IX INTERNATIONAL SYMPOSIUM ON NEW ORNAMENTAL CROPS

GUADALAJARA, MEXICO. 2019



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SEPTEMBER 30 – OCTOBER 3

CENTRO DE INVESTIGACION Y ASISTENCIA EN TENCOLOGIA Y DISEÑO DEL ESTADO DE JALISCO

CONFERENCE HANDBOOK

Program and abstracts

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Welcome

On behalf of the International Society for Horticultural Science (ISHS), it is our pleasure to welcome you to the IX INTERNATIONAL SYMPOSIUM ON NEW ORNAMENTAL CROPS. The symposium is organized by the Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ), where we have been working in ornamental crops for almost 15 years now, so this is the perfect opportunity for us to host this symposium. CIATEJ is one of 26 in the national system of public research centers of the National Council of Science and Technology of Mexico (CONACYT).

Following the history of the current symposium, on the last meeting in Perth, Australia, we agreed to host this important symposium in 2019. This is the IXth symposium on new ornamental crops which has been held in different cities around the world: Perth, Australia; Buenos Aires, Argentina; Funchal, Portugal; Parana, Brazil; Chania, Greece; Baltimore, USA and Faaborg, Denmark. In previous editions, this symposium was known as New Floricultural Crops, since last edition in Perth, it changed to New Ornamental Crops, to include even more research in the field. However, there has been many other symposia in the scope of the ISHS workgroup New Ornamentals.

This will be an exciting symposium, where the research being conducted worldwide, in order to produce new ornamental crops will be presented through high quality scientific presentations.

The symposium will also include a field trip to different landscapes in the region where we will be able to observe a large number of wild species in their natural habit.

Guadalajara is known as the city of Mexicanity. It is located in the western-pacific area of Mexico. Guadalajara is the capital of the state of Jalisco, the agricultural giant of Mexico, home of mariachi music, traditional clothing and tequila.

I am sure that you will enjoy this symposium!

Welcome



Rodrigo Barba-Gonzalez
Convener

Organizing Committees

International Scientific Committee

Chad T. Miller, Kansas State University, United States of America

Edith Salome-Castañeda, Universidad Popular Autónoma del Estado de Puebla, Mexico

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Gabriela Facciuto, Instituto Nacional de Tecnología Agropecuaria, Argentina

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Johan Van Huylenbroeck, Flanders research institute for agriculture, fisheries and food, Belgium

John Dole, North Carolina State University, United States of America

Jose Luis Piña-Escutia, Universidad Autónoma del Estado de México, Mexico

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Kanchit Thammasiri, Mahidol University, Thailand

Mark Roh, Dankook University, Mokpo National University, South Korea, Retired

Pejman Azadi, Agricultural Biotechnology Research Institute of Iran, Iran

Richard Criley, University of Hawai'I at Manoa, United States of America

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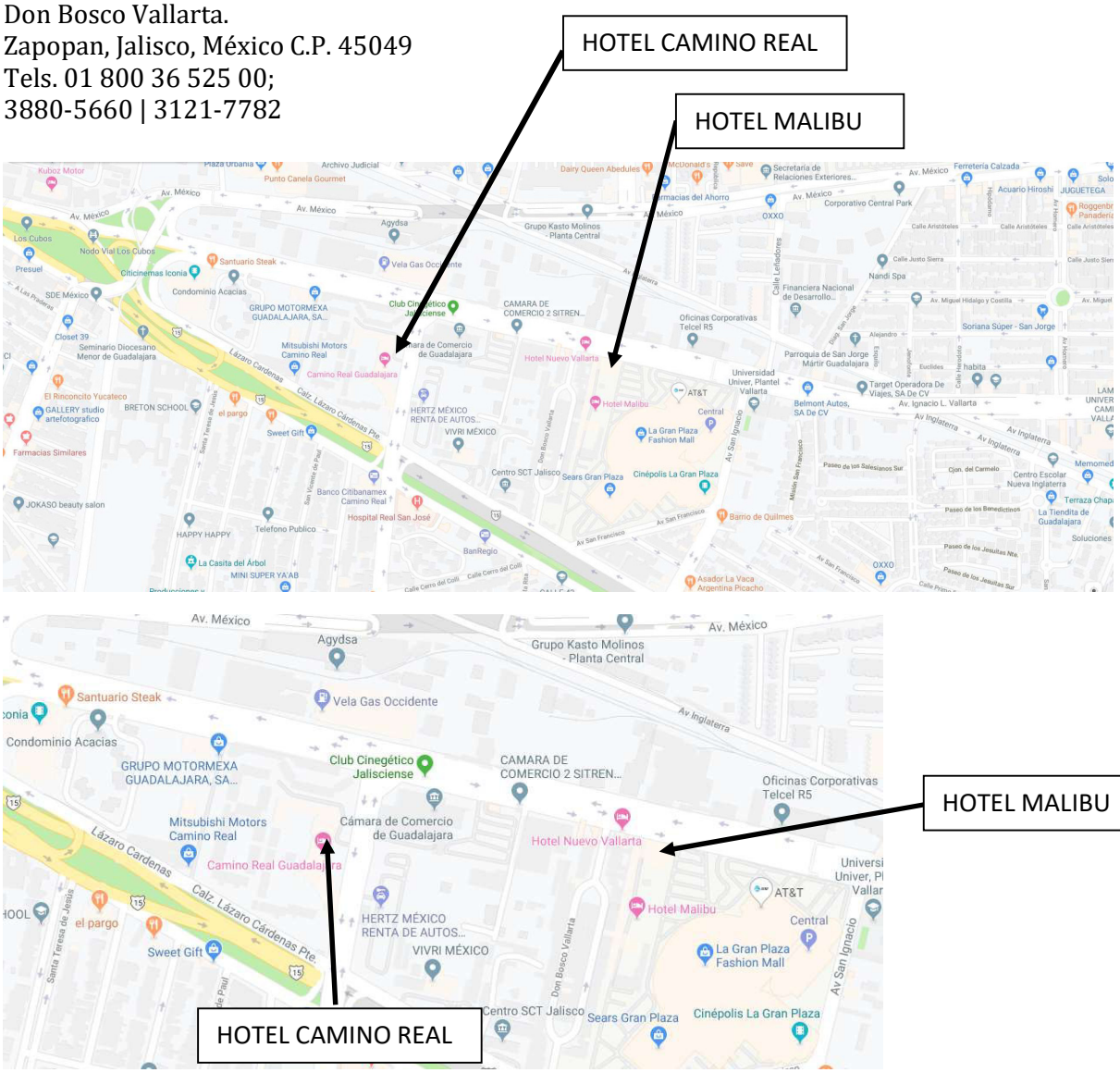
Gobierno de Tapalpa
2018 - 2021
"DE FRENTE CON LA GENTE"

General Information

Conference Venue

The IX International Symposium on New Ornamental Crops will be held at the HOTEL MALIBU, which is located in a privileged zone of the city, surrounded by touristic sights and hotels.

HOTEL MALIBU
Av. Vallarta # 3993
Don Bosco Vallarta.
Zapopan, Jalisco, México C.P. 45049
Tels. 01 800 36 525 00;
3880-5660 | 3121-7782



Symposium Dinner

The Symposium dinner will be held at the Hotel Camino Real, Avenida Ignacio Luis Vallarta 5005 Chapalita, Camino Real, 45040 Guadalajara, Jalisco.

Program

IX International Symposium on New Ornamental Crops

Monday, September 30th 2019

19:00 – 22:00		Registration and Welcome Reception

Tuesday, October 1st 2019

8:00 – 9:00		Registration
9:00 – 9:15		Welcome
9:15 – 9:30		Margherita Beruto: ISHS
9:30 – 10:40		**Session "Sustainable use of biodiversity for floriculture and landscape" Chair:**
9:30 – 10:00	1	Keynote lecture by Dr. Johan Van Huylenbroeck: Breeding for sustainable ornamental plants
10:00 – 10:20	2	Dr. John Dole: Evaluating woody ornamentals as cut flowers
10:20 – 10:40	3	Assist. Prof. Orville Baldos: Collection, selection and evaluation of native Hawaiian plants for landscape and indoor uses
10:40 – 11:10		Coffee Break
11:10 – 12:40		**Session "Potential use of native flora"**
11:10 – 11:40	4	Keynote lecture by Dr. Kenneth W. Leonhardt: Variety improvement in tropical ornamentals, for landscape uses and floral products
11:40 – 12:00	5	Dr. Bruno Trevenzoli Favero: Preliminary prospects of northwestern amazonian shade tolerant species with ornamental potential
12:00 – 12:20	6	Dr. Henrik Lütken: New ornamental bedding plants for temperate and cold regions
12:20 – 12:40	7	Prof. Rolston St. Hilaire: Bigtooth maples are ornamental Acer taxa that can thrive in dry environments
12:40 – 13:40		Lunch
13:40 – 15:10		**Session "Native plants and genetic resources"**
13:40 – 14:10	8	Keynote lecture by Prof. Dr. Chunlin Long: Will East Asia continue to make contributions to the world's gardens?
14:10 – 14:30	9	Prof. Qixiang Zhang: China One-Thousand New Floral Plants Project
14:30 – 14:50	10	Prof. Dr. Seiichi Fukai: New development of *Torenia*
14:50 – 15:10	11	Dr. Pablo Morales: *Argylia radiata* polyploidization, first approach for future plant breeding
15:10 – 15:40		Poster Session I (Coffee Break)
15:40 – 17:00		**Session "Genetic resources and biotechnology"**
15:40 – 16:00	12	Dr. Kenneth W. Leonhardt: Breeding and selection of *Leucospermum* hybrids for tropical climates
16:00 – 16:20	13	Dr. Kenneth W. Leonhardt: Reducing seed pod litter in two tropical landscape tree Species, the royal poinciana tree (*Delonix regia*) and the monkey pod tree (*Albizia saman*) by polyploid induction
16:20 – 16:40	14	Ms. Karla E. Gonzalez García: Antioxidant properties in bracts of sun Poinsettia (*Euphorbia pulcherrima*) from Mexico
16:40 – 17:00	15	Dr. Moumita Malakar: Molecular characterization of ten *Heliconia* (Heliconiaceae) genotypes by means of RAPD markers
17:00 – 18:00		ISHS Business Meeting (ISHS Members)

Wednesday, October 2nd 2019

8:00 – 9:00		Registration
9:00 – 10:40		**Session "Propagation and production"**
9:00 – 9:30	16	Keynote lecture by Prof. Jose Merced Mejia-Muñoz: Research on dahlia, the national flower of Mexico
9:30 – 9:50	17	Prof. Dr. He Chaoxing: Effects of different compost and field amount of vegetable straw on the soil environment and ginger yield
9:50 – 10:10	18	Dr. Ilse Iliana Pérez: Effect of light and phytohormones on the differential response of the organogenic-embryogenic somatic clone of *Agave victoriae-reginae*
10:10 – 10:30	19	Dr. Moumita Malakar: Discernment of pollen grain fertility and stigma receptivity plying hasty-easy techniques of *Heliconia*
10:30 – 10:50	20	Ms. Isabel Niebla López: Effect of different storage temperatures in flowering of *P. Tuberosa* L
10:50 – 11:20		Coffee Break
11:20 – 13:10		**Session "Postharvest biology, technology and quality"**
11:20 – 11:50	21	Keynote lecture by Dr. John Dole: Current and future directions in cut flower postharvest handling
11:50 – 12:10	22	Dr. John Dole: Vase life of 58 new cut flowers
12:10 – 12:30	23	Dr. Vera Zykova: Introduction of new species to extend the period of decorative duration of flower collections of the Nikitsky Botanical Gardens
12:30 – 12:50	24	MSc. Javier C. Fragoso JimenezVolatile compounds in flowers of *Polianthes* genus
12:50 – 13:10	25	Mr. Hayato Morimoto: Evaluation of carnation flower diversity in terms of flower color, flower color pattern and flower pigment
13:10 – 14:10		Lunch
14:10 – 15:30		**Session "Disease control"**
14:10 – 14:30	26	Dr. Mary Hausbeck: Advances in *Botrytis* control for flower crops
14:30 – 14:50	27	Ms. Bridget Giffei: Assessing fire blight resistance of new Cotoneaster genotypes inoculated with *Erwinia amylovora* in the field
14:50 – 15:10	28	Mr. Bryant Davenport: Development of a real-time duplex isothermal assay for the detection of Tobacco Rattle Virus and an endogenous internal RNA control in ornamental hosts
15:10 – 15:30	29	Dr. Kenneth W. Leonhardt: Polyploidy as an *Erythrina* gall wasp management strategy for the indian coral tree, *Erythrina variegate*
15:30 – 16:00		Poster Session I (Coffee Break)
16:00 – 16:30		Round table: Future of new ornamental crops
16:30 – 16:45		Young Mind Awards
16:45 – 17:20		Closure
20:00 – 23:00		Symposium Dinner

Thursday October 3rd 2019

8:00 – 19:00	Post-Symposium Tour

Keynote Speakers

Dr. Johan Van Huylenbroeck

ILVO Plant Sciences Unit, Belgium

Dr. Kenneth W. Leonhardt

Dept. of Tropical Plant and Soil Sciences, University of Hawaii, United States of America

Dr. Chunlin Long

College of Life and Environmental Sciences, Minzu University of China. China

Prof. Jose Merced Mejia-Muñoz

Departamento de Fitotecnia, Universidad Autónoma Chapingo, México

Dr. John Dole

Dept. of Horticultural Science, North Carolina State University, United States of America

Session I

Sustainable use of biodiversity for floriculture and landscape

Breeding for sustainable ornamental plants

Johan Van Huylenbroeck

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During the last decades, the main goal in many commercial ornamental breeding programs has remained unchanged in a changing world: to develop new cultivars with improved floral attributes (color, shape, perfume, enhanced vase life), leaf characteristics or plant habit. Only recently sustainability has gained increased interest by ornamental plant breeders. Enhanced disease and pest resistance, increased tolerance against abiotic stresses and less input of chemicals during the production phase or for postharvest treatments are big challenges but have great potential for future markets. How successful man can be to reach these novel breeding targets will depend largely on a multidisciplinary approach and collaboration between biologists, breeders, physiologists, plant pathologists and molecular biotechnologists. Public private partnerships can enhance the process, especially in the pre-breeding phase. Conservation and access to well characterized genetic resources is a first and important step. Only a small fraction of the world wide available germplasm is used in breeding and the genetic background of the major commercial ornamental crops is rather small. To enlarge the genetic genepool and to create breakthrough innovations interspecific and intergeneric hybridization are major drivers. It enables to introgress novel genes (biotic or abiotic stress resistance, plant architecture,…) absent in a specific target species. Tools such as robust bioassays for screening of offspring or parent plants and molecular techniques might help to speed up this process. In future, when more genomic data become available, the knowledge of the underlying causal genes of specific traits will increase. Together with precision breeding techniques this will allows to direct the breeding process. However, success application in ornamentals will largely depends on the regulatory framework of these new technology.

Keywords: Breeding, sustainability, biotic and abiotic stress resistance

Evaluating woody ornamentals as cut flowers

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Woody plant species are an important part of field-grown cut flower operations as they do not have to be replanted every year, provide potential for year-round harvests, and offer a broad range of cut flowers, fruits, foliages and decorative stems. The Association of Specialty Cut Flower Growers in cooperation with North Carolina State University and woody plant suppliers conducted three separate trials from 2004 to 2006 (14 cultivars), 2008 to 2010 (eight cultivars) and 2010 to 2012 (nine cultivars) to evaluate 31 taxa for cut flower production. North Carolina State University and five to ten commercial cut flower growers per trial across the United States evaluated the plants. The most productive taxa were *Callicarpa* 'Early Amethyst' and 'Welch's Pink', *Hydrangea paniculata* 'Limelight', *Indigofera amblyana*, and *Rosa* 'Mon Petit Chou' and 'Perfumed Passion'. *Aronia arbutifolia* 'Brilliant' and *Callicarpa Americana* 'Welsh's Pink' produced stems over 90 cm long in the second year. In addition to providing production data, the trial sites also rated each cultivar for market appreciation, likelihood of growing the cultivar again, and ease of cultivation. Based on trialer ratings the best performers in the trials were *Aronia arbutifolia* 'Brilliant', *Callicarpa Americana* 'Welsh's Pink', *Callicarpa dichotoma* 'Early Amethyst', *Heptacodium miconioides*, *Hydrangea paniculata* 'Limelight', *Ilex verticillata* 'Berry Nice', *Physocarpus opulifolius* 'Diabolo', *Rosa* 'Honey Freelander', 'Mon Petit Chou' and 'Toscana' and *Syringa x hyacinthiflora* 'Asessippi'.

Keywords: Trial program, yield

Collection, selection and evaluation of native Hawaiian plants for landscape and indoor uses

Orville Baldos[1], Darel Kenth Antesco[2], Aleta K. Corpuz[3], Christyn Wong[1]

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The use and demand for native plants as ornamentals is increasing in the United States. In Hawaii, native plants have been promoted and utilized as a response to conservation and invasive species issues in the state. Despite increased use in the past three decades, the lack of variety/selections and care information still hinders its widespread use. To fill these gaps, a research program was initiated to collect, evaluate and propagate underutilized non-endangered plants for landscape/container and indoor uses. Collection of seeds, cuttings or divisions of target species from wild populations, nurseries and germplasm repositories across the state are ongoing. Species that are currently being studied include 'aweoweo (*Chenopodium oahuense*), 'ilima (*Sida fallax*), nehe (*Melanthera integrifolia*), pa'u o hi'iaka (*Jacquemontia ovaliifolia*) and 'ala'ala wai nui (*Peperomia* spp.). Morphological characterization indicated a wide variety of forms available for developing use specific selections. Differences in propagation approaches were also observed within and between species collections. Initial trials identified potential selections that are suitable for use in landscape/container and for indoor use. Production protocols are currently being refined for these selections.

Keywords: Native Hawaiian plants, landscaping, houseplants, container plant, Hawaii

Session II

Potential use of native flora

Variety improvement in tropical ornamentals, for landscape uses and floral products

Kenneth W. Leonhardt

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The 2017 value of Hawaii's floriculture and nursery products is estimated at $77.6 million. This includes cut flowers, orchids, lei flowers, cut and potted foliage, potted flowering plants and container grown landscape plants. The ornamental plant industry in Hawaii, and worldwide, depends on the creation and introduction of improved cultivars. This presentation will describe several strategies used to develop improved cultivars of dracaena, gingers, stephanotis, several landscape tree species and a dendrobium orchid. The strategies include traditional breeding, polyploidy induction, radiation induced mutations and virus eradication.

Keywords: Polyploidy induction, radiation induced mutations

Preliminary prospects of northwestern amazonian shade tolerant species with ornamental potential

Almecina Balbino Ferreira[1], L. Garcia[1], Lin Chau Ming[2], Henrik Lütken[3], Bruno Trevenzoli Favero[3]

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The ornamental plant market in Brazil is growing substantially with a turnover of 1.4 billion USD in 2014. In addition, an increase in the supply of certain floricultural products, especially the trade of tropical flowers and foliage in both foreign and domestic markets has exposed the potential of traditionally non-explored regions, especially the Brazilian Amazon. Moreover, it can be expected that species that are growing on the forest floor are suitable candidates as novel potted plants fit for low light indoor conditions caused by the long and dark winters on the northern hemisphere. Therefore, analyses targeting novel and under-explored ornamental species were carried out at the Zoobotanical Park of the Federal University of Acre (UFAC), Rio Branco/Brazil. This park has a natural area with 115 ha of well-preserved Amazon Forest and it is suitable for this research. The study aimed to locate, collect and identify ornamental plant species while investigating their habitats in respect to occurrence in shaded areas. The field information was systematized with respect to the usage of various species in the literature, providing data for future research projects and contributing to the preservation of ornamental species diversity at the campus. The methodology used was divided into two phases: 1st the botanical samples were collected and the plant specimens conserved in herbarium. The second phase included a comparative study carried out using the specific literature available. The results include a list with different species and varieties of tropical perennial plants found in the forest of the Zoobotanical Park, in a shaded environment, with potential for ornamental use as potted plants. These selected species are distributed in the following genera: *Costus* L., *Calathea* G. Mey, *Heliconia* L., *Zamia* L., representatives of the botanical families: Costaceae, Marantaceae, Heliconiaceae and Zamiaceae, respectively. These plants are of economic interest and versatile because they can be grown in pots and as bedding plants and have great diversity of varieties among species.

Keywords: Amazonian Ornamental Plants, shade tolerant plants, tropical foliage, tropical flowers

New ornamental bedding plants for temperate and cold regions

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The production of ornamental plants has a yearly turnover of several billions of euros with Europe being the major producer. There is increasing demand for novelty in the ornamental plant production and several strategies have been made to accommodate this request. However, they have mainly targeted potted plants and cut flowers and not bedding plants. In the Nordic countries, the growing focus on new Nordic cuisine has led to increased interest in native edible plants/urban gardening and it now seems that this trend is spreading to wild ornamental plants. This is shown in terms of the first horticultural nurseries are starting to sell indigenous plants as bedding plants. In order for the wild plants to be competitive with the domesticated cultivars that are often of foreign origin, it is important that they fulfil a plethora of features. One of the most important criteria is large and colorful flowers as well as attractive leaf features. Furthermore, the plants need to be easy to cultivate and as a consequence of climate changes, drought tolerance is highly appreciated. On the other hand, the advantage of the endogenous plants is that they are fully cold adapted as they occur in the wild in contrast to the more exotic plants frequently grown. In this context, urban landscaping in proximity of salted roads during winter is turning its interest to naturally occurring species from the Nordic flora, which are salt tolerant. In the current study, we review novel wild plants of different genera for their potential to be new ornamental bedding plants for temperate and cold regions. These plants include wild plants from Europe; *Geranium argenteum, Dianthus superbus, Linum austriacum, Vincetoxicum hirundinaria* and *Rhodiola rosea.* The plants are assessed in terms of their potential as bedding plants in urban environments in temperate/cold areas.

Keywords: Drought tolerance, nordic plants, salt tolerance, urban gardening, wild plants

Bigtooth maples are ornamental *Acer* taxa that can thrive in dry environments

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With a geographic range that covers Utah, Idaho, Wyoming, Arizona, New Mexico, and Texas, bigtooth maple (*Acer grandidentatum* Nutt.) has one of the largest ecological ranges among the North American *Acer* genus. The plant has a patchy distribution in its ecological range and does not appear to be limited to a specific habitat. Because bigtooth maples grow in a variety of edaphic conditions, we reckon that the plant may be adaptable to the environmental stress encountered in managed landscapes. Bigtooth maple is a relatively small tree and has fall foliage colors that range from yellow to crimson. Using half-siblings from provenances in its indigenous range, we established a research program to test the tolerance of bigtooth maples to environmental stresses. Seedlings from selected provenances in Texas, New Mexico, and Utah contained ecotypes that were tolerant to salinity, radiation, and drought. Further progeny selection work resulted in one cultivar *Acer grandidentatum* 'JFS-NuMex 3', marketed as Mesa Glow®. Mesa Glow® has an upright branch structure which is a desirable trait in a plant destined for use in an urban environment. The plant has deeper red fall colors than previous bigtooth maple selections.

Keywords: Aceraceae, *Acer grandidentatum*, environmental stress, fall color, woody ornamentals

Session III

Native plants and genetic resources

Will East Asia continue to make contributions to the world's gardens?

Chunlin Long[1], Johan Van Huylenbroeck[2]

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The East Asia is one of the richest global regions in biocultural diversity, lying in three floras: Pan-Arctic flora, Paleotropical flora and East Asian flora. There are more than 600 endemic genera and 31 endemic families in the region. In this floristic kingdom, 75% of families of extant gymnosperms and more than 60% of angiosperm families (258 of 416) can be found. The East Asian flora has also a higher species diversity (more than 3000 genera) than other regions of the Northern Hemisphere. The East Asia-originated plants have made great contributions to the world's horticulture industries and landscapes. Ernest Henry Wilson, a plant hunter, gardener and botanist, collected and shipped about 2000 species of living ornamentals and many herbarium specimens from Asia to Europe and North America. Most of these plants were collected from China in 1899-1918 by Wilson. Many of Wilson's collections have become important components of introduced flora of western gardens and urban areas. Will East Asia continue to make contributions to the world's gardens in the future? The authors reviewed recent publications and analyzed the development trends during the past decade from botanical explorations and experiment-based studies. The results revealed that there are huge potentials to develop new ornamental crops from East Asian flora. The rapid economic development in East Asian countries (particularly China, Japan and South Korea) provided enough financial supporting for breeding and domesticating new ornamentals in the past 60 years. A great number of plant species and varieties will be developed as ornamentals from East Asian countries in the future.

Keywords: East Asian flora, economic development, mother of gardens, new ornamental crops

China One-Thousand New Floral Plants Project

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China is one of the distribution centers and genetic diversity centers of ornamental plants in the world. Since 1982, we have investigated and studied the flower germplasm resources in China, established the evaluation system for wild flowers and identified 7938 species in China. Moreover, 11 germplasm nurseries were established nationwide, including three national flower germplasm banks of *Prunus mume*, *Lagerstroemia indica* and *Prunus triloba*, in which more than 15,000 resources were collected. Using morphological and molecular markers, the core germplasms of 9 important species were constructed, including *Prunus mume*, *Lagerstroemia indica*, *Prunus triloba* and *Syringa oblata.* A number of important germplasms with special characters were excavated, such as cold-resistant germplasms of *Prunus mume,* strongly aromatic *Dendranthema indicum* and *Opisthopappus taihangensis*, *Lagerstroemia caudate* resources with sweet fragrance and *Rosa laxa* resources with characters of cold-resistant, drought-resistant and powdery mildew-resistant. These special germplasms provide a basis for the improvement of the modern cultivars mentioned above.

According to the characteristics of wild flower germplasms in China, the development strategy for these new resources was formulated, and a number of new technologies such as test-tube sowing, leaf cutting, plant types control and regulation of flowering time were developed, and the "China One-Thousand New Floral Plants Project" was organized. At present, more than 100 kinds of new flowers, such as *Primula forbesii*, *P. maximowiczii*, *Cypripedium calceolus* and *Primulina* Spp. have been pushed into market and gradually popularized.

Keywords: Wild flower, new floral plant, genetic diversity, core germplasm

New development of *Torenia*

Seiichi Fukai, Tanapoom Laojunta

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Torenia is an important summer bedding plant. Number of commercially available cultivars has been increased during last decade, especially clone cultivars. Only three species have been used in the breeding program of *Torenia* whereas more than 40 species are recognized. This report provides an overview of recent technological advances in three respects: breeding, propagation and preservation of *Torenia*. Both mutation breeding and interspecific hybridization contributed to expand genetic variations and produce new cultivars in *Torenia*. Reciprocal crossings of 6 species, *T. baillonii, T. bicolor, T. concolor, T. fournieri, T. hirsutissima,* and *T. siamensis*, produced several new interspecific hybridizations through ovary-ovule culture. Both back-cross and self-pollination are useful to expand phenotype variations in the interspecific hybrids. Efficient young plants production system is required because demand of bedding plants in flower market is concentrated in the early spring. Leaf cutting is the most efficient and economical vegetative propagation method, although in vitro propagation is applicable in *Torenia*. Reliable preservation method of both mother plants of clone cultivars and genetic resources are required. New cryopreservation technique, cryo-plate vitrification method, is successfully applied in *Torenia*.

Keywords: Bedding plant, breeding, cryopreservation, interspecific hybridization, leaf cutting

Argylia radiata polyploidization, first approach for future plant breeding

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Argylia radiata (L.) D. Don (Fam.: Bignoniaceae) is an herbaceous perennial plant, native from the North of Chile and part of "Flowering Desert". This understudied species has potential as an ornamental crop because of its blue-green foliage and multiple floral stems with trumpet flowers.

As first approach of *A. radiate* breeding process, polyploidization trials were run. Two induction agents, oryzalin and nitrous oxide, were tested at *in vitro* level. Under sterile conditions, *A. radiate* microplants were put inside Eppendorf tubes with oryzalin solution. Two concentrations and two times of exposition were assayed: 0.01 mg L^{-1} during 24 hours (T1); 0.01 mg L^{-1} during 48 hours (T2); 0.05 mg L^{-1} during 24 hours (T3); 0.05 mg L^{-1} during 48 hours (T4). Regards to the experiments with nitrous oxide, microplants of *A. radiate* were put on sterile Eppendorf tubes and located inside a gas chamber. The nitrous oxide was injected at 5 atm during 24 hours (T5) and 48 hours (T6). For all treatments, 5 plants were used. After the induction essays, the plants were transferred to a free hormones medium during 3 weeks and the regenerated shoots were cut, leaving only 1 bud per explant. This process was repeated twice. The microplants, regenerated from those buds, were treated as independent lines (56 lines were obtained), and they were transferred to fresh medium every 12 weeks during 1 year. No plants from T3 and T4 were possible to regenerate. After that period, a small piece of tissue, from each line, was analyzed by flow cytometry, detecting 1 mixoploid (25% 4n and 75% 2n) from T2. This material could be used in the future to obtain a complete tetraploid plant by bud's isolation, to generate polyploid pollen or it can be used as part of a breeding program.

Keywords: *Argylia,* polyploidization, oryzalin, nitrous oxide, tetraploid

Session IV

Genetic resources and biotechnology

Breeding and selection of *Leucospermum* hybrids for tropical climates

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One objective of the protea research program at the University of Hawaii is to help the Hawaii floriculture industry expand with selected protea varieties that can be grown on low elevation lands formerly cultivated in sugar or pineapple, or on low elevation lava fields on the Island of Hawaii, since these lands are more available and less expensive than the upper elevation lands where protea has traditionally been grown.

Leucospermum (pincushion) hybrids were evaluated for growth and flowering characteristics at Kunia, a warm, 76m elevation site on the Island of Oahu, and compared with the performance of the same cultivars grown at Kula, a cool, 920m elevation site on Maui, and a location of concentrated protea production in Hawaii. The mean temperature of 23.0°C at Kunia is 5.3°C warmer than at Kula, the mean maximum temperature of 28.0°C at Kunia is 5.7°C warmer than at Kula, and the mean minimum temperature of 18.0°C at Kunia is 4.8°C warmer than at Kula

Twenty-nine hybrids were grown at both the Kunia and Kula locations. A few hybrids were simple primary crosses, while others were complex hybrids with 4 to 9 species in their genealogy, sometimes representing 4 taxonomic sections.

Data linking the composition of taxonomic sections in the genealogy of hybrids with their ability to flower at warm temperatures show that *Leucospermum* species in the section Cardinistylus appear to contribute some warm temperature flowering ability to their hybrids.

Keywords: *Leucospermum*, protea, pincushion, temperature tolerance, breeding, Principal Component Analysis

Reducing seed pod litter in two tropical landscape tree Species, the royal poinciana tree (*Delonix regia*) and the monkey pod tree (*Albizia saman*) by polyploid induction

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The Royal Poinciana tree (*Delonix regia*; Fabaceae - Caesalpinioideae), also known as the flamboyant tree, is a Madagascar native and cultivated in all tropical countries as an ornamental for its large, showy, spring and summer flame-red flowers. It usually grows to a modest height of 6 to 10 meters, but spreads widely, and its dense foliage provides full shade. Pods are green and flaccid when young and turn dark-brown and woody and can be up to 60 cm long and 5 cm wide. A mature tree can produce in excess of 1000 pods in a season. They are a nuisance and must be raked and disposed before a lawn can be mowed.

The Monkey Pod tree (*Albizia saman*; Fabaceae - Mimosoideae) is native to the grass savannah of northern South America and is widely cultivated in the tropics as an ornamental and for shade. It has a dense, spreading crown, sometimes 30 m across, with widely spreading branches from low down. Pods are straight, green turning dark brown or black, 12-20 cm long, 1-2 cm wide, 1.2 cm thick, indehiscent, containing numerous seeds embedded in a resinous, sticky, brownish pulp. A mature tree can produce in excess of 1000 pods in a season. The gummy pods stick to shoes and slippers and are not easily swept from sidewalk surfaces.

Sterile, non-seeding forms of these species would be desirable for landscape purposes. Since a triploid (3N) plant, the progeny of a tetraploid (4N) crossed to a diploid (2N) would likely be sterile, procedures were used to first create tetraploid plants by treating meristems of diploid seedlings with 0.1% colchicine solution for 48 h. One tetraploid *Delonix* and 10 or more tetraploid *Albizia* trees began flowering at age 6 years and have flowered annually for the past 3 or 4 years. Crosses to the respective diploid forms have not been successful to date, but the induced autotetraploid plants have much reduced fertility and reduced pod production. The 4N *Delonix* produces about 90% fewer pods than a 2N plant of similar size. The pods usually contain aborted seeds. The occasional seeds that appear normally formed, usually do not germinate.

The 4N *Albizia* trees produce a range of abnormal pods, including some as short as 3 cm long and others that don't produce seeds or resin. Total pod production is reduced, but the degree of reduction has not been determined. The best selections will be grafted for increase and distribution.

Keywords: Polyploid induction, colchicine, induced sterility

Antioxidant properties in bracts of sun Poinsettia (*Euphorbia pulcherrima*) from México

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Poinsenttia (*Euphorbia pulcherrima*) is a very popular ornamental, it is grown and commercialized all over the world. In México there are several sun varieties which in recent years have been introduced in gastronomical dishes; so there is and increased interest in studying the nutritional and nutritraceutical properties of this ornamental plant, however, there are very few studies. The objective of the present work was to evaluate some nutraceutical properties of five cultivars of sun poinsettia from México grown under greenhouse conditions in the experimental station of the Autonomous University of Chapingo. Well developed bracts were collected from the cultivars 'Amanecer Navideño', 'Juan Pablo', 'Valenciana', 'Valenciana Superior' and 'Corona', in each case extractions were made using methanol-water (80: 20 v/v). Evaluations of total phenolic content CFT (Folin ciocalteu), total flavonoids FT (catechin), and antioxidant capacity (DPPH, FRAP, ABTS) were made, using trolox as reference antioxidant. The 'Corona' cultivar showed the highest CFT (86.34 ± 6.27 mg EAG gbs−1), in FT, 'Amanecer Navideño' had the highest value (0.19 ± 1.18 mg EC gbs−1), this same variety showed the highest antioxidant capacity. Among the five cultivars studied there were significant differences for antioxidant capacity.

Keywords: *Euphorbia*, phenolic compounds, antioxidant capacity, flavonoids.

Molecular characterization of ten *Heliconia* (Heliconiaceae) genotypes by means of RAPD markers

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Heliconia a trendiest specialty cut flower of tropics is gaining popularity for its inflorescence's charismatic form and alluringly blended hues in the world and in Indian market too. It is a monophyletic genus with roughly 200 to 250 species of neotropical origin. It resides in the Heliconiaceae family of Zingiberales order former incorporated in Musaceae for fusion of inverted flowers, single staminode and drupe type fruits elite for it. Exploitation of molecular markers may aid in perceptive recognition of several species and varieties, since taxonomic confusions and uncertainties subsist among them. In this context, ten species and varieties were analyzed using RAPD markers. Thirty primers among seventy were chossen, which amplified 1281 polymorphic DNA fragments with each primer giving a mean of 42.7 polymorphic bands. The genetic similarity matrix constructed with Jaccard's coefficient using RAPD marker scores showed that the highest value was between *H. psittacorum* var. 'Choconiana' and *H. psittacorum* var. 'Lady Di' (0.384), while the lowest was between *H. psittacorum* var. 'Choconiana' and *H. stricta* var. 'Dwarf Jamaican Red' (0.244). Ten species and varieties of *Heliconia* formed three distinct clusters at similarity coefficient value of 0.33, implying a parallelism between genetic and morphologic or taxonomic variability of *Heliconia* genotypes. 'Golden Torch', 'Choconiana', 'Lady Di' and *H. wagneriana* included in cluster I while 'Choconiana', 'Lady Di' formed a more cohesive entity. On the contrary, *H. stricta* var. 'Dwarf Jamaican Red' produced a separate cluster validating that taxonomically related entries clustered together and distant ones segregated. So, the current sequels demonstrate that RAPD is a rapid, relatively economical and functional for the characterization of genetic divergence between different *Heliconia* genotypes.

Keywords: Heliconia, DNA, molecular characterization, RAPD, cluster

Session V

Propagation and production

Research on dahlia, the national flower of Mexico

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Dahlia (*Dahlia* spp.) is an important plant in the world as potted plant and cut flower. It is native to Mexico, where it was source of food, medicine and ornamental value and in 1963 it was declared as the National Flower of Mexico. In 2000, a national program of collection, conservation and exploitation of dahlia species was started; currently 29 dahlia species are now in the National Center for Genetic Resources. A group of researchers from different universities is engaged in a study the morphological and chemical characterization of species to develop new varieties for ornamental, nutritional and medicinal use. The Mexican Dahlia Association promotes the cultivation and conservation of species in rural areas of the country, especially in temperate climates. In these areas, dahlia species and varieties are grown to obtain high yields of tuberous roots and flowers for their consumption as a functional food, as well as for the preparation of other products such as honey, jam, flour and cookies. Special attention is on the research of the consumption of tuberous roots for people suffering from diabetes, as dahlia tubers has been shown to regulate blood glucose levels, and lowers cholesterol and triglycerides. *Dahlia coccinea* and *D. campanulata* are the most interesting species for high yield of tubers and inulin.

Keywords: Breeding, inulin, genetic resources, tubers, diabetes

Effects of different amount compost of vegetable straw on the soil environment and ginger growth in greenhouse

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The effects of different amounts of tomato and cucumber stalk compost (20, 40, 60, 80 t•hm^{-2}) were studied on the growth, yield and root environment of ginger variety Shannong No.1. The best results were obtained with 80 t•hm^{-2} with the maximum amount compost by mix with soil than ordinary soil control (CK:without compost). Under this treatment, the soil bulk density was 0.91g•cm^{-3}, which was significantly lower than the control, low about 17.27%. The porosity of maximum treatment was 60.54%. but the porosity of the soil control is much high, significantly increased by 26.64%. The contents of soil organic matter, alkali nitrogen, total nitrogen, available nitrogen, available phosphorus, available potassium, microbial biomass carbon and microbial biomass nitrogen were 35.93 mg•kg^{-1} and 186.67 mg•kg^{-1}, respectively. 0.256%, 168.33 mg•kg^{-1}, 14.85 mg•kg^{-1}, 1380.91 mg•kg^{-1}, 102.63 mg•kg^{-1}, 175.47 mg•kg^{-1}, which increased significantly by 10.11% and 39.13%, respectively. 55.15%, 32.54%, 25.12%, 46.88%, 48.96%, 50.14%, the treatment of 80 t•hm^{-2} returning to the field have the most obvious effect on the soil enzyme activity. The improvement of the root zone environment encourages the growth of ginger plants and improves the ginger production.

Keywords: Vegetable straw; straw returning to field; soil environment; ginger yield

Effect of light and phytohormones on the differential response of the organogenic-embryogenic somatic clone of *Agave victoriae-reginae*

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Agave victoriae-reginae Moore (Asparagaceae) is endemic to the center of the Chihuahua desert. Due to its ornamental value, for decades it was subject to looting by foreigners who supplied the markets of the United States and Europe. Cataloged as an endangered species by the Mexican authorities and cited in appendix II of CITES. The generation of clonal propagation systems to be used in the legal market is considered a way to reduce the looting of wild plants by offering plants through biotechnological routes. Biotechnological selection studies can lead to propagation systems without growth regulators and, at best, they can be used for genetic responses that can be an adequate tool for propagation purposes and genetic studies. The objective of this study is to determine the response of an organogenic-embryogenic somatic clone (OES) and its response to the effect of light and growth regulators. The clone was obtained after evaluating a large number of germinated seeds, it was derived from the callus and it culminated in the formation of somatic embryogenesis, for approximately 30 years the morphogenic response remained under in vitro culture in basal MS medium. The explants were grown in DM with 0, 0.5 and 1 $mg.L^{-1}$ of Kinetin vs 0, 0.5 and 1 $mg.L^{-1}$ of 2, 4-D, under light and dark conditions. The OES tissue increases its organogenic response in the presence of KIN in low concentration in the presence of light, likewise, 2, 4-D at low concentration reduces the response times to somatic embryos in the dark. Similar responses are expressed with delay in the basal medium both in the presence of light and in the dark. The absence of phytohormones that might induce somaclonal variations during their cultivation, guarantees the maintenance of the clone for generations.

Keywords: *Agave victoriae-reginae*, embryogenic, light, organogenic, phytohormones

Discernment of pollen grain fertility and stigma receptivity plying hasty-easy techniques of *Heliconia species* L. under optical microscope

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Evaluation of pollen grain fertility and stigma receptivity are an essential pre-requisite for breeding program of *Heliconia* sp. Acetocarmine staining method adopted for pollen fertility and stigma receptivity by Baker's procedure, 6% Hydrogen peroxide (H_2O_2) and Macherey-Nagel Peroxtesmo Ko peroxidase test papers on *Heliconia psittacorum X spathocircinata* cv. 'Golden torch', *Heliconia psittacorum* var. 'Choconiana', *Heliconia psittacorum* var. 'Lady di', *Heliconia rostrata, Heliconia humilis, Heliconia humilis* var. 'Dwarf', *Heliconia wagneriana, Heliconia stricta* and *Heliconia metallica* cultivated at Agricultural Experimental Farm, Baruipur of University of Calcutta were accomplished. Samples consisted of five mature anthers and thirty freshly cut stigmas at different stages of flower development of each species. Utmost pollen fertility scrutinized under Magnüs MLX Plus at 10 and 40X augmentations as exhibited by 'Choconiana' (100%), 'Lady di' (94%) and *H. metallica* (93%) and *H. humilis* (91.87%) along with sizeable pollens ranged from 581.11 µm to 392.25 µm while unstained, sterilepollens of 'Golden torch' and *H. stricta* were significantly smaller sized. Prominently stained stigma tips by Baker's and Peroxtesmo tests were perceived in all taxa. Thus, 'Golden torch' and *H. stricta* as female parents and others as pollen parents can be utilized for hybridization.

Keywords: *Heliconia*, pollen, stigma, fertility, receptivity, microscope

Effect of different storage temperatures in flowering of *P. Tuberosa* L.

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Currently, the production of *P. tuberosa* as a cut flower has a great importance worldwide and is carried out both in greenhouse and at open field. An important issue, in different areas where tuberose is cultivated, is the control of flowering; for which it has been evaluated the use mainly of growth regulators and to a lesser extent the forcing with temperatures. In this work, the effects of different temperatures (4, 12 and 27 °C) and weeks of storage (4, 5, 6 and 7) on the variables: days to flowering (DTF), length of flower stem (LFS), thickness of the flower stem (TS), length of the spike (LS) and number of flowers (NF) were evaluated in bulbs of *P. tuberosa* var. Double. The bulbs were established in a greenhouse, the experimental unit consisted on a plastic box with 20 bulbs, with five repetitions. An analysis of variance and comparison of means was performed (Duncan, $p < 0.05$). Statistical differences between the treatments for the DTF variable were observed, where the early flowering was reported in the treatment of 7 weeks of storage at 27 ° C, meanwhile, the latest flowering happened with the bulbs stored at 12 °C for 6 weeks. On the other hand, 4 °C treatments weren't statistically different to the control (room temperature). In general, storage treatments at 27 °C showed an earlier flowering in relation to the rest of the treatments. The treatments at 12 °C were the ones that delayed more the flowering and in intermediate values are the treatments of 4 °C and the control. The rest of the variables were not affected by the storage treatments, which is important from the point of view of moving the production without affecting the quality of the flowers.

Keywords: Bulbous ornamental, plant forcing, cut flower

Session VI

Postharvest biology, technology and quality

Current and future directions in cut flower postharvest handling

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Proper postharvest management is critical in providing high customer satisfaction, but can be complicated by the many marketing channels, some of which involve long-distance transport and prolonged storage. Maximizing vase life starts with postharvest testing of new species, proper cultivar selection and optimum preharvest care. Vase life among the cultivars within a species can vary over 200%. Gene editing tools, such as CRISPR, will increasingly allow breeders to strategically modify commercially successful cultivars to increase postharvest life. Vase life varies with environmental conditions during production, such as temperature, light and water stress, and the last two weeks before harvest are especially important. While much literature says that morning harvest is best, afternoon harvest results in longer lasting flowers and higher endogenous carbohydrate levels for some species. Post-harvest treatment with floral preservatives is required to maximize vase life of most species. Various sugars are key components of many floral preservatives and work is progressing on finding novel sugars that can extend vase life. Botrytis and ethylene continue to be major postharvest problems and research is showing a strong link between the two issues. Cut flowers are often stored for days to weeks to accommodate production peaks/valleys and fluctuating customer demand and novel long-term storage techniques are being developed. Optimum handling after harvest must include placing flowers in solutions with the proper pH, EC and preservatives. Finally, proper cut flower handling by producers, shippers and wholesalers will be lost if retailers are not trained to provide optimal handling as well.

Keywords: Flower foods, specialty cut flowers

Vase life of 58 new cut flowers

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The study is part of 13-year project to determine the vase life of promising new cut flowers and foliages and overall effectiveness of commercial hydration and holding solutions. Stems of 58 cultivars from 22 genera were pretreated with either a commercial hydrating solution or deionized (DI) water for 4 hours and placed in either a commercial holding solution or DI water for 44 hours. Treatment with a holding preservative produced the longest vase life for 21 cultivars in the genera *Agastache*, *Antirrhinum*, *Digitalis*, *Eustoma*, *Filipendula*, *Helianthus*, *Lilium*, *Penstemon*, *Perovskia*, *Physostegia*, and *Tagetes* indicating that holding preservatives should be used with most taxa. Commercial hydrators increased the vase life of one cultivar in each of three genera, *Agastache*, *Hibiscus* and *Tagetes*, but reduced the vase life of two cultivars in two genera, *Helianthus* and *Tagetes*. All treatments produced a statistically similar vase life for 32 cultivars in the genera *Campanula*, *Coreopsis*, *Daucus*, *Dianthus*, *Digitalis*, *Helianthus*, *Lilium*, *Monarda*, *Rudbeckia*, *Saliva*, *Stokesia*, *Tagetes*, and *Veronica*. Of the 58 taxa tested, most of the taxa tested would be suitable for commercial production with a vase life of at least 10 days. *Eupatorium* 'Baby Joe' and *Tagetes* 'Oriental Gold' had a vase life longer than 21 days for at least one of the treatments. *Campanula* 'Champion Pro Deep Blue'; *Dianthus* 'Deep Maxine' and 'Magenta Bicolor'; *Digitalis* 'Plum Gold'; *Eustoma* 'Rosanne 1 Deep Brown and 'Rosanne 1 Green'; *Helianthus* 'EH16-13'; *Hibiscus* 'Mahogany Splendor'; *Tagetes* '888 Deep Gold', 'Falcon Yellow', 'Garland Orange' and 'Storm Gold'; *Rudbeckia* 'Viette's Little Suzy' and *Veronica* 'Charlotte' had a vase life of 14 to 21 days. Twenty-three other taxa had a vase life of 10 to 14 days. *Penstemon* 'Arabesque Appleblossom', *Perovskia* 'Longin', and *Saliva* 'Burgundy Candles' had a vase life of less than 7 days.

Keywords: holding solution, hydrator, preservative

Introduction of new species to extend the period of decorative duration of flower collections of the Nikitsky Botanical Gardens

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The existing cultivar diversity of a plant is determined by the range of species used in the breeding programs. As a result, the duration of flowering, the decorative period in the landscape, is inherited from these original species. The introduction of species not originally included in the breeding of the cultivars with earlier or later flowering periods are especially valuable in extending the decorative durations of plants in the Nikitsky Botanical Gardens collection. For example, lilac cultivars flower on the Southern Coast of the Crimea (SCC) from the second week of April to the second week of May. Introduction of late flowering species *Syringa josikaea* J. Jacq. ex Rchb and *S. pekinensis* Rupr. extended the flowering period from the second week of May to the end of the first week of June and interspecies hybrid *S. x chinensis* Willd. flowered 5–7 days earlier than the collection cultivars, increasing the total flowering period of the lilac collection. Garden roses in the SCC have a very long flowering period from May to the end of December, which is further extended by the introduction of species *Rosa banksiae* W.T. Aiton and *R. fortuneana* Lem., which bloom in the second week of April. Clematis cultivars begin flowering in early May and continue until September. Two introduced early flowering species: *Clematis armandii* Franch. And *C. montana* Buch.-Ham. ex. DC. and one subvariety of *C. montana* var. *rubens* start flowering in the first to third weeks of April. Introduction of late flowering species *C. peterae* Hand. – Mazz. increased the duration of flowering of the clematis collection until the first week of November. The iris (*Iris × hybrid* hort.) collection begins flowering in the first week of April and ends in the first week of June. However, the introduced species *I. unguicularis* Poir. flowers in December and January, under SCC conditions, extending the decorative period of the iris collection. In summary, introduced species and interspecies hybrids with very early or late flowering periods have significantly extended the overall decorative periods of garden rose, lilac, clematis and iris collections.

Keywords: lilac, clematis, iris, rose, cultivar, flowering period

Volatile compounds in flowers of *Polianthes* genus

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The genus *Polianthes* (Asparagaceae) is endemic from Mexico, the main use of this genus is ornamental, represented for this purpose tuberose (*Polianthes tuberosa* L.) which is mainly used in the perfumery for its sweet fragrance in its flowers. Regarding the wild species of this genus, little is known about the chemical composition in its different structures. In the present work, the volatile profile in flowers from wild and commercial cultivars belonging to the genus *Polianthes* was studied. Different compounds like aldehydes, alcohols, esters, monoterpenes, sesquiterpenes, and lactones were identified. The flowers of *P. sessiliflora* showed a similar composition with the commercial cultivars (*P. tuberosa* var. simple and double), while the rest of the wild genotypes showed different chemical composition. there are not study which analyzing the volatile compounds in flowers of wild specimens of the genus *Polianthes*, so it is the first study comparing the volatile composition in the flowers from wild and commercial cultivars, where the different profiles allowed us to group these genotypes for their use in perfumery, pharmaceutical or agro-industrial applications.

Keywords: *Polianthes*, chemical composition, flower compounds, volatile composition

Evaluation of carnation flower diversity in terms of flower color, flower color pattern and flower pigment

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Carnation (*Dianthus caryophyllus* L.) cultivars were bred by multiple crossing in wild *Dianthus* species, and the perpetual flowering carnations are thought to be developed in 19th century through crosses by using *Dianthus chinensis* from China. Although variation of flower color and flower color pattern is enriched annually, the information about the flower color characteristics has remains inadequate. Thus, we investigated the flower color characteristics of ca. 130 Dianthus cultivars (mainly carnations). The results showed that the flower color pattern of adaxial surface of the petals was classified into 11 groups, and there were some cultivars having different flower color patterns on the adaxial and abaxial surfaces of the petal. The flower colors can be divided into 15 groups. Furthermore, we investigated the major flower pigments being responsible for flower colorations. It is known that a cyanic flowered carnation cultivar accumulates either one of pelargonidin 3,5-cyclicmalyl-diglucoside, cyanidin 3,5-cyclicmalyl-diglucoside, pelargonidin 3-malylglucoside or cyanidin 3-malylglucoside in the petals as the major anthocyanin. However, we found a few exceptions. Although none of single colored carnation cultivars accumulated the same amount of pelargonidin and cyanidin in the petal, a certain cultivar with variegated petals accumulated the pelargonidin and cyanidin glucosides in the base and the sector of the petals as the major anthocyanin, respectively. The co-accumulation of pelargonidin and cyanidin in a petal might contribute to the development of the novel flower colors.

Keywords: carnation breeding, flower color, flower color pattern, flower pigment

Session VII

Disease control

Advances in *Botrytis* control for flower crops

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Flower crops are constantly threatened by the fungal pathogen *Botrytis cinerea* Pers.:Fr. which causes gray mold or Botrytis blight. Symptoms of *Botrytis*-caused diseases include leaf spots; blighting; stem cankers; rots of corms, rhizomes, tubers and seeds; and damping-off of seedlings. Blighting may affect leaves, petioles, blossoms, and stems. *Botrytis cinerea* is ubiquitous, has a wide host range, and causes significant losses at all stages of flower production. This study investigated plant protection products for their ability to limit Botrytis foliar and flower blight under greenhouse conditions. Floral crops known to be especially susceptible to Botrytis blight were inoculated once with conidia from *B. cinerea* cultures grown on potato dextrose agar for four weeks. Plants were incubated under high relative humidity conditions. Prior to inoculation, plant protection products were applied as a foliar spray using a hand-pump compressed-air sprayer and reapplied at specific intervals. Assessment included the number of leaves and/or blossoms with sporulating *B. cinerea* and an overall disease severity rating. Data were analyzed using SAS PROC GLM and statistical differences were compared using the Fisher's Protected Least Significant Differences test (P=0.05). The results of multiple, replicated trials indicate that the following plant protection products were especially effective in limiting Botrytis blight: polyoxin D zinc salt, pyraclostrobin/boscalid, chlorothalonil, fenhexamid, iprodione, fluopyram/trifloxystrobin, azoxystrobin/benzovindiflupyr, and isofetamid. Biopesticides were also tested and included *Bacillus subtilis*, *Pseudomonas chlororaphis*, *Aureobasidium pullulans*, extract of *Swinglea glutinosa*, thyme oil, and *Reynoutria sachalinensis*. When used alone, the biopesticide products did not adequately control *B. cinerea*. Successful management of Botrytis blight in floral crops requires integration of this latest research with sanitation and environmental control strategies.

Keywords: Gray mold, *Botrytis cinerea*, fungicides, biopesticides

Assessing fire blight resistance of new Cotoneaster genotypes inoculated with *Erwinia amylovora* in the field

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The genus *Cotoneaster* Medik. encompasses hundreds of woody shrub species whose growth habits range from prostrate to upright. *Cotoneaster* species are desirable in landscapes for their low maintenance requirements and year-round aesthetic interest. However, the health and aesthetic quality of many *Cotoneaster* species is threatened by the bacterial disease "fire blight," caused by *Erwinia amylovora* (Burrill 1882) Winslow et al. 1920. This study assessed fire blight resistance of three new *Cotoneaster* genotypes (H2011-02-001, H2011-01-002, and H2011-02-005) bred for disease resistance and two commercially available cultivars, *Cotoneaster dammeri* 'Coral Beauty' and *C. dammeri* 'Lowfast' under field conditions. Fourteen replicates of each taxa were planted in Davis, CA (USDA climate zone 9; Yolo silty clay loam soil) in May 2017. For plant establishment, irrigation at 100% of reference evapotranspiration (ET_o) was provided during the first summer after planting. In the second summer after planting (2018), plants received deficit irrigation at 50% of ET_o. In June 2018, seven replicates of each taxa were artificially inoculated with a local isolate of *E. amylovora* by bisecting the two youngest leaves on one branch with scissors dipped in a bacterial suspension of 10^9 CFU/ml. An additional seven replicates were artificially inoculated using the same method with sterile deionized water as a control. Fire blight susceptibility was assessed by calculating the Percent Shoot Necrosis (PSN = 100*(lesion length/total branch length)) once a week for eight weeks after inoculation. Taxa with a PSN greater than 0% were considered susceptible and taxa with a PSN equal to 0% were considered resistant. H2011-02-005 (mean PSN=14.5+/-8.4%), *C. dammeri* 'Coral Beauty' (mean PSN= 4.4+/-4.4%), and *C. dammeri* 'Lowfast' (mean PSN=12.3+/-11.1%) showed varying levels of susceptibility. H2011-02-001 and H2011-01-002 showed no necrosis (mean PSN=0.0+/-0.0%) and were considered resistant. The two resistant genotypes are candidates for new ornamental introductions where fire blight is prevalent.

Keywords: Disease resistance, artificial inoculation, field experiment, new ornamental plants, woody perennial

Development of a real-time duplex isothermal assay for the detection of Tobacco Rattle Virus and an endogenous internal RNA control in ornamental hosts

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Tobacco rattle virus (TRV) is capable of infecting upwards of 400 plant species including prominent ornamentals such as Dicentra, Peony, Hosta, Epimedium, Clematis, Astilbe, Heuchera, Tulip, and Petunia. The virus can often be present in these hosts yet remain symptomless. Reliable detection of all infectious TRV isolates is often limited to molecular methods due to the expansive host range, genomic arrangement, and absence of the RNA2 segment in some isolates. Agdia presents a novel isothermal diagnostic tool for the detection of *Tobacco rattle virus*. The isothermal assay utilizes recombinase polymerase amplification to detect over 25 diverse TRV isolates in a 20-minute real-time detection scheme and matches the sensitivity of existing real-time and conventional PCR methods. The assay incorporates an endogenous RNA quality control to detect the presence of inhibitors from fragrant ornamentals, succulents, and starchy potato tubers and prevent a false negative diagnosis of TRV. The assay demonstrates competency of target detection in over 70 plant species utilizing a crude extraction comparable to common serological assays. Paired with a portable fluorometer, the assay will allow for a broader screen of TRV across different hosts in diverse environments.

Polyploidy as an Erythrina gall wasp management strategy for the indian coral tree, *Erythrina variegata*

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The erythrina gall wasp (EGW; *Quadrastichus erythrinae* Kim) was first collected in Hawaii in 2005 on Erythrina variegata L., a then popular landscape species. It quickly spread to all islands causing severe damage to the native *Erythrina sandwicensis* Degener as well as most introduced species. *E. variegata* 'Tropic Coral', a fastigiate form was widely used as a windbreak for crop protection and soil and water conservation. However, today it is nowhere to be found. Galls on leaves, petioles and stems are induced by the larvae of the tiny EGW. Larvae develop within plant tissues, causing the formation of galls on leaves, petioles and stems. Leaves curl and become massively deformed while petioles and stems become swollen. Heavy infestations cause defoliation and death of trees. Thousands of trees have been killed by this pest. Polyploid individuals of *E. variegata* show a high level of tolerance to the EGW, while in the same plot diploid individuals are destroyed or nearly destroyed. The induction of polyploidy in EGW-susceptible *Erythrina variegata* may be a strategy to return this species and its cultivar 'Tropic Coral' to cultivation in Hawaii and other areas where this pest is a problem.

Keywords: Erythrina gall wasp, polyploidy, *Erythrina variegata*

Poster Session I

Pericallis hadrosoma - a new flowering potted plant

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Pericallis hadrosoma Svent. endemic from Gran Canaria (Canary Islands, Spain) is a robust plant, with up to 200 pinkish/purplish flowers per inflorescence. Due to high decorative value of the inflorescences, the plant has a high potential as a new greenhouse grown flowering potted plant. Four seedlings of a F_2 progeny were provided from the Jardín Botánico Canario Viera y Clavijo at Tafira in Gran Canaria. The possibility for plant propagation has been investigated under greenhouse and in vitro conditions. Top and internode cuttings were used in both propagation methods and additionally the propagation by seeds was run in the greenhouse. Vegetative propagation by cuttings as well as in vitro propagation gave positive results, while seed propagation resulted in ununiform plant material. Different temperature regimes were tested: 4°C, 18°C, 23°C or 26°C, where for both in vitro and greenhouse propagation the 18°C was most beneficial for plant quality. The treatments with chemical growth retardants were applied to reduce the growth of stem. The chemicals used were: paclobutrazol (Bonzi), daminozide (Alar), or chlormequat chloride (Cycocel). The compact plants with a suitable height were achieved by spray treatment with 2.5 $ml \cdot l^{-1}$ daminozide. In our studies we have successfully investigated propagation and growth regulation of *Pericallis hadrosoma*. However, the control of flower induction in this attractive ornamental plant needs to be carefully investigated in the further studies. Further, an extended breeding program is necessary to achieve the attractive and saleable product.

Keywords: Chemical growth regulation, in vitro propagation, vegetative propagation

Expansion of flower trait variations in interspecific hybrids between *Torenia fournieri* and *Torenia baillonii*

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Increase of variations in flower color and shape is the key to success as floricultural crops. Combination of *Torenia fournieri* having various flower color and *T. baillonii* (B) having yellow petal could produce wider flower color variations in *Torenia*. Three flower colored *T. fournieri* (violet, deep pink and white) were crossed with B. The progenies had intermediate chromosome number of parents and showed narrow variation in petal color. They were male sterile but ovule was partially functional. One of the interspecific hybrids was backcrossed with both parents. (*T. fournieri* violet(TFV) × B) × B produce much higher numbers of progenies with wider petal color variations than (TFV × B) × TFV. Investigation of chromosome number of each progeny suggested that n=9 female gamete in (TFV × B) had higher potential to produce progeny than n=8 female gamete. Progenies of (TFV × B) × TFV showed poor petal color variation and its self–pollination produced progenies showing petal color variations without yellow. On the other hand, cross combination of (TFV × B) × B and its self–pollination produced progenies showing wide range of yellow base petal color variations. Present results demonstrate that back cross and self- pollination produce wider flower variations in *Torenia* interspecific hybrids. In the backcross progenies plants having serrated-petal appeared. The new characteristics transmitted to progenies though further crossings.

Keywords: Interspecific hybrid, backcross, pigment accumulation, chromosome number and serrated petal

Survey of a Tuscan population of *Ophrys passionis* subsp. *garganica* E. Nelson ex H. Baumann & R. Lorenz

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The genus *Ophrys* (bee orchid) is widely recognized as a model for the evolution of floral biology due to the complex morphology of its labellum, similar to a bee, which allows the implementation of a pollination strategy by sexual deception, called 'pseudocopulation'. Among the *Ophrys* section *Araniferae*, many species and aggregates result particularly controversial by a systematic point of view. One of these species is *Ophrys passionis* Sennen (Subsection *Sphegodes*), which is subdivided into 2 main subspecies; subsp. *garganica*, in South-Central Italy, and the nominotypical subspecies, widespread from Northern Spain to South-Western France and Provence. Considering the species as a whole, there is a clear disjunction in the distribution area, in correspondence of Liguria and Corsica, where the species have never been found. The present work, funded by Italian Ministry of Agriculture, Food, Forestry and Tourism Policies within the RGV-FAO Project, concerns an isolated population of the subsp. *Garganica* near its Northern limit of distribution, showing some atypical morphological traits with respect to the populations of Southern and Central Italy. The need to deepen the knowledge on this particular population arises from the progressive reduction of the number of plants observed from 2015 to date, mainly due to the destructive action of wild boars and porcupines. Since this population is approximately located at an equidistant position from the North-Western (France) and South-Eastern (Italy) limits of *O. passionis* areal *sensu latu*, we carried out a comparative study among this population and other typical populations of both subspecies, taken in Southern and Central Italy and in Western France. The survey was carried out using both morphometric and molecular markers (ISSR), in order to provide a systematic classification as objective as possible to the population under study, and to evaluate the opportunity to undertake any protection and/or repopulation actions, in accordance with the aims of the RGV-FAO Project.

Keywords: Orchidaceae, bee-orchid, morphometric analysis, ISSR

Treatments extend the vase life of cut wild poinsettia (*Euphorbia pulcherrima* Willd. Ex Klotzsch)

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Poinsettia (*Euphorbia pulcherrima* Willd. Ex Klotzsch) grows wild from Sinaloa, Mexico to Guatemala (Steinmann, 2002). This plant grows in tropical forests, and unlike commercial poinsettias cultivated in greenhouses, these poinsettias grow as shrubs with floral stems of almost one-meter in length. The local growers sell the poinsettias at the end of each year as cut flower; however, due to its short vase life (1 day), the price per dozen stems is very low (US $ 0.60). Consequently, the care of the plantations has been abandoned, with the consequent loss of genetic variability. The presence of latex, a milky sap produced by the stems, is one of causes of the low water absorption, resulting in a short vase life. The latex composition includes alkaloids, terpenoids and a large number of enzymes. Therefore, the aim of this work was to evaluate different preservative solutions [tap water, salicylic acid (AS: 0.5, 1.0 and 2.0 mM) and Floralife®] to increase the vase life of poinsettias. The floral stems were harvested in Ixtapa de la Sal, Mexico in November 2017 and 2018, and then transferred to the laboratory, where stems were cut to the same length and/or sorted by stem caliper and placed in the corresponding preservative solution. The results showed that salicylic acid at low concentrations prolonged the vase life of the poinsettias for up to 6 d, with significant gain in fresh weight and good appearance of bracts and leaves, but AS at 2.0 mM resulted in foliar damage, although the bracts continued to look attractive. Water and Floralife® solution did not increase the vase life. Further studies are necessary to determine the mode of action of AS in the stems of poinsettia to develop a more efficient preservative solution.

Keywords: Postharvest, enzymatic activity, bracts, quality

Some of the results of interspecific hybridization of garden roses in the South of Russia

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Experiments on interspecific hybridization of garden roses were conducted in the Nikitsky Botanical Gardens – National Scientific Center. The most interesting results in hybridization was the use of *R. fedtschenkoana* Regl. The native habitat of this species covers Central Asia, China and Afghanistan. The flowers are often white large (7–8 cm in diameter), not double-flowered, with an unpleasant aroma, single or gathered in inflorescences (up to 4 pcs). The bushes are up to 6 m tall with leathery leaves and large straight thorns. Flowering period is short (6–7 days), and it occurs in May, it is abundant and single. The plant has a decorative value when it is with fruits. A complex resistance to fungal diseases is also a valuable feature of the species. For the purpose of obtaining disease-resistant cultivars, the crossings of this species with a cultivar of floribunda garden group 'Kordes' Sondermeldung' were made. *R. fedtschenkoana* was used as a paternal parent form. Among the F_1 hybrids that were not capable of forming fruits, valuable stable forms with double flowers were selected. To increase the decorative effect of these forms and, in particular, to eliminate the inherited from the paternal form unpleasant smell of flowers, saturating crosses with the cultivar 'Kordes' Sondermeldung' were carried out. Among the F_2 hybrids 7 sustainable early flowering valuable forms were selected as candidates for the cultivars classified as the garden groups of semi-climbing and large-flowered climbing roses. One of these forms, 'Vesennyaya Zarya', received the status of a cultivar. Another saturating crossing with the cultivar 'Kordes' Sondermeldung' allowed us to obtain two valuable resistant forms, which had the characteristic of remontant flowering. Thus, it has been established that the form of *R. fedtschenkoana* Regl. is highly promising for the creation of cultivars resistant to fungal diseases under the conditions of the Southern Coast of Crimea.

Keywords: Species, hybrid, cultivar, complex resistance, remontant flowering, saturating crossing.

Morphologic features of *Iris pumila* L. in Crimea and its potential use in ornamental horticulture

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Iris pumila L. is one of three wild species of Iris genus in the Crimean peninsula. Its natural habitat is quite large – from Central Europe to the Southern spurs of the Ural range. As a rare species is listed in the Red Books of Russian Federation (2008), Republic of Crimea (2015) and city Sevastopol (2018). In the Crimea *I. pumila* grows as single plants and clones, with a diameter of from 7.0 to 85.0 cm, have from 7 to 420 shoots. The share of generative shoots is from 3 to 45%. The morphological features of *I. pumila* in natural populations of the Crimean Peninsula were studied. It has been found that the length of the outer perianth lobes is from 2.5 to 5.6 cm, the width of the outer lobes is from 0.8 to 2.0 cm, the length of the inner lobes is from 2.3 to 5.3 cm, the width of the inner lobes is from 0.5 to 2.7 cm, the height of the generative shoot is 5.5 to 16.5 cm. The maximum size of flowers and generative shoots, as well as the minimum variation of these indicators were noted on the coastal slopes of the southern exposure (mount Dzhan-Kutoran) and in the north of the Prisivashye. Under the same conditions the largest and most floriferous clones were discovered. The smallest size of flowers and generative shoots were found in the piedmont Crimea (mount Arman-Kaya). *I. pumila* in the Crimea is characterized by a significant diversity of coloring of perianth lobes. Plants with flowers of brown-yellow, yellow, purple, lilac-blue, lilac-purple, white color of various shades were found. In the steppe zone a population with three distinct types of color (with brown-yellow, lilac-blue and purple flowers) was identified. Taking into account that the introduction of rare species in the culture of botanical gardens is one of the strategies for their conservation, we have introduced plants of *I. pumila* with different color variants of flowers. The species is promising for use in alpine scree gardens and in the form of group plantings in sunny areas, as well as for breeding work with Miniature Dwarf Beardeds group.

Keywords: Clone, generative shoot, introduction, hybridization

Obtaining a protocol for slow growth for in vitro conservation of *Eustoma* cultivars (Gentianaceae)

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Eustoma grandiflorum (RAF.) Shinn, commonly known as lisianthus, belongs to the Gentianaceae family. Native from the southern regions of the United States and northern Mexico, their flowers are available in a variety of colors and similar in appearance to roses, resulting in their popularity as an ornamental plant. Numerous varieties of lisianthus have been developed, which are difficult to maintain. Thus, low-cost methods are required for its conservation. The objective of this research was to obtain an effective protocol for *in vitro* conservation of *E. grandiflorum*, which represents an essential part of the overall strategy for the conservation of genetic resources. Other advantages of *in vitro* conservation are that it allows the spread of clonal material in little time in aseptic and controlled environments, which makes it possible to obtain virus-free plants. The addition of sugar alcohols retards the growth in culture mediums, which is important to reduce the labor needed to conserve germplasm for a longer time. This research was conducted at the Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco A.C. (CIATEJ) using a completely randomized design, decreasing the concentration of the storage medium (100%, 50% or 0% MS medium), under variable temperatures (5°C, 18°C or 24°C), with different carbon sources, such as sucrose (30%) or sugar alcohols (1%, 1.5% or 2%), and a photoperiod of 8 hours' light. Cultures were maintained for 150 days. The data were analyzed using an analysis of variance. The results showed that at 150 days of culture the best growth medium due to the reduced growth rate of *E. grandiflorum* is composed with a concentration 30 g.L sucrose, MS salts at 50% and subjected under a temperature of 5°C. To our knowledge there are no published reports on *in vitro* conservation protocols for *E. grandiflorum*.

Keywords: Conservation, lisianthus, mannitol,sorbitol.

The orthologous Flowering Locus T (FT) and LEAFY (LFY) genes in the floral transition of *Polianthes tuberosa*

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The tuberose (*Polianthes tuberosa* L.) is an endemic plant from Mexico that belongs to the family *Asparagaceae*, which for its beauty and fragrance is used as a cut flower or for the perfumery industry. Although it is a species cultivated in different parts of the world, the literature regarding the forcing and the morphological and biochemical changes during the floral transition is minimal and with contradictory results; also studies in tuberose at the level of gene expression are limited. The objective of this work was to isolate and identify the FT and LFY orthologous genes in *P. tuberosa*. For which we proceeded to the generation of cDNA sequences using degenerate primers with the purpose of obtaining partial sequences of the orthologs of FT and LFY (500 bp and 450 bp respectively), later the complementary regions were obtained by the RACE technique. The degree of homology with respect to previous reports with other related geophytes, as well as the potential use of these *P. tuberosa* orthologs in the evaluation of their expression during the floral transition will be discussed.

Keywords: Flowering locus T, leafy, gene expression, orthologous

Obtaining polyploids of wild species of the genus *Polianthes*

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In the present work the effect of different times and concentrations of colchicine to get polyploid plants of four wild species of the *Polianthes* genus (*P. montana*, *P. pringlei*, *P. platyphylla* and *P. zapopanensis*) was evaluated. Diploid *in vitro* seedlings (2n = 2x = 60) were immersed in 6 colchicine concentrations (0, 0.001, 0.01, 0.05, 0.1 and 0.2%) with two exposure times (24 and 48 hours). The survival of the explants, the number of buds produced and the height of shoots were evaluated. Some seedlings showed necrosis in the concentration of 0.2%, however 100% survival was achieved. Both the number of shoots and shoot height showed mean values inversely proportional to the colchicine concentration. The chromosome counts from roots revealed that 0.2% of colchicine was the most accurate concentration to obtain polyploids in *Polianthes* since in the four treated species at least one tetraploid was obtained (2n = 4x = 120) with this concentration. In addition, in *P. montana* an octoploid was obtained (2x = 8x = 240). Regarding the submersion time, there were no differences in the effect at 24 hours and 48 hours, except in *P. platyphylla*, which only obtained a tetraploid at 48 hours with 0.2% colchicine. Such results will serve as a reference to lead to more efficient protocols in obtaining polyploids which can be used in *Polianthes* breeding.

Keywords: Ornamental geophytes, plant breeding, tissue culture, colchicine

Detection of endopolyploid cells in root tips from two geophytic species pretreated with α-bromonaphthalene

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Variation of celular ploidy levels (somatic polyploidy or endopolyploidy) can result from aberrant DNA re-replication during S-phase, but it can also occur as a normal component of animal or plant development, this is common among mollusks, arthropods, amphibians, and fish, but it is rare among mammals. In plants, it has been described in several species including ferns and flowering plants such as maize, sunflower, tomato, *Arabidopsis*, brassicas, orchids, among others. Endopolyploidy could be achieved by at least four different mechanisms: endoreduplication, endomitosis, acytokinetic mitosis, or cell fusion; the most common of these is endoreduplication. In this work, we report the frequency of endopolyploid cells in root tips from two species of geophytes: *Polianthes howardii* and two polyploid cytotypes of *Sprekelia formosissima* (diploid and pentaploid). The root tips were pretreated in 1:1000 aqueous α-bromonaphthalene solution, fixed in methanol:acetic acid (3:1) solution and macerated in an enzyme mixture solution, finally metaphasic chromosome preparations were stained in 1 µg/ml 4',6-diamidino-2-phenylindole (DAPI) or 2% acetorcein solutions and observed in a fluorescence microscopy. The results showed a low frequency of endopolyploid cells in all analyzed plants, being smaller for *S. formosissima,* 1% for pentaploid cytotype and 3% for diploid cytotype, whereas for *P. howardii* it was 5%. The kind of mechanism for achieved endopolyploidy for each species is discussed.

Keywords: Endocycle, endoreplication, ornamental species, *Polianthes howardii*, *Sprekelia formosissima*

In vitro biological activity of metabolic extracts of wild and cultivated species of the genus *Polianthes*

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Nardo (*Polianthes tuberosa*) is the most well-known species of the genus *Polianthes*. However, the rest of the wild species have been little studied and might possess useful plant secondary metabolites (SM). In this work, extractions of SM from the bulbs of wild and cultivated species of the genus *Polianthes* were carried out to evaluate their antimicrobial activity *in vitro*. Extractions with methanol were made from bulbs of *P. tuberosa* var. Double and of the wild species: *P. platyphylla*, *P. montana*, *P. clivicola*, *P. howardii, P. pringlei* and the genera *Manfreda sp.* And *Prochnyanthes* from the Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco A.C. (CIATEJ) work collection. The bioassays were performed in vitro with the disc diffusion technique (Kirby-Bauer method). The phytopathogens *Dickeya dadantii* and *Pseudomonas aeruginosa* were grown in semi-solid agar and poured uniformly onto Petri dishes with Mueller Hinton agar. Discs were placed on the surface with 20 µl crude extracts (50 mg/1 ml and 100 mg/1 ml), Ciprofloxacin (0.1875 mg/1 ml) or methanol as a negative control. The plates were incubated at 37°C for 24 hours. Bioassays with *P. aeruginosa* showed percent of inhibition (PI±SE) with all the crude extracts; *Prochnyanthes* (PI=24±2.34%) showed the greatest greater inhibitory capacity. With *D. dadantii* the extracts of *P. pringlei* (PI=21.8±2.39%), *P. montana* (PI=9±1.16%), *Manfreda* (PI=14.4±1.7%) and *Prochnyanthes* (PI=15.5±0.86%) were the most effective. Extracts, even among those from the same genus, have shown diverse responses, depending on the individual metabolites stored in the bulbs. This study provides the basis for characterization of SM from bulbs of the *Polianthes* genus with antibacterial activity.

Keywords: *Polianthes tuberosa*, *Pseudomonas aeruginosa*, *Dickeya dadantii*, secondary metabolites, antibacterial activity.

Stability of the variegation leaf pattern of monocotyledons during *in vitro* propagation

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Due to their remarkable ornamental character, plants with variegated leaves, i.e. having several colors, are very appreciated and have a high commercial potential. However, the propagation of variegated cultivars can be challenging, especially when an in vitro propagation procedure is required. Plants with different variegation patterns can be generated more or less frequently, particularly in the case of monocotyledons. Thereby they lose their esthetic and economic values, that causes products losses which can slow or even stop the distribution of new ornamental varieties. Several causes can induce variegation patterns (chimeras, epigenetic, differential gene expression, viruses, etc.), and influence their stability during the propagation process.

Cultivars of variegated *Yucca*, *Cordyline* and *Phormium* were introduced *in vitro* for propagation. Three media, with different plant growth regulator compositions, were tested. This study was firstly interested in characterizing more precisely each variegation pattern through histological observations. Then, the propagation rates were quantified and the variegation stability was estimated by observing plants obtained after 3 or 6 cycles of proliferation. During the *in vitro* process, samples were periodically fixed with the objective to determine through a histological study the origin of the new generated shoots: *de novo* organogenesis or axillary shoot development. Different propagation results were recorded, according to the cultivar and the culture medium. The level of conformity is compared with the histological observations. The possibility to predict the phenotypic stability of a new variegated cultivar will be discussed.

Keywords: Micropropagation, histology, ornamental plant, true-to-type

Cytogenetic relationships in three varieties of *Tigridia pavonia* (L.f.) DC

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Tigridia pavonia (L.f.) DC is a wild species with great ornamental value and nine varieties. Of these varieties Penélope has been considered as a natural hybrid resulting from the cross between Trinidad and Dulce varieties. The objective of the present work was to establish the cytogenetic relationships of the varieties Trinidad, Dulce and Penélope through classic cytogenetic techniques and the physical mapping of 5s and 45s rDNA genes by FISH. The karyotype of the Trinidad variety showed a chromosome number of 2n= 2x= 28, a karyotypic formula of 28m, observingand six hybridization sites of the genes 5s and 45s rDNA are observed. On the other hand, the Penélope variety showed a chromosome number of 2n= 2x= 28 + 3B, a karyotypic formula of 26m + 2sm + 3B, and the presence of 6 hybridization sites of the genes 5s and 45s rDNA. Likewise, Penélope presented three extra numeric chromosomes, similar to the one reported earlier in the Dulce variety, however, the number of hybridization sites as well as the localization of Penélope and Dulce revealed a higher similarity to the ones reported in the Trinidad variety. The high cytogenetic similarity among the variety Penélope, Trinidad and Dulce suggest that the latter two may be the parents. This information could be the basis for future evolutionary analyses or breeding programs.

Keywords: *Tigridia pavonia*, natural hybrids, karyotype, Fluorescent *In Situ* Hybridization, B chromosomes

The importance of mitotic spindle poisons in plant breeding

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The production of polyploids can be most useful in many genetic and cytological research projects of a purely theoretical kind, such as studies on the action and interaction of genes in polyploids and studies on chromosome behavior in polyploid meiosis. A production of polyploids can also be valuable in experimental taxonomy, when the origin of naturally occurring polyploid species or races is investigated. The use of acromatic spindle inhibitors has gained great importance in recent decades as a means of generation of ploidy in cytogenetic work, due to their ability to stop the growth of the mitotic or meiotic spindle in the cell division, resulting in a cell stay with twice as much genetic material. Colchicine inhibits the polymerization of microtubules by binding to tubulin, one of the main constituents of microtubules. The availability of tubulin is essential for the mitosis, so that colchicine works effectively as a "mitotic poison" or poison spindle. Orizalyn is an herbicide that follows the same principle as colchicine, depolymerizing the mitotic spindle, at appropriate concentrations, a greater efficiency can be obtained allowing a greater amount of polyploid cells. The use of nitrous oxide against other mitotic arresters has the advantage of being able to be introduced under pressure, which leads to a higher polyploid cell index. In this work, the use of different chemical agents to produce polylploid plants is reviewed.

Keywords: Chromosomes, cytogenetics, polyploidy

Poster Session II

Importance of molecular cytogenetic markers in plant breeding

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Cytogenetics is the science that studies the structures and properties of chromosomes as well as their behavior during the division of somatic (mitosis) and germinal (meiosis) cells and their influence on the phenotype. Cytogenetics also studies the factors that cause chromosomal changes. New work in the area of molecular cytogenetic studies use probes to mark and identify a part of the chromosome and to obtain the karyotype of the cells of a species. Molecular cytogenetic markers are the set of techniques that are carried out through fluorescent labeling tests. Some of the techniques are Fluorescent In Situ Hybridization (FISH), Spectral Karyotyping (SKY) and Compartive Genomic Hybridization (CGH), which through different methodologies manage to obtain the characteristics of a chromosome. A probe is a fragment of DNA or RNA of small size that detects the presence of complementary sequences in the genetic material, these sequences can be similar or equal and for its visualization the probe is marked with a nucleotide that has some atom with radioactive isotopes or fluorochromes. The sequences that make up the probes are an important part for the identification of the chromosomes. Sequences of different individuals are used to define karyotypes, which help to identify chromosomal sections of species not studied and compare them with those that are already known. In plants, repetitive sequences have been used as probes, such as: wheat ribosomal DNA (rDNA 18S-5.8S-26S (45S, pTa71), rDNA 5S (pTa794), fragments of the RuBisCo gene of Polianthes tuberosa (RBCL), retrotrasposons, telomeric DNA sequences and centromeric for identification of the karyotype of species and hybrids and to improve the current classifications providing new information beyond observation of visible characteristics. In this work we present the molecular cytogenetic techniques used in the genetic improvement of plant species.

Keywords: Chromosomes, Fluorescent *In Situ* Hybridization, introgression

Adaptability of *Rhododendron* species to climate and growth conditions at Lushan Botanical Garden

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China is one of the centers of origin for *Rhododendron* with 571 reported species. Recently, Wang et al (2018) developed a strategy which allows to connect data present in *Rhododendron* herbarium specimens with other existing information from i.e. soil or climate databases. Hereby predictions on the potential value of certain wild species and their possibility to adapt to certain regions or climate conditions can be made. In Jiangxi province, located in the southeast of China, Lushan Botanic Garden is a subtropical alpine botanical garden (altitude 1000-1360 m; annual average temperature 11.4 °C, maximum 31.0 °C; minimum -17.0 °C; rainfall 1929.2 mm; relative humidity 80%). In the herbarium database of Wang et al (2018) 735 specimens belonging to 35 species originate from Jiangxi Province. These were mainly found in the mountainous region of the province. In order to explore the adaptability mechanism of *Rhododendron* to specific climatic conditions in Lushan, we studied the rhododendrons from different origins and phylogenetic positions. So far, 328 species have been collected from all over the world, covering 8 subgenera. The adaptability of species from the China-Japan floristic region were superior to that of the China-Himalayan floristic region. Species from the subtropical humid monsoon climate zone adapt better than the species in the subtropical semi-humid climatic zone of South Asia. The species with wide distribution and wide ecological range are more adaptable compared those with a narrower ecological range. The semi-evergreen or deciduous rhododendrons which evolved from the original center in southwest of China to the middle eastern China with low altitude had higher adaptability than the alpine groups. Furthermore, the adaptability of seedlings propagated from seeds collected from original habitats was better than the seedlings directly transplanted from original habitats. These results are valuable information for further breeding and selection of rhododendrons that are adapted to local growing conditions.

Wang S, Leus L, Van Labeke MC, Van Huylenbroeck J (2018) Prediction of Lime Tolerance in Rhododendron Based on Herbarium Specimen and Geochemical Data. Frontiers in Plant Science 9, 1538

Keywords: *Rhododendron*, adaptation, climate

Morphological diversity of flowers *Pulsatilla halleri* (All.) Willd. subsp. *taurica* (Juz.) K. Krause

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Pulsatilla halleri (All.) Willd. subsp. *taurica* (Juz.) K. Krause is an endemic of the mountainous Crimea, a polycarpic summer green grass, aeropedophyte, lithophyte, mesoxerophyte, heliophyte. Conservation status: rare. The plant is highly decorative during the flowering (February - May) and decorative during the fructification period (May - June). It was introduced into the Nikitsky Botanical Garden in 2002. It is of interest for cultivation in rockeries and rock gardens. A study of the morphological diversity of flowers in places of natural growth has been conducted. Flowers of *Pulsatilla halleri* subsp. *Taurica* are unisexual; the genus is apokarpic; stamens are numerous. The perianth is simple, actinomorphic, goblet-bell-shaped, consisting of six free large purple, silky-villous on the outside petal-like tepals. Upon examination of natural populations, the plants with abnormal structural variants (teratological changes) of flowers have been discovered. Four groups of anomalies have been identified: the change in the number of tepals (from 4 to 13); the change in the shape and size of tepals (emergence of double and triple divided tepals, tepals with a notched edge, tepals of varying length in one perianth, the change in the tepals' width from 1 to 1,7 cm); petalization of stamens and carpels, as well as a group with combinations of the types considered. The most common combination (37.5% of cases) featured changes in one perianth, both in number and in the form of tepals. As a rule, the emergence of additional tepals of the perianth occurred asymmetrically. The described morphological diversity demonstrates the plasticity of flowers *Pulsatilla halleri* subsp. *taurica*, tendency to form double-petalled flowers, and high potential of this plant for ornamental gardening and breeding.

Keywords: Endemic, tepals, teratological changes of the flower, petalization, ornamental gardening

Comparison of water-use classifications of landscape plant species developed by horticultural experts to information derived from irrigation research trials: implications for water use recommendations for new ornamentals

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In response to recurring drought, increasing population, and limited water supplies, the State of California updated its water conservation measures pertaining to landscape irrigation in 2010 and 2015. Nearly all new landscapes require water budgets for proposed landscape designs. The main reference tool used to estimate plant water use in the design, the Water Use Classification of Landscape Species (WUCOLS), was revised in 2014 (WUCOLS IV). WUCOLS IV contains water-use recommendations for over 3,500 taxa, placing plants in one of four categories of water needs corresponding to the following percentage ranges of ETo: 70-90% (High), 40-60% (Moderate), 10-30% (Low), and < 10% (Very low). To account for the wide range of climates in California, the state was divided into six regions, and local committees of experienced horticulturists developed region-specific irrigation recommendations. Since 2005, researchers at UC Davis evaluated the water-use of landscape plants, developing irrigation recommendations for 138 taxa from 60 genera. Beginning with the 2012-2014 trial period, industry cooperators submitted new and recently introduced cultivars for irrigation testing. Irrigation recommendations determined by these trials were compared to WUCOLS IV recommendations to assess the agreement between trials results and the water-use categories assigned by horticultural experts. Comparing interrater relatability using Cohen's Kappa found weak agreement (κ=0.167) between the datasets. Trials results agreed with WUCOLS IV for 28 taxa, and disagreed for 24 taxa. This limited agreement emphasizes the need for continuing water-use research to accurately classify new ornamental introductions, which may not have the same water requirements as their parent material, reference species, or preceding cultivars.

Keywords: Water-use, WUCOLS, plant trials, irrigation, new ornamentals, low water-use

Etilingera elatior var. Red Torch growth and chlorophyll content as affected by LEDs in vitro

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The use of LEDs in tissue culture as a light source is advantageous because it presents high intensity of radiation, low heat generation and a reduction of electrical power consumption. Allowing a higher photosynthetic rate and energy formation, influencing plant growth. The objective of this study was to evaluate the effect of light type on the number of leaves, stem length and chlorophyll content of *Etilingera elatior* (Zingiberaceae), an ornamental plant with international marketing potential. The experiment was in a completely randomized experimental design with 30 replicates per treatment, each plant in vitro was considered a repetition. The treatments were kept in a growth room at 25 °C, photoperiod 18/6 and submitted to different sources of light and intensity: Blue LED: Red (LED AV) (60 μMs-1m-2), white LED (38 μMs- 1m-2) and White light (White fluorescent, 20 w, Osram, Brazil). After 60 days, the evaluations were performed. The data were submitted to analysis of variance (ANOVA), using R Studio software and the means compared to each other by the Scott-Knott test with 5% probability. The results according to the number of sheets for AV LED, White LED and white light (16.93, 14.87 and 11.8 cm respectively) showed significant differences. Meanwhile, stem lengths for AV LED, White LED and white light (7.64, 7.63 and 7.8 respectively) showed no significant differences. In the chlorophyll content, leaves of the apical part, the White LED (31,43) and the LED lights AV and white light (37,53 and 31,43 respectively), there are significant differences. Thus the chlorophyll content in the middle part of the seedling, White LED (55,87) and the AV LED and white light (33,25 and 27,85 respectively), there are significant differences. Meanwhile, basal chlorophyll content had significant differences between white light (44.89) and White LED and AV LED (32.66 and 29.39, respectively). LED supplemental light can reduce electricity consumption and increase productivity to improve some parameters of plant growth and metabolism.

Keywords: Zingiberaceae, growth, chrlorophyll, Light Emission Diodes (LEDs).

Chromosomal numbers in parental and hybrids plants of the genus *Echeveria*

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Echeveria is an American genus of approximately 40 species. This genus is distributed from southwest Texas to central and South America. Mexico being the country where most of species are concentrated. Many of the species of this genus are cultivated as ornamentals for the beauty of their leaves and flowers. The objective of the present study was the determination of the chromosome number of: *Echeveria chihuahuensis*, *E. colorata*, *E. laui*, *E. strictiflora* and *E. subalpine* and the hybrids generated from some of these parental species: *E. chihuahuensis* x *E. colorata*, *E. laui* x *E. strictiflora* and *E. strictiflora* x *E. subalpina*. Methodology: Roots of each of the study species were pre-treated in cold water for 24 hours and fixed in Farmer's reagent. After two days the roots were hydrolyzed in 1N hydrochloric acid and stained with Schiff's reagent. The preparations were made by the squash method and the best fields with metaphase stage cells were photographed for the chromosome count. Results: Chromosome number found in *E. chihuahuensis* was 2n = 50, *E. colorata* 2n = 54, the hybrid of these two species *E. chihuahuensis* × *E. colorata* 2n = 50. *E. laui* 2n = 26-28. *E. strictiflora* 2n = 24. The hybrid of these two species *E. strictiflora* x *E. laui* 2n = 28. *E. subalpine* 2n = 60-62, *E. strictiflora* × *E. subalpina*, showed two genotypes, in some plants 2n = 26 and in other cases 2n = 50. It is advisable to use Genomic *In Situ* Hybridization (GISH) to confirm the conformation of the genome in hybrid plants.

Keywords: *Echeveria*, chromosomal numbers, hybrid plants.

Morphological characterization and identification of Pa'uohi'iaka (*Jacquemontia sandwicensis* A. Gray) accessions for hanging basket use

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Pa'uohi'iaka (*Jacquemontia sandwicensis* A. Gray) is a prostrate-growing vine, endemic to the coastal areas of the Hawaiian Islands. It is typically used as a groundcover in landscaping but is not as commonly used as a container plant. In the wild, morphological variations of pa'uohi'iaka exists but little effort has been done to characterize and identify selections for hanging basket use. In this study, six accessions collected from three main islands were characterized to identify potential selections for hanging baskets. Six sample plants from each accession were propagated and grown outdoors for three months. Plants were pruned four inches from the base to encourage lateral branching and allowed to re-grow for another month. Quantitative and qualitative morphological characters were recorded. Principal component analysis and cluster analysis were conducted to determine similarities or differences between accessions and to identify characters that contribute most to the variation between accessions. Results indicate that each accession possesses its own unique set of morphological characters. Cluster analysis revealed that accessions fall into three distinct groups. Leaf shape, leaf length, adaxial and abaxial stem color, length of internodes, length of lateral branches, flower color and number of flowers were the most important variables contributing to the variation between the accessions. Length of internodes and number of lateral branches were the most important traits for selecting accessions for hanging baskets. Among the six accessions, Puhala Bay, Lyon Arboretum and South Point were identified as selections with the most potential for use in hanging baskets. These accessions responded well to pruning by exhibiting a compact form with dense foliage, short internodes and high number of lateral branches.

Keywords: *Jacquemontia sandwicensis*, hanging baskets, native Hawaiian plants, germplasm collection and evaluation

Micropropagation of the small Sacasil cactus (*Echinocereus poselgeri* Lem.) (Cactaceae)

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The small Sacasil cactus (*Echinocereus poselgeri* Lem.), (Cactaceae), is native to northern Mexico. Grows in the Chihuahuan Desert in limestone soils, in extremely dry conditions. This species has been little studied and due to its morphological characteristics (thin cylindrical stems, dark bluish blue color, 30 to 60 cm high, with a diameter of 2 cm and white radial spines on its ribs with a very bright magenta pink bloom), represent a new interesting ornamental option. The objective of this work was to generate an efficient regeneration protocol for the massive production of the species. During the fall of 2017 seeds were collected from the eastern region of the municipality of Guadalcázar in San Luis Potosí. An aseptic culture was established in the Laboratorio de Cultivos de Tejidos Vegetales (LCTV) of the Campo Experimental Saltillo CIRNE-INIFAP, the multiplication and rooting stages were established in 2018-2019 in MS medium with 50% macronutrients. Multiplication stage: four concentrations (2.5, 5.0, 7.5 and 10 mg L^{-1}) of the cytokinins 6-benzylaminopurine (BAP) and kinetin 6-furfurylaminopurine (KIN) and the auxins naphthaleneacetic acid (NAA) and indolebutyric acid (IBA) keeping a relationship 10:1. The number of shoots (SN) and its size (SS) were measured. Rooting stage: two concentrations of sucrose (2% and 4%) and two auxins, indole acetic acid (IAA) and indole butyric acid (IBA) (1 and 2 mg L^{-1}) were tested. The number and length of roots per shoot were measured. At each stage, five explants (nodal sections) were established per bottle with 8 replicates per treatment in a completely randomized experimental design with factorial arrangement. An analysis of variance (ANOVA) and a Tukey multiple range test ($P \leq 0.05$) were performed using the Statistical analysis system (SAS) 14.1 software. The best multiplication rate (3.73 shoots/explant) and height (5.05) mm) were obtained with the treatment of 7.5 mgL^{-1} of KIN + 0.75 mgL^{-1} of IBA. The rooting of shoots was obtained when increasing the concentration of sucrose and IBA, generating root production by vitroplant of 80% with respect to the treatment without phytohormones.

Keywords: Cacti, In Vitro culture, growth regulators, ornamentals

Current Status of New Ornamental Crops Market in Croatia

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The ornamental crops market in Croatia is predominately oriented on traditional crops. New crops that do find way to the buyers are mainly new varieties of known, long-established ornamental species. This could partially be explained by limited investment in the research and marketing of new ornamental crops in Croatia, conservative consumer preferences, and the market which is primarily import based. In 2018 Croatia has imported ornamental plants in the amount of almost 6.8 mil euros, with the following six ornamental crops sold on the wholesale market: roses, carnations, gladioli, orchids, chrysanthemums and lilies, none of which belong to the group of new ornamental crops. Even though there are currently no breeding programs on ornamentals, Croatia is rich in native plant species which are almost unlimited source of new ornamental crops. Some of the species which are being currently analyzed for their potential as ornamental crops are: *Anthemis tomentosa* L., *Astragalus monspessulanus* L. ssp. *Illyricus* (Berhardt) Chater, *Convolvulus lineatus* L., *Corydalis acaulis* (Wulfen) Pers., *Iris adriatica* Trinajstić ex Mitić, and *Iris illyrica* Tomm., all belonging to endangered and/or endemic plant species. This paper provides the outline of current status of the market for new ornamental crops, but also the outline of the botanical characteristics of these plants, discuss the potential for their introduction into horticultural production, and their usage as ornamental and landscaping species.

Keywords: Market, botanical characteristics, introduction

Sustainable Landscaping with *Prunus* species

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In present times, serious changes of ecological balance in global ecosystem have significant impact on human population, influencing their socioeconomic status in both, rural areas, and big metropolitan zones. In such circumstances sustainability becomes an inevitable principle that should be applied in all aspects of civilization, human activities and its interactions with environment. Sustainability is a complex concept that involves a myriad of ecological, environmental, socioeconomic, and technical factors, including their interdependence. Therefore, it includes the principles that should be applied in residential landscaping as a part of the strategy of holistic urban planning.

The genus *Prunus* encompasses a wide range of species and varieties that can be used as landscaping plants due to their high ornamental, but also their ecological values. Majority of them is traditionally used as fruit species, some have medicinal value or can be used for erosion control. In this way the genus *Prunus* offers a landscaping potential for both, urban and rural sustainable landscapes.

The goal of this paper is to evaluate landscaping potential of wild native edible *Prunus* taxa, but also cultivated varieties used as fruit trees, and propose their ornamental function as a structural part of cultivated/urban landscapes. We evaluate characters of potential ornamental value of *Prunus* species, such as: habitus, foliage, flowers, change in autumn colour, phenological dynamics, bark appearance etc. Also, their ecological potential through erosion control, attraction of birds, insects and other species, and possible pharmaceutical values are described. The susceptibility of these taxa to pests and diseases, and their growing conditions as an important basis for developing ecological aspect of horticultural and landscaping sustainability are also discussed.

Keywords: *Prunus*, sustainability, native species, ornamentals, ornamental value, landscaping, edible landscape

In vitro multiplication and rooting of *Echeveria pumila* free of phytoplasmas

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The genus *Echeveria*, (Crassulaceae), native from Mexico has great ornamental potential, *Echeveria pumila* presents commercial importance due to its phyllotoxia in spiral and obovate-cunead leaves of blue-greenish or gray color, however some plants present symptoms of stem flattening (fasciation) and reduction of the size of the leaves, characteristic of plants infected with phytoplasmas. The objective of this work was to design a protocol for in vitro multiplication and rooting of phytoplasma-free *Echeverria* shoots. Sprouts generated from meristems of *Echeveria pumila* var *glauca*, maintained *in vitro* for five years by successive subcultures in a Murashige and Skoog (MS) base medium, were used. For multiplication, two concentrations of benzyl adenine (BA) (0.2 mg and 2 mg L-1) were tested in combination with naphthalene acetic acid (ANA) (0.02 mg/L and 0.2 mg L-1) respectively in MS medium. Number of sprouts per explant and size obtained after 30 days during two successive subcultures was evaluated. In the rooting stage, sprouts with an average size of 2 cm were used. They were cultivated in a MS medium with 50% of its macrosals, enriched with 1 mg/L of Indol butyric acid (AIB) during 24 hours and later transferred to a similar medium without hormone. Rooting kinetics, number and size of roots were evaluated after 30 days. Soil survival was evaluated 120 days after establishment in a mixture composed of tezontle and peat moss (2:1 v/v). The highest multiplication rate (13 shoots) was achieved in the medium with 2 mg L-1 of BA plus 0.2 mg L-1 of ANA. Roots were observed 7 days after the start of the process in 90% of the shoots with an average of 17 roots per explant with length of 6-15 mm. Survival was 94% with an average plant diameter of 3.5 cm with 24 leaves. Plants sanity was verified through PCR.

Kewords: in vitro culture, growth regulators, Crassulaceae, micropropagation

Cryopreservation of ornamental plants: *Genipa americana*, *Handroanthus serratifolius*, and *Strelitzia reginae*

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Cryopreservation of ornamental plants has been considered as a tool for long-term preservation of commercial and native species. For this technique, it is important to know the effect of low temperatures used during the freezing process on the genetic stability and on anatomical aspects of the conserved species. Cryopreservation has been performed through slow-freezing, dehydration, vitrification, droplet-vitrification, encapsulation on cryo-plate method. The cryopreservation of some species as a *Handroanthus serratifolius* and *Genipa americana*, is important since these ornamentals are native of the Brazilian savannah and threatened due to excessive deforestation and predatory extractivism actions. Otherwise, species as *Strelitzia reginae* do not have yet commercial cultivars and limitations on propagation as seed dormancy. Furthermore, cryopreservation is important to preserve the species and commercially important crops, since, constantly new cultivars are produced and introduced in the market, which may compromise the production of some species used currently, and may, in the future return to economic importance. Cryopreservation protocols of *H. serratifolius*, *G. Americana* and *S. reginae* were recently developed successfully. Cryopreservation of *H. serratifolius* nodal segments exposed to the PVS2 vitrification for 15 minutes followed by immersion in liquid nitrogen (NL) promoted 53.3% plant development. Silica gel dehydration followed by immersion in NL was shown to be highly efficient for cryopreservation of *G. Americana* seeds, with 35% germination after thawing, and maximum survival rate (100%), with growth and normal establishment of the seedlings after acclimatization. *S. reginae* zygotic embryos can be cryopreserved using silica gel dehydration for 30 minutes. Plants from cryopreserved embryos did not show alterations in anatomy and genetic stability, promoting the development during the acclimatization process.

Financial support: Capes, CNPq and Fapemig.

Keywords: Conservation, in vitro conservation, ornamental plants

In-vitro Mutagenesis efficiency with EMS (Ethyl methanesulfonate) on *Eustoma grandiflorum*

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The floral market in Mexico, in a growing boom and gradually gaining importance in the national economy, not only needs variety but quality, something that the floral market has left aside in Mexico to be mostly national consumption. Inside the new possibilities lisianthus (*Eustoma grandiflorum*) are flowers of interest on the international market because it is an attractive species for the producers, slightly cultivated and original of warm areas of the southern region of the United States and the North of Mexico. It possesses attractive flowers and showy colors such as purple and yellow, product of a wide range of flavonoids and anthocyanins. In order to obtain new forms and colors, mutagenesis has been often performed using physical and chemical ways as Gamma rays, X-rays or Ethyl methanesulfonate (EMS) respectively. In this research we tested four concentrations of EMS (0.25M, 0.5M, 0.75N and 1M) as inductor of genetic variability in four genotypes of lisianthus (C40, C43, C74, C83) in vitro. Also, we evaluated two times of application (1 and 2 hours). Our results showed that EMS becomes toxic at 1 h and the survival percentage of plants decrease at 1M. Likewise the survival percentage decrease in some plants was inversely proportional to increase in the concentration of EMS. The median lethal concentration was 0.5M, in which it was observed a decrease in size as well as rachitic and disordered growth in genotypes as C40. This demonstrates the high degree of toxicity of EMS and its capacity to induce changes, although these can be unspecific.

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