strains obtained from sweet cherry trees in Izmir. The screening technique was based on the growth of Pss strains on minimal agar medium supplemented with different concentrations of copper. Out of 68% of tested Pss strains exhibited high levels of copper resistance in culture by the growing at 1.0-1.5 mM copper concentrations. This result explained us that bacterial canker of sweet cherry orchards in western Anatolia was being an important and threatening problem for cherry production.

Quality characteristics of the fruits are the main attribute for evaluation of sweet cherry varieties. In practice very often there are opposite opinion about quality characteristics of the fruits between producers and consumers. As new cherry orchards are being planted growers must evaluate potential new cultivars based on factors such as ripening time, fruit quality and market acceptance. Knowing the potential receptivity of a cultivar by the consumer will help growers make informed decisions on what to plant. The objective of this study was to identify the sensory attributes of nine sweet cherries cultivars as evaluated by a consumer panel. More than 40 participants took part in the sensory evaluation conducted in a pomological laboratory. Each participant was asked a series of preliminary questions that included demographic information...
and preference for fruit size, shape, color and stem versus stem less cherries. All cultivar were evaluated by visual appearance, skin color, attractiveness of the fruits, taste etc. In addition, participants tasted all nine cultivars and ranked them according to overall preference. The participants in this pilot evaluation preferred a cherry that was large in size and dark in color. Sweet tasting cherries were preferred the most by the panelist while cherries that lacked flavor or were too sour were preferred the least.

PP-27  
**Health control of stone fruits and virus elimination under in vitro conditions**

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Viral/phytoplasma infection causes big losses in the stone fruit production affecting the quality and quantity of the fruits throughout the world. Healthy nursery production could reduce the infection level of the orchards. The micropropagation, the in vitro plant material is getting more and more widespread so in the rootstock as in the cultivar production and in the cultivar exchange. Health control of the starting material is very important. The viral infection reduces also the affectivity of the micropropagation procedure. The healthy like tree could contain infected buds. That's why the control of the health status of each bud, following the in vitro establishment is necessary. Virus detection can happen with a cheap, but not enough sensitive method, by ELISA, or an expensive, but very much sensitive method, by PCR. Development of in vitro virus elimination method, including sensitive PCR methods for virus and phytoplasma detection in the micropropagation procedure help to avoid the mass production of infected plant material and shortened the time required for the in vivo virus elimination procedure. This represents a good possibility to reduce the impact of virus and phytoplasma infections on the planting material in Europe. Efforts of breeders to produce viral resistant/tolerant cultivars together with the efforts of nurseries to produce healthy planting material are required by the European farmers.

PP-28  
**Survey of old cherries occurrence in Slovak regions: evaluation and preservation**

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The paper is focused on the evaluation of morphological and pomological characteristics of several indigenous cherry trees (*Prunus avium* L.) that were found in different regions of Slovakia. The experimental work has been performed during two years (2014-2015). On the selected
territory in Slovakia old trees of cherry with an estimated age of 60-80 years were monitored. The trees were studied and evaluated for morphological characteristics. The following characteristics were investigated: period of flowering and ripening, morphological characteristics of the flowers, fruit size, fruit weight, and description of quality characteristics of the fruits. Descriptor list of genus Cerasus Mill. was used for description.

The results have shown high variation of attributes levels among evaluated genotypes. From the 14 monitored localities, the most valuable genotypes were found in the locality Horna Streda – Cachtice, Krakovany, Nitra and Brdarka. During the collecting expeditions 170 genotypes of sweet cherry fruit of the different quality were found. The most interesting 96 genotypes have been grafted onto rootstocks with different intensity of growth (Cerasus avium (L.) Moench., Cerasus mahaleb and GISELA5). Trees will be used for the establishment of experimental genetic resources orchards. Some of selected cherry genotypes can be used for commercial growing after tests, while some of them can be used only for collection of genetic resources. This work was accomplished with the support of COSTFA1104 project and project APVV-0174-12 the Agency for Research and Development (APVV) of Slovak Republic.

PP-29

Cherry orchard for tomorrow

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In France, sweet cherry is generally trained in the now well-known vase training system, which doesn’t allow to cover cherry trees against rain or insect, such as cherry fruit fly or Drosophila suzukii. A new orchard, planted in 2012 in the research station La Tapy, aims to (a) test innovate training systems that could allow installation of covers or nets, and (b) study durability of an orchard under row-by-row nets against flies coupled with a plastic cover against rain. In the first trial, four different training systems have been planted with the scion cultivar Regina and the rootstock Gisela 6. Two kinds of axis have been tested, a traditional one and one trained in order to contain easier trees under a cover (Bi-axis could allow to reduce the vigor compared to axis). With the fruiting wall, the mechanization of the pruning can allow to reduce cost, and to maintain easier trees under a cover. The second trial is led within the framework of a national project of which the objective is to study low-pesticide crop system, using about 50% less pesticides compared to a traditional IPM system. This trial use axis training system with two varieties (Regina and Belge) and the rootstock Gisela 6. The low-pesticide system is under net and plastic cover. The economic performance of the two trials should be studied to determine the viability of these systems of production.
Environmental effects on some physico-chemical properties of ‘Burlat’ and ‘van’ sweet cherry cultivars in Morocco

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Fruit analyzed in the present work were harvested in 2014 and 2015 from two sweet cherry cultivars ‘Burlat’ and ‘Van’ cultivated in two different regions of the Middle Atlas mountains. The mean of the flesh fruit width was 7.01 and 6.34 mm for ‘Van’ and ‘Burlat’ cherries, respectively. The fruit weight ranged from 5.6 g for ‘Burlat’ to 7.4 g for ‘Van’. The analysis of variance showed significant effect of the year and the region for the fruit weight and flesh fruit width. The value of fruit weight was higher in 2015 (6.18 g) than in 2014 (5.09). Similar results were obtained for the flesh fruit width (7.97 mm in 2015 vs 4.69 mm in 2014). The fruits produced in Laanaceur site were thicker and heavier than those produced in Toufselt. Soluble solids content in ‘Van’ were higher (14.5 °Brix) than those obtained in ‘Burlat’ (13.7 °Brix). Titratable acidity was between 7.6 g malic acid/l in ‘Burlat’ and 7.9 g malic acid/l in ‘Van’ cherries. The analysis of variance showed that the year effect was significant for Titratable acidity, with the value obtained in 2014 (8.6 g malic acid/l) higher than that obtained in 2015 (7.1 g malic acid/l). The region effect was no significant for Titratable acidity and soluble solids content. These results show that the year and the region effects influence the physical component of the fruit produced in Middle Atlas Mountains in Morocco, whereas the region effect didn’t affect the chemical traits considered in the present work.

Total anthocyanins, total flavonoids, total phenolics and antioxidant activity of sweet cherry cultivars under Moroccan climatic conditions

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Total anthocyanins, total polyphenols, total flavonoids and antioxidant activities of four sweet cherry (Prunus avium L.) cultivars cultivated under two climatic conditions in Morocco were determined. The analysis of variance showed a significant effect of the region only on the total polyphenols and total anthocyanins contents. These results confirm that the expression of total anthocyanins and total polyphenols contents in sweet cherry are influenced by the growing climatic conditions. However, the genotypic effect was significant only for the antioxidant activities and total flavonoids content. The Cerisette cherries had the highest value for total
flavonoïdes (517.6 mg eqRE/l), whereas the lowest value was obtained in “Burlat” cherries (481.7 mg eqRE/l). The total anthocyanins content was within the range of 1.09 et 2.89 mg/l cyanidine 3-glucoside. “Burlat” cherries were highest in total anthocyanins and antioxidant activities (DPPH and ABTS). “Napoleon” cherries showed the lowest value of total anthocyanins and total flavonoid contents. Total polyphenols content varied between 305.9 and 306.6 mg EqGal/l. The present results show that the sweet cherry fruits produced under Moroccan climatic conditions are rich on total flavonoid content.

Matrix Assisted Laser Desorption Ionisation-Time of Flight Mass Spectrometry (MALDI-TOF MS) has become a revolutionary and powerful tool for the identification of bacteria, yeast and fungi. Commercial systems available are all based on databases containing protein mass patterns deduced from standardized spectra of bacterial reference strains. Different identification algorithms for spectral matching are applied, all based on weighted pattern recognition. The current pattern recognition based systems require standardized sample preparation and to a certain extent comparable culturing conditions. These reference databases mainly focus on clinical relevant species and cover between 700-2000 species. As publicly available bacterial whole genome data is tremendously increasing, a new database approach completely based on genome derived in silico data was developed. This centralized database called PAPMID (Putatively Assigned Protein Masses for Identification) will be made accessible through a web based commercial application. Ribosomal proteins were chosen as universal marker candidates as they are constitutively expressed and therefore abundant in detectable amounts independently of sample preparation and culturing conditions. Ribosomal proteins are highly conserved and therefore allow a highly accurate species identification. To some extent even subtyping within a species is possible. This new approach enables an automated spectral quality control and allows a phylogenetic interpretation of acquired bacterial spectral data. The PAPMID database is independent of the MALDI-TOF MS instrument, and currently contains more than 9’200 genomes covering an excess of 3’200 bacterial species. It is updated on a monthly basis. First validations with clinical and environmental isolates showed a promising high sensitivity and specificity.
PP-33  Genomic investigation of cherry pathogenic
Pseudomonas syringae pathovars

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Bacterial canker caused by members of the Pseudomonas syringae (Ps.) species complex is the most
relevant bacterial disease affecting sweet and sour cherry plantations. Despite their economic
significance, there is a severe lack of genomic information of cherry pathogenic bacteria. Our aim
was to establish the first complete genome sequences of the main cherry pathogens of the Ps.
species complex in order to elucidate the mechanisms behind their host variation, epidemiology
and pathogenicity as well as to explore their genetic diversity and phylogenetic relationships.
A total of 12 strains belonging to the six most representative cherry pathogenic Ps. pathovars
were selected for de novo whole genome sequencing using the next generation sequencing
technology PacBio. Despite the high number of repetitive sequences and transposable element,
thanks to the long reads achieved by the PacBio technology, it was possible to circularize the
chromosome of all the sequenced strains as a single sequence of about 6 Mb. Within strains of
the same pathovar a high overall collinearity of the chromosome was observed. Several putative
plasmidic contigs were identified but not all could be circularized. The number of circularized
plasmids per strain was highly variable ranging from none to a maximum of six. Differences in
plasmid content were observed even within strains of the same pathovar. For all chromosome and
plasmid sequences, automatic annotation, gene content analysis as well as comparative genomic
investigations were performed. These high quality genomes constitute a solid foundation to
serve as template for further assemblies of related strains.

PP-34  Evolution of physicochemical parameters and consumers’ acceptance
of ‘Sweetheart’ cherries during storage under modified atmosphere


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Sweet cherry is a fleshy non-climacteric perishable stone fruit, with great economic importance
in some interior regions of Portugal. It is of main importance to develop simple and inexpensive
storage methods that allow small farmers to enlarge their offer period. So “Modified Atmospheres”
(MA) using commercial plastic materials should be studied in order to give substantiated information about the storage period, intrinsic quality and consumers’ acceptance. Sweet cherry composition depends among others, on cultivar, climate and ripening stage. Factors like light intensity, temperature and fruit ripening influence the stability of phytochemicals and compositional constituents in sweet cherries and consequently affect the sensory quality of these fruits. The nutritional role of cherries depends on their chemical composition, being a major source sugars, organic acids and antioxidant compounds, such as anthocyanins, phenolic acids and flavonoids. Sweetness and skin colour influence consumers’ acceptance of cherry cultivars, as do fruit weight and firmness. The aim of this work was to study the evolution of several physicochemical parameters, phenols and total antioxidant activity and also consumers’ acceptance of ‘Sweetheart’ cherry stored under MA conditions, using two different plastic bag types, in order to give information to small producers. Some differences were found between the different plastic materials, mainly in firmness, acidity and antioxidant compounds and even weight loss. However, both materials allow a storage period of up to 20 days with very good fruit quality and nutritional value.

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**PP-35 Quality evaluation of ‘Sweetheart’ cherry in different ripening stages**

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The decision about the ideal ripening stage for harvest is very controversial for producers and consumers, because the haste in collecting sweet cherries does not allow them to reach their best conditions in terms of nutritional, sensory and functional properties. The chemical composition of sweet cherries affects their sensory quality, sweetness and skin colour, and influences consumers’ acceptance of cherries, as do fruit weight and firmness. Fruit weight and size are very important characteristics for the commercial market value of cherries. Fruit firmness is of extreme importance, because it is often associated with freshness. The aim of this work was to study several physicochemical parameters, such as phenols and total antioxidant activity of ‘Sweetheart’ cherry in four distinct ripening stages, defined by colour, 1 being the less mature and 4 the ripest fruits. Fruit weight increased from stage 1 to stage 3, but did not change significantly in stage 4. A significant loss of firmness was observed during ripening. Changes in colour were evidenced in $C^*$ values, decreasing from stage 1 to 4, due to a greater accumulation of anthocyanins. In fact, values of antioxidant capacity increased significantly ($P>0.05$) with ripeness, from low (25.4 %) to high (73.8 %), with emphasis for stage 4. Therefore, considering the nutritional value of cherries, the ripest stage is the best one, although other quality parameters, namely firmness, weight and colour, remained almost unchanged between more ripe stages (3 and 4).
MALDI-TOF MS and genetic diversity profiles of Colletotrichum acutatum - causal agent of bitter rot on cherries in Poland

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During the summers of 2012-2014, from 50 sour cherry and sweet cherry orchards, located in central, north and south regions of Poland, fruit with the visible bitter rot symptoms were sampled. In total, 181 of fungal isolates (152 from sour and 29 from sweet cherry fruits, respectively) were obtained. On the basis of morphological characters on PDA medium, all isolates were classified to the genus Colletotrichum and subsequently were identified by PCR with species specific primers as C. acutatum sensu lato. In order to determine genetic diversity of all isolates, the analysis of amplification patterns obtained with four ISSR and three RAPD primers and PCR MP was conducted. For morphological and genomic diversity characterization and comparison, 14 strains of C. acutatum originating from other host plants and of other Colletotrichum species were included to the analysis. The genetic analysis revealed high level of diversity among isolates while the highest diversity was revealed by ISSR technique. The isolates from cherry fruits were clearly separated from grayish isolates from strawberry and pink-colored cultures from pear and cranberry. No relationship has been found between obtained amplification patterns and geographical origin of isolates, as well as host – sour or sweet cherry. Additionally, 50 selected strains were subjected to analysis of protein profiles of fungal mycelium grown on PDA, using MALDI-TOF mass spectrometry. The resulting dendrogram, built on the basis of obtained proteins profiles, showed similar tendency in grouping the isolates as the dendrograms obtained on variable DNA markers.

Development of rapid and specific system for detection of Pseudomonas syringae pv. morsprunorum races 1 and 2 the causal agent of bacterial canker, using conventional and real-time PCR

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Bacterial canker occurs in cherry growing areas all over the world. The causal agent Pseudomonas syringae affects all organs of the aboveground parts of trees, causing reduction of yield. Despite the availability of different approaches for characterisation and genotyping of P. syringae, they require time-consuming and labour-intensive classical microbiological methods or complex
analyses including comparison of amplification patterns and sequencing. Therefore, there is still need to develop a rapid and specific method of diagnosis that would allow the detection and identification of the causal agent of stone fruit bacterial canker. The aim of this study was to design and validate novel specific primers for rapid and specific detection of Psm1 and Psm2. Thanks to our study specific primers were developed to detect the causal agent of stone fruit bacterial canker using conventional and real-time polymerase chain reaction (PCR) methods. They enabled accurate detection of Psm1 and Psm2. For conventional PCR, the detection limits when using pure cultures were 100 cfu/reaction and 101 cfu/reaction for Psm1 and Psm2, respectively, while in plant material they were 100–101 cfu/reaction using primers for Psm1 and 3×102 cfu/reaction using primers for Psm2. Real-time PCR assays with SYBR Green I showed a higher limit of detection – 100 cfu/reaction in both pure culture and in plant material, which corresponds to 30–100 fg and 10–50 fg of DNA of Psm1 and Psm2, respectively. To our knowledge this is the first PCR-based method for detection of the \textit{P. syringae} pv. morsprunorum. This work was financed by the National Science Centre, Poland, Grant DEC-2013/08/M/NZ9/00138 and by the Polish Ministry of Science and Higher Education Grant No. 118/N-COST/2008/0. P. Albuquerque was supported by the project ‘Genomics Applied to Genetic Resources’, co-financed by the North Portugal Regional Operational Programme 2007/2013 (ON.2 – O Novo Norte).

\textbf{PP-38 S-allele identification by PCR analysis in 20 sweet cherry cultivars}

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The diploid sweet cherry (\textit{Prunus avium} L.) is cultivated in Europe for its edible fruit. Sweet cherries are generally self-incompatible. Self-incompatibility and cross-incompatibility between various cultivars has been attributed to the multi-allelic S locus. The S genotype of cherry cultivars is an agronomically important character. Cultivars with the same S genotype are cross incompatible. Knowledge about the S-allele constitution of cultivars is very important for fruit growers and breeders regarding planning of new orchards, for artificial hybridization and as a genetic marker. Precise identification of existing cherry cultivars is essential for cherry orchard establishment, efficient germplasm collection management and selection of genotypes in cherry breeding programmes. In this study, PCR analysis with PaCons I-F+R and PaCons-II-F+R primers and allele-specific primers were used to characterize the S-genotype of 20 unknown cherry cultivars. The unidentifiable alleles have been cloned and then sequenced. The conducted sequences have been compared with the data the NCBI database.
**PP-39**  
**Status of prunus collection in Estonia**

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Systematic collecting of plum and cherry genotypes in Estonia was triggered by the damage of extremely severe winters of 1939-1940 and the following three years that resulted in destroying over 80% of Prunus trees in Estonia. As a result maintaining winter hardy genotypes and breeding lines has been the main goal. The Prunus field collection maintained at Polli Horticultural Research Centre of Estonian University of Life Sciences includes 84 plum, 72 sweet and 15 sour cherry accessions. From these, 57 sweet cherry and 4 sour cherry accessions are of Estonian origin, either cultivars or breeding lines. In the EURISCO database information on passport data of 38 cherry accessions is listed and the contents are updated regularly based on records in the national database. Observations on phenological performance, pest and disease resistance and winter hardiness have been conducted for majority of the accessions. Photos and short phenotypic descriptions of the accessions are available at sordivaramu.emu.ee.

**PP-40**  
**Exploring possible effects of multiple Wolbachia Infestations on adult demographic traits of the European cherry fruitfly**

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The European cherry fruit fly, *Rhagoletis cerasi* (Diptera: Tephritidae) (L.) is a key pest of sweet and sour cherries in Europe and western Asia. Environmental variability determines diapause termination and life-history traits of locally adapted populations of *R. cerasi*, reflecting the role of gene-flow and plasticity in shaping fitness traits. *Wolbachia pipientis* (a wide spread, endosymbiont of *R. cerasi* populations) among other effects, may dramatically affect reproduction and longevity of its hosts. Although, both prevalence and structure of multiple Wolbachia infections in *R. cerasi* populations have been recently elucidated possible effects on adult demographic traits remain rather unexplored. Under a common garden experimental approach, we systematically recorded the adult life span, female oviposition and body size of three German populations of *R. cerasi* that bare differential infection rates of multiple *Wolbachia* strains in order to reveal possible effects of multiple infections. Data analyses revealed similar body size and fecundity rates among the three populations. Female longevity differed among the three populations, which however can not be attributed to differential *Wolbachia* infection. Molecular analysis revealed a dynamic association between *Wolbachia* infection(s) and German populations of the European cherry fruit fly taking also into consideration recent similar studies, which, however, can not explain variation in life history traits among the three populations considered. The practical and evolutionary importance of our findings is discussed.
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The company “Milis Plant Nurseries” is engaged in the production and sale of fruit, forest and ornamental seedlings. In the mid 1960s, Constantine Milis, in tune with the needs of Greek tree growers for healthy propagating material, and with the use of expert know-how in tree growth in cooperation with local geotechnicians, created the first nursery of fruit trees (peaches, cherries, apricots, plums, apples, pears, etc.). A few years later, his son and current owner, Basil Milis, took over the reins of the company enriching its range of offered items, subjects and varieties. In collaboration with both universities in the country and with European Institutes, “Milis Plant Nurseries” has developed plant nurseries that are able to meet the increased demands of producers, always with a view at ensuring the quality of the plants.
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