The book of abstracts : V Balkan Symposium on Fruit Growing, June 18-21, 2023, Zagreb, Croatia

THE BOOK OF ABSTRACTS

V Balkan Symposium on Fruit Growing
June 18-21, 2023
Zagreb, Croatia

BSFG 2023

University of Zagreb Faculty of Agriculture
Department of Pomology

V Balkan Symposium on Fruit Growing

The Book of Abstracts

June 18-21, 2023, Zagreb, Croatia

ORGANIZER

University of Zagreb Faculty of Agriculture
under the auspices of the International Society for Horticultural Science

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V BALKAN SYMPOSIUM ON FRUIT GROWING
JUNE 18-21, 2023, ZAGREB, CROATIA

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PROGRAMME

"V Balkan Symposium on Fruit Growing"

June 18-21, 2023
Zagreb, Croatia

www.5bsfg.com

Sunday, June 18, 2023

17:00 - 19:00 Registration of participants

18:00 - 19:00 Welcome reception at the hotel Dubrovnik

Monday, June 19, 2023

8:00 - 9:00 - Registration of participants

CONGRESS HALL – HOTEL DUBROVNIK

Opening ceremony

9:00 - 9:30 **Welcome speech of organizers and guests**

9:30 - 10:00 **PLENARY LECTURE**
G. Ondrasek
Salt stress in fruit growing

10:00 - 10:30 **PLENARY LECTURE**
S. Ercisli
Exploitation of wild edible fruit in the Balkan Peninsula:
A historical journey

10:30 - 10:40 Discussion

10:40 - 11:10 Coffee break

ORAL presentations

Session 1: Biodiversity, plant genetic resources and breeding

Chairpersons: Samir Debnath, Ivana Glisic

11:10 – 11:35 **Keynote lecture**
S. C. Debnath
Micropropagation strategies and epigenetic variation for production and genetic enhancement of small fruit crops

11:35 – 11:50 **A. Konjic, A. Okic, J. Grahic, F. Bogunic,**
A. Hajrudinovic-Bogunic, N. Pojskic, F. Gasi
Ploidy screening in apple germplasm using flow cytometry to improve GWAS accuracy

11:50 – 12:05 **S. Ercisli, G. Ilhan**
Basic chemical composition and distribution in a large number of sea buckthorn genotypes from Anatolia

12:05 – 12:20 **I. Oguz, H.I. Oguz, N. E. Kafkas, D.A. Sonmez**
Mulberry (*Morus* spp.) - production and potential in Adıyaman: a review

12:20 - 12:30 **Discussion**

12:30 - 12:40 **Presentation of the sponsors**

12:40 - 13:10 **POSTER OF THE SESSION 1&2 (BIODIVERSITY, PLANT GENETIC RESOURCES AND BREEDING & BIOTECHNOLOGY AND PHYSIOLOGY)**

13:10 - 14:20 **Lunch**

Session 2: Biotechnology and physiology

Chairpersons: Thomas Kon, Biserka Milić

14:20 – 14:45 **Keynote lecture**
T. Kon, C.D. Clavet
Minimization of stem-end splitting in 'Gala' apples with aminoethoxyvinylglycine and GA4+7

14:45 – 15:00 **S. Gandev, P. Ivanov, A. Dimitrov, P. Filyova**
Propagation of apple, pear, plum, and sweet cherry in a hot water system during the dormant period

15:00 – 15:15 **V. Beyá-Marshall, A. Verdugo, G. Reginato**
The efficacy of 1-aminocyclopropane-1-carboxylic acid (ACC) in thinning apples: Chilean experience

15:15 – 15:30 **R. Ilic, I. Glisic, T. Milosevic, G. Paunovic**
Characteristics of some apricot cultivars (*Prunus armeniaca* L.) in the first years after planting

15:30 – 15:45 **V. Beyá-Marshall, A. Verdugo, G. Reginato**
Thinning efficacy of 1-aminocyclopropane-1-carboxylic acid (ACC) on ‘French’ plums

15:45 - 15:55 **Discussion**

15:55 - 16:15 **Coffee break**

Session 3: Cultivation systems and pest control

Chairpersons: Sandra Münzel, Dragan Milatovic

16:15 - 16:40 **Keynote lecture**
S. Münzel, C. Feller
Healthy apples by increasing soil vitality - Monitoring results of extensive soil analyses on Central European farms

16:40 – 16:55 **F. Acheampong, A.N. Miller, M. Babadoost**
Occurrence of fruit rot disease in Illinois commercial apple orchards in USA

16:55 – 17:10 **M. Cvetkovic, J. S. Cvijanovic, B. Pasalic**
Are 2-D orchard canopy management systems in the production of European plum grown on a vigorous rootstock a step forward?

17:10 – 17:25 **T. Smrke, J. Jakopic, M. Hudina, R. Veberic**
Optimal growing conditions for highbush blueberries

17:25 – 17:35 **Discussion**

17:35 – 17:45 **Presentation of the sponsors**

17:45 – 18:15 **POSTER SESSIONS 3 (CULTIVATION SYSTEMS AND PEST CONTROL)**

Tuesday, June 20, 2023

Session 4: Postharvest, fruit quality and food science

Chairpersons: George Manganaris, Claudia Sánchez

08:30 - 08:55 **Keynote lecture**
Manganaris G., S. Gedeon, E. Georgiadou, C.J.G. Hernandez Gil, N. Valanides, A.M.Taliadorou, M. Balsells, G. Gohari, A. Assiotis, F.T. Barberan, V. Fotopoulo
The effectiveness of priming agents on the qualitative and phytochemical properties of strawberry fruits

08:55 - 09:10 **M. Butac, E. Mareși, A. Stan**
Plum cultivars grown in Romania – a comparison between traditional cultivars widely grown and promising new ones

09:10 - 09:25 **M. Vukovic, B. Levaj, R. Vidrih, K.L. Batelja, S. Juric, M. Vincekovic, T. Jemric**
Vegetative, generative characteristics and bioactive properties of peach 'Suncrest' under red and white photoselective anti-insect netting

09:25 - 09:40 **A. Koricanac, D. Milatovic, B. Popovic, O. Mitrovic, I.S. Glisic, N. Milosevic**
Changes in fruit quality during ripening of two European plum cultivars

09:40 - 09:50 **Discussion**

09:50 - 10:20 **POSTER SESSION 4 (POSTHARVEST, FRUIT QUALITY AND FOOD SCIENCE)**

10:20 - 10:50 **Coffee break**

Session 5: Sustainability, economics and management

Chairpersons: Hamid Ashrafi, Edite Kaufmane

10:50 - 11:15 **Keynote lecture**
H. Ashrafi, L. Redpath, M. L. Gumpertz, J. R. Ballington, N. Bassil
Genotype, environment, year, and harvest effects on fruit quality traits of blueberries (*Vaccinium corymbosum* L.)

11:15 - 11:30 **D. Nikolic, V. Rakonjac, D. Milatovic, A. Vukovic Vimic, M. Vujadinovic Mandic**
Response of plum cultivar 'Stanley' to climatic conditions at different locations and in different years

11:30 - 11:45 **E. Chitua, M. Coman, M. Calinescu, I. Mazilu**
The impact of climate changes in the last 50 years on the main fruit tree species in Southern Romania

11:45 - 12:00 **I. Pohajda, Z. Gudelj - Velaga**
Implementation of environmental and climate measures of the Croatian Rural Development Programme in the fruit growing sector

12:00 - 12:15 **I. V. Petric, R. Leder, D. Cenbauer, I. Prsa, B. Duralija**
Current situation of fruit wine production in Croatia

12:15 - 12:25 **Discussion**

12:25 - 12:35 **Presentation of the sponsors**

12:35 - 13:05 **POSTER SESSION 5 (SUSTAINABILITY, ECONOMICS AND MANAGEMENT)**

13:05 - 14:15 **Lunch**

ONLINE PRESENTATION

Chairperson: Mohammad Babadoost

14:15 - 14:30	**Keynote lecture** **K. Mikac, I. Pajac Zivkovic, M. Kadoic Balasko, D. Lemic, H. Benitez, J. D. Davila** Improved understanding of *Cydia pomonella* biology in Croatian apple production systems
14:30 - 14:40	**P. Engel, D. Lolletti, F. R. De Salvador, R. Muleo** Effect of crop load and different thinning methods on two kiwifruit cultivars
14:40 - 14:50	**N. E. Kafkas, S. Kafkas** Strawberry breeding strategies in Turkey
14:50 - 15:00	**F. Nádosy, E. Peti, N. Zsemlye Farkasné, D. Örsi Ujfalussyné, Z. Békefi Kovácsné, É. Preininger, R. Rácz Szabó** Evaluation of some potential combinations of almond rootstocks and cultivars
15:00 - 15:10	**A. M. Khan, S. Usanmaz, I. Kahramanoğlu** Improving the storage quality of dragon fruit by combining environmentally friendly coatings and modified atmosphere packaging
15:10 - 15:20	**Discussion**
15:20 - 15:50	**Coffee break**
15:50 - 17:00	**Conclusions, presentation and election of the next BSFG host, closing ceremony**
20:00 -	**GALA DINNER**

Wednesday, June 21, 2023

Technical tour

Time	**Program**
08:00 a.m.	Departure from Zagreb
09:00 a.m. - 10:15 a.m.	Sasinovec / Hazelnut plantation, fruit processing lines and storage chambers (Pantera promet d.o.o. - Ljesnjaci ZG)
10:30 a.m. - 12:15 p.m.	Donja Zelina / Experimental orchards Centre for Pomology (HAPIH)
13:15 p.m. - 14:30 p.m.	Velika Ludina / Blueberry plantation (EKO-BERI d.o.o.)
15:45 p.m. - 17:00 p.m.	Petrovina Turopoljska / Soilless strawberry plantation (JAGODAR-HB d.o.o.)
18:00 p.m.	Return to Zagreb

POSTER presentations

Monday, June 19, 2023

Session 1: Biodiversity, plant genetic resources and breeding

01. **S. Ercisli, G. Ilhan**
    Some important fruit characteristics of the wild grown carob (*Ceratonia siliqua* L.) in Western Anatolia

02. **M. Nesheva, V. Akova, I. Staneva, P. Minkov, L. Todorova**
    Diversity of wild apple genetic resources in the region of Troyan, central Bulgaria

03. **F. Iancu, V. Isac, M. Sturzeanu, M. Coman**
    Evaluation of genetic diversity in strawberry (*Fragaria* x *ananassa* Duch.) using SSR markers

04. **S. Radicevic, S. Maric, R. Cerovic, M. Djordjevic, N. Milosevic, I. Glisic, M. Lukic**
    Breeding work and floral biology research in cherries at Fruit Research Institute, Cacak - achieved results and new perspectives

05. **S. Maric, I. Glisic, N. Milosevic, T. Vujovic, S. Radicevic M. Djordjevic**
    S-RNase genotyping of autochthonous apple cultivars grown in the region of central and southwestern Serbia

06. **I. Glisic, N. Milosevic, J. Tomic, M. Milinkovic, M. Djordjevic, S. Maric, S. Radicevic, B. Popovic**
    In situ characterization of plum landraces originated from the region of western Serbia

07. **M. Meland, M. Fotiric Aksic, O. Frøynes, L. Lasic, N. Pojskic, F. Gasi**
    Applicability of microsatellite markers in estimating fertilization success in Norwegian apple orchards

08. **S. Marcelic, F. Klanac, M. Matek Saric, M. Baricevic, A. Gasparovic Pinto, I. Paskovic, M. Polic Paskovic, M. Zorica, S. Kolega, Z. Sikic, T. Kos**
    Morphological and pomological characterization of wild olives on the island of Ugljan

09. **M. Nesheva, V. Akova, I. Staneva, N. Neshev, L. Todorova**
    Fruit quality of local Bulgarian pear (*Pyrus communis* L.) genetic resources

10. **S. Kafkas, E. Kafkas**
    Cultivar breeding in cultivated pistachio

Session 2: Biotechnology and physiology

01. **F. Niederholzer, L. Milliron, D. Wolter, M. Bozzo**
    Bloom thinning 'Improved French' prune with caustic sprays

02. **I. Perju, I. Mineață, I. E. Golache, I. V. Ungureanu, S. Sîrbu**
    Phenology and fruit production of sweet cherry in the context of climatic conditions in North-Eastern Romania

03. **M. F. Calinescu, I. C. Mazilua, E. Chitua, F. Plaiasu, M. Chivu**
    Evaluation of some cherry cultivars grafted on Gisela 5 rootstock grown in the hilly area of the South of Romania

04. **M. Djordjevic, I. S. Glisic, N. T. Milosevic, S. Radicevic, S. Maric, I. P. Glisic, R. Cerovic**
    Influence of temperature at the time of pollination on the effective pollination period and fruit set in plum

05. **A. I. Yordanov, S. G. Tabakov, T. D. Donkov**
    Influence of the rootstocks *Prunus mahaleb* seedling, 'MaxMa 14' and 'GiSelA 6' on the course of some phenophases and dormancy in sweet cherry cultivars

06. **S. Spasojevic, C. Oparnica, J. Milivojevic, D. Radivojevic**
    Chemical thinning of apple fruit: a review

07. **M. Kiprijanovski, S. Georgievski, N. Saraginovski, T. Arsov**
    Improving of the fruit set and productivity of the pear trees after spring frost

08. **D. Radivojevic, J. Milivojevic, C. Oparnica, S. Spasojevic, I. Djekic**
    Effect of preharvest gibberellic acids application on productivity, fruit characteristics and flower bud formation of sweet cherry 'Regina'

09. **E. Mendelné Pászti, L. Szalay, K. Hrotkó, Á. Mendel**
    Apricot cultivars and rootstocks with different fruiting surface development: preliminary results

10. **B. Milic, J. Gosic, G. Barac, M. Milovic, N. Magazin, J. Kalajdzic, Z. Keserovic**
    Growth control of 'Oblačinska' sour cherry (*Prunus cerasus* L.) grafted on 'Mahaleb' (*Prunus mahaleb* L.) rootstock by using bioregulators

11. **V. Beyá-Marshall, T. Fichet**
    Effect of synthetic auxin sprays on yield and double seed incidence of almond trees, and orchard profit under different conditions of fruit set and PAR interception

12. **M. Michailidis, C. Polychroniadou, I-D. S. Adamakis, I. Ganopoulos, G. Tanou, C. Bazakos, E. Karagiannis, A. Molassiotis**
    Calcium signature in kiwifruit ripening through multi-omics integration

13. **I. Perju, I. E. Golache, I. Mineață, I. V. Ungureanu, S. Sîrbu**
    The growth and fruiting characteristics of some sweet cherry cultivars under the pedoclimatic conditions of the North-Eastern part of Romania

14. **D. Georgiev, M. Georgieva, D. Hristova, N. Marinova**
    Fruit bearing of the primocane raspberry cultivar 'Autumn bliss' in the Troyan region

Session 3: Cultivation systems and pest control

01. **I. Al-Suwaid, C.A. Mihai, A.C. Butcaru, F. Stanica**
    The intensity of bacterial disease infestation in some apricot cultivars monitored with the WinFOLIA system

02. **G. Trempetic, T. Kiss, T. Necas**
    Analysis of the '*Candidatus Phytoplasma prunorum'* titer in the tissues of apricot (*Prunus armeniaca* L.) trees throughout the year

03. **G. Popski, T. Mihova, P. Minkov, B. Stefanova, S. Todorova**
    Morphological and biochemical characteristics of the fruit of apple cultivars introduced into RIMSA Troyan

04. **S. G. Tabakov, A. I. Yordanov, T. D. Donkov**
    Use of peach-almond hybrid rootstocks and two interstocks for the apricot cultivar 'Hargrand'

05. **J. Dragisic Maksimovic, N. Ramovic, D. Radivojevic, J. Milivojevic**
    Differentially colored photoselective nets: a sophisticated technological concept to improve fruit quality parameters in soilless grown blueberries

06. **N. Saraginovski, M. Kiprijanovski, T. Arsov, S. Georgievski**
    Results of the evaluation of certain sweet cherry cultivars on the semi-vigorous 'MaxMa 14'

07. **J. Vukotic, J. Kalajdzic, V. Stojsin, B. Milic, M. Grahovac, M. Petres, D. Budakov**
    Impact of bull's eye rot on apple fruit properties under different storage conditions

08. **N. Milosevic, I. Glisic, M. Djordjevic, S. Radicevic, S. Maric, T. Milosevic**
Tree growth, productivity and fruit properties of early ripening European plum (*Prunus domestica* L.) cultivars

09. **Z. Rankova, T. Moskova, N. Neshev, M. Yanev, G. Dimitrov**
Effect of different approaches to soil surface maintenance on weed infestation and growth performance of young peach orchard

10. **P. Ivanov**
Mating disruption and population development of *Grapholita molesta* (Busck, 1916) (Lepidoptera: *Tortricidae*) in apricot orchards

11. **D. Milatovic, D. Boskov, G. Zec, M. Stojanoski, N. Tesic**
Evaluation of late season sweet cherry cultivars in the region of Belgrade

12. **K. Klamkowski, W. Treder, A. Tryngiel-Gac, K. Wójcik, A. Masny**
Suitability of a new telemetric capacitance-based measurement system for irrigation management of strawberry plants

13. **A. Obradovic, T. Popovic, J. Adamovic, A. Prokic, M. Ivanovic**
Identification of *Xanthomonas arboricola* pv. *corylina* strains isolated from hazelnut (*Corylus avellana*) in Montenegro

14. **N. Magazin, G. Barac, M. Milovic, J. Kalajdzic, B. Milic, Z. Keserovic**
The effects of crop load reduction on apple (*Malus domestica* Borkh.) yield and fruit quality

15. **I. Pajac Zivkovic, D. Cirjak, I. Miklecic, M. Pintar, B. Duralija, D. Lemic**
First evidence of the brown marmorated stink bug and its population size in perennial crops in Croatia

16. **M. Pesakovic, J. Tomic, Z. Karaklajic Stajic, B. Rilak, V. Durović, L. Mandic, S. Milenkovic**
Effectiveness of organic and synthetic products on the occurrence of gray mould and strawberry fruit quality

17. **A. Bokulic Petric, I. Juran, T. Milicevic, A. Mesic**
Spirotetramat - application in fruit growing, efficacy, resistance and toxicity

18. **T. Milicevic, B. Duralija, A. Mesic, A. Vokurka**
Fungal foliar diseases of strawberry in Croatia – etiology, epidemiology and chorology

19. **D. Lolletti, P. Engel, A. Polito, R. Manganiello, F. R. De Salvador**
Evaluation of susceptibility of peach and nectarine accessions in the National Fruit Germplasm Collection at CREA-OFA in Rome (Italy) to peach leaf curl

Tuesday, June 20, 2023

Session 4: Postharvest, fruit quality and food science

01. **J. Fiala, T. Necas**
    Characteristics of European and Asian pear cultivars and pear hybrids compared to production potential under South Moravian conditions

02. **J. Sic Zlabur, S. Voca, K. Licitar Osmicevic, M. Dujmovic, M. Skendrovic Babojelic**
    Nutritional properties and quality of paw-paw fruit from Croatia

03. **M. Michailidis, C. Skodra, E. Karagiannis, M. Samiotaki, I. Ganopoulos, G. Tanou, C. Bazakos, A. Dalakouras, A. Molassiotis**
    Moving beyond the molecular mechanism of superficial scald in apple fruit

04. **E. Zezulová, T. Necas, M. Mrázová, T. Kiss**
    Apricot kernels as a new source of protein and antioxidants

05. **O. Mitrovic, A. Koricanac, B. Popovic, S. Radicevic, I. S. Glisic, A. Leposavic, S. Maric**
    Quality of dried sour cherries from different Serbian cultivars

06. **J. Milivojevic, D. Radivojevic, D. Milosavljevic, V. Maksimovic, S. Spasojevic, J. Dragisic Maksimovic**
    The later, the better? Differences in field performance and fruit quality traits in newly introduced Italian short-day strawberry cultivars

07. **K. Mesa, L. Contador, C. Pereira, A. Albornoz, S. González**
    Effect of extended cold storage in 'Sugar plum' on organoleptic characteristics and development of internal browning

08. **M. Fotiric Aksic, B. Rabrenovic, U. Gasic, D. Dabic Zagorac, M. Natic, M. Meland**
    Bioactive compounds in seeds of raspberry (*Rubus idaeus* L.) cultivars grown under Norwegian conditions

09. **Z. Rankova, I. Staneva, V. Akova**
    Influence of different approaches to soil surface maintenance on the content of leaf pigments and essential nutrients in apricots

10. **A. Zhivondov, S. Savchovska, S. Malchev**
    Results of biometric analyses of fruits of selected sweet cherry hybrids

11. **M. Fotiric Aksic, U. Gasic, T. Tosti, J. Milivojevic, Z. Tesic, M. Meland**
    'Amira' versus 'Regina': Variation in biometrical traits and chemical composition across the harvests of organically grown primocane fruiting raspberry cultivars

12. **A. Zhivondov, S. Savchovska**
    Yield and fruit quality of new Bulgarian peach cultivars

13. **M. Milovic, N. Magazin, B. Milic, R. Kovac, J. Kalajdzic, G. Barac, A. Bajic**
    Effect of foliar application of Ca, MAP packaging and 1-MCP treatment on apricot fruit quality after 15 days of storage

14. **A. Bisko, A. Cepelak, S. Slunjski, K. Konopka, B. Lazarevic**
    Chemical composition of black chokeberry (*Aronia melanocarpa*) leaf, fruit, juice and juice sediment

15. **S. Marcelic, S. Kolega, G. Fruk, M. Petric, M. Zorica, T. Kos**
    Fruit cracking and fruit firmness of 15 sweet cherry cultivars: a two-year study in Zadar county

16. **J. Tomic, M. Pesakovic, B. Rilak, I. Glisic, N. Milosevic, F. Stampar, M. Mikulic-Petkovsek, J. Jakopic**
    Rootstock and harvest season affect the chemical composition of plum

17. **M. Skendrovic Babojelic, J. Sic Zlabur, A. Loncaric, T. Kovac, L. Jakobek, Bojan Sarkanj, Danijel Cicek, M. Sarko**
    Evaluation of pomological and physico-chemical properties of traditional apple cultivars from Pozega-Slavonia county

18. **C. Sánchez, D. Garcia, A. Eira**
    Effect of pre-harvest factors on the shelf-life of 'Gala' apples after 5 months of storage

19. **A. Bebek Markovinovic, D. Brdar, I. Brcic Karaconji, K. Jurica, D. Lasic, P. Putnik, T. Bosiljkov, B. Duralija, D. Bursac Kovacevic**
    Development of functional strawberry tree fruit-based product by 3D food printing technology

20. **L. Maslov Bandic, K. Vlahovicek-Kahlina, S. Juric, B. Duralija**
    Green extraction of flavonoids from mandarin peel

21. **A. M. Antolkovic, M. Mijic, K. Krbavcic, M. Skendrovic Babojelic**
    Physico-chemical and anatomical properties of the fruits of different mandarin cultivars

Session 5: Sustainability, economics and management

01. **F. Stanica, D. I. Dumitrascu, C. A. Mihai, A. C. Butcaru**
    A digital system to evaluate the canopy parameters in some cherry, apricot and nectarine cultivars

02. **A. M. Antolkovic, L. Maslov Bandic, S. Juric, G. Fruk**
    Digital image analysis for assessing quality parameters of mandarin (*Citrus reticulata* B.) fruit

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PLENARY LECTURES

SALT STRESS IN FRUIT GROWING

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Abstract

Salt stress is one of the most widespread abiotic disorders in agroecosystems, caused by elevated concentrations of dissolved salts in water resources used for irrigation and fertilization. However, due to i) global climate change (e.g. extreme drought events, reduced freshwater input to rivers, increased seawater intrusion) and ii) an increasing tendency to reuse grey hydro-resources (saline/brackish waters, wastewaters) in irrigated agri-food production, salt stress and its associated negative environmental implications are expected to become even more critical, especially in fruit growing. Some of the most widely consumed fruits, such as citruses, strawberries, and avocados, belong to the most salt-sensitive crops with the lowest salinity threshold (~1 dS/m). Prolonged accumulation of salts (Na^+, Cl^-) in the soil leads to a variety of primary (osmotic stress) and secondary (ion imbalances/toxicity, formation of reactive oxygen species) physiological imbalances, which negatively affect fruit growth and productivity. The impact of salt stress on fruit crops depends on many factors, notably; fruit crop species/variety, stage of growth and development, salinity duration/level, rootstock type, and soil and water management strategy. To mitigate salt stress in fruit growing, there is a wide range of sustainable measures and approaches, including the application of modern irrigation/drainage systems, management of seawater intrusion and groundwater level, selection of salt-tolerant species/genotypes, application of microbial inoculation and mycorrhiza, grafting with salt-tolerant rootstocks, soil and water conditioning (application of organic and mineral soil amendments, desalination). Further research on salt stress in fruit growing is essential to develop effective and sustainable solutions that can help growers to maintain productivity in the face of climate change and environmental degradation.

Keywords: salinity, salt sensitive crops, climate change, soil management, water management

EXPLOITATION OF WILD EDIBLE FRUIT IN THE BALKAN PENINSULA: A HISTORICAL JOURNEY

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Abstract

The Balkans has hosted many different cultures throughout history and agriculture and especially horticulture plants including fruits, vegetables, flowers, and aromatic and medicinal plants have been the most important part of the life of the Balkan people. Horticultural cultivation has also become an important cultural heritage in the Balkan countries, which has been transferred from generation to generation. Balkan countries show a great richness of wild edible fruits. In the Balkan region, wild edible fruits are used by people for raw material, and food, either as edible products or for culinary ingredients, medicinal use, or ornamental and aesthetic purposes. Wild edible fruits are a genetically very diverse group and play a major role in rural society end the economy of the Balkans. Wild edible fruits are an important component of traditional food but are also central to the healthy diets of the modern urban population. Wild edible fruits in the Balkan peninsula present numerous species, cultivars, genotypes, and accessions. More recently there has been an increasing interest in wild edible fruits grown in the Balkan peninsula. Because the food industry is currently searching for new functional foods and nutraceuticals to help meet the demand presented by the consumers of natural, immunity-boosting, and health-promoting plant-based food products. Even though superficial works have been carried out in the past two decades on the nutritional aspect of wild edible fruits available in the region, a large number of species being endemic in nature still remained unexplored and are in wild forms, which are yet to be properly identified and fully exploited. Detailed information about the health-promoting components of wild edible fruits in the Balkan peninsula could lead to a better understanding of the beneficial effects including their utilization in functional foods and as ingredients in nutraceuticals and pharmaceuticals.

Keywords: underutilized fruits, biodiversity, bioactive substances, functional foods, sustainability

SESSION 1

BIODIVERSITY, PLANT GENETIC RESOURCES AND BREEDING

ORAL PRESENTATIONS

MICROPROPAGATION STRATEGIES AND EPIGENETIC VARIATION FOR PRODUCTION AND GENETIC ENHANCEMENT OF SMALL FRUIT CROPS

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Abstract

Small fruit crops are a nutrient powerhouse for antioxidant properties. They have long been enjoyed as health-promoting delicious food. Although significant progress has been achieved in the propagation of small fruit crops using tissue culture techniques, genetic stability can be a problem for commercial micropropagation. Clonal fidelity can be monitored at morphological, biochemical, and molecular levels. Micropropgated plants in small fruit crops show increased vegetative growth, rhizome production, and fruit yield containing a higher antioxidant activity that might be due to epigenetic variation. The understanding on epigenetics at molecular level will help to overcome the drawbacks of in vitro culture and maintain the clonal fidelity in micropropagules. The talk will provide an in-depth study of various aspects of phenotypic variation in micropropagated small fruit crops and the epigenetic effects on these variations along with the role of DNA methylation, to fill the existing gap in the literature.

Keywords: In vitro culture, somaclonal variation, shoot regeneration, somatic embryogenesis, DNA - methylation, antioxidants

PLOIDY SCREENING IN APPLE GERMPLASM USING FLOW CYTOMETRY TO IMPROVE GWAS ACCURACY

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Abstract

In 2020, the apple core collection of Bosnia and Herzegovina (B&H) was genotyped using Axiom® Apple 480 K SNP array in order to conduct genome-wide association studies (GWAS). The core collection was previously constructed by merging simple sequence repeats (SSR) profiles from traditional apple accessions conserved ex-situ in B&H into a single database. The database was then used to identify a subset of 52 genotypes that best represent the overall genetic diversity of the analyzed apple accessions. A significant characteristic of B&H's traditional apple germplasm is the high occurrence of triploids, which negatively affect the quality of the SNP genotypic data analyses and can lead to false marker-locus-trait associations. Identification and consequent exclusion of triploid genotypes from apple genome-wide association studies have so far significantly relied on previously published SSR. Namely, accessions displaying more than two different alleles on SSR loci are designated as putative triploids. A more accurate method for determining ploidy levels entails the use of flow cytometry. In this study, we compare the use of both approaches (SSRs and flow cytometry) for ploidy screening of accessions within B&H's apple core collection and discuss the implications of undetected triploids on SNP quality parameters such as call and heterozygosity rate.

Keywords: SNP array, SSR markers, *Malus domestica*, ploidy, heterozygosity rate

BASIC CHEMICAL COMPOSITION AND DISTRIBUTION IN A LARGE NUMBER OF SEA BUCKTHORN GENOTYPES FROM ANATOLIA

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Abstract

Hippophae rhamnoides L., also known as sea buckthorn, is a member of the family Elaeagnaceae. It is a fascinating plant that grows widely in various regions of Asia, Europe, and North America, from longitude 2° to 123° E, latitude 27° to 69° N, and from 0 to 3300 m above sea level. Sea buckthorn has proven highly adaptable to extreme conditions, including temperature ranges of –43 to 40 °C, drought, high altitude, salinity, alkalinity, and inundation. The broad geographical distribution and diverse growing conditions may contribute to the extensive diversity of sea buckthorn. Sea buckthorn (*Hippophae rhamnoides*) is accepted as an important horticultural plant and recent scientific studies on this plant have been increased. The leaves, flowers, seeds, and fruits are used as medicine for centuries in particular among local communities. The plant is accepted as a superfood and especially its fruits contain a high level of vitamins A, B_1, B_2, B_6, and C, as well as other active bioactive ingredients that are very important for human health. It's been used traditionally to slow down the aging process. In various sea buckthorn-growing countries, people use sea buckthorn for burns, eczema, acne, indigestion, high blood pressure, wrinkled skin, and many other purposes. In the present study, a large number of sea buckthorn genotypes obtained from seeds and showing a high level of heterozygosity were used for soluble solids content, pH, and total acidity analysis. Genotypes differed from each other in terms of the biochemical characteristics examined. In the fruits of the 96 genotypes examined, soluble solid content, pH and total acidity were 7.6-18.4%; 2.2-2.9 and 2.22-4.62%, respectively. Results indicated that there was enough diversity among the above traits and could be important for both breeding and sea buckthorn-related industries.

Keywords: Hippophae rhamnoides, forgotten fruits, superfood, diversity, bioactive content

MULBERRY (*Morus* spp.) - PRODUCTION AND POTENTIAL IN ADIYAMAN: A REVIEW

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Abstract

Mulberry belongs to the *Morus* genus of the Moraceae family. There are known 24 species and 100 varieties belonging to this family. It is commonly grown to feed silkworms in many regions including Asia, Africa, America, Europe, and India. Mulberry cultivation in Turkey dates comes to ancient times. In Turkey, 69.475 tons of product are obtained from 2.030.741 fruit-bearing mulberry trees. In Adiyaman, one of the Southeastern provinces, 5.745 tons of mulberry are produced from 73.511 mulberry trees. Mulberry cultivation has become very popular in the Adiyaman region in Turkey recently. Mulberry fruit has a significant market potential as processed products rather than fresh consumption, especially in the Tut district of Adiyaman province. In general, many products such as molasses, jam, fruit pulp, mulberry paste, dried mulberry, fruit ice cream, vinegar, fruit juice concentrate, and spirit are obtained from the mulberry fruit. The mulberry fruits that are used and widely grown in Turkey are *Morus alba* L. (white mulberry), *Morus nigra* L. (black mulberry), and *Morus rubra* L. (red or purple mulberry), but there are many more. When the contents of mulberry fruits were evaluated in general, it was determined that they were very high in terms of bioactive components and therapeutic potential. In addition, mulberry fruits have important pharmacological properties such as anti-inflammatory, anti-cholesterol, anti-diabetic, antioxidant, and anti-obesity effects for human health. Studies on isolating phytochemical compounds from mulberry fruits and determining their composition in detail have increased in recent years. Compared to mulberry leaves and bark, the use of mulberry fruits in traditional medicine is less common. As a result, the aim of this study was to reveal and summarized the general production potential and economic evaluation of mulberry cultivation in the Adiyaman region in Turkey.

Keywords: cultivation, production, propagation, *Morus* species, health benefits

SESSION 1

BIODIVERSITY, PLANT GENETIC RESOURCES AND BREEDING

POSTER PRESENTATIONS

V Balkan Symposium on Fruit Growing
June 18-21, 2023, Zagreb, Croatia,

SOME IMPORTANT FRUIT CHARACTERISTICS OF THE WILD GROWN CAROB (*Ceratonia siliqua* L.) IN WESTERN ANATOLIA

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Abstract

The use of the fruit of *Ceratonia siliqua* L. in the food industry has a long tradition in Turkey. Although these fruits currently belong to marginal species, there is an increasing interest in cultivating this crop. The main goal of the present study was to determine the pomological properties of 10 genotypes of wild-grown carob (*Ceratonia siliqua* L.) fruit grown in western Anatolia and to find out whether it is possible to differentiate these ecotypes from one another by means of the analysis of variance of the obtained data. In the study the parameters were pod and seed weight, pod dimensions, seed ratio, pod, and seed colour and shape were investigated as morphological traits. As biochemical traits Soluble solid content (SSC), titratable acidity, vitamin C, and protein and dietary fiber contents were determined. Results showed significant differences in pod weight and dimensions and seed weight. The genotypes are in general open tree growth habits. The pod weight of ten genotypes varied from 14.9 g (AEG^{-7}) to 26.6 g (AEG^{-3}). The average pod dimensions (width, length, and thickness) were between 16.11 and 24.41 mm, 14.12 and 20.40 cm, and 5.67 and 9.14 mm, respectively. The SSC ranged from 53.10 to 66.23% in the pods of wild carob genotypes. The results of this study demonstrate the significant effect of genotypes on the morphological and biochemical characteristics of carob fruits. More specifically, this research shows the important role of variability in the pod weight, dimensions, and seed weight. In addition, biochemical content in carob fruit showed health-promoted compounds which may contribute to enhance of this wild carob fruit consumption.

Keywords: pomological properties, underutilized fruits, biodiversity, carob fruits, sustainability

DIVERSITY OF WILD APPLE GENETIC RESOURCES IN THE TROYAN REGION, CENTRAL BULGARIA

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Abstract

In Bulgaria, the apple (*Malus domestica* L.) has a long history of cultivation, and a big diversity of genetic recourses is found in the country. Wild relatives of this fruit species could be found in forests or other habitats. The local genetic resources are valuable for their excellent adaptation to the climatic and soil conditions of their natural habitat. In addition, they often have a number of valuable characteristics, such as resistance to diseases and pests that should be preserved and used as donors in the breeding programs. The current study aimed to describe the diversity of the population of wild seedlings found in expedition studies in the Troyan, Central Bulgaria region and to assess their value for future breeding purposes. To complete this objective fruit size, fruit flesh firmness, total soluble solids content (°Brix), skin, and fruit flesh colour were measured. All studied characteristics were highly variable in the population. Fruit flesh colouration varied from white to pinkish. Very high sugar content had PM 11 (18.08%), PM 12 (18.32%), PM 25 (17.44%). All analyzed samples had a higher content of invert sugars and lower sucrose content. Of all the studied forms, PM 17 and PM 104 had very low acids content.

Keywords: fruit breeding, fruit quality, local genetic resources, *Malus domestica* L., seedlings

EVALUATION OF GENETIC DIVERSITY IN STRAWBERRY (*Fragaria* X *ananassa* DUCH.) USING SSR MARKERS

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Abstract

In Romania, the strawberry is an important horticultural crop. Therefore, knowing the genetic diversity for the purpose of developing new cultivars and introducing them into culture becomes important for this species. Molecular biology, which has advanced rapidly in recent times, has become an ally in the work of enriching the genetic base of culture. The aim of the study was to highlight the genetic diversity of 40 cultivars belonging to the species *Fragaria* x *ananassa* Duch., which were analyzed with the help of 10 SSR markers. Using statistical calculations, it was possible to evaluate the degree of genetic polymorphism, but also the similarities and differences between the cultivars. The results of the molecular screening showed the presence of di-, tri-, and tetranucleotides in most of the cultivars included in the study. All 10 molecular markers were polymorphic, most of them producing more than two bands for each cultivar. These results could lay the groundwork for further strawberry breeding and conservation.

Keywords: horticultural, cultivar, screening, molecular biology, polymorphism

BREEDING WORK AND FLORAL BIOLOGY RESEARCH IN CHERRIES AT FRUIT RESEARCH INSTITUTE, CACAK - ACHIEVED RESULTS AND NEW PERSPECTIVES

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Abstract

Decades-long cherry breeding work at Fruit Research Institute, Čačak (FRI), implies the use as a main method planned hybridization within *P. avium* and *P. cerasus*. Combined with the selection from the natural populations, the method resulted in realization of two sweet cherry ('Asenova Rana' and 'Čarna') and five sour cherry cultivars ('Čačanski Rubin', 'Šumadinka', 'Sofija', 'Nevena' and 'Iskra'), three hybrids in the procedure of recognition, and numerous being intensively studied. Current sour cherry breeding work is based on the use of domestic genotypes, well adapted to the environmental conditions of the area (either obtained by planned hybridization or indigenous), and foreign genotypes – tolerant to diseases, with high cropping potential and good fruit quality. Different aspects of reproductive biology in cherries – flowering phenology, pollen tube growth in vitro and in vivo (pollen tube growth dynamics, pollen-pistil interactions in the style and ovary), cytoembryology (ovule development stage, viability of ovule and embryo sac, early embryogenesis), are among the main research activities at FRI. Within the past decade, the research on gametofitic self-incompatibility (GSI) in cherries has been advanced by identification of S-haplotypes in cultivars, landraces and hybrids using consensus, specific and dCAPS primers to reveal S-RNase and SFB functional/non-functional variants. Besides the GSI, other possible types of pollen-pistil interactions have also been considered, primarily in the context of temperature conditions during the flowering. Nowadays, within the CherrySeRB project whose FRI is the leading institution, characterization of the indigenous genotype potential for desirable reproductive properties and defining 'good reproductive behaviour cherry model' that can face warmer temperature conditions during the flowering are in focus. The main CherrySeRB idea is connection of production challenges arising from climate change and the richness of Serbian and Balkan cherry germplasm that is still unused enough, which represents a novelty in breeding approach, applicable to other fruit species.

Keywords: P. avium, *P. cerasus*, breeding, S-genotyping, reproductive biology

S-RNASE GENOTYPING OF AUTOCHTHONOUS APPLE CULTIVARS GROWN IN THE REGION OF CENTRAL AND SOUTHWESTERN SERBIA

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Abstract

Apple (*Malus* × *domestica* Borkh.) is one of the most important and widely cultivated deciduous fruit crops around the world, with an annual production of more than 93 million tonnes in 2021. This pome species, with an average production of 468.258 tonnes (2017-2021) and together with plum, is crucial in the total fruit production of the Republic of Serbia. Although there are at least ten thousand reported apple cultivars in the world, as well as that new ones are realized every year within breeding programs, the number of cultivars is likely underestimated since many local landraces have not been documented. Identification of S-genotypes in autochthonous cultivars is an important step in their molecular characterization and also of enormous significance for breeders and growers, since apple exhibits a gametophytic self-incompatibility, controlled by the multi-allelic S-locus which prevents self-fertilization. The aim of this work was to identify the S-genotypes in the following ten autochthonous apple cultivars grown in individual growers' orchards in the regions of central and southwestern Serbia: 'Budimka', 'Džumurka', 'Ilinjača' (Jezdina), 'Ilinjača' (Trnava), 'Kolačara', 'Kraljica', 'Lepocvetka', 'Senabija', 'Šumatovka' and 'Vidovača'. The use of the polymerase chain reaction (PCR) method with consensus primers, that correspond to the previously identified C2 and C5 conserved regions, and allele-specific primers revealed eleven alleles: S1 to S5, S7, S20, S24, S26, S28, and S44. Among the assessed cultivars, the following ploidy levels at the S-locus have been identified: four cultivars were diploids, three triploids and one was tetraploid; additionally, the S1Sx genotype was revealed in two cultivars. This study provides new information about the cross-compatibility of cultivars and pollenizers and might be used in parental choice within breeding programs, as well as in the choice of cultivars/pollenizers for commercial orchards.

Keywords: *Malus* × *domestica*, indigenous genotype, gametophytic self-incompatibility, S-locus, S-RNase

IN SITU CHARACTERIZATION OF PLUM LANDRACES ORIGINATED FROM THE REGION OF WESTERN SERBIA

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Abstract

Eleven plum landraces (‘G-1’ to ‘G-11’) of unknown origin were sampled and analyzed as single trees on their own roots in orchards of the western Serbia region during 2020/21. The investigation included the most important agronomic traits such as harvest date, fruit and stone weight, fruit dimensions, surface area, soluble solids, and total acids as well as the ratio between them, total phenols and total anthocyanins, antioxidant activity, and field resistance to 'Sharka' disease (Plum pox virus). The collected material showed a wide range of variability in the studied properties. The investigated plum genotypes ripened between the 30th of July (‘G-1’) and the 15th of September (‘G-11’). The ‘G-3’ was characterized by the largest fruit (37.12 g), while the smallest fruit was found in ‘G-4’ and ‘G-5’ (11.76 g; 13.39 g). In terms of the fruit's chemical composition, the best results were obtained in ‘G-5’ and ‘G-11’ characterized by the highest content of soluble solids (20.45%; 21.10%) and the ratio between soluble solids and total acids (21.73; 30.14). The smallest content of soluble solids (14.25%) was found in ‘G-9’, while ‘G-3’ and ‘G-4’ had the smallest ratio between soluble solids and total acids (8.53; 9.59) due to the high value of total acids content (1.94%; 2.09%). The genotype ‘G-2’ was characterized by the highest content of total phenols (197.50 mg GAE 100 g^{-1} FW) and antioxidant activity (63.26%), while the value for total anthocyanins was highest in ‘G-5’ and ‘G-8’ (17.32 and 18.93 mg C3G 100 g^{-1} FW, respectively). The lowest level of bioactive compounds was found in ‘G-3’. Regarding the field resistance to 'Sharka' disease, the assessed genotypes can be divided into three groups, without symptoms (‘G-2’ to ‘G-4’, ‘G-6’ and ‘G-7’), with minor symptoms (‘G-1’, ‘G-8’ and ‘G-9’) and with moderate symptoms (‘G-5’, ‘G-10’ and ‘G-11’).

Key words: Prunus domestica L., ripening time, fruit properties, sharka resistance

APPLICABILITY OF MICROSATELLITE MARKERS IN ESTIMATING FERTILIZATION SUCCESS IN NORWEGIAN APPLE ORCHARDS

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Abstract

Microsatellite markers have previously proven efficient in identifying successful pollinizers within commercial pear and plum orchards in Norway. However, using a similar approach in apples is complicated by the fact that Norwegian commercial apple orchards are usually comprised of numerous main cultivars and pollinizers. In addition, traditional apple cultivars grown on nearby farms, as well as natural crabapple populations can serve as pollen donors, making positive pollinizer identification difficult. In order to investigate the applicability of microsatellite markers in estimating the fertilization success among apple cultivars and its pollinizers, in 2020 a pilot study was conducted within several apple orchards located in southwestern Norway. The study entailed a genetic characterization of 105 apple embryos, collected from the fruit of seven main cultivars ('Discovery', 'Elstar', 'Julyred', 'Katja', 'Rubinstep', 'Summerred' and 'Vista Bella') using 15 polymorphic microsatellite markers. The same marker set was used on all main cultivars and all the pollinizers present in the orchards. Consequent paternity analyses successfully identified the individual pollen donor for 96% of analyzed apple embryos. The number of successful pollinizers varied greatly depending on the cultivar, with ‘Aroma’ having a single pollen donor for all its embryos and 'Rubinstep' embryos displaying a very diverse set of identified pollinizers. The obtained results clearly indicate that the employed microsatellite marker set can be recommended for a large-scale study on apple pollinizer efficacy.

Keywords: pollinizers, embryos, paternity analyses, *Malus domestica* Borkh., cultivars

MORPHOLOGICAL AND POMOLOGICAL CHARACTERIZATION OF WILD OLIVES ON THE ISLAND OF UGLJAN

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Abstract

The wild olives (*Olea europaea* ssp. *europaea* var. *sylvestris*) emerge from seeds of either cultivated or wild populations. Preservation of biological diversity and the source of raw materials for industry (leaf) are the basis for their wider research. There is a large presence of wild olives in extensive olive groves on the island of Ugljan in Zadar County. Some individuals differ in fruit size, fertility, and resistance to drought and harmful organisms. The aim of this preliminary research is to morphologically describe six isolated individuals (trees) of wild olives located on the island of Ugljan. In the period from January to November 2017, their morphometric examination was carried out. It included measurements of five morphological characteristics of the leaf, four of the inflorescence, thirteen of the fruit, and twelve of the stone. The measurements were carried out according to the international method for the description of olive cultivars used by the International Olive Council (IOC). The comparison of characteristics was performed by one-way analysis of variance, and the reverse Tukey test was used to compare mean values. By comparing the morphological characteristics of leaves, inflorescences, fruits, and stones, significant differences were found among the studied individuals. According to the characteristics of the leaf and the number of flowers per inflorescence, one individual was singled out, for which the largest average leaf area and the largest average number of flowers per inflorescence were determined. The highest average mass of fruit and stone was found only in one of all the research individuals. Morphological characteristics of leaves and fruits at harvest are influenced by the cultivar, but also by a number of other agroecological factors. The obtained preliminary results are useful for mass selection when selecting individuals of interest for further vegetative reproduction, which would be a preparation for genetic identification research.

Keywords: biodiversity, fruit, inflorescence, leaf, morphology, cultivar

FRUIT QUALITY OF LOCAL BULGARIAN PEAR (P*yrus communis* L.) GENETIC RESOURCES

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Abstract

Information on the utilization of fruit species in Bulgaria dates back to 4000 years ago. The fruit growing in the country has developed significantly in the 17th century. In many of the small settlements, especially in the mountain areas, old and local fruit cultivars, and forms are still preserved. The current study aimed to describe in detail the fruit quality of some appreciated by the population old and local pear genetic recourses. To complete this objective, fruit size, fruit flesh firmness, total soluble solids content (°Brix), and skin colour of the cultivars 'Mayska', 'Mehmedka', 'Eniseyka' and five local forms found in Plovdiv and villages in the Karlovo region were measured. 'Mehmedka' had the largest fruits of 125.33 g with the highest TSS content (18°Brix). The lowest fruit weight and TSS content were measured for the earliest ripening 'Mayska'. To evaluate the fruits chemical content analyses were performed. The cultivar 'Mehmedka' has a significant amount of invert sugar in its composition (12.36%). The sucrose content in the fruits is low and varies from 0.19% in 'Mayska' to 2.64% in 'Eniseyka'. Acids, which are a natural sugar balancer in fruit, range from 0.22% to 0.84%. Relatively higher acidity had the tree local forms VA 1 (0.84%), MN 1 (0.75%) and LT 1 (0.73%). The identified old cultivars and local genetic recourses could be a valuable addition to fruit breeding or organic fruit production. Their location was mapped, and planting material was produced from the forms threatened with extinction.

Keywords: chemical analyses, fruit colour, fruit size, local forms, pome fruits

CULTIVAR BREEDING IN CULTIVATED PISTACHIO

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Abstract

The genus *Pistacia* L. is a member of the Anacardiaceae family and includes eleven species *Pistacia vera* L. is only one commercially important species for its edible nuts. Several of the other species have been mainly used as rootstock seed sources for *P. vera*. Most of the cultivars in the production are selections by the growers. Very long juvenile period, dioecy, and alternate bearing characters become major limitations in pistachio breeding programs. Due to the dioecy nature of the pistachio, the breeders need to develop both female and male cultivars. We started a new cultivar breeding program in pistachio in 2016. The cross-pollinations were done in 2016 and sexes of the progenies were determined by using female-specific sex marker. About 8.500 female and 2.000 male progenies from 55 different combinations were planted in the December of 2017. The first flowering started in the spring of 2022 in three male progenies, and several hundreds of female and male progenies were expected to be flowered in the spring of 2023.

Keywords: marker assisted selection, variety, *P. vera*, progeny, cross pollination

SESSION 2

BIOTECHNOLOGY AND PHYSIOLOGY

ORAL PRESENTATIONS

MINIMIZATION OF STEM-END SPLITTING IN 'GALA' APPLES WITH AMINOETHOXYVINYLGLYCINE AND GA_{4+7}

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Abstract

Stem-end splitting (SES) is a widespread, physical defect that can affect multiple commercially important apple cultivars. The incidence of SES is variable across years and can be influenced by environmental factors, genetics, and management decisions. We investigated the effects and interactions of exogenous applications of aminoethoxyvinylglycine (AVG) and GA_{4+7} on SES incidence and fruit quality. A two-year experiment was conducted in a mature 'Banning Gala' orchard at the Mountain Horticultural Crops Research and Extension Center in Mills River, NC, USA. Trees were 0.9 m x 4.0 m spacing, trained to the tall spindle, and received plant protectant sprays that adhered to local recommendations throughout the growing season. Starting at 5 weeks before anticipated harvest, three applications of AVG (0.33, 44, and 66 $mg \cdot L^{-1}$) and GA_{4+7} (0 and 50 $mg \cdot L^{-1}$) were applied in an aqueous solution with 0.05% (v/v) organosilicon surfactant. Treatments were applied to 3-tree plots using a CO_2 sprayer calibrated to apply 935 L per hectare. Plots were sampled over a 5-week period to quantify SES incidence and fruit quality. The experiment had a completely randomized design and had a 4 x 2 factorial treatment structure with five replications. Main effects and interactions were determined via analysis of variance. Regression analysis was conducted where appropriate. In both years, as AVG concentration increased, SES was reduced and fruit maturity was delayed. However, the effect of GA_{4+7} and the interaction between AVG and GA_{4+7} was not significant across all measured responses. Multiple applications of AVG at relatively low concentrations were effective in reducing SES. Additional research is warranted to determine if plant growth regulator applications or other inputs can reduce internal ring cracking, which precedes SES.

Keywords: ethylene inhibitor, gibberellin, *Malus* × *domestica*, plant growth regulator, ripening

PROPAGATION OF APPLE, PEAR, PLUM, AND SWEET CHERRY IN A HOT WATER SYSTEM DURING THE DORMANT PERIOD

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Abstract

The fruit cultivars of apple (*Malus domestica* Borkh.), pear (*Pyrus communis* L.), plum (*Prunus domestica* L.), and sweet cherry (*Prunus avium* L.) are heterozygous and propagated by seeds do not lead to subsequent quality of the selected cultivars. For this reason, various techniques and methods are used in the world for vegetative propagation of the above-mentioned fruit species, the most popular of which are budding and grafting. The experiment for the propagation of apple, pear, plum and sweet cherry was done by the method of hot callus with a hot water system. The grafting was done in the first ten days of February, i.e., when the fruit species were in winter dormancy. 'Whip-and-tongue' and 'V-graft' grafting techniques were performed. The connection between scion and rootstock was done in two ways – plastic tape and rubber hose. Successfully grafted plants were potted and then adapted for one month. Before and after adaptation, the percentage of successfully propagated trees was reported. The highest percentage of propagated plants before adaptation for the 2019-2022 trial period was in apple (94.4%-95.6%) and plum (76.3%-94.4%), followed by pear (73.8%-86.9%) and sweet cherry (63.3%-76.7%). The obtained experimental results give ground to make the conclusion that the use of a hot water system, during the winter dormancy of the fruit species apple, pear, plum and sweet cherry, leads to their successful propagation.

Keywords: fruit tree, hot callus, grafting, planting material, whip-and-tongue, V-graft

THE EFFICACY OF 1-AMINOCYCLOPROPANE-1-CARBOXYLIC ACID (ACC) IN THINNING APPLES: CHILEAN EXPERIENCE

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Abstract

In Chile, apple trees commonly show a high fruit set: ~2.0-2.5 fruits/cluster; therefore, strong chemical thinning is needed to avoid or reduce hand thinning. 1-aminocyclopropane-1-carboxylic acid (ACC; Accede®), an ethylene precursor has been registered as a flower or fruitlet thinner. Then, it must be validated according to weather conditions and cultivars. The aim of this study was (i) to evaluate the efficacy of ACC concentrations since bloom up to later 'rescue' treatments, and (ii) to evaluate it as part of commercial chemical thinning programs (CCTP). Six trials in 'Brookfield Gala' and 5 in 'Fuji Raku Raku' were done during four seasons. Across the seasons and cultivars, ACC, alone or as part of a CCTP, reduced fruit set in a dose-moment-cultivar-dependent manner. ACC at full bloom (224 and 448 mg/L) shows great efficacy for thinning 'Gala' flowers, being equivalent to 12 mg/L of NAA; since petal fall to 10-12 mm fruit diameter, 448 mg/L reduces fruit set, and greater concentration (672 mg/L) is needed when fruits reach 18 to 25 mm. 672 mg/L plus coadjuvant or oil or greater concentration showed slight to moderate leaf drop since 18 to 25 mm, depending on the season. Ethephon 400 mg/L was similar to 672 mg/L at 25 mm. 'Fuji' requires a greater ACC rate; at full bloom, 600 mg/L reduced the fruit set from 2.5 to 1.5 fruits/cluster, considered good thinning for 'Fuji' strains. From 4 to 10-12 mm fruit diameter, and good weather for thinning (less carbohydrate availability), 400 to 600 mg/L could reduce fruit set, but not under bad conditions (cold nights and hot sunny days). A similar response was found for 'rescue' treatments, only 800 mg/L reduces fruit set when the weather is favorable for thinning. ACC is a promising full bloom and late rescue thinner for apples, especially at the 18 to 25 mm stage when other thinners are ineffective.

Keywords: Malus domestica, ethylene precursor, fruit set, 'Fuji' apples, 'Gala', crop load, late thinning

CHARACTERISTICS OF SOME APRICOT CULTIVARS (*Prunus armeniaca* L.) IN THE FIRST YEARS AFTER PLANTING

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Abstract

The region of Čačak (Western Serbia) is one of the centers of apricot production in Serbia. In harvest years, 3-4.000 tons of apricot fruits are produced in this region, which is about 10-15% of apricot production in Serbia. In this paper, characteristics of the most commonly grown apricot cultivars in Serbia ('Hungarian Best', 'NS – 4', 'Zaklopačka Ruža', 'Roxana'), as well as cultivars that are less known or still in the investigation phase ('Aurora', 'Goldrich', 'Betinka', 'Candela') are presented. The cultivars are grafted on 'Myrobalan' seedling rootstocks (*Prunus cerasifera* Ehrh.). The planting distance is 5.5 × 3.5 m (520 trees per ha). The experiment was conducted in the second, third, and fourth years after planting (2017-2019). The average flowering start of the cultivar 'Hungarian Best' (control) was on March, 23. Earlier flowering start (1-3 days) was observed in 'Betinka', 'Aurora', and 'Goldrich'. In contrast, 'NS – 4', 'Zaklopačka Ruža', and 'Roxana' started flowering 2-3 days later. The onset of ripening in 'Hungarian Best' was on 09 July. 'Betinka', 'Candela', 'Goldrich' and 'Aurora' had an earlier start of ripening (2-25 days, respectively), while 'Zaklopačka Ruža', 'NS – 4' and 'Roxana' ripened 2-25 days later, respectively. In the third year after planting, yields are higher for 'Goldrich' (9.84 kg tree^{-1}) and 'Roxana' (4.75 kg tree^{-1}). In the following, the fourth year after planting, all cultivars had high reproductive potential, but spring frost before flowering froze the flower buds before they opened. Freezing of flower buds ranged from 22-25% ('NS - 4', 'Zaklopačka Ruža' and 'Hungarian Best'), up to 100% ('Aurora' and 'Goldrich'). In the 5th year after planting, the yield ranged from 4.3 kg tree^{-1} ('Candela') to 19.1 kg tree^{-1} ('Hungarian Best'). The largest fruit was found in 'Zaklopačka Ruža' (88.42 g), and the smallest in 'Betinka' and 'Hungarian best'.

Keywords: young trees, flowering, fruit ripening, yield, reproductive potential

THINNING EFFICACY OF 1-AMINOCYCLOPROPANE-1-CARBOXYLIC ACID (ACC) IN 'FRENCH' PLUMS

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Abstract

1-aminocyclopropane-1-carboxylic acid (ACC) as a precursor of ethylene has been recently tested as a flower or fruitlet thinner in different fruit crops; however, no studies have been reported on *Prunus domestica* 'French' plums. The aim of this study was to evaluate the efficacy of ACC as a chemical thinner when sprayed at different concentrations and stages, during two seasons. In the first season, 224, 448, and 672 mg L^{-1} were applied at full bloom, shuck split, 8-10 mm fruit diameter, or pit hardening. The thinning response was dependent on the concentration –as higher the concentration, higher thinning-, and stage -higher thinning degree at full bloom, independent of the concentration-. In this sense, the data variation was explained by the stage of spray in 49%, 12.5% by the concentration, and 8.52% due to the interaction, being the spray moment more important than the concentration. During the second season, it was explored 112 to 448 mg L^{-1} at full bloom and 448 and 672 at 8-10 mm, being those stages the most sensitive as previously detected. No differences were detected between ACC concentration or between stages, then, the use of ACC in full flower or in 8-10 mm fruits shows a safety range of use at the concentrations used, which would allow certainty of the expected thinning degree after knowing the fruit set. Sprays at the higher dosage at 8-10 mm fruits showed slight leaf drop but not compromising the total leaf area. When we deduct the effect of crop load on yield efficiency and fruit size, no changes in yield was observed and fruit size was not affected in both seasons. Therefore, ACC seems to be a very promising tool as a chemical thinner in 'French' plums.

Keywords: P. domestica, ethylene, fruit set, European plum, crop load, thinning window

SESSION 2

BIOTECHNOLOGY AND PHYSIOLOGY

POSTER PRESENTATIONS

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BLOOM THINNING 'IMPROVED FRENCH' PRUNE WITH CAUSTIC SPRAYS

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Abstract

Consistent, high yields (6-9 t ha^{-1}) of large fruit (< 37 dried fruit kg^{-1}) delivers optimum economic value in prune (*Prunus domestica*) production in California, USA. Orchards with heavy fruit sets are mechanically thinned at the reference date, ~45 days after full bloom. To assess caustic chemical bloom sprays as an alternative to current thinning practices, a four-year (2015-2018) study was conducted in a mature, commercial 'Improved French' prune orchard. Annual treatments included potassium thiosulfate (1, 1.5, or 2% v v^{-1}) and an unthinned control. Lime sulfur (2.5% v v^{-1}) with fish oil or vegetable oil concentrate (2% v v^{-1}) was applied in 2017-2018. Treatments were applied at 25%, 80%, or 25% and 80% open flowers to individual trees in a spray volume equivalent to 1871 L ha^{-1}. Total dry fruit yield (kg $tree^{-1}$) and total large fruit yield (kg $tree^{-1}$) were determined at commercial harvest. Thinning results varied annually with field conditions, treatment materials, and treatment timing(s). Caustic sprays consistently reduced fruit set and increased the percentage of large fruit at harvest compared to unthinned controls but improved orchard economics in only one of the four years of this study. Under high crop load potential (no pruning, strong bloom), excessive amounts of low-value (small) fruit remained at harvest in bloom-thinned trees despite significant increases in large fruit yield compared to the control. Caustic sprays over-thinned relative to the unthinned control in light bloom conditions. Caustic thinning sprays improved return bloom the year following heavy bloom compared to the unthinned control. Bloom thinning with caustic sprays may complement current thinning practices in 'Improved French' prune orchards in California, but as tested here, are not a consistently viable alternative. Pruning levels, weather conditions, and cropping history are co-factors to consider in future bloom thinning research in "Improved French' prune.

Keywords: lime sulfur, potassium thiosulfate, economics, return bloom, fruit size

PHENOLOGY AND FRUIT PRODUCTION OF SWEET CHERRY IN THE CONTEXT OF CLIMATIC CONDITIONS IN NORTH-EASTERN ROMANIA

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Abstract

Known as one of the most appreciated fruits in the world, the professional and scientific networks built around the production of sweet cherry (*Prunus avium* L.) have required the knowledge of phenological data trends in experimental sites and in extremely contrasting climatic conditions. The studies were performed for three consecutive years (2018–2020) at the Research Station for Fruit Growing situated in the North-East part of Romania, using eleven cultivars of sweet cherry as research material, of which, seven national cultivars ('Bucium', 'Cătălina', 'Cetătuia', 'George', 'Golia', 'Maria' and 'Marina') and four foreign cultivars with international relevance ('Regina', 'Kordia', 'Hudson' and 'New Star'). The aim of this study was to evaluate the effect of air temperature on the onset of phenophases according to the BBCH scale by performing the heat requirement by calculating the sum of active temperature (SAT), growing degree-days (GDD), and the correlation coefficient between the number of days and the sum of active temperature. The annual temperature has increased progressively, from 10.65 ℃ in 2018 to 11.87 ℃ in 2020, while the annual precipitation has decreased (from 529.8 mm in 2018 to 443.6 mm in 2020). The physicochemical characteristics of the fruit were also evaluated. The highest values concerning the fruit's weight have been recorded for 'Regina' (11.0 g) and the content of soluble substance was between 9.03 and 20.48 ºBrix. The obtained results showed statistically significant differences, the phenological changes were a reaction to temperature and precipitation but will support the development of predictive models for sweet cherry phenology and the anticipation of breeding strategies to maintain and improve cherry production in temperate continental climates.

Keywords: Prunus avium L., fruit development, climate, temperature, phenophases

EVALUATION OF SOME CHERRY CULTIVARS GRAFTED ON THE ROOTSTOCK 'GISELA 5' AND GROWN IN THE HILLY REGION IN THE SOUTH OF ROMANIA

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Abstract

During 2020-2022, determinations were made regarding the yield and fruit quality of twelve sweet cherry cultivars grafted on the rootstock 'Gisela 5' grown in a high-density orchard (1.667 trees/ha), at the Research Institute for Fruit Growing Pitesti, Romania, in the Sub-Carpathian hills area. Lower and upper baselines for crop water stress index (CWSI) for sweet cherry cultivars were calculated and the cultivar's sensitivity to water stress conditions during the summer was evaluated. The study results indicated that an average fruit yield over 10 t/ha was obtained for the 'Bellise' and 'Karina' cultivars, while for 'Folfer', 'Regina', 'Merchant', and 'Burlat' the fruit yield exceeded 9 t/ha. 'Areko' cultivar stood out mainly due to the high fruit weight (12.17 g) and was followed by 'Penny', 'Folfer', 'Kordia', 'Fertard', 'Vanda', and 'Regina', with fruits weight over 9 g. 'Fertard' and 'Kordia' cultivars presented the highest firmness and 'Vanda' the highest pH. 'Regina', as well as 'Penny', 'Kordia', 'Vanda', and 'Merchant' cvs., had above average total soluble solids. Large fruits showed high firmness and total soluble content, while firmness correlated negatively with pH and positively with total soluble content. The earliest ripening cultivars were 'Burlat', 'Merchant', and 'Bellise', and the latest were 'Sweetheart', 'Fertard', and 'Penny'. The least adapted cultivars to water stress, which most easily lose water from their tissues through transpiration, and are prone, to dehydration, were 'Bellise' and 'Folfer', while 'Merchant' proved to have the lowest water stress sensitivity.

Keywords: high-density orchard, yield, fruit quality, hydric stress sensitivity, CWSI baselines

INFLUENCE OF TEMPERATURE AT THE TIME OF POLLINATION ON THE EFFECTIVE POLLINATION PERIOD AND FRUIT SET IN PLUM

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Abstract

So far, the concept of effective pollination period (EPP) for several cultivars of plum, apricot, apple, pear, almond, and others has been proven as a suitable parameter to set up a relationship between the variation in the reproductive process and cropping behaviour. Among a number of autochthonous plum cultivar present in plum orchards in Serbia, 'Crvena Ranka' is the most important. It's a self-sterile cultivar (characterized by the appearance of cytoplasmic male sterility), so the presence of an adequate pollenizer is needed. The fruit set and EPP in this plum cultivar were evaluated under natural field conditions in western Serbia during 2021 and 2022. Pollination of flowers with a mix of dry pollen was subsequently done during the first 10 days after full bloom. The initial and final fruit set was recorded four weeks after pollination and at the period of physiological maturity of the fruit, respectively. Results show that in both years the number of initial fruit set increased up to five days after anthesis. The same was archived with the final fruit set in the first year while in the second, the highest number of fruit sets was observed on the fourth day after anthesis (40.67% and 54.48%, resp.). In the first year, five days after anthesis a slight decrease in the final fruit set was observed with the lowest, but still satisfactory values, on the 10th day after anthesis (11%). In the second year, decreasing in fruit set was more evident and was below 4% on the seventh day after anthesis. The reason for such a significant decrease in fruit set was the spring frost occurred five days in a row. Taking into account clearly the effects of weather conditions on fruit set, based on obtained results, it can be estimated that the EPP for plum cultivar 'Crvena Ranka' is 10 days.

Keywords: Prunus domestica L., flowers, anthesis, pollen, fruits

INFLUENCE OF THE ROOTSTOCKS *PRUNUS MAHALEB* SEEDLING, 'MAXMA 14' AND 'GISELA 6' ON THE COURSE OF SOME PHENOPHASES AND DORMANCY IN SWEET CHERRY CULTIVARS

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Abstract

The influence of rootstocks *Prunus mahaleb* seedling, 'MaxMa 14' and 'Gisela 6' on the course of different phenophases in sweet cherry cultivars 'Burlat', 'Van' and 'Katalin' was studied in the period of full bearing over four growing seasons. The experimental orchard was established in 2014 in South Bulgaria near the town of Plovdiv in a typical cherry-growing region with relatively low fertile soil with drip irrigation provided. The obtained results showed that the rootstock 'Gisela 6' significantly delay the flowering and ripening period of the cultivars included in the study. Contrary to the common belief that fruit trees have no visible development during the dormancy period, we noted that rootstocks *Prunus mahaleb* seedling and 'MaxMa 14' had significantly increased their diameter compared to 'Gisela 6' during the dormant period. Activity in the dormant period was also presented in the cultivars. During this period they increased their diameter more intensively when grafted on *Prunus mahaleb* seedling and 'MaxMa 14' than if they were combined with the rootstock 'Gisela 6' and thus form significantly thicker stems. In the three cultivars included in the study, the weakly growing rootstock 'Gisela 6' induced 25-30 days earlier end of vegetation compared to *Prunus mahaleb* seedling, and the rootstock 'MaxMa 14' took an intermediate position in this parameter.

Keywords: Prunus avium, dormant period, flowering, ripening, end of vegetation

CHEMICAL THINNING OF APPLE FRUIT: A REVIEW

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Abstract

Apple (*Malus domestica* Borkh.) is highly prone to biennial bearing and necessarily requires thinning of excessive fruits to provide a marketable and regular yield. Therefore, chemical fruit thinning represents the most used and efficient practice that ensures optimal and high-quality yield. This paper presents an overview of the apple fruit chemical thinning experiments since 2000, with the most commonly used chemical agents: NAA, 6-BA, Ethephon and Metamitron. The research was conducted using the Web of Science and Google Scholar search engines, with suitable keywords that adjusted the database to the search objectives. Thinning results are often inconsistent, considering that their efficacy depends on many factors, such as time of application, concentration, carbohydrate supply, and weather conditions. NAA thins the fruits effectively, without much influence of weather conditions, if the fruit development stage and concentration are adjusted to the variety. However, in some cultivars it still can negatively affect fruit size, causing pygmy fruits. This negative effect can be overcome by combining NAA with BA, considering that BA shows an influence on the fruit size increase. BA affects the thinning of fruits and their size in proportion to the concentration, most successfully when applied at 10-14 mm in fruit diameter. Ethephon as a post-bloom thinner can be applied in a wide time range, even after 20 mm fruitlet stage, but it is regarded as erratic and inconsistent. Metamitron is also effective in thinning larger-sized fruits, while the concentration must be adjusted to the climatic conditions for adequate results, which depends in particular on the night temperatures. Double application of Metamitron is suggested to achieve a more effective reduction in fruit set and the return bloom enhancement.

Keywords: NAA, BA, ethephon, metamitron, post-bloom thinners

IMPROVING OF THE FRUIT SET AND PRODUCTIVITY OF THE PEAR TREES AFTER THE SPRING FROST

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Abstract

Ensuring regular and quality yield in the orchards is challenging for the producers. In pear trees, good productivity could be achieved by increasing fruit set and fruit size. On the other hand, late spring frost and the damages it causes on the flowers and fruitlets are very common. For improving the fruit set in pear trees in such cases, various management practices are used around the world. In the paper, the results of the evaluated effects of various growth regulators and biostimulants on the fruit set, the productivity, and growth of seven-years-old 'Williams' and 'Abate Fetel' trees grafted on pear seedlings, after damages of flowers caused by late spring frost are presented. In the research, the following treatments were used: gibberellic acid GA3 (ProGibb plus 10 %, - 3 x 100 g/ha), gibberellic acid GA3 (ProGibb 40 % SG - 1x 50g/ha), gibberellic acid GA3 (ProGibb 40 % SG – 2 x 25 g/ha), prohexadione calcium (Regalis – 3 x 0.8 l/ha), biostimulant based on the extract of the seaweed *Ecklonia maxima* (Basfoliar Kelp SL^{-1} x 2.5 l/ha) and amino acids (Aminosol -3 x 3l/ha). The treatments were applied two days after frost (during the full flower period) and in a 10-day interval, respectively according to the variants. Trunk growth, length of shoots, fruit set, number of fruits per tree, yield, average fruit weight, fruit length, fruit diameter, seed number, fresh firmness soluble solid content, and acids were assessed. The results indicate that some of the treatments have certain positive effects on the vegetative growth, fruit set, yield, and quality of the fruits.

Keywords: Pyrus communis L., growth regulators, biostimulants, yield, fruit quality

EFFECT OF PREHARVEST GIBBERELLIC ACIDS APPLICATION ON PRODUCTIVITY, FRUIT CHARACTERISTICS AND FLOWER BUD FORMATION OF SWEET CHERRY 'REGINA'

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Abstract

The aim of this experiment was to examine the effect of two gibberellic acids: GA_3 and GA_{4+7} on the flower bud formation of 'Regina' sweet cherry as well as fruit characteristics and productivity. Three-year-old sweet cherry trees cv. 'Regina' grafted on 'Gisela 5' were trained to a slender spindle with a planting density of 4.0 x 1.33 m (1,880 trees/ha). Gibberellic acids were applied once (3 weeks before fruit ripening) or twice (7 weeks and 3 weeks before fruit ripening) at concentrations of 30, 60, and 90 mg/L, respectively with 600 L water per hectare. Untreated trees served as a control treatment. Results indicated that the applied gibberellins significantly increased fruit weight compared to the control treatment. The greatest increase in fruit weight was observed in the treatments with concentrations of 60 and 90 mg/L. However, yield per tree did not differ significantly among the applied treatments. GA_3 treatments significantly increased fruit firmness compared to GA_{4+7} treatments. The number of gibberellins application and their concentration did not differ significantly. However, all the applied treatments significantly increased fruit firmness compared to the control treatment. GA_{4+7} increased fruit acidity compared to those treated with GA_3, while other quality attributes, such as external colour and soluble solids content were not affected by gibberellins application. Heavy rain just before the fruit harvest caused the cracking of fruits. The percentage of cracked fruit was 90% higher in all gibberellins treatments compared to the control treatment. Fruits treated with GA_3 showed a higher percentage of cracking than those treated with GA_{4+7}. Also, the fruits that were treated with the highest concentration of gibberellins (90 mg/L) expressed the highest percentage of cracking. The applied gibberellins did not reduce the number of flower buds on the spurs as well as the number of flowers per flower bud.

Keywords: Prunus avium, GA_3, GA_{4+7}, yield, fruit quality, return bloom

APRICOT CULTIVARS AND ROOTSTOCKS WITH DIFFERENT FRUITING SURFACE DEVELOPMENT: PRELIMINARY RESULTS

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Abstract

Because of the exceptionally high number of available apricot cultivars (*Prunus armeniaca* L.) and rootstocks, and the high risk of production, it is increasingly pressing to find out, which scion-stock combinations can be cultivated successfully. 16 apricot scion cultivars were budded on 6 different rootstock cultivars. 'Apricot seedling', 'Montclar', 'Myrobalan 29C', 'Wavit', 'Rootpack R', and 'Fehér besztercei' were used as rootstock. Scions included 'Bergarouge', 'Bergeron', 'Ceglédi óriás', 'Ceglédi szilárd', 'Flavor Cot', 'Goldrich', 'Gönci magyar kajszi', 'Harogem', 'Lady Cot', 'Lilly Cot', 'Pannónia', 'Pink Cot', 'Roxana', 'Spring Blush', 'Tardif de Valence' and 'Tom Cot'. This research is performed in the experimental orchard of the MATE Research Centre for Horticultural Sciences, Research Institute of Fruit Growing, Research Station of Cegléd, Hungary. The experiment was settled in the spring of 2018 with 3 x 5 m spacing, data is collected in 3rd leaf (2020). The main effect of the different rootstocks can be observed in the growth habit of scions, meanwhile, the scion cultivar also had a moderate impact. The survival rate ranged from 58% ('Apricot seedling') to 94% ('Rootpack R'). Considering the trunk cross sectional area, rootstocks 'Wavit' (5.98 cm²) and 'Fehér Besztercei' (7.58 cm²) resulted in the weakest growth for all cultivars, followed by 'Myrobalan 29C'(17.28 cm²) and 'Apricot seedlings' (19.56 cm²), while 'Montclar' (20.41 cm²) and 'Rootpack R' (22.8 cm²) produced the strongest trees.

Keywords: central-Hungary, climate adaptation, rootstock, scion, soil, vegetative growth

GROWTH CONTROL OF 'OBLAČINSKA' SOUR CHERRY (*Prunus cerasus* L.) GRAFTED ON 'MAHALEB' (*Prunus mahaleb* L.) ROOTSTOCK BY USING BIOREGULATORS

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Abstract

The contemporary production of 'Oblačinska' sour cherry is encountered an increasing lack of human workforce, primarily in the harvest. Harvest costs can be reduced by using a combined harvester machine. For mechanical harvest purposes, cherries are grafted on *mahaleb* rootstock, which induces excessive vigor in trees and imposes the need for vigor control. The experiment was set up in 2021 and 2022 in 'Oblačinska' sour cherry trees, grafted on mahaleb rootstock, and planted in 2019 at a 4 × 2 m planting distance. Romulan containing paclobutrazol (PB) was applied by soil drench once with the rates of 0.4, 0.7 and 1.3 L ha^{-1} at the beginning of bud swelling. Foliar bioregulator sprays were applied twice, at 3-5 leaves developed and two weeks later at the rates 1.0, 1.5 and 2.0 L ha^{-1} of PB and 1.0, 1.25 and 1.5 kg ha^{-1} Regalis Plus containing Prohexadione-Ca (ProCa). PB applied by soil drench was the most effective in reducing shoot growth and the effect was persistent until the end of the growing season. Shoots length was in average 6.4 cm in June and 6.0 cm in July 2021, while 3.7 cm in June and 3.2 cm in November 2022 in PB soil drench applied treatment. ProCa was more effective than PB as a foliar spray in reducing shoot growth, with new growth emerging by the end of the season. Fruits from trees treated with ProCa were larger and had a higher stem-removing force than control ones. Fruits from PB-treated trees had higher SSC, acidity, stem removing force and fruit firmness, while lower L* colour parameter. Both PB and ProCa can be used as efficient tools to control the vigor of sour cherry grafted on mahaleb rootstock, whereas the effects depend on the application method and chemical rates.

Keywords: vegetative growth, shoots, vigor, Paclobutrazol, Prohexadione Calcium

EFFECT OF SYNTHETIC AUXIN SPRAYS ON YIELD AND DOUBLE SEED INCIDENCE OF ALMOND TREES, AND ORCHARD PROFIT UNDER DIFFERENT CONDITIONS OF FRUIT SET AND PAR INTERCEPTION

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Abstract

Low yield is the main weakness of almond orchards in Chile (under 2.000 kg/ha vs 2.500 kg/ha in California or Australia) mainly due to weather conditions that would affect pollination and fruit set. Across the last seasons, small kernel size has been an issue for growers. Synthetic auxin sprays have been reported to increase fruit size in different fruit trees, but they have not been validated in nuts crops. With the aim of improving seed size, a study assessing the effect of two synthetic auxins (2,4-DP and NOA plus 4-CPA) in 'Nonpareil' almond trees. The results were integrated, and the profit of the best treatment of each auxin was simulated under different scenarios, according to fruit density and orchard PAR interception (Photosynthetically active radiation intercepted). To normalize tree size, the fraction of PARi was expressed as m^2 of PARi (fraction multiplied by allocated space). Auxin treatments were done at full bloom and shuck split, based on commercial products available in Chile: StonegrossÒ (2,4 DP) and PropulseÒ (NOA plus CPA), and contrasted with not sprayed trees. Different concentrations (30 and 40 mg L^{-1} of NOA; 75 mg L^{-1} of 2,4-DP) were evaluated as a unique spray or double. At harvest, auxin treatments significantly increased seed size and, consequently, the yield efficiency adjusted by crop load (~7 to ~8%) without affecting crop load or double seeds. The double spray of 30 or 40 mg L^{-1} of NOA did not show a better response than a single application of 30 mg L^{-1} of NOA or 75 mg L^{-1} of 2,4-DP at full bloom. Finally, the spray of 30 mg L^{-1} of NOA or 75 mg L^{-1} generates a sufficient yield increase to make the application profitable, even under conditions of low fruit density (250 fruits/m^2 PARi) in orchards intercepting at least 60% PAR.

Keywords: Prunus dulcis, 2,4-dichloro phenoxy propionic acid (2,4-DP), 2-naphthyloxyacetic acid (NOA), 4-chlorophenoxyacetic acid (4-CPA), crop value, plant growth regulators

CALCIUM SIGNATURE IN KIWIFRUIT RIPENING THROUGH MULTI-OMICS INTEGRATION

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Abstract

Kiwifruit postharvest ripening has been reported to be related to calcium (Ca), however, the underlying mechanisms by which Ca regulates this process remain largely unknown. In the present study, 'Hayward' kiwifruit was harvested at the commercial stage and immediately dipped in 2% $CaCl_2$. Afterward, the fruit was cold stored (0 °C) for 3 months and the subsequent ripening traits were evaluated at 20°C for 7 days. Calcium-treated kiwifruits exhibited higher Ca concentration and intracellular calcium (Ca^{2+}) fluoresce signals in the outer pericarp and placenta accompanied by a reduction in softening and ethylene production. Fluorescent microscopy with cell wall primary antibodies showed that de-esterified homogalacturonans (HG) (antibody LM19) was increased while arabinogalactan proteins (AGPs) (antibodies LM19 and LM30) were depressed in Ca-treated fruit. Metabolomic analysis revealed that 27 primary metabolites (i.e. glucolic acid, oxoproline and galactinol) were altered by Ca in pericarp tissue. RNAseq analysis performed either at early (12 hours) or late (3 months of cold storage) period following Ca dipping identified 89 and 370 differentially expressed genes that are mainly involved in ethylene, calcium, and cell wall metabolism. Also, Ca-exposed fruit was characterized by an elevated abundance of numerous (> 890) proteins, notably during the late period. Weighted correlation and network analysis based on the integration of transcriptome, metabolome, and proteome datasets identified candidate modules involved in the Ca postharvest action in kiwifruit. These results provide basic information regarding the Ca function in fruit ripening, which may be helpful for kiwifruit postharvest control.

Keywords: kiwifruit, calcium, cell wall, metabolomics, ripening, transcriptomics, proteomics

THE GROWTH AND FRUITING CHARACTERISTICS OF SOME SWEET CHERRY CULTIVARS UNDER THE PEDOCLIMATIC CONDITIONS OF THE NORTH-EASTERN PART OF ROMANIA

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Abstract

The influence of the climate in the North-Eastern of Romania on the growth and fruiting characteristics of some sweet cherry cultivars during three consecutive years was investigated. The aim of this paper is to identify the influence of climate on the growth and fruiting characteristics of the chosen sweet cherry cultivars. Between the years 2019-2021, the phenological stages of five sweet cherry cultivars from the international and local assortment were observed ('Kordia', 'Hudson', 'New Star', 'Cetățuia' and 'Mara'). The climatic conditions in the north-east of Romania was also monitored and the influence of the temperatures from 2020 on the start of vegetation was observed. 'Cetățuia' and 'Maria' (10th March) was the first cultivars and 'New Star' was the last to start vegetation (30th March). Significant differences were recorded between cultivars regarding the biometric characteristics based of the average values of trunk cross-sectional area (TCSA), crown volume and crown density. Also, during the research, the garnishing of the ridges with the fruit formations was determined, establishing the predominant type. High temperature and heavy rainfall in the summer months resulted in vigorous growth and flower bud differentiation was delayed due to overlapping shoot growth, this was especially evident in 'Cetățuia' and 'Hudson' cultivars. Yield obtained depended on the fertility of the cultivars, the interaction between them. In the biotope conditions and applied fruit growing technology, the average yield of kg/tree varied between 29.5 kg/tree ('Hudson') and 19.9 kg/tree ('Cetățuia'). All the obtained results were interpreted statistically by the Duncan's test and the limit comparation test (LTC).

Keywords: Prunus avium L., fruiting shoots, biometric characteristics, yield, climate

FRUIT BEARING OF THE PRIMOCANE RASPBERRY CULTIVAR 'AUTUMN BLISS' IN THE TROYAN REGION

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Abstract

The scientific experiment was conducted during the period of 2018 - 2019 in a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture in Troyan. The objective of the study was the primocane raspberry cultivar 'Autumn bliss'. The plantation was created in the autumn of 2016. Planting distances are 3.00/0.50 m. The vegetative parameters, such as the average number, average height, and average thickness of the shoots were observed. An intermediate fruit bearing of the raspberry plants was recorded between the spring-summer and summer-autumn harvests, because of the growth of shoots that bloom and form fruits. From the reproductive indicators, the average fruit weight, and the yield of 1 m^2 in the spring-summer, intermediate, and summer-autumn harvests were recorded. Greater shoot height (1.22 m) and thickness (9.74 mm) were recorded in the second year. The average highest yield was obtained from the spring-summer harvest with 0.540 kg/m^2. In the first year, a very high correlation dependence between the number of shoots and height (0.98) and a number of shoots with yield (0.94) was recorded.

Keywords: Rubus idaeus, average weight, vegetative indicators, yield

SESSION 3

CULTIVATION SYSTEMS AND PEST CONTROL

ORAL PRESENTATIONS

V Balkan Symposium on Fruit Growing
June 18-21, 2023, Zagreb, Croatia,

HEALTHY APPLES BY INCREASING SOIL VITALITY - MONITORING RESULTS OF EXTENSIVE SOIL ANALYSES ON CENTRAL EUROPEAN FARMS

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Abstract

The importance of soil as the basis of food production for a constantly growing world population is existential. The aim of a project of the Leibniz Institute of Vegetable and Ornamental Crops e.V. is the creation of a catalog of measures to increase soil fertility in outdoor cultivation. To achieve this goal, scientific monitoring of pilot farms are planned, starting with extensive soil analysis, the selection of area-specific measures, up to the evaluation of the effectiveness of these measures. Among other things, the nutrient supply status of the soils of 13 different apple-growing areas, located in Germany, Poland and the Czech Republic, is presented. They differ in the age of the apple plantation (2009 to 2020), the area history, the soil type and inter-row planting. Sampling was done at 0-30 cm depth separately for inter-row and tree-row. Humus content, pH, lime content, and macro- and micronutrient content and soil life, will be examined. The results showed that the contents of macronutrients were in the optimum or even above. However, deficiencies in soil properties also appeared. For example, the pH was lower than 5.0 in two farms, and only low humus contents of < 2% were found in 1/3 of the plants. Also, a deficit of soluble calcium could be detected in 3 plants and of boron in 8 plants. The microbial life in all the studied soils was in an optimal range. However, there are significant differences in microbial life between the tree and inter-vegetation series. The derivation of individual area-specific measures concern the change of inter-row planting, the use of micronutrients, soluble lime or compost, and are to be implemented in the pilot farms. Their success in improving and maintaining good soil vitality is to be analyzed and documented 2 to 3 years after implementation.

Keywords: soil fertility, nutrient supply status, pH, microbial life, monitoring

OCCURRENCE OF BITTER ROT DISEASE IN ILLINOIS COMMERCIAL APPLE ORCHARDS IN USA

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Abstract

Three fruit rots of apples have been reported in the Midwest of the United States, which are bitter rot, black rot, and white rot caused by *Colletotrichum* spp., *Botryosphaeria obtusa*, and *Botryosphaeria dothidea*, respectively. No research had been conducted on the incidence of apple fruit rots in Illinois. Orchard surveys were conducted within three weeks prior to fruit harvest in 2020 and 2021 to assess the incidence of fruit rots in Illinois commercial apple orchards. Five trees of each cultivar were randomly selected and 60 fruits (five fruits in each of the upper, middle, and lower canopies of eastern, northern, western, and southern sides) per tree, were examined for fruit rot symptoms. Results showed 20 of 30 orchards and 21 of 33 orchards with symptomatic fruit rot in 2020 and 2021, respectively. Incidence of the symptomatic fruits ranged from 1 to 100% (mean 27%) in 2020 and from 0.7 to 100% (mean 20%) in 2021. Symptomatic fruits were observed in most of the orchards in central and southern Illinois. Only bitter rot was observed in orchards. The incidence of fruits with bitter rot symptoms in 'Empire', 'Golden Delicious', 'HoneyCrisp', and 'Jonathan' apples was higher than the rots in other apple cultivars. Symptomatic fruits were collected from 'Braeburn', 'Cortland', 'Empire', 'Fuji', 'Gala', 'Golden Delicious', 'GoldRush', 'Granny Smith', 'HoneyCrisp', 'Jonagold', 'Jonathan', 'McIntosh', 'Red Delicious', apples and an unknown cultivar in 33 different orchards throughout the state. Infected tissues were cultured on potato dextrose agar medium, and the pathogens were isolated. Based on the cultural characteristics and sequences of the glyceraldehydes-3-phosphate dehydrogenase (GAPDH) and β-tubulin 2 (TUB2) genes of 270 isolates, 136, 129, and 5 isolates were identified as *Colletotrichum fioriniae*, *C. siamense*, and *C. chrysophilum*, respectively.

Keywords: apple, summer diseases, fungal diseases, bitter rot, *Colletotrichum* species

ARE 2-D ORCHARD CANOPY MANAGEMENT SYSTEMS IN THE EUROPEAN PLUM PRODUCTION GROWN ON A VIGOROUS ROOTSTOCK A STEP FORWARD?

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Abstract

The reasons for the intensification of plum training systems have universal significance, similar to other fruit species: earlier return on investment, labor utilization, and high yield with good fruit quality. Finding new training systems is mainly defined by increasing their efficiency in the broadest sense of the word (better absorption of sunlight, better labor utilization, mechanization of certain work operations, cost reduction in raising orchards, etc.). The aim of the work is to analyze the fruit characteristics of the cultivar Empress - 'Grossa di Felisio' (*Prunus domestica* L.) grown in a two-dimensional training system. The research was conducted during the period 2021-2022, at the Experimental Education Center of the Faculty of Agriculture University of Banja Luka (Bosnia and Herzegovina). The orchard was established in 2019. The rootstock was *Prunus cerasifera* Ehrh. The training system is Upright Fruiting Offshoot (UFO) formed according to the principles defined in cherry cultivation. The control trees were grown in a plum spindle system. The planting spacing for both training systems was 4.0 x 2.0 m. In total, 50 fruits were collected for analysis of fruit characteristics. This study analyzed: the number of fruits per tree, yield per tree, unit area (ha), and essential morphometric and chemical characteristics of the fruit. The two-dimensional shape of the UFO resulted in a larger fruit size, and thus, a higher yield per tree and unit area. The training system had a significant influence on the morphometric characteristics of the fruit, whereas it was somewhat less influential on the chemical elements. Two-dimensional training systems of plums have a promising predisposition for mechanizing pruning and easier harvesting; therefore they deserve attention in the future.

Keywords: plum, training system, UFO, efficiency, morphometric characteristics, quality

OPTIMAL GROWING CONDITIONS FOR HIGHBUSH BLUEBERRIES

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Abstract

Increasing consumer interest in highbush blueberry (*Vaccinium corymbosum* L.) has led to expanded production, even in areas where natural cultivation conditions are not suitable. Specific requirements for soil with high organic matter and low pH mean that new production methods are being introduced, such as planting in ridges or pots with a completely adjusted substrate. To protect the yield against biotic and abiotic stress, blueberries can be grown in high tunnels or under a hail net. The response to changed environmental conditions can be cultivar dependent. We tested the performance of three blueberry cultivars, 'Duke', 'Aurora', and 'Brigitta', planted in pots or a ridge under a high tunnel or black hail net. The high tunnel increased the maximal air temperature on average by 7.2 °C, and the harvest for all three cultivars began 6 to 18 days earlier compared to the hail net. During the experiment, substrate water content was maintained at the same level for the pots and the ridge, although the substrate temperature fluctuations were higher in the pots. Growing blueberry plants in 60 L pots had no negative effects on plant volume, ripening time and quality parameters. The yield and quality of all three cultivars were better under the hail net than in the high tunnel. 'Duke' and 'Brigitta' performed the best when planted in the pots and were grown under a hail net. The content of sugars and organic acids and sugar/organic acid ratio depended highly on different cultivars, and each cultivar responded differently to growing conditions. The plants under the high tunnel were exposed to higher stress, and consequently, the fruit from all three cultivars, contained higher individual phenolic contents compared to the hail net. In terms of fruit quality, all cultivars performed better under the hail net compared to the high tunnel.

Keywords: quality, stress, *V. corymbosum*, protected environment, sugars, organic acids, phenolics

SESSION 3

CULTIVATION SYSTEMS AND PEST CONTROL

POSTER PRESENTATIONS

V Balkan Symposium on Fruit Growing
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THE INTENSITY OF BACTERIAL DISEASE INFESTATION IN SOME APRICOT CULTIVARS MONITORED WITH THE WinFOLIA SYSTEM

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Abstract

The study presents some research results regarding the sensitivity of more than 25 new apricot cultivars to bacterial disease under the influence of rootstock and planting systems. The new apricot varieties plot was planted in 2017 in the Experimental Field of the Faculty of Horticulture in Bucharest using Romanian and foreign varieties grafted on 'Myrobalan 29C', 'Saint Julien A', and 'GF677' rootstocks. The planting distances varied from 4.5 x 3.0 m for Trident to 3.5 x 2.0 m for Parallel U, and integrated orchard management was applied. Leaves were collected at the end of the growing season (September - October), and the incidence of the bacterial disease was evaluated using the WinFOLIA system simultaneously with their morphologic parameters. The results present the influence of cultivar and rootstock for some experimental variants on the bacterial attack degree. 'Rubista/M29C' showed the highest sensibility (8.04%), followed by 'Delice/M29C' (4.38%) and 'Wonder Cot/M29C' (3.62%). The lowest values were presented at 'Farclo/M29C' (1.34%), 'Mikado/M29C' (1.48%), and 'Bergeron/M29C' (1.53%). 'Primaya/SJA' showed a higher attack on Trident than on Parallel-U due to higher vegetative growth, while 'Myrobalan 29C' and 'Saint Julien A' rootstocks' influence was different on 'Farbali' than on 'Farclo'. The WinFOLIA system proved to be a handy tool in this type of evaluation, bringing valuable information while not being time-consuming.

Keywords: Trident, Parallel-U, 'Myrobalan 29C', 'Saint Julien A', 'GF677'

ANALYSIS OF THE 'Candidatus Phytoplasma prunorum' TITER IN THE TISSUES OF APRICOT (*Prunus armeniaca* L.) TREES THROUGHOUT THE YEAR

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Abstract

'Candidatus Phytoplasma prunorum' is able to persist and could be detected in phloem tissue throughout the year due to the activity of sieve tubes in *Prunus* species during the winter season. This study focuses on monitoring 'Ca. P. prunorum' titer over the course of the year in shoots of apricot trees. The real-time PCR assay was used for absolute and relative quantification of 'Ca. P. prunorum' in connection to basic phenological phases and weather conditions during the observation period. As an experimental material, 9 trees of 3 apricot hybrids were selected. They have grown in the same orchard and tested positive for 'Ca. P. prunorum'. One-year-old or annual shoots were sampled from each of the 3 main branches of the crown. Samples were collected every two weeks during the winter and spring period and once a month during the summer and autumn periods. The expected seasonal pattern of phytoplasma quantity suggests a gradual rise in its quantity in plant tissue and a drop at a certain time point between the dormancy and vegetation period. The drop in phytoplasma titer was determined in dependence on recorded phenological phases and weather conditions. The relationship of phenological phases and weather conditions with phytoplasma titer measurements was analyzed to confirm the suitability of either absolute or relative quantification.

Keywords: ESFY, real-time PCR, *P. armeniaca*, phytoplasma quantification, weather conditions

MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF THE FRUITS OF APPLE CULTIVARS INTRODUCED INTO RIMSA TROYAN

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Abstract

The study was conducted during the period 2019-2021 (in 2019-2020) for the Troyan RIMSA, Bulgaria with the following introduced apple cultivars: 'Melrose', 'Reanda', 'Revena', 'Retina', 'Pilot', grafted on rootstock MM 106 and 'Pingo', 'Remo', 'Reglindis', 'Grafenstein' and 'Rosenaisenapfel' - on seed rootstock. It has been established that the climatic factors in the Troyan region are changing in the direction of increasing the average monthly summer temperatures and decreasing the amounts of vegetation precipitation during the fruit ripening period. 'Grafenstein' and 'Retina' cultivars are the earliest for the region to ripen (9.08 and 23.08 respectively) and form medium-sized fruits weighing 60-80g. 'Pingo', 'Pilot', 'Revena' are the latest ripening cultivars, they ripen at the beginning of October, the weight of the fruit is > 100 g, they show satisfactory resistance to summer droughts. The studied cultivars have a red main colour of the skin, with interrupted or continuous streaks and green colored areas, mainly on the side not exposed to the sun. Most cultivars have white flesh intended primarily for fresh consumption. A correlation was found between the accumulation of dry matter in the fruit and the amount of total sugars, as well as between dry matter and invert sugar.

Keywords: climatic factors, *Malus* sp., biometric indicators, sensory profile, dry matter, total sugars

USE OF PEACH-ALMOND HYBRID ROOTSTOCKS AND TWO INTERSTOCKS FOR THE APRICOT CULTIVAR 'HARGRAND'

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Abstract

The possibilities of growing apricot cultivars on rootstocks with good drought resistance, lime resistance and tolerance to replant soils by using peach and European plum interstocks were studied for four years. The results showed that the use of 'GF677' and 'Garnem' rootstocks with interstocks of 'Redhaven' (*Prunus persica*) and 'Stanley' (*Prunus domestica*) significantly accelerated crown development of 'Hargrand' apricot trees due to the strong vigour and abundant branching with wide deviation angles induced by both peach-almond hybrids. In these combinations, the number of flower buds per linear meter on the annual shoots was significantly greater compared to the most commonly used 'Myrobalan' seedling (*Prunus cerasifera*) rootstock which formed smaller plants alone, as well as in combination with 'Stanley' interstock. At the end of the study, the variants with rootstocks 'GF677' and 'Garnem' grafted with the interstock 'Stanley' had significantly larger stem diameters than the other combinations included in the study. The smaller stem diameter of 'GF677', 'Garnem' and the interstock 'Redhaven', however, did not result in significant differences in scion thickness between these cultivars. The first significant yield obtained in 2022 showed significantly greater productivity of the variants in which the peach-almond hybrids 'GF677' and 'Garnem' were involved compared to the commonly used 'Myrobalan' seedling rootstock. There was no difference in productivity under the influence of the two interstocks. The fruit size was significantly larger in the combinations of 'GF677' and 'Garnem' with 'Stanley' interstock, and the smallest fruits were obtained from trees on 'Myrobalan' seedling rootstock. The formation of suckers was noted only when 'Myrobalan' seedling rootstock was used.

Keywords: Prunus armeniaca, Prunus persica, growth, productivity, yield

DIFFERENTIALLY COLORED PHOTOSELECTIVE NETS: A SOPHISTICATED TECHNOLOGICAL CONCEPT TO IMPROVE FRUIT QUALITY PARAMETERS IN BLUEBERRIES

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Abstract

This research aimed to investigate the influence of different colored photoselective anti-hail nets on the fruit quality traits in the highbush blueberry (*Vaccinium corymbosum* L.) cultivar 'Duke'. The field study was carried out in the blueberry orchard established in Gruža village (Central Serbia) in the spring of 2017 by using pots with a volume of 113 l. The pots were filled with a substrate mixture made of coniferous sawdust and white peat (ratio 50:50) and placed at a distance of 0.8 m in a row and 3.0 m between rows (4.170 plants/ha). During the growing season of 2022, the following colors of photoselective anti-hail nets were used: blue, red, yellow, pearl, and black (produced by Agrinova, Italy). Fruit quality parameters obtained under colored photoselective nets were compared to black nets, as a control treatment. The application of red photoselective nets had a positive effect on the titratable acidity, the content of total anthocyanins and phenols in the fruit, as well as on the total carotenoids content (0.59%, 5.51 mg C-3-G eq/100 g FW, 1.49 mg GA eq/g FW, 66.3 mg/g FW, respectively) compared to the control (0.45%, 3.50 mg C-3-G eq/100 g FW, 1.26 mg GA eq/g FW, 29.3 mg/g FW, respectively). The pearl net positively influenced the content of pigments, chlorophyll a and b (151 and 179 mg/g FW, respectively) in comparison with the control (132 and 144 mg/g FW, respectively), while total antioxidant capacity was the highest in fruits under the yellow net (1.29 mg AsA eq/g FW). In general, the black anti-hail net performed worse than the photoselective-colored nets. These findings demonstrate a new insight into the potential use of different colored photoselective anti-hail nets for fruit quality modulation of soilless grown blueberries.

Keywords: titratable acidity, total anthocyanins and phenolic content, total carotenoids content, 4-chlorophyll, antioxidant capacity

RESULTS OF THE EVALUATION OF CERTAIN SWEET CHERRY CULTIVARS ON THE SEMI-VIGOROUS 'MAXMA 14'

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Abstract

Sweet cherry is an important fruit crop in R.N. Macedonia. The most common rootstocks which are used for sweet cherry cultivation in our country are 'Mahaleb' (*P. mahaleb*) and 'Mazzard' (*P. avium* L.) seedlings which induce vigorous fruit trees that are challenging to properly manage under more intensive production conditions. This paper presents data from the evaluation of vegetative and fruit-bearing characteristics of four sweet cherries *(P. avium* L.) cultivars: 'Carmen', 'Ziraat 0900', 'Kordia' and 'Regina', with different ripening periods, grafted onto the semi-vigorous clonal rootstock 'MaxMa 14' (*P. mahaleb* x *P. avium*). The trial was set in an experimental orchard in the central part of R.N. Macedonia with a planting distance of 2 x 4 m and data was gathered for six consecutive years since the establishment of the orchard. For the evaluation of the vegetative characteristics, we determined: the trunk-cross-section area and volume of the tree crown. For the assessment of the fruit-bearing characteristics, we determined: yield, average fruit and stone weight, fruit dimensions (width, thickness, and height), fruit firmness, stalk dimensions, stalk pull force, soluble solids content (SSC), and titratable acidity (TA). Based on the results, 'MaxMa 14' could serve as a promising semi-vigorous alternative to the vigorous 'Mahaleb' and 'Mazzard' rootstocks. In terms of the yield and the fruit quality characteristics, statistically, significant differences are present between the evaluated parameters.

Keywords: Prunus avium L., growth, productivity, fruit quality, rootstock, cultivar

IMPACT OF BULL'S EYE ROT ON APPLE FRUIT PROPERTIES UNDER DIFFERENT STORAGE CONDITIONS

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Abstract

Apples are the second most cultivated fruit in Serbia, and by storing the possibility to meet market demands is enhanced throughout the year. During storage, the physiochemical quality of apple fruits could be affected by pathogens and abiotic stress. Among fungal diseases, *Neofabraea alba* is a major pathogen within the complex that causes bull's eye rot in apples during the postharvest period. In this study, economically significant apple cultivars ('Golden Delicious', 'Red Delicious', 'Granny Smith', 'Red Jonaprince', 'Gala', 'Fuji', 'Idared', and 'Braeburn') were artificially inoculated with N. alba (isolate J67/2) and together with the untreated control inspected for physical (weight loss and firmness) and chemical characteristics (total soluble solids and titratable acidity) of fruits. The tests were done before storage and then after the storage period: (I) 82 days in the normal atmosphere -NA and (II) Shelf life- 28 days at room temperature. The higher weight loss was noted after shelf life preservation, while the firmness of the apple slightly varied across all tested cultivars depending on the storage method. The significant difference was evaluated between cultivars and inoculated and healthy fruits as a source of variation. Total soluble solids were the highest in artificially inoculated 'Red Delicious' after SL (8.75%) and 'Idared' after NA storage (13.36%), while the decrease in value was noted in 'Granny Smith' after both storage methods compared to the healthy fruits. The highest decrease in acidity was noted in inoculated 'Gala' fruits by 48.53% compared to healthy fruits after storage termination. Overall, significantly higher titratable acidity was detected in Shelf life fruits compared to NA storage and initial values investigated at the beginning of the research. This research indicates the impact bull's eye rot has on qualitative parameters of apple fruits depending on cultivar and storage method.

Keywords: Neofabraea alba, postharvest, weight loss, firmness, titratable acidity, total soluble solids

TREE GROWTH, PRODUCTIVITY AND FRUIT PROPERTIES OF EARLY RIPENING EUROPEAN PLUM (*Prunus domestica* L.) CULTIVARS

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Abstract

European plum is one of the most important temperate zone fruit species in the northern hemisphere. In the Republic of Serbia (RS), this species is beside apple and raspberry of great importance in terms of production, processing, consumption, export, employment of people and tradition. Therefore, constant improvement of plum production is necessary. The extension of the harvest season and the presence of fresh fruits on the market for a longer period is one of the significant aspects of that improvement. This is achieved by developing new cultivars with an earlier or later ripening time as well as cultivars that have better storage capability. Generally, cultivars with an earlier or later ripening time have a better price on the fresh fruit market. However, these cultivars, particularly of early ripening time have not been present to a significant extent in the orchards in the RS. Bearing this in mind, we investigate tree vigour (TCSA), productivity (yield per tree and yield efficiency), and the most important fruit physical (fruit and stone weight, flesh percentage, fruit dimensions, and sphericity) and chemical properties (contents of soluble solids, total and reducing sugars, saccharose and total acids, as well as ripening index and pH value) of three domestic ('Boranka', 'Čačanska Rana' and 'Valerija') and three introduced ('Katinka', 'Tegera' and 'Opal') early ripening cultivars which were harvested from the middle of the first to the end of the second decade of July. Obtained results showed that significant differences were found among cultivars for all examined characteristics. Overall, the assessed early-ripening cultivars could be grown to some extent in commercial orchards in the RS.

Keywords: Plum, early ripening time, vigour, yield, fruit characteristics

EFFECT OF DIFFERENT APPROACHES TO SOIL SURFACE MAINTENANCE ON WEED INFESTATION AND GROWTH PERFORMANCE OF YOUNG PEACH ORCHARD

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Abstract

The study was carried out in 2020 – 2022 in a fruit-bearing peach orchard established on the territory of the Fruit-Growing Institute – Plovdiv. The object of the study was the 'Redhaven' cultivar grafted on the vegetative rootstock 'GF677'. The following variants of maintaining the soil surface were investigated: soil application of flumioxazin – Pledge 50 WP at two rates (200 and 400 g/ha); foliar treatment with the herbicide combination flumioxazin + quizalofop-ethyl - Pledge 50 WP (200 g/ha) + Targa Super 5 EC (2.0 l/ha); foliar treatment with glyphosate – NASA 360 EC (5.0 l/ha); non-chemical methods: mechanized soil tillage and untreated control. The results for the efficiency of the applied herbicides and rates showed the same trend throughout the years of the study and very good control of the weed vegetation was achieved. In the variants treated with flumioxazin – Pledge 50 WP – 200 g/h and Pledge 50 WP – 400 g/ha, weed species were not detected until the 90th day after the date of treatment. On the 120th day, single plants of purslane species appeared in those variants, which is typical of the development of the so-called late secondary weed infestation. The applied herbicide combination Pledge 50 WP – 200 g/ha + Targa Super 5 EC – 2.0 l/ha acted as a total herbicide and destroyed fully the developed weed vegetation. The results about the effect of the different approaches for soil surface maintenance on the tree growth showed the same trend for higher values of all the analyzed indicators in the variants with the applied weed control compared to the untreated weed-infested control. The highest values for the cross-sectional area and crown volume were reported in the variant treated with the higher rate of flumioxazin – Pledge 50 WP – 400g/ha.

Keywords: weeds, herbicides, growth manifestations, stem cross-sectional area, tree height

MATING DISRUPTION AND POPULATION DEVELOPMENT OF *Grapholita molesta* (BUSCK, 1916) (Lepidoptera: *Tortricidae*) IN APRICOT ORCHARDS

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Abstract

Mating disruption (MD) is a species-specific and environmentally friendly pest management technique. Since the conception of mating disruption, the species-specificity and low toxicity of pheromone applications have led to their consideration for use in area-wide programs to manage invasive moths. *Grapholita molesta* (Busck) (Tortricidae) is a troublesome pest on peaches, pears, nectarines, plums, apples and apricots; its first generation also can inflict significant damage to shoot tips. The aim of this study was to test the effectiveness of mating disruption (MD) in the control of oriental fruit moth (*Grapholita molesta* Busck.) in apricot orchards. The trial of mating disruption in the present study were carried out with ISOMATE® OFM TT dispensers in a 0.9 ha apricot orchard in 2020-2022. According to the list of permitted plant protection products for Bulgaria, ISOMATE® OFM - TT have a category of use - non-professional. According to the manufacturer's recommendation, the placement height is 2/3 of the total height of the trees, once during the growing season. Pheromone traps type "Delta" of the Hungarian company CSALOMON® were used. The ISOMATE OFM TT dispensers, installed before the first flight of OFM at the rate of 250 units per ha, efficiently reduced shoot damage – down to 0.1-0.05%. In the reference orchard with 6 insecticide treatments against OFM, damage reached 4-5.6%. The results indicate that mating disruption for control of *Grapholita molesta* Busck. can be used in IPM management for apricots orchards.

Keywords: dispenser, pheromone, OFM, effectiveness, Isomate

EVALUATION OF LATE SEASON SWEET CHERRY CULTIVARS IN THE REGION OF BELGRADE

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Abstract

Phenological characteristics, vigor, yield, fruit cracking susceptibility, and fruit quality of eight sweet cherry cultivars of very late maturation time were evaluated in the six-year period (2017–2022) in the area of Belgrade. The 'Regina' cultivar was used as a control for comparison. Compared to the control cultivar, the average date of the start of flowering was from 4 days earlier ('Sweetheart') to 1 day later ('Colney' and 'Symphony'). The average harvest date was from June, 19 ('Skeena') to June, 27 ('Staccato'). The lowest average yield per tree (2.6 kg) was obtained in the 'Staccato' cultivar, and the highest (7.0 kg) in the 'Katalin' cultivar. In three of the six years of research (2019-2021), late spring frosts occurred, which significantly reduced the yield. Compared to the control cultivar, a significantly higher yield was found only in the 'Katalin' cultivar, while lower vigor had two cultivars ('Sweetheart' and 'Colney'). The average fruit weight was the highest in the control cultivar - 'Regina' (10.6 g), and it was statistically significantly lower in the two cultivars ('Sweetheart' and 'Staccato'). The most susceptible cultivars to fruit cracking were 'Skeena' and 'Selah'. The content of soluble solids ranged from 19.0% ('Regina') to 20.8% ('Symphony'), and the total acid content ranged from 0.72% ('Skeena') to 0.98% ('Staccato'). The highest score for fruit appearance was received by the 'Regina' cultivar, for fruit firmness by the 'Skeena' cultivar, and for taste by the 'Katalin' cultivar. Based on the obtained results, for cultivation in the Belgrade region, besides the control cultivar 'Regina', the cultivars 'Katalin', and 'Symphony' can also be recommended.

Keywords: Prunus avium, flowering, maturation, yield, fruit cracking index, fruit quality

SUITABILITY OF A NEW TELEMETRIC CAPACITANCE-BASED MEASUREMENT SYSTEM FOR IRRIGATION MANAGEMENT OF STRAWBERRY PLANTS

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Abstract

Water deficiency is a major cause of stress and reductions in crop yield and quality. The growth in food demand and decreasing water resources have been driving forces to develop new technologies for the efficient use of water in agriculture. A number of methods are available to assist growers in determining when water is needed and how much is required. One is to characterize soil/substrate water status by measuring water content or potential. Soil moisture sensing technology has been available to the irrigation market for many years. However, its adoption into common usage has been slow, possibly because of the high price of some sensors or low-quality measurements produced by others. Modern technical solutions using the Internet of Things technologies allow the long-term operation of wirelessly communicating sensors. The suitability of a new wireless smart farming system for controlling the irrigation of strawberry plants was assessed in the study. The system (name: AGREUS®) includes soil/substrate moisture sensors, executive (valve) modules, and an application available on the web portal. Laboratory tests included an appraisal of the precision of soil/substrate moisture measurements carried out with the probes. The calibration procedure involved the determination of a relationship between relative permittivity (probe output) and actual water content for several soils and soilless media. The elaborated coefficients (calibration models) were implemented in a form of software on the web portal. Operational tests were conducted on strawberry plants cultivated in containers under greenhouse conditions. The performed analyses have shown the usefulness of the system for automatic control of irrigation. The system allows for continuous monitoring of changes in moisture and automatic application of irrigation depending on the adopted soil/substrate moisture thresholds.
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Keywords: soil moisture, growing media, water management, irrigation schedulling, *Fragaria* x *ananassa*

IDENTIFICATION OF *XANTHOMONAS ARBORICOLA* PV. *CORYLINA* STRAINS ISOLATED FROM HAZELNUT (*Corylus avellana*) IN MONTENEGRO

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Abstract

Due to market demands and a favorable climate, hazelnut production has increased in Montenegro recently. However, yield is occasionally affected by different hazelnut pathogens. Bacterial blight is one of the most damaging diseases of hazelnut worldwide. In June 2021, leaf spot, bud, and twig necrosis were observed on young hazelnut plants (*Corylus avellana*) cultivar Hall's Giant, near Cetinje, central Montenegro. From symptomatic samples, yellow, convex, and mucoid bacterial colonies were isolated. Fourteen strains were selected based on their hypersensitivity in pelargonium. The pathogenicity of the strains was tested by spraying young leaves of potted hazelnut plants with the bacterial suspension (108 CFU/mL SDW). The reference strain *Xanthomonas arboricola pv. corylina* (Xac) NCPPB 3037 and sterile distilled water (SDW) were used as a positive and negative control, respectively. Lesions appeared on the leaves of all inoculated plants within 5 to 6 weeks after inoculation, while leaves sprayed with SDW remained symptomless. All strains were Gram-negative, catalase positive, oxidase negative, obligately aerobic, hydrolyzed starch, gelatin, and esculin, did not reduce nitrate and did not grow at 37°C and in the presence of 5% NaCl, showing the same biochemical profile as the reference Xac strain. PCR with XarbQ-F/XarbQ-R primers produced a fragment of 402 bp in 14 strains and the reference Xac, confirming their affiliation to *X. arboricola* species. Additionally, PCR analysis with primers XapY17-F/ XapY17-R, produced a single band of 943 bp. Amplification and sequencing of the partial rpoD gene of two selected strains (GenBank Nos. OQ271224 and OQ271225), showed that the strains share 99.47% to 99.92% rpoD sequence identity with Xac strains CP076619.1 and HG992342.1 isolated from hazelnut in France and HG992341.1 in USA. Therefore, the strains isolated from hazelnut in Montenegro were identified as *Xanthomonas arboricola pv. corylina.*
This study was supported by Administration of Food Safety, Veterinary and Phytosanitary Affairs, Montenegro, partly funded by Ministry of Science and Technological Development, Montenegro; and the Ministry of Education, Science and Technological Development, Republic of Serbia and University of Belgrade, Faculty of Agriculture (Contract No. 451-03-68/2022-14/200116).

Keywords: bacterial blight, leaf spot, bud necrosis, pathogenicity, biochemical characteristics, PCR, rpoD

THE EFFECTS OF CROP LOAD REDUCTION ON APPLE (*Malus domestica* Borkh) YIELD AND FRUIT QUALITY

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Abstract

Apple fruit thinning represents a mandatory practice by which we regulate crop load, fruit size, and yield as the ultimate goal in fruit production. The purpose of the present research was to clarify the impact of crop load reduction on fruit set, yield, and fruit quality of apple cultivars 'Gala', 'Fuji', and 'Mairac'. Fruit clusters were removed after the June drop and crop load levels were defined at 45 (low) and 80 (high) fruit clusters per tree in 'Gala', 80 (low) and 110 (high) for 'Fuji' and 45 (low), 80 (medium) and 110 (high) in 'Mairac'. Fruits were sampled at harvest and subjected to analysis which included: fruit weight (g) and diameter (mm), fruit size distribution, firmness (N), starch index (1-10), soluble solids content (SSC, %), and sugars content (mg 100 g^{-1}), titratable acidity (TA, % malic acid). The number of fruits per tree at harvest, yield, and yield efficacy was correlated with crop load level, while the highest fruit weight was obtained at the low crop load levels in all cultivars. Fruit size distribution shifted to the higher class categories at the lower crop load levels. Fruits were softer and the starch index was higher at lower crop loads in 'Gala' and 'Mairac', presuming the advanced maturity. Fruits soluble solids content (SSC) and titratable acidity (TA) were the highest in 'Mairac' among cultivars, with the highest levels at the highest crop load. In 'Gala' and 'Fuji', SSC and total sugars content were higher in fruits at the lower crop loads.

Keywords: thinning, fruit cluster, fruit weight, SSC, TA, flesh firmness

FIRST EVIDENCE OF THE BROWN MARMORATED STINK BUG AND ITS POPULATION SIZE IN PERENNIAL CROPS IN CROATIA

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Abstract

The brown marmorated stink bug (*Halyomorpha halys* (Stål, 1855)) is a highly invasive insect pest that has recently spread throughout Europe, causing enormous economic damage. In Croatia, this pest was first detected in 2017. Its rapid spread from urban to rural areas and its first mass emergence were detected in a soybean field in Zagreb County in 2019. In this paper, we report the first occurrence of the brown marmorated stink bug in perennial crops in five counties in Croatia (Zagreb County, Osijek-Baranja County, Vukovar-Syrmia County, Primorje-Gorski Kotar County, and Istria County). It was detected in nine economically important perennial crops [apple (*Malus domestica* Borkh.), apricot (*Prunus armeniaca* L.), sweet cherry (*Prunus avium* L.), fig (*Ficus carica* L.), grapevine (*Vitis vinifera* L. 1753), pear (*Pyrus communis* L.), plum (*Prunus domestica* L.), olive (*Olea europea* L.), and hazelnut (*Corylus avellana* L.)]. The size of the population varied from a few to 80 individuals. The highest population size was found in hazelnut (79 individuals), pear (31 individuals), and sweet cherry (22 individuals). Given recent reports of economic damage by this pest in our neighbouring countries, the observed population size is a cause for concern. Considering the invasiveness of the pest and the favourable climatic conditions for its spread in Croatia, it is strongly recommended to monitor its population size in all agricultural crops in order to prevent economic losses.

Keywords: Halyomorpha halys (Stål, 1855), invasive species, hazelnut, pear, sweet cherry, population growth, fruit production

EFFECTIVENESS OF ORGANIC AND SYNTHETIC PRODUCTS ON THE OCCURRENCE OF GRAY MOULD AND STRAWBERRY FRUIT QUALITY

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Abstract

In recent years, the demand for strawberries on the world market is constantly increasing, primarily due to their unique taste and health benefits. Fruits produced without the use of agrochemicals, which are at the same time safer, more nutritious and healthier, are in particular demand. These forced researchers to identify ecologically safe techniques that can satisfy consumer preferences. Although many aspects of environmental methodologies in strawberry cultivation have already been investigated, the application of biosafe fertilizers and/or pesticides which greatly contribute to healthy food is still rare. Based on this background, a new formula of the liquid vermicompost-based product (VCMo), consisting of microbes from *Trichoderma*, *Bacillus*, *Pseudomonas* and *Azotobacter* genera, suitable for both nutrition and protection, has been developed at the Fruit Research Institute Čačak (Republic of Serbia). Its effectiveness was assessed by measuring the degree of gray mould (*Botrytis cinerea* Pers.) infection and changes in quality (fruit weight and dimensions, total phenolic content and antioxidant activity) of strawberry fruits. In addition, its efficacy has been compared to the biodegradable product (FitoBotryfun) and a combination of synthetic fungicides (Switch+ Signum). As regards the control of gray mould, the highest efficacy was achieved by the Switch+ Signum application, followed by VCMo, while the efficacy of FitoBotryfun was less satisfactory. On the other hand, the highest quality of the strawberry fruits was observed in VCMo treatment followed by FitoBotryfun and Switch+ Signum. The obtained results suggest that VCMo can be an alternative to chemical-based fungicides in *B. cinerea* control programme of strawberries. All this together qualifies VCMo as a promising biological treatment that meets the needs of both growers and consumers.

Keywords: *Fragaria* x *ananassa* Duch., *B. cinerea*, *Trichoderma sp.*, *Bacillus sp.*, phenolics, antioxidative activity

SPIROTETRAMAT - APPLICATION IN FRUIT GROWING, EFFICACY, RESISTANCE AND TOXICITY

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Abstract

Spirotetramat is one of the novel structural pesticides in the class of spirocyclic tetronic acid derivatives used to control whiteflies, aphids, scale insects, mealybugs, psyllids, thrips, and other sucking insects on agricultural crops. Spirotetramat is used on vegetables, field crops and fruits such as pome and stone fruits, grapes, citrus, small fruits, nuts, and bananas. Spirotetramat is a systemic insecticide that penetrates the leaf cuticle and migrates in the plant through the phloem and xylem. Plant protection products containing spirotetramat are currently registered in 24 EU Member States. "Movento" a plant protection product containing spirotetramat, is available on the Croatian market for use on various crops in Croatia. Spirotetramat could be used instead of banned insecticides such as neonicotinoids and some banned pyrethroids but can also replace currently approved active substances such as spinosad and abamectin. The efficacy of spirotetramat on fruit species varied across a broad spectrum of sucking pests. Spirotetramat showed slow action with prolonged activity and mostly achieved good efficacy against larval stages (juveniles). The effect on adult stages was not always satisfactory, although the reproduction of adult females was affected. Spirotetramat does not appear to exhibit cross-resistance to other conventional insecticides unless they are in the same chemical class. The objective of this review is to summarize the approved uses of spirotetramat against fruit pests in Croatia and EU Member States and to discuss the available studies that investigated the efficacy of spirotetramat under laboratory and field conditions against adult and juvenile stages of various fruit pests. The review includes the results of the studies that investigated the efficacy of spirotetramat on pome and stone fruit, small fruit, and citrus, and shows lower efficacy against aphids and pear psylla. Some of the studies suggest that spirotetramat could be included in integrated pest management systems.

Keywords: Tetronic acid derivative, insecticide, authorizations, pest control, sucking pests, survival

FUNGAL FOLIAR DISEASES OF STRAWBERRY IN CROATIA – ETIOLOGY, EPIDEMIOLOGY AND CHOROLOGY

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Abstract

Numerous diseases occur on strawberries and some of which appear primarily preventively on the leaves. Long-term monitoring of disease incidence in strawberry plantations in Croatia has identified four fungal diseases that occur almost regularly on strawberry leaves, but with very different intensity depending on cultivars and weather conditions in certain years. It is very difficult to distinguish them from each other based on disease symptoms alone, and an etiological diagnosis is required for accurate identification. Therefore, the identification of the causal agent of the disease was based on the morphology of the sporulation organs of the pathogenic fungi (fruiting bodies and spores). The following pathogenic fungi were found: *Ramularia grevilleana* (syn. *Mycosphaerella fragariae*), the causal agent of common leaf spot disease; *Diplocarpom earlianum* (syn. *Marssonina fragariae*), the causal agent of leaf scorch; *Gnomoniopsis comari* (syn. *Gnomonia comari*), the causal agent of leaf blotch and *Paraphomopsis obscurans* (syn. *Dendrophoma obscurans*), the causal agent of leaf blight. Common spot and leaf scorch occur earlier in the growing season (in spring), while leaf blotch and leaf blight appear in the later part of the growing season (in summer). The intensity of the disease is highly dependent on the strawberry cultivar, due to differences in sensitivity/resistance among strawberry cultivars. The severity of disease symptoms depends not only on the sensitivity of the cultivars but also on the age of the leaves and weather conditions, especially in the case of a common leaf spot, which can be a cause of incorrect identification. The occurrence of these diseases is also related to the type of cultivation, in (open or protected areas). The incidence of these diseases is very low in protected areas, but in the open field, they are the most common diseases of strawberries.

Keywords: Fragaria x ananassa, common leaf spot, leaf scorch, leaf blotch, leaf blight

EVALUATION OF SUSCEPTIBILITY OF PEACH AND NECTARINE ACCESSIONS IN THE NATIONAL FRUIT GERMPLASM COLLECTION AT CREA-OFA IN ROME (ITALY) TO PEACH LEAF CURL

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Abstract

Peach and nectarine cultivars are affected by several pathogens, among which also the fungus *Taphrina deformans* Berk. causing peach leaf curl, a serious disease in most cultivation areas around the world. In addition, agriculture is facing environmental pollution caused by treatments on the one hand and progressive restrictions imposed by European and national legislations on the other, especially in the use of copper and dithiocarbamate, necessary to control *Taphrina deformans*. Over the last 30 years breeding for leaf curl resistance has not been particularly fruitful worldwide, and no recent systematic assessment of the susceptibility of the most commercially widespread and autocthonous cultivars has been reported. During 2018-2020 we carried out a screening on leaf curl susceptibility in the large peach and nectarine collection held in the National Collection of Fruit Germplasm at the Research Centre for Olive Fruit and Citrus. We surveyed 660 varieties of peach, 276 of nectarine and 56 of clingstone cultivars and selections, for a total of 981 accessions. Infection was evaluated on whole canopies, about four weeks after full bloom, on a 0-4 scale (0 = no visible symptoms; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100% of leaves with symptoms). Only two cultivars scored 0; while 61 accessions (6.22%) scored 1; 126 accessions (12.84%) scored 2.334 accessions (34.05%) scored 3 and 460 accessions (46.89%) scored 4. This work generally confirms the results obtained for the same accessions by other authors in the past, but also updates the susceptibility to the pathogen of other cultivars for which such information was missing.

Keywords: Prunus persica, *Taphrina deformans,* germplasm collection, susceptibility

SESSION 4

POSTHARVEST, FRUIT QUALITY AND FOOD SCIENCE

ORAL PRESENTATIONS

THE EFFECTIVENESS OF PRIMING AGENTS ON QUALITATIVE ATTRIBUTES AND PHYTOCHEMICAL PROPERTIES OF STRAWBERRY FRUITS

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Abstract

Strawberry (*Fragaria* x *ananassa* Duch.) is one of the most popular fruits in the world due both to its taste and health-promoting properties. The fruit's organoleptic quality characteristics include aroma, sweetness, acidity, and fruit firmness. Numerous studies propose the application of chemical agents to improve fruit quality. The use of priming agents (PAs) is a promising strategy that is being widely expanded over recent years to enhance the nutritional quality of fruits. To this end, our study aimed to evaluate the effect of the pre-harvest application of an array of priming agents (melatonin, sodium alginate, their combination, and putrescine) on the qualitative attributes and phytochemical properties of an early-harvested strawberry cultivar. The priming agents were applied at three successive developmental stages, namely large green (LG), small white (SW), and large white (LW). Fully-ripe strawberries without visible damage or disease symptoms were harvested and an array of quality attributes [(fresh fruit weight, volume, color, flesh firmness, soluble solids content (SSC), and titratable acidity (TA)] were determined. In addition, an array of phytochemical properties were assessed [anthocyanins (pelargonidin-3-glucoside (Pg-3-gluc), cyanidin-3-glucoside (Cy-3-gluc) and pelargonidin-3-rutinoside (Rg-3-rut), flavonols (quercetin, kaempferol, myricetin, and other flavonol glycosides), flavan-3-ols (proanthocyanidins and catechins), hydroxybenzoic and hydroxycinnamic acid derivatives (caffeic, ferulic and p-coumaric derivatives, gallic, and other hydroxybenzoic derivatives, ellagic acid, and ellagitannins (ellagic acid conjugates; hydrolysable tannins such as sanguin H6 sanguinarin, lambertianin, etc).]. The potential beneficial effect of the application of such priming agents on the qualitative and phytochemical properties of strawberries is discussed.
This work has received funding from the European Union's Horizon Europe Program with the acronym PRIMESOFT (Grant Agreement: 101079119)

Keywords: Fragaria, priming agents, biostimulants, melatonin, sodium alginate, putrescine, quality

PLUM CULTIVARS GROWN IN ROMANIA – A COMPARISON BETWEEN TRADITIONAL CULTIVARS WIDELY GROWN AND PROMISING NEW ONES

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Abstract

Plum is the most important species in Romania, where the climatic conditions are favorable for the spread of plum cultivars belonging to the European group. The plum assortment is constantly changing according to the requirements of consumers and growers. This paper presents the results regarding the behavior of new promising plum cultivars ('Andreea', 'Romanța', 'Milenium', 'Jojo', 'Haganta', 'Toptaste', 'Topfirst', 'Cacanska Lepotica') comparative with traditional cultivars widely grown in Romania ('Stanley', 'Anna Spath', 'Early Rivers', 'Tuleu Gras' and 'Centenar'). The cultivars are located in a field trial established in 2015 within the Genetics and Breeding laboratory of the Research Institute for Fruit Growing Pitești, Romania. The trees, grafted on the 'Mirobolan C5' rootstock, were planted at a distance of 4 x 3 m, and the crowns were trained as the flat open center. During the 2018-2022 period, the following observations and determinations were carried out: ripening time, yielding capacity in kg/tree, fruit quality (weight, flesh firmness, soluble solids content), and behavior to Plum Pox Virus (PPV). Following the observations and determinations made the 'Topfirst' and 'Cacanska Lepotica' were noted by earliness (3rd decade of July) at the same time as 'Centenar' but not earlier than the old cultivar 'Early Rivers'; 'Jojo' and 'Haganta' are late ripening in the same period as the old 'Anna Spath'; 'Romanța', 'Jojo', 'Haganta' are very productive cultivars (over 10 kg/tree in the six-year after planting), larger than the 'Stanley' known as one of the most productive cultivar; 'Romanța', 'Milenium', 'Haganta' has very large fruits (over 60 g on average) much larger than the fruits of the five old cultivars; 'Jojo' and 'Haganta' are resistant to PPV while all old cultivars are sensitive. These cultivars can complement the old Romanian plum assortment, and even replace some of them.

Keywords: Prunus domestica L., assortment, ripening time, yield, fruit quality, PPV resistance

VEGETATIVE, GENERATIVE CHARACTERISTICS AND BIOACTIVE PROPERTIES OF PEACH 'SUNCREST' UNDER RED AND WHITE PHOTOSELECTIVE ANTI-INSECT NETTING

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Abstract

Nowadays, nets play an irreplaceable role in the production of many fruit species due to the extreme weather conditions caused by climate changes and the high-quality demands of consumers. Not so long ago, a new technology emerged, namely photoselective and anti-insect nets. In addition to providing basic protection (from hail, wind, excessive solar radiation, etc.), photoselective nets allow spectral manipulation of transmitted light, thus promoting the desired photomorphogenic responses of plants, while anti-insect nets provide protection against certain pests by creating mechanical barrier. The main objective of this study was therefore to determine whether red and white photoselective anti-insect nets (mesh size 2.4 x 4.8 mm) differ in their effect on vegetative, generative traits and bioactive properties of peach 'Suncrest'. The study was conducted in a peach orchard in Vratišinec, northern Croatia. Data were analysed using the T-test in SAS Ver. 9.4 statistical software (SAS Institute, NC). Statistically, significant differences were obtained for the following traits: leaf petiole length, fruit weight, width, radius, and volume, L^*, a^*, b^*, C^* and h° fruit ground colour parameters and a/b, CCL, COL, $CIRG^1$ and $CIRG^2$ fruit ground colour indexes and for total fruit polyphenol content. For the other vegetative (trunk cross-sectional area, length, internode length, thickness and density of internodes of the one-year shoot, as well as leaf blade length, width, surface and shape index), morphological (fruit length, shape index and endocarp weight), productive (yield, yield efficiency, fruit flesh ratio and density, share of decayed fruit), basic quality (L^*, a^*, b^*, C^* and h° fruit additional colour parameters and a/b, CCL, COL, $CIRG^1$ and $CIRG^2$ fruit additional colour indexes, fruit firmness, total soluble solids, titratable acidity and total soluble solids/titratable acidity ratio) traits and bioactive properties (fruit antioxidant potential ABTS and DPPH, β-carotene content and total anthocyanin content) no significant differences were obtained.

Keywords: light manipulation, netting, sustainable production, fruit quality, bioactive properties

CHANGES IN FRUIT QUALITY DURING RIPENING OF TWO EUROPEAN PLUM CULTIVARS

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Abstract

The maturity stage at harvest is one of the main determinants of fruit quality. In order to determine the optimal harvest time of plum fruits for fresh consumption, it is important to highlight the quality changes that occur during ripening. Therefore, the aim of this study was to evaluate the physical, chemical, antioxidant and sensory properties of the fruits during ripening of two European plum cultivars, worldwide cultivated 'Stanley' and the new late-ripening plum cultivar 'Petra', released at the Fruit Research Institute, Čačak. Fruits of 'Stanley' were harvested four times during the 28-day period, while three harvests were made seven days apart for 'Petra'. Although similar patterns of change in some important quality parameters were observed in both cultivars (i.e., fruit firmness and total acidity decreased significantly, soluble solids content as well as content of total sugars, invert sugars, and sucrose increased), almost all examined physical attributes (fruit weight, stone weight, dimensions of fruit, shape index, stalk length, force of detachment stalk from fruit) changed differently among the cultivars studied during ripening. The content of total phenolic compounds and antioxidant capacity slightly decreased in 'Petra' during ripening, while no clear trend was determined in 'Stanley'. Sensory analysis included evaluation of appearance, aroma, taste and consistency of the plum fruit and the results showed that the later harvested fruits of both cultivars had better taste and aroma. The quality changes during ripening of 'Stanley' plum were significantly pronounced and consequently the fruit characteristics and suitability for fresh consumption differed between the harvests. On the other hand, overall quality of 'Petra' fruit was more consistent during the ripening period indicating that it has the potential to supply the local market with fruit of uniform quality regardless of harvest time.

Keywords: Prunus domestica L., 'Stanley', 'Petra', harvest, firmness, sensory evaluation

SESSION 4

POSTHARVEST, FRUIT QUALITY AND FOOD SCIENCE

POSTER PRESENTATIONS

V Balkan Symposium on Fruit Growing
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CHARACTERISTICS OF EUROPEAN AND ASIAN PEAR CULTIVARS AND PEAR HYBRIDS COMPARED TO PRODUCTION POTENTIAL UNDER SOUTH MORAVIAN CONDITIONS

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Abstract

Commercial cultivation of Asian pears and pear hybrids is not yet very common in Central Europe. The pear species can be well hybridized with each other and the results so far indicate that there is great potential in the cultivation of interspecific hybrids. The purpose of this study is to compare the characteristics of commonly grown European pear cultivars with Asian cultivars, hybrids and new hybrids bred at the Institute of Fruit Growing in Lednice. At first sight, the Asian pears differ in shape from the European ones. Compared to European pears, they are much juicier, but at the same time less aromatic. They often have a bitter skin which adversely affects the overall taste. Some Asian cultivars have a strong tendency to overbear. Twenty promising cultivars and hybrids were selected for comparison and evaluated for flowering and ripening dates, fruit weight, appearance, flavour, juiciness and flesh aroma. Total soluble solids (refractometer), firmness (penetrometer), and titratable acids content were also determined. The heaviest fruits were those of 'Kieffer' (339 g on average), while the lowest weight was those of strongly overbearing 'Nanguo' (50 g on average). The sweetest fruit was from the interspecific hybrid 'Wu Jiu Xiang' (18.9% of total soluble solids), which also placed second in acidity (0.4 % of total titratable acids). Compared with the cultivars, some of the new hybrids were well above average in the acid content (more than 0.7 % of total titratable acids). The results of firmness showed that the thinnest skin was that of the Chinese 'Zao Su Li', pierced by a pressure of 0.53 MPa, while the thickest skin was that of the European (Czech cultivar) 'Bohemica' (1.48 MPa).

Keywords: Pyrus, pear, pomology, fruit quality, phenology

NUTRITIONAL PROPERTIES AND QUALITY OF PAW-PAW FRUIT FROM CROATIA

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Abstract

Asimina triloba (L.) Dunal, commonly known as paw-paw is the only temperate fruit species in the family Anonacae of the genus *Asimina*, otherwise characteristic of tropical climates. *Asimina triloba* L. is the species with the largest edible fruit native to North America. Even in native areas of this species, the fruits are mostly collected from wild populations, while commercial cultivation is limited to small private orchards. The fruits of this species are becoming increasingly popular, mainly because they have great potential for fresh consumption, but also for processing, and have a number of beneficial effects on human health. The fruits of paw-paw are characterized by high energy value, but also by high nutritional potential, as they contain significant amounts of various vitamins, minerals, and other phytochemicals important for human health. Since there are also small orchards of this species in the Republic of Croatia, the aim of this work was to determine the nutritional potential, bioactive compound content, and antioxidant capacity of the paw-paw fruits from different growing areas in Croatia. All analyzed paw-paw fruits from Croatia are characterized by a high content of dry matter (average value regardless of location 23.76%) and high values of total sugars (average value 20.11%). According to the analyzed bioactive compounds, the fruits also contain high values of vitamin C (average 35.69 mg/100 fw), total phenols (average 224.02 mg GAE /100 g fw), and β-carotene (average 95.62 µg /100 g fw), as well as high values of antioxidant capacity (average 2412.92 µmol TE/L). According to the analyzed physicochemical parameters, paw-paw fruit can be considered as a nutritionally valuable raw material, and all the studied locations (mainland and coastal Croatia) are suitable for cultivation of this fruit species with significant nutritional, biological, and functional potential.

Keywords: locations, bioactive compounds, total phenols, β-carotene, vitamin C, antioxidant, capacity

MOVING BEYOND THE MOLECULAR MECHANISM OF SUPERFICIAL SCALD IN APPLE FRUIT

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Abstract

Although low-temperature storage can delay apple (*Malus domestica* Borkh.) fruit ripening and senescence, it may cause the superficial scald disorder under subsequent ripening at room temperature, which seriously affects fruit quality. The aim of this research was the in-depth characterization of the molecular mechanisms underlying scald development, using high-throughput sequencing technologies (transcriptomics, methylomics), coupled with mass spectrometry-derived proteomics and metabolomics. 'Granny Smith' fruits were harvested at two harvest (early and late) stages, and after 3 months of cold storage (0 ^{o}C), they were exposed to room temperature (20 ^{o}C) for scald development. Data indicated that scald symptoms were mostly observed in early harvested apples, which is highly linked to their enhanced transcriptional and translational activity during and just after cold storage. Analysis of post-translational protein modifications (PTMs) also revealed strong oxidation events following cold exposure. Global and target methylation analysis identified several genes, including α-farnesene synthase (AFS) and polyphenol oxidase (PPO), that subjected to cold-derived epigenetic alternations. RNAi-based silencing of α-AFS and PPO genes through pump-infiltration and injection in apple peel influenced scald phenotype. The combination of large scale -omics and functional characterization approaches may contribute to understand the molecular mechanism of superficial scald development in apple fruit.

Keywords: apple, methylation, proteomics, RNA silencing, superficial scald, transcriptomics

APRICOT KERNELS AS A NEW SOURCE OF PROTEIN AND ANTIOXIDANTS

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Abstract

At the time of climate change, it is important to seek a new sustainable additional source of nutrition. Thus, the use of many natural resources as possible and minimizing the amount of waste in food or technological processing. A by-product of apricot fruit, the apricot kernel is except a high content of protein a rich source of bioactive compounds. In this study apricot kernels with the sweet taste of forty-two different apricot cultivars were analyzed. All these cultivars grow in conditions in Czechia, but their geographical origin is different. The attractiveness of kernels was evaluated by measuring the weight (1.0 ± 0.2 g on average) and kernel-to-stone weight ratio (31 ± 1% on average). The percentage of protein content (22 ± 4% on average), when the range was 28.8 to 14.6%. In addition, an analysis of total phenolics, flavonoids, and antioxidant capacity was performed. The pilot experiment for the dispersibility index of apricot kernels and mineral content (potassium, sodium, calcium, magnesium) was performed. According to the obtained results, the apricot cultivars were evaluated as non/perspective in their kernel processing.

Keywords: P. armeniaca, nutritional value, sources of food, fruit, kernel

QUALITY OF DRIED SOUR CHERRIES FROM DIFFERENT SERBIAN CULTIVARS

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Abstract

Dried fruit is classified as a nutritionally highly valued food due to its high content of phenolic compounds and antioxidant capacity. Furthermore, due to a high content of natural sugars giving the body the necessary energy, dried fruit is an essential part of a balanced meal. Therefore, the aim of our paper is to examine the quality of dried sour cherry from newly developed and indigenous cultivars originating from Serbia. Sour cherry cultivars and promising genotypes developed at Fruit Research Institute, Čačak ('Šumadinka', 'Sofija', 'Nevena' and 'GV-10') and autochthonous cultivars 'Oblačinska' and 'Feketićka' were used for testing. Drying of pitted fruit was performed in an experimental drier at an air temperature of 70 °C until reaching 75% of the total dry matter. Contents of total dry matter, sugars, total acids, as well as sugar/acid ratio and pH value were determined in fresh fruit. Large discrepancies manifested in the values of evaluated parameters point to distinct varietal specificities. Besides the aforementioned parameters, total phenols and antioxidant capacity, as well as sensory characteristics (appearance, flavour, aroma, and consistency) were analyzed in dried sour cherry fruits. Based on the results of sensory analyses of dried sour cherry fruits, the cultivar 'Feketićka' had the best, whereas cultivar 'Šumadinka' received the lowest grades, which is consistent with the sugar/acid ratio. On the other side, dried fruits of cultivar 'Feketićka' had the lowest values of contents of total phenolics and antioxidant capacity, whereas the highest values were found in cultivar 'Sofija'. Based on evaluated quality parameters, all tested cultivars have been found suitable for processing by drying. Sensory analysis revealed that the dried fruits of all tested sour cherries had supreme sensory quality.

Keywords: chemical composition, phenolic content, antioxidant capacity, air-drying, sensory analysis

THE LATER, THE BETTER? DIFFERENCES IN FIELD PERFORMANCE AND FRUIT QUALITY TRAITS IN NEWLY INTRODUCED ITALIAN SHORT-DAY STRAWBERRY CULTIVARS

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Abstract

The aim of this study was to compare newly introduced mid- and late-ripening strawberry cultivars ('Arianna', 'Tea' and 'Federica') with the commercially important cultivar 'Joly' to identify the best-performing ones for extended market supply. A field study was carried out in a strawberry plantation situated in the municipality of Šid (Serbia), in the period of 2021–2022. The orchard was planted in July 2020 in double rows on beds covered with black polyethylene foil. Cultivars were evaluated for their flowering and ripening time, yield components, and plant growth, as well as for biometrical fruit traits (fruit weight, index of fruit shape) and nutritional value (the content of soluble solids - SSC, total acids - TA, vitamin C, total anthocyanins –TACY, total phenolics - TPC and total antioxidant capacity - TAC). This research revealed that the earliest average beginning of ripeness was recorded in cultivar 'Arianna' (May 19), while the latest was in cultivar 'Federica' (May 29). The number of branch crowns and leaves per plant was significantly lower in cultivars 'Tea' and 'Federica' compared to the cultivar 'Joly', whereas no significant differences in plant height were observed among the tested cultivars. 'Tea' was superior in terms of highest productivity (947 g/plant and 4.17 kg/m^2), followed by the cultivar 'Joly' (865 g/plant and 3.81 kg/m^2). Contrary to this, the lower yield was found in the two other tested cultivars 'Federica' (698 g/plant and 3.07 kg/m^2) and 'Arianna' (773 g/plant and 3.40 kg/m^2). The most productive cultivar 'Tea' had the largest fruit weight (29.7 g) and it was also characterized by the lowest content of TA, TACY, and TPC (0.56%, 18.5 mg PG-3-G eq 100 g^{-1} FW and 0.72 mg GA eq g^{-1} FW, respectively). Significantly higher amounts of soluble solids were found in all newly introduced cultivars in comparison to the standard cultivar 'Joly' (9.15%). The differences in TAC levels between 2021 and 2022 were significant showing higher values in the second year of trial with the dominance of cultivar 'Arianna' (1.24 mg AsA eq g^{-1} FW).

Keywords: ripening time, plant growth, productivity, fruit size, nutritional value

EFFECT OF EXTENDED COLD STORAGE IN 'FRENCH PLUM' ON ORGANOLEPTIC CHARACTERISTICS AND DEVELOPMENT OF INTERNAL BROWNING

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Abstract

Until recently, 'French plum' Chilean production has been traditionally export in its dried form. Nevertheless, in the last few years, some companies have begun exporting it in fresh form due an increase of the demand of it in Asiatic market. China is the only destination for Chilean 'French plums' and, by the distance between both countries, the shipping transport take, at least, 35 days. Extended cold storage leads to chilling injuries, which are a series of physiological disorders that appears after the fruits are removed from cold storage, unfortunately detected by the consumers. In this type of plums, internal browning is the most common symptom of chilling injuries. The aim of this study is to analyze the effect of 2 periods of extended cold storage: 35 and 50 days. The evaluations were made after each cold storage plus 3 days at 20°C. For examination of internal browning, a visual scale of 4 points was used. Furthermore, flesh color, flesh firmness, solid soluble content and acidity were measured. The results shown the more extensive cold storage the stronger intensity of internal browning. Further investigations of post-harvest technology and physiology are required to develop suitable commercial management of 'French plum'.

Keywords: ripeness, chilling injuries, 'French plums', cold storage, flesh color

BIOACTIVE COMPOUNDS IN SEEDS OF RASPBERRY (*Rubus idaeus* L.) CULTIVARS GROWN UNDER NORWEGIAN CONDITIONS

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Abstract

Raspberries are considered enjoyable, refreshing fruits with an outstanding taste and aroma that provides energy and contribute to a balanced diet. The contents of nutrients in raspberries depend on the cultivar, cultivation type, soil characteristics, ripeness, storage time, and post-harvest technologies. The objective of this study was to analyze the fatty acids and polyphenolic composition of seeds from 17 raspberries (*Rubus idaeus* L.) cultivars grown in Norway. The composition of fatty acids was determined according to the standard method of capillary gas chromatography. The separation and quantification of the polyphenols were performed using a Dionex Ultimate 3000 UHPLC system connected to TSQ Quantum Access Max triple-quadrupole mass spectrometer equipped with heated electrospray ionization (HESI) source. Out of 25 detected fatty acids, unsaturated linoleic acid (up to 58.65% in 'Borgund'), linolenic acid (up to 37.31% in 'Stiora') and oleic acid (up to 17.72% in 'Agat') were the most abounded. Saturated fatty acids palmitic and stearic acids were quantified in small amounts and the highest was in 'Balder' (up to 2.38% and 0.80%, respectively). The sum of quantified polyphenols was the lowest in the cultivar 'Ninni' (953.0 mg/kg) and the highest in 'Glen Dee' (1829.69 mg/kg). Ellagic acid was predominant in raspberries seeds, and it ranged from 884.72 ('Stiora') to 1611.76 mg/kg ('Glen Dee'), followed by p-coumaric acid (from 2.18 in 'Vene' up to 118.69 mg/kg in 'Glen Dee') and quercetin 3-O-glucoside (from 2.73 'Anitra' up to 24.92 mg/kg 'Glen Ample'). The variation in analyzed content of the studied chemical compounds in Norwegian raspberry seeds helped us differentiate examined cultivars and proved that the kernel`s composition was attributed to genetic factors. Besides, according to the polyphenolic and fatty acids profile, can be concluded that raspberry seeds can be used for the production of `functional food`.

Keywords: fatty acids, polyphenols, functional food, linoleic acid, ellagic acid

INFLUENCE OF DIFFERENT APPROACHES TO SOIL SURFACE MAINTENANCE ON THE CONTENT OF LEAF PIGMENTS AND ESSENTIAL NUTRIENTS IN APRICOTS

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Abstract

The study was carried out in 2020-2021 in a young apricot orchard established on the territory of the Fruit Growing Institute – Plovdiv. The object of the study was the 'Goldrich' cultivar. The following variants of soil surface maintenance were studied: soil application of flumioxazin – Pledge 50 WP at two rates (200 and 400 g/ha); foliar application of the herbicide combination flumioxazin + quizalofop-ethyl – Pledge 50 WP (200 g/ha) + Targa Super 5 EC (2,0 l/ha); foliar treatment with glyphosate – NASA 360 EC (5,0 l/ha); non-chemical methods: mechanical soil tillage and weed-infested (untreated) control. The contents of chlorophyll and essential nutrients (N, P, K, Ca, Mg and Fe) in apricot leaves were determined. The best results for chlorophyll a, b, and a + b content were obtained in the variants treated with Pledge 50 WP (200 g/ha) + Targa Super 5 EC (2,0 l/ha) and Pledge 50 WP (400 g/ha). Chemical weed control favoured the accumulation of larger amounts of nitrogen, phosphorus, potassium, and magnesium in the leaves, and the differences with the weed-infested control were statistically proven. These data show a lack of depressing influence of applied herbicides and doses on the development and physiological status of young apricot trees, which gives reason to apply them for controlled weeding in the first years after the establishment of plantations.

Keywords: apricot, herbicides, chlorophyll a, chlorophyll b, chlorophyll a+b, mineral nutrients

RESULTS OF BIOMETRIC ANALYSES OF FRUITS OF SELECTED SWEET CHERRY HYBRIDS

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Abstract

The study was conducted in the period 2020 – 2022 at the Fruit-Growing Institute in Plovdiv, Bulgaria. The object of the study was six newly bred sweet cherry hybrids, selected from a total of 450 seedlings and propagated on the standard 'Mahaleb' rootstock. All six hybrids were grown in a collection plantation at a planting distance of 5 × 4 m, following a standard technology. The data from the biometric analyses of the fruits of the hybrids 'No.17-90', 'No. 17-37', 'No. 28-105', 'No. 3-103', 'No.4-93' and 'No.2-24' were compared with those of the standard cultivars 'Bigarreau Burlat', 'Bing' and' Van'. The results show that hybrid 'No.17-90' has the largest fruits – almost 10 g. The fruits of hybrids 'No.17-37' and 'No.28-105' also have a higher weight than those of 'Van' cultivar. The fruit weight of the hybrids 'No. 3-103' and 'No. 4-93' is larger than that of the standard cultivar 'Bigarreau Burlat'. Hybrid 'No. 17-90' has the highest fruit flesh yield. As a result of the present study, as well as on the basis of other previous studies on the same selected sweet cherry hybrids, we consider it appropriate to present elites 'No. 17-90' and 'No. 17-37' for official recognition as new, original sweet cherry cultivars.

Keywords: Prunus avium L., fruit weight, fruit size, maturity date

'AMIRA' VERSUS 'REGINA': VARIATION IN BIOMETRICAL TRAITS AND CHEMICAL COMPOSITION ACROSS THE HARVESTS OF ORGANICALLY GROWN PRIMOCANE FRUITING RASPBERRY CULTIVARS

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Abstract

Two Italian primocane fruiting raspberry cultivars, 'Amira' and 'Regina', were grown in the village Smilovac, central Serbia, under the organic production system. The aim of this study was to analyze the morphological traits and chemical profile of fruits during three harvests per season in two consecutive years (2019-20). Cultivar 'Regina' had larger fruits than 'Amira', but in both cultivars, the largest fruits were picked in the first harvest (3.67 and 3.96 g in 'Amira' and 'Regina', respectively), and the smallest in the third (2.53 and 2.50 g, respectively). Also, as the harvest progressed, soluble solids, total acidity, and almost all sugar and polyphenolic components were increased, while vitamin C was decreased. Averagely, cultivar 'Regina' had slightly higher soluble solids than 'Amira' (13.5% versus 13.2%), and vitamin C (19.65 mg100 g^{-1} versus 17.88 mg100 g^{1}). Cultivar 'Amira' had a higher level of average acidity (0.61%) compared to 'Regina' (0.45%). The most important sugars were glucose, fructose, and sucrose. The levels of glucose, fructose, sucrose, and sorbitol were higher in 'Amira' (36.58, 39.71, 1.97, and 4.15 g/kg, respectively) compared to 'Regina' (33.91, 36.29, 1.56, and 2.12 g/kg, respectively). The cultivar 'Regina' stood out due to the highest level of xylose, galactitol and galactose (0.055 and 4.843 g/kg, respectively). The most abounded polyphenol was ellagic acid followed by vanillic acid and catechin. The cultivar `Regina` stored higher levels of vanillic acid, rutin, p-hydroxybenzoic acid, syringic acid, quercetin, quercetin 3-O-rhamnosid and isorhamnetin 3-O-rutinoside, and for the rest of polyphenols `Amira` gave better results. According to the obtained data both cultivars 'Amira' and 'Regina' could be grown in organic production. Cultivar 'Regina' could be distinguished by its larger fruits, higher level of soluble solids and vitamin C, while 'Amira' could be underlined due to the higher level of the majority of chemical components that belong to the sugar and polyphenolic profile.

Keywords: Rubus idaeus L., fruit weight, soluble solids, acidity, vitamin C, sugars, polyphenolics

YIELD AND FRUIT QUALITY OF NEW BULGARIAN PEACH CULTIVARS

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Abstract

The study was carried out in the period 2020 – 2022 in a collection plantation established on the territory of the Fruit-Growing Institute in Plovdiv. The biometric characteristics of the fruits and stones, as well as the major phenological stages of five new dessert peach cultivars, were studied and compared with the standard cultivars 'Maycrest' and 'Redhaven'. The new cultivars were developed as a result of the breeding program launched at the Fruit-Growing Institute – Plovdiv in 1989. They were officially recognized as new original cultivars in Bulgaria during the period 2008 – 2012. Observations showed that the fruits of the cultivars 'Flavia' and 'Philina' were the earliest to ripen (21 – 22 June), a little before those of the standard 'Maycrest'. The latest to ripen, in mid-September, were the fruits of 'Evmolpia' cv., which is characterized by the latest flowering period. The cultivar is resistant to Thaphrina deformans, while Laskava cv. is resistant to Sphaerotteca pannosa Puldin cv. shows a high degree of resistance to extreme summer droughts. The results of the biometric analyzes showed that the fruits of 'Evmolpia' and 'Laskava' cultivars had the largest average weight – over 330 g. Taking into account the very early ripening period of the fruits of 'Flavia' and 'Filina', they are comparatively large, with an average weight of over 180 g. All the studied cultivars have a high fruit flesh ratio, the values varying from 95.73% in 'Puldin' cv. to 97.14% in 'Filina' cv.

Keywords: Prunus persica L., fruit weight, fruit size, pomological evaluation

EFFECT OF FOLIAR APPLICATION OF Ca, MAP PACKAGING AND 1-MCP TREATMENT ON APRICOT FRUIT QUALITY AFTER 15 DAYS OF STORAGE

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Abstract

The storability of apricot fruits was examined after foliar application of Ca-nutrients and postharvest treatments, i.e. MAP packaging and application of 1-MCP. The experiment was carried out in 2017 on the apricot cultivar 'Buda'. Foliar application of 0.1% of Calcium (Wuxal®Calcium) was done in stages when apricot fruits reached a diameter of 11 mm, 21 mm, and 30 mm. Postharvest treatment included: modified atmosphere packaging (MAP) and 1 –MCP. The fruit firmness, chemical composition, and colour were analyzed at harvest and following 15 days of cold storage. Apricots treated with Ca and stored in MAP conditions retained a higher degree of hardness following the storage versus the control and fruits treated with 1-MCP, respectively. Apricot colour changed due to the storage and different postharvest treatments, but not as a consequence of Ca application. The highest change in colour was present in fruits treated with 1-MCP after cold storage. At harvest, Ca-treated apricots showed a lower TA when compared to the untreated fruits, while regarding TSS no significant difference was recorded among the fruits. On the other side, following cold storage Ca-treated apricots were characterized by significantly higher TSS. Carotenoid content was influenced by packaging, while in the case of phenols, this effect was achieved by storage and a combination of storage and Ca treatment. Based on the obtained results, it can be assumed that, if apricots are planned for storage and transport, a combination of foliar Ca treatment and MAP packaging can be recommended.

Keywords: Calcium treatment, postharvest treatment, firmness, fruit color, chemical composition

CHEMICAL COMPOSITION OF BLACK CHOKEBERRY (*Aronia melanocarpa*) LEAF, FRUIT, JUICE AND JUICE SEDIMENT

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Abstract

Leaves, fruits, juice, and juice sediment of black chokeberry (*Aronia melanocarpa*, cv.'Nero') were analyzed for the content of macroelements, % of DM (N, P, K, Ca, Mg), and microelements, mg/kg in DM (Fe, Zn, Mn, Cu, and B). Also, the chemical composition of black chokeberry juice and juice sediment in three different stages of precipitation: 0.5, 1.5, and 2.5 years was determined. The following values were determined in the leaf: 1.85(N), 0.70(P), 0.94(K), 2.30(Ca), 0.52(Mg) and: 111.80(Fe), 29.25(Zn), 80.05(Mn), 4.80(Cu) and 91.15(B), and in the fruit: 0.73(N), 0.19(P), 1.37(K), 0.20(Ca), 0.11(Mg), and: 25.45(Fe), 5.45(Zn), 8.56(Mn), 3.28(Cu) and 45.55 (B). In the leaf, the most abundant macroelement is Ca, and the most abundant microelement is Fe, while in the fruit the most abundant macroelement is K, and the most abundant microelement is B. Average values of macroelements and microelements in the juice were, mg/L: 1057.3(N), 267.9(P), 3407.4(K), 242.4(Ca), 200.3(Mg), and: 0.89(Fe), 0.39(Zn), 2.34(Mn), 0.07(Cu), 0.51(B), and in the juice sediment, % of DM: 0.70(N), 0.03(P), 1.35(K), 0.04(Ca), 0.07(Mg), and: mg/kg DM: 94.24(Fe), 1.25(Zn), 9.79(Mn), 14.42(Cu) and 3.31(B). Potassium is the most abundant macroelement both in the juice and in the sediment. As for the microelements, Mn is the most abundant in the juice and Fe in the sediment. Significant sedimentation was determined in Cu, while Mn and especially B and Zn had significantly lower values in the sediment.

Keywords: black chokeberry, macroelements, microelements, sedimentation, fruits

FRUIT CRACKING AND FRUIT FIRMNESS OF 15 SWEET CHERRY CULTIVARS: A TWO-YEAR STUDY IN ZADAR COUNTY

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Abstract

Cultivation of sweet cherry (*Prunus avium* L.) is spread across the Republic of Croatia, but its importance is greater in the Mediterranean region, especially for early ripening cultivars. Extreme weather conditions during flowering and ripening negatively affect the commercial of fruits. Aim of this work was to determine the occurrence of sweet cherry fruit cracking and fruit firmness and to examine it with the amount of precipitation during fruit development. Research was conducted during 2019 and 2020 at the sweet cherry orchard in Ninski Stanovi, Zadar County. Fruits were harvested at commercial maturity. Fruit cracking index (CI) and fruit firmness (FF) of fifteen sweet cherry cultivars ('Burlat', 'Cristalina', 'Early Burlat', 'Ferrovia', 'Germersdorf', 'Giorgia', 'Grace Star', 'Lapins', 'Regina', 'Samba', 'Summit', 'Sunburst', 'Sweet Early', 'Sweet Valina' and 'Volovsko srce') were evaluated. Statistical comparison of fruits was made by one-way analysis of variance and Tukey post hoc test. Person correlation between CI and FF of all cultivars and both years was also carried out. Significant differences were found for CI and FF between the cultivars. Furthermore, the influence of the year on the measured parameters is also visible. 'Grace Star' has shown the lowest CI value in 2019 (2.80), while 'Sweet Early' in 2020 has shown the highest CI (52.4). FF ranged from 1.09 kg/cm^2 in 'Early Burlat' in 2019 to 2.82 kg/cm^2 in 'Volovsko srce' in same year. There is a moderate negative correlation between the CI and FF. Obtained results are useful for the selection and valorization of sweet cherry cultivars for the Mediterranean growing area in the Republic of Croatia. Conducted research contributes to the assessment of extreme weather conditions risk, mostly precipitation, which could affect the cracking and firmness of sweet cherry fruits.

Keywords: cracking index, fruit quality, precipitation, *Prunus avium*, harvest date

THE ROOTSTOCK AND TIME OF HARVEST INFLUENCE THE CHEMICAL COMPOSITION OF THE PLUM

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Abstract

Despite Serbia being among the world's largest producers of plums with about 5% of production, seedlings of 'Mirobalan' (*Prunus cerasifera* Ehrh.), characterized by a number of disadvantages, represent the most commonly used plum rootstock. Considering the intensification of plum production this study was aimed to characterize by yield and content of sugars and organic acids, as well as phenols in plum cultivar 'Čačanska Lepotica' grafted on four vegetative rootstocks (three medium vigor 'Docera 6', 'Wavit' and 'Weiwa' and one low vigor rootstock 'Dospina 235') during two years (2017–2018). According to the analyses of primary metabolites, the harvest season effect was more predominant than the rootstock. Fruits harvested in 2017 were the best results for total sugars and sugars/acids ratio (94.0 g/kg FW and 5.6, respectively) while fruits harvested in 2018 had significantly higher phenol content (253.8 mg/kg FW). The dominant phenolic compounds in plum fruits were phenolic acids and flavanols, while flavonols and anthocyanins were determined in a lower concentration. The results demonstrate a significant influence of rootstock on phenolic content in plum fruits. All tested phenolic groups were significantly higher in the fruit of 'Čačanska Lepotica' grafted on 'Docera 6' and 'Dospina 235' in both tested years, except the content of flavonols and anthocyanins in grafting combination with rootstocks 'Wavit' and 'Weiwa' in 2017. In order to improve the intensity of plum growing and the nutritional quality of fruits, 'Docera 6', rootstock with hypersensitive resistance to Plum pox virus (PPV), can be recommended for further expansion in agroecological conditions of southeast Europe.

Keywords: Prunus domestica, vegetative rootstocks, sugars, organic acids, phenols

EVALUATION OF POMOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF TRADITIONAL APPLE CULTIVARS FROM POZEGA-SLAVONIA COUNTY

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Abstract

Traditional apple cultivars are generally characterized by unusual pomological properties, which is one of the reasons for their lower attractiveness and acceptance by consumers compared to commercial apple cultivars. In Croatia, many traditional apple cultivars are grown in gardens or in smaller collective orchards. The aim of the study was to determine the pomological and physico-chemical properties of 12 traditional apple cultivars ('Bobovec', 'Božićnica', 'Crvenka', 'Ivanlija', 'Kanada', 'Ljepocvjetka', 'Mašanka', 'Paradija', 'Gloria Mundi', 'Slavonska Srčika', 'Šampanjka' i 'Zlatna Zimska Parmenka') and one commercial cultivar 'Idared'. The fruits were harvested in a private orchard with traditional apple cultivars in Požega-Slavonia County. After the laboratory analyses (weight, height and width of fruits, fruit shape index, number and weight of healthy seeds, firmness of fruits, soluble solids content, total acids, ratio of soluble solids content and total acids, pH), it was found that the cultivars differed in the studied properties. Fruit weights ranged from 89.99 g ('Mašanka') to 384.08 g ('Gloria Mundi'), while most other cultivars had smaller variations in fruit weight and size compared to the cultivar 'Idared'. The fruits of most traditional cultivars had firmness from 5.6 to 8.9 (kg/cm^2), soluble solids content (13.2-16.8 °Brix) and total acidity (0.5-1.2% as malic acid), which is a higher value than the commercial cultivar 'Idared'. The results show that most of the studied apple cultivars have certain positive fruit quality properties (e.g. firmness, harmonious sugar and acid taste), which give the fruit freshness and fullness of flavor and are suitable for fresh consumption, storage, or processing.

Keywords: Malus domestica, cultivar, orchard, laboratory analyses, fruit quality, fruit size

EFFECT OF PRE-HARVEST FACTORS ON THE SHELF-LIFE OF 'GALA' APPLES AFTER 5 MONTHS OF STORAGE

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Abstract

Pre-harvest factors can affect fruit quality, especially when not applied correctly. The effects can appear right after the harvest, but often become more evident after storage, affecting the final quality of the fruits that reach the consumer. The present work has been focused on the study of the effect of pre-harvest treatments, such as excess of water and/or nitrogen supplementation applied one month before harvest, on the quality of 'Gala' apples after 5 months of cold storage plus 14 days of shelf-life at room temperature. Fruits were stored under three different conditions: controlled atmosphere + 1-methylcyclopropene (CA+1-MCP), dynamic controlled atmosphere (DCA), and DCA+1-MCP. In addition to physical properties such as size, firmness, and peel colour, several important parameters like total soluble solids, acidity, and quality index were analyzed. Loss of weight or firmness, as well as the development of physiological disorders or pathologies, were also evaluated. After 5 months of storage, no significant differences in the main quality parameters were observed among modalities and a dynamically controlled atmosphere preserved good fruit quality through storage. During the shelf-life period, a slight discoloration of the apples was observed, regardless of pre-harvest treatments or storage conditions. Weight loss was significantly higher in the modalities with nitrogen in excess (4-16%). The total soluble solids content was higher in fruits with excess nitrogen or irrigation, compared with the control. Fruits stored under a dynamically controlled atmosphere showed a better quality index at the end of shelf-life than ones under a controlled atmosphere.

Keywords: Malus domestica, nitrogen, water excess, postharvest quality, shelf-life

DEVELOPMENT OF FUNCTIONAL STRAWBERRY TREE FRUIT-BASED PRODUCT BY 3D FOOD PRINTING TECHNOLOGY

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Abstract

The strawberry tree fruit (*Arbutus unedo* L.) has great potential for the development of functional products due to its high bioactive potential and health-promoting properties. The objective of this research was to investigate the potential of 3DP in the production of strawberry tree fruit-based functional foods. The formulation for 3DP was developed by separately adding different proportions (4, 6 and 8%) of wheat and corn starch. Two programs with different printing parameters: printing speed, ingredient flow speed, first-layer-nozzle height, and line thickness were tested for the printability of a strawberry tree fruit-based formulation. The final 3D printed product looked like a heart printed in three layers, in which total phenolic content (TPC), chlorophyll a (CHL A) and chlorophyll b (CHL B), carotenoids (CAR) and antioxidant capacity [2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) methods] were determined spectrophotometrically. The starch type had a statistically significant effect on the content of all bioactive components and antioxidant capacity, except for two chlorophylls. The proportion of starch had a statistically significant effect on all observed components and antioxidant capacities. When starch content was increased, there was a decrease in TPC, pigments, and DPPH antioxidant capacity, which is in line with expectations, considering that blends with higher starch carrier content contained a lower amount of strawberry tree fruit, which is a source of TPC and pigments. The 3DP programs showed no statistically significant effect on TPC, while they showed a significant influence on pigments. A significant effect of the 3DP program on DPPH antioxidant capacity was not observed, while the FRAP method gave the opposite results. In conclusion, both starches are suitable as carrier materials and can be used for the preparation of 3DP products, and 3DP can be successfully used for the production of a strawberry tree fruit-based functional product.

Keywords: Arbutus unedo, total phenolic content, carotenoids, antioxidant capacity, functional food

GREEN EXTRACTION OF FLAVONOIDS FROM MANDARIN PEEL

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Abstract

Due to the increase in waste products resulting from food processing, new strategies, and new policies must be developed to manage the increase in waste generated by the agri-food industry. The peels of mandarin fruit are the main processing waste for juice production and other food materials, which are frequently discarded. Mandarin peel is a rich source of bioactive compounds, especially flavonoids. Polymethoxylated flavones (PMFs) are effective natural bio-preservatives found nearly exclusively in the *Citrus* genus, particularly in the peels of mandarins. The objective of this study was to optimize the solid-liquid extraction of flavonoids from dried mandarin peel using the green solvent ethanol. The percentage of ethanol/water mixture, duration, and temperature of extraction were all tested. The highest yield of total flavonoids (43.93 mg/g DW) from mandarin peel was obtained under the following conditions: 62% ethanol in water (v/v) as a solvent was used for 30 minutes at 75 °C with a solid-to-liquid ratio of 1:3. HPLC analysis of the extract identified hesperidin (27.9158 mg/g) as the major compound found in the mandarin peel. The extract contained the following PMFs: sinesetin (0.2339 mg/g), nobiletin (0.4772 mg/g), and tangeretin (0.1785 mg/g). Mandarin peel extract, a possible citrus waste, has been confirmed as a valuable source of flavonoids.

Keywords: citrus waste, polymethoxylated flavones, solid-liquid extraction, hesperidin, peel extract

PHYSICO-CHEMICAL AND ANATOMICAL PROPERTIES OF THE FRUITS OF DIFFERENT MANDARIN CULTIVARS

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Abstract

Mandarin (*Citrus reticulata* Blanco) is one of the most important fruit species in Croatian fruit growing. Easy peeling, pleasant flavor, low seediness, fragrance, and important nutritional properties are the most desirable internal quality parameters of mandarins accepted by consumers. This work aimed to evaluate the physical and chemical properties of the fruit (weight, fruit width, and height, juiciness, juice volume, total soluble solids (TSS), total acids (TA), and pH) and peel anatomy (size, position and filling of oil glands) of six mandarin cultivars ('Chahara', 'Etna', 'Okitsu', 'Saigon', 'Unshiu' and 'Zorica') grown in the Neretva Valley area. The cultivars differed significantly in the studied properties. The result showed that fruit weight (120.58 g), juice volume (55.40 ml), TSS (12.92 °Brix), and pH (3.24) were higher in mandarin 'Okitsu'. The highest fruit shape index was determined for the cultivar 'Zorica' (0.84). TSS to TA ratio with relative values of TSS (°Brix) determined whether the fruit is edible. In the analysis, the cultivar 'Etna' had the highest TA (1.50) but the sweetest cultivar is the 'Saigon' with the highest TSS (10, 96° Brix) and TSS/TA ratio (12.62). Microscopic analysis of the peel of the fruits of the mandarin cultivars clearly shows the oil glands, the cells have a regular shape, and the tissue is compact. In the cultivars 'Chahara' and 'Etna', the oil glands are smaller, while in the cultivar 'Zorica', the glands are larger than in the other cultivars. Considering the uniform size of the fruits, good juiciness, and favorable ratio of acids and sugars, the cultivar 'Saigon' proved to be the best and most productive in this work.

Keywords: Citrus reticulata Blanco, Neretva Valley, cultivars, quality parameters, fruit peel

SESSION 5

SUSTAINABILITY, ECONOMICS AND MANAGEMENT

ORAL PRESENTATIONS

GENOTYPE, ENVIRONMENT, YEAR, AND HARVEST EFFECTS ON FRUIT QUALITY TRAITS OF BLUEBERRIES (*Vaccinium corymbosum* L.) CULTIVARS

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Abstract

Blueberries (*Vaccinium* spp.) comprise a broad range of perennial woody species, in which native *Vaccinium* species are found across North America, from Canada through Mexico. Introgression of native species into cultivated germplasm has adapted *Vaccinium* germplasm to a range of climates and growing conditions for cultivated blueberry. Genetic differences signify phenotypic variance that is observed among blueberry accessions. In addition, variability in geographic and climatic growing conditions between or among environments may further affect fruit and plant phenotypic expression. As a result, a phenotype is a function of genetic background (G), environment (E), and their interaction (G × E). In addition, other temporally regulated factors such as year (Y) and harvest time (H) impact plant and fruit quality phenotypic variation. Our research aimed to assess the genotypic performance of five blueberry cultivars, including 'Echota', 'O'Neal', 'Reveille', 'Summit', and 'Sunrise'. The selected cultivars were phenotyped for various fruit quality-related traits over two sequential harvests in two years and two locations. Our results indicated that genotype is a major source of variation for most phenotypic traits. Further, the effect of Y× H as well as G × Y× H, significantly affected the majority of studied phenotypic traits. Within the studied genotypes, 'Reveille' and 'O'Neal' phenotypic stability were consistent across locations and years, with summit characteristics stable across years, locations, and harvests. Clonal plant replicates within genotype, harvest, and environment, as well as individual fruit measures were the most significant source of variability.

Keywords: blueberry, GXE, fruit quality, genotype by environment, phenotypic traits

RESPONSE OF PLUM CULTIVAR 'STANLEY' TO CLIMATIC CONDITIONS AT DIFFERENT LOCATIONS AND IN DIFFERENT YEARS

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Abstract

The phenotypic response of plum cultivar 'Stanley' in relation to the main production and technological traits was studied at four localities in Serbia (Prokuplje, Kuršumlija, Aleksandrovac, and Osečina) during the two-year period (2020-2021). Differences between localities and years were found in the data on climatic conditions. For the period from April to August, the locality of Prokuplje had the highest average temperature and the lowest total precipitation, while the locality of Aleksandrovac had the lowest average temperature and the highest total precipitation. In all localities, higher average temperatures and lower total precipitation were measured in 2021 compared to 2020. Most traits varied significantly in different localities. The highest average yield (20 t/ha), fruit weight (43.0 g), fruit length (51.2 mm), fruit width (38.7 mm), fruit thickness (38.0 mm), and flesh rate (95%) were found for the cultivar 'Stanley' at the Osečina locality, while the highest soluble solids content (19.6%), total sugar (13.8%), invert sugar (12.3%) and the ratio between total sugar content and total acid content - TSC/TAC (21.4) were found at the Kuršumlija locality. In order to overview the data for similarities and dissimilarities, PCA was applied to take into account all studied factors and all characteristics. Traits with higher scores on PC1 are stone properties (weight, width, and thickness), flesh rate, soluble solids, total sugar, and fruit development period. The highest contribution of PC2 corresponded to TSC/TAC and flowering time. The distribution of the units on the scatter plot shows that the cultivar 'Stanley' had differences in the stability of the traits by year in the studied localities. The lowest stability was observed in the locality Aleksandrovac, followed by the locality Kuršumlija, while the highest stability was observed in the localities Osečina and Prokuplje. Osečina locality can be recommended as the best location for growing this cultivar.

Keywords: *Prunus domestica,* cultivar, trait, temperature, precipitation, PCA

THE IMPACT OF CLIMATE CHANGES IN THE LAST 50 YEARS ON THE MAIN FRUIT TREE SPECIES FROM SOUTHERN ROMANIA

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Abstract

The studies were carried out at the Research Institute for Fruit Growing Pitesti, Romania, using a climate database from 1973 to 2022. Similar data from Constanta, Baneasa, Voinesti, and Targu Jiu Research Station were also used. The representativeness of the Pitesti temperature trends for the entire Southern area of Romania was verified and validated, using the National Meteorological Administration data for 13 other localities. It was established that the most pronounced increasing trends of the climatic elements in the last 50 years were recorded for the average, maximum, and minimum air and soil surface temperatures, sunshine duration, and potential evapotranspiration. Increasing trends in monthly temperatures were irregular. The best statistically ensured was only the increase in summer temperatures ($P \leq 0.001$). In the last 50 years, the annual rainfall deficit has almost doubled from 86 to 159 mm today, of which 124 mm were registered only in July and August. Significant increases in maximum and average temperatures in February, March, and April ($P \leq 0.05$) were also noted. Meanwhile, the minimum temperatures remained almost unchanged, creating increasingly larger thermal amplitudes at the beginning of the growing season. However, no increases in air temperatures were reported in January and May. The increasing temperatures in November and December determined the earlier satisfying of the chilling requirements (UTAH method) for most fruit species by 10-15 days. The frequency and amplitude of thermal oscillations during dormancy have increased, and trees' cold early deacclimation was followed by floral buds frost in 2004, 2014, and 2015. Two-week earlier onset of vegetation season, driven by increasing maximum and average temperatures in February, March, and April, caused higher frequency and severity of late frost damage. In 10 years (2008-2017) there were 8 climatic accidents caused by frosts, winter temperature fluctuations of up to 40°C in 3-7 days, and late frosts.

Keywords: temperature trends, chill hours, late frosts, thermal amplitude, drought

IMPLEMENTATION OF ENVIRONMENTAL AND CLIMATE MEASURES OF THE CROATIAN RURAL DEVELOPMENT PROGRAMME IN THE FRUIT GROWING SECTOR

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Abstract

The Common Agricultural Policy, which includes the Rural Development Programme of the Republic of Croatia for the period 2014-2020, provides support for farmers in the form of environmental and climate measures. Submeasure 10.1. Agri-environment-climate, in fruit production, contains seven different operations: 10.1.2. Grassing of permanent crops, 10.1.7. Maintaining extensive orchards, 10.1.12. Installing pheromone, visual and feeding traps, 10.1.13. Confusion technique in permanent crops, 10.1.14. Improved management of inter row area in permanent crops, 10.1.15. Application of organic fertilizers in permanent crops and 10.1.16. Mechanical weed control within rows of permanent crops. Fruit producers, beneficiaries of operations during their implementation receive compensation for loss of income or additional costs. The aim of the operations is to reduce or prevent the negative impact of agriculture on natural resources, biodiversity and climate. The seven-year study of the implementation of the mentioned operations in Croatia embraced 20 counties and the City of Zagreb. For each operation, the following parameters were monitored: areas under permanent crop production, distribution of fruit crops under operations, number of beneficiaries and amount of support. This research is carried out by season revealed a continuous increase in the area under the production of permanent crops and the number of beneficiaries of the operations. Osijek-Baranja County has the most areas where operations have been implemented. Measures 10.1.16. Mechanical weed control within rows of permanent crops was applied to the most areas and by the most beneficiaries. Proportionately, the largest amount of support for beneficiaries was allocated for this operation. In relation to other fruit species, it was determined that walnut is the dominant crop in which operations were applied. The obtained results provided the basis for the improvement and selection of environmental and climate interventions in the Strategic Plan of the Common Agricultural Policy of the Republic of Croatia 2023-2027.

Keywords: Common Agricultural Policy, Submeasure 10.1., support for farmers, orchards, biodiversity measures, climate measures, protection of natural resources

CURRENT SITUATION OF FRUIT WINE PRODUCTION IN CROATIA

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Abstract

Records of fruit wine production date back to 10.000 years B.C. and today they are made by fermenting almost any type of fruit. The share of a particular fruit species in the global production of such wines is mainly influenced by weather, climatic conditions, geographical location, and production tradition. In Croatia, fruit wines are traditionally produced in the continental area, mainly in Slavonia, Moslavina, Prigorje, Bilogora, Zagorje, and Međimurje. In Europe, most fruit wines are made from apples and pears, while on the Croatian market, most fruit wines are made from blackberries and chokeberries. Fruit wines of Croatian producers are represented on the market in six categories: fruit wine, fruit dessert wine, fruit sparkling wine, fruit semi-sparkling wine, flavored fruit wine, and diluted fruit wine. The aim of this paper was to analyze the production and quality trends of the two most common categories of fruit wines: fruit wine and fruit dessert wine. During the eight-year period examined, a total of 4.686.80 hL in the fruit wine category and 2.433.96 hL in the dessert wine category were produced. Considering only the category of fruit wines, it is worth highlighting the year 2017 with the highest production of 984.30 hL. After the negative production trend in 2018 and 2019, the production remains stable in the last four years of the studied period and in 2022 it amounts to 516.20 hL. On average, from 2015 to 2022, the most represented fruit wine declared by Croatian producers was in the fruit wine category, mainly from blackberries. In this research, the average values of physico-chemical parameters for this product were determined as follows: actual alcohol 11.9±1.0 % vol., total sugars 119.9 ± 52.4 g L^{-1}, and total acidity expressed as malic acid 11.6 ± 2.4 g L^{-1}.

Keywords: *Rubus*, *Aronia*, fruit wine quality, fruit dessert wine, blackberries, chokeberries, physico-chemical parameters

SESSION 5

SUSTAINABILITY, ECONOMICS AND MANAGEMENT

POSTER PRESENTATIONS

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A DIGITAL SYSTEM TO EVALUATE THE CANOPY PARAMETERS IN SOME CHERRY, APRICOT AND NECTARINE CULTIVARS

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Abstract

Modern analysis methods offer new possibilities to understand the interaction of the fruit tree with the environment and its response to orchard management. WinCANOPY system analyses tree canopy through indirect methods (image analysis). The system includes image acquisition hardware - a fisheye lens camera and computer programs for hemispheric and covers image analysis and data visualization. The paper aims to present the influence of the planting system on three stone fruit species, sweet cherry, apricot, and nectarine, on several canopy parameters. Foliar index, direct, diffuse, and total radiation were measured. At the same time, the canopy dynamic during a growing season in the analyzed species was monitored. Vertical Axis, Parallel-U, Trident, Drapeau Marchand, Mikado, Tatura Trellis, and Simple Palmette were as the studied canopies, and images were taken in all cardinal points, three times a day. The results quantified the canopy projection on the ground for all experimental variants. The foliar index varied depending on cultivar and planting system/canopy, the highest values being at Trident, followed by Drapeau Marchand at apricot, and Tatura Trellis, followed by Drapeau Marchand at the sweet cherry. Total and diffuse radiation at the canopy level was monitored in dynamics in all four cardinal points. These results were significant for optimizing technical decisions regarding pruning and other tree management actions.

Keywords: non-destructive equipment, foliar index, direct, diffuse, total radiation

DIGITAL IMAGE ANALYSIS FOR ASSESSING QUALITY PARAMETERS OF MANDARIN (*Citrus reticulata* B.) FRUIT

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Abstract

The fruit peel colour is one of the first and most important quality parameters evaluated by consumers. The manual classification of mandarins according to their colour is a subjective prediction based on human judgment of maturity level based on the colour of the peel. Methods for assessing mandarin fruit quality are generally based on biochemical analysis which causes the destruction of fruits and it's time-consuming. The aim of this study was to test the possibility of predicting the ripeness of mandarin fruit by studying the relationship between hyperspectral imaging with spectral reflectance indices (SRIs) and fruit quality parameters (brightness (L^*), red-green (a^*), blue-yellow (b^*), total soluble solids (TSS), titratable acidity (TA), and TSS/TA ratio). The characteristics of fruit quality of mandarin samples (n=150) were measured at various stages of ripening. Pictures were taken in the Pomology laboratory with Specim IQ hyperspectral camera at a range from 400 to 1000 nm at the distance from the fruit at 50 cm. The outcomes showed that at various levels of ripening, the fruit quality and SRIs differed. There was a significant variation in the mean values in L^* ranged from 48.03 to 65.83, a^* ranged from 10.02 to 42.00, b^* ranged from 37.46 to 60.99, TSS ranged from 7.20 to 13.80° Brix, TA ranged from 0.37 to 1.43, TSS/TA ratio ranged from 6.65 to 25.68. The results showed that the value of the red colour has a greater effect than the green and blue colour in the SRIs in predicting ripeness, as there is a direct relationship between the colour and the level of sweetness. Combining passive sensing data might aid in the efficiency of the calibration models for monitoring fruit ripeness in the orchard or in packing houses.

Keywords: peel color, ripeness, spectral reflectance indices, quality parameters, hyperspectral camera

STATUS OF INSECT BIODIVERSITY IN PEACH AND APRICOT ORCHARDS UNDER IPM

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Abstract

Integrated pest management (IPM) is a sustainable approach to crop protection, based on cost/benefit analysis that takes into consideration the economic, societal, and environmental impacts. The Food and Agriculture Organization of the United Nations and the European Union defined IPM as "all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimize risks to human health and the environment; IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms". The purpose of the present study was to establish the species composition of insects in peach and apricot orchards after three years of using integrated pest management methods and approaches. During the 3-year monitoring period, 27 species of insects from 15 entomological families were found in the peach orchards and 16 species from 11 families in the apricots. Of the beneficial insect, 9 species from three families have been identified. The use of methods and approaches of integrated plant protection increases the population density of beneficial insect species. Among the economically important pests, an increase in the population of wood pests was observed.

Keywords: pests, fruit, destiny, beneficial, monitoring

BIOSTIMULANTS IN ORGANIC FRUIT PRODUCTION

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Abstract

Organic fruit production is confronted with the consequences of abiotic and biotic stress factors, such as drought, soil salinisation, unavailability of soil nutrients, soil degradation, resistant pests, temperature stress, to name but a few of the causes of significant yield and quality loss in fruit production. The area of orchards cultivated according to organic farming principles is increasing, which is also related to the demand for organically produced fruit. The use and development of safe and environmentally friendly preparations for organic farming is increasing. Humic substances complex organic substances, beneficial chemical elements, seaweed extracts and microbial biostimulants have been shown to play a key role in reducing fertiliser dependence, increasing stress resistance, and final yield and fruit quality. The positive effects of named biostimulants include improved root growth, better nutrient uptake and higher phytohormone production. Osmotic adjustment under abiotic stress conditions has also been confirmed. The use of preparations such as biostimulants can be an important tool for improving organic fruit production. Numerous studies have shown that biostimulants can improve cultivation efficiency, quality, and safety. The use of biostimulants is an ecologically sound practise with no negative impact on the environment, fruit quality and overall yield and have a possibility for addressing sustainability issues in organic production, i.e., a potential for integration into the management of modern organic orchards.

Keywords: sustainable agriculture, fruit quality, yield, stress resistance, seaweed extracts, humic acids

ADVANTAGES OF USING RGB AND THERMAL IMAGING CAMERAS IN FRUIT AND GRAPE PRODUCTION

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Abstract

With the development of modern technologies using different cameras, photographs can be used very effectively to assess and analyze the quality of plants. The aim of this research is to show the advantages of using digital RGB (red, green, blue) and thermal cameras in orchards and vineyards. Two experiments were conducted during the 2021 growing season, the first in three apple orchards (Croatia) and the second in one vineyard (Serbia). By analyzing and processing photos (11,602) taken with an RGB camera (experiment 1 – apple orchards) using machine learning, the following recognition algorithms were obtained: apple scab detection rate is 65.08%, powdery mildew detection rate 49.16%, aphid detection rate 55 .08%, while it is high for a number of chemical elements, for example, nitrogen deficiency was determined, as much as 73.50%. The analysis and processing of photos (118) taken with a thermal imaging camera (experiment 2 - vineyard) where the vines were irrigated by the drop-by-drop method, we conclude: the average temperature of the vines during the growing season was 25.1°C, which indicates that the plants were not under water stress. However, the average temperature of the grass cover in the interrow space that was not directly irrigated was 39.4°C and was mostly above the air temperature, which indicates water stress of the lawn. Thermal imaging cameras provide data on the temperature of the plant cover, which is important for determining the water stress of the plants and setting the watering norm and the interval between watering for potential irrigation. While the RGB camera can predict the development of diseases and defects at an early stage, which improves fruit quality and increases yields. So we conclude that the use of the above equipment will contribute to successful and high quality production without negative impact on the environment.

Keywords: vine, apple, fruit detection, fruit quality, water stress, pests, environment

IS VISUAL DIAGNOSIS A RELIABLE METHOD FOR DETERMINING IRON AND MANGANESE DEFICIENCY ON APPLE LEAVES COMPARED TO CHEMICAL ANALYSIS?

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Abstract

Visual diagnosis is the most basic method of assessing the nutritional status of a plant. The method is based on visual observation of colour changes on leaves and characteristic changes (morphological, coloristic) on fruits. Visual diagnosis is a good indicator, but it is necessary to perform chemical analysis to draw definitive conclusions about the nutritional status of a plant. In this research, the subject of observation are deficiency symptoms of iron and manganese and their content in apple (*Malus domestica*) leaves. Goals of this research were to determine the reliability of visual diagnosis compared to results of chemical analysis, whether or not the symptom of iron deficiency masks the symptom of manganese deficiency (similar symptom to iron deficiency), and finally, if there is a correlation between leaf content of these two microelements. After visual diagnosis determination, three apple shoots with iron deficiency symptoms were collected from an intensive apple orchard (location Ribnica, Velika Gorica, Croatia) and afterwards subjected to chemical analysis. Iron deficiency symptom was present on young and middle-aged leaves. Hence, from each shoot, samples of young, middle-aged, and old leaves were taken for chemical analysis. Results showed iron lack on all leaves, regardless of age, but the most on young leaves. All values obtained ranged from 30.1 to 57.5 mg Fe/kg DW (dry weight), which is at the lower limit of optimal values (40-400 mg Fe/kg DW). When speaking of manganese, values ranged from 6.7 to 15.8 mg Mn/kg DW, which is all below the lower limit of optimal values (20-200 mg Mn/kg DW). Visual diagnosis proved to be correct and reliable in case of iron. Furthermore, chemical analysis showed manganese deficiency as well, so it could be concluded that iron deficiency symptom masked manganese deficiency. The correlation between iron and manganese leaf content was negative and strong.

Keywords: correlation, *Malus domestica*, microelements, nutrient deficiency, visual symptoms

THE LATEST RESULTS OF BREEDING JAPANESE QUINCE (*Chaenomeles japonica*) AND THE POSSIBILITIES OF USING ARTIFICIAL INTELLIGENCE METHODS TO OPTIMIZE THE BREEDING PROCESS

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Abstract

Latvia was one of the first countries in Europe to start breeding of Japanese quince as a fruit crop for processing for its nutritional value in the 1950s. After evaluation at the Institute of Horticulture in 2012 first cultivars were selected and registered in Latvia. Continuing the breeding work, a new cultivar 'Jānis' was selected from the extensive selection material and submitted for registration in 2023. This cultivar is thornless, partly self-fertile, fruits are smooth, beautiful, homogeneous, 40-70 g, with valuable phenol, acid and vitamin content, ripen in the middle of September. Shrub with erect, slightly spreading branches, productive. The process of breeding Chaenomeles japonica takes 15-20 years from crossing to cultivar. To select candidate cultivars, the characteristics of several thousand seedlings must be evaluated, which is largely done visually. However, this is a time-consuming process, visual rating and scoring is relatively subjective. Therefore, LatHort and EDI are conducting research on the application of new techniques for non-invasive fruit phenotyping, adapting the use of machine learning techniques (ML), which allows us to efficiency the breeding process. In this phase, we focus on acquiring RGB and 3D images, creating a manually labelled dataset, and developing a deep neural network for Japanese quince detection. The labelled dataset for Ch. japonica consists of labelled images of fruits captured at two phenological development stages. Both stages of quince images classified as immature and mature were annotated using ground truth ROI. The dataset contains 1541 high-resolution RGB .jpg images with the same number of annotated .txt files. A total of 17 320 annotations were provided. The YOLO algorithm was used for quince detection from RGB images.

Keywords: cultivars, phenotypic characterization, machine learning, RGB and 3D imaging

CURRENT STATUS AND PROSPECTS OF FRUIT TREE AND GRAPEVINE PLANT MATERIAL IN SERBIA

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Abstract

Fruit production in Serbia, based on the data of the Statistical Office for 2018, is organized on a total area of 183602 ha, while there is about 2000 ha of vineyards. An increase in fruit and grape production in Serbia was observed over the last two decades. This increase was associated with a growth of fresh and frozen fruit export and increased demand from consumers in the local market. The use of healthy, certified virus-free plants to establish new fruit orchards and vineyards is one of the most important steps to increase fruit and grape quality and production productivity. The production of fruit and grape planting material has a long tradition in Serbia, starting from the 19 century. Nowadays, nearly 400 registered nurseries yearly produce more than 10 million fruit trees and more than 6 million vine grafts (average 2017-2022). Above 60% of production was certified and planting material was placed on the domestic and foreign markets. Russian Federation is the major importer, with almost 50% of the total export value. Serbia is also an importer of micro-propagated berry material and certified seeds, as well as some categories of planting material whose production volume, cultivar, and rootstock diversity are not enough to cover the growing demands of fruit and grape producers. More than 60% of imported material originated from Italy and Netherlands. The scope of the presented article was to summarize data for the 5-year period (2017-2022) related to the diversity, categories, and production volume of planting material, export, and import volume and value. Also, an overview of some possibilities for enhancing the system of quality fruit tree and grapevine planting material production was given.

Keywords: fruit trees, strawberry runners, vine grafts, nursery production, propagation

USING ARTIFICIAL INTELLIGENCE TO DETERMINE DIFFERENT THINGS IN APPLE FRUIT PRODUCTION

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Abstract

Fruits are important sources of minerals and vitamins necessary for human health and in some cases even a source of sugar for satisfaction and pleasure. Climate change and global transport in the last decades raised problems in fruit production regarding the faster spread of pests and diseases and their ability to overwinter in new environments. On the other hand, a hardworking environment and tasks in agricultural production decreased the availability of manpower. The rapid development of information technologies (sensors, machine learning, IoT, etc.) and the lack of manpower in agriculture empowered the development of new tools for fruit growers. In the last 10 to 15 years lots of new tools and automatic detection were developed for use in agriculture. The aim of the RDI (Research, Development and Innovation) project AgriArt comprehensive management system in the field of precision agriculture was to develop a system for the automatic detection of various things in apple fruit production. A total of 11.602 photos were taken and 153.154 annotations of 42 classes were annotated. The average precision of detection for classes was calculated based on the confusion matrix. The best results were obtained with the detection of 'Healthy leaf' (0.74), 'Juvenile fruit' (0.72), 'Leaf apple scab' (0.70), and 'Leaf miner' (0.68). Good results were obtained with the detection of 'Flower cluster' (0.63), 'Fruit apple scab' (0.63), 'Leaf aphid' (0.55), 'Fruit' (0.53), 'Leaf mildew' (0.52), and 'Generative spur' (0.50). Other classes had average precision lower than 0.50 ('Deformed fruit', 'Fruit frost damage', 'Fruit mildew', 'Spur woolly aphid', 'Undeveloped leaf', 'Juvenile leaf') precision or a small number of annotations ('Deformed leaf', 'Fruit monilinia,' 'N deficiency' and 'P deficiency') that are not suitable for this analysis. The usage of RGB cameras in combination with machine learning techniques and automatic detection shows promising results.

Keywords: machine learning, IoT, *Malus domestica*, automatic detection, pest detection, disease detection, fruit damage detection

SESSION ONLINE

IMPROVED UNDERSTANDING OF *Cydia pomonella* BIOLOGY IN CROATIAN APPLE PRODUCTION SYSTEMS

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Abstract

The codling moth is an economic pest of apple production in Croatia and has a cosmopolitan distribution. We have been working on CM biology, ecology, and genetics for over a decade to better understand how this pest has only changed its distribution, abundance, and movement patterns and what this means for improving control practices and management of the species in Croatia. Our initial work commenced with a study into the biology and ecology of CM under different treatments. Our findings showed that in the untreated orchard, two generations of CMs were observed per year, whereas an additional third flight period of the moths was observed in the treated orchards. This work was followed by a population genetic study which showed no genetic differentiation was found. Our most recent work on CM population genetics using SNPs found evidence that population sub-structuring may be occurring as a result of improved integrated control practices in Croatian apple orchids over the last decade. To further investigate population sub-structuring we investigated phenotypic traits under selection (ie. wings) using geometric morphometric (GM) methods. GM methods showed a reliable pattern of differences related to the type of control practice CM was subjected to. The combined use of SNPs and GM to detect resistant variants is a completely new approach and provides new insights into CM control. Recent innovative methods we've undertaken involve the use of structural engineering numerical modeling using the finite element method (FEM) to investigate the dispersal capabilities of CM in Croatia by modeling wing deformation against different wind speed moths experienced in the field. Our findings showed CM from the ecological orchards displayed the least wing deformation as the wind speed increased and had the most structurally sound wings compared to CM from integrated control orchids that had wings that were less structurally sound.

Keywords: geometric morphometrics, population genetics, microsatellites, Single Nucleotide polymorphisms, finite element modelling

EFFECT OF CROP LOAD AND DIFFERENT THINNING METHODS ON TWO KIWIFRUIT CULTIVARS

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Abstract

Commercial returns from kiwifruits (*Actinidia* spp.) are strictly related to fruit weight and, consequently, to their distribution in commercial classes. Fruit weight can be manipulated directly in the orchard, regulating crop load by thinning. The work was carried out in a kiwifruit orchard in Central Italy on two cultivars, 'Gold3' and 'Hayward'. We envisaged three levels of fruit thinning: farm crop load, as usually adopted by growers in the cultivation area, taken as 100% level, with a range of 40±20 n° of fruits per m^2 of canopy according to the seasons and orchard management in the years of the triennium; high crop load with a 120% level; and low crop load with an 80% level. A supplementary trial consisted in bud thinning before flowering, leaving only the king flower for each inflorescence, reducing the number of fruits to 80% of the farm crop load. Albeit variations from one year to another, crop loads significantly influenced average fruit weight and their repartition in commercial classes. Compared to the farm crop load, fruit weight decreased by 1-7% in high crop load while it increased by 8-9% in low crop load. Bud thinning led to a significant increase in fruit weight compared to farm crop load, ranging between 14-20%. In addition, this practice being able to be carried out a month before fruit thinning, also allows for better organization of work and manpower in the orchard. The effect of thinning is even more evident in commercial classes: Low crop load increased the number of fruits > 90g by 11-14% while bud thinning increased it by 9-26%. Concerning qualitative characteristics, fruit thinning anticipated ripening and increases soluble solids and dry matter content. This work intends to propose practical advice to kiwifruit growers on fruit thinning to organize the most suitable and economically efficient management practices in their orchards.

Keywords: Actinidia deliciosa, *A. chinensis*, fruit load, pomological and qualitative characteristics, 'Gold3', 'Hayward'

STRAWBERRY BREEDING STRATEGIES IN TURKEY

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Abstract

Among the berries, strawberries are one of the most popular and have very large market advantages, and highly profitable fruits and their popularity increases year by year in Turkey. Due to having various ecological conditions, various growing technologies such as open-field and protected cultivation, and soilless systems and appropriate cultivars Turkish consumers can find fresh strawberries all across the year. Strawberry cultivation is done using foreign strawberry cultivars. In addition, we have some local strawberry cultivars such as 'Osmanlı', 'Tüylü', 'Kara', 'Ereğli', and 'Dağ çileği' but they are grown in very limited areas. Those cultivars were used as a parent in the previous cross-breeding programs. Until now several breeding programs were done by Research Institutes, Universities, and private companies in Türkiye. We were involved in an international EU PRIMA project as a Turkish partner to characterize our strawberry germplasm resources including our local cultivars for their susceptibility to grey mold disease and to identify QTLs related to the disease. We were also involved in another international EU HORIZON 2020 project to identify our strawberry genetic resources based on their breeding values specifically drought stress for further breeding programs. In this manuscript, late advances in strawberry breeding strategies and new approaches were summarized.

Keywords: Fragaria, breeding, grey mold, drought stress, QTLs

EVALUATION OF SOME POTENTIAL COMBINATIONS OF ALMOND ROOTSTOCKS AND CULTIVARS

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Abstract

The main aim of our investigation was to evaluate cultivar–rootstock combinations of almonds. Experimental orchards were established in 2019 in Cegléd and Érd at the Hungarian University of Agriculture and Life Sciences, and in Tordas at the National Food Chain Safety Office. Trees were planted at a distance of 6 x 4 m. We worked with four rootstocks ('Cadaman®/Avimag', 'GF677', 'Garnem®', and *Prunus amygdalus*) and four late-blooming cultivars ('Tétényi rekord', 'Lauranne® Avijor', 'Supernova', 'Marokkói'). 'Marokkói' variety bred by Pullulo Ltd. is a late flowering, self-fertile cultivar. All combinations were planted in Cegléd and Tordas in 5-5 replications, and in Érd in 10 replications. We investigated the height of trees, corona and trunk diameter, the density of flower buds, time of flowering, and the extent of spring frost damage. Furthermore, we examined fruit ripening time, fruit quantity, length, thickness, and weight of fruit and nuts. 'Tétényi rekord' began blooming, and then 'Marokkói' followed it at the end of March, while the other two cultivars bloomed rather in April. Due to the cold nights during spring, frost damage may be up to 50% (e.g. 'Tétényi rekord' on 'Garnem®' and 'GF677' rootstocks or 'Supernova'). 'Lauranne® Avijor', which bloomed the latest, we measured the least frost damage, it was less than 10%. Flower buds per meter in the first year were outstanding in the case of 'Tétényi rekord' and 'Lauranne® Avijor'. Varieties blooming in April have less frost damage loss, and consequently, a larger yield can be expected. The first results show that the varieties 'Lauranne® Avijor' and 'Supernova' on 'GF677' and *P. amygdalus* rootstocks are the first to bear fruit. Next year it is planned that further cultivars and rootstocks will be investigated such as 'Rootpack® R', 'Rootpack® 40' rootstocks, and 'Penta', 'Makako', 'Vairo' cultivars.

Keywords: frost damage, flower bud, blooming, growth rate, nut

IMPROVING THE STORAGE QUALITY OF DRAGON FRUIT BY COMBINING ENVIRONMENTALLY FRIENDLY COATINGS AND MODIFIED ATMOSPHERE PACKAGING

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Abstract

Pitaya or dragon fruit (*Hylocereus* spp.) has been gaining an important demand and popularity in tropical and sub-tropical regions of the world, mainly because of its high antioxidant activity and diverse nutrients. However, dragon fruits have a thin rind which makes them very prone to water and quality loss during storage. Therefore, this research was carried out to determine the impacts of potassium sorbate (PS) and edible coating (EC) treatments separately and in combination with the modified atmosphere packaging (MAP). A total of 6 treatments were tested in current research, namely: 1) control, 2) EC, 3) PS, 4) MAP, 5) MAP + EC, and 6) MAP + PS. Fruits were stored at 10-11 °C and 90-95% relative humidity. Studies were continued for 35 days and the quality measurements were done at 7-day intervals. According to the results obtained, fruits with no treatment had a total of 22.9% weight loss in 35 days, which was maximally reduced to 11.6% with the combination of MAP and PS treatments. The same treatment was noted to have the highest influence on the preservation of the loss in soluble solids concentration and to have the highest impact on the prevention of fruit decay. Similarly, the sensory eating quality and sensory visual quality of the fruits were noted to be highest at the MAP + PS treatment and were followed by the MAP + EC and MAP treatments. In conclusion, results revealed the highest impact of MAP on the preservation of the fruit quality during storage and highlighted that the combination of MAP with PS or EC produces better results in the prevention of postharvest losses.

Keywords: bract browning, edible coating, modified atmosphere packaging, potassium sorbate, sensory quality

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