

## IHC2018-Symposium 12

### S12- Berry Fruit (3rd International Symposium)

#### ORAL PRESENTATIONS

##### KEYNOTE 1

#### IMPROVING THE SENSORIAL AND NUTRITIONAL QUALITY OF STRAWBERRY FRUIT IN RESILIENT CONDITIONS

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In the last few decades, the most knowledgeable consumer on the diet and its nutritional principles pays particular attention to the overall quality assessment, comprising the agronomic/commercial quality, the organoleptic quality and the nutritional quality. All those characteristics are very variable among different species, but also among different varieties within the same species. The aim of this study is to select new genotypes of strawberries with high quality and nutritional value. Fruits of 93 strawberry selections from interspecific crosses *Fragaria* × *ananassa* (FA) × *Fragaria virginiana* glauca (FVG) (F1), back-crossing (BC1, BC2, BC3), advanced selections from F. × *ananassa* intraspecific crosses and cultivars were analyzed for sensorial (Soluble Solids-SS and Titratable Acidity-TA) and nutritional (Total Antioxidant Capacity-TAC, Total Phenolics Content-TPC and Total Anthocyanins Content- TAcyC) quality parameters. Fruit of the most interesting 47 genotypes were further analyzed (HPLC analyses) for their contents of Vitamin C and specific Anthocyanins and Phenolic Acids. Results on sensorial quality evidenced higher SS content in fruit of BC3 selections, while the highest TA values observed for F1 were reduced in the following generations. BC3 fruit showed the highest TAC values, while the highest values of TPC and TAcyC were detected in fruit of F1 and Fxa selections. The highest fruit content of Vitamin C was detected in fruit from BC1 selections. The highest fruit TPC was detected in BC3 selections. The genetic population created with this breeding program showed an ample variation in fruit sensorial and nutritional composition, depending to FVG genetic source but also by the FA parents used in the succeeding cross combinations.

**Keywords:** breeding, genetic resources, bioactive compounds



## SESSION I:

### OS 1-1:

#### GENERATION OF STRAWBERRY HYBRIDS POPULATION THROUGH SELECTION OF POTENTIAL OF ANTHOCYANIN-RICH CULTIVARS FOR BREEDING INTERVENTION

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This research was aimed to generate a series of strawberry hybrids population through selection of potential of anthocyanin-rich cultivars for breeding intervention. Two parental cultivars (Praratchatan No.72 and Praratchatan No.80) were crossed by complete diallel with a mix of the same breed and mixed breed as follows: hybrid pair no.1 (Praratchatan No.80 x Praratchatan No.72), hybrid pair no.2 (Praratchatan No.72 x Praratchatan No.80), hybrid pair no.3 (Praratchatan No.80 x Praratchatan No.80) and hybrid pair no.4 (Praratchatan No.72 x Praratchatan No.72). The results showed that hybrid pair no.1 had the most normal shape (100%) and hybrid pair no.2 had the highest achenes (2,432 seeds). We selected a total number of 300 seeds for each pair for germination test. It was found that hybrid pair no.2 had the highest germination percentage and survival rate 61.3% and 45.1%, respectively. The survival rate of seeds of all hybrid pairs was accounted by planting them under greenhouse condition yielding a total number of 320 survived plants. From these results, we selected 9 plants in all hybrid pairs with fruits having the richest anthocyanin content. Our results revealed that among the plants evaluated, hybrid pair no.2 clone-38 had the highest vegetative growth, giving the canopy width, canopy height, petiole length at 27 cm, 25 cm and 16 cm, respectively. In addition, these clones have had the highest no. of leaves (24 leaves), leaf area (3,024 cm<sup>2</sup>) and total available fruit (10 fruits/plant). In terms of postharvest physico-chemical quality of strawberry hybrid cultivars, that these clones have had fruits with the highest L\*, chroma and hue angle of peel color (31.12, 44.87, 50.03°) and flesh color (41.31, 28.65, 65.30°). Moreover, the optimal pH, ratio of total soluble solids to titratable acidity and total anthocyanin content were found to be highest in these clones at 3.07, 24, 42.84 mg/100 gFW, respectively.

**Keywords:** population, strawberry hybrid plant, anthocyanin

### OS 1-2:

#### BLACKBERRIES: A MODEL FOR INTEGRATING RESEARCH WITH OUTREACH AND EDUCATION TO FARMERS AND THE PUBLIC

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A research project to evaluate the performance of seven thornless blackberry (*Rubus* sp.) cultivars grown on an innovative rotating cross arm (RCA) trellis was established at the University of Missouri Southwest Research Center, Mount Vernon, MO, USA in April 2016. The project presented a unique framework for outreach education activities to farmers, home gardeners, and the public. Nine farmer workshops centered on the planting focused on blackberry production practices through the growing season, highlighting the use of thornless cultivars and the RCA trellis. A demonstration project in the planting highlighted monitoring and control of spotted wing drosophila, a devastating invasive insect pest. Three taste-testing events encouraged farmers and the public to evaluate characteristics of blackberry fruit from the project. Several hundred youth learned integrated pest management practices during events in the planting. Local food pantries and a child-feeding program distributed blackberry fruit from the planting, increasing awareness of locally grown blackberries to over 500 members of a new demographic rarely reached through research projects. Tours and blackberry processing demonstrations increased awareness of blackberries to several hundred members of the general public. A volunteer program instituted at the research site allowed home gardeners to gain skills in growing blackberries while becoming fully engaged in the research. Yield, pest incidence, and fruit quality data from the study will form the foundation of a revised Blackberry Grower Guide that will further benefit established and potential new farmers.

**Keywords:** blackberry, extension, outreach, education, farmer



## OS 1-3:

### SMALL FRUIT BREEDING TENDENCIES IN LITHUANIA

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Small fruit growing in Northern countries presents specific challenges – cold and frost resistance, short vegetation period, low yield and berry quality. Horticultural plant breeding has been the major activity at the Institute of Horticulture LAMMC, focused on black currant (*Ribes nigrum*), gooseberry (*Ribes uva-crispa*), strawberry (*Fragaria annanassa*; *Fragaria vesca*) raspberry (*Rubus idaeus*) and other. Research is concentrated on plant development and biotechnology applications aimed at ensuring high quality of propagation material for fruit plant production practices. The breeding program of small fruit plants involves the conventional and interspecific hybridization, in vitro techniques, usage of molecular markers for early diagnosis of important traits. The availability of genetically diverse germplasm is an important basis for successful breeding of plant cultivars. The laboratory of cryobiology was recently established to long term preservation of horticultural and ornamental plant genetic resources. Recently new cultivars and promising hybrids of small fruits were released.

**Keywords:** ribes, *Rubus*, *Fragaria*, breeding, cultivars and hybrids

## OS 1-4

### DOES SECTORIAL PRUNING MAKE POSSIBLE REDUCED LABOR USE WITH HIGHER FRUIT YIELDS AND QUALITY IN HIGHBLUSH BLUEBERRY?

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Our research group has been developing new pruning strategies for highbush blueberry that allow to: (i) reduce labor needed to perform this task, (ii) simplify the instructions to allow the use of unskilled labor, (iii) improve light availability in the canopy center to increase fruit yield and quality, and (iv) reduce canopy size to minimize labor needed for harvest. In this context we evaluated a new pruning concept: sectorial pruning (SP). This involves basal cane removal each year in winter of ¼ of the canopy. The trial was done on two adult 'Brigitta' fields (Romeral and Linares: Lat. 35° S) and one 'Duke' field (Linares). SP of the north-east quarter of the canopy was compared to quick pruning (QP) in which the oldest cane was removed from the base in each quarter of the plant. In the following season in both locations and varieties, SP generated a greater number of canes but did not alter total new shoot growth. In the first harvest after pruning treatments in the Linares location, SP plants had greater yield both for 'Duke' (87.5% higher) and 'Brigitta' (32.4% higher), which was associated with greater fruit weight in 'Brigitta' and higher fruit number in 'Duke'. SP increased fruit diameter and reduced its acidity in 'Brigitta'-Romeral but did not induce changes in fruit quality for 'Brigitta'-Romeral or 'Duke'-Linares. Average fruit weight at harvest was significantly greater for SP in 'Brigitta' (66.3%) but not for 'Duke' (11% higher). SP did not alter soluble solids in any variety or location. These results could, at least in part, be due to increased light availability induced by SP in shaded parts of the canopy. This would have induced greater number of flower buds and allow leaves to form greater amounts of sugars to feed the growing fruits. Results of the second season will also be presented and discussed.

**Keywords:** fruit quality, plant productivity, pruning intensity, vegetative growth

## SESSION II:

### OS 2-1:

### THE EFFECT OF PH LEVEL AND CALCIUM-CARBONATE ON BIOMASS AND MINERAL UPTAKE OF BLUEBERRY GROWN IN TISSUE CULTURE

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Blueberry production has undergone a dramatic increase in the last decades in the best-suited soils for this crop; therefore new plantations are expanding into unfavorable soils (pH>5.5). Under such conditions it has been widely suggested that the minor elements become the limiting factor in the plant's growth. The objective of this work was to study the effect of pH on the biomass accumulation and mineral uptake, using in-vitro blueberry plants. Blueberry, Cv. Ochlockonee were grown in Woody Plant Medium at four different pH levels: 5, 6, 7 and 8 controlled by 1M HCl, MES, BES and Tricine, respectively, and additional treatment of 1% CaCO<sub>3</sub>. The pH of the medium was measured periodically. The biomass accumulation and the mineral concentration were determined after three months. The pH of the medium of all treatments increased gradually almost at the same rate and the initial hierarchy was maintained. Although the pH changed with time, shoots, roots and total dry biomass significantly decreased as the pH increased. The dry biomass of the CaCO<sub>3</sub> treatment was 50% of that in the medium without CaCO<sub>3</sub> at the same pH. Mineral concentrations in plant organs were not affected significantly by the pH; however, mineral accumulation in plant organs decreased as the pH increased. Furthermore, the uptake of all minerals per fresh root weight decreased at the highest pH treatments. Ca accumulation in the roots was significantly higher in the CaCO<sub>3</sub> treatment compared to the medium without CaCO<sub>3</sub> at the same pH. These results are in agreement with our preliminary results obtained by a blueberry pots experiment. We suggest that blueberry development in high pH is restricted due to the inhibition of mineral uptake, which is amplified in the presence of CaCO<sub>3</sub>.

**Keywords:** blueberry, pH, calcium-carbonate, mineral uptake

## OS 2-2:

### HUMAN HEALTH CONTENT OF WILD STRAWBERRY (*Fragaria vesca*)

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*F. vesca* is a perennial herb, typically known as the common wild woodland strawberry of Europe and Asia. It has a large geographical range and a wide environmental tolerance. This study describes human health content of a number of natural growing strawberry plants sampled from Uzundere district located North Eastern Anatolia. The human health content included total soluble solids, antioxidant activity, vitamin C, total phenolics, total ellagic acid and total anthocyanins. Antioxidant activity of fruit samples was determined by FRAP (Ferric reducing antioxidant power) assays. We found statistically differences among among wild strawberries (*Fragaria vesca*). The common growing strawberry cultivar Camarosa (*Fragaria ×ananassa*) was also included the study to make better comparison with cultivated strawberry and wild ones. The total phenolics ranged from 117 mg to 241 mg gallic acid equivalent per 100 g fresh fruit. The total anthocyanin content was found between 28.47 and 60.15 mg/100 g indicating high differences. The total ellagic acid content was between 18.85 and 28.62 mg per 100 g. The results showed that all wild grown strawberries exhibited higher human health content than cv. Camarosa.

**Keywords:** Strawberry, phenolic content, human health

## OS 2-3:

### VEGETATIVE PROPAGATION FOR THREE MEXICAN STRAWBERRY CULTIVARS GROWN IN TWO BED SYSTEMS

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This two-year research (2014-2015) aimed to compare the vegetative growth of three Mexican strawberry cultivars ('CP-Jacona', 'CP-Zamorana' and 'CP-06-15') while grown under a high tunnel in two bed systems:





fertigation (soil) and soilless (volcanic gravel). Three experiments were performed in a split-plot design in central Mexico. Two evaluations for vegetative propagation and one for fruit production were carried out. Regarding cultivars, no significant differences were detected concerning fresh weight distribution nor leaf area, but the number of runners was different in 2014 and 2015 and the number of primary sprouts was different in 2014. In respect of bed system, plants had a stronger growth while growing as vegetative in gravel. In 2014 and 2015, leaf area ( $p \leq 0.0003$  and  $p \leq 0.0001$ ), root fresh weight ( $p \leq 0.006$  and  $p \leq 0.0001$ ) and leaf fresh weight ( $p \leq 0.002$  and  $p \leq 0.0001$ ) were higher in plants from gravel than those from soil. In 2015, number of runners ( $p \leq 0.012$ ) and number of sprouts ( $p \leq 0.004$ ) were higher in gravel than in soil. Also, sprouts achieved a stronger root in gravel compared with those in soil, but this effect was only significant in 2014 ( $p \leq 0.006$ ). There was no effect from bed system on leaf fresh weight from the sprout. Crown fresh weight from the sprout was only affected by bed system in 2015, when it was higher in soil ( $p \leq 0.029$ ). When plants were grown for fruit production, root fresh weight was higher in plants from gravel compared with those from soil ( $p \leq 0.03$ ), but there was no effect of bed system on aboveground fresh weight, including that for fruit. It is concluded that soilless with volcanic gravel in a bed, under a high tunnel in central Mexico, is a suitable system for vegetative propagation of 'CP-Jacona', 'CP-Zamorana' and 'CP-06-15'.

**Keywords:** soilless, volcanic gravel, fresh weight, runners, sprouts

## OS 2-4:

### HARVEST SEASON AND SOME FRUIT QUALITY CHARACTERISTICS OF STRAWBERRY UNDER COVER AND OPEN FIELD

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In this study, it was evaluated earliness, harvest season and some quality characteristics of some short day (SD) (Camarosa-standard cultivar, 'Benicia', 'Rubygem', 'Festival', 'Fortuna', 'Amiga') and day-neutral (DN) ('Monterey', 'Albion', 'San Andreas', 'Sweet Ann') strawberry cultivars in plastic greenhouse and open field conditions. The experiment was carried out in June 2014–September 2015 in Samsun, Black Sea Region, Turkey. Frigo plants were planted on 7-8 July, 2014 in both two growing places. Fruit harvest started on 1-24 April as depend on cultivars in greenhouse. 'Monterey', 'Albion', 'San Andreas', 'Benicia', 'Festival', 'Fortuna' were the earliest, 'Sweet Ann' was the latest. Fruit harvest was on 6-20 May as depend on cultivars in open field. 'Fortuna' and 'Benicia' were the earliest; 'Sweet Ann' was the latest. Harvest season proceed until early September except 'Benicia' in greenhouse. The harvest season was 119-153 days. 'Albion', 'Monterey', 'San Andreas' 'Fortuna' and 'Festival' had the longest harvest period with 153 days. The harvest season was 103-147 days in open field. Harvest season extended into autumn with the DN cultivars and lasted on October 5. The DN cultivars such as 'Albion' (147 days), 'San Andreas' (141 days) and 'Sweet Ann' (133 days) had the longest harvest period in open field. Marketable yield was the highest in 'Fortuna' (766.5 g/plant) in greenhouse. 'Monterey' (963.1 g/plant) followed by 'Sweet Ann' and 'Albion' came to the fore in terms of marketable fruit yield in open field. Misshapen fruit was the highest 'Sweet Ann' followed by 'Rubygem', 'Camarosa' and 'San Andreas' in greenhouse and 'Camarosa' and 'Rubygem' in open field. Thus Camarosa and Rubygem consistently had a high misshapen fruit percentage in both growing places. In the experiment, damaged fruit was quite a few and ranged from 5.1 to 26.9 g/plant in greenhouse. Damaged fruit was the highest in 'Sweet Ann' (288.0 g/plant) and ranged from 22.0-288.0 g/plant in open field.

**Keywords:** *Fragaria × ananassa*, greenhouse, earliness, damaged fruit, marketable yield

## OS 2-5:

### PERFORMANCE OF SOME STRAWBERRY CULTIVARS UNDER COVER

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This study was carried out in Samsun, Black Sea Region, Turkey in 2014-2015. The study was planned to determine adaptation of some day-neutral ('Monterey', 'Albion', 'Sweet Ann', 'San Andreas') and short day cultivars ('Camarosa', 'Benicia', 'Fortuna', 'Rubygem', 'Festival', 'Amiga') in greenhouse. Frigo plants were planted on 7-8 July, 2014. The yield was the highest in 'Fortuna' (879.9 g/plant) and 'Camarosa' (792.8 g/plant). 'Sweet Ann' had the highest fruit weight (17.5 g), 'Festival' had the least fruit weight (11.6 g). The highest fruit firmness was obtained from 'Amiga' (0.61 kg/cm<sup>2</sup>), 'Fortuna' had the least fruit firmness (0.41 kg/cm<sup>2</sup>). 'Festival', 'Rubygem', 'Monterey' and 'Albion' (6.8-6.5%) had the highest soluble solid content; 'Sweet Ann' (5.4%) had the lowest soluble solid content. Titratable acid content was the highest in 'Albion' (0.76%) and the lowest in 'Amiga' (0.53%). The highest vitamin C content was determined in 'Rubygem' and 'Benicia'. The highest values of lightness (L) were obtained from 'San Andreas' and 'Sweet Ann', the lowest value of lightness was 'Monterey'. The highest value of Chroma (C) was 'Amiga'; the lowest values of Chroma were 'Benicia' and 'Sweet Ann'. In considering the value of hue angle (h°), the lightest red fruits were obtained from 'Sweet Ann', the darkest red fruits were obtained from 'Camarosa', Monterey and 'Rubygem'. In the experiment, it was also obtained data of runner number, crown number, leaf number, and leaf area and plant dry weights of strawberry cultivars experimented.

**Keywords:** *Fragaria ×ananassa*, greenhouse, adaptation, yield, quality

## OS 2-6:

### THE EFFECTS OF FLOWER REMOVAL ON SUMMER AND FALL FRUIT PRODUCTION OF 'ALBION' AND 'SWEET ANN' STRAWBERRIES

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Day-neutral strawberries can produce fruit during the summer and fall when regular strawberry production has ceased. Thus, high retail value of strawberries in summer has increased demanding for summer-fall fruit production with day-neutrals. However, the information on crop management of day neutral strawberries for different cultivars and locations is limited. This study was aimed to compare flower removal applications related to those effects on harvest season extension, fruit production, berry size, plant growth in summer and fall production of 'Albion' and 'Sweet Ann' day-neutral strawberry cultivars. Frigo plants of these two cultivars were planted on 7 July, 2017. Totally thirty plants were planted in a typical double-row raised beds with a 30 × 30 cm spacing. Cultivars were randomly plotted in four replications. The flower removal applications included 1) no flower removal, 2) flower removal 30 days after planting, 3) flower removal 60 days after planting, 4) flower removal 90 days after planting. In the experiment, it was examined harvest date, harvest season extension, marketable and total yield, damaged fruit, fruit size, soluble solid and titratable acid content. Crown number, leaf area, root, crown, leaf and total plant fresh and dry weights in the three plants removed end of season were determined. There was not statistically difference between flower removal applications in each cultivar in terms of total fruit production and fruit size. 'Sweet Ann' had higher crown number, and flower removal 90 days after planting caused the highest crown number in 'Albion'.

**Keywords:** strawberry, day neutral cultivars, flower removal, summer and fall crop, yield, quality

## SESSION III:

### OS 3-1:

### THE PRODUCTIVITY OF SOME SOUTHERN Highbush AND Rabbiteye Blueberry Cultivars Under Turkey Conditions

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Turkey has the northern highbush blueberry cultivation and the harvest begins at the end of June or at the beginning of the July and ended at the end of the July. We aimed to prolong the harvest period with southern highbush (SHB) and rabbiteye (R) blueberry cultivars. In The present study southern highbush (*Vaccinium*



corymbosum) and rabbiteye (*Vaccinium ashei*) blueberry cultivars have been achieved and evaluated in the conditions of The Black Sea Region-Turkey. It was tried five southern highbush ('Misty', 'Ozarkblue', 'O'Neil', 'Jubilee' and 'Sharpblue') and four rabbiteye ('Climax', 'Powderblue', 'Tifblue' and 'Austin') blueberry cultivars for early and/or late harvesting. However phenology, bush and flower number, berry weight, berry diameter, yield and some berry characteristics (TSS and acidity) of the varieties were also determined. 'Misty' was the earliest cultivar (bud burst at 7 January and first harvest at 16 May) while 'Tifblue' was the latest (bud burst at 3 March and first harvest at 15 June). 'Tifblue' had the biggest berry (2.85 g.) while 'Austin' with the highest yield (892.31 g bush<sup>-1</sup>). 'O'Neil', 'Tifblue' and 'Climax' gave the large berry while others were medium. We proved that southern highbush blueberry show earliness and rabbiteye blueberry cultivars prolonged the harvest period till the end of the August ('Climax' and 'Powderblue').

**Keywords:** *Vaccinium corymbosum*, *Vaccinium ashei*, phenology, bush and berry characteristics, yield

## OS 3-2:

### THE EFFECT OF FOLIAR CALCIUM APPLICATIONS ON KEY (POST) HARVEST FRUIT QUALITY ATTRIBUTES IN RABBIT-EYE BLUEBERRY (*Vaccinium ashei*)

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Hard berry texture is currently one of the most important quality attributes to assure fruit acceptability by consumers. The amount of calcium associated with the cell wall may affect fruit texture. Therefore foliar calcium applications are considered as a management practice among blueberry growers. However, the reported results associated with the effect of foliar calcium treatments on blueberry hardness are not completely conclusive. Most of the studies on blueberry fruits do not explore the interaction effect between the soil available calcium and the foliar calcium application. The aim of this study is to determine the effect of foliar calcium application on the fruit texture and fruit calcium concentration. Five-year-old 'Rahi' blueberries (*Vaccinium ashei*) were transplanted at bloom stage into 45 L pots with two different calcium amounts (5 g and 0.5 g Ca per pot). After transplanting, the plants were kept under glasshouse conditions. Foliar calcium chloride (16.9% Ca; Stopit, YaraVita, Norway) adjusted to pH 5.5 was applied at a rate of 250 mg/plant at eight developmental stages from fruit-set until mature-blue fruit. Plants treated with buffer only (pH 5.5) at the same eight stages were considered as a control. During the plant growing period the physiological parameters of photosynthesis and stomatal conductance were assessed. At harvest and during postharvest storage the fruit hardness (texture analysis) and the calcium concentration were determined. This paper will discuss the relevance of foliar calcium applications under sub-optimal and optimal substrate calcium conditions.

**Keywords:** fruit quality, foliar Ca treatment, plant physiology, mineral nutrition

## OS 3-3:

### THE RESULTS OF EVALUATION BLUEBERRY (*Vaccinium*) CULTIVARS IN THE WEST GEORGIA CONDITION

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Blueberry (*Vaccinium*) production is a promising and emerging sector for Georgia. The blueberry production is mainly concentrated in the western regions of Georgia, where are favorable agro-ecological conditions for the proper growth and development blueberries. The main emphasis in the blueberry research is given to find and identify the most adaptable and suitable blueberry cultivars for specific humid West Georgian conditions. The Study of the performance of 9 new introduced blueberry cultivars has conducted in the Imereti region (West Georgia) during 2012 – 2016 Years. The main aim of the research was to study phenological and agronomical traits of blueberry cultivars. There are investigated peculiarities of vegetative growth, organoleptic, and biochemical composition of the berries, productivity and fruit quality of blueberry cultivars. Also, the data was collected regarding of susceptibility to the main diseases. There are found important varietal differences according to of productivity of berries, which is correlated with quality of fruits. According to study results, was



identifying a group of blueberries cultivars: 'Patriot', 'Bluegold' and etc, which are prospective for planting new blueberry plantation.

**Keywords:** blueberry, Georgia, cultivars, bluegold, Patriot

## OS 3-4:

### EVALUATION OF SOME HORTICULTURALLY IMPORTANT TRAITS AND PLOIDY LEVEL OF TURKISH WILD *VACCINIUM* SPECIES

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Turkey has rich gene pool of several economically important *Vaccinium* species which are biologically closely related with the cultivated blueberry species. Although fruit of those *Vaccinium* species have been collected from the nature by local inhabitants for millennium, they are not commercially cultivated. A study was carried out leading to the collection, characterization of horticultural traits and estimation of ploidy level of those wild species. *Vaccinium* species mainly Whortleberry (*V. acrostaphylos*), billberry (*V. myrtillus*) and bog bilberry (*V. uliginosum*) with the significant potential in horticulture were identified and collected from different habitat with diverse altitude during the land expedition of Eastern Black sea region of Turkey. Thirteen horticulturally important morphological traits like fruit length, fruit width, fruit weight, fruit color, dry matter of fruit, seed number per fruit, number of fruit per branch, leaf length, leaf width, leaf weight, dry matter of leaf, leaf color and internode have been recorded and analyzed in details in population and species level. Significant differences have been observed among those species regarding the analyzed traits. In addition, Flow cytometry analysis of the nuclear DNA content of the young leaf tissue and chromosome counting from the leaf bud facilitate the determination of ploidy level of those studied plant sample. It was found that plant species can be strictly divided into two groups' diploid (bilberry and bog bilberry) and tetraploid (Whortleberry). It is evident that our initial result could be highly valuable for further characterization and improvement of wild or cultivated *Vaccinium* species in Turkey.

**Keywords:** *Vaccinium* species, *V. acrostaphylos*, *V. myrtillus*, *V. uliginosum*, horticultural traits, Flowcytometry, chromosome counting, ploidy

## OS 3-5:

### NITRATE AMMONIUM RATIOS AND ELECTRICAL CONDUCTIVITY IN QUALITY OF BLUEBERRIES

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The blueberries are so crowded because of their properties and healthy benefits, furthermore the size and flavour are some attributes needed for its commercialization, and nutrition could be influence in these attributes. We determined the effect of nitrate/ammonium ratio and electrical conductivity on blueberry's quality. The study was carried out from August 2016 to May 2017 at Universidad Autónoma Chapingo, México, under hydroponic and greenhouse conditions, cultivar Biloxi was used. A factorial experiment was used with two factors and three levels for each one, electrical conductivity at levels of 1.0, 1.5 and 2.0 dS·m<sup>-1</sup> and nitrate/ammonium ratio (NAR) of 50/50, 30/70 and 10/90, resulting in nine treatments; for each one a hydroponic solution was supply, pH value was 5.0 for all nutrient solutions. The determined response variables were yield, total soluble solids (oBrix), fruit size arrangement in three categories (-1 and 30/70 NAR was the most outstanding, the NAR was the most influential factor in all measured variables. Respect to the total soluble solids, there was not observed statistical significant difference, which varied from 14.4 to 15.44 °Brix; anthocyanin's content was strongly





influenced by fruit size, the average of the largest fruit category was 85 mg/100 g, in contrast the smallest blueberries recorded an average of 141 mg/100 g.

**Keywords:** *Vaccinium corymbosum* L., nutrient solution, Brix, anthocyanins

## OS 3-6:

### ARTIFICIAL SHORTENING OF DAY LENGTH TO ADVANCE THE FLOWER INDUCTION PERIOD OF SONATA

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Within the European Goodberry framework research is executed to create new possibilities in flower induction and dormancy in soft fruit cultivations. In Belgian strawberry cultivation a year round production is realized with the introduction of SON-T or LED assimilation lamps to create harvest periods in winter and early spring. The variety Sonata is preferred in early spring for its high fruit quality, high production potential and the regular fruit setting even when growth is strongly forced with heating and lighting regimes. The Junebearer Sonata is grown into a trayplant during autumn in Belgium, flower induction and the build-up of production potential occur between half of September and half of November. Due the high chilling requirement of the variety, trayplants cannot be planted before the 25th of December and harvest cannot start before end of March. Research Centre Hoogstraten started to cover developing Sonata trayplants from 7 August 2017 each evening at 19.00pm until 9.00 am in the morning to artificially shorten the day length towards 10 hours. Covering the plants was executed each night until 24 September. Sonata could advance the start of the flower induction phase from 19 September to 29 August. The trayplants were put into cold storage on the 31st of October, an advancement of 28 days. After 6 weeks in cold storage the trayplants were planted in a greenhouse with SON-T assimilation lamps on 29 November. At the end of January the plants carried the first white, set fruits and the first harvest is expected close to 15 February 2018. The artificial day shortening realized therefore an advancement of the start of the harvest period of around 40 days.

**Keywords:** strawberry, flower induction, Sonata, shortening daylength, winter cultivation

## SESSION IV:

### OS 4-1:

### BLACKBERRY (*Rubus* spp.) IN SAO PAULO, BRAZIL: ADAPTABILITY AND FERTILIZATION WITH NITROGEN AND POTASSIUM

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A field experiment was carried out in São Paulo State, Brazil, with the objective of investigating the adaptability and response to fertilization with nitrogen (N) and potassium (K) of four cultivars (cv) of blackberry (*Rubus* spp.). The nutritional status of the blackberry is one of the factors that most influence the amount of fruits and fruit quality. A split-plot design was used with a combination of four rates of N (0, 75, 150 and 300 kg ha<sup>-1</sup> of N) and K (0, 50, 100 and 200 kg ha<sup>-1</sup> of K<sub>2</sub>O) applied to main plots and four cv (Tupy, Choctaw, Brazos and Guarani) as the sub-plots treatments. All cultivars presented a positive response to the application of N and K with increase in fruit yield. In the first production cycle, maximum yield was obtained with the application of 216 kg/ha<sup>-1</sup> of N and 145 kg/ha<sup>-1</sup> of K<sub>2</sub>O. The cv differed significantly in phenology and fruit production. The 'Choctaw' was the later and less productive (3.3 t/ha), while 'Brazos' reached 6.7 t/ha. Besides studying crop responses to fertilization with N and K, establishing production functions, it is intended to support the review of the management recommendations of the blackberry, especially for the growing conditions of the Jundiaí region in São Paulo.

**Keywords:** plant nutrition, K, N



## OS 4-2:

### EFFECT OF PROCESSING METHODS ON QUALITY OF BLACKBERRY JUICE

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The manufacture processes of clarified blackberry juice include extraction, clarification, pasteurization and storage, which all affect the quality of juice including anthocyanin content in juice and light transmittance and color of juice. In the extraction stage, the use of pectinase drastically increase light transmittance from 27% to 74%, but decrease anthocyanin content by 5%~22%. In the clarification stage, the juice was clarified by gelatin, chitosan and bentonite and still-treatments at -2

results showed that the still-treatment at -2 °C for 6h and 12h as light transmittance of the obtained clarified juice achieve up to 80% and the anthocyanin retention rate achieve up to 95%. In the sterilization stage, total anthocyanins content of clarified blackberry juice dramatically decreased by 25%~36% and the light transmittance decreased by 7%~13% with pasteurization at 90 °C for 3min. In the storage stage, the test results showed that clarified juice was more stable when stored at 3 °C~5°C than 23°C for 13 weeks.

**Keywords:** blackberry; juice; extraction; clarification; pasteurization; storage

## OS 4-3:

### PHYSIOLOGICAL MECHANISMS OF POST-HARVEST RED DRUPELET REVERSION IN FRESH BLACKBERRIES

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Red drupelet reversion is a physiological disorder in blackberry fruit which causes individual drupelets that are black at harvest to revert to a red colour, usually during post-harvest cool storage. The disorder can affect anywhere from a single drupelet to over half of a fruit, and can occur in the majority of a crop in severe cases. The objectives of this study were to examine the physiological mechanisms and identify changes occurring at a whole-fruit, drupelet, and cellular level when a fruit is affected by the disorder. Affected drupelets contained 43% of the total anthocyanin content of unaffected drupelets, with acylated and disaccharide-substituted anthocyanin species proving less susceptible to degradation than the dominant monosaccharide-substituted cyanidin-3-glucoside. Electrolyte leakage from affected drupelets was significantly increased indicating cell membrane damage. Microscopic examination observed changes to cell structural characteristics including larger intracellular spaces and vacuolar shrinkage in affected tissue. Preliminary evidence suggests that mechanical damage causing cellular decompartmentalisation leading to anthocyanin degradation is a key mechanism in the development of red drupelet reversion in blackberries.

**Keywords:** blackberry, reversion, physiology, red drupelet disorder

## OS 4-4:

### YEAR ROUND PRODUCTION OF THE PRIMOCANE RASPBERRY CULTIVAR KWANZA

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Cv. Kwanza has attracted much attention since its introduction in 2011. Kwanza fruit is light in colour and extremely firm, making it compared to other previously grown 'primocane' cultivars highly suited for West-



European markets. Before the introduction of Kwanza, raspberry production was dominated by 'floricane' varieties. In such systems harvest is preceded by an intensive nursery year necessary for optimizing production the following year. The introduction of cv. Kwanza, a 'primocane' fruiting type, offers growers the opportunity to explore new growing techniques and innovative methods with plant material to create greater production efficiencies. Ideally year round production of Kwanza with minimum gaps in supply would be achieved. This is therefore the objective of recent research efforts taking into account cost, quality and production parameters. To this end various cultivation techniques have been developed the last 7 years, whereby a range of trial possibilities is created by each. Variation in the sequence of crops, planting date and storage time are a few examples. The purpose of this article/poster is to show the current potential and limitations of cv. Kwanza.

**Keywords:** Kwanza, primocane raspberry, year round production, cultivation techniques, optimization

## OS 4-5:

### A WELL-BALANCED NUTRIENT SOLUTION FOR RASPBERRIES

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A well-balanced nutrient solution for raspberry production on substrate is the key to healthy growth, reducing susceptibility to pest and disease and optimizing flower and fruit quality. Primocane raspberry cultivar 'Kwanza' is highly productive and lends itself to a single crop during one season. The production method shows a lot of similarities with a typical floricane culture however much greater production efficiencies can be realized. Despite these efficiencies fruit quality during autumn in the greenhouse is often lacking. Reduced fruit firmness and a typical weakening of the skin are among the most important shortcomings of the cultivar. An optimal fertigation strategy for Kwanza has been the subject of several years of research with particular attention to improving fruit quality whilst maintaining its productivity. It is generally recognized that from fruit-bearing onwards the plant demand for potassium strongly increases. Old and senescing leaves show symptoms of potassium deficiency readily commencing from then. Research over the past three years clearly indicates an important increase in the plant demand for potassium already prior to bearing fruit and more particularly from the commencement of flowering. This information is important to estimate when a grower must switch from a vegetative feed regime towards a more generative one (higher potassium concentrations). High potassium concentrations in the nutrient solution during fruiting (generative phase) in Kwanza are used to overcome the earlier described shortcomings of the cultivar, however, a higher number of misshaped fruits and a greater incidence of dry sepals on fruit is often observed.

**Keywords:** raspberry, fertigation, vegetative/generative, nutrient solution, substrate

## OS 4-6:

### EFFECT OF FOLIAR POTASSIUM FERTILIZATION ON YIELD AND FRUIT QUALITY OF STRAWBERRY, RASPBERRY AND BLUEBERRY

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On-farm trials were conducted to evaluate the effect of potassium foliar fertilization on yield and fruit quality of strawberry, raspberry and blueberry at Gharb region (Morocco) in 2017. Foliar fertilization treatments were: (T<sub>0</sub>) Control, (T<sub>1</sub>) A foliar application of 1.6% K<sub>2</sub>SO<sub>4</sub> at flowering stage, (T<sub>2</sub>) A foliar application at fruit growing stage and (T<sub>3</sub>) Two foliar applications at flowering and fruit growing stages. Experimental designs were a completely randomized block with 3 replications. Data collected included growth parameters, fruit production and fruit quality parameters. For strawberry, a single foliar potassium spray at flowering increased yield by 10%. Two sprays increased yield by 7%. A single foliar application during fruit growth did not affect yield but increased fruit size by 4%. Foliar fertilization improved sugar content and acidity of strawberry fruits but not dry matter content. Chlorophyll content, leaf area and stomatal resistance of strawberry leaves were increased by foliar potassium fertilization. For raspberry, foliar potassium fertilization increased leaf chlorophyll, stomatal



resistance and yield. Two foliar sprays increased yield by 40%. A single foliar application during fruit growth increased yield by 29% but had no effect on yield when applied at flowering. Two foliar sprays of increased raspberry fruit size by 6%. Raspberry fruit acidity was reduced by 13% with a single foliar potassium application and by 6% with two applications. Foliar fertilization had no effect on sugar or dry matter contents. For blueberry, a foliar application during fruit growth improved fruit yield by 13% and fruit size by 19%. Application at early flowering increased fruit size by 13%. Foliar fertilization increased sugar and dry matter contents without affecting acidity or pH. Foliar fertilization increased leaf chlorophyll content and reduced stomatal resistance. Overall, potassium foliar fertilization improved berries yield and fruit quality as well as crop growth parameters.

**Keywords:** foliar fertilization, potassium, strawberry, blueberry, raspberry

## OS 4-7:

### COMPARISON OF VOLATILES IN VARIOUS RASPBERRY FRUITS BY HS/SPME/GC/MS TECHNIQUES

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As a member of the Rosaceae family raspberry (*Rubus idaeus* L.) is a producing a red fruit with a sweet but enthusiastic flavor. Volatile compounds play a key role in the formation of the flavor of food products. The chemical and physical properties of the different volatiles vary, and this may influence the results obtained in volatile determinations depending on the method used. Headspace and solvent extraction methods are mostly used to characterize berry aroma by analyzing volatile compounds. HS-SPME (Headspace-Solid Phase Micro Extraction) technique is a solvent-free, in-expensive, rapid and versatile method for the extraction of organic compounds. Although, the economic and nutritional importance of raspberry, there has been very limited papers in the literature related to volatile compounds in this fruit. The aim of the present work was to compare various raspberry varieties such as 'Kweli', 'Tulameen' and 'Imara' by HS-SPME GC/MS (Gas Chromatography/Mass Spectrometry) based on their volatile profiles.

**Keywords:** SPME, raspberry, GC/MS, volatiles

## OS 4-8:

### COMPARISON OF STRAWBERRY (*F. ×ananassa* cv. 'Florida Fortuna') VOLATILES USING VARIOUS SPME FIBERS BY GC/MS TECHNIQUES

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The cultivated strawberry (*Fragaria ×ananassa* Duch.) is an important berry crop in the world due to the having flavorful taste, unique and highly desirable aroma. Sugars, acids, and aroma volatiles contribute to the characteristic strawberry flavor, which is dependent on the proper balance of these chemical constituents. While sugars and acids are responsible for the sweetness and tartness of the fruit, aroma volatiles provide the unique, fruity flavors that characterize a strawberry. Esters are quantitatively and qualitatively the most abundant class among the flavor compounds. Headspace extraction methods provides especially the SPME (Solid Phase Micro Extraction, is a solvent-free, inexpensive, rapid and versatile method for the extraction of flavor compounds. There are many kind of fibers that used identification of volatile compounds. In this paper, it was aimed compare various SPME fibers (CAR/PDMS, PDMS, CAR/PDMS/DVB) using GC/MS (Gas Chromatography Mass Spectrometry) to identify volatile compositions in fruits of Florida Fortuna cultivar.

**Keywords:** strawberry, flavor, SPME, GC/MS







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## KEYNOTE 2

### MULBERRY: A MIRACLE FRUIT

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Mulberry (*Morus*, *Moraceae*) plants are distributed widely in temperate, subtropical and even tropical regions in the world. Both fruits and leaves from *Morus* have been used as medicinal materials and nutritional foodstuff. Mulberry fruit now well known as functional fruit and there were enormous number studies conducting on this miracle fruit. In temperate regions, mulberry fruits harvested several times in a single fruiting season thus mulberry trees are distinct high yield characteristics which very attractive for farmers. Studies showed that several mulberry species such as *Morus alba*, *Morus nigra* etc. has been used as an edible fruit and traditional medicine in mulberry growing countries such as China, Turkey, India etc. Mulberry fruits are very rich for nutritive compounds such as fatty acids, amino acids, vitamins, minerals, and bioactive compounds, including anthocyanins, rutin, quercetin, chlorogenic acid, and polysaccharides. Furthermore, the extracts and active components of mulberry fruit have demonstrated numerous biological activities, including antioxidant, neuroprotective, antiatherosclerosis, immunomodulative, antitumor, antihyperglycemic, and hypolipidemic activities in in vitro and in vivo studies, and they have received increasing interest from researchers and pharmaceutical companies.

**Keywords:** mulberry, diversity, distribution, human health content



## SESSION V:

### OS 5-1:

#### SELECTION OF MULBERRY (*Morus alba*) IN GİRESUN PROVINCE TURKEY

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This research was carried out in Giresun province in Turkey for determining characteristics of 36 selected mulberry (*Morus alba*) types in 2013-2014 years. In the scope of productivity observations, fruit weight, total soluble solid (TSS), seedless, fruit juice yield, fruit dry yield, titratable acidity and taste were measured. Among the selected types fruit weight ranged 0.75-3.26 g, total soluble solids 12.80-26.73%, fruit juice yield 19.58-48.13% and titratable acid contents 0.04-0.18 mg 100 ml-1. These types are intended for fresh consumption, pekmez, for drying and processing in jam.

**Keywords:** *Morus alba*, selection, yield, fruit quality, Giresun

### OS 5-2:

#### A REFINEMENT AND CATEGORIZATION OF *Lycium barbarum* SUBSTRATE PH VALUES AND NUTRIENT DISORDERS

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To produce goji berries [*Lycium barbarum*], growers must be equipped with cultural information to recognize and remedy nutrient disorders and pH imbalances. pH and nutrient diagnostic criteria for goji are absent from current literature. Therefore, goji plants were grown in two studies to determine nutrient disorders and optimal substrate pHs. In experiment 1, two goji cultivars were grown to determine an optimal substrate pH for early plant establishment. The goji plants were grown using an 80:20 peat perlite mix calibrated to four target pHs (5.0, 6.0, 7.0 and 8.0) and allowed to grow for five weeks. Upon termination, data was taken on plant dry weight, height and diameters, SPAD values, and plant tissue values. Results indicate that the optimal pH for goji is between 6.0 and 7.0. In both lower and higher pH substrates, plants exhibited stunting and either had adequate green coloration (lower pH) or interveinal chlorosis and yellowing (higher pH). Plants grown in the desired pH range were larger and exhibited darker green growth and higher SPAD values. In the second study, plants were grown in silica sand culture to induce nutrient deficient conditions. Nutrient-deficient treatments were induced with a complete nutrient formula minus a single nutrient. Boron (B) toxicity was induced by increasing the element 10-fold. Daily documentation and photographs were taken of symptoms as they developed. Out of 13 treatments, nine exhibited symptomologies. Symptoms of manganese (Mn), phosphorus (P), potassium (K), iron (Fe), and sulfur (S) deficiencies, manifested early therefore, these nutrients should be monitored more closely by producers. Unique symptoms were observed on N, P, and Mg deficient plants.

**Keywords:** substrate pH, nutrient disorders, goji berries, macronutrients, micronutrients, deficiency, toxicity

### OS 5-3:

#### INTERACTION BETWEEN ABA METABOLISM AND LIGHT QUALITY ON ANTHOCYANIN AND SUGAR SYNTHESIS IN GRAPES

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The interaction between abscisic acid (ABA) and blue or red light irradiation on anthocyanin and sugar syntheses in 'Kyoho' (*Vitis labrusca* × *V. vinifera*) grape berries was examined. The following two experiment groups were created in 2015. In the first group, ABA antagonist of PYL-PP2C receptor (AS-6) was treated to the



cluster at 38 days after full bloom (DAFB) (one week before veraison) and 48 DAFB (veraison). The second group was the untreated control group. The anthocyanin and sugar concentrations, ABA metabolism, and their related gene expressions were analyzed at 38, 48, 58, and 68 DAFB. The anthocyanin, glucose, fructose, sucrose concentrations, and the VIMyBA2 and VvUFGT expression levels were inhibited in AS-6 treated berries. In contrast, the expression levels of VvPC2C9 in AS-6 treated berries were increased at 48 DAFB. These results suggest that endogenous ABA is associated with anthocyanin and sugar syntheses in grape skin. To consider the effects of light on ABA metabolism and anthocyanin formation, three experiment groups were created in 2016. In the first group, blue (clusters)/blue (leaves) LED was irradiated for six hours at night from full bloom to harvest. In the second group, blue (clusters)/red (leaves) LED was similarly irradiated. The third group was the untreated control. The VvNCED1 expression levels were increased in the first and second groups compared to the untreated control. The CYP707A1 expression levels in the second group was decreased at 62 DAFB. The VvPP2C9 expression levels in the first and second groups were inhibited. These expression levels influenced ABA concentrations in the skin. The anthocyanin concentrations were increased in the first and second groups. These results suggest that light quality influences ABA metabolism, resulting in anthocyanin formation in the grape skin.

**Keywords:** plant hormones, Absciscic acid, grapes, Anthocyanin, gene expression

## OS 5-4:

### THE EFFECTS OF DIFFERENT HARVEST TIME ON BIOCHEMICAL CONTENTS OF BLACK MYRTLE (*Myrtus communis* L.) FRUITS

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The myrtle (*Myrtus communis* L.) is a member of the Myrtaceae family, it deploys in the coastal areas of the Aegean, Marmara and Mediterranean regions and it is an evergreen typical Mediterranean bush. Because of myrtle which grows naturally in the ecologies dominated by the Mediterranean climate, is showing resistance to the disease, harmful and negative soil conditions, it is allowing for growing organically of its fruits. The myrtle is growing naturally in our country in two types as white and black fruit. The black myrtle fruits are mainly consumed as fresh fruit (edible), dried fruit and fruit tea, also it is used in the marmelade and jam production. There are great interest for black myrtle fruits because of their high antioxidant capacities and phenolic properties. The aim of this study is to determine the variations of the biochemical contents of black myrtle fruits at different ripening stages. Black myrtle fruits which were collected at 15-day intervals in Antalya in 2016 were used as a material of the study. This study is to determine the total phenolic content, total flavonoid content, total anthocyanin and antioxidant activity in the fruits of the black myrtle. As a result, it was found that there are significance differences between the different harvest times of the fruits of black myrtle. The highest total phenolic content (4754.27 mg/GAE 100) and total flavonoid content (506.07 mg/CTE 100) were recorded at 1st harvest, whereas antioxidant activity (1430.78  $\mu$ M troloks/g) was recorded at 5th harvest. Moreover, total anthocyanin content increased by each harvest.

**Keywords:** black myrtle, fruits, harvest time, biochemical content





## POSTER PRESENTATIONS

### SESSION I: ALL POSTERS

#### PS 1-1:

#### FLOWER PRODUCTION AND EFFECT OF FLOWER HARVEST ON BERRY YIELDS WITHIN SIX AMERICAN ELDERBERRY GENOTYPES

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American elderberry (*Sambucus nigra* subsp. *canadensis*) is being increasingly cultivated in North America for its use in dietary supplements. While the flowers of European elderberry (subsp. *nigra*) are commonly consumed as an anti-viral in Europe, the horticultural production of American elderberry flowers is nascent. A large field experiment with American elderberry was established in 2015 in southwest Missouri, USA to evaluate flower production and to determine the impact of a partial flower harvest on fruit yield and quality, and plant morphology. The study concurrently compared four promising new genotypes to two established cultivars. In 2017, 96 randomized plots with six genotypes were assigned treatments of 0, 20, 30, and 100% flower harvest, with four replicated plots per genotype/treatment. Flower and fruit production data, pest and disease incidence, phenology, plant growth response, and fruit quality data were determined. The six genotypes showed differences in flower cyme number, total flower dry matter produced, mean cyme size, budbreak, fruit ripening date, fruit yields, berry size, and plant height. The experimental genotypes Pocahontas and Rogersville showed promise in terms of flower and fruit productivity, and produced taller plants compared with the standard cultivars Bob Gordon and Wyldewood. While total fruit yields were correspondingly reduced in plots that received 0, 20, and 30% flower cyme harvests (3.6, 3.0, and 2.9 kg fruit per plot, respectively), these differences were not statistically significant. Likewise, mean fruiting cyme weight, berry size, soluble solids in fruit, and plant height were not affected by the various flower cyme harvest treatments. While these results are preliminary, up to 30% harvest of flower cymes did not significantly reduce elderberry fruit yields, but neither did it improve berry size or fruit quality as might have been expected.

**Keywords:** sambucus, elderberry, flower harvest, yield

#### PS 1-2:

#### COMPARISON OF THE CHANGES IN TEXTURE AND CELL WALL POLYSACCHARIDE COMPOSITION DURING RIPENING OF *Fragaria* × *ananassa* and *Fragaria chiloensis* FRUITS

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Changes in texture and cell wall polysaccharide composition were compared during fruit growth between *Fragaria* × *ananassa* 'Camarosa' and *F. chiloensis* '94BAU-1A' from immature green to ripe stages. Firmness of both fruit and cortex in '94BAU-1A' decreased faster than that of 'Camarosa' as the fruit matured, resulting in softer fruit and cortex firmnesses. Cell wall polysaccharides in maturing fruit differed significantly between '94BAU-1A' and 'Camarosa'. Although uronic acid concentration in the water-soluble fraction increased as the fruit matured, irrespective of genotype, the value of '94BAU-1A' was higher than that of 'Camarosa'. Neutral sugar concentration in the water-soluble fraction also increased as shown in the uronic acid concentration, but the values did not differ significantly between the two genotypes throughout the growth stages. In contrast to the water-soluble fraction, uronic acid concentrations in the Na<sub>2</sub>CO<sub>3</sub>-soluble fractions decreased as the fruit matured, especially in '94BAU-1A'. In 'Camarosa', neutral sugar concentration in the KOH-soluble fraction decreased gradually throughout the growth stages, while that of '94BAU-1A' decreased from green to green-white stages and remained constant thereafter, resulting in similar values between the two genotypes at the ripe stage. In '94BAU-1A', high molecular polyuronides in the water-soluble fraction was lost from green-white to



white stages, while that of 'Camarosa' was fairly sustained. On the other hand, the profiles of molecular size distribution of polyuronides in the Na<sub>2</sub>CO<sub>3</sub>-soluble fraction did not apparently differ between the two genotypes.

**Keywords:** gel filtration, firmness, hemicelluloses, pectin

## PS 1-3:

### STRAWBERRY 'FLAIR' AND 'FELICITA' SUITABILITY FOR FORCING UNDER HIGH TUNNEL

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Strawberry cultivars 'Zehyr', 'Honeoye' and 'Rumba' are grown for early production in Latvia. In open field conditions, 'Zephyr' is early and productive, however, it is not suitable for early yield in high tunnels. 'Honeoye' is appropriate for growing in tunnels, while due to rather sour taste it is not well appreciated by consumers. 'Rumba' has good berry quality, while it is not enough winter hardy and berries come few days later than 'Honeoye'. Two new Dutch cultivars 'Flair' and 'Felicitas', and 'Rumba' as a control were included in this study. The trial was established in August 7, 2014 in the FVG high tunnel (60x4x3.32m; 240 m<sup>2</sup>). Frigo plants: category A+ for 'Flair' and 'Felicitas' and category A for 'Rumba' were used. Plants were planted in double rows in planting distances 0.30 x 0.25 m and 1.20 m between row centers (6 plants per m<sup>2</sup>). Beds were mulched with black plastic, supplied by drip irrigation. The number of inflorescences per plant; number of flowers per inflorescence; average number of flowers per plant; productivity; berry weight, quality and the assessment of storage were evaluated. The number of inflorescences depended on the plant age and the category of plants. The higher plant category, the more inflorescences on the plant were observed. Besides, the number of inflorescences increased by every year. The increase in number of inflorescences had effect on the berry weight and quality. The more flowers and berries were observed, the berries were smaller. 'Flair' had the highest yield per plant, better berry firmness and a higher content of soluble solids than control cultivar 'Rumba'. 'Rumba' had the highest sensory evaluation among evaluated cultivars, while 'Flair' got the highest taste rating. According to evaluation results obtained in 4-year period 'Flair' might be suitable for forcing of yield under high tunnels in Latvia.

**Keywords:** *Fragaria × ananassa* Duch, 'Rumba', number of inflorescences, yield, berry quality

## PS 1-4:

### FRUIT PRODUCTIVITY AND QUALITY OF STRAWBERRY PLANTS IN RESPONSE TO DIFFERENT LIGHT CONDITIONS: ADDITIONAL LED LIGHTING IN SPRING AND SHADING IN SUMMER

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Light-emitting diodes (LEDs) have tremendous potential as supplemental or sole-source lighting systems for crop production. The effect of supplemental lighting was tested on yield and fruit quality of strawberries grown on substrate under plastic tunnels (cv. Joly, tray plants). The control treatment were exposed to sunlight only and for the LED treatment the plants were exposed also to supplemental LED light (from 05.30 to 9.00 and from 18.00 - 21.30) from the very beginning of flowering to the end of harvest. The additional light had an intensity (PAR) of 40 µmol/m<sup>2</sup>/s at plant height. The results showed, that yield and fruit weight were not influenced by light treatments. However, fruit soluble solids content, an index of sweetness, were increased significantly under additional LED lighting. During summer the temperature can increase very high, up to 45°C, especially under plastic tunnels. Under such conditions the effects of shading (40 % less light) from beginning of June to end of August on yield and fruit quality of strawberries grown on substrate (cv. Morano, mini-tray plants) were analysed. Photosynthesis, yield, fruit weight and soluble solid contents of the fruits were significantly lower in the shading treatment under plastic tunnel compared to the non-shaded plants. However, number of inflorescences and fruit number were not significantly influenced by shading. The importance of light conditions for strawberry production are discussed.



**Keywords:** *Fragaria ×ananassa*, fruit quality, LED lighting, photosynthesis, shading, yield

## PS 1-5:

### IDENTIFYING STRAWBERRY RESILIENT CULTIVARS WITH REDUCED WATER DEMAND

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Strawberries cultivation systems generally requires high amounts of water supply, especially in some phases of the cultivation cycle. New strawberry cultivars with lower water demand are now requested to reduce input in the cultivation process, to reduce costs, to save this precious resource and increase adaptability to changing climatic conditions. With the aim to study the genotype effect on water demand, the yield and fruit quality of different strawberry cultivars ('Cristina', 'Romina', and 'Sibilla') grown at reduced water restitution (80% and 60%) were compared with the full (100%) restitution of water lost from restart of growth to fruit ripening. To monitor the response to these treatments, vegetative (n° of crown/plants, n° and size of leaves, plant height, n° floral axis), productive (ripening period, average weight of the fruit, commercial and total production, unmarketable production), and qualitative (sugar content, titratable acidity, fruit color and firmness) parameters were detected. The water reduction affected in different manner the three cultivars, with 'Cristina' and 'Romina' resulting the most adaptable to these resilient conditions. In particular, with 80% water restitution, 'Cristina' and 'Romina' did not show negative effects on plant development, while 'Sibilla' showed plant wilting and reduced plant development and yield. Fruit quality of the three cultivars was not altered by water reduction, except for the sugar content, that increased at decreasing amounts of water restitution. The three cultivars highly suffered the reduction at 60% of water restitution. The results confirm the importance of genotype rusticity for reducing water use in strawberry cultivation systems. 'Cristina' and 'Romina' are able to maintain regular plant development, yield and fruit quality at 80% of water restitution. At a further reduction (60%) at a lower yield correspond an increased fruit quality. The research will continue to identify other new cultivars even with higher resilience to water limitation.

**Keywords:** cultivation systems, rusticity, water stress

## PS 1-6:

### FRUIT QUALITY CHARACTERISTICS OF SOME STRAWBERRY VARIETIES IN DİYARBAKIR REGION OF TURKEY

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The sugars and acids, together with small amounts of dissolved vitamins, proteins, pigments, phenolics, and minerals, are commonly referred to as soluble solids. Total soluble solids to total acids ratio is a very important parameter in evaluating fruit quality, because it determines fruit flavour harmony. Like other fruits sweetness is a desirable attribute that is often governed, in part, by sugar concentration. Therefore, the determination and quantification of sugars and sweetness is of great importance in many fields of plant food sciences research. The changes in composition of sugars and organic acids and volatile compounds during ripening process play a key role in flavor development and can affect the chemical and sensory characteristics of fruit. For this reason, the assessment of sugars and organic acids content of a fruit is of interest to food experts and researchers. In this study, it was aimed to compare sugar and organic acid profiles and their ratios in Kabarla, Sweet Ann, Albion, DPI Rubygem, Festival, Sweet Charlie strawberry varieties. Sugar and acid compounds were identified and quantified using HPLC techniques.

**Keywords:** strawberry, HPLC, sugars, organic acids

## PS 1-7:



## **PHENOLOGICAL DESCRIPTION FOR THREE NEW MEXICAN CULTIVARS OF STRAWBERRY (*Fragaria ×ananassa* Duch) IN VEGETATIVE PROPAGATION AND UNDER A PROTECTED SYSTEM**

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Phenological description is obligated during the evaluation of any cultivar before it is introduced into a new cropping system. In this study, three strawberry cultivars recently released in central Mexico were evaluated under a high tunnel in 2015 and 2016 in order to describe their phenological behavior during vegetative propagation either on soil or on soilless culture. Cultivars 'CP-06-15', 'Jacona' and 'Zamorana' were compared in a split-plot design; the commercial cultivar 'Albion' was used as a reference in 2016. In general, cultivars behaved similar with 799-870 and 623-627 growing degree days (GDD) needed to begin the stolon emission in 2015 and 2016, respectively; also, 1315-1334 and 792-883 GDD were needed to begin the sprout formation in 2015 and 2016, respectively. Stolon emission period was 63-70 and 71-80 days long in 2015 and 2016, respectively, while sprout formation lasted 60-65 and 40-48 days in 2015 and 2016, respectively. Regarding cropping systems, soilless cropping by hydroponics in volcanic gravel advanced stolon emission only in 2015 comparing with soil cropping (803 vs 874 GDD;  $p=0.002$ ) but not in 2016 (625 GDD for any cropping system). Sprout emission was delayed by the soilless cropping comparing to soil cropping in both years (1365 vs 1272 GDD,  $p=0.001$  in 2015; 884 vs 804 GDD,  $p=0.041$  in 2016). Sprouting period length was not affected by the cropping system and the stolon formation period was longer in soilless than in soil during 2015 (71 vs 63 days;  $p=0.011$ ) although this relation got inverted in 2016 (63 vs 86 days;  $p=0.002$ ). As a conclusion, strawberry Mexican cultivars 'CP-06-15', 'Jacona', 'Zamorana' and the commercial 'Albion' behave similar regarding phenology of stolon and sprout formation; also, soilless cropping by hydroponics in volcanic gravel may retard the sprout emission comparing with the soil cropping.

**Keywords:** growing degree days, stolon, sprout, soilless

### **PS 1-8:**

## **PLANT GROWTH, YIELD AND FRUIT QUALITY OF *Fragaria ×ananassa* GENOTYPES UNDER SUPPLEMENTAL LED LIGHTING SYSTEM AND SUBSTRATE CULTIVATION**

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The use of substrates in protected strawberry production is increasing rapidly among growers with the advantages of prolonging the growing season, increasing yield and improving fruit quality. Under protected crop it has been reported that low light conditions may reduce plant productivity. An experiment was conducted from November 2014 to May 2015 to evaluate if light levels during autumn and winter period were limiting for strawberry growth under Portuguese conditions. Plant growth, precocity, total yield and fruit quality of eight *Fragaria ×ananassa* genotypes grown under LED light and without supplemental light, using 'Camarosa' as standard cultivar were examined. Fresh bare-rooted plants were cultivated in two commercial substrates, a substrate mix (40% pine bark + 40% peat + 20% coconut-fiber) and coconut-fiber (100%), under glasshouse located in Oeiras (38° 41' N, 09° 19' W). Plants exposed to supplemental LED lighting showed a tendency to be more vigorous although this effect was not statistically significant. Fruit yield did not change with LED lighting but on contrast there was a strong effect of substrate (*Fragaria ×ananassa* relied above all on genotype and substrate type).

**Keywords:** strawberry, light-emitting diode, glasshouse, leaf area, fruit yield, fruit quality

### **PS 1-9:**

## **COMPARISON AND COMPREHENSIVE EVALUATION OF FRUIT QUALITY OF DIFFERENT BLUEBERRY VARIETIES**





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In the present study, fruit quality of 22 blueberry varieties introduced in Shandong province were analyzed and comprehensive evaluated. The results showed that the nine quality indicators are greatly different among different blueberry varieties. Variation coefficients of fruit weight, fruit specific gravity, hardness, soluble solid content, valid acidity value (pH), anthocyanin content, vitamin C (VC) content were all greater than 10.00 %, indicating high difference between varieties. Meanwhile, variation coefficients of fruit shape index and peel brightness index (L\*) were less than 10.00 %, which were more stable indicators. Seven quality indicators including fruit weight, fruit shape index, hardness, L\*, soluble solids, pH and anthocyanin were screened out, using correlation analysis and principal component analysis method, as the core indicators to comprehensive evaluate fruit quality of different blueberry varieties. Analytic hierarchy process was applied to give weight to the core index, and mathematics model of comprehensive evaluation was established to calculate the comprehensive evaluation index of different blueberry cultivars, thereby evaluating the fresh and processing suitability of different blueberry varieties. According to the main quality indexes of blueberry, the system cluster analysis of 22 blueberry varieties was carried out by using the IBM SPSS Statistics 20.0 Pearson correlation method. The classifications of 22 blueberry varieties obtained from both two methods were consistent, show that principal component analysis and cluster analysis can be used to analyze the blueberry fruit quality index, comprehensive evaluate the fresh and processing suitability of different blueberry varieties.

**Keywords:** blueberry; quality characteristics; core indicators; variation coefficients; principal component analysis; cluster analysis

## PS 1-10:

### EFFECT OF WATER STRESS ON BLUEBERRY CULTIVATION IN POTS

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RDI is applied in countries with arid climates as it saves water more than in humid or temperate climates. Water deficit beyond the allowed limit will have negative consequences which are reflected in the development and ripening of fruits. In this paper, we investigated the effect of water stress caused by regulated deficit irrigation (RDI) on highbush blueberry cv. Bluegold cultivated in pots. Our study was conducted in Kosovo during 2017 in a two-year old blueberry, using a nested experimental design. Spacing between rows was 2 m apart within rows spacing was 0.60 m. The aim was to assess the different levels of irrigation on production indices. Three levels of irrigation were applied, four irrigation drippers; three drippers; and two irrigation drippers. For each treatment we used 10 trees in pots (volume 20 l). Based on two-way analysis of variance, we found significant changes in: fruit weight, total yield and length of fruit while, changes were not significant for fruit number and fruit diameter. For all indices, the lowest values were found in treatment with two irrigation drippers demonstrating that under our climatic conditions blueberry cultivation in pots cannot be performed with less water or without irrigation. Considering the young age of highbush and long-term consequences of water stress the experiment will be continued.

**Keywords:** bluegold, water stress, RDI, pots

## PS 1-11:

### APPLICATION OF GIBBERELIC ACID AND CPPU INCREASES BERRY SIZE AND YIELD OF Highbush BLUEBERRY (*Vaccinium corymbosum*) 'SPARTAN'

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Highbush blueberry fruits produced in Japan are usually screened for size. Aiming to produce large berries, we investigated the effects of applying gibberellic acid (GA) and CPPU on mature highbush blueberry plants of the cultivar 'Spartan'. Experiments were conducted from 2011 through 2017 in the experimental field of the Department of Agriculture at the Tokyo University of Agriculture, in Japan. In 2011 and 2012, the effects of a single application of 100 mg L-1 GA, 10 mg L-1 CPPU, or a mixture of both growth regulators at these same concentrations were analyzed. Each compound was sprayed on blueberry bushes 4 to 6 days after 80% flowering. The results showed that fruit set was sufficiently high even in untreated controls, whereas no significant treatment effect on fruit set could be detected. Compared to controls, GA, CPPU, and the mixture application increased average berry weight by 20 to 26%, 12 to 23%, and 38 to 49%, respectively. The total yield of treated plants was 0.3 to 1.4 kg/bush higher than that of controls. However, berry maturity was delayed by a few days in the CPPU- and mixture-treated plants. In 2016 and 2017, a combination of a 100 mg L-1 GA spray 5 days after flowering and a 20 mg L-1 CPPU spray 10 days after flowering was tested. Although it delayed berry maturity by a few days, the combination treatment increased berry weight by 14 to 32% (i.e., 2.9 g in 2016 and 2.7 g in 2017); meanwhile, the total yield was 1.0 to 1.3 kg/bush higher (i.e., 3.8 kg/bush in 2016 and 3.5 kg/bush in 2017) than that of untreated controls. Our results indicate that the application of both GA and CPPU was effective in enhancing the production of large berries and fruit yield of highbush blueberry 'Spartan.'

**Keywords:** GA, forchlorfenuron, fruit set, berry weight, berry-size distribution, berry maturity

## PS 1-12:

### FIELD PERFORMANCE OF 'BLUECROP' Highbush BLUEBERRY IN A SOILLESS GROWING SYSTEM BY USING DIFFERENT FERTILIZERS

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Highbush blueberries (*Vaccinium corymbosum* L.) are considered commercially important blueberry types and recently have become a popular commercial crop in Republic of Serbia covering the total area more than 300 ha (Milivojević et al., 2017). Although the majority of blueberries are soil grown, interest in soilless culture has also increased recently. In both growing systems plants are typically planted in substrate mixture consisted of moistened peat moss and pine sawdust replacing of the original soil with the organic material. The pH in the growing media is maintained at a sufficiently low level within the range of 4.0 to 5.0. Soilless culture system may offer new advantages, such as: easier nutrient management and better control of irrigation with manipulating plant growth, fruit to shoot ratio, and fruit quality. This production system enables higher planting densities (4.170 plants per ha) aiming to reach maximum production per unit area. In our experiment, 5-year-old plants of 'Bluecrop' blueberry were planted in 50 l polypropylene pots at the beginning of April 2016. The growing media was pine sawdust (65%), white peat (30%) and perlite (5%). Each pot was filled with the mix and placed at distance of 0.8 m within the row and 3.0 m between the rows. Water and some mineral nutrients were applied by using two drip emitters in each pot, whereas mineral and organic granulated fertilizers were added directly in substrate. The effect of the two treatments: 1. mineral fertilizers (water soluble and granulate) and 2. combined application of mineral (water soluble and granulate) and organic fertilizers (pellet) on the number and length of shoots per bush, yield components and fruit quality of highbush blueberry were monitored in this study. Combination of mineral and organic fertilizers increased yield per bush (1.63 kg), fruit weight (2.02 g) and soluble solids content (13.86%) in the fruit. Leaf nutrient levels were within the optimal ranges in the combined treatment; whereas both leaf N and K content were slightly increased above normal concentrations as a response to mineral fertilizers (2.68% and 0.79%, respectively). Our study could provide a better knowledge of the different fertilizers influences on the optimization of nutrient management in a soilless growing system.

**Keywords:** highbush blueberry, soilless culture, fertilizers, yield, fruit quality

## PS 1-13:

### THE APPLICATION OF AN EDIBLE COATING LENGTHENS THE QUALITY OF BLUEBERRIES (*Vaccinium corymbosum*) DURING POSTHARVEST STORAGE



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The cultivation of blueberry (*Vaccinium corymbosum*) in Mexico has increased up to 60% per year in the cultivated area due to diverse factors (ideal weather, adequate areas for production, etc.), which has made it profitable for its producers, according to with the National Association of Exporters of Berries of Mexico (ANEBERRIES). The commercial value of this fruit is affected mainly by the postharvest dehydration since it generates weight loss, sagging and softening. A weight loss from 3 to 5% of the initial weight causes wrinkling in the fruit diminishing the quality of fruits. The use of edible films or coatings represents an alternative to preserve the quality of fruits due to its ability to reduce water loss, respiration and transpiration rate, to maintain firmness and, in general, delay the senescence of the fruit. Therefore, the aim of this study was the evaluation of the application of an edible coating of carboxymethylcellulose and bee wax to preserve for a longer time the quality aspects of blueberry fruits during postharvest storage. The physiological parameters evaluated were weight loss, firmness, color; as well as the following biochemical parameters: titratable acidity and total soluble solids. The edible coating altered the characteristic appearance ("Bloom") of the blueberry fruits, however, the blueberries with the edible coating had a lower weight loss (2.4%) and a greater firmness (1.04 N), compared with the control (4.7% and 0.63 N, respectively) after 9 days of storage at 10 °C with a relative humidity of 90-95%. In the case of total soluble solids and titratable acid, there was no significant difference between the blueberries without the coating and those that did have the coating.

**Keywords:** weight loss, firmness, bee wax, carboxymethylcellulose, *Vaccinium corymbosum*

## PS 1-14:

### COMPARATIVE ANALYSIS OF VEGATATIVE SHOOT APEX TRANSCRIPTOME PROFILE BETWEEN A THORNY BLACKBERRY (*Rubus* L.) VARIETY AND ITS LESS-THORN MUTANT

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Transcriptome sequencing can be used to determine gene sequences and transcript abundance in non-model species. Transcriptome data are especially desirable in *Rubus* species and limited genomic research has been performed though certain members such as blackberry and raspberry play an economically important role in production. Furthermore, prickless trait of the plant was an important breeding target in blackberry. Hence, we report the extensive sequence and transcript abundance data for the vegetative shoot apex transcriptome of a blackberry cv. Boysenberry and its thorn bud variant with thin and less thorns on stems obtained using the Illumina HiseqTM 2500 platform. Approximately, 5,751 Mb sequencing reads were generated and assembled de novo, yielding about 63,632 high quality unigenes over 200 bp, which have a total length of 38.92 Mb and with an average length of 612 bp and the N50 length of 926 bp. Of these, 39,349 were identified as putative homologs of annotated sequences in the public protein databases, of which 346 were associated with the trichome morphogenesis, branching and differentiation in other species. Digital abundance analysis identified 219 transcripts differentially enriched in Boysenberry and its thorn bud variant, with 80 genes down-regulated and 139 genes up-regulated in the variant. Gene ontology (GO) and KEGG pathway analyses indicated that 31 reliable metabolic pathways are altered in the mutant, including pyrimidine metabolism, starch and sucrose metabolism and biosynthesis of amino acids. This study provided a new sight into the molecular investigation of the blackberry thorn formation and shoot apical meristem development in *Rubus* species.

**Keywords:** blackberry (*Rubus* L.), prickle, transcriptome, bud mutant

## PS 1-15:



## INFLUENCE OF DROUGHT STRESS ON THE LEAF MORPHOLOGY AND PHYSIOLOGICAL CHARACTERISTICS IN BLACKBERRY (*Rubus* L.) SEEDLING

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In the present study, the physiological changes and morphological characteristics were investigated in the leaves of blackberry cv. 'Boysenberry' seedlings subjected to 14-day drought stress by withholding irrigation. The leaf relative water content (RWC), and concentrations of photosynthetic pigments and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) in leaves were analyzed. The results showed that RWC increased slightly at first and then decreased. H<sub>2</sub>O<sub>2</sub> content changed slightly in leaves of 'Boysenberry' during the experiment period. Drought stress induced significant accumulation of photosynthetic pigments, and reached the peak on day 10. Besides, scanning electron microscopy (SEM) revealed a drought-resisting apparent structure in 'Boysenberry'. Drought stress significantly influenced the stoma on the lower epidermis of the leaves. As compared to the control, higher stomatal density was observed under drought conditions. Besides, there were elongated cone-shaped unicellular trichomes densely distributed on the abaxial surface of the lower epidermis. Overall, these results demonstrated that 'Boysenberry' exhibited a certain degree of drought adaption. It was suggested that increased drought tolerance of 'Boysenberry' was due to high stomatal and trichomes density, better accumulation of photosynthetic pigments and maintenance of tissue water contents.

**Keywords:** blackberry (*Rubus* L.), drought stress, leaf morphology, physiological characteristics

### PS 1-16:

## COMPARATIVE ANALYSIS OF FRUIT CHARACTER AND NUTRITIONAL QUALITY BETWEEN FIVE BLACKBERRY (*Rubus* L.) HYBRID STRAINS AND THEIR PARENTS

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In order to provide a scientific basis for breeding new blackberry (*Rubus* L.) cultivars in China, this paper analyzed the indexes of fruit character and nutritional quality for five primary selected hybrid strains (5-8-2, 6-6-3, 7-7-4, 7-10-2 and 7-10-6) as well as their parent cultivars grown in Nanjing China. The result showed that 6-6-3 had the largest fruit size with average fruit weight of 7.89 g and biggest fruit weight of 14.58 g, and was intermediate compared with that of its parents. Its aggregate fruit with larger seeds contained the largest number of small fruits, which showed significant over-parents heterosis. The fruit size of 7-7-4 and 7-10-2 were the smallest, lower than that of their parents. 5-8-2 had the highest yield, which was 3.37 kg plant<sup>-1</sup>. 5-8-2, 6-6-3 and 7-10-6 had higher soluble solids content (SSC) than the others. The total acid content (TAC) of 5-8-2 fruit was the lowest, which was only 1.08%. Thus, 5-8-2 with lower SSC/TAC was sweeter. Besides, the SSC, TAC and SSC/TAC of 6-6-3 showed over-parents heterosis significantly. Our result suggested that the fruit character and nutritional quality of 5-8-2 and 6-6-3 were better than those of other primary selected hybrid strains and also inherited the characteristics of their parents, can be used as germplasm resources for further study.

**Keywords:** blackberry (*Rubus* L.), hybrid strain, fruit character, nutritional quality

### PS 1-17:

## PHOTOSYNTHETIC HEAT ADAPTATION MECHANISM IN RUBUS: A COMPARISON BETWEEN TROPICAL *R. Rosifolius* AND TEMPERATE *R. Idaeus*

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Some tropics-originated ideobatus, a subgenus of *Rubus*, species maintain a consistent high net carbohydrate assimilation rate ( $A$ ) at high temperatures while the temperate-originated raspberry (*Rubus idaeus* L., in the same subgenus) does not. To assess the photosynthetic heat adaptation mechanism of ideobatus species,  $A$  of 'Summer Festival' raspberry and the tropical roseleaf raspberry (*R. rosifolius*) leaves at various intercellular  $CO_2$  concentrations ( $C_i$ ) and photosynthetic photon flux densities (PPFD) was measured with a simultaneous measurement of leaf chlorophyll fluorescence.  $A/C_i$  and light response curves at 25, 30, and 35 °C were fitted with a modified Farquhar, von Caemmerer and Berry (FvCB) model. Contributions of photosynthetic parameters, i.e., diffusional variables ( $p_{diff}$ , stomatal conductance ( $g_s$ ) and mesophyll conductance ( $g_m$ )) and photochemical variables ( $p_{bio}$ , maximum carboxylation rate ( $V_{cmax}$ ), electron transport rate ( $J$ ), initial slope of  $J$  versus light ( $\phi$ ), and convexity factor ( $\theta$ )), to  $A$  of roseleaf raspberry at various temperatures were quantified using 'Summer Festival' raspberry as a reference. No difference in  $A$  was detected between the two species at 25 °C. At 30 and 35 °C,  $A$  of roseleaf raspberry was 33% and 47% higher than that of 'Summer Festival' raspberry, respectively. At 35 °C,  $A$  of roseleaf raspberry was 33% and 47% higher than that of 'Summer Festival' raspberry, respectively. The increase in  $A$  between the two species. At 35 °C, the increase in  $A$  of roseleaf raspberry was mostly contributed from  $p_{diff}$ , with 51% contribution from  $g_s$  and 47% from  $g_m$ .

**Keywords:** FvCB model,  $A/C_i$  curve, diffusional limitation, photochemical limitation.

## PS 1-18:

### ANTIOXIDANT ACTIVITY, ORGANIC ACIDS AND BIOACTIVE COMPOUNDS OF ANDEAN BLACKBERRIES (*Rubus glaucus* Benth)

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Andean blackberries are considered an important source of vitamins, minerals and different phytochemicals due to their high content in polyphenols, including anthocyanins, ellagitannins and phenolic acids, which present beneficial effects in human health and prevent chronic diseases. Among other factors, harvest maturity and postharvest conditions may affect the concentration of phenolics and the antioxidant activity of the berries. In this study, the effects of harvest maturity and storage temperature on antioxidant activity, organic acids and polyphenols and anthocyanins concentration of Andean blackberries were evaluated. Blackberries were harvested at maturity stages 3 (light red) and 5 (dark purple), packed in PET clamshells ( $200 \pm 10$  g) and stored under room temperature ( $18 \pm 2$  °C) and cold storage ( $8 \pm 1$  °C). Organic acids (citric, malic, ascorbic) and total anthocyanins were determined by HPLC, total phenolic content with the Folin-Ciocalteu method and antioxidant activity by the DPPH method. The analyses were performed on day 1 and every 3 d during storage. At harvest, similar total organic acids, polyphenols and antioxidant activity were observed in the fruit from both maturity stages whilst the anthocyanins were significantly higher in the more mature fruit. What's more, some differences in the individual acids were observed. During storage and regardless of temperature, total organic acids, total anthocyanins and polyphenols content, and antioxidant activity increased in the fruit harvested at maturity stage 3. On the other hand, in the blackberries harvested at maturity stage 5, a decrease in the organic acids was observed whilst the anthocyanins, the phenolic compounds and the antioxidant activity remained unchanged. According to the Ecuadorian Quality Standard, blackberries can be harvested as soon as they reach the stage maturity 3. However, at this stage the fruit presented a 5-fold lower anthocyanin content and could result unacceptable for consumers due to undeveloped full color.

**Keywords:** anthocyanins, ripeness, Mora de Castilla, polyphenols

## PS 1-19:

### DELAY OF RASPBERRY HARVESTING SEASON WITH SUCCESSIVE PRIMOCANE PRUNING

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To avoid inflorescence drying and sunburn of primocane raspberry fruits due to summer heat in tunnels, we try to delay the harvest season with full pruning of primocanes at 'Amira' and 'Polka' variety. We cut green shoots on 25th April, 8th May and 15th May and compared the vigor of plant, the beginning of harvesting and yield to unpruned control. The date of pruning had significant influence on the beginning of harvesting at both varieties. The harvesting was successfully delayed and the yield was comparable to unpruned control at raspberries cut on 25th April and 8th May. Later pruning was no longer acceptable for our climate conditions due to late ripening.

**Keywords:** climate change, late harvesting, yield, fruit quality

## PS 1-20:

### DIFFERENCES IN BLACKBERRY FRUIT QUALITY

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Blackberries are mostly cultivated in North America and Europe probably due to their pleasant sour-sweet taste and attractive deep purple color. Their chemical composition varies among cultivars, growing conditions, ripeness stage, and other factors. Because of their successive ripening in the summer months, they have to be picked several times. The aim of our study was to evaluate how fruit quality varies between the picking dates. Fruits of five blackberry cultivars were picked between the end of July till the beginning of September in weekly intervals. The metabolites were analyzed with HPLC/PDA-MS/RI system. The color parameters ( $L^*$ ,  $C^*$  and  $h^0$ ) didn't differ between cultivars and just to some extent between sampling dates. The intense, almost black color of blackberries can be correlated to the composition and high levels of anthocyanins present in the cells. Blackberries owe their color mainly to cyanidin glycosides, with cyanidin glucoside being the prevailing form. The lowest amount of total anthocyanins was present in the first sampling date and remained stable on a high level from third to the sixth sampling date. The taste of blackberries is mainly defined by the balance between the sugars and organic acids. This ratio was the lowest in first two samplings with some fluctuations toward the end of the sampling period. The oscillations were probably triggered by different weather conditions, which were also the reason for vitamin C fluctuations, but a general decreasing trend toward the last sampling was observed. The fruits at the last sampling date had the highest soluble solid content, higher pH values, and the lowest fruit weight. With our experiment we were able to show that blackberries maintain high fruit quality throughout the picking season, however, fluctuations in quality are present due to changeable weather conditions.

**Keywords:** sugars, organic acids, vitamin C, phenolics, berries

## PS 1-21:

### PERFORMANCE OF SEVEN BLACKCURRANT CULTIVARS UNDER TWO SOIL MAINTENANCE SYSTEMS

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Blackcurrant is one of the main berry crops grown in Latvia, yet the obtained yields are low. Cultivars and cultivation practices can play a big role in increasing productivity. The aim of this research was to evaluate seven blackcurrant cultivars: 'Gagatai', 'Ijunskaia Kondrashovoi', 'Kriviai', 'Selechenskaya', 'Svita Kiyevskaya', 'Vernisazh' and 'Titania' using two growing practices: with application of pine bark mulch and increased N fertilization rate, and without mulching where herbicides were applied in rows. The trial was established in 2010 at Pūre Horticultural Research Centre, Latvia. The planting distance was 3.0 m between the rows and 1.0 m between the bushes in the row. Randomized split block design with four replicates was applied. Plant vegetative growth, phenological parameters, winter hardiness, yield, fruit quality, incidence of pests and diseases were evaluated during the years 2012-2016. Cultivars 'Gagatai' and 'Vernisazh' were the most productive among evaluated cultivars and characterized by good adaptability for growing in local conditions. No significant differences were stated in blackcurrant phenological development, productivity and fruit size among both



growing practices that were evaluated. However, the application of pine bark reduced the growth of weeds, and in addition plants were less damaged by leaf spot diseases and aphids in comparison to growing without mulching.

**Keywords:** *Ribes nigrum* L., mulching, pine bark, phenology, yield, fruit size, spreading of pests and diseases

## PS 1-22:

### DETERMINATION OF FRUIT GROWTH IN NERO AND VIKING ARONIA CULTIVARS

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This study was conducted to determine fruit growth and development in 'Nero' and 'Viking' aronia cultivars growing on five-year-old plants. In the study, fruit dimensions (mm), fruit weight, soluble solids content, pH value and titratable acidity were determined in the period of fruit growth. While a slow development was detected in fruit dimensions and weight at the beginning of fruit development period, very rapid increase was observed between July and September. This study indicated that both cultivars grew in a double sigmoid curve from the fruit set to the harvest. Furthermore, we found that average fruit weight, soluble solids content, and pH value of the fruit juice was increased while titratable acidity was decreased during growing and development periods.

**Keywords:** aronia, fruit growth, fruit development

## PS 1-23:

### POMOLOGICAL AND SOME TECHNOLOGICAL CHARACTERISTICS OF BLACK MULBERRY (*Morus nigra* L.) FROM TURKEY NATIONAL MULBERRY GENETIC RESOURCES

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There are more than 400 years of mulberry culture history in Anatolia. Mulberry genotypes gathered from different regions of Turkey are kept in the mulberry genetic resources parcel of Malatya Apricot Research Institute. In this study carried out in 2016, it was aimed to determine the pomological characteristics and some technological properties of 7 black mulberry (*Morus nigra* L.) genotypes in the parcel. In the study; it was determined that fruit weights were between 1.53 g (Ürgüp Horum) and 2.83 g (Gümüşhacı Köyü Horum), fruit widths were between 12.77 mm (Erzincan Karadut) and 15.61 mm (Şelalele Karadut), fruit lengths were between 16.38 mm (Ürgüp Horum) and 22.16 mm. TSS varied between 13.1% (Erzincan Karadut) and 21.7% (Ürgüp Horum) pH varied between 3.45 (Karacaköy Horum), 3.84 (Ürgüp Horum), TA varied between 0.8% (Erzincan Karadut) and 1.54% (Karacaköy Horum), Must yield varied between 53.10% (44 MRK 01) and 70.26% (Karacaköy Horum) and the drying efficiency varied between 16.90% (Şelale Karadut) and 25.34% (Ürgüp Horum). At the end of the study, Gümüşhacı Köyü Horum genotype was found to be suitable as table and Karacaköy Horum genotype, which has high fruit juice yield, was determined to be considered as must.

**Keywords:** mulberry, pomology, must yield, dried fruit yield

## PS 1-24:

### HIGH QUALITY LED LAMPS AS AN ALTERNATIVE FOR THE INCANDESCENT GLOW BULB

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Within the European Goodberry framework research is executed to create new possibilities in flower induction and dormancy in soft fruit cultivations. Junebearing strawberry cultivations starting in the winter or early in spring often need night interrupting lighting to compensate for an insufficient amount of cold to break dormancy. In the past Belgian growers used incandescent light bulbs at a density of 10 W/m<sup>2</sup> and used them cyclic from sunset to sunrise during half an hour of each hour until a desired stretching of the crop. Due to the unavailability of incandescent bulbs growers and practical researchers started looking for worthy alternatives. Several light companies reacted by producing LED modules with different spectra. A few years of research at Research Centre Hoogstraten demonstrated the importance of far-red light in the correct ratio to red light. In the spring of 2017 a trial demonstrated and confirmed the positive effects of four LED lamps on a second cultivation of Elsanta in a glasshouse. After the autumn production the glasshouse was heated throughout the winter to create a severe shortage of cold and a dormant crop at the start of the second cultivation in February. Four LED lamps ranging from 1,2 to 1,8 W/m<sup>2</sup> were compared to a Eco halogen bulb at 7 W/m<sup>2</sup> and an unlighted control. All LED lamps could generate a comparable stretching of the crop as the lighted control and the plants could produce at their full potential with better quality of fruit on the first flower trusses than the unlighted control. The costs of the LED modules range from 15 to 22€/per lamp. Based on the electric consumption and the life span an investment in LED lamps will be earned back after 4-5 years compared to the old 100W incandescent bulbs when used in strawberry cultivations.

**Keywords:** strawberry, cold, breaking, dormancy, cyclic, investment

## PS 1-25:

### **DETERMINATION OF SOME PHYSICAL AND BIOCHEMICAL PROPERTIES OF MYRTLE (*Myrtus communis* L.) DISTRIBUTED IN NATURAL FLORA OF ANTALYA**

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Myrtle (*Myrtus communis* L.) is an evergreen shrub belonging to the family of Myrtaceae that grows spontaneously throughout the Mediterranean area. In Turkey, myrtle tree is found growing in pine forests and riversides, particularly in the Taurus mountains, from just above sea level to 500–600 m. Their antioxidant activity has been attributed to the presence of phenolic compounds. The purpose of this work is to characterize myrtle plant through its total phenolic and flavonoid content, phenolic composition and antioxidant activity order to determine the promising type. Phenolic compounds were extracted from leaf and berry, phenolic composition was determined by LC-MS-MS, antioxidant activity was measured with DPPH method. In conclusion, it was determined that significant differences between locations in respect to the phenolic compositions and antioxidant activity. Promising types are determined in accordance with these differences.

**Keywords:** *Myrtus communis* L., phenolic composition, antioxidant activity

## PS 1-26:

### **DEFINING THE RELATIONSHIPS BETWEEN SOME FRUIT CHARACTERISTICS OF WILD STRAWBERRY ACCESSIONS BY EXPLANATORY FACTOR, HIERARCHICAL CLUSTER AND FUZZY CLUSTERING ANALYSES**

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This study was conducted to detect genetic diversity among several wild strawberry accessions native to Eastern Anatolia of Turkey, and to reveal the relationships between their fruit characteristics (fruit weight, fruit length, pH, soluble solid content, taste, aroma, L, A and B). Explanatory factor, hierarchical cluster and fuzzy clustering analyses were performed. Four latent factors explained 87.7 (%) of the strawberry data. The first factor had greater positive loadings on A (0.850), B (0.921), soluble solid content (0.747) and negative loading on L (-0.680). The first factor could be considered as a 'fruit color-soluble solid content' factor. The second factor named as an 'organoleptic' factor had a large positive loading on aroma (0.976) and taste (0.976). The third factor had negative loadings on fruit length (-0.901) and fruit weight (-0.855) and was called a 'pomology'





factor. The fourth factor was a `pH` factor with a loading value of -0.914. In hierarchical cluster analysis, the first five accession pairs (6-8, 12-13, 12-14, 6-9 and 1-2) showed the highest similarity ranging from 89.522 to 94.758. The accessions 1, 2 and 4 were allocated to the first cluster (81%), the accessions 3 and 5 were assigned to the second cluster (82.32%). The first four accessions grouped as the first cluster in the fuzzy clustering. The accessions 6-10 were assigned to the second cluster, and the accessions 5 and 11-15 were allocated to the third cluster. We can conclude that the statistical methods used in this study could be utilized in strawberry breeding strategies.

**Keywords:** Factor analysis, fruit characteristics, fuzzy clustering, hierarchical cluster analysis, strawberry

## PS 1-27:

### EVALUATION OF FRUIT FIRMNESS AMONG THE SEGREGATION POPULATION STRAWBERRIES DEVELOPED FROM 'OTTOMAN' X 'CAMAROSA'

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Turkish strawberry production has an increasing trend. 'Ottoman' is one of the Turkish strawberry genetic resources with unique horticultural attributes such as aroma content. However, fruit firmness of 'Osmanlı' is low. In this study, a segregation population having 340 individuals, produced from 'Ottoman' x 'Camarosa' were characterized for many horticultural traits for two years. The hybrids were grown in an annual hill cultural system with summer planting on open field conditions and flowering and runnering dates were recorded. Flower and leaf characteristics were determined in December in both experimental years, while pomological traits of fruit width, length and weight, soluble solids, fruit firmness, fruit external and internal colors were determined periodically during the whole experiment. A great deal of diversity was recorded among the hybrids for the most of the traits evaluated. For example, fruit firmness ranged between 0.2 – 1.5 kg/cm<sup>2</sup>; while the ranges for soluble solids, total fruit number and yield were 4.0 – 15.0 %, 2 – 192 and 11.9 – 1220.8 g, respectively. The data from two experimental years were compared using regression analysis. Except petiole length, leaf width and length, all other traits evaluated had statistically significant correlation between their two years (P = 0.000 – 0.017). 78 individuals from this population were genotyped with 33 SSR primer pairs which had previously been proven to be informative for this population.

**Keywords:** Strawberry, *Fragaria ×ananassa*, fruit firmness, molecular markers, SSR

## PS 1-28:

### FLOWER BUD FORMATION IN THE PLUG STRAWBERRY (*Fragaria ×ananassa*) PLANTING MATERIALS GROWN ON DIFFERENT LOCATIONS

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In strawberry production, the sustainability of the increasing trend and fulfilling the complete potential, expanding the harvesting period of has great importance. For this purpose, the better understanding of the flower bud formation in the strawberry cultivars from different background and determination of plating material types and planting dates are required. We investigated meristems coming from different locations (Amasya = high elevation and Antakya = low elevation) and sampled in four different dates (1 September, 15 September, 1





October and 15 October) using 'Cal Giant-3', 'Camarosa', 'Festival', 'Kabarla' and 'Sweet Charlie' cultivars; 2). During the investigation of the meristems, five plants of each of the high and low land locations' mother, and daughter plants and plug planting material was observed. The plug planting materials produced in the low and high land locations were planted on the planting dates of 1 September, 15 September, 1 October and 15 October and the fruits were subjected to the pomological analyses for 'Camarosa' and 'Festival'. The planting dates had statistically significant differences for 'Festival'. Although there were some statistically significant differences among the pomological traits tested, constant patterns for all periods and cultivars resulted from either planting material type or planting dates was not recovered. The results indicated that to increase the early yield in strawberry production, studies targeting to identify cultivars with low chilling requirement which could form flower buds under less favorable conditions may result in more advantageous results.

**Keywords:** flower bud, strawberry, earliness, *Fragaria ×ananassa*, plug, high elevation, low elevation



## Yet to Register

### PS 1-29:

#### ORGANIC PRODUCTION OF BLUE HONEYSUCKLE BERRIES - AN ALTERNATIVE WITH HIGH NUTRITIONAL VALUE FOR CONSUMERS AND ADDED VALUE FOR SMALL FARMS

**Martina Bavec**, Ms. Mateja Senica, Martina Robacer, Franc Bavec, Jure Kolaric, Janja Postruznik, Maja Mikulic-Petkovsek, Franc Stampar

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Increasing interest among European consumers for food rich in different health-promoting compounds brings on the market new crops and their products named “super food” mostly imported from overseas. Searching for fresh fruits with high nutritional value brought interest for edible blue honeysuckle berries (haskap) as possible substitute of American blueberries or as a new berry crop for production on small-scale farms. The first yields of early varieties are in May before strawberries and other berries which means the first income for the producer. Edible blue honeysuckle berries are not demanding for low pH as the other blueberries, resistant to low temperatures and as a new crop there is not expected much problems with pests and diseases except birds which can reduce yields and protection is needed. Market analyses showed demand for organically produced berries and based on these facts first seedlings with Canadian varieties were planted in Slovenia in 2014. Since then over 50 ha is planted on small scale farms or on farms as complementary activity. In 2017 the first analysis of primary and secondary metabolites confirmed their high nutritional value compared to other fruits dependent on different environmental factors. Although in East Europe and Russia blue honeysuckle berries are traditionally consumed mostly processed, in European Union edible blue honeysuckle berries are not listed among fresh fruits and are treated as “novel foods”. Evaluation of nutritional value some processed products compared to fresh berries showed promising results, and possibilities for a new innovative processed products are under development. SWOT analysis presents several possibilities for further development, but also some threats. Further research and development of agricultural practices for organic growing of different blue honeysuckle varieties interesting for consumers should be conducted in different agro climate conditions.

**Keywords:** *Lonicera caerulea* subs. *edulis*, haskap, edible honeysuckle berry, organic production, nutritional value, functional food

### PS 1-30:

#### EFFECTS OF DIFFERENT ENVIRONMENTS ON STRAWBERRY QUALITY

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Strawberry is now widely cultivated in China, the United States, Japan and Europe. Strawberry has very high nutritional value, beautiful color, and delicious taste, so it is popular all over the world. According to FAO's statistics, from 2000 to 2014, China's strawberry production had increased from 1.18 million t to 3 million t, the yield per unit area had reached to 2,7000kg/hm<sup>2</sup>. China has become the world's largest producer of strawberries. In China, most of our strawberries are planted in the greenhouses, so the environment of greenhouse is essential. In early October 2016, the researchers planted strawberries in Beijing (116°E, 40°N) and Kunming (102°E, 25°N) at the same time. The two key environmental factors, light and temperature were very different in these two areas. The diurnal temperature difference was greater in Kunming than Beijing. And through the environmental monitoring system placed in the greenhouse, we found in sunny days, Kunming's greenhouse light intensity was stronger than Beijing. According to environmental data, strawberry photosynthesis in Kunming should be stronger, which meant more photosynthetic products were synthesized. To compare the two areas of strawberries, the following fruit quality parameters were analyzed: soluble solids content (SSC), titratable acidity (TA) and sugar. The results showed that, the SSC and sugar of Kunming's strawberries were higher than Beijing's, but TA's difference was small. And in order to further compare them, a metabolic analysis was conducted. In Kunming's leaves and fruits, the results showed that sucrose content was higher. It



can be inferred Kunming's strawberry leaves in the daytime synthesized more sucrose, which could be more transported to fruits. And the glucose content was also higher in Kunming's strawberries. These results prove Kunming's strawberry quality is better than Beijing's.

**Keywords:** environment, strawberry

## PS 1-31:

### STUDY ON FRUIT VOLATILES OF STRAWBERRY VARIETIES FROM DIFFERENT COUNTRIES

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For consumers, pleasing odor is a sensory standard as important as taste to evaluate strawberry fruit quality. Nowadays strawberry cultivars developed by Chinese, Japanese or American breeders are widely planted in China. Most Japanese cultivars are usually considered to have better smell and quality than other cultivars. Fruit volatiles of 3 Chinese cultivars (or selection) (CN), 3 Japanese cultivars (JP), and 3 American cultivars (AM) were detected and compared to understand the difference of aromatic compounds among these cultivars.

'Jingtaoxiang', 'Jingzangxiang', 06-54-6, 'Benihope', 'Tochiotome', 'Sachinoka', 'Monterrey', 'San Andreas', and 'Albion' were planted in greenhouse in 2016. Mature fruits were picked and analyzed by gas chromatograph-mass spectrometer (GC-MS). The results showed that there were no significant differences in total number of volatiles and number of ester, aldehyde, terpene, and ketone among CN, JP, and AM varieties. Average 8.0 alcohols were detected in JP varieties and significantly more than CN and AM ones. Remarkably less acids and less furans were separately found in JP varieties and AM varieties. There were average 11.0 prominent compounds whose relative contents were no less than 1% found in CN varieties, while average 11.7 and 14.0 compounds in JP and AM varieties. Methyl acetate, ethyl acetate, methyl butyrate, ethyl butyrate, methyl hexanoate, 2-hexenal, hexanoic acid,  $\alpha$ -farnesene, and linalool were popular as prominent volatiles in tested materials. 2-Hexenal had the top content in this study, however, no remarkable differences were found. Butyl acetate and 1-methylethyl butyrate were only prominent in AM varieties, and their contents were significantly higher than those in CN and JP varieties. The average content of hexanoic acid in JP varieties showed noteworthy higher than other varieties.

**Keywords:** *Fragaria × ananassa*, aromatic compounds, GC-MS

## PS 1-32:

### STUDY ON FRUIT VOLATILES OF STRAWBERRY VARIETIES FROM CHINA, JAPAN AND UNITED STATES

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**Keywords:** *Fragaria*  $\times$  *ananassa*, aromatic compounds, GC-MS

## PS 1-33:

### VOLATILE ORGANIC COMPOUNDS IN THREE STRAWBERRY (*Fragaria* $\times$ *ananassa* Duch.) VARIETIES WITH WHITE FLESH

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The aroma of strawberry (*Fragaria*  $\times$  *ananassa* Duch.) is one of the most iconic fruit scents. Strawberry varieties with white flesh was unusual in production of China. For future using these strawberries, the volatile organic compounds (VOCs) were analyzed. Var. 'White Princess' and var. 'Xiaobai' were selected by Chinese breeders from seedling of white strawberry and bud sport selection of var. 'Benihoppe', respectively. 'Tokun' was a decaploid variety from Japan.

The 35 most abundant VOCs synthesized by these varieties were identified using head space solid phase microextraction (HS-SPME) and evaluated by gas chromatography-mass spectrometry (GC-MS), including 21 types of esters, 2 types of ketones, 3 types of aldehydes, 2 types of alcohols, 2 types of organic acids, 2 types of furans, 2 types of terpenes and 1 lactone. The total relative content of esters in 'White Princess' and 'Tokun' were the highest, while aldehydes were the highest VOCs in 'Xiaobai'. But the total relative content of two types of VOCs in the three varieties were similar.  $\gamma$ -dodecalactone with peach flavor, which was one of the most important VOCs for sensory impressions was identified from 'White Princess' and 'Tokun'. Other important VOCs (linalool, nerolidol and DMMF) were higher in 'White Princess' and 'Xiaobai' than 'Tokun'. Therefore, 'White Princess' was not identified to send peach flavor by smell could be related to interaction of important VOCs. The composition of VOCs attributed to the different aroma of the three varieties.

**Keywords:** strawberry, white flesh, volatile organic compound, aroma

## PS 1-34:

### DNA FINGERPRINT MAP OF STRAWBERRY CULTIVARS IN CHINA USING NEWLY DEVELOPED SSR MARKERS

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Recent years, strawberry industry developed rapidly in China because of its high economic efficiency, short growth period and large market. According to the needs of strawberry industry, more and more cultivars were introduced and bred. Therefore, it was necessary to establish variety identification and protection system, investigate the genetic diversity and relationship. Molecular marker technique, which was one of the most important tools in molecular biology research, was mainly used in fingerprint map construction, marker associated selection and genetic map construction. Especially, SSR and SNP markers were already applied to variety identification and protection, including strawberry in many other countries. In this study, more than 6,000 genomic SSR markers (GW-SSR) and about 120 coding region SSR markers (EST-SSR) were newly developed based on the whole genome sequences of *F. pentaphylla*, which was an endemic diploid strawberry species in



China. On the basis of repeat units, all the markers could fall into 7 categories. In consideration of conservatism and conversion efficiency of markers between diploid and octoploid strawberry cultivars, only EST-SSR markers were used for further study. Ten samples (2 diploid and 8 octoploid) were chosen for polymorphism analysis via PCR and capillary electrophoresis. The results showed that 60 EST-SSRs were suitable for PCR test. Among these markers, about 43 markers were amplified successfully in diploid samples, of which around 30 markers could be detected in octoploid samples, while relevance ratio and transfer ratio was 71.7%, 69.8%, respectively. Finally, we got 16 stable polymorphism markers to construct the fingerprint map of approximate 50 strawberry cultivars which were mainly grown or bred in China. These results could be used as basis of variety identification and application, and have significance for developing of strawberry industry in China. Meanwhile, the markers could also be employed to study the genetic relationships of strawberry species with different ploidy.

**Keywords:** strawberry cultivars, SSR markers, fingerprint, marker transfer

## PS 1-35:

### FUNCTIONAL CHARACTERISATION OF WATERLOGGING AND HEAT STRESSES TOLERANCE GENE PYRUVATEDECARBOXYLASE2 FROM ACTINIDIA DELICIOSA

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A previous report showed that both PDC genes were significantly up-regulated in kiwifruit after treatment with waterlogging using Illumina sequencing technology, and that the kiwifruit AdPDC1 gene is required during waterlogging but might not be required during other environmental stresses. Here, the function of another PDC gene, named AdPDC2, was analysed. The expression of the AdPDC2 gene was determined using qRT-PCR, and the results showed that the expression levels of AdPDC2 in reproductive organs were much higher than those in nutritive organs. Waterlogging, NaCl and heat could induce the expression of AdPDC2. Overexpression of kiwifruit AdPDC2 in transgenic Arabidopsis enhanced the resistance to waterlogging and heat stresses in five week-old seedlings, but could not enhance resistance to NaCl and mannitol stresses at the stage of seed germination and in early seedlings. These results suggested that the kiwifruit AdPDC2 gene may play an important role in resistance to waterlogging and heat stresses in kiwifruit.

**Keywords:** kiwifruit, pyruvatedecarboxylase2 gene, waterlogging, heat stress, transgenic plants, environmental stresses

## PS 1-36:

### INCREASING STRAWBERRY FRUIT SHELF-LIFE

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Strawberry fruit is characterized by a unique flavour and taste. The fruit are harvested at full maturity, causing high susceptibility to mechanical damage, pathological and physiological disorders during postharvest storage, with a maximum shelf-life of 4 days. Due to high levels of postharvest spoilage, increased fungicide resistance and a growing health concern from the consumer, the industry is currently searching for an economically viable, effective and affordable alternative to improve fruit quality and reduce spoilage. Although various postharvest treatments, including a chitosan coating and hot water treatments have been investigated, an effective standard treatment is yet to be identified. The aim of this study was to investigate the efficacy of a dual-release sulphur dioxide (SO<sub>2</sub>) generating pad, in combination with modified atmosphere packaging (MAP) to control postharvest fungal development on strawberry fruit. The study specifically focused on preventing postharvest development of Botrytis cinerea, commonly referred to as grey mould. Strawberry fruit exposed to SO<sub>2</sub> showed a noticeable decrease in decay development, especially when the SO<sub>2</sub> treatment was combined with MAP. The treatment successfully decreased the B. cinerea incidence by more than half, allowing for a longer cold storage period than is currently available with standard industry practices.





**Keywords:** shelf-life, strawberry, Botrytis cinerea, modified atmosphere packaging, sulphur dioxide pads

## PS 1-37:

### STRAWBERRY 'FLAIR' AND 'FELICITA' SUITABILITY FOR FORCING UNDER HIGH TUNNEL

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Strawberry cultivars 'Zehyr', 'Honeoye' and 'Rumba' are grown for early production in Latvia. In open field conditions, 'Zehyr' is early and productive, however, it is not suitable for early yield in high tunnels. 'Honeoye' is appropriate for growing in tunnels, while due to rather sour taste it is not well appreciated by consumers. 'Rumba' has good berry quality, while it is not enough winter hardy and berries come few days later than 'Honeoye'. Two new Dutch cultivars 'Flair' and 'Felicità', and 'Rumba' as a control were included in this study. The trial was established in August 7, 2014 in the FVG high tunnel (60x4x3.32m; 240 m<sup>2</sup>). Frigo plants: category A+ for 'Flair' and 'Felicità' and category A for 'Rumba' were used. Plants were planted in double rows in planting distances 0.30 x 0.25 m and 1.20 m between row centers (6 plants per m<sup>2</sup>). The soil type was heavy loam. Beds were mulched with black plastic, supplied by drip irrigation. The number of inflorescences per plant; number of flowers per inflorescence; average number of flowers per plant; productivity; berry weight, quality and the assessment of storage were evaluated. The number of inflorescences depended on the plant age and the category of plants. The higher plant category, the more inflorescences on the plant were observed. Besides, the number of inflorescences increased by every year. The increase in number of inflorescences had effect on the berry weight and quality. The more flowers and berries were observed, the berries were smaller. 'Flair' had the highest yield per plant, better berry firmness and a higher content of soluble solids than control cultivar 'Rumba'. 'Rumba' had the highest sensory evaluation among evaluated cultivars, while 'Flair' got the highest taste rating. According to evaluation results obtained in 4-year period 'Flair' might be suitable for forcing of yield under high tunnels in Latvia.

**Keywords:** *Fragaria × ananassa* Duch, number of inflorescences, yield, berry quality

## PS 1-38:

### STRAWBERRY TRANSCRIPTOME ANALYSES IN RESPONSE TO M. PHASEOLINA INFECTION

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In recent years, the emergence of the charcoal rot of the strawberry caused by *Macrophomina phaseolina* has been reported to cause important losses worldwide. The use of resistant cultivars is a desirable alternative to the disease management. However, there is scarce knowledge about how molecular mechanisms are involved in this plant-pathogen interaction. The objective of this work was to study the transcriptomic and physiological response of strawberry plants to *M. phaseolina* infection. For this, we established a pathosystem using micro-propagated strawberry plants cv 'Camarosa' that was previously probed to be of middle susceptibility to the disease. Crown and leaf samples were taken at 0, 24, 48, 72 and 96 hours post inoculation (hpi). The kinetics of the transcriptomic response was evaluated by quantitative PCR with JA (FaAOS, FaLOX, FaWRKY33, FaMYC and FaJAR) and SA (FaEDS1, FaPAD4, FaGRAX1, FaWRKY1, FaPR1) responsive marker genes. Samples showed interesting expression profiles at 0, 24, 48 and 72 hpi. The kinetics and the expression level were similar in both routes and tissues, an increased expression was detected at 72 hpi in all cases; curiously, both pathways had an incomplete activation. Leaf samples of these 4 time points were selected to determine plant hormone profiles, while crown and root samples were used to make a RNA-seq analyses. Brassinosteroids, gibberellins and auxins had an important increase in inoculated plants, while cytokinin were found in lower concentrations. Interestingly, SA and JA hormones components presented higher concentrations in inoculated plants despite that the classical marker genes of both routes were not completely activated. Our RNA-seq data shows that different networks of defense mechanisms are involved in the defense response of strawberry plants to *M. phaseolina*.



infection. Candidate genes in resistant and susceptible cultivars are under study, with the aim that these findings can enhance breeding efforts in strawberry.

**Keywords:** Charcoal rot, RNA-seq, defense response, *Fragaria x ananassa*

## PS 1-39:

### AGRONOMIC PERFORMANCE OF ITALIAN STRAWBERRIES IN SANTA CATARINA, BRAZIL

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The strawberry (*Fragaria x ananassa* Duch.) is cultivated in all continents. In Brazil, the states of Minas Gerais and Rio Grande do Sul are the main strawberry producers, and for the progress of the culture in the country it is essential to introduce new adapted cultivars, more productive and with higher fruit quality. In this sense the objective of this work is to divulge the first results of the genetic materials developed by the CRA-FRF of Italy, introduced in Brazil. The experiments were carried out at the College of Agriculture and Veterinary of the Santa Catarina State University (CAV / UDESC), in the city of Lages, Santa Catarina, Brazil. The evaluated cultivars were Pircinque, Aromas, Garda and the selections 'FRF 85.4' and 'FRF 149.18'. The seedlings were planted in low tunnels with beds covered with polyethylene film and drip irrigation. The experimental design was a randomized block design, with four replications and 10 plants per parcel. The analyzed variables were: total number of fruits per plant, total accumulated production, total yield, and average mass of commercial fruits. The qualitative variables were: soluble solids content, titratable acidity, RATIO and firmness. Vegetative variables were determined by fresh mass and dry mass of different parts of plants. The data were submitted to analysis of variance (ANOVA) and the means analyzed by the Scott Knott test at 5% probability of error. In the study conditions, it was observed that the two selections, 'FRF 85.4' and 'FRF 149.18' do not express the same productive and qualitative potential as the others. The cultivar Pircinque stood out as promising for cultivation in the conditions of Lages, Santa Catarina, because it presented a good vegetative development that conferred a high yield, with bigger and heavier commercial fruits and higher RATIO value.

**Keywords:** *Fragaria x ananassa* Duch, Pircinque, breeding

## PS 1-40:

### EFFECT OF AMINO ACID SPRAYING ON YIELD AND QUALITY OF STRAWBERRY UNDER SOILLESS CULTURE SYSTEM

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Amino acids adjust important metabolic pathways that are essential for yield and quality of fruit. In this study, effect of foliar application of amino acids on yield and quality of strawberry fruit was evaluated in a factorial experiment based on completely randomized design. Experimental treatments were included 0, 500 and 1000 µM of amino acids Alanine, Glutamine, Arginine and two cultivars of strawberry (Camarosa and Gaviota). Foliar application of amino acids, the first spray started at 30 days after planting, the second at flowering and the third at fruit set stages. The results showed that the interaction effect between amino acid and cultivar on all traits (yield, fruit number, TSS, TA, TSS/TA, total anthocyanin content and phenol) was significant. Gaviota cultivar in Arginine 1000 treatment produced about 59.86% increasing yield and 75% increasing fruit number versus control, respectively. Also, the highest of TSS (total soluble solid) was observed in Alanine 500 and Arginine 1000 treatments in Camarosa cultivar which between them were no significantly different. Alanine 500- Camarosa treatment showed the maximum of TSS/TA (total soluble solid/ titratable acidity). The best total anthocyanin content showed in Glutamine 1000- Camarosa treatment that produced about 51.5% increasing total anthocyanin content, compared to control. So, the highest of phenol was observed in Alanine 500 treatment in both cultivars and Arginine 500- Camarosa. In summary, the selection of right amino acid type and cultivar could improve yield and quality of strawberry fruit in soilless culture system.



**Keywords:** fruit, cultivar, Alanine, Glutamine, Arginine

## PS 1-41:

### EFFECT OF ESSENTIAL OIL OF MENTHA SPP. AND THYMUS SPP. ON POSTHARVEST SHELF LIFE OF STRAWBERRY (*Fragaria ananassa* L. cv. Parose)

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In order to improve the shelf life of strawberry (*Fragaria ananassa* L. cv. Parose), an experiment was conducted to investigate the effect of essence treatments of *Thymus* L. and *Mentha spicata* L. at concentrations of 0, 150, 300 and 450 µl/l. This experiment was arranged as completely randomized design with three replications. Strawberry fruits were treated and transferred to cold place (4 °C) with 90% humidity. Various factors such as decay percentage, total soluble solids (TSS %) total acidity (TA %), TSS to TA ration (TSS / TA), pH, fruit firmness and weight loss percentage were measured. The results showed that the effect of essential oils on TSS%, TA%, weight loss percentage, pH and fruit firmness were significant at 1% level. The fruit firmness, TSS% and TA% were increased in fruits treated with medicinal essential oil of *Mentha spicata* L. and *Thymus* L. The highest fruit firmness, TSS% and TA% were observed in fruit treated with *Mentha spicata* L. and *Thymus* L. essential oils at 300 µl/l as compare to the untreated fruits. The highest fruit decay was obtained in untreated fruit. So, the use of essential oils of *Thymus* L. and *Mentha spicata* L. with concentration of 300 µl/l is recommendable for improvement of postharvest quality and shelf life of strawberry fruit.

**Keywords:** *Mentha spicata*, parose, shelf life, strawberry, *Thymus* L.

## PS 1-42:

### COMPARISON OF STRAWBERRY FLOWER BUD DIFFERENTIATION IN DIFFERENT LATITUDES AND ALTITUDES

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To elucidate the response of flower bud differentiation to environment on strawberry through determining the time of the floral bud differentiation in different latitudes and altitudes within cultivars. And the plants were treated with different temperatures and daylengths. Six cultivars ('Jing Zangxiang', 'Jing Taoxiang', 'Benihope', 'Sweet Charlie', 'Akihime', 'Ningyu') were planted at three locations with different environments from north to south of China, determined the time of the floral bud differentiation by anatomical methods and its relation temperature and daylength in a 10-days interval from the earliest discernible evidence of floral initiation until anthesis. The comparison of two different treatments of 'Benihope', seeding cultivation in high altitude region, night cooling treatment. Floral bud differentiation development phases and date of flowering and harvest were recorded. Beijing latitude is 39.968886 and elevation is 58 meters, Nanjing latitude is 31.9532445 and elevation is 24 meters, Kunming latitude is 25.078558 and elevation is 2117 meters. The earliest development phases and date of flowering was Yunnan followed by Nanjing, the latest was Beijing. Night cooling treatment was the earliest, both the two treatment were earlier than the control in the two treatments of 'Benihope'. Short daylength and appropriate low temperature promoted the flower bud differentiation. Strawberry flowering started earlier in high altitude and low latitude region of China.

**Keywords:** strawberry, floral bud differentiation, altitude, latitude

## PS 1-43:



## A STUDY ON ENVIRONMENTAL FACTORS AFFECTING STRAWBERRY YIELD USING PATTERN RECOGNITION TECHNIQUES

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This paper investigates the importance of various environmental factors that have a strong influence on strawberry yields grown in greenhouse using various pattern recognition methods. The environmental factors influencing the production of strawberries were six factors such as average inside temperature, average inside humidity, average CO<sub>2</sub> level, average soil temperature, cumulative solar irradiance, and average illumination. The results of analyzing the observed data using Dynamic Time Warping (DTW) showed that the most significant factor influencing the strawberry production was average inside humidity, while it was found that average illumination was the lowest influential environmental variable. Second, the results of the analysis data using Multidimensional Scaling (MDS) showed that the most influential factors on the yields, such as average CO<sub>2</sub> level, average inside humidity, and average illumination were differently given for each farms. However, these results are based on the distance in 3D space and can be deduced from the fact that there is not a large difference between these distances. Therefore, in order to increase the harvest of strawberries cultivated in the farms, it is necessary to manage the environmental factors such as thoroughly controlling the humidity and maintaining the concentration of CO<sub>2</sub> constantly by ventilation of the greenhouse.

**Keywords:** strawberry yields, environmental factors, Graphic Analysis Method, Dynamic Time Warping, Multidimensional Scaling Method

### PS 1-44:

#### NEW CHALLENGES FOR BLUEBERRY CULTURE IN THE CLIMATE CHANGE REGIME

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Over the past 30 years, although there have been no significant changes in average annual rainfall and yearly rainfall, there have been increasing disturbances in rainfall distribution and extreme weather events. In this regard, with significant effects on blueberry production, we register the increase in hail and longer periods without rainfall. Since 1968, when the first field of experimental blueberry was established in Romania, the blueberry was cultivated in our country in a non-irrigated system, without significant production losses, but after 1990 the crops suffered even in the case of irrigated plantations due to water scarcity. During the dormant period, between November and March 2016, rainfall amounted only 15.8 mm, an unprecedented situation over the past 60 years since the Bilcești weather station is operating. The extremely low amount of rainfall together with low temperatures occurrence, especially in February-March 2016, had the effect of dehydration the aerial part of the plants from all of the blueberries plantations situated in the Northern part of Argeș County. This phenomenon completely compromised production in most crops or, in the best case, caused a severe reduction of production by over 60-70%.

**Keywords:** highbush blueberry, water scarcity, extreme weather

### PS 1-45:

#### GROWING BLUEBERRIES IN CONTAINERS, AN ALTERNATIVE TO PROMOTE BLUEBERRY IN AREA WITH INAPPROPRIATE PEDOLOGICAL CONDITIONS

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The interest in blueberry culture in Romania had a sinuous evolution from 1968 to the end of the last century. Areas cultivated with blueberries fluctuated from less than 10 hectares in the 70's to about 300 hectares in the late 80's and less than 30 hectares at the end of the 20th century. After that, the interest in blueberry production constantly increased and the surface cultivated with blueberries reaching more than 800 hectares today. A special attention have been paid by researchers to the possibility of growing blueberry in neutral and even alkaline pH areas, apart from the native soils. After 2000, we have conducted numerous studies on the use of different substrates materials in various crops and cultivation systems, choosing containers for growing the plants. Of the cultural systems tested, we appreciated that the safest way of cultivation is in pots. This growing system, despite additional initial costs and a greater vulnerability, can provide an increase in productivity of 2-3 times per hectare.

**Keywords:** highbush blueberry, pots, high density plantations

## PS 1-46:

### COMPETITIVESOUTHBERRIES: INNOVATIVE, COMPETITIVE AND SUSTAINABLE OFF-SEASON SMALL FRUIT PRODUCTION SYSTEMS

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In order to increase the competitiveness of the small fruit sector in the Portuguese Southern regions through the development and demonstration of innovative production technologies ensuring the sustainability of systems and the enhancement of endogenous genetic resources, an operational group was created in Portugal involving 6 partners, four of them growers, located in the southern part of Portugal (southwest coast and Algarve). The objective of the CompetitiveSouthBerries project is to take advantage of the excellent climatic conditions of the southern regions to develop innovative production technologies for different berry crops. For raspberry and blackberry the aim is to optimization the long-cane production system in order to obtain three crops per year in raspberry and a very early harvest for blackberry; for strawberry new substrate technologies with tray plants for winter production; for blueberry the growth cycle manipulation for an early and late fruit harvest; for endemic species the establishment of field trials of genotypes of interest for *Rubus* spp. and *Corema album* based on fruit quality and yield for the export market. Demonstration trials are already running for each species vs. technology and dissemination activities are taking place. From the meetings already organized it was possible to recognize the bottlenecks of the berry industry and gather the new technologies that will develop it further.

**Keywords:** raspberry, blackberry, strawberry, blueberry, *Corema album*, protected cultivation

## PS 1-47:

### FRUIT EVALUATION OF DIFFERENT PORTUGUESE RUBUS ULMIFOLIUS SCHOTT ECOTYPES

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Portugal has a great variety of climates that leads to a high number of *Rubus ulmifolius* ecotypes dispersed through all the territory. INIAV (Instituto Nacional de Investigação Agrária e Veterinária) holds a collection of endemic Iberian *Rubus* spp. Different Portuguese ecotypes of *Rubus ulmifolius*, selected by its possible fruticulture interest, are present in this collection. Among the selections, one ecotype revealed superior characteristics of vegetative vigor, fruit size and yield (Arrepiado). In order to evaluate the potential use in a wild blackberry line of a breeding program, four ecotypes of *R. ulmifolius*, Arrepiado, Serpa, Barrancos and Fataca were studied and the following fruit biometric traits were analysed: fruit shape (longitudinal and transversal axes); fruit weight (fresh and dry) and number of seeds per fruit. Results showed significant differences for all biometric fruit traits. The ecotype Arrepiado had the highest fruit weight and number of seeds per fruit, with a longitudinal axis longer than the transversal axis giving it an elongated shape, instead of a round shape as the other three. Cytometry analysis of leaf samples from the four ecotypes were carried out in order to compare genome size. Cytometry revealed no differences regarding genome size. The significant increase of the analyzed





fruit biometric traits cannot be explained by a higher degree of genetic polymorphism. Further morphological studies should take place in order to confirm if *Arrepiado* is a distinct botanical form of *Rubus ulmifolius*. Furthermore, this ecotype has an interesting potential to be part of a blackberry breeding program with wild fruit taste characteristic.

**Keywords:** wild blackberry, biometric traits, small fruits, cytometry

## PS 1-48:

### PHENOLICS MAY FOOL THE MITE

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One of the biggest problems encountered in commercial black currant plantations in the majority of the European countries is the infestation by the arachnid gall mite (*Cecidophyopsis ribis* Westw.). Gall mites cause galling of the buds leading to a damaging condition known as “big bud”. Furthermore, the gall mite is the sole vector of black currant reversion virus (BRV), which could render the plant sterile within a few years thereby leading to severe yield losses. Chemical control of gall mite is difficult because the mites are concealed inside the galled buds for most of their lives. None of the currently available acaricides has systemic properties and chemical agents have been withdrawn due to environmental and health risks. New resistant cultivars are the most ecologically friendly and economically preferable way to fight gall mite problems. The most robust source of resistance is the Ce-gene derived from gooseberry. Another source of resistance comes from *R. nigrum* var. *sibiricum*, which is controlled by the P gene. However the biochemical mechanisms for the resistance is still not known. Plant secondary metabolites play an important role in the chemical defence that repel, restrain or attract pests and pathogens. We hypothesized that specific phenolic compounds are involved in the host pathogen interaction between the black currant plant and the black currant gall mite, and directly associated with plant resistance. We analysed the presence/absence of gall mite infested buds in defined breeding populations, screened the same plant material for the resistance Ce-gene using a PCR based specific marker, analysed bud phenols of resistant (Ce- and P-genes) and susceptible plant material by untargeted HPLC-DAD-analysis, and performed statistical analyses to associate peaks with resistant plant material. We found three peaks significantly associated with gall mite resistance. Attempts to identify the phenolic compounds are ongoing and results will be presented.

**Keywords:** Black currants, gall mite, DNA marker, resistance, secondary metabolites

## PS 1-49:

### CHLOROPHYLL, CAROTENOID AND VITAMIN C METABOLISM REGULATION IN ACTINIDIA CHINENSIS ‘HONGYANG’ OUTER PERICARP DURING FRUIT DEVELOPMENT

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Ascorbic acid (AsA), chlorophyll and carotenoid contents and their associated gene expression patterns were analysed in *Actinidia chinensis* ‘Hongyang’ outer pericarp. The results showed chlorophyll degradation during fruit development and softening, exposed the yellow carotenoid pigments. LHCb1, CLH1, CLH2 and CLS1 gene expressions were decreased, while PPH2 and PPH3 gene expressions were increased, indicating that downregulation of chlorophyll biosynthesis and upregulation of its degradation, caused chlorophyll degreening. A decrease in the expression of the late carotenoid biosynthesis genes (LCYB1, LCYE1, CYP1, and CYP2) and degradation genes (ZEP1, VDE1, VDE2, NCED2, and CCD1), showed biosynthesis and degradation of carotenoid could be regulatory factors involved in fruit development. Most genes expression data of L-galactose and recycling pathway were coincide with the AsA concentrations in the fruit, suggesting these are the predominant pathways of AsA biosynthesis. GMP1, GME1 and GGP1 were identified as the key genes controlling AsA biosynthesis in ‘Hongyang’ outer pericarp.



**Keywords:** *Actinidia chinensis* 'Hongyang', Carotenoid, Chlorophyll, Fruit development, Gene expression, Vitamin C

## PS 1-50:

### MORPHOLOGY AND VIABILITY IN VITRO OF POLLEN FROM TWO MULBERRY VARIETIES (*Morus latifolia*)

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Viable pollen is generally essential for fruiting of fruit crops. However, little is known regarding mulberry pollen (*Morus* spp.). Therefore, this study aimed to examine morphology and viability in vitro of pollen from monoecious plants of *Morus latifolia* var. 'Unryuu' and 'Mizumihaiteku'. The shape and size pollen grains were examined. In 'Unryuu' and 'Mizumihaiteku', pollen grains were prolate in shape, and there were no significant differences in the equatorial axes, polar axes, and P/E values. Next, pollen germination and tube growth in vitro experiments were performed with 100 ppm H<sub>3</sub>BO<sub>3</sub>+300 ppm Ca(NO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O (BCa) or Brewbaker and Kwack (BK) solid media in 10, 15 and 20% sucrose and incubated at 20, 25 and 30°C, respectively. Pollen from 'Unryuu' germinated well in BCa medium supplemented with 15-20% sucrose and incubated at 25°C, and the pollen germination rate was 43.1% after incubation for 24 h. The growth of pollen tubes was optimal in BCa medium supplemented with 10% sucrose and incubated at 25°C, and measured 182.2 µm in length after incubation for 24 h. Pollen from 'Mizumihaiteku' germinated well in BCa medium supplemented with 15% sucrose and incubated at 25-30°C, the pollen germination rate was 50.5% after incubation for 24 h. The growth of pollen tubes was optimal in BCa medium supplemented with 10% sucrose and incubated at 30°C, and measured 259.1 µm in length after incubation for 24 h. We concluded that the morphological traits of pollen from two varieties are similar, whereas 'Mizumihaiteku' had better viability in vitro than that from 'Unryuu'. The BCa medium was more efficient for pollen culture for both varieties. These results could lead to the development of a more feasible strategy for the pollination of orchards.

**Keywords:** mulberry, pollen morphology, pollen germination, pollen tube growth, media, temperature, sucrose

## PS 1-51:

### EFFECT OF POMEGRANATE PHENOLIC EXTRACT ON MARGARINE PRESERVATION

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Margarine is known to be sensitive to oxidation damage, due to this, synthetic antioxidants which are known by their property to mitigate oxidation phenomenon and avoid the appearance of rancid defects are added. For this reason, approved antioxidants such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and tetra-butyl hydroquinone (TBHQ) are widely used in food industry as potential inhibitors of lipid oxidation.

Actually, consumers prefer purchasing natural products which led to increased interest in the use of natural antioxidants found in fruits and vegetables that could delay oxidation processes. Natural antioxidants from food products, such as those contained in flesh, and peel extracts, have been tested. They increase the resistance of fats to oxidation and consequent rancidity.

The aim of the present work was to check possibility to substitute a synthetic additive (Tocoblend) used in fats and oils productions by phenolic compounds extracted from acid pomegranate (*Quares cutivar*).

This cultivar has a high content of phenolic compounds. Indeed, its juice contains  $234.22 \pm 14.70$  mg EAG /100 mL, while in the peel, variable amounts are quantified depending on extraction method, is about  $227.10 \pm 7.06$  mg EAG / g DE when acetone was used as solvent and  $133.65 \pm 4.85$  mg EAG / g DE with water.

The physicochemical characteristics of formulated margarines are in accordance with a pre-established recipe and quality standards. Furthermore therefore, the quality of margarines enriched with extracts and juice is improved.



**Keywords:** *Punica granatum* L., phenolic compounds, extraction, antioxidant activity, margarine formulation

## PS 1-52:

### EFFECT OF POMEGRANATE PEEL EXTRACT ON MARGARINE PRESERVATION

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