IHC2018-Symposium 9
Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops

ORAL PRESENTATIONS

KEYNOTE 1

ADVANCES IN CULTIVAR AND ROOTSTOCK BREEDING: A CASE STUDY IN PEACH

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Environmental challenges, changes in production systems, and human preferences are driving the need for delivery of new scion and rootstock cultivars for sustainable production. The latest innovations in science and technology are integrated in plant breeding to provide sustained solutions to production challenges and market demands. Understanding the genetics of the key traits of importance for fruit tree production and sustainability is the main generator of advances in breeding of new cultivars that can address changing needs of the fruit industry. Characterization and utilization of genetic diversity, and application of genomic technologies are needed to improve breeding efficiency in both scion and rootstock cultivar development. Functional and comparative genomics studies utilizing synteny and collinearity among species and genera are often applied in development of new cultivars with desirable traits via marker-assisted selection in breeding programs. Routine DNA-informed breeding has become reality via translation of the new discoveries into practical breeding-friendly tools and knowledge. A multidisciplinary approach that incorporates the application of modern technological tools in peach scion and rootstock cultivar development in the Clemson University peach breeding program will be presented.

Keywords: (Last update 4 December 2017 18h16)
DNA-informed breeding, genetic diversity, cultivar improvement, genomic Technologies

SESSION I: Breeding strategies and cultivar evaluation

OS 1-1:

BREEDING OF RED-FLESHED APPLES CONTAINING BOTH MDMYB10 AND MDMYB110A GENES

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The dormant shoots from one-year-old seedlings selected by DNA markers were top-grafted onto adult apple trees in Spring 2015, and flowered and fruited for the first time in 2017. The petals of 8 cross-breeding lines between type 2 cultivar ‘Irodori’ and type 1 cultivar ‘Honey Rouge’were redder in both sides which is characteristic in the expression of MdMYB10 and MdMYB110a genes. The anthocyanin content of the flesh in the hybrids with dark red skin is higher than that of male parent ‘Honey Rouge’. It is likely that three types of genes of MdMYBA, MdMYB10 and MdMYB110a in the fruit flesh may express at the same time. The fruits in the progenies generally mature later than ‘Honey Rouge’when air temperatures become low, and stable redder flesh may be obtained. The fruit quality in the hybrids may be improved because the Brix content increased.

Keywords: Red-fleshed apple, breeding, MdMYB10, MdMYB110a

OS 1-2:

CHARACTERISATION OF A POPULATION OF PLUM X PEACH HYBRIDS FOR USE AS LOW-CHILL ROOTSTOCKS

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Control of excess vegetative vigour is a major expense in low-chill peach orchards in subtropical Australia. Size controlling rootstocks adapted to the subtropics would be a valuable tool in improving orchard efficiency. A population of plum (Prunus salicina) x peach (P. persica) hybrid seedlings was produced using two low-chill plum selections and 'Okinawa' and 'Flordaguard' peach as parents. The hybrids have been screened for ease of propagation as softwood cuttings, susceptibility to root-knot nematodes (Meloidogyne incognita and M. javanica), leaf colour, bud-take when spring budded and initial growth of budded scions. Key characteristics of this germplasm are described. Field testing of the superior hybrids will commence in 2018.

Keywords: breeding, Prunus

OS 1-3:

GROWING ENGLISH AND FRENCH CIDER APPLE CULTIVARS IN SWEDEN STATUS:

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Production of alcoholic apple cider has a long tradition in especially England, France and Spain. The designated cider apple cultivars grown in these countries, are closely related to dessert apples but have a higher content of phenols, with procyanidins (tannins) and possibly other phenolic compounds providing the distinct cider aroma. A recently planted observation trial together with data collected in a commercial orchard, have provided valuable information on the feasibility of growing English and French cider apple cultivars in Southern Sweden. Chemical contents (sugar, acid and phenols) were determined in fruit juice of 21 cider apple cultivars in 2016 and 2017. In spite of the approximately one month later fruit ripening in Sweden, contents were on the whole quite similar to previously reported data for the same cultivars in their countries of origin. Large-scale cider production may necessitate storage of the harvested fruit for some weeks or months before juicing. Due to their higher phenolics content, cider apple cultivars can be expected to be relatively resistant to fungal storage rots. Inoculation with blue mould (Penicillium exansum) spores was undertaken in 2016 and 2017 on 7 cider apple cultivars and 7 dessert apple cultivars for comparison. Contrary to expectations, the cider apple cultivars were significanly more susceptible to blue mould.

Keywords: Malus x domestica, Cider, Chemical contents, Storage rots, Penicillium expansum

OS 1-4:

PROPAGATION OF SOME TURKISH HAZELNUT CULTIVARS BY STOOLING

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The present study has been conducted between February 2013 and January 2014 at Department of Horticulture, Agriculture Faculty, Ondokuz Mayis University, in the province of Samsun. The objective of this study was to determine the propagation performance of the "Acı", "Allahverdi", "İncekara", "Kalınkara", "Okay 28" and "Sivri" Turkish hazelnut cultivars by stooling (mound layering). For this purpose, six-year-old bushes with 5-6 stools are used as stock plants and 20 stool shoots are used per bush. Gridling was used in all cultivars as a standard application that has the highest effect on adventitious root formation. A mixture of soil - perlite (2:1) was used as a rooting medium. Statistical differences among hazelnut cultivars were found for each trait. Rooting percentage has varied between 50.01% and 74.33%, rooted nursery plants ready for planting due to rooting score (3, 4 and 5 grades) percentage has varied between 27.86% and 36.83%, primary root number has varied between 12.84 and 22.08, primary root length has veried between 15.37 cm and 20.15 cm, fresh root weight has varied between 3.77 g and 5.94 g, shoot length has varied between 93.12 cm and 137.36 cm, shoot diameter has varied between 10.28 mm ile 14.42 mm, bud number has varied between 19.40 and 30.68, fresh shoot weight has varied between 47.13 g and 127.89 g. In the study, great success has been achieved during 2013-2014 period on these hazelnut cultivars.

Keywords: Corylus avellana, mound layering, root formation

SESSION II: Rootstock evaluation 1

OS 2-1:

THE AFFINITY OF ROOTPAC ROOTSTOCKS WITH NECTARINE AND PEACH CULTIVARS STATUS:

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Interspecific hybrids or clones from different fruit species can be used as rootstock in peaches. Recently, Rootpac rootstocks have begun to be used for peaches. Therefore, grafting capability and the compatibility of them with peach and nectarine cultivars should be examined. The aim of this study is to determine the compatibility characteristics of different clonal Rootpac rootstocks with peach-nectarine cultivars. Graft unions of peaches & nectarines on Rootpacs were monitored at Fruit Research Institute in Eğirdir, Isparta, Turkey. Peach cultivars 'Monroe', 'Royal Glory', 'Q'Henry', 'Vista Rich' 'Cresthaven' and nectarine cultivar 'Venus' were grafted on Rootpac rootstocks (Rootpac-R, Rootpac-90, Rootpac-70, Rootpac-40, Rootpac-20) by T budding method. The graft samples were evaluated under microscope 1, 4 and 12 months after grafting. Cambial differentiation occurred after a callus bridge was formed between two parts of the graft. The graft union and development was observed to be successful. Consequently, no evidence for histological incompatibility was seen. In addition to this, in this cultivar/rootstock combinations, incompatibility symptoms (drying, chlorosis on the leaves, premature death of the trees, marked difference in the growth rate or vigor of scion and stock, over growth at, above or below the graft union, etc.) were not observed in the second and the third leaf seasons of the plants.

Keywords: Incompatibility, graft union, peach, scion, rootstocks

OS 2-2:

EARLY PERFORMANCE OF PROMISING SÖ QUINCE CLONES (CYDONIA OBLONGA MILL.) AS COMPATIBLE ROOTSTOCK FOR PEARS (PYRUS COMMUNIS)

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A breeding project was initiated in Turkey about 50 years ago to develop clonal quince rootstocks compatible with pears. A total of 97 quince genotypes were selected all over Turkey. They were grafted with European pears (Pyrus communis L.) such as early-season (‘Akça’, ‘Şeker’ and ‘Bartlett’), and late-season (‘Ankara’) cultivars in a research plot in Ankara University, Faculty of Agriculture, Department of Horticulture in Ankara. Promising genotypes were selected based on plant vigor and yield after 20 years of evaluation. Seven of them were successfully propagated clonally. They were registered in 2017 and named SÖ (Prof.Dr. Sabahattin Özbek) quince rootstock series; SÖ39-200, SÖ17-77, SÖ16-69, SÖ18-82, SÖ57-314, SÖ58-315 and SÖ59-327. In this study, survival rate and plant development of 4 years old European pear cultivars grafted on these quince rootstocks and EMA (East Malling ‘A’) as control were evaluated. Cultivars incompatible on quinces were ‘Bartlett’ on SÖ39-200, 17-77, 16-69, 18-82, 57-314, 58-315, 59-327 and EMA, and ‘Dr. Jules Guyot’ on SÖ39-200, 16-69, 18-82 and EMA. Cultivars compatible on quinces were ‘Beurre Hardy’ on SÖ 39-200, 16-69, 18-82 and EMA, ‘Ankara’ on SÖ 39-200, 16-69, 18-82, 57-314, 58-315, 59-327 and EMA, ‘Deveci’ on SÖ 39-200, 17-77, 16-69, 18-82 and EMA, and ‘Passe Crassane’ on SÖ 39-200, 17-77, 16-69, 18-82, 57-314, 58-315, 59-327 and EMA. Plant height, canopy diameter, cross section area, annual shoot length, internode length, and number of fruit bearing branches were determined.

Keywords: Quince rootstock, SÖ rootstocks, graft compatibility, plant survival, vigor

OS 2-3:

EFFECTS OF APPLE ROOTSTOCKS ON NUTRIENT CONTENT IN 'HONEYCRISP' SCIONS

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Rootstocks not only influence tree growth vigor, branch angle, biennial bearing, and productivity but also have a key role when gathering mineral nutrients from the soil and shuttling them into different sinks in the canopy. Determining tree nutrient requirements is urgently needed for effective management of high value cultivars such as ‘Honeycrisp’, which have high susceptibility to bitter pit. Therefore, identifying rootstocks with better nutrient uptake and more positive effects on fruit quality may represent the most economical long-term solution to many fruit quality problems associated with nutrient imbalances. Two Malling (M.9T337 and M.26EMLA), one Budagovsky (B.10), eight Geneva® (G.11, G.202, G.214, G.30, G.41, G.5890, G.935, G.969), and four Vineland (V.1, V.5, V.6, V.7) rootstocks on Honeycrisp as the scion cultivar were used for this study. The trial was planted in 2014 as a completely randomized design, with 10 single tree replications. Higher Ca leaf content was observed on G.30 and G.890 rootstocks, whereas G.969, G.935, and V.1 had the lowest. Nitrogen was higher on G.5890 and M.26, and the lowest values were observed on M.9T337, G.202, V.1, and G.935. Similarly, lower Mg (%) was observed on V.1, G.935, and G.969. Taking into account all the assessed nutrients (N, Ca, S, Fe, Cu, Al, Mg, P, K, B, Zn, and Mn), rootstocks were clustered within six different groups. In addition clustering the variable values revealed which variables were connected. N and Ca were highly associated (correlated). On the other hand, P, K, and B were correlated with Zn and Mn. B.10 and M.26EMLA were pretty similar. G.30, G.41, and G.5890 were clustered within the same group. That group was characterized by high N, Ca, S, Fe, Cu, and Al content, whereas K and Mn were fairly low. With lower N and Ca content, G.11, V.5, V.6, G.214, and V.7 were clustered within the same group. G.202 and G.935 had similar nutrient profile, both with high levels of P, K, and B. With the lowest Mg, P, and K values, G.969 was clustered alone. M.9T337 and V.1 were clustered together, both with low N and Ca, and high Zn and Mn.

Keywords: Bitter pit, Ca, Fruit quality, K, Mg, N, Nutrient uptake

OS 2-4:

IMPACT OF APPLE AND CHERRY ROOTSTOCKS ON PHLOEM COMPOSITION AND APHID RESISTANCE

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Rootstocks are an important component of modern tree fruit production and can control plant size, vigor, yield and responses to biotic and abiotic stresses. In trials involving 31 apple rootstocks, differences have been observed in aphid infestations. Aphids feed on the plant phloem and its organic nitrogen composition may affect aphid infestation success. Therefore, the effect of rootstocks on the organic nitrogen composition of phloem exudates from apple and cherry scions was determined during 2 growing seasons and relationships with aphid resistance was explored. Phloem was sampled from leaves by immersing petioles from 'Honeycrisp' apple and 'Skeena' sweet cherry leaves in 15 mM EDTA. Apple leaves from experimental orchards in Nova Scotia, Ontario and British Columbia, Canada were sampled from trees grown on 10 different rootstocks. Cherry leaves from experimental orchards in Nova Scotia and British Columbia were sampled from trees grown on 3 different rootstocks and 3 training systems. Sampling occurred both before and after the time of typical aphid infestation. Organic nitrogen composition of phloem exudates was determined using ultra high performance liquid chromatography (UHPLC) with fluorescence detection following derivatization with o-phthalaldehyde-ethanethiol-9-fluorenylmethyl chloroformate (OPA-ET-FMOC). A total of 31 nitrogenous compounds were identified in both apple and cherry samples including 21 amino acids. In apple, all compounds were significantly affected by rootstock and sampling time and the most abundant amino acids included proline (Pro), glutamate (Gln), alanine (Ala) and serine (Ser). Amino acid content declined during the growing season and was highest in M26, G935, G11, G41 and G202. In cherry, the most abundant amino acids included Ala, Gln, glutamine (Gln), and Ser and rootstock significantly affected the content of Pro, Aspartate (Asp), and Hydroxyproline (hyp), while training system only affected Pro levels. The impact of rootstocks on phloem amino acids and aphid resistance will be discussed.

Keywords: Root-stock, apple, cherry, phloem composition, amino acids, aphid resistance

OS 2-5:

PIN1B ENCODES A PUTATIVE AUXIN EFFLUX CARRIER AND CONTRIBUTES TO DWARFING EFFECT IN M9 INTERSTEM APPLE TREE

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Grafting is widely used in the cultivation of horticultural plants, apple trees grafted onto dwarfing rootstock Malling9 (M9) produce dwarfing tree architecture with high yield and widely applying in production. Previously, we have reported that in Malus 'Red Fuji' (RF) trees growing on M9 interstem and Malus robusta

(Mr, vigorous) rootstock, auxin (IAA) content was relatively higher in bark tissue of M9 interstem than that in scion or rootstock. As IAA polar transportation largely depends on the PIN-FORMED (PIN) auxin efflux carrier. Herein, we identified two putative auxin efflux carrier genes in Malus genus, PIN1a and PIN1b, which were closely related to the AtPIN1. In RF/M9/Mr, we found that PIN1b was expressed preferentially compared to PIN1a, and the expression of PIN1b was significantly lower in the interstem than that in the scion and rootstock. In our study, transiently expressing 35S-PIN1b-GFP fusion protein showed that PIN1b protein was localized on cell plasma membrane in onion/tobacco epidermal cells. The distinct expression of PIN1b and IAA content were concentrated in the cambium and adjacent xylem or phloem. Interestingly, an PIN1b mutant allele with a TATA-box and Dof transcription factor absence in the promoter region upstream of M9 exhibited decreased PIN1b expression compared to Mr. The altered PIN1b promoter is responsible for changing polar auxin transport in M9 and Mr rootstocks. PIN1b over-expressing interstem in tobacco exhibited increased IAA contents in roots, which suggested PIN1b contributed to polar auxin transport. It is proposed that natural allelic differences decreased promoter activity is closely associated with lower PIN1b expression in the M9 interstem, which might limit the basipetal transport of auxin within phloem and cambial tissue, and in turn might contribute to the dwarfing effect. Taken together, these results reveal allelic variation underlying an important apple rootstock trait, and specifically a novel molecular genetic mechanism underlying dwarfing mechnism.

Keywords: auxin, M9 interstem, dwarfing, PIN1b, gene expression, promoter activity

OS 2-6:

THE INFLUENCE OF ROOTSTOCK ON APPLE YIELD, FRUIT QUALITY ATTRIBUTES, AND MINERAL NUTRIENTS OVER SEVERAL YEARS

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The influence of several rootstocks on tree growth, yield, fruit quality attributes, and mineral nutrient concentrations of ‘Aztec Fuji’ apple under conditions of the Intermountain west region of the United States was studied between 2010 and 2015. Averaging over 2010 through 2015, trees on B.70-20-20, B.67-5-32, CG.3001, B.64-194, PiAu51-11, G.222, and CG.4004 had the largest trunk cross sectional area (TCSA) but those on B.7-20-21 and B.71-7-22 and CG.4003 had the smallest TCSA. Cumulative yield between 2011 and 2015 in trees on CG.4004, G.41, CG.3001, and G.935N were higher while in trees on PiAu9-90 and B.71-7-22, CG.4003 and B.7-20-21 were lower than trees on other rootstocks. Cumulative yield efficiencies in trees on G.935N, G.214, CG.2034, M9T337, and B.9 were highest, while trees on B.70-20-20, B.7-20-21 and PiAu9-90 were among the lower ones. Averaging quality attributes between 2012 and 2015, trees on CG.3001, CG.4004, G.222, G.41N, B.70-20-20, M.26.EMLA, and PiAu51-11 had the largest fruit while those on B.7-20-21, CG.4003 and PiAu9-90 had smallest fruits. Fruit color was the best in trees on G.814 and CG.5087 rootstocks. Fruit from trees on B.7-20-21 had the highest soluble solids concentration (SSC) and firmness because of their smallest size. Trees on B.70-20-20 were among those with the least color, SSC and firmness among all trees. Fruits on G.935, Supporter 3, and G.214 had more advanced starch degradation pattern (SDP) while those on CG.5087 had the lowest SDP than those on others. Averaging between 2012 and 2014 for leaf minerals, trees on B.20-20-21 and CG.5087, and G.11 had higher concentrations of leaf N but those on CG.2034, PiAu990, and Supporter 3 had lower leaf N than those on other rootstocks. Trees on B.64-194 and B.70-20-20 had higher concentrations of leaf K but those on G.935T, G.935N, and G.4003 had lower leaf K than those on other rootstocks.

Keywords: Apple rootstock, apple nutrition, high density orchard, modern orchards

OS 2-7:

EFFECTS OF DWARFING AND SEMI-DWARFING APPLE ROOTSTOCKS ON THE GROWTH AND YIELD OF GALA, FUJI AND YORK APPLE TREES

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A field trial consisting of three apple cultivars (‘Red Yorking’, ‘Rising Sun Fuji’, and ‘Buckeye Gala’) grown on eight to ten dwarfing and semi-dwarfing rootstocks (G.16, G.41, G.935, G.11, G.30, Bud.9, M.9 Nic 29, M.26, M.7 and/or MM.111) was established on a research farm (AHS, Jr. AREC, Winchester, VA, USA) in 2011. This trial investigated the effects of rootstocks on tree growth [e.g. trunk cross sectional area (cm2), TCSA], yield (kg/tree), fruit drop (%), yield efficiency (fruit weight/cm2 TCSA) and cumulative yield (2013-2017) of the scion varieties. Trees were planted in a 12’ X 22’ tree spacing and distributed in four randomized blocks (with two trees per experimental unit) for each cultivar. Analysis of the seven-year dataset showed significant differences among rootstocks, particularly on tree vigor; with B.9 and G.41 exhibiting the lowest TCSA values; whereas M.111 and M.26 show the highest TCSA values. Because of their dwarfing effects on the grafted scions, both Bud.9 and G.41 resulted in the highest yield efficiency for all the three scion varieties in 2017. However, in terms of the cumulative yield, Bud.9 showed the lowest values (55 and0- 87.9 kg/tree) for Gala and Fuji, respectively. The highest cumulative yield for Gala and Fuji (167.8 and 203.1 kg/tree) was obtained when trees were on G.30 and M.26, respectively. For York, values of the cumulative yield were not significant between G.30, M.7 and G.41. Fuji and Gala trees on G.935 also showed cumulative yield comparable to those on G.30, but were less vigorous. Rootstocks also showed significant effects on the percentage of fruit drop for Fuji and Gala, but not for York. We will consider suitability for high-density planting systems, cumulative yield, and reported resistance to fire blight in making planting recommendations in the Mid-Atlantic region.

Keywords: Rootstocks, apple, yield efficiency, cumulative yield, dwarfing rootstocks

OS 2-8:

EFFECT OF CROP LOAD MANAGEMENT AND CANOPY ARCHITECTURE ON YIELD AND FRUIT QUALITY OF LATE-SEASON PLUM 'ANGELENO'

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The Australian summerfruit industry has identified sales growth is impeded by low consumer satisfaction with fruit quality, leading to low prices and static consumption. The effect of crop load on fruit production was studied in an experimental orchard at Tatura, Australia. The objective of the study was to identify crop load management practices, under Tatura Trellis and vase training systems, to enable plum to maximise uniformity in fruit quality attributes. Crop loads were applied to induce a range of competitive source/sink responses between fruit and available assimilate. Different thinning regimes were implemented in season 2016/17 based on the number of fruit left on the trees: (1) high: minimally thinned; (2) medium (commercial standard as control): moderately thinned and; (3) low: heavily thinned. Despite identical tree density and age, larger canopies occurred on Tatura Trellis compared to vase. Larger tree size was reflected in trunk diameter and canopy radiation interception (fPAR), providing capacity to support greater fruiting levels and high yields. Mid-season fPAR was ~68 % under Tatura Trellis compared to ~52 % for vase trees. Fruiting level did not affect flowering date or fPAR for a given canopy architecture. However, trunk growth was higher under low crop load on Tatura Trellis. Overall, high cropping levels reduced fruit weight and lowered packout performance compared to medium and low crop load treatments under both training systems. Irrespective of training and cropping level combination, fruit sweetness was high (≥ 17.2 °Brix), with low variability (CV ≤ 11 %). Over half of all fruit grown on Tatura Trellis exceeded 18 °Brix, compared to ≤ 38 % on vase. Under low crop load, a high proportion of fruit met Australian export standards for fruit size and sweetness. For vase trained trees, fruit maturity and firmness were similar across crop load treatments. However, for Tatura Trellis training system, high cropping levels produced less mature and firmer fruit.

Keywords: Vase, Tatura Trellis, fruiting level, brix, maturity, firmness, planting system, high density.

KEYNOTE 2

THE FIRST 50 DAYS AFTER ANTHESIS ' IMPLICATIONS FOR APPLE YIELD, FRUIT QUALITY AND CANOPY MANAGEMENT

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International markets are increasingly demanding fruit with high visual, taste and textural appeal. High sensory appeal of fruit products is widely recognised to result in repeat purchasing by the consumer, and premium returns to the producer. Hence, precision technologies for canopy management are increasingly being implemented in modern orchard systems in New Zealand to reduce variable fruit quality in the supply chain. In a study of 4 commercial apple cultivars (‘Braeburn’, ‘Royal Gala’, ‘Scilate’, and ‘Scifresh’), increases in fruit total non-structural carbohydrate and fruit dry matter concentration were of the greatest magnitude 25-85 days after anthesis, but did not greatly change from day 85 until commercial harvest. By 50 days after anthesis, fruit instrumental firmness for each cultivar was ≈20 kgf, declining to ≈9 kgf by commercial harvest. Fruit dry matter content (i.e. taste potential) and firmness (i.e. textural potential) at harvest appeared to be determined by factors occurring in early spring. We discuss how both fruit yield and quality can be increased further in modern orchard systems through management decisions (orchard and training system design) and practices (pruning, crop loading and vigour control) that work with the underlying physiology of trees to maximise early season fruit development.

Keywords: vigour, flowering, fruit set, crop load, pruning, training systems

SESSION III: Orchard architecture and training systems

OS 3-1:

ORCHARD ARCHITECTURE EFFECTS ON YIELD AND ECONOMICS OF TWO APPLE CULTIVARS

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Tree training systems for apple have changed dramatically in the last ten years in the eastern U.S. In general commercial growers have changed to narrow upright systems with in excess of 1500 trees/ha. To evaluate these newer training systems a planting was established with two cultivars; Jonagold/B.9 and Fuji/M.9 T337, both at 1.525 x 4.3 m (1537 trees/ha) in 2008. Training systems included a Vertical Axe (VA), Minimally Pruned (MP), Tall Spindle (TS) and Tall Trellis (TT). At the end of the 9th growing season there was no difference in tree size within cultivars due to training system. Cumulative average number of fruit per tree and hectare was greatest for both cultivars on the MP system. Total cumulative kg/ha yield was not significantly different for Jonagold as influenced by training system. However, for Fuji, trees in VA and MP systems had significantly better yield per ha than the TT but similar to TS. Time to prune and train each system was recorded for the first 9 years and trees in the TT system required the most annual time. Cumulative efficiency for Jonagold in the TS was significantly lower than that for trees in the TT training system. There was no significant difference in cumulative efficiency for Fuji by system. Fruit samples were collected at harvest and run across a grader to determine size distribution. Partial economic analysis of Jonagold showed that income was greatest for trees in the VA system, labor costs

were highest for the TT system and the net return was greatest for trees in the MP system. Dollar values for Fuji trees were all higher than those for Jonagold. Income and net returns were highest for trees in the VA system and labor costs were highest in the TT system.

Keywords: apple, production systems, Jonagold, Fuji, training systems, tall spindle, trellis, vertical axe, income, costs

OS 3-2:

COMPARISON OF 'SOLAXE' AND 'TALL SPINDLE' SYSTEMS FOR 'FUJI'/M.9 APPLE TREES AT COMMERCIAL ORCHARDS IN SOUTH KOREA

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Average apple production per ha in South Korea has been below 20 tons for the last 10 years. However, it has been shown in Autumn 2017 that one “solax” trained and another “tall spindle” trained orchards exceeded 100 tons per ha, respectively. This is more than 5 times over average production, which indicates that the low production so far for Korean apple industry can be improved greatly by adopting one or both systems. Therefore, this report concentrates on the performance of production yield, quality of apples produced, cost of orchard establishment, and reached the conclusion that the solaxe system was more beneficial than the tall spindle because it is less costly to plant wiht fewer number of trees andless neeed for employment of facilities.

Keywords: Orchard system, Solaxe, Tall spindle, cost of orchard establishment, production yield

OS 3-3:

THE EFFECT OF PLANAR CORDON ORCHARD SYSTEM DESIGN ON LIGHT INTERCEPTION AND YIELD OF SWEET CHERRY AND APRICOT

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Orchard yield potential per hectare is understood to be proportional to mature canopy light interception. Consequently, yields could be increased by increasing light interception, thereby improving potential economic returns to growers. Studies of production physiology of diverse planting systems designs have demonstrated that the upper limits of light interception in apple orchards to be ~65% of incoming radiation, with yield potential constrained accordingly. New planting systems for cherry and apricot are being investigated in New Zealand, with the aim of doubling yield of high quality fruit by increasing light interception through new planting systems designs that allow a reduction in inter-row distances. Closer row spacing requires new tree forms with narrow planar canopies for adequate canopy light distribution. The tree structure comprises two cordon leaders angled at ~45 degrees above the horizontal and oriented along the row, each with six vertical non-branched fruiting shoots spaced 25 cm apart, with an anticipated height of 3 to 3.5 m. This achieves narrow planar trees, 3 m long and ~0.4 m wide in a vertical trellis system. An additional format is a narrow vee formed by alternating the vertical fruiting shoots onto a vee trellis separated by 1 m in width at the top. Three cultivars of each of cherry (in 2014) and apricot (in 2015) were planted at 2 m and 1.5 m inter-row spacing (1667 and 2222 trees per ha, respectively). Whole canopy fractional light interception of three-year-old apricot and four-year-old cherry plantings will be measured during the 2017–18 growing season to determine planar cordon canopy row spacing effects and vertical versus vee trellis effects on the canopy light relations. These data will be compared with a same-aged conventional centre leader orchard system in full canopy. Yield data will also be presented.

Keywords: Prunus avium, Prunus armeniaca, PAR, irradiance, orchard systems, productivity

OS 3-4:

FORMATION OF IDEAL TREE CANOPY IN NEWLY PLANTED SWEET CHERRY ORCHARDS

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The formation and distribution of lateral branches are inadequate and non-uniform in cherry trees due to intrinsic apical mechanisms (i.e., apical dominance and apical control). The lateral branches of cherry trees develop strongly and have narrow branch crotch angles. This study was carried out at Malatya Apricot Research Institute from 2013 to 2015. In the study, one-year-old whips composed of the '0900 Ziraat' cultivar grafted on 'Mahaleb' rootstock were planted at 5 x 5 m spacing, in March 2013. In the planting year, Nicking, Nicking+(BA+GA4+7), Scoring, Scoring+(BA+GA4+7), bud removal, bud removal+(BA+GA4+7) and Knipboom+(BA+GA4+7) treatments were applied to the 50-120 cm part of the one-year-old trees without heading. In the control group, heading was applied to trees without any other branching treatment. Each treatment was represented by three replicates of 3-tree groups. In the second year of planting (2014), in March, BA+GA4+7 was applied to the 120-170 cm part of the tree, in all treatments. The number of lateral branches, lateral branch angle, lateral branch length, tree height, trunk diameter, necrosis occurred, fruit bud formation, uniform and homogeneous branch distribution were investigated. The results indicated the superiority of Nicking+(BA+GA4+7) treatment over other treatments towards ideal branching and high crop yield in the early years of planting.

Keywords: acrotony, fruitful tree, prolepsis, Prunus avium, Prunus cerasus, syllepsis

OS 3-5:

THE NEW TRAINING SYSTEMS FOR CHERRIES IN TURKEY

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Turkey is one of the most important countries of the world in terms of fruit production and cherry export. Many studies on world have been carried out on to increase yields and fruit quality, save labor and time, and reduce production costs. These studies, in particular, aim to improve canopy management, fill the allotted orchard space in a short time, increase the uniformity of the yield surface of the canopy, and achieve early fruiting. So, new training systems are required for a good orchard management. In this study, the new training systems such as Tall Spindle Axe (TSA), Super Spindle Axe (SSA), Uprighting Fruiting Offshoot (UFO) and Kym Green Bush (KGB) were investigated compared to Vogel Central Leader (VG) in terms of quality and yield in 2013-2017. ‘0900 Ziraat/Gisela 6’, ‘0900 Ziraat/MM 14’ and ‘0900 Ziraat/PHLC’ combinations were used. First data was obtained from ‘0900 Ziraat/Gisela 6’ due to tree losses in other combinations. Data of ‘0900 Ziraat/MM 14’ and ‘0900 Ziraat/PHLC’ will be obtained next years. However, tree growth characteristic of the both combinations were examined. In the study, it was determined diameter, length and number of primary shoots on leader and also initial fruit properties such as fruit diameter, weight (g), firmness(kg/cm2), fruit color values,soluble solid content (%), titratable acid content (%) andyield (g/tree). The trees were formed in the earliest of training systems TSA and SSA. The trees, the highest yield was obtained from the TSA system (2.42 g). The largest

fruits (10.6 g) were obtained from the SSA system. This information will be especially helpful in decisions for choosing the training system when sweet cherry orchards are being established in Turkey. The study was supported by TUBITAK (TOVAG 113 O 234). So, we thank to TUBITAK.

Keywords: Prunus avium, orchard management, '0900 Ziraat', cherry, training system

SESSION IV: Orchard management and physiology

OS 4-1:

13C-PHOTASSIMILATE AND 15N-UREA FOLIAR DISTRIBUTION IN SWEET CHERRY (PRUNUS AVIUM L.) KGB AND UFO TRAINING SYSTEMS

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The contribution of different leaf populations, as a source of carbon (C) and nitrogen (N) for reproductive organs of sweet cherry has not been described for Upright Fruiting Offshoots ("UFO") and Kym Green Bush ("KGB") training systems (TS). Additionally, branch autonomy has not been studied in both TS. In 2016, two field experiments using double isotopic enrichment with 13C and 15N for the combination "Lapins"/"Colt", were carried out in Rancagua, Chile. Fifteen trees per TS were selected and leaves of individual branches were pulsed with 13CO2 and painted by hand with 15N-urea 105 days after harvest (March 30, 2016). Ninety days after labeling (July 30, 2016), whole labeled branches were removed destructively. In both TS, wood had the highest C content (62-72 %) while reproductive buds of spurs registered the highest 13C concentration. 15N remained in directly labeled leaves (38-48 %), wood (45-48 %) and buds (7-13 %). No significant 13C and 15N translocation to reproductive buds of adjacent branches was detected neither in KGB nor UFO. Accordingly, vertical fruiting branches of KGB and UFO might be considered autonomous structures during the period previous to leaf senescence, in the vigorous sweet cherry combination "Lapins"/"Colt".

Keywords: stable isotopes, branch autonomy, dormancy, plant architecture, source-sink relationships.

OS 4-2:

AIR ROOT PRUNING CONTAINERS ALTER ROOT ARCHITECTURE AND INCREASE CANOPY AND ROOT GROWTH OF APPLE TREES COMPARED TO FIELD GROWN LINERS

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Trees account for the majority of expenses when establishing high-density plantings. The vast proportion of nursery trees are produced in the field and shipped bare-root. These trees are prone to transplant-shock and may require additional time to fill orchard space. The objectives of this project were to 1) compare two nursery production systems (air root-pruning containers and field-produced liners [i.e., bare-root trees]) on the growth and development of above-ground and below-ground organs of apple trees during the formative 'nursery' year and, 2) correlate these parameters with canopy growth and fruiting during the establishment years in the orchard. We hypothesized that container-produced trees would possess higher-quality root systems that mitigate transplant-shock and result in rapid canopy infill to expedite orchard return on investment.

This experiment was conducted in 2017 at the Michigan State University Horticulture Teaching and Research Center. Three apple cultivars 'Gala', 'Fuji', and 'Honeycrisp' were bench-grafted to M9 Nic29 rootstock and divided into two production systems: Ellepot containers and field liners. Entire plants were carefully harvested from each production system several times throughout the season. Leaf area, average leaf size, trunk cross-sectional and total above-ground dry matter were quantified. Whole root systems were scanned to determine root growth and architecture (size classes) then dried (dry matter). Growth of Ellepot-produced trees was more uniform and total leaf area, average leaf size, and seasonal above ground dry matter were significantly ($P < 0.05$) greater than field grown trees, irrespective of scion. Root morphology differed drastically between the two

systems. Ellepot-produced trees had markedly higher fine root production and greater root length density compared to field liners. In spring 2018, container and bare-root trees were established in an orchard. Root and canopy development are being monitored throughout the season.

Keywords:

OS 4-3:

CANOPY MANAGEMENT FOR OPTIMIZING PRODUCTIVITY OF POLYCULTURE COFFEE PRODUCTION SYSTEM

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Systematic management of canopy is an important tool that can be used for optimal integration of food crops and cash crops and, hence, attainment of food security and income diversification by small scale farmers. Many coffee and cocoa farmers often face a difficult choice between cash (tree) crops and food crops on their limited landholdings, which can be avoided by growing both crops concurrently. In their natural ecosystems, these tree crops grow under large trees that constitute the uppermost storey and shade the smaller tree crops that form the middle storey. In most developing economies, coffee and cocoa are grown under polyculture farming systems involving the tree crops grown under larger trees, both of which grow over the mostly seasonal food crops that constitute the understorey. Productivity of these food crops is then dependent on the fraction of sunlight transmitted through the canopies of the shade trees (upper canopy) and coffee (middle canopy); and the availability of water and nutrients. In this short review, we considered how management of the upper (shade tree) and middle (coffee) canopies influences yields of the fruit tree and associated food crops and hence productivity of the whole farm and improve food security outlook. Canopy management of shade trees and coffee bushes should be such that allows at least 40% of incident sunlight to be transmitted below the coffee plants to enable concurrent cultivation of food crops. We provide examples of how the presence of food crops exerts minimal impact on coffee yield and quality, and also on overall resource requirements; the latter is particularly critical during times of vigorous growth when coffee requires large amounts of inputs. Desirable features of shade trees that are critical for optimizing productivity include tolerance of minimal management, persistence, short and open canopy, and deciduous phenology. We identify research needs in the design and management of polyculture systems in order to optimize productivity and raise net economic benefits.

Keywords: competition, coffee, ecosystem services, food crops, micro-climate, nutrient supply, water supply

OS 4-4:

SUGAR ANALYSIS OF APPLE LEAVES TREATED WITH METAMITRON (BREVIS®) FOR FRUIT THINNING

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Fruit thinning is an important management practice to produce apples of high quality fruit. Inhibition of fruit set and stimulation of fruit drop by chemical products, are widely used in integrated fruit production. During the last few years fruit thinning research has been focused on the use on the photosynthetic inhibitor metamitron (Brevis®, 15% metamitron as active ingredient). This agent has shown to be a very effective in apple. The aim of this study was to determine the sugar profile in apple leaves treated with different concentration of this thinning agent. In order to realize what is going on with the primary metabolism in leaves before and after application of metamitron, the apple cultivar ‘Summered’ was sprayed after flowering with metamitron at NIBIO

Ullensvang, western Norway in 2016. Four different treatments were applied: (1) 1.1 kg/ha Brevis® when fruitlets were 8-10 mm, (2) 2.2 kg/ha Brevis® when fruitlets were 8-10 mm, (3) 1.1 kg/ha Brevis® when fruitlets were 8-10 mm + when fruitlets were 12-24 mm and (4) 2.2 kg/ha Brevis® when fruitlets were 8-10 mm + when fruitlets were 12-24 mm, together with control where no metamitron was applied. Leaves from the different treatments were collected before and after the treatments. The contents of sugars (glucose, fructose, sucrose and maltose) and sugar alcohol (sorbitol) were analyzed by ion chromatography. The third day after the application, the levels of sorbitol and glucose were significantly lower, while sucrose and maltose was significantly higher in all treatments comparing to the control. Sixth day all sugars dropped under the control level except for sucrose. Ninth day, the levels of sorbitol and maltose were higher, while fructose was lower in all treatments than in the control. According to the obtained results, fructose and glucose seemed to be the most stable sugars during application of metamitron.

Keywords: Malus domestica Borkh., fruit set, glucose, fructose, sucrose, maltose, sorbitol

OS 4-4:

FRUITLET GROWTH MODEL TO PREDICT CHEMICAL THINNING RESPONSE ON APPLES IN SOUTHERN BRAZIL

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Variability and unpredictability in chemical thinning has been a problem for apple growers for more than 50 years. This situation motivated an intense work to identify factors related to fruit abscission. Among such factors, daily fruit measurement is the only practical method to assess early thinning response. Measuring fruit growth is useful to assess potential fruit drop after thinner application. The objective of this study was to evaluate the efficiency of fruitlet growth model for prediction of chemical thinning on apples in Southern Brazil. The work was carried out in São Joaquim – Santa Catarina State, in the orchards of Epagri – São Joaquim Experimental Station (28°16'30" S, 49°56'09" W, altitude 1,400m). The orchard was planted in 2006, the evaluated varieties were Fuji Suprema and Maxi Gala, grafted on M.9 with 1 x 4 m spacing. At 4 days after thinner application, 50 fruits per tree were measured. After 6 days new measurements were taken. The data obtained were inserted in the worksheet developed by Greene et al. (2013). Based on growth rate, the prediction of thinning efficiency was determined, as well as whether or not there was a need for new applications. The following thinning treatments were compared: "Conventional" chemical thinning - Benzyladenine (10/14) + manual thinning (11/8); chemical thinning based on the fruitlet growth model - 2 applications of Benzyladenine (10/14 and 10/21) + Metamitron (11/9). The number of fruits predicted by the model, the number of fruits manually thinned and the number of fruits harvested were evaluated. The fruitlet growth model to predict chemical thinning response was accurate when comparing the number of fruits predicted and number of fruits produced by tree. The results of the first year evaluation are promising and indicate that the model can be useful to decision making on the proper timing for thinners application, as well as on the need to repeat them or not.

Keywords: Benzyladenine, Metamitron, fruitlet growth rate

OS 4-4:

PLANT GROWTH REGULATORS DO NOT REDUCE BIENNIAL BEARING OF TWO CIDER APPLE CULTIVARS IN VERMONT, USA

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Crop load management is a critical component of commercial apple production. For commonly-grown dessert cultivars removal of a portion of fruit each season via chemical thinning helps to maintain fruit size, quality, and annual bearing characteristics. Commonly-used thinning protocols in northeastern U.S.A. orchards include application of carbaryl at petal fall alone or in combination with other plant growth regulators (PGRs). European-origin cider apple cultivars typically do not respond similarly to chemical thinning programs used in production of dessert fruit. In the past two decades, application of PGRs at a later timing in midsummer has increasingly been used to increase fruit bud development for the following year on certain dessert apple cultivars with pronounced biennial bearing tendencies. In 2016 and 2017, multiple PGR programs were applied to 'Kingston Black' and 'Ellis Bitter' trees in a commercial orchard in Vermont, U.S.A. Trees were evaluated for crop yield, juice quality, and return bloom in each season. During the two years of the study, both cultivars exhibited strong biennial production habit. Within each year, PGR treatments had inconsistent effects on crop yield, but no effects of practical significance on juice quality. Despite a lack of PGR effects on substantially reducing bienniality, interactions of specific treatments and cultivars may inform continued research on this topic.

Keywords: crop load, thinning, 'Kingston Black', 'Ellis Bitter', juice quality

SESSION V: Rootstocks evaluation 2

OS 5-1:

SOME PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF APPLE ROOTSTOCKS TO IRON STRESS AND BI-CARBONATE TREATMENT

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Iron deficiency is an important problem in apple growing orchards especially in soils with high bicarbonate. In this study, different treatments including low iron nutrition, FeEDTA 2µM (-Fe) and normal iron with NaHCO3 10µM (+Fe) in half-strength Hoagland nutrient solution with the control FeEDTA 90µM (+Fe) were evaluated for physiological and biochemical responses of 6 apple rootstocks (M9, M26, M7, M25, MM106, MM111) in pots containing perlite. Responses of M26, MM111 and MM106 rootstocks to iron deficiency and bicarbonate presence, regarding leaf and root dry weight, leaf chlorophyll content and total leaf iron concentration, followed the same pattern and the values showed a significant decrease. Ferric chelate reductase activity in M9, M7 and M25 was increased by –Fe treatment. Shoot tips auxin content increased in response to iron deficiency in M9, M7 and M25 in both iron stress and bicarbonate treatments, and in MM106 by -Fe treatment. The root auxin content also followed the same trend. Total root phenolic compounds increased in M9 and M7 under -Fe and bicarbonate treatments and in M25 and MM106 only in the treatment of -Fe, while it decreased in the bicarbonate treatment. Leaves' catalase activity subjected to -Fe and presence of bicarbonate in all rootstocks decreased but this decrease was not meaningful in M9 and M7.Leaf peroxidase decreased in all rootstocks except for the M7 and this reduction was not significant for M9 according to -Fe and presence of bicarbonate. According to the physiological and biochemical response to iron deficiency and bicarbonate treatment, the investigated rootstocks could be divided into three categories: M9 and M7 had suitable adaptation and defense responses against iron deficiency and bicarbonate treatment, M26 and MM111 were quite sensitive and M25 and MM106 were intermediate.

Keywords: chlorosis, peroxidase, catalase, ferric chelate reductase

OS 5-2:

MILLENNIUM PLANTING DENSITY TRIAL OF `BRAMLEY´S SEEDLING' APPLE ON M.9 AND M.27 ROOTSTOCKS 2000 - 2017

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As financial pressures increase in apple production, Irish apple growers are moving to higher density planting systems. The resulting increased costs of establishment need to be paid with higher yields. In 2000 an experiment was established to commercially evaluate a range of planting densities using the M9 rootstock which was the most popular and the M27 rootstock which was anticipated to work well at higher densities. Thus a range of different densities was planted: M9's at 672, 961 and 1492 trees Ha-1 and M27's at 1279, 1492 and 1957 trees Ha-1 (imperial spacings were used to suit the local industry). Yield has increased year on year. Lower planting densities had repaid their establishment costs by the 7th harvest whilst the higher densities took until the 9th harvest. By the end of the 16th harvest the highest M9 density was significantly more productive than the others (12' x6'). with the highest M27 density (11'x5') in second place. The financial returns relative to the yields from the differenet tree densities allow growers to make appropriate decisions as to what will suit them best.

Keywords: tree density, bramley, m9, m27, financial appraisal

OS 5-3:

INFLUENCE OF DIFFERENT ROOTSTOCKS ON THE VEGETATIVE PARAMETERS OF PLUM CULTIVARS ' PRELIMINARY RESULTS

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Myrobalan (Prunus cerasifera) seedlings are very popular rootstocks for plums in Latvia. Vigorous trees, incompatibility between rootstock and some cultivars, as well as intensive suckering are reasons why new rootstocks more suitable for intensive orchards are needed. The trial includes rootstocks that originate from regions with similar climatic conditions (thaws in the end of winter and spring, algid temperature in summer, and volatile winters). In an experiment at the Institute of Horticulture, Latvia University of Agriculture that was planted in 2015, five vegetatively propagated rootstocks of different origin and vigor were compared for their influence on six domestic plums cultivars. Research was done from 2015 to 2017, using rootstocks 'Wangenheim' prune, VVA-1, S766, M633, 'Weiwa' and Prunus cerarsifera as the control in combination with well-known cultivars 'Victoria', 'Jubileum' and Latvian cultivars 'Ance', 'Adelyn', 'Sonora', and 'Lotte'. In the initial years, there were no significant differences for trunk cross sectional area for cultivars and among the different combinations of cultivars and rootstocks. Significant differences between the various combinations of cultivars and rootstocks were found for suckering. Significantly high numbers of suckers were found for all cultivars on the rootstocks P.cerasifera, M633, and S766. Few suckers were found for all cultivars on the rootstocks Weiwa and VVA-1. Almost no suckers were observed on all cultivars on rootstock 'Wangenheim'. Highest tree death (vs. mean of 5.6% for all cultivars) was on 'Weiwa' rootstock, and the lowest mortality was on S766 and Wangenheim (1.8%). The earliest yield was from cultivar 'Victoria' on S766, and cultivar 'Ance' on 'Wangenheim' prune.

Keywords: Prunus domestica L., rootstocks, suckers, trunk cross section area.

OS 5-4:

EVALUATION OF APPLE ROOTSTOCKS PLANTED IN DIFFERENT LOCATIONS IN SOUTH AFRICA

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Challenges faced with apple farming in South Africa include harsh environmental conditions, drought, woolly apple aphid, and apple replant disease complex. The objective of this study was to evaluate new dwarfing, semi-dwarfing and semi-vigorous rootstocks from the GENEVA® range against the South African industry standard

rootstocks (MM.109, M.793, and M.7). During the 2013 season, identical apple rootstock trails with 'Fuji' as scion were established at three localities (Oak Valley, Breëvlei and Helderwater) in South Africa. At each locality, M.9 Emla, M.9 Nic29, G.222, M.7, MM.109/M.9, MM.109/G.222, M.793/M.9, M.793/ G.222, G.778/M.9, and G.778/G.222 were planted in 7 blocks of 3 trees per rootstock as the "more dwarfing site". M.7, G.202, G.778, M.793, MM.109, and G.228 were planted in 10 blocks of 3 trees per rootock as the adjacent "more vigorous site". All trials were established on fumigated sites previously planted to apple and were managed differently, but according to standard commercial practice. The trees at Oak Valley and Helderwater were planted at 4 m x 1.5 m, while those at Breëvlei were were planted at 3.5 m x 1.5 m. All trees from all the three farms were assessed for vegetative and reproductive performance. G.778, G.228, G.202, G.222 rootstock and G.778 either G.222 or M.9 as interstems appeared to be more consistent in producing higher yields than the industry standard rootstocks of comparative vigour in all the orchards. These rootstocks have potential to improve apple production in South Africa.

Keywords: dwarfing, vigorous, vegetative performance, reproductive performance, fruit quality

OS 5-5:

PERFORMANCE OF GENEVA® APPLE ROOTSTOCKS IN SOUTHERN BRAZİL

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Growing apples in Southern Brazil is possible thanks to the occurrence of temperate climate conditions. However, chilling accumulation on these areas is different depending on the year and on many years it is not enough to determine a regular budburst on apple cultivars. Since 2011, trials with Geneva® rootstocks (CG) have been showing better budburst on cultivars grafted on them than grafted on traditional rootstocks used in Brazil. In a trial aimed at verifying the chill requirement of various rootstocks and their influence on the grafted cultivar, it was possible to observe that G.213 requires less chilling accumulation than M.9. The vigors of cv. Maxi Gala grafted on G.213 and G.757 are similar to M.9, however when grafted on G.814 and G.202 trees are more vigorous than on M.9, tending to be a semi-vigorous. This characteristic makes G.814 more adapted to be planted in shallow and rocky soils. Trial results show that G.814 is precocious, and produced 53 t.ha-1 accumulated yield in the third leaf. In a replant area trial G.213 reaches 127 t.ha-1 in the fifth leaf, more than Marubakaido with M.9 interstem (104 t.ha-1) and M.9 (83 t.ha-1). On a non-replant soil G.213 grafted with 'Maxi Gala' gets 25% more accumulated yield than M.9. On both, replant and no-replant areas trial with cv. Fuji Suprema, G.213 is more vigorous, branches better and is more precocious than M.9. General observations for CG's grafted cultivars behavior are: naturally bigger angle of insertion of the lateral branches in the main trunk, precocity, better performance on replant areas and better budburst, being nice options for new areas and replant areas in southern Brazil.

Keywords: rootstock, fruit production, CG, area replanting

OS 5-6:

SCION ARCHITECTURE ON DWARFING AND PRECOCIOUS CANDIDATE PYRUS ROOTSTOCKS

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As part of the search for easy-to-propagate, precocious, dwarfing Pyrus rootstock we undertook a study to investigate the growth expression mechanism of three different vigour rootstocks. These rootstocks were selected from a population of 'Old Home' and 'Louise Bonne de Jersey' seedlings, previously phenotyped for differences in vigour as rootstocks. A pot-based study of newly-grafted rooted cuttings of a low-, medium-, and high-vigour Pyrus rootstock was established, and also included Cydonia oblonga Mill. 'Quince BA29' and 'Quince C' as controls. A metamer-based assessment of Pyrus communis L. 'Doyenné du Comice' scion growth on the rootstocks was undertaken, to build an understanding of the plant growth that leads to dwarfed trees. Scions on more dwarfing rootstocks terminated their primary axis extension earlier in the season, than high-vigour rootstocks, leading to smaller trees. Sylleptic branching of the scions resulted mostly in spur development, rather than extended growth units, with the low-vigour Pyrus rootstock producing the lowest number of spurs and shoots. All the Pyrus rootstocks flowered in the second year after grafting, as did the Quince controls, indicating the selections being investigated were precocious, though the various Pyrus and Quince rootstocks expressed different flowering intensities. Initial data suggested that the dwarfing mechanism of these rootstocks may be similar to that of apple rootstocks with 'M9' parentage.

Keywords: Rootstock, Pyrus, Quince, metamer, syllepsis, flowering

OS 5-7:

EFFECT OF STRAW MAT AND OTHER MULCHING ON APPLE ROOT ARCHITECTURE AND SOIL ENVIRONMENT IN ROOT-ZONE

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The experiment was carried out using three-year old potted apple trees (Malus domestica cv. Starkrimson) mulched with straw mat, agriculturalcarpet, transparent-plastic film and horticultural fabric. It was investigated that the variation of root architecture and root activity, the moisture, temperature, total organic carbon andavailable nutrients in root-zone soil two years in a row. The results shows that the new root volume, root fractal dimension and root activity increased significantly by mulching above 4 kinds of materials. The root tip number and fractal dimension were the highest and root structure was more complex after mulching straw mat, the root diameter, root volume and surface-area were the largest and the roots were thick and strong after mulching agriculturalcarpet. The relative water content in the soil mulched with straw mat and horticultural fabric was largest; transparent-plastic film had the highest stabilizing capacity on soil moisture change than other in the four treatments. In summer and early autumn, the temperature increment in the soil mulched with transparent-plastic film was the largest and that was the lowest mulched with straw mat. In late autumn, the temperature increment in the soil mulched with straw mat and agriculturalcarpet was largest and the maintaining effects of horticultural fabric on soil temperature was the poorest. Straw mat and agriculturalcarpet made the soil temperature more stabilized.Four treatments all enhanced the stability of soil pH and increased the content of soil alkali-hydrolyzable N, available P and available K. The straw mat, agriculturalcarpet and horticultural fabric all increased total organic carbon content in root-zone soil. For comprehensive effect, the order of beneficial degree was straw mat, agricultural carpet, horticultural fabric and transparent-plastic film from high to low.

Keywords: Straw mat; Mulching; Apple; Root architecture; Soil environment; Nutrients

KEYNOTE 3

APPLE PLANTING SYSTEMS - CURRENT INITIATIVES AND SOME PROSPECTIVE VIEWS ON HOW TO IMPROVE SUSTAINABILITY

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Apple cultivation has evolved tremendously in past decades. Both apple productivity and aesthetic of the fruit have been strongly improved resulting from genetic improvement, optimization of tree training and pruning, and orchard layout and management. However, these improvements were also done at the expense of an increasing dependence on external inputs such as water, fertilizers and pesticides. This dependence is now questioned because of the generated environmental pollutions and health issues. In the last decades, an increasing amount of initiatives have been developed that open the way towards more sustainable apple production systems. Concepts as well as on-station and on-farm works are developed in various contexts such as 'Integrated Fruit Production' and 'Organic Agriculture' with the objectives to increase biological regulations of pests and diseases or to improve soil fertility. All together results point out the importance of diversifying resources and habitats in the orchard and its vicinity to foster ecosystem services related to pest suppression and soil fertility. They also indicate some practical guidelines consisting in a better management of grass alleys and lining hedgerows within and around the orchard, respectively. From a more prospective view and taking inspiration from tropical fruit-tree based agroforestry, these works suggest that combining apple trees with other herbaceous and woody plants with various uses (soft fruit, aromatic plants etc.) opens to more resilient systems against pests and diseases, possibly mitigating climate change. They also enlarge our vision of the current apple orchard towards a multi-functional system including apple among other productions. From the 'plant science' point of view this emerging paradigm challenges current knowledge of the physiology, architectural development and production of the apple tree interacting with neighboring plants. It also stimulates necessary collaborations with other research fields such as socio-economics, for example on how the grower may handle those complex agroecosystems, optimize labor and valorize production.

Keywords: apple, organic agriculture, integrated fruit production, ecosystem services, agroforestry, climate change, socio-economics

SESSION VI: Sustainable orchard systems

OS 6-1:

Growing AgroForestry systems with Apple (GAFA project) ' Preliminary results on the influence of adult walnut trees on growth and branching of two-year-old apple trees

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Current agriculture has to face new scientific and societal challenges by increasing its production while addressing environmental concerns. Different solutions have been considered including more efficient practices that improve resilience of agricultural systems to external pressure (climatic disturbances, new diseases, economic crises). While apple cultivation has evolved tremendously in the past decades to increase tree productivity and fruit quality, it is highly dependent on external inputs such as water, fertilizers and pesticides. This dependence is now questioned because of the generated environmental pollutions and health issues. Agroforestry systems (AFS), i.e., the association, in one field, of tailored perennial and annual crops and possibly animals, are proposed as a way to use positive interactions between various plants to reduce pest and disease pressure, to improve resources use and to buffer extreme climatic events. In temperate climate, AFS associate a tree stratum and a (or several) crop stratum, e.g. fruit trees and vegetables. We set up in South-East France, characterised by a Mediterranean climate, an original AFS composed of mature walnut grown for timber, apple trees in an intermediate vertical stratum, and lucerne at the lowest stratum. Comparing apple trees in the

AFS and in full sun, we first showed a significant effect of walnuts on the below-canopy microclimate reducing incoming global radiation and acting as a buffer on temperatures surrounding the apple trees. Secondly, AFS significantly altered apple stem geometry (higher slenderness and lesser tapering), architecture (less branching) and morphology (average individual leaf area and specific leaf area). Results will be discussed with regard to the putative long-term effects of agroforestry conditions on the apple tree architecture and fruiting.

Keywords: Apple trees, Agroforestry, Architecture, Phenology, Leaf area, Specific leaf area

OS 6-2:

SOIL FERTILITY AND MICROBIAL BIODIVERSITY IN OLIVE ORCHARDS MANAGED DIFFERENTLY: RESILIENCE AND ADAPTATION TO CLIMATE CHANGE

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Soil restoration is an important challenge of the 21st century, facing the increasing soil degradation, characterized by decline in quality and decrease in ecosystem goods and services. Several studies confirmed that sustainable orchard management practices (e.g., no-tillage, cover crops, shredding of pruning material) might sequester atmospheric CO2 into soil, tree biomass and litter, enhancing soil organic carbon (SOC) stock and biodiversity. Higher biodiversity in ecosystems leads to greater stability and multifunctionality. In bacteria-plant interactions, both the bacteria and the plant profit from each other. These interactions play an important role in agriculture, positively affecting plant status and improving product quality.
This study was aimed at identifying and comparing soil fertility parameters and microbial communities in soil, xylem sap and leaves (aerial part) between olive trees managed under sustainable practices for 17 years (i.e., no-tillage, drip irrigation with urban wastewater and recycling of polygenic carbon sources like cover crops and pruning material) and trees managed under conventional one (i.e., soil tillage, burning of pruning residues, mineral fertilization, rainfed) in a mature olive grove located in Southern Italy. During three different periods of the year, samples of soil, xylem sap and leaves were collected in both treatments for DNA extraction and metagenomic analysis of the microbial communities. Soil samples were also collected for biochemical analyses. The degree of soil quality has been expressed by the biochemical index Nc/Nk ratio. Soil organic carbon (SOC) and water soil storage capacity were also compared between the two systems.
Results revealed that the long term of adoption of sustainable agricultural practices increased SOC, organic-N, microbial biomass and biodiversity, and yield, with benefits to the whole agro-ecosystem stability and its resilience against biotic and abiotic factors.

Keywords: metagenomic analysis, soil organic carbon, resilience of ecosystem, circular economy

OS 6-3:

NUTRITIONAL STATUS OF STONE FRUIT TREES ON DWARFING AND VIGOROUS ROOTSTOCKS UNDER WARM MEDITERRANEAN CONDITION

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Fruit tree orchards are usually based on a combination of scion and rootstock. The new management trends towards intensification need rootstocks with contrasting vigor to control tree vigor. For stone fruit trees, new released dwarfing rootstocks (‘Rootpac-20’ and ‘Krymsky1’) were suggested for high planting density in

replacement of well adapted one 'Garnem'. Two experimental orchards of almond and peach were considered in a warm production area northern Tunisia. A sweet almond cultivar 'Tuono' grafted on Garnem and Rootpac-20 were planted at 4m x 2m and 4m x1.5 m spacing, respectively. For peach, tree spacing was 2m x 6m on both rootstocks. This investigation aims to explore the nutritional status induced by vigorous and dwarfing rootstocks in warm conditions. The main macro element (N, P and K) analysis was monitored for the scion-rootstock combinations. Results showed that rootstock type influenced the nutritional status of fruit trees. Dwarfing rootstock Rootpac-20 seems to affect the leaf mineral contents for almond with visual chlorosis symptoms, whereas Krymsky-1 performed similar results as the invigorating Garnem for peach. This study gives additional information on the adaptability of Prunus rootstocks via leaf mineral analysis as a nutritional status tool.

Keywords: mineral analysis, planting system, Prunus dulcis, Prunus persica.

OS 6-4:

QUANTIFYING WHITE ROOT GROWTH DYNAMICS OF BEARING APPLE TREES IN A MEDITERRANEAN CLIMATE, SOUTH AFRICA

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White root growth peaks have been reported on numerous occasions in the Northern Hemisphere (NH) for deciduous crops and forest plantings. Variation from the bimodal seasonal pattern was reported, but apple trees usually conformed to this pattern. Only a few papers on this subject reported on findings in the Southern Hemisphere, in Australia – therefor the need to quantify white root growth dynamics in South Africa. A CID root scanner was used in existing orchards in the Elgin area to quantify white root growth dynamics non-destructively over three growing seasons. Root growth dynamics showed a bimodal seasonal pattern for bearing 'Golden Delicious', 'Cripps Pink' and 'Fuji' orchards, with peaks in summer and autumn/winter. This was irrespective of rootstock, soil type or management practices. The occurrence of a summer root growth peak agreed with existing literature, except that it started later (mid November) than in the NH. The summer peaks were smaller compared to the respective post-harvest peaks and agree with literature. The unusual long root growth peak in June started shortly after harvest, and continued through winter until the end of August, and may be due to relative high soil temperatures in this area. This is unique to local conditions and may impact on the tree carbohydrate and nutrient reserve status.

Keywords: bimodal pattern, 'Golden Delicious', summer flush, winter flush

SESSION VII: Innovative management practices

OS 7-1:

OVERCANOPY IRRIGATION IN A PEAR ORCHARD IN THE FERRARA PROVINCE: ANALYSIS ON MICROCLIMATIC, PHYSIOLOGICAL AND PRODUCTIVE EFFECTS

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To test the efficacy and sustainability of evaporative cooling, four blocks of a commercial Abbè Fetel pear orchard in Medelana (Ferrara, Italy) were subjected to two irrigation regimes: drip irrigation alone (DRI) or, between July and August (the hottest period of the year), supplemented by overcanopy irrigation (OCI). Stem/leaf water potential, leaf gas exchange and leaf fluorescence measurements where performed the day before, soon after and the day after OCI, twice along the growing season. Daily fruit growth, leaf and fruit temperature and microclimatic parameters within the blocks where monitored for the entire experiment. No difference was found in leaf/stem water potentials, leaf fluorescence or leaf gas exchanges the day prior and after OCI. Photosynthesis, transpiration and stomatal conductance were improved on the OCI day. Also, fruit growth increased only on the OCI day, with higher rates all day long, but no further effects in the following days. Leaf, fruit temperature and microclimatic measurements within the blocks were only affected during OCI. Yield data show no difference between the two irrigation regimes. OCI in the environment tested affects tree performance only during application and a few hours afterwards. This management practice reduces water use efficiency resulting in more water applied per ton of fruit, likely a result related to the hot and humid climate of the Ferrara province.

Keywords: Irrigation management, gas exchange measurements, fruit growth, water use efficiency, leaf fluorescence

OS 7-2:

DİFFERENTIAL THERMAL ANALYSIS SHEDS LIGHT ON THE EFFECT OF ENVIRONMENT, CULTIVAR, ROOTSTOCK, AND CROP LOAD IN PEACH FLORAL BUDS EARLY ACCLIMATION AND MAXIMUM COLD HARDINESS

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Reduction in fruit production due to cold damage in floral tissue is the biggest single limitation to profitability in the Colorado peach industry. This study identified the critical temperatures of peach buds during the different phases of dormancy. Cold hardiness, expressed as lethal temperature for 10% (LT10), 50% (LT50), or 90% (LT90) of peach buds was quantified successfully with differential thermal analysis (DTA). Four peach cultivars including ‘Suncrest’, ‘Sierra Rich’, ‘Cresthaven’ and ‘Red Haven’ were tested during late fall to early spring in two consecutive seasons. DTA analysis showed that temperature causing freezing injury was related to the initiation of the low temperature exotherms (LTE’s) after October 21st and 25th for the two seasons tested, respectively. Cold hardiness followed a predictable seasonal pattern in all four cultivars: an acclimation phase in late fall, a period of maximum hardiness in winter (mid December to late January), and deacclimation going into spring. Temperature fluctuations lead to considerable “noise” in this general trend. Sudden freezing events induced hardiness and unseasonal warm temperatures induced temporary deacclimation. Differences in hardiness were found for all the peach cultivars that were evaluated. ‘Sierra Rich’ was the least hardy and showed minimum response to freezing events and deacclimated faster as a response to unseasonal warm temperatures, compared to the other cultivars tested. DTA analysis successfully predicted field bud damage on ‘Sierra Rich’ and ‘Red Haven’ during the winter and spring of 2016-17. In addition, data on the effect of rootstock and crop load in acclimation and maximum hardiness were collected. During bud swell, DTA was not an effective method for detecting LTE in peach buds. The information that was generated in this study will provide a better understanding of peach cold hardiness and will support growers in decision-making of frost control practices and estimate potential losses.

Keywords: Prunus persica, low temperature exotherms, oxidative browning, dormany, cold damage

OS 7-3:

PROMOTING FRUIT SET OF `INGEBORG´ PEARS IN A NORTHERN CLIMATE

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The triploid pear cultivar `Ingeborg' is currently the main commercial pear cultivar grown in Norway. However, fruit set and subsequent yields of this cultivar have proven to be variable and overall rather low. In order to promote the fruit set, different bioregulators were applied during and after bloom and compared against an untreated control. Investigations were done during the period 2016-2017, at NIBIO Ullensvang, western Norway. The treatments were applied to individual whole trees in a randomized complete block design with four replications. Different dosages of gibberellins (GA3, trade name GIBB 3, 10 % active ingredient (a.i.) and GA4/7, trade name Novagib® , 1% a.i.) were applied at full bloom and at petal fall. Additional applications of the growth retardant prohexadione-Ca (trade name Regalis®, 10 % a.i.) were applied when bourse shoots had 3-5 leaves and one month later. Ethephon (Cerone (480 g a.i./L) was applied four times starting about 7 days after petal fall with ca. 7 days intervals. All gibberellin applications significantly increased fruit set compared to the untreated control. One single application with GA3 (3 g/ha) almost tripled the fruit number per 100 flower clusters when compare to the control (136 and 46, respectively). The yield response was similar (16.8 kg to 9.6 kg, respectively). Similar results gave one application with GA4/7 (12 g /ha) with the same crop load level and the fruit weights at the same level as the control (130 g). Prohexadione-Ca treatments significantly reduced shoot growth of the pear trees. Two treatments with 125 g or one treatment of 250 g reduced the growth by ~35%. Two treatments increased the fruit set and the yield. The multiple ethephon applications (275 ml/ha in total) had no effect on fruit set nor shoot growth. However, the amounts of return bloom were significant improved compared to the other treatments.

Keywords: Pyrus communis L, gibberellins, ethephon, Prohexadione-Ca

OS 7-4:

PRECISION CROP LOAD MANAGEMENT IN 'GALA' APPLES

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Pruning and thinning are the most important management practices used to adjust crop load. The level of fruiting buds left during pruning can greatly influence fruit thinning, fruit quality, tree vigor and return bloom. The main objective of this project was to determine the proper bud load to optimize fruit size and maximize crop value of 'Gala' apple. Trees were pruned to six different bud loads at tight cluster stage in the spring of 2014, 2015, 2016 and 2017. Bud loads were defined as the ratio of flower buds: final desired fruit number per tree. The initial desired fruit number for these trees was determined at 130 fruit/tree to achieve 100 count fruit size and 75 t/ha. The seven bud loads were 1 bud: 1 final fruit per tree or 1.5:1, 2.0:1, 2.5:1, 3.0:1, 3.5:1. After pruning, trees were hand or chemically thinned. At commercial maturity, trees were harvested and fruit number, weight and quality were recorded. When data from all four years were combined irrespective of thinning treatment, a strong and statistically curvilinear relationship was observed between crop value and bud load, although only 6% of the variation was explained by this model. This resulted in a relatively high bud load optimum of 2.0-2.5. Moreover, results indicate that maximum crop value was achieved when fruit size was about 150 g and fruit number per tree was 321 fruits/tree which is double the target fruit number we had assumed before the experiment. When years were studied separately, 2016 gave very different results than the other 3 years with a negative linear relationship between crop value and bud load with the lowest bud load having the highest crop value. This was likely due to the severe drought conditions experienced in that year resulting in very small fruit size.

Keywords: Pruning, Bud Load, Thinning, Crop Value

OS 7-5:

NEAR INFRARED SPECTROSCOPY CAN NON-DESTRUCTIVELY ASSESS THE EFFECT OF ROOTSTOCK, CROP LOAD AND CANOPY POSITION ON PEACH FRUIT HARVEST MATURITY AND INTERNAL QUALITY

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Peach fruit internal quality and maturity in terms of dry matter content (DMC), soluble solids concentration (SSC), fruit firmness (FF) and index of absorbance difference for chlorophyll (IAD) are important harvest quality indices that correlate with consumer acceptance. Traditional methodology for fruit quality and maturity assessment is destructive and hard to adopt for field measurements. Near infrared (NIR) spectroscopy was used to test whether physicochemical and maturity properties of peach fruit could be determined non-destructively. Multivariate prediction models of DMC and SSC as well as IAD and FF of 'Sierra Rich', 'Cresthaven' and 'Red Haven' peaches, were developed using fruit samples coming from different crop loads and developmental stages. Prediction models created in the spectral range from 729-935, 477-657 and 600-750 nm for DMC and SSC, FF and IAD, respectively. Regression data were tested for linearity (R2) and root mean square error of prediction (RMSEP) to determine accuracy of the models. A second fruit population was used to validate the models. Regression statistics of the prediction models for the three cultivars were: R2=0.95-0.98, RMSEP=0.39-0.47% for DMC; R2=0.92-0.95, RMSEP=0.48-0.62% for SSC; R2=0.94-0.95, RMSEP=0.08-0.09 for IAD; R2=0.14-0.43 and RMSEP=4.4-13.0 N for FF. DMC and SSC could both be predicted very accurately in all peach cultivars tested. It is noteworthy, that high correlation was observed between DMC and SSC. Finally, the created models were used to predict the effect of rootstock, crop load, peach fruit position in the canopy on harvest internal quality and maturity. Results showed that vigorous rootstocks and heavy crop loads reduced fruit DMC, SSC and fruit maturity. On the other hand, fruit coming from the upper canopy had more DMC, SSC and were more mature. Models developed in this study will be used to efficiently assess the effect of orchard and environmental factors in peach fruit harvest quality.

Keywords: Prunus persica, dry matter content, soluble solids concentration, fruit firmness, index of absorbance difference

OS 7-6:

EFFICACY OF METAMITRON AS A POSTBLOOM THINNER - THE AMERICAN NORTHEAST EXPERIENCE

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Apple fruitlets growth after pollination is dependent on carbohydrates, which are produced through photosynthesis. When photosynthesis is limited, the carbohydrate supply is reduced and so the competition for carbohydrates among fruits increases. The use of metamitron, a photosynthesis inhibitor, was investigated in a 2-year experiment (2016 and 2017) on mature Crimson Gala/M.9 trees during two timings in the apple thinning window – petal fall and at 10-12mm fruit size, at Geneva, NY, USA. Three different metamitron rates were imposed at each timing: 200 mg L−1; 350 mg L−1 and 500 mg L−1. Untreated control trees were also included for comparison. In 2016, the effect of metamitron on whole tree photosynthesis was more pronounced at 10-12mm fruit size stage than petal fall. The higher the rate the greater was the reduction in whole-tree photosynthesis, with the maximum reduction three days after application. Whereas, in 2017 photosynthesis reached its lowest around 7-8 days after application. We associated the rapid decline in 2016 with warm temperatures and a significant carbohydrate deficit while in 2017 the temperatures were lower especially at night and the deficit was less. There were no differences among rates. The maximum reduction in photosynthesis due to metamitron was around 40% in both years. Metamitron reduced fruit set and fruit load in a concentration-dependent manner. There was no interaction of year or timing with treatment; however, the thinning effect was greatest when metamitron was applied at 10-12mm fruit size. Final fruit size was greatly increased when the chemical thinner was applied due to the reduction in crop load; though no significant differences were found between 350 mg L−1 and 500 mg L−1. Metamitron has great potential as a tool to optimize chemical fruit thinning. Further investigation is needed to better understand the response of metamitron in years when photosynthesis rates are low.

Keywords: apple thinning, whole-tree photosynthesis, metamitron

POSTER PRESENTATIONS

P 1:
CLADODE PRUNING AFFECTS YIELD AND FRUIT QUALITY OF `ROJA LISA´ CACTUS PEAR: A PRELIMINARY STUDY

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The annual pruning of cactus pear cladodes is needed not only to promote and renew productive cladodes, but also to maintain tree size and shape. However, this practice receives little attention from the cactus pear growers. Therefore, the objective of this study was to assess the initial effect of an experimental pruning (EP) and grower's pruning (GP) of cactus pear cladodes on the fruit yield (FY), fruit size distribution (FSD), quality at harvest and shelf life of fruit. The experiment was conducted in a drip-irrigated commercial orchard during 2006 using six-year-old plants of 'Roja Lisa' cultivar. The EP consisted in: 1) eliminating unproductive cladodes, and those shading other ones, around the plant and exposing the center of each plant, and 2) concentrating fruit cladodes in the outer part of the plants. The PP consisted in eliminating randomly some cladodes from the central part, and around the plants only. Treatments were arranged in a completely random design with eight and ten replicates (a single plant as replication) for the EP and GP, respectively. The response variables were: FY, FSD, and fruit quality (FQ) at harvest and after storage. The FQ attributes were: mean fruit mass (MFM), flesh firmness (FF), total soluble solids concentration, pulp and peel mass, dry matter concentration, and fruit mass loss (FML) during storage. In relation to GP, EP increased MFM by 42% and produced 15% more of the marketable fruit (fruit equatorial diameter from 5.0 cm to 7.0 cm) while total FY was reduced by 39.0%. The FF was higher in EP fruit than GP fruit after storage. The other FQ attributes were similar in both pruning treatments at harvest or after three weeks at room temperature. The FML was also similar in both pruning systems. Further research needs to be done on this topic.

Keywords: *Opuntia ficus*-indica (L) Mill, fruit size and distribution, storability

P 2:
EFFECTS OF CROP LOAD ON YIELD AND FRUIT QUALITY OF `JINLINGHUANGLU´ PEACH

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To assess crop load effect on yield and fruit quality of peach fruits, an experiment was conducted for 3 years from 2014 to 2016. The 'Jinlinghuanglu' peach trees with vase shape were used. The experiment was arranged as a completely randomized design with 4 treatments: T1 (150 fruit per tree), T2 (250 fruit per tree), T3 (300 fruit per tree) and T4 (350 fruit per tree) with 6 replicates. It was found that the peach trees of T4 provided a relatively high yield but lowest fruit weight, while T1 gave the lowest

yield but highest fruit weight. The peach trees of T2 had a relatively lower yield but relatively higher fruit weight, however, T3 provided a relatively higher yield but relatively lower fruit weight. The leaf-fruit ratio reduced with crop load increasing. The peach trees treated with T1 had high level of soluble solids content (SSC), sugar-acid ratio and total sugar content (the totality of sucrose, glucose, fructose and sorbitol). In addition, inner fruit quality in both T2 and T3 was a little lower than T1. Moreover, the fruit coloring degree was not significantly affected by crop load. It was concluded that crop load between 250 and 300 fruit per tree was better for 'Jinlinghuanglu' peach trees during full bearing period, assuring higher yield and larger fruit size.

Keywords: full bearing period, fruit weight, leaf-fruit ratio, appearance color, inner quality

P 3:
COMPARISON OF TALL SPINDLE AXES AND VOGEL CENTREL LEADER SYSTEMS IN CHERRY

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The study was carried out to compare Tall Spindle Axes and Vogel Centrel leader systems on sweet cherry combinations of '0900 Ziraat/ Gisela 5' and '0900 Ziraat / M×M 60 in Samsun in Turkey in 2010-2017. Young sweet cherry trees were planted by Tall Spindle Axes (TSA) and Vogel central leadersystems in February in 2010. In the study, trees growth characters such as tree length, tree diameter, height of crown, tree volume and their yield and some fruit quality properties including weight, width, length, total soluble solid and acidity were determined. In the experiment the best results were obtained from TSA in terms of yield (0900 Ziraat/Gisela 5) and fruit weight (0900 Ziraat/M×M60). Tree lenght and tree volume were higher at 0900 Ziraat / M×M60 combination in TSA.

Keywords: cherry, Gisela 5, M × M 60, training system, growth, yield, fruit quality

P 4:
EFFECT OF CROP LOAD MANAGEMENT AND CANOPY ARCHITECTURE ON YIELD AND FRUIT QUALITY OF LATE-SEASON PLUM 'ANGELENO'

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The Australian summerfruit industry has identified sales growth is impeded by low consumer satisfaction with fruit quality, leading to low prices and static consumption. The effect of crop load on fruit production was studied in an experimental orchard at Tatura, Australia. The objective of the study was to identify crop load management practices, under Tatura Trellis and vase training systems, to enable plum to maximise uniformity in fruit quality attributes. Crop loads were applied to induce a range of competitive source/sink responses between fruit and available assimilate. Different thinning regimes were implemented in season 2016/17 based on the number of fruit left on the trees: (1) high: minimally thinned; (2) medium (commercial standard as control): moderately thinned and; (3) low: heavily thinned. Despite identical tree density and age, larger canopies occurred on Tatura Trellis compared to vase. Larger tree size was reflected in trunk diameter and canopy radiation interception (fPAR), providing capacity to support greater fruiting levels and high yields. Mid-season fPAR was ~68 % under Tatura Trellis compared to ~52 % for vase trees. Fruiting level did not affect flowering date or fPAR for a given canopy architecture. However, trunk growth was higher under low crop load on Tatura Trellis. Overall, high cropping levels reduced fruit weight and lowered packout performance

compared to medium and low crop load treatments under both training systems. Irrespective of training and cropping level combination, fruit sweetness was high (≥ 17.2 °Brix), with low variability (CV ≤ 11 %). Over half of all fruit grown on Tatura Trellis exceeded 18 °Brix, compared to ≤ 38 % on vase. Under low crop load, a high proportion of fruit met Australian export standards for fruit size and sweetness. For vase trained trees, fruit maturity and firmness were similar across crop load treatments. However, for Tatura Trellis training system, high cropping levels produced less mature and firmer fruit.

Keywords: Vase, Tatura Trellis, fruiting level, brix, maturity, firmness, planting system, high density.

P 5:

DEVELOPMENT OF FLOWER-BUDWOODS SCIONS BORNE ON BOURSE SHOOTS IN `RUH YUE´ ASIAN PEAR (PYRUS SPP.) UNDER AN ANNUAL SELF-SUFFICIENT TOP-GRAFTING SYSTEM

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The most prevalent annual top-grafting system for Japan pear in Taiwan require importing flower-budwoods scions borne from terminal shoots of pear plants cultivated in Japan. Recently, a self-sufficient production model of flower-budwoods scions produced from bourse shoot under an annual top-grafting system for the ‘Ruh Yue’ Asian pear (Pyrus spp.) [‘Shinseiki’ pear (P. pyrifolia) × ‘Beijing white’ pear (P. ussuriensis)] has been established in the lowland region of central Taiwan. However, the problem of irregular fruit sets due to abortion and abnormal inflorescence needs to be determined. To elucidate the major factors that affect flower-budwoods scions quality, we investigated bourse shoot growth and histological changes on its lateral buds in 2016. Bourse shoots growth began in mid-January and ceased in mid-April. Using paraffin section, the external and internal structures of pear buds revealed that the majority of buds underwent flower bud differentiation after bourse shoot cessation. Approximately 80% of buds transformed into flowering buds at the bourse shoot in mid-April. All plump buds transformed by mid-May, and all floral primordia were with carpel by mid-August. A complete ‘Ruh Yue’ flower bud comprises 12-13 scales, 1-2 vegetative primordia, 9-10 bracts, and 7–9 floral primordia. However, flower bud abortion and abnormality rates were 1.1% and 4.2%, respectively, in mid-August and 1% and 25.2%, respectively, in September; these rates increased in October, with abortion and abnormality rate of 14.3% and 57.2%, respectively. It was suggested that the well-developed flower buds could be found by mid-August. Further investigation on factors inducing abortion and abnormality of inflorescence emerging from flowering bud is needed.

Keywords: Top-grafting, Asian pear, Flower-budwoods scion, Abortion, Abnormality, Inflorescence

P 6:

EFFECT OF GA_3, THIAMIN, CULTURE MEDIUM TYPE AND OTHER PARAMETERS ON MICROPROPAGATION OF GF677 ROOTSTOCKS (HYBRID OF PEACH AND ALMOND): A REVIEW

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GF677 rootstock propagation is strongly demanded to provide almond orchards in all the world . It is a good rootstock for almond and peach orchards in moderate or poor fertility soils. Vegetative propagation of peach can be achieved by hardwoods, semi-hardwoods and soft wood cuttings as well

as by suckers, root cuttings and also tissue culture approaches(7,8,9).These rootstocks are so important due to lots of reasons such as the effective management in orchards, to improve of products. The use of rootstock has led to reducing costs for the Gardner. GF677 is a vigorous rootstocks that were used for both peach and almond trees. Nowadays, they are propagated via micropropagation. In the world. Micropropagation is one of the new methods for mass production of true to type rootstocks by direct regeneration in tissue culture technique. Micropropagated rootstocks are used by the Gardner in the modern gardens. The goal of this research was study of some parameter such as GA3, leaf and petiole, modified MS media, Myo-inositol, thiamine, and different pH to optimizing of GF677 micropropagation.

Keywords: leaf and petiole, modified MS media, Myo-inositol, culture medium pH, rosetting plantlets, thiamine

P 7:

LONG TERM EVALUATION OF SUPER-DWARF ROOTSTOCK: IMPACT ON TREE GROWTH, PRODUCTIVITY AND APPLE FRUIT QUALITY

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Impact of planting distances on apple tree growth, yield parameters and internal fruit quality was evaluated in 14-17 year old orchard planted on super-dwarf P 22 rootstock. Trial was performed at the Institute of Horticulture Lithuanian Research Centre for Agriculture and Forestry in 2014-2017. Apple trees of cv. Auksis were planted at the distances 3×1; 3×0.75; 3×0.50 ir 3×0.25 m. The strongest growth, the highest number and total length of shoots, the highest amount of flower clusters and yield per tree was recorded at planting distances 3x1 and 3x0.75. The growth and yield per tree of very dense planted apples (3x0.25) was significantly lower. In spite of that these trees were the most productive and gave the highest yield per area. The average fruit weight, diameter and colour were the best at planting distances 3x1 and 3x0.75. Fruit quality parameters significantly decreased in super dense orchard. Long term evaluation of apple trees on super-dwarf P 22 rootstock revealed that planting distance 3x0.75 guarantees annual yields of high quality fruits even in 14-17 year old intensive orchard. In the case of orchard replacement after 10-12 years the optimal planting distance of apple trees on P 22 rootstock is 3x0.5 in order to get the highest yield in the young age

Keywords: vegetative growth, yield, Malus x domestica, planting distance, flowering

P 8:

In Vitro PROLIFERATION OF THREE SELECTED ROOTSTOCKS OF PEACH AND NECTARINE (GN, TETRA AND GF677)

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GN, Tetra and GF677 are valuable rootstocks as compatible with the most important stone fruitscultivars. These rootstocks are reproducible by asexual methods such as cuttings, layering and suckers, but with modern techniques of tissue culture can be product much more efficient and free

from contamination multiply. In this study, in vitro micropropagation explants of healthy and active branches from the base to the length of 1.5 - 2 cm with at least one bud, after the disinfection process in MS medium containing 0.5 mg/l GA3, 0.01 mg/l IBA and 0.5 mg/l BAP was established. Maximum Buds activated in MS medium containing (0, 0.5,1, 2 and 4 mg/l) BAP and 0.1 mg IBA were cultured. The largest number of branches, the longest branches and the largest number of leaves at a concentration of 1 mg/l BAP were observed. In a survey of vitrification compared agar andgel right. The results showed that the percentage of vitrification in agar (17%) was less than to gel right (37%), but the number of branches (2.1), the largest branch (2.5 cm) and apparent growth was better in gel right. The better length of branch with 2.8 cm was obtained at a concentration of 0.01 mg/l IBA, 2 mg/l BAP,0.5 mg/l GA3 and 1 mg/l 2ip.

Keywords: Vegetative Rootstock, Micro propagation, In vitro Proliferation, BAP concentration.

P 9:

RESEARCH ON THE MECHANISMS OF IPT5B GENE EXPRESSION AND DWARFING REGULATION IN ROOT OF M.9 ROOTSTOCK

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The rootstock is critical for the cultivation of fruit crop, since the yield and quality of fruit production have been affected seriously. Dwarfing rootstock is widely used in some major countries for apple production around the world. Unfortunately, the molecular mechanism of dwarfing in the apple rootstock is poorly understood. In this study, root zeatin contents were detected in Mailing 9 (M.9) rootstock (dwarfing) and Robusta rootstock (vigorous). The results showed root zeatin content in dwarfing rootstock was significantly lower than that in vigorous rootstock. Then we screened a candidate gene named isopentenyl transferases5b (IPT5b) from the Cytokinin (CKs) metabolic pathways through the difference of gene expression. Further studies found an abundance of Single Nucleotide Polymorphisms (SNP) and Insertion-Deletion (InDel) differences in IPT5b gene promoter region between M.9 rootstock and Robusta rootstock. With Arabidopsis protoplast transformation, vector construction for segmental deletion and site-directed mutagenesis of IPT5b gene promoter helped to determine Deletion variant as the core site for promoter activity, which located at 1172bp of ATG upstream sequences. Based on developed detection for Deletion variant, correlation with dwarfing was confirmed in germplasm resources of apple rootstock and Robusta×M.9 hybrid population. Zeatin biosynthesis in root was certified to be affected with Deletion variant in IPT5b heterologous transformation, which implied that zeatin levels in root acted as the intermediate link between Deletion variant and dwarfing.

Keywords: apple, dwarfing, rootstock, cytokinin, isopentenyl transferase

P 10:

BREEDING OF NEW CULTIVARS OF THE FRUIT CROP JAPANESE QUINCE (*Chaenomeles japonica*)

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Chaenomeles is well known as an ornamental plant. The breeding of it as a fruit crop started in Latvia in the beginning of the 1950s. It has been introduced as a new unique fruit crop around the Baltic sea. Fruits are characterized by high nutritive value: organic acids, vitamin C, phenolic compounds, pectin, aroma, and are suitable for processing. C.japonica is very diverse in plant and fruit characters, and many important traits are controlled by additive as well as non-additive genes, so breeding of new

cultivars took many years. The main goal of the breeding program was to obtain cultivars with high yielding, locally adapted plants, resistant to frost and diseases, erect, not too dense and without thorns, early ripening, with good pollination, and high content of biologically active compounds. Breeding strategy was based on extensive test crosses and progeny tests in field trials. The main methods were controlled crosses choosing genotypes with desirable traits as parents. Performing hybridization, selection and evaluation in several populations, promising genotypes were obtained. In 2012 the first cultivar 'Rasa' was registered in Latvia. Also, two another cultivars – 'Darius' and 'Rondo' - were created in the common program together with Lithuanian and Swedish breeders. All of these cultivars are thornless, productive - total yield during 5 years can reach 20-28 kg per bush (maximal in 1 year: 8 kg per bush), resistant to leaf spot and fruit rotting. Fruits are yellow, 40-50 g, contain vitamin C 60-95 mg% and phenolic compounds 520-740 mg% in average, and ripen at the beginning or middle of September. Since 80-90 % of all studied genotypes are self-fertile, partial self-fertility of 'Rasa' is a positive trait. Since Chaenomeles is relatively resistant to diseases and pests, it can be grown in an environmentally friendly way, and interest in it as a commercial fruit crop has increased.

Keywords: Chaenomeles japonica, yield, fruit weight, plant habit, ripening time, self- compatibility, biochemical content

P 11:

SENSITIVITY OF APPLE (*Malus domestica* B.) FRUIT PEEL TO HIGH IRRADIANCE AND TEMPERATURE AS INFLUENCED BY A RANGE OF ROOTSTOCKS IN SOUTH AFRICA

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Exposure of developing apple fruit to high irradiation can result in high sunburn incidence and poor red colour in warm production areas such as South Africa. The influence of the rootstock on this response is poorly studied. We determined the photothermal sensitivity (as indicated by chlorophyll fluorescence, Fv/Fm) of peel photosystems of 'Rosy Glow' apples on a range of nine current and new rootstocks varying from dwarfing to vigorous, during 2014-2015 and 2015-2016. This was complemented by in-field measurements on an extended set of 16 rootstocks of leaf and fruit surface temperature and red colour (hue angle) one to three months prior to harvest, and fruit colour, sunburn incidence and maturity at harvest. For the photothermal stress trial, fruit from either sun-exposed or shaded canopy positions were subjected to five durations (1-5 hours) of exposure to ambient high irradiance and high temperature. Measurements of Fv/Fm were conducted immediately after each exposure duration, and repeated over the course of the following 24, 48, 72 and 96 hours in the laboratory. Damage to peel photosystems, as indicated by reduced Fv/Fm values, occurred after all exposure durations. Duration of exposure, the recovery period, and previous shading or exposure in the canopy were the dominant influences on photothermal stress response. Apples exposed to photothermal stress for one hour showed a general recovery over the five-day period, whereas apples exposed for two hours and longer did not recover fully. Except for small differences in red colour amongst the more vigorous rootstocks in 2014-2015, rootstock did not influence in-field measurements of colour or surface temperature one to three months prior to harvest. However, differences between rootstocks were found for final colour, sunburn incidence and maturity. Results generally indicate that apple peel photosystem sensitivity to high irradiance and temperature is not influenced by the rootstock.

Keywords: Apple rootstock, Chlorophyll fluorescence, Photosystem, Photothermal stress

P 12:

EARLY DETECTION OF GRAFT COMPATIBILITY FOR `XIAOGUO TIANSHI´ AND `NIUYANSHI´ AS ROOTSTOCKS OF PCNA PERSIMMON `TAISHUU´

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Graft incompatibility between some pollination constant non-astringent (PCNA) persimmon and Diospyros lotus (Date plum, frequently used rootstock in East Asia) resulted in propagation failure or weak tree vigor in orchard production which hindered those PCNA cultivars popularization. Extensive compatible rootstocks selection and breeding is principal to promote PCNA persimmon cultivars industrialization. Two novel genotypes called “Xiaoguo Tianshi” and “Niuyanshi” were selected from the Dabieshan region in central China. The graft compatibility of ‘Fuyuu’ (worldwide spread cultivar) series cultivars (such as ‘Taishuu’) and “Xiaoguo Tianshi” and “Niuyanshi” as rootstocks were not well understood. In vivo and in vitro grafting was carried out to compare the micropropagated and field performance through graft union strength microscopy. Early graft compatibility of ‘Taishuu’ with “Niuyanshi” or “Xiaoguo Tianshi” were investigated based on in vitro micro-grafting by using field grafting plants as reference. (1) The microscopy observations showed that in micro-grafting, the graft interface of ‘Taishuu/Date plum’ turned brown and cell proliferation termination, adhesion between the scion and rootstock was very loose. The persistence of a necrotic layer at the graft interface could account for the incompatibility between ‘Taishuu’ and Date plum and poor growth. (2) The cohesion of ‘Taishuu’ and “Niuyanshi” or “Xiaoguo Tianshi” by the proliferation of a callus bridge between the partners and the successive differentiation and restoration of the continuity of new vascular tissue, this brought scion better upgrowth. (3) The behaviour of the grafts grown in vitro was positively correlated to that of the same combinations in the field. (4) After 2 years observation, ‘Taishuu/Date plum’ vanished at half a year after grafting, but the seedlings of ‘Taishuu’ grafted on “Niuyanshi” or “Xiaoguo Tianshi” growing well. Our results suggested that grafting in vitro could be a reliable method for an early detection of graft compatibility in different Diospyros graft combinations. [This research was supported by the Special Fund for Agro-scientific Research in the Public Interest (201203047)]

Keywords: PCNA persimmon; rootstock; graft compatibility; in vitro grafting; field grafting

P 13:

TRANSCRIPTOME PROFILING OF MATURITY GENES IN FRUIT DEVELOPMENT OF SWEET PERSIMMON (Diospyros kaki)

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Secondary metabolites, flavonoids, are critical in plant development and environmental stress responses that are highly influential in quality of fruit crops. Previous genetic and biochemistry studies in diverse plants uncovered key enzymes involved in the flavonoid biosynthesis pathway. Proanthocyanidins(PAs) are colorless phenolic oligomers synthesized from the anthocyanin branch of the flavonoid pathway. PAs accumulate during persimmon (Diospyros kaki Thunb.; 2n=6x=90) fruit maturation, and are associated with a strong astringent sensation. Many approaches have been utilized to remove the astringency, but molecular understanding that underlie the process remain still elusive. Here we examined the transcriptomes of two commercially grown late (Fuyu) and early (Soshu) maturity cultivars of persimmon in Korea. To understand changes during the maturation of fruit, we performed de novo transcriptome assembly for four major stages (i.e., 9 WAB (week after blooming), 12 WAB, 15 WAB, and 18 WAB) that are selected based on physiological changes in each cultivar. Average rates of read mapping for the eight representative stages of all fruit maturity were 84.59%. As expected, the transcriptome data well reflected the physiological changes including free sugar content, physical characteristics of fruits, tannin contents of each cultivar. Grouping of the differentially up- or down-regulated genes more than two-fold over maturation time in each cultivar (e.g., 9 WAB of Fuyu vs 12 WAB of Fuyu), or at maturation time between the cultivars (e.g., 9 WAB of Fuyu vs 9 WAB of Soshu) further revealed distinct expression profiles responsible for the fruit maturity that can be used for marker selections.

Keywords: persimmon, transcriptome

P 14:
STUDY OF SOME PHYSIOLOGICAL FACTORS DURING CLIMATIC ADAPTATION OF ALMOND (*Prunus amygdalus* B.) CULTIVARS

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Cultivation and extension of commercial almond cultivars in Iran, especially East Azerbaijan has increased in recent years. As different almond cultivars have different physiological behaviors, therefore, climatic adaptation must be studied before recommending for planting new cultivars. Our studies were carried out on new almond cultivars including SAHAND, A200, A230, SHOKOUFEH, YALDA, AZAR and MONAGHA from 2011 to 2017. Results showed that cold resistance of flower buds in SHOKOFEH cultivar was relatively higher than other cultivars. Instead shoots of SHOKOFEH were susceptible to severe cold more than other cultivars, because of late entry into dormancy. The variation of flowering date in AZAR, HARIR and YALDA cultivars were less than SAHAND, FERRAGNES, SHOKLFEH, A200 and A230. Temperature reaction of flower buds after dormancy in A230, FERRAGNES, and SHOKOFEH were slow but in MONAGHA, AZAR, and YALDA were fast, respectively. There were several factors that affected flowering date of almond. For example, chilling requirement, heat- sum requirement and temperature reaction, based on growth temperature and time of entry to dormancy. The effects of these factors on flowering time could be less or more in different climatic conditions. In this research the role of each of these factors were evaluated in Azerbaijan climatic conditions.

Keywords: Almond, dormancy, flowering time, adaptation

P 15:
A NEW EARLY RIPENING APRICOT CULTIVAR 'KUIJIN

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Kuijin apricot is a early ripening cultivar bred by Shandong Institute of Pomology. Its female parent is Erhuacao and its male parent is Honghebao. In 1990, hybridization was carried out and hybrid fruits were collected, the embryo culture plants were obtained after cold storage, inoculation, embryo culture, low temperature treatment in vitro and light culture, the plants were transplanted in September and lived through the winter in greenhouse. In 1992, the seedlings were planted in seed selection nursery. In 1994, the seedlings flowered and yielded, with big fruits and good quality, as the superior line. In 1995, top grafting were carried out, the grafted trees fruited two years later, fruits performance outstanding, as the best line. Breeding began in 2000, field observations in Mengyin county showed big fruits, good flavor, high and stable yield. In 2009, the variety accepted by experts and approved by crop variety approval committee of Shandong Province. The tree has a robust vigor and open canopy, its fruit shape is nearly round with an average fruit weight 89.1g, the fruit skin is orange, fruit surface bright, clean and beautiful. The flesh is yellow, fine meat, juicy, sour-sweet and aroma, with soluble solids content of 13.2%. Normal year, in Mengyin county the flower bud germinating in early March, late March is the flowering period, the fruit ripening at the end of May and the fruit growth period is 56d. The self fertile ability of the variety is high, the orchard with large area can keep high yield year after year without pollination tree. This variety has strong resistance to drought, they can grow well even they were planted in the orchard of 50 degrees slope, 320 ~ 460m elevation and without irrigation. Meanwhile it has a strong ability to resist florescence frost.

Keywords: Apricot; cultivar

P 16:
PHYSIOLOGICAL RESPONSES OF PEAR ROOTSTOCKS TO SALT STRESS

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Salt stress is one of the abiotic stress factors that considerably limits plant development. The majority of fruit species including pear (Pyrus spp.) are susceptible to salt stress. This study carried out in a greenhouse environment in 2017. The physiological responses of commercially available pear rootstocks (OHxF 97, OHxF 333, Fox 11 and BA29) to salt stress was determined. To establish salt stress, NaCl-containing irrigation water at 3mM (control), 20mM, 40mM, and 80mM was applied to the potted one-year-old plants for eight weeks. The volume of the pots was 18 lt. Leaf relative water content, membrane stability, malondialdehyde (MDA) content and stomatal conductance were measured. Results show that leaf relative water content was relatively lower in Fox 11 rootstock at 80mM. Membrane stability was relatively higher in BA29 rootstock at 20mM and 80mM. MDA content was higher in BA29 rootstock at 20mM, 40mM, and 80mM treatments. Stomatal conductance was lower in Fox 11 and BA29 rootstocks at 20mM and 40mM treatments. These findings indicate that the tolerance of Fox 11 and BA29 rootstocks are low to salinity stress.

Keywords: Pyrus, salinity, stress, salt tolerance

P 17:
NATURE OF POLYPLOIDY IN FRUITS AND ITS IMPORTANT ROLE IN BREEDING

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The history of polyploidy is based on ancient times and takes place an important role in speciation. Polyploidy is a key force in the evolution of both wild and cultivated plants and they exhibit superiority forms than their diploid parents in some cases. This study provides an updated review data related to polyploidy in fruit species. In the first section, types of polyploidy and formation was investigated for the perspective of the both wild and domesticated fruits forms. In the second part of the study polyploidy possibilities and methodologies was investigated for the future breeding opportunities. The superiority forms of polyploidies have been the target of fruit breeders in recent years and they use this key to improve the quality and productivity of fruit species. Apple, strawberry, banana, pineapple, kiwifruit, European plums, cherries, citrus and jujube fruits was detailed in the review. Natural polyploidy has led to the formation of apple species in ancient times and it is very important tool for apple breeding for today. Decaploidy is need to progress for high quality and aromatic fruit production in strawberry. Polyploidy has increased the fruit size, while it has reduced the feather and nucleus ratio for too many fruits.The advantages and disadvantages of polyploidy were explained in this study. The history of evaluation, forming of polyploidy and results has discussed. Reviewed details has very important for the modern fruit breeding studies, and it will supply valuable information to obtaining gen pools and breeding programs.

Keywords: Polyploidy, Polyploidy fruits, polyploidy breeding, Autopolyploid, Allopolyploid

P 18:

INDUCING BRANCHES IN NURSERY `MAXI GALA´ APPLE TREES IN THE DIFFERENT ROOTSTOCK

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Plant growth regulators (PGRs) have been used to boost apple yield and fruit quality; however, further studies have to be made to improve nursery tree quality. This experiment aimed to establish a protocol to produce feathered nursery trees with the highest number of lateral branches of approximately 20 cm. The experiment was carried out in 2015/2016 and 2016/2017. In both years, the sprays began when the plants reached 50 cm from the graft union every 14 days. In the first year, the treatments (full rate of active ingredient) were: benziladenine (BA), GA+BA4+7 at rates of 1250, 2500 and 3750 ml.ha-1, and thidiazuron at rates 125, 250 and 375 ml.ha-1.. The PGRs rates were split into five sprays. In the second year, BA was tested at 2000 ml.ha-1 (four sprays), 3000 ml.ha-1 (two sprays), and 4000 ml.ha-1 (four sprays); BA+GA4+7 at 2500, 5000 and 7500 ml.ha-1 (five sprays each rate); and cyclanilide + ethephon at 25, 50 and 75 ml.ha-1 (five sprays each rate). In both seasons, the PGRs were compared with an untreated control. The sprays were applied to the apical meristem of ‘Maxi Gala’ apple trees grafted on the rootstocks M.9, Marubakaido/M.9 interstem, G.202 and G.213. The variables evaluated were number of branches and branch length. In 2015/2016, for M.9 only BA at 3750 ml.ha-1 reached the objective, while the other rootstocks and all PGRs whatever the rates

promoted branches longer than the ideal, as observed by the rootstocks Marubakaido/M.9, G.202 and G.213, which produced branches around 40 cm. It was beneficial that BA and GA+GA4+7 at the highest rates increased the number of branches. In 2016/2017, BA at 4000 ml.ha-1 for M.9 increased branch number of shorter length, even though for Marubakaido/M.9 and G.202, BA at the highest rate promoted more acceptable nursery plants.

Keywords: lateral branching; Malus domestica; PGR; precocity; uniformity.

P 19:
IDENTIFYING SUCCESSFUL POLLINIZERS OF PLUM CULTIVARS `EDDA´ AND `OPAL´ IN ULLENSVANG, NORWAY, USING MICROSATELLITES

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In order to identify successful pollinizers of plum cultivars ‘Edda’ and ‘Opal’, sixty mature fruits were collected from these two cultivars in the autumn of 2017. The fruits were harvested within three different orchards located in Ullensvang, Norway. After the harvest, kernels were separated from the fruit and used for the extraction of single embryos located within each kernel. DNA extraction was subsequently conducted from the obtained embryos, followed by genetic characterization using seven microsatellite markers. At the same time, leaves were collected from the plum cultivars ‘Edda’ and ‘Opal’, as well as from all other plum cultivars present in the investigated and nearby orchards (‘Mallard’, ‘Jubileum’, ‘Reeves’, ‘Avalon’, ‘Valor’, ‘Cacanska Lepotica’ and ‘Hermann’). DNA extraction was carried out from the leaves and the isolated genetic material used for genotyping, apply the identical approach to the one conducted on the plum seeds. The obtained microsatellite data, from the cultivars and the embryos was used for conducting paternity analyses based on log likelihood ratio. The results revealed that the most successful pollinizer of ‘Edda’, a self-sterile cultivar, within all examined orchards was ‘Opal’. The most successful foreign pollinizer of ‘Opal’ was ‘Mallard’. However more than two thirds of embryos extracted ‘Opal’ fruits did not show any alleles not already present in ‘Opal’, which is expected considering that this plum cultivar is self-fertile. Although European plum is hexploid, making the scoring alleles and paternity analyses rather complicated, the approach used in this study gave clear answers regarding the most successful pollinizers.

Keywords: European plum, paternity analyses, self-fertility

P 20:
ALTERNATIVES TO USE OF HYDROGEN CYANAMIDE IN BUD BREAKING IN APPLE 'MAXI GALA'

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For budburst induction on apples the main practice adopted is hydrogen cyanamide with mineral oil spraying, though, due to the toxicity of this molecule it is essential to study efficient alternative methods in breaking dormancy, when cold requirements are not achieved. This study aimed to evaluate alternatives products to the use of hydrogen cyanamide to induce budburst on apple 'Maxi Gala'. The experiment was conducted in a randomized block design with four replications in a commercial orchard located at the city Vacaria - RS during the agricultural years 2012/13 and 2013/14. The treatments were : T1 - control (no treatment) ; T2 - OM (Mineral Oil) 2% ; T3 - OV (Vegetal Oil) 2% ; T4 - OV 4% ; T5 - OM 2% + OV 2% ; T6 - OM 2% + 4% OV ; T7 - Dormex® + OM and T8 - Erger® + Ca nitrate. The results were subjected to anova and means comparison by Duncan's test. The variables analyzed were budburst percentage and yield per plant. The highest budding was observed in the treatment T8, however this had the lowest production. The highest yield was observed in treatments T1, T4 and T6. The treatment with Erger® despite having the highest budding was not efficient on fruit yield. In the next cycle there was no significant difference for the variables, average fruit weight, number of fruit, soluble solids and firmness. Treatments with Erger®, mineral oil 2% + vegetal oil 4 % and only vegetal oil 4% had the highest yield. For the agricultural year 2012/13 and 2013/14 all treatments anticipated and standardized the shoots compared to control. The treatment of OM 2% + OV 4% promoted budburstof apple plants with the same efficiency as the use of hydrogen cyanamide.

Keywords: Key-words: dormancy break; Malus domestica B.; toxicity.

P 21:

`GALA FULT´, RED, CRUNCHY, JUICY, AND EARLY APPLE ' A URUGUAYAN VARIETY

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Apple is one of the main deciduous fruits grown in Uruguay. The selection of early varieties is one of the main objectives raised by INIA and other actors in the fruit sector. Since 2008, the apple variety 'Gala Fult', obtained and protected by Los Sauces nursery (INASE Nº 1631) owned by Agronomist Fernando Rocca, has been included in the National Register of Cultivars of the National Seed Institute - INASE of Uruguay. 'Gala Fult' is an early red apple, obtained from a spontaneous mutation of a Mondial Gala apple bud, which sprouts and blooms earlier. The National Program of Research in Fruit Production of the National Institute of Agricultural Research, in agreement with Los Sauces nursery, and since 2009, has been carrying out the agronomic evaluation of the apple 'Gala Fult' on two clonal rootstocks, M9-Pajam 2 and M7. This research was carried out at "Wilson Ferreira Aldunate" Experimental Station - INIA Las Brujas, at distances of 3.5 m by 1.5 m between plants (1904 trees / hectare). The trees were driven in Tall Spindle, in plots of 10 trees, with four repetitions in a block design with random plots. The flowering of 'Gala Fult' was abundant and homogenous, occurring between the 5th and 12th of October, with a period of full bloom to harvest of 100 days. Pollination can be achieved successfully with a variety of group Gala and / or Red Delicious. It has a high percentage of fruit set. 'Gala Fult' produces the fruit in well-exposed young fruiting structures and in a smaller proportion fruit was observed in terminal bristle buds. The fruit, at harvest, acquires an intense deep red color (without streaks). The appearance of this red overcolor in the fruits was restricted many

times by the existence of leaves, branches and / or fruits. The combination of 'Gala Fult' on M9 - Pajam 2 resulted in trees of lower height, less vigorous and with a more balanced sprouting than those plants grafted on M7 rootstock. No significant differences were found in terms of average fruit size. The accumulated yields were similar in 'Gala Fult' combinations with both evaluated rootstocks. 'Gala Fult' variety is precocious, with an average production of 42 tons / ha and average fruit size, with the evaluated rootstocks.

Keywords: Apple, Gala Fult, Rootstock,

P 22:
EVALUATION OF FRUIT MINERAL CONTENTS IN TWO APPLE CULTIVARS GROWN IN ORGANIC AND INTEGRATED PRODUCTION SYSTEMS

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Apples are an important source of bioactive compounds, especially minerals. Minerals (both macro and micro-elements) are responsible for the good functioning of the human body, and involving in the metabolism of carbo-hydrates, lipids, proteins; vitamins and enzymes. The objective of this study was to determine and compare the content of some minerals (K, P, Ca, Mg and Fe) in two different apple cultivars (‘Red Aroma Orelind’ and ‘Discovery’), both in skin and pulp, grown in organic and integrated production systems in western Norway in 2015. Samples of frozen fruits were prepared by microwave digestion using an Ethos 1 microwave system (Advanced Microwave Digestion System, Milestone, Italy). All analyses were performed in triplicate on a Thermo Scientific iCAP 6500 Duo ICP (Thermo Fisher Scientific. Cambridge, UK). Among all examined minerals, results showed that potassium was found in the largest quantity in both apple cultivars and in both management systems, which average amount was 944.3 µg/g of frozen weight (FW). Calcium was on the second place with its average of 180.6 µg/g FW. Both apple cultivars had largest amounts of both K and P (in skin and pulp) in organic production comparing to fruits coming from integrated production. ‘Red Aroma Orelind’ showed much higher level of Fe in organic fruits compared to integrated. The present study showed that the highest values of K/Ca, (K+Mg)/Ca and Mg/Ca were obtained in cultivar Discovery under organic production (both in skin and pulp), which probably means that those fruits should exhibit the lowest level of physiological disorders during storage.

Keywords: Malus domestica Borkh., potassium, calcium, phosphor, magnesium

P 23:
A NEW PLUM CULTIVAR: 'HUAXIU'

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'Qiuji' plum (Prunus salicina L.) was bred by Japan and has been fit to plant in China from 1997. In July 2007, a natural bud mutation of ‘Qiuji’ was found in northeast of Jiangsu, Eastern China, and named as ‘Huaxiu’. After eight years of experiment and observation, we found the mutated traits of all clones was stable. Trees of ‘Huaxiu’ are vigorous with a strong sprout capacity: 92.1 % germination percentage and 30.2 % branching rate. The chilling requirement of dormancy is 512 ± 17 h with respect to the average of the 8 years. 'Huaxiu' is a mid-early ripening cultivar. The fruits characterizes by oblate with average weights of 97.081 g, a dark purple (N186B) skin ground and an orange (18A) flesh with light red (N30B) blush. The fruits also have excellent storage capacity. They can keep good quality for at least 5 weeks at 25 °C. At the commercial
(13.4 oBrix on average) with slightly acid (1.43 g malic acid/100 mL on average). 'Huaxiu' is proved to be a new attractive plum cultivar suitable for larger range of region.
Keywords: Prunus salicina L., bud mutant, chilling requirement, early maturing, fruit quality

P 24:

THE EFFECT OF WOOD CUTTING DIAMETER ON THE ROOTING AND SAPLING PERFORMANCE OF BLACK MULBERRY CUTTINGS

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The study examined the effect of wood cutting thickness on rooting and sapling performance in black mulberry. The wood cuttings were taken in November, classified into three groups according to their diameter, immersed in a 5000 ppm IBA solution for five seconds, and then planted in a sub-heated perlite condition with three replicates. Rooting ratio, number of roots and root length were measured in cuttings which were kept in perlite for 90 days. Correlation between cutting diameter and cutting weight with rooting data was examined by regression analysis. Rooted cuttings were planted into 10 liter pots containing 1: 1: 1 ratio of peat: perlite: soil mixture after labeling cutting diameter, cutting weight, root number and root length of each rooted cutting as initial data. When vegetative growth was stopped, the effects of initial cutting diameter, cutting weight and root characteristics on the sapling quality expressed as plant diameter, weight and height, root length and number, shoot number, total leaf number were evaluated by multiple regression. In the study, while rooting rate in all cuttings was found to be 47.11%, the percentage of rooting was determined in thin (6-10 mm) cuttings as 28.18%, in middle thick (10-15 mm) cuttings as 63.70 and 100% in thick (15-20 mm) cuttings. Although the difference between rooting rates according to cutting thicknesses was found to be significant, no linear relationship was found between cutting diameter, cutting weight with rooting performance data. There were also low bilateral and multiple regression identified in relations between the initial data like cutting diameter, cutting weight, root number and root length of rooted cuttings with sapling quality expressed as plant diameter, weight and height, root length and number, shoot number, and total leaf number.
Keywords: Black Mulberry, Cutting, Rooting, Performance.

P 25:

THE EFFECTS OF WATER STRESS ON ANTIOXIDANT ENZYMES ACTIVITIES AND PROTEIN CONTENTS IN LEAVES OF FIVE PRUNUS ROOTSTOCKS

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In this study, the effects of water stress on the ascorbate peroxidase (APX), peroxidase (POD), catalase (CAT) and superoxide dismutase (SOD) antioxidant enzyme activities and total soluble protein content in the leaves of five Prunus rootstocks (Arda, GF 677, Garnem, Rootpac-20 and Nemaguard) were investigated. One year old plants were grown in 18 liter containers and treated with the two levels of deficit irrigation regimes for water stress: 50% field capacity (FC) and 25% FC. Moreover, the control plants were irrigated at field capacity (100% FC). The leaf samples were taken on the 24th day of treatments. The results showed that antioxidant enzyme activities and protein contents of leaves showed changes with both rootstocks and levels of irrigation treatments. In all rootstocks, the stressed plants exposed to 25% FC had higher APX activity than the control plants, while the stressed plants exposed to 50% FC had lower activity levels, except for Rootpac-20 rootstock. POD and SOD activities (respectively, 0.63 A460- min-1mg-1 protein and 9.56 U.mg-1 protein) were the highest in the leaves of Garnem rootstock exposed to 50% FC, whereas CAT activity (6.26 U.mg-1 protein) was the highest in the control plants of Rootpac-20 rootstock. In general, water stress reduced the protein content of leaves.

Keywords: Prunus rootstocks, drought stress, leaf, peroxidase, catalase

P 26:

SOME FRUIT CHARACTERISTICS OF NEW TURKISH APPLE CULTIVARS FROM BLACK SEA REGION

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Eastern Black Sea region has rich apple genetic resources resulted from hybridization of different Malus species and their hybrids with Malus orientalis in this region which is on the silk trade route from Chine through Central Asia to Europe. M. orientalis is a native species in North Anatolia, the Caucasus and northern Iran. We evaluated genetic material in Eastern Black Sea region in an area at 0-250 m elevation with high precipitation and humidity from Ikizce (Ordu) to the border of Georgia for

fruit characteristics, late flowering, and resistance to scab and fire blight during 2009-2013. Total of 241 genotypes were selected, grafted on M9 rootstock, and a replicated trial plot was established at Department of Horticulture, Faculty of Agriculture Ankara University. Pomological analyses of 50 genotypes favorable for fresh consumption were performed between 2013 and 2016. Four cultivars named Erva (#150), Vita (#41), Alya (#103) and Mira (#131) were found superior and now they are in the process of registration. First two are early and others are late genotypes. They are remarkable in late blooming (Alya), resistance/tolerance to scab (Erva and Mira) or scab and fire blight diseases (Vita). In this study, fruit characteristics of them based on apple descriptor were presented that fruit size is small/medium or medium, attractiveness is good, over color is pink/red, type of over color is splashed, eating quality is good or extremely good, and texture is fine or extreme fine. Harvest dates are mid-July - early August for early ones and late September - early October for late ones in Ankara conditions.

Keywords: Eastern Black Sea, Malus, selection, fruit quality, late blooming, scab, fire blight

P 27:

INTERMEDIATE LIMITED IRRIGATION DEPENDING ON FULL BLOOMING DATE ENHANCE TO THE FRUIT QUALITY OF `HARYEJOSAENG´ SATSUMA MANDARIN UNDER PLASTIC FILM HOUSE

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‘Haryejosaeng’ is an early ripening type of satsuma mandarin which was bred from a cross of C. unshiu ‘Tachima Wase' with C. natsudaidai at the Citrus Research Institute of Rural Development Administration. This cultivar is early ripening, vigorous and quicker decrease of acid than ‘Miyagawa’ satsuma mandarin, which has the same fruit quality and harvesting times. Usually, water stress is well known to enhance sugar accumulation in satsuma mandarin (Citrus unshiu Marc.) fruit. But there is no suitable cultivation system to produce high quality fruit of this cultivar in a non-heated plastic film house. This experiment was to develop a cultivation technique for production of high quality ‘Haryejosaeng’ fruit using limited irrigation based on the full bloom period within a shorter growth period. Treatments consisted of 30D (until 9 Brix limited irrigation from 30 day after full bloom), 45D (from 45 days after full bloom), 60D (from 60 days after full bloom) and re-irrigation started at 9°Brix. In the results, as limited irrigation depending on days after full bloom, TSS of 30D were significantly higher than any other treatment, but acid contents significantly decreased as short term of limited irrigation. As increased the terms of limited irrigation, fruit weight and size were decreased, but there is no problem to match the ideal fruit size at harvest time. There were also higher anti-oxidant activity and flavonoid contents in limited irrigation from 30 than 45 and 90 days after full bloom at the fruit maturation. To make a high quality of ‘Haryejosaeng’, it was useful to limit irrigation from 30 to 45 days after full bloom and reirrigate at 9Brix for increasing TSS, anti-oxidants and total flavonoid contents at the maturation time in ‘Haryejosaeng’ satsuma mandarin grown in a non-heated plastic film house.

Keywords: Haryejosaeng, limited irrigation, fruit quality, flavonoid

P 28:

LOW TEMPERATURE CONDITION IS A MORE ESSENTIAL FACTOR THAN SUNLIGHT IRRADIATION FOR ANTHOCYANIN SYNTHESIS IN THE FLESH OF RED-FLESHED `PINK PEARL´ AND `RUBY SWEET´ APPLES

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Anthocyanin synthesis is responsible for the red color of apple fruit skin and flesh. It is known that both low temperature condition and sunlight irradiation are required to induce anthocyanin synthesis in the skin of apple fruit. However, effect of these environmental factors on pigmentation in the flesh of red-fleshed apple fruit remain to be elucidated. ‘Pink Pearl’ and ‘Ruby Sweet’, type 2 red-fleshed apples, are harvested early in September and mid-October, respectively, at Morioka, Japan. Anthocyanin concentration in the fruit flesh of both cultivars was measured from 2014 to 2017. In 2014, 2015 and 2017, the temperature started to decrease late in August as usual, whereas in 2016, the temperatures stayed relatively higher until early in September. Anthocyanin concentration in the flesh of both cultivars in 2016 was substantially lower than in 2014, 2015 and 2017. In addition, bagging treatment was conducted to examine the effect of light condition on pigmentation in the flesh. The treatment was applied to ‘Pink Pearl’ fruit in 2014 and 2015, and ‘Ruby Sweet’ fruit in 2016 and 2017, respectively. Approximately 70 % anthocyanin in the flesh of bagged ‘Pink Pearl’ fruit accumulated compared to sun-exposed fruit in both years. In regard to bagged ‘Ruby Sweet’ fruit, no anthocyanin in the flesh accumulated in 2016, whereas 50 % anthocyanin accumulated compared to sun-exposed fruit in 2017. In fact, anthocyanin in the flesh of both apples accumulated under the dark condition when the temperatures in late summer decreased properly. These results indicate that, although sunlight irradiation increases anthocyanin accumulation in the flesh of these red-fleshed apples, low temperature condition in the late summer is more essential for its synthesis.

Keywords: Anthocyanin, Apple, Red flesh, Sunlight, Temperature

P 29:

RESPONSE OF YOUNG FUJI APPLE TREE WITH DIFFERENT ROOTSTOCKS TYPES TO POTASSIUM NUTRITION

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Dwarfing cultivation is the direction and trend of apple industry in the world.Dwarfing self-rooted rootstock and interstocks are the main ways to realize apple dwarfing and high density cultivation. The absorption and translocation of nitrogen, phosphorus and potassium of young apple trees were influenced significantly by the different types of dwarfing rootstocks. Nutrient requirements of different types of dwarfing rootstocks were vary in different growth period. Potassium was closely related with photosynthesis, hormones synthesis, and other nutrients absorption in the trees growing process. The potassium absorption and translocation mechanism of apple trees with different rootstock types in different periods is not yet clear. Therefore, the absorption and translocation of mineral nutrition of young apple trees with T337 self-rooted rootstock and interstocks were explored. The difference of growth index, mineral nutrition, endogenous hormones, photosynthetic function of young apple trees with T337 self-rooted rootstock, T337 interstock and vigorous rootstock under different K nutrient solution were studied. This study provided a theoretical basis for rational fertilization, high yield and high efficient cultivation techniques of apple industry.The main results were as follows:(1) There was differences in the nutrients absorption and growth potential of young Fuji apple trees with

two kinds of dwarfing rootstocks. The growth potential of Young Fuji apple trees with T337 self-rooted rootstock was significantly weaker than that with T337 interstocks.Nitrogen, phosphorus and potassium absorption rate of young Fuji apple tree with T337 self-rooted rootstock were the highest at 120-150 days after planting. Nitrogen and phosphorus absorption rate of trees with T337 interstock were highest at 60-90 days after planting, and potassium absorption rate was the highest at 30-60 days after planting. In the annual growth period, nitrogen, phosphorus and potassium absorption ratio of young Fuji apple tree with T337 self-rooted rootstock was 5.02:1:12.26,and that with T337 interstock one was 5.01:1:12.62.(2)There was differences in the growth potential and biomass of young Fuji apple trees with three types of rootstocks under different concentrations of potassium. The growth potential and biomass under low and high potassium treatment conditions were lower than that of medium potassium. And the rank of growth potential and biomass under different potassium concentration treatment was vigorous rootstock> T337 interstock> T337 self-rooted rootstock.(3) There was differences in the mineral elements absorption of young Fuji apple trees with three types of rootstocks under different concentrations of potassium.With different concentration of potassium, the total nitrogen, phosphorus and potassium accumulation were medium potassium treatment higher than low and high potassium treatment. And the leaf potassium content were high potassium > medium potassium > low potassium. The leaf calcium content of young Fuji apple tree with T337 self-rooted rootstock and interstock were affected by the concentration of potassium. The higher potassium, the lower leaf calcium content. However, for Fuji apple tree with vigorous rootstock , high concentrations of potassium prevented the calcium accumulation in leaf, medium potassium promoted the calcium accumulation in leaf. The leaf nitrogen content of young Fuji apple trees with T337 self-rooted rootstock was lower than T337 interstock and vigorous rootstock. And in the whole annual growth cycle, the content of magnesium had small differences.(4) There was differences in the leaf endogenous hormones content of young Fuji apple trees with three types of rootstocks under different concentrations of potassium. Under the low and high potassium concentrations treatment, the leaf IAA, GA, ZR content were lower than medium potassium treatment. However, the content of ABA was higher than that in medium potassium treatment. And that was to say (IAA+GA+ZR)·ABA-1 was lower than medium potassium treatment. The IAA content of young Fuji apple trees with T337 interstock were lower than T337 self-rooted rootstock and vigorous rootstock. And the leaf ABA content of T337 self-rooted rootstock was higher than T337 interstock and vigorous rootstock expect for the September.(5)There was differences in the leaf net photosynthetic rate (Pn) of young Fuji apple trees with three types of rootstocks under different concentrations of potassium.The leaf Pn under medium potassium treatment were higher than that under low and high potassium treatment. And the leaf Pn of young Fuji apple trees with T337 self-rooted rootstock and interstock were lower than vigorous rootstock expect for August.

Keywords: Apple tree with dwarfing rootstock, potassium nutrition, biomass, mineral elements, endogenous hormones

P 30:

STUDY AND OPTIMIZATION ON DYNAMIC FACTOR OF SOIL SYSTEM ORGANIFICATION PROCESS IN THE NORTHERN COAST

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Apple orchards are mostly distributed in the gentle hills in China. Soil organic matter content is low, and a series of unreasonable soil management practices such as a lot of fertilizer and pesticides year after year were applied, which resulted in declining of soil fertility, low yield and poor fruit quality. The apple industry's healthy development was restricted seriously. In this study, the dynamic change of SOM, synthesis and decomposition of organic matter, soil microbial population structure, soil physical and chemical properties and soil enzymes activities of orchard soil, field soil and undisturbed soil from same parent soil material were compared. The change characteristics of various factors were explored under different cultivation mode. The differences of soil system organification

process of different land use pattern were sought out and the core of power factor was analyzed. Soil environment was regulated purposefully by artificial measures. The response mechanism of orchard soil on the artificial control measures was verified. The science and disadvantages of existing organic orchard soil management system were evaluated from point of organic matter behavior. The technology strategy orchard soil fertility were provided, which provide theoretical and technical support for apple orchard soil management in northern Bohai Bay.The main results were as follows:(1)The effects of different land use pattern on soil system organification process showed that: The soil invertase,β-glucosidase and neutral phosphatase activity significantly affected by different land use, while the cellulase and urease activities did not reach a significant level. Soil enzyme activities were increased with decreasing soil depth, the order of variation along soil depth was natural soil>orchard orchard>field soil. Orchard soil organic matter and N, P, K content ranged between field soil and natural soil, the total potassium content of orchard soil was higher than farmland and natural soil, potassium content of 0~10cm orchards soil was higher than the other two land use way. Richness index (S) and diversity index (H) of orchard soil microbial were significantly higher than field soil and natural soil.It was found that the differentiation of soil microbial communities for different land use pattern were mainly caused by carbohydrate and polymers carbon is to distinguish between different land use soil profile differences in soil microbial community function main carbon source. Soil organic carbon (SOC) content and humus fractions HA and HM were reduced with soil depth, the farmland soil had the highest in all soil layers, and undisturbed soil were lowest; the distribution of the FA in the soil layers was different. Cellulase and urease and soil total K highly was significant positively correlation, sucrase and soil total nitrogen, available nitrogen, total phosphorus, phosphorus, potassium existed significant positive correlation, β-glucosidase and soil available nitrogen was significantly positively correlated with total nitrogen, total potassium, potassium significant positive correlation; soil organic carbon and total nitrogen existed a significant positive correlation with available nitrogen, total phosphorus, potassium significant positive correlation; humic and soil total nitrogen, available nitrogen , total phosphorus, potassium significant positive correlation.(2)The effects of soil management regulations on soil system organification process showed that: Covering branches and weeds improved the apple orchard soil nutrient levels and the quality of carbon pools, however, covering branches had more contribution than covering weeds to the stability of the soil carbon pool, which provided a strong guarantee for the realization of the orchard within the material cycle, energy flow, and lay a solid foundation for the environment quality increase of the orchard soil.(3)The effects of soil organic materials on soil system organification process sin northern Bohai Bay showed that: the cellulase, invertase, catalase activity and nitrogen, available phosphorus and potassium content that sheep processing were the highest, followed by rice shell. Phosphatase activities of rice husk were the highest. The test results of same process for indoor cultivation, processing and field trials pot were varied. For pot experiment, total nitrogen and total phosphorus content of soybean straw treatment was the highest, highest organic matter content of rice husk were the highest. For field trials, the nitrogen content corn of stalk treatment were the highest, total P content of rice husk processing was the highest, total K content of soybean processing was the highest. Different organic materials significantly increased plant organs apple nutrients accumulation level. Among the most obvious enhance role was sheep processing, followed by rice husk processing.(4)The effects of adding small organic molecules and earthworms on soil system organification process sin northern Bohai Bay showed that:Adding the small molecules of glucose and earthworm, microbial functional diversity, the activity of soil cellulase, invertase and β-glucosidase increased significantly, and improved the activity and stability of the soil carbon pool. It contributed to increase the soil humic content and microbial functional diversity while adding urea and glucose at the same time.Average Well Color Development (AWCD) values were significantly affected by small molecular organic compounds and numbers of earthworms. It was found that the differentiations of soil microbial communities were mainly caused by carbohydrate and polymers carbon.The addition of small molecules of glucose to exogenous organic matter provided more available of the carbon sources for the soil microbes, so that microbial bloom and the microbial functional diversity also had significant increase.The earthworm activity accelerated the soil organic pool transformation, and improved the activity and stability of the soil carbon pool.Small organic molecules have a significant effects on the baccata vigor.Baccata vigor was the weakest adding only the growing glucose handling, photosynthetic performance was degraded, plant nitrogen deficiency, while adding urea to improve

plant photosynthetic capacity, and promote the growth of baccata. Earthworm activity increased baccata plants for moisture and nutrients NPK utilization, promoting baccata plant height, leaf number increased dry rough.

Keywords: North of Bohai Bay; Apple Orchard Soil; Organification Process; Land Use Patterns; Organic Materials

P 31:

EFFECT OF DIFFERENT APPLICATIONS ON DWARFING OF FIG NURSERY TREES (*Ficus carica* cv. `Bursa Siyahı´)

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The study to specify the effects of different applications on Bursa Siyahı variety of fig nursery trees for dwarfing was performed during 2012-2013 in the experimental parsel of Department of Horticulture, Agriculture Faculty of Adnan Menderes University. Beside the control application, on the purpose of creating artificial dwarfing on the fig nursery trees, one gibberellic asid inhibitor Prohexadione-calcium (Pro-Ca) was equally used as 125 and 250 ppm. Also, the application of branch bending was performed on nursery trees which were curvedly planted on 30° angle with ground level and which were cultivated by strapping to galvanised wires. 125 ppm Pro-Ca + branch bending and 250 ppm Pro-Ca + branch bending applications were also used in the study and yet, totally six applications were attempted. The fig nursery trees were planted 1*1.5 m distances on plots where branch bending applicated, and 1 * 1 m interrow and intrarow distances on plots where the other applications made. Pro-Ca applications, by means of the period when new shoots on nursery trees become 5 cm tall, were performed twice in growing season. For the purpose of specifying the effects on dwarfing of the applications, the parameters of nursery trees leaf, stem and root growth were examined. When the results of the study were generally reviewed, by uses of 250 ppm Pro-Ca application and 250 ppm Pro-Ca + branch bending application, poorer growth criteria nursery trees were taken in comparison with control group nursery trees.

Keywords: Fig, Prohexadione-calcium, pruning, branch bending, dwarfing

P 32:

CLONAL ROOTSTOCKS FOR PEACH IN BRAZIL: VEGETATIVE GROWTH AND FOLIARY NUTRIENT CONTENTS IN CV. BRS-KAMPAI, IN JARINÚ-SP

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Although widely cultivated in southern and southeastern Brazil and the large number of canopy cultivars available, theuse of specific rootstocks is not common in peach orchards. The incidence of the early peach death syndrome in southern Brazil has caused great damage to the producers since 1970s and motivated this studyto evaluate the effect of rootstocks on plant development, nutritional status and fruit quality; in this way, to provide farmers with materials that are tolerant to early peach

tree death and high performance in the field. In 2014, 20 experiments were installed throughout the producing regions of Brazil, from Pelotas/RS (31°40'S; 52°26'W) to the Carandaí/MG (20°57'S; 43°48'W). One of observation units is located in Jarinu (23º 06' 05" S; 46º 43' 42" W; 755m), São Paulo State, and was implanted with 19 grafted materials under the Kampai cultivar, in addition to the self-rooted cultivar. Some materials have been alternating the ranking of those that provide higher plant height (m): Cadaman (0.83 – 3.73), Flordaguard (0.81 – 3.61), GxN9 (0.95 – 3.60), Mexico Fila-1 (0.95 - 3.86), Nemared (0.44 - 3.65), Tsukuba-3 (0.65 - 3.71), and the cultivar self-rooted crown (0.92 - 3.85), respectively in 2014 and 2017. Okinawa cultivar, widely used by nurserymen, was intermediate (0.81-3.28), but above the average of the experiment. Measurements of graft diameter also showed the same trend. Another parameter studied was the survival of the grafted plants. Two rootstock cultivars had 100% mortality in the second year of evaluation (Marianna and Myrobalan-29C), suggesting problems of incompatibility or climatic adaptation. Leaf tissue analyzescarried out in 2015 showeddifferences in potassium accumulation by Kampai cultivar grafted on Nemared (34.6 g/kg),on I-67-52-4 (33.7 g/kg) andon Tsukuba-2 (32.2 g/kg), as well as significant differences in nutrients as calcium, magnesium, iron, copper, manganese, zinc and boron.

Keywords: BRS Kampai; rootstock; peach

P 33:
RESPONSES OF 'FUYU' PERSIMMON TREES TO DIFFERENT N APPLICATION RATES

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This study evaluated the effect of different nitrogen (N) rates during summer on fruit characteristics, changes of leaf nutrients after harvest, reserve accumulation, and early growth the following year. With pot-grown young 'Fuyu' persimmon trees, different rates of 0, medium and high N were fertigated to each tree using urea solution in summer. All the fruits were harvested in early November. Although not significant, fruits were larger for the high N rate. Fruits for the 0-N rate, having lower N concentration, were softer and had better coloration and higher soluble solids, indicating that they matured earlier. Increasing N rate significantly increased cross-sectional area of the trunk. The N fertigation tended to increase leaf concentrations of soluble sugars, starch, and amino acids. Contents of N, P, K, soluble sugars, starch, and amino acids per unit leaf area gradually decreased in all the treatments during after fruit harvest, and the extent of the decrease was the lowest for the 0-N rate. On the other hand, those of Ca, Mg, and protein did not consistently change during this period. The N fertigation resulted in higher concentrations of N in dormant shoots, and although not great, it also increased soluble sugars, starch, amino acids, and protein. Clear differences were found in number of flower buds per one-year-old branch and total shoot length per tree the following year. Trees with high N rate had more flower buds, compared with those of 0-g N trees. It was concluded that N rate during summer should be adjusted with considering the changes of fruit maturation, mobilization of leaf nutrients, and reserve accumulation.

Keywords: Persimmon, nitrogen, reserve accumulation, tree growth

P 34:
SCORING EFFECTS ON TREE VIGOR AND FRUIT QUALITY OF 'FUYU' PERSIMMON TREES

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A series of experiments were performed to determine scoring effect on stabilizing tree vigor and enhancing fruit quality of 'Fuyu' persimmon. Trunks of vigorous trees were scored with a grafting knife in early April, May, June, and July at 10 cm above the graft union. Scoring from April to June reduced occurrence of water sprouts and increased fruit set the year of treatment, compared with non-scored control. However, average weight, color, and soluble solids of the fruits were better in July-scored trees. Although not great, the desirable effects on shoot growth and fruit quality were observed in June and July treatments the following year. Considering the results for two years, early June scoring at the trunk was recommendable to control tree vigor. Vigorous scaffolds or secondary scaffolds were scored by a knife with 1 mm-thick blade or a pruning saw with 2 mm-thick tooth in mid-June. The scored scaffolds produced less water sprouts but larger fruits with higher soluble solids, compared with the non-scored control. When the bases of vigorously grown two-year-old lateral branches were scored with pruning scissors or pruning saw at dormant pruning, number of water sprouts decreased and fruits became larger. Occurrence of shoots at the base after the scoring was another benefit, which can be used as bearing mother branches the next season. However, scoring with pruning scissors was better than pruning saw to prevent insect from invading to the scars.

Keywords: persimmon, scoring, fruit characteristic, tree growth

P 35:

GRAPEVINE ROOTSTOCKS DIFFERENTIALLY AFFECT GENES EXPRESSION AND TRANSCRIPTOME PROFILING OF `RUBY ROMAN´ BERRY SKIN GRAFTED ON DIPLOID AND TETRAPLOID ROOTSTOCKS

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Skin color of grape berry is an important trait in determining the market price. In Japan, the consumers have a tendency to prefer the red color, large sized table grape berries. ‘Ruby-Roman’ (Vitis ×labruscana) is a new tetraploid cultivar which has bright ruby red skin and extremely large in berry size such that the fresh weight exceeds 20 grams. ‘Ruby-Roman’, as well as its ancestor ‘Kyoho’, a black tetraploid table grape, belongs to V. ×labruscana, a subgroup of grapes that originated from the hybridization of American native species (V. labrusca) with European species (V. vinifera). The color of berry skins is determined by the quantity and composition of anthocyanins, and anthocyanin biosynthesis is considered to be controlled by some regulatory genes including of a transcription factor named MYB. In V. vinifera, the VvmybA genotype determines grape skin color, and white-skinned genotypes have the non-functional allele Haplotype A, which is consisted of two transcriptional inactivation genes, VvMYBA1a and VvMYBA2w. From the berries of tetraploid ‘Kyoho’ grape (V. ×labruscana), some Myb-related transcription-factor genes such as VlmybA1-1, VlmybA1-2, VlmybA1-3 and VlmybA2 have been isolated. The genotype which had the functional alleles VlmybA1-2 (VlmybA2)and VlmybA1-3 is named Haplotype E. The color locus in most V. ×labruscana grape consisted of Haplotype E and Haplotype A, and the color strength of skin is determined by the numbers of functional haplotype. ‘Ruby-Roman’, as well as some red skin color tetraploid cultivars, contains three Haplotype A and one Haplotype E1. In this study, we investigated

the expression of anthocyanin biosynthesis-related genes in the berry skin of 'Ruby-Roman' scion grafted on the different types of rootstock by means of real-time PCR, and transcriptome analysis.
Keywords: anthocyanin biosynthesis, gene expression, tetraploid grape, skin coloration

P 36:

IMPROVEMENT OF PROPER TRAINING SYSTEM OF INTENSIVE PLANTING IN BURSA SIYAHI FIG CULTIVAR

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This study was carried out with Bursa Siyahı fig cultivar in Horticultural Deparment of Agricultural Faculty of Adnan Menderes University during 2016-2017. In the study, Y trellis and uni-cordon training systems, beside positive control (no pruned and no wire-stake system) and negative control (well-pruned and no wire-stake system), were applied on the trees were planted in 2012 February. To observe the effect of different training systems on the fig trees, some vegetative and generative characteristics were determined. The vegetative growth, yield and fruit quality performances such as shoot number (number/tree), average shoot lenght (cm), average shoot diameter (mm), yield per tree (kg/tree), yield per decar (kg/da), yield per trunk cross sectionel area (kg/cm²), averege fruit weight (g), of the trees constituted on wire-stake combination systems (Y trellis and uni-cordon) and positive/negative control systems were analysed during experiment. The use of Y Trellis (1x1 m) training system and negative control for Y Trellis (well-pruned and no wire-stake system) led to increased plant growth and yield in Bursa Siyahı fig cultivar.
Keywords: *Ficus carica* L., Training systems, Growth, Yield

P 37:

IS CUTTINGS METHOD A RELIABLE TOOL FOR ESTIMATING PISTACHIO'S CLIMATIC REQUIREMENTS IN WARM MEDITERRANEAN CONDITIONS?

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As the most of woody perennial temperate trees, pistachios enter in dormancy during winter in order to survive to unfavourable conditions and to frost damage. Estimating chilling and heat requirements is essential for choosing appropriate pistachio cultivars for a given site and for insuring viable orchards. To this end, we tried to estimate chilling and heat requirements of pistachios cultivars using cuttings method under controlled environment during 2 years. Pistachio cuttings were collected after tree defoliation in autumn from Sfax central Tunisian region and placed in cold room at 4-6°C to receive different chilling quantities ranging from 100 to 1000 hours. After achieving the desired chilling amounts, pistachio cuttings were entered to growth chamber to be exposed to warm

temperature between 23 and 25°C. During this period, phenological stages of flowering buds were followed until bloom. Daily temperature and humidity were also registered and chilling and heat accumulations were also calculated. Normally, chilling requirements are delineated from the relationship between chilling accumulation and heat requirements (GDH). For most of woody perennial species the relationship between chilling units and forcing units (GDH) is a hyperbolic curve. Forcing units decrease as accumulated chilling units increase and then stabilize reaching a threshold value beyond which the GDHs no longer increase. Therefore chilling requirements for bud dormancy release could be chilling units that buds accumulated and for which correspond the threshold GDH value. Meanwhile, in our experiment and during two years, we found that for the pistachio this relationship had a different appearance and sometimes the majority of buds remained dormant. Thus, it was complicated to determine chilling requirements or/and the estimates were biased. Moreover, heat requirements are usually calculated from the date of bud dormancy release until the date when 50 % of flowers are open. However, in our experiment flowering percentages were sometimes null or very low, making it impossible to estimate heat requirements for flowering. From our findings during these two years, we have been able to elucidate the following hypothesis: in warm and semi-arid regions, trees are exposed to lack of chilling and drought and consequently, at the autumn and after harvest pistachio branches had very few reserves due to difficult climatic conditions which makes several buds in the cuttings (devoid of leaves and roots) are unable to flower or break their dormancy even in optimal conditions. As a conclusion, it is difficult to estimate climatic requirements for pistachio in warm semi-arid conditions using this cuttings method without taking into account the starch accumulation during the previous year in the wood.

Keywords: Pistachios, chilling requirements, heat requirements, cuttings methods, warm semi-arid conditions

P 38:
`VENICE´ A NEW BRAZILIAN APPLE CULTIVAR FROM EPAGRI

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The apple cv. ‘Venice’ was developed by Santa Catarina State Agricultural Research and Rural Extension Agency (Epagri) and is the result of a cross between ‘Imperatriz’ and ‘Baronesa’, it has medium chilling requirement, high resistance to Glomerella leaf spot, fruits have long cold storage, high visual and organoleptic quality. The objective of this work was to evaluate the agronomic performance of cv. Venice in São Joaquim – Santa Catarina State. The work was carried out between 2012 and 2017, in São Joaquim – Santa Catarina State, in the orchards of Epagri – São Joaquim Experimental Station (28°16'30"S, 49°56'09,34" W, altitude 1,400m). The orchard was planted in 2009, the plants were grafted on G.814, with 1 x 4 m spacing. The cv. Venice was compared to Fuji Suprema and Gala Galaxy. The dates of occurrence of the main phenological stages, yield per plant and the physicochemical characteristics of its fruits were evaluated. The cv. Venice began sprouting on August 16, on average 15 days before Gala and Fuji. Its flowering occurred between August 31 and September 25. Its harvest occurred in the second half of March, between cvs. Gala and Fuji. The cv.

Venice produced 20 kg per plant and 29 tons per hectare, 53% higher than the others. Regarding quality, at harvest, cv. Venice showed 77% of red color with two color pattern, 13 °Brix, acidity of 66.7 Meq L-1 and flesh firmness of 91.7 N flesh firmness. Its fruits are firm, crispy and juicy, which makes it able to become an option for diversification of apple cultivars in Brazil.

Keywords: Agronomic performance, apple breeding, medium chilling requirement

P 39:
BEHAVIOUR OF SOME APPLE HYBRIDS SELECTED IN KYUSTENDIL, BULGARIA

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The selection of new apple cultivars is focused on high and stable yield, fruit quality, tolerance to biotic and abiotic stress. As result of the breeding activities during the last 10-20 years at the Institute of Agriculture - Kyustendil many new apple hybrids were obtained to increase the genetic basis for breeding. This article presents some biological (as period of flowering and ripening, fruit bearing habit, productivity, suitable pollinators) and qualitative characteristics (fruit weight and dimentions, storage period) of 5 apple hybrids, preliminary selected as promising. The trees were grafted on rootstock MM106 and planted in the spring of 2007 at distance 4.5 x 2.5 m. Data were collected for 4 years during full bearing period (2014-2017). In the studied hybrids, average yield per tree ranged from 24.0 to 33.9 kg, fruit weight - from 119.6 to 228.5 g, ripening date was from 18 to 29 September, the fruit have long storage period - 90-140 days under non controled conditions. The hybrids produce fruit mainly on two-year-old fruting wood, on short and weak twigs. ‘Hybrid 1/5’ (Malus robusta ×‘Liberty’) was found as the most promising in term of examined characteristics for growing under agroclimatic conditions of Kyustendil region.
Keywords: breeding, phenology, ripening time, yield, fruit quality

P 40:
REACTION OF APPLE CULTIVARS TO ABIOTIC AND BIOTIC STRESS FACTORS

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The study was carried out during 2015-2017 at the Agricultural Insitute - Kyustendil. The aim was to evaluate a part of the apple cultivars grown in the collection plantations of the Institute to some stress factors (winter and late spring frosts and the degree of attack on the leaves and fruit from apple scab and powdery mildew). It was established that ‘Rosana’, ‘Fuji nagafu 6’, ‘Charden’, ‘Prima’ and the new bulgarian cultivar ‘Siyana’ had the best resistance to late spring frosts (- 4 °C). The damages on young fruits (about 20 mm in diameter, BBCH-72) in these cultivars were in the frame of 40-50%. The most sensitive were the cultivars ‘Rubinola’, ‘Belgoden’, ‘Braeburn’, ‘Čadel’, ‘Oregon Spur’ and ‘Super Chief’.- with injuries between 80-90%. ‘Rubilola’, ‘Teser T219’ and ‘Siyana’ showed resistance to scab and weak sensitive to powdery mildew, while the rest cultivars were sensitive to these diseases.

Keywords: spring frosts, resistance, apple scab, powdery mildew

P 41:
EVALUATION OF DIFFERENT ROOTSTOCKS WITH `VAN´ SWEET CHERRY CULTIVAR

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The rootstocks ‘Gisela 5’, ‘Gisela 6’, ‘CAB 6P’, ‘MaxMa 14’, ‘MaxMa 60’, ‘F 12/1’ and ‘Alkavo 2’ budded with ‘Van’ sweet cherry cultivar were tested at the Institute of Agriculture - Kyustendil, Bulgaria. Trees on ‘IK-M9’ (local Mahaleb seedling rootstock) were used as control. The trial was established in the spring of 2008. The trees were spaced at 4.0 x 3.0 m, shaped in freely growing crown and irrigated by spraying over the crowns. Tree vigour, yield, yield efficiency, fruit size and fruit quality were evaluated during 2013-2015. According to trunk-cross sectional area and crown dimensions the most vigorous rootstocks were ‘MaxMa 60’, ‘Alkavo 2’ and ‘MaxMa 14’. The most dwarfing rootstocks were ‘Gisela 5’ and ‘Gisela 6’. The highest cumulative yield per tree and yield efficiency were recorded on ‘MaxMa 60’, ‘IK-M9’ and ‘F 12/1’. No significant differences were found in the average fruit weight and in the chemical composition of fruit.
Keywords: tree vigour, yield, yield efficiency, fruit size, chemical composition

P 42:
`MARLENA´ - A NEW APPLE CULTIVAR FROM BULGARIA

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The cultivar have been obtained through controlled hybridization between ‘Florina’ and ‘Macfree’ at the Institute of Agriculture - Kyustendil, recognized as a new cultivar in 2010. The original seedling was propagated on MM 106 rootstock and the trees were planted at a distance of 4.5 x 2.5 m and grown under conventional technology for apple. In the article we present data for biological and economic qualities of the cultivar for the period 2014-2017. It was found that on rootstock MM 106 the trees had moderate growth and fruit mainly on one- and two-year-old twigs. The cultivar has regular and high productivity. The fruits ripened between 15 and 20 September. They are large (210 g), with very good quality. The skin is yellow-greenish in color, covered almost entirely with a light red cover color. During the study the trees showed resistant to apple scab, which is a major advantage of the cultivar, and makes it very suitable for organic fruit production.
Keywords: *Malus domestica*, selection, growth, yield, fruit

P 43:
EVALUATION OF APPLE CULTIVARS, ROOTSTOCKS AND ORCHARD DESIGNS UNDER ORGANIC MANAGEMENT

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We have planted apple grafts in an experimental plot of 1 ha to compare 2 orchard designs under organic management in a northeastern climate. The plot was devided in two subplots of 0.5 ha each. Planting density, spacings and training systems differs between subplots (one intensif and the other is semi-extensif) . Three cultivars and 3 rootstocks were being examined in both subplots. Indicators of hardiness, growth, vigor, and pest tolerance are being followed up for each combination of cutivar and rootstock.

Keywords: apple, training systems, rootstocks, heirloom variety, organic management, planting density, hardiness

P 44:
DETERMINING POMOLOGICAL AND BIOCHEMICAL FUTURES OF SOME PECAN NUTS VARIETES WHICH IS GROWN IN GAP REGION

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Pecan nuts is hard-shelled fruit and belongs to family of Carya varieties. İt is grown in different parts of the World. It is grown in on the slopes of the Aegean and Mediterranean regions facing the sea. İn aditon, positive results were obtained in the studies on the pecan walnut which is grown GAP region. In this study, five different types of pecan nuts were analyzed. Those types are Ideal, Harris süper, Mahan, Schley, and Mohawk. Those types has been analysed for pomological features such as Fruit Weight (9.096;10.722;5.910;5.425;10.845) mm , Fruit Length (42.702; 44.177; 51.833; 34.514; 38.539) mm, Fruit Width (21.995; 24.026; 22.439; 23.950; 26.224) mm, Fruit Height (23.795; 24.280; 23.660; 23.209; 25.412) mm, Fruit Crust Thickness (1.101; 0.833; 0.584; 0.739; 0.826) mm, and Fruit Internal Weight. (4.093; 6.106; 2.941; 2.323; 5.857) mm. İn additon to total fat (45,41, 50.74, 45.27, 46.18; 58.69), percent moisture (6.260, 4.421, 11.560, 2.700, 2.068), ash (9.61, 11.89, 13.56, 12.40, 10.53). Also it has been analysed for fruit oil acids such as saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, trans fat, omega-3, omega-6, omega-9. İn this study, similar results were obtained with the literature . Due to its pomological and chemical properties, it has been determined that Mahan and Ideal varieties are most suitable for GAP region.

Keywords: Pecan ; pomological features; chemical properties

P 45:
PEDICELS EFFECTS ON FINAL FRUIT SIZE IN APPLE

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Regulation of fruit size is a major economical factor for numerous horticultural crops. Specifically, in apple, increases in fruit size will result in increased market value. Many factors play role in determining final fruit size in apple, many of which have been well studied. Besides being responsible for the attachment of fruit to the tree, the apple fruit pedicel also provides a connection between the fruit and the source of water and nutrients. Therefore, we hypothesized that the pedicel can be a factor that regulates the apple fruit size. Accordingly, this study was conducted to determine the relationships between final fruit size and both pedicel size and pedicel anatomy. We used 10 apple genotypes differing in fruit size from 1g to 336g. During two consecutive years, apple fruit size and both pedicel diameter and length were measured and analyzed. Our results demonstrated that among the genotypes, there was a positive correlation between pedicel diameter and final fruit weight at harvest. In contrast, a significant negative relationship between pedicel length and fruit weight was found. Additionally, a positive correlation between number of tracheary elements in the pedicel and fruit size was detected among the genotypes. Genotypes with larger fruit size generally were characterized by pedicels with larger diameter and shorter length, and both larger and more tracheary elements.

Keywords: Fruit weight, apple pedicel, tracheary element

P 46:
PHENOTYPICAL DESCRIPTION OF TRADITIONAL VARIETIES OF APPLE (*Malus domestica*) FROM "SIERRA NORTE" OF MADRID (MADRID REGION, SPAIN)

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A total of 67 morphological descriptors from 27 endangered traditional varieties of apple tree (Malus domestica) surveyed in 13 municipalities from “Sierra Norte” of Madrid were evaluated to assess their phenotypical variability. The trees studied were first grafted in a Fruit Germplasm Bank set and maintained by the Institute for Rural, Agrarian and Food Research and Development of Madrid (IMIDRA) since 2007. This Bank is allocated in Arganda del Rey (Madrid, Spain) in a Mediterranean climate, area characterized by cold winters and warm, dry summers. Soils belong to the alluvial terrace type, order Alfisol. Nevertheless, the donor accessions were from the “Sierra Guadarrama” Mountain Range, ruled by a colder and wetter environment, with less water stress and soils inherently granitic and more acidic. Neither pests nor diseases affect significantly the health of the Germplasm Bank. The morphological traits described were leaf, flower, fruit and one-year winter stem and following IPGRI and UPOV descriptors. Some of them, like pubescence, were described in almost all the organs. Ten samples of commercial varieties of apple (‘Fuji’, ‘Gala’, ‘Golden’, ‘Granny Smith’, ‘Reineta’ and ‘Verde Doncella’) and four wild individuals of putative crab apple trees (Malus sylvestris) were collected in the studied area and were included in the present description as reference accessions. Both quantitative and qualitative obtained data were analyzed by a Principal Component Analysis (PCA) to detect the main sources of variability in evaluated plant material, allowing the selection of the best descriptors for the Cluster Analysis (CA). This study will provide some preliminary information about the phenotypic diversity of the endangered traditional varieties from “Sierra Norte” of Madrid, a compulsory step for future conservation and genetic breeding programmes.

Keywords: Morphological characterization, Agrodiversity, PCA, Cluster Analysis

P 47:

EFFECT OF DIFFERENT SHADING LEVELS ON FRUIT QUALITY AND HARVEST TIME IN GRANNY SMITH APPLE

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This study was carried out to determine the most suitable shading level of hail-net system for high density apple orchards getting more popular in Turkey. Granny Smith cultivar on M9 and hail-nets at 3 different shading rates (32%, 42% and 56%) were used. Experiment was designed as three replicates and eight plants at each replicate according to randomized complete block. Each year, hail-net system was covered on experiment area on 15 June. Light, temperature and humidity data were obtained from HOBO. The parameter of fruit width, length, weight, firmness, water-soluble dry matter, acidity, pH, sunburn and red flush percent on skin and yield had been measured and recorded. The tip of sunburn seen in the study was determined as sunburn browning. Direct light exposition on sunburn development was found significantly important because of not differences among applications in terms of air temperature. Sunburn percent at 2007 was higher than 2006 because of total hour number on threshold temperature (32oC) of former. Red flush amount and percent decreased while increasing shading ratio as well as sunburn. But while higher shading made sunburn lower, it also caused the

decrease in yield. At the result of evaluation of yield and quality parameters, 32% was determined as the most profitable hail-net shading ratio.

Keywords: Hail-net system, sunburn, profit, yield, Malus x domestica

P 48:

EFFECT OF DIFFERENT PLANTING DENSITY AND TRAINING SYSTEMS TO EARLY YIELD AT JONAGOLD ON M9 ROOTSTOCK

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This study was carried out to determine the most suitable training system and planting distance for high-density orchards during five consecutive years at Eğirdir Fruit Growing Research Station. In this experiment was used three training systems and five plant distances with Jonagold apple variety on M9. Training systems; Slender Spindle (SS), Vertical Axis (VA), Hybrid Tree Cone (HYTEC). Planting distances in rows; 40, 80, 120, 160 and 200 cm, between rows; 350 cm. In addition, it was tested as double system for Slender Spindle (SSD). The distance of double rows was 2 meters. This experiment performed as randomized block design with three replications and five tree per replications. As a result; up to a certain point, an increment in trunk cross-sectional area with enlargement of planting distance was determined then at this point has become stable. Fruit yield better correlated with tree density. We also determined that the most profitable tree density (2380 trees/ ha of VA with 32.373 Euro) was less than the most productive density (7140 tree/ ha of VA with 21.71 t/ha).

Keywords: Tree density, dwarf rootstock, productivity, Vertical axis, planting distance

P 49:

THE ANALYSIS OF GROWTH, YIELD AND QUALITY OF DIFFERENT TOMATO GRAFTING COMBINATIONS IN COCONUT CHAFF CULTIVATION

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Tomato grafting with excellent rootstocks is an efficient path for achieving high quality and yield. Since different rootstocks with distinct affinities to the specific scion, which affects the stress resistance, yield and quality. Hence, the rootstocks screening is extremely essential during the process of production. In the present work, Ruifen 882 was used as scion, eight rootstocks were Jiulv 787, Ganzhen 1、Guozhen 1, Guangxi, Chongqing, Yiselie, Y16-A07 and Guizhen 1. Using the coconut chaff cultivation in solar greenhouse, we determined the survival rate of grafting, growth indexes, yield and quality with different rootstocks grafting. The survival rates of grafting of Jiulv 787 and Guozhen 1 were significantly higher than other combinations, reaching to 97.88% and 97.93% respectively. Although the plant heigh, stem diameter and number of blades have no advantage

compared with the control (own-rooted seedlings and self-grafted seedlings), the yields of differnet grafting combinations were higher than the control during late-stage of havesting, suggesting that grafting combinations had resistance to premature aging. Among them, the yields of Jiulv 787 and Y16-A07 combination were the most outstanding. In the pairwise comparison, the lycopene contents of Guozhen 1, Yiselie, Y16-A07 and Guizhen 1 grafting combinations were even more, and the sugar-acid ratio of Jiulv 787, Ganzhen 1, Yiselie, Y16-A07 and Guizhen 1 combinations were higher. Noteworthily, eight grafting combinations markly elevated the yields and qualities compared with the control. By comprehensive comparison, Jiulv787, Y16-A07 and Yiselie combinations had excellent performances in the grafting affinity, development, yield and quality, and were appropriate for the coconut chaff cultivation in solar greenhouse.

Keywords: Tomato, Rootstock, Graft, Quality, Yield

P 50:

EFFECT OF REPEATED POLLINATION ON SEED FORMATION AND FRUIT QUALITY IN KOREAN GOLD KIWIFRUITS

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The kiwifruit is cultivated mostly under a plastic film house in Jeju, Korea and artificial pollination is an essential step for fruit set. The study was conducted to investigate the effect of repeated pollination with dry pollen on seed formation and fruit quality in ‘Halla Gold’ and ‘Sweet Gold’ kiwifruit vines (tetraploid Actinidia chinensis) bred in Korea. Single pollination (SP), double pollination repeated on the same day (DPS) or over one day (DPO), and triple pollination repeated twice in the same day and once over one day (TP) were treated with ‘Chieftain’ (hexaploid A. deliciosa) pollen. All cultural practices including fruit set and vine management were applied equally and conventionally. At harvest, fruits were collected and seed formation and fruit maturity were evaluated. In ‘Halla Gold’, the number and the weight of seeds in the fruits with SP and DPS were lower than those of DPO and TP, whereas there were no differences in fruit fresh weight. In ‘Sweet Gold’, the number and the weight of seeds in the fruits were the highest, whereas fruit fresh weight was the lowest in the treatment of TP. There were no differences among SP, DPS, and DPO in the number and weight of seed and fruit fresh weight. Despite the divergence of seed formation and fruit fresh weight, there were no differences in dry matter, soluble solids, acidity, firmness, and flesh color among the pollination treatments. The result indicated that repeated or successive pollination doesn’t inhibit seed formation and fruit quality greatly in Korean gold kiwifruits.

Keywords: dry matter, dry pollination, fruit weight, seed number, successive pollination

P 51:

WAX BIOSYNTHESIS IN SWEET CHERRY FRUIT IS PROMOTED BY THE COMBINED APPLICATION OF ABSCISIC ACID AND METHYL JASMONATE

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Wax biosynthesis in sweet cherry fruit is promoted by the combined application of abscisic acid and methyl jasmonate. Plant cuticle acts as a mechanical barrier against different biotic and abiotic agents mainly due its hydrophobic composition. Cuticle is composed of the insoluble polymer cutin and a mixture of chloroform-soluble lipids named as waxes. The integrity of the cuticle could be important for the reduction of the cracking phenomenon in sweet cherry fruit. On the other hand, hormonal regulation could be a key point for wax biosynthesis. With the aim to evaluate the effect of hormonal applications on wax cuticle biosynthesis, we performed exogenous applications of abscisic acid (ABA), methyl jasmonate (MeJA) and both combined (ABA+MeJA) at small green developmental stage (S1; 20 DAA) of sweet cherry fruit (cv. Bing), and evaluated the effects at ripe stage (S4; 77 DAA). In general, we observed a 2.4-, 2.1-, and 2.2-fold increase in fatty acids, alkanes and secondary alcohols concentrations in ABA+MeJA treatment, respectively. Alkanes contents were also increased by 1.3- and 2.1-fold by ABA and MeJA treatments, respectively. Sterols content was increased only by MeJA treatment (5.1-fold). ABA+MeJA-treated fruit exhibited a significant increment in C16, C18 and C20 fatty acid contents. MeJA and ABA+MeJA treatments raised between 1.8- and 2.3-fold the C27, C28, C29, C30 and C31 alkanes levels. Regarding triterpenols, ABA+MeJA treatment increased 2.3- and 3-fold the β-amyrin and uvaol contents, and MeJA-treated fruit exhibited a 3.2-fold increment in uvaol level with respect to control fruit. The results showed that the application of ABA plus MeJA had a synergistic effect on waxes accumulation and could be used for the management of cuticle biosynthesis in sweet cherry fruit.

Keywords: *Prunus avium*; cuticle; fatty acids; alkanes; triterpenols.

P 52:

EXOGENOUS ABSCISIC ACID (ABA) APPLICATIONS INCREASE ENDOGENOUS LEVELS OF ABA, JASMONIC ACID (JA) AND SALICYLIC ACID (SA) ALONG WITH SKIN COLOR CHANGES IN SWEET CHERRY FRUIT

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Chilean sweet cherry fruit production has high quality standards. Today exogenous hormonal applications can help to improve fruit quality. In order to enhance the fruit resistance to cracking, exogenous ABA, methyl jasmonate (MeJA) and both combined (ABA+MeJA) were applied to developing sweet cherry fruit (cv. Bing) grown in a commercial orchard of central Chile. We performed hormonal applications at small green fruit developmental stage [S1; 20 days after anthesis (DAA)], and analyzed the levels of ABA, JA, SA, 1-aminocyclopropane-1-carboxylic acid (ACC), indole-3-acetic acid (IAA), and gibberellins (GA4 and GA7) 5 days after the application (S1) and at the ripe stage (S4; 77 DAA). We also evaluated fruit quality parameters such as firmness, weight, solid soluble content (SSC), titratable acidity (TA) and cracking index (CI) at S4 stage. ABA applications significantly increased the levels of endogenous ABA, JA and SA at S1 stage, whereas MeJA and ABA+MeJA applications did not change the levels with respect to the control. The IAA, ACC, GA4 levels were not affected by any treatment, while all treatments inhibited the GA7 level at S1 stage. All hormones levels were not significantly different from the control at S4 stage with the exception of ABA+MeJA treatment on GA7. On the other hand, all hormonal treatments reduced the CI, MeJA-treated fruit had a lower SSC/TA ratio, whereas ABA-treated ones exhibited the highest a* and the lowest hue values. Thus, ABA application increased ABA, JA and SA levels along with fruit reddening. MeJA could have an inhibitory effect on ABA responses, since ABA+MeJA treatment significantly reduced ABA, JA and SA levels. The collective role of ABA, JA and SA on sweet cherry fruit development appears as an interesting topic that deserves further research.

Keywords: *Prunus avium*, phytohormones, fruit development and ripening, cracking.

P 53:

EFFECT OF VARIOUS ROOTSTOCKS ON MACROELEMENTS OF THREE GRAPEVINE (*Vitis vinifera* L.) VARIETIES IN THE NURSERY

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The research experiment was carried out to determine the effect of four rootstocks (41B, 140 Ru , SO4 and fercal) on macro elements contents (N, P, K, Ca and Mg) of three scions grape varieties (Halawani, Baladi and Bayadi). Studied rootstocks had no statistically effect on Nitrogen contents of petioles but the scions varieties had. Rootstocks increased the levels of P in petioles compared with control (own rooted) plants. Vines grafted onto the rootstock 140Ru and 41B had significantly higher petiols P than those on their own roots varieties. Scions had no effect statistically on P concentrations, but had an effect on K concentrations. Petioles K levels increased significantly on all varieties by using SO4 as a rootstock. There were significant differences of Ca and Mg contents of petioles among rootstocks and scions varieties too. Petioles of own rooted plant and SO4 rootstock had the highest Ca concentration ,whereas the lowest Ca levels was at 140Ru and 41B in the investigated three varieties. Petiole Mg contents were greater for vines on 140Ru than for vines on SO4 and Fercal , whereas own rooted plants had intermediate levels of Mg.

Keywords: Scions, 140Ru, 41B, SO4, Fercal. Halawani,.Baladi and Bayadi

P 54:

COMPARISON OF FRUIT NUTRITION TRAITS FOR PRUNUS PSEUDOCERASUS SPECIES

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To select the fine varieties and provide the basis for exploitation and ultilization of cherry resources in Taian, Shandong, evaluation of 30 types of prunus pseudocerasus was carried out by comparison of fruit main nutrition traits on the base of principal component analysis and cluster analysis, including single fruit weight, pH value, total sugar content, reducing sugar content, total acid content, vitamin C content and anthocyanin content. The results showed significant differences in nutrition traits among the fruit of different varieties. The coefficients of variation (CV) of single fruit weight, total sugar, reducing sugar, and vitamin C were larger than those of other indices, and the CV value of pH, total acid and anthocyanin were small. The principal component analysis was performed and showed that the main component (PC1) and the second main component (PC2) have a characteristic value greater than 1, and their accumulative variance contribution was 67.72%, and the first two main components reflect most of original variables. Based on the results of principal component analysis, the 30 cherry cultivars were divided into five types, among which there were obvious difference in the nutrition traits. Through principal component analysis and clustering analysis, the comprehensive evaluation shows that 'Red Honey,' '13-33', 'Qin-Lin' have the highest comprehensive qualities, and they can be utilized as the raw materials for the breeding, refining, developing and utilization of prunus pseudocerasus species.
Keywords: prunus pseudocerasus; fruit nutrition traits; principal component analysis; cluster analysis

P 55:

THE EFFECT OF DIFFERENT TRAINING SYSTEMS AND PLANTING DENSITIES ON SOME BIOCHEMICAL PROPERTIES IN "BLACK DIAMOND" PLUM CULTIVAR

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In this study was investigated of different training systems and planting distances to effects on total phenolic compounds (TPC), total flavonoid content (TFC) and total antioxidant capacity (TAC) in “Black Diamond” plum cultivar that as economically important for Turkey. The research was carried out in fruits that grafting to Myrobolan 29C rootstocks at eight years old trees in Isparta province of Eğirdir, in 2017. There are four different training systems which central leader, vase, slender spindle and V trellis. There are three planting distances that 100cm, 200cm, 300cm in central leader and vase systems (not support system) and four planting distances that 80cm, 120cm, 160cm and 200cm in slender spindle and V trellis systems (support system). When the effect of training systems was examined on the TPC, it was determined that the central leader and V trellis systems had higher values than the other systems and there was a statistical difference between them ($p<0,05$). When TFC was assessed, it was determined that the central leader system had a higher content than the thin spindle and V trellis systems ($p<0,05$). In terms of TAC, it was determined that thin spindle and central leader systems had a higher value from V trellis system, therefore they were different from them ($p<0,05$). When the effect of planting distances was examined on TPC, it was found that the amount of TPC increased as the planting distance increased in all systems ($p <0,05$). The TFC was increased in the center leader and vase systems as the planting distance increased, while the 160cm and 120cm distances in the V trellis system were found to be different from the others ($p<0,05$). In terms of TAC, there was a difference between planting distances in vase and V trellis systems, but no difference was found in other systems ($p<0,05$). The TAC was increased as the planting distance increased in the vase system ($p<0,05$). The maximum value was found to be 160cm in V trellis system that was found to be different with 120cm and 200cm planting distances ($p<0,05$). Central leader training system was ahead according to the other systems when the results of the first year was evaluated. The biochemical properties was generally increased at not support systems that planting distances as increased.

Keywords: *Prunus japonica*, training, phenolics, flavonoids