Third International Symposium on the Genus *Lilium*

April 1-3, 2014
Zhangzhou
China

Third International Symposium on the Genus *Lilium*

Welcome

Dear colleagues,

Welcome to the Third International Symposium on the Genus *Lilium*
The Second International Symposium on the Genus *Lilium* was held in Pescia (Italy) from August 30 – September 3, 2010. It was decided that the Third Symposium in this series would be held in the USA, but due to organizing difficulties it was changed into China. It is an honour for me to take over this job. Therefore the Third International Symposium on the Genus *Lilium* will be held in Zhangzhou, China from March 31 – April 3, 2014. The organizing Institution, the Sino-Europe Agricultural Development Center (SEADC), is located in Zhangzhou, Fuijan province and is co-founded by Wageningen University in 2011. SEADC has a strong focus on *Lilium* as ornamental crop and believes that this symposium will promote the lily and the lily culture in China.
I want to thank all the scientists for their participation; the reviewers for correcting the papers and the private and public sponsors for their financial contribution.
We hope you will enjoy the Third International Symposium on the Genus *Lilium* as well as your stay in Zhangzhou and China.

Jaap van Tuyl
Convener.

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1. Organization of the Third International Symposium in the genus *Lilium*

Convener

Jaap van Tuyl

Organizing Committee

W. Zhu, *Sino-Europe Agricultural Development Center (SEADC), China*
S. Xie, *Sino-Europe Agricultural Development Center (SEADC), China*
J.M. van Tuyl, *SEADC, China; Wageningen University, The Netherlands*
P. Huang, *Vice-Major Zhangzhou, China*
R. Cai, *China Cross-Straits Tech. & Project Fair (6.18), China*
Z. Chen, *Fujian Provincial Department of Forestry, China*
Y. Zhang, *Zhangzhou Municipal Government, China*
M. Dai, *Fujian Provincial Department of Forestry, China*
M. Zheng, *Zhangzhou China Merchants Development Zone, China*
C. Gan, *Zhangzhou China Merchants Development Zone, China*

Scientific Committee

J.M. van Tuyl, *Wageningen University, The Netherlands*
S. Xie, *Sino-Europe Agricultural Development Center, China*
R. Kamenetsky, *ARO, The Vulcani Center, Israel*
K.B. Lim, *Kyungpook National University, South Korea*
W.B. Miller, *Cornell University, Ithaca, USA*
H. Okubo, *Fukuoka University, Japan*
D. Mu, *Chinese Academy of Agricultural Sciences, China*
P. Arens, *Wageningen University, The Netherlands*
S. Zhou, *Jiangxi Agricultural University, China*
Q. Wang, *Northwest A&F University, China*
M. Zaccai, *ARO, The Vulcani Center, Israel*

2. General Information

Congress secretariat
The registration takes place in the reception hall of China Merchants Hotel
Secretary: Songlin Xie tel. +8615159654345
Convener: Jaap van Tuyl tel. +31653362858
Website www.lilium2014.org

Congress Venue
China Merchants Hotel, No. 28, Zhaoshang Avenue, CMZD, Zhangzhou, Fujian Province, P.R. China , tel. : +86-596-6851311

Catering
Lunches will be served in the Restaurant of China Merchants Hotel

Speakers
Please deliver your presentation as soon as possible at the congress reception desk; please check your poster number in the author's index

Lectures
All lectures will be given in the large presentation hall of China Merchants Hotel

Poster sessions
Poster set-up will start Monday, March 31, 2014 at 19.00. Check your poster number in the author's index

Internet access
For the participants, free WIFI is available in the reception hall; guests of China Merchants Hotel have free internet in their room

3. Excursions

Two excursions are scheduled on April 1, after lunch from 12.30-14.30 and the last day April 3 a full day excursion is organized, started at 8.30 in front of China merchants Hotel until around 18.00.

April 1 (12.30-14.30)

Visit to Zhangzhou Merchants Development Zone
Visit to the Sino-Europe Agricultural Development Center (SEADC)

April 3 (8.30-18.00)

Visits:

1. Bulb growing Fields of Chinese sacred lily (*Narcissus tazetta var chinensis*)
2. Phalaenopsis exhibition Center
3. Flower distribution Center
4. Jubao, Phalaenopsis company

   LUNCH

5. Zhangzhou flower garden
6. Fujian Forestry Science Centre
7. Chinese cymbidium company

Return to Hotel between 17.00-18.00

Please register for the excursions at the registration desk!!

4. Program Third International Symposium on the Genus *Lilium*

31-3-2014

- ✓ **8.30-10.00 Narcissus workshop Int. part CHAIR: Jaap van Tuyl**
  - Jan Pennings: narcissus cultivation, assortment and breeding aspects
  - Donald Duncan: International Daffodil registration by RHS

10.00-10.20 Coffee & tea break

- ✓ **10.20-11.30 Narcissus workshop Dom. part CHAIR: Zhiping Shen**
  - Shaofeng Wang: Postharvest Physiology and Technology of Carved Narcissus Bulbs
  - Xiaohong Lin:

12.30-13.30 Lunch

- ✓ **13.00-15.00 Company Fair CHAIR: Zhiping Shen**
- ✓ **15.10-15.40 Discussion between companies**
- ✓ **15.40-16.00 Signing of agreements**
- ✓ **17.00-19.00 Welcome reception and dinner *Lilium* Symposium**

1-4-2014 *Lilium* Symposium

✓ 8.30-9.15 Opening ceremony CHAIR: Wangzhao Zhu

- *P. Huang* (Vice-Mayor Zhangzhou-city)
- *Z. Hu* (Head Zhangzhou China Merchants Development Zone)

- *A. Dijkhuizen* (Emeritus president Wageningen UR)

✓ 9.15-12.00 Biodiversity CHAIR: Rina Kamenetsky

- *L1 Hiroshi Okubo (keynote lecture):* History of *Lilium* species in Asia
- *L2 Xuewei Wu (keynote lecture):* Native Species of the Genus *Lilium* in China
- *L3 Ki-Byung Lim (keynote lecture):* Ecological, morphological and cytogenetic analysis of Korean Martagon *Lilium* species

10.45-11.00 coffee tea break

- *L4 Sho Yamamoto:* Morphological and micro satellite analysis of putative natural hybrid population between *Lilium japonicum* and *L. auratum* in Izu Peninsula, Japan
- *L5 Qing-lin Liu:* Investigation and Cultivation of *Lilium cernuum* from Northeast China
- *L6 Yunpeng Du :* Investigation, Evaluation and Molecular Phylogeny of the Genus *Lilium* Resources Native to China

12.00-12.30 Lunch

12.30-14.30 Excursion: Zhangzhou Merchants Development Zone & SEADC

✓ 14.30-16.15 Flowering CHAIR: Bill Miller

- *L7 Rina Kamenetsky (keynote lecture):* Flowering biology in *Lilium*: achievements and research challenges
- *L8 Narges Mojtahedi :*Molecular cloning, characterization and expression pattern of 9-cis-epoxycarotendoid dioxygenase (NCED) from *Lilium longiflorum*
- *L9 Jipeng Liu:* Analyses of Flavonoid-Biosynthesis Gene Expression in the Flowers of Major Lily Cultivars
- *L10 Zhou Bin:* Rhythmic Changes in the Metabolic Network of Lily Flowers
- *L11 Yin Junle:* Role of LoAAT1 in Volatile Esters Formation and its Rhythm Release in Lily Flower
- *L12 Michele Zaccai:* Studying the vernalization response of *Lilium longiflorum* with RNA-seq data

16.15-16.30 coffee tea/break

- ✓ **16.30-18.30 Post harvest and cultivation aspects**
- ✓ **CHAIR: Hiroshi Okubo**

  - *L13 Bill Miller (keynote lecture):* Postharvest aspects of *Lilium*
  - *L14 Ding Mu (keynote lecture):* Production and cultivation of lily in China
  - *L15 Lianwei Qu:* Production of lily bulbs and cut flowers in Liaoning Province of Northeast China
  - *L16 Malik Fiaz Hussain Ferdosi:* Effect of NPK on growth and yield attributes of lily
  - *L17 Liu Yang:* The effect of ABA synthesis inhibitor "Fluridone" on cut flower quality of Oriental hybrids lily "Sorbonne"
  - *L18 Vinodh Subramani:* Effect of different planting seasons and fertigation levels on flower yield and quality of Asiatic hybrid *Lilium* cultivars

2-4-2014 *Lilium* Symposium

- ✓ **8.30-11.15 Genetics and Breeding CHAIR: Jaap van Tuyl**

  - *L19 Paul Arens* (*keynote lecture*): Molecular Breeding of *Lilium*
  - *L20 Rodrigo Barba-Gonzalez* (*keynote lecture*): Cytogenetics of lily
  - *L21 Sixiang Zheng:* Selection of *Lilium* Oriental Cultivar 'Red Guiyang' with Fusarium-resistance
  - *L22 Songlin Xie:* GISH Investigation of Crossover Events during Meiosis of Interspecific Hybrids of Lily
  - *L23 Bui Thi Thu Huong:* Enhancing the heat tolerance of lily plants by Agrobacterium mediated transformation
  - *L24 Shujun Zhou:* Aneuploidy in lily breeding
  - *L25 Beatrice Nesi:* Development, selection and propagation of interspecific hybrids of *Lilium*
  - *L26 Zhigang Wang:* Research advances on *Lilium lancifolium* Thunb. in China
  - *L27 Shujun Yu: The PVP Status of Lilium in China, Holland, and the World*

11.15-11.45 coffee tea break & photographing

- ✓ **11.45-13.00 Tissue Culture CHAIR: Ki-Byung Lim**

  - *L28 Qiaochun Wang (keynote lecture):* Plant regeneration and cryopreservation of *Lilium*
  - *L29 Manas Ranjan Sahoo:* In vitro regeneration techniques for conservation of Shirui Lily (*Lilium mackliniae*)
  - *L30 Zhang Lin:* Introduction of embryogenic callus and floral organ organogenesis derived from callus of *Lilium* Oriental 'Sorbonne'

- *L31 Zhang Yiping:* In vitro Selection for Oriental Hybrid Lily Clonal Lines with Culture Filtrate of *Fusarium oxysporum f. sp. lilii*

13.00-14.00 Lunch

✓ 14.00-16.00 Plant Protection CHAIR: Paul Arens

- *L32 Cor Conijn (keynote lecture):* Lily diseases and their developments in control
- *L33 Gary Chastagner:* The effectiveness of reduced-risk and new biocontrol products in controlling fire on lilies
- *L34 Haiquan Huang:* Screening and characterization of Plant Growth-Promoting Rhizobacteria Containing ACC Deaminase from Lily Soil and Roots
- *L35 Leifeng Xu:* Construction of LMoV and CMV Binary Virus Resistant RNAi Vector and transformation into *Lilium*
- *L36 Yajun Wang:* Impacts of salt and low temperature stresses on lily (*Lilium* 'Oriental Hybrids' var. Siberia) photosynthesis incorporated with models
- *L37 Qianhan Shang:* An Investigation of Fungal Pathogens Causing Wilt Disease on Lanzhou Lily (*Lilium davidii var. unicolor*)

16.00-16.30 coffee/tea break

16.30-17.00 Business meeting

19.00-21.00 Symposium dinner

5. List of Abstracts

Oral presentations

Poster presentations

6. Abstracts of Lectures

L1

History of *Lilium* species in Asia

Hiroshi Okubo

Faculty of Agriculture, Kyushu University, Fukuoka
Japan

Abstract
Ancestors of currently and commercially important lily cultivars, Asiatic, Oriental, Longiflorum, Trumpet, and their intersectional hybrids such as LA (Longiflorum × Asiatic), LO (Longiflorum × Oriental), OT (Oriental × Trumpet) and OA (Oriental × Asiatic), are mostly of Asiatic origin.
From literature, a set of two Chinese letters pronounced “Pai Ho” that corresponds to *L. brownii* var. *colchesteri* first appeared in the book “Shen Nong Ben Cao Jing” in A.D. 453-536 in China. A plant described by a different letter in an ancient book “Nan-Du-Fu” in A.D. 78-140 is also considered to be *L. brownii* var. *colchesteri*. This is probably the oldest description of lily in Asia. The first mention of lily in Japan is found in the oldest history (or myth) book, “Kojiki” in A.D. 712. The lily is considered to be *L. japonicum*. Later, *L. auratum* appeared in the history book “Nihonshoki” (A.D. 720).
In art works, the oldest depiction of lilies in China is probably a wall painting in Mogao Caves #130 in Dunhuang, Gansu Province in High Tang Dynasty (A.D. 712-765). They seem to be *L. lancifolium* (*L. tigrinum*). In a fragment of a flag for religious purposes woven almost at the same time (A.D. 710-756) in Japan, *L. japonicum* is embroidered. The oldest fine art of lilies in Japan is probably “Hamamatsuzu” in 1333-1573. The lily is *L. concolor*.
The introduction of these Asian lilies to Europe started with *L. dauricum* from Siberia in 1743. Later, C.P. Thunberg described Japanese *L. longiflorum*, *L. japonicum*, *L. speciosum*, and *L. callosum* in “Flora Japonica” published in 1784. In 1830, P. F. B. von Siebold brought live bulbs of seven species to the Netherlands from Japan, but only *L. speciosum* flowered in 1832. Further introductions from Japan included *L. auratum*, *L. japonicum*, and *L. rubellum*. The Chinese *L. lancifolium* and *L. brownii* were introduced into England in 1804, and *L. regale* in 1905. There were interesting, sometimes curious stories during these introduction. Examples are: *L. dauricum* was first supposed to be an American species; there is an 87 years gap in Europe between the description and introduction of live plants of *L. japonicum*, during which Chinese *L. brownii* first mistakenly gained its scientific name as *L. japonicum*. Such history of these Asiatic lilies is presented.

L2

Native Species of the Genus *Lilium* in China

X.W. Wu[12] , M. Tian[12], L.H. Wang[12], GF Cui[12], R.P. Yu[12], Z.H. Lu[12], W. J. Jia[12], S.P. Qu[12], M. Gui[12] and J. H. Wang[12]

[1]Flower Research Institute, Yunnan Academy Agricultural of Science, Kunming, China.
[2]National Engineering Research Center for Ornamental Horticulture, Kunming, China.

Abstract:
China, the central distribution area of *Lilium* in the world, is home a reported 55 species and 30 varieties. They are mainly distributed in four areas which are South West, East, North West and North East of China. Given the complex climate and topography of China, *Lilium* species show a great diversity, including Martagon, Sinomartagon, and Daurolirion. The height of Chinese native species runs from less than 15cm (*L. souliei, L. lophophorum, and L. amoenum*) to more than 2m (*L. leichtlinii, L. henryi,* and *L. primulinum*). Leaves are alternate or verticillate. Flower shapes are campanulate, trumpet, and revolute. This paper introduces morphological and distribution characters of 85 native species including *L. hansonii, L. martagon, L. tsingtauense, L. distichum, L. medeoloides, L. paradoxum, L. medogense, L. lophophorum, L. lophophorum* var. *lophophorum, L. lophophorum* var. *linearifolium, L. nanum, L. nanum* var. *nanum, L. nanum* var. *flavidum, L. brevistylum, L. concolor, L. concolor* var. *concolor, L. concolor* var. *pulchellum, L. concolor* var. *megalanthum, L. dauricum, L. henrici, L. henrici* var. *henrici, L. henrici* var. *maculatum, L. bakerianum, L. bakerianum* var. *bakerianum, L. bakerianum* var. *aureum, L. bakerianum* var. *delavayi, L. bakerianum* var. *rubrum, L. bakerianum* var. *yunnanense, L. sempervivoideum, L. amoenum, L. pinifolium, L. souliei, L. saccatum, L. huidongense, L. speciosum, L. henryi, L. rosthornii, L. primulinum, L. primulinum* var. *Myanmarnicum, L. Primulinum* var. *Ochraceum, L. Nepalense, L. Nepalense* var. *Myanmarnicum, L. Nepalense* var. *Myanmarnicum, L. Wardii, L. Matangense, L. Stewartianum, L. Habaense, L. Taliense, L. Jinfushanense, L. Lijiangense, L. Duchartrei, L. Lankongense, L. Amabile, L. Leichtlinii, L. Leichtlinii* var. *Maximowiczii, L. Pumilum, L. Davidii, L. Davidii* var. *Davidii, L. Davidii* var. *Willmottiae, L. Cernuum, L. Callosum, L. Papilliferum, L. Fargesii, L. Xanthellum, L. Xanthellum* var. *Anthellum, L. Xanthellum* var. *Luteum, L. Tigrinum, L. Brownii, L. Brownii* var. *Brownii, L. Brownii* var. *Giganteum, L. Brownii* var. *Viridulum, L. Wenshansense, L. Anhuiense, L. Regale, L. Formosanum, L. Formosanum* var. *Formosanum, L. Formosanum* var. *Microphyllum, L. Longiflorum* var. *Centifolium, L. Leucanthum, L. Leucanthum* var. *Leucanthum, L. Leucanthum, L. Sulphureum, L. Sargentiae, L. Tianschanicum,* and *L. Pyi*.

L3

Ecological, Morphological and Cytogenetic Analysis of Korean Martagon *Lilium* Species

K.-B. Lim

Department of Horticultural Science, Kyungpook National University,
Daegu 702-701
Korea

Abstract
A comprehensive evaluation of habitat associations and distribution patterns of four *Lilium* species in Korea was carried out and data regarding its ecological and morphological characteristics under different regions and environmental conditions were collected. During survey it was observed that the species are well distributed nationwide with highly variable altitudes such as L. tsingtauense (300-700m), one unknown species (450-800m), L. hansonii (350-850m) and *L. distichum* (750-1,000m) above sea level. Maximum (~80%) of natural habitats of these species richness were found in the northern slopes of mountains whereas, only (~20%) habitats were present in Southern regions. Morphological studies revealed that each of these species had its own unique morphological characteristics. On the basis of morphological observations such as bulbs, stem, leaves and flowers these four species were clearly differentiated. The 5S rDNA loci were the same in three species, section Martagon lily, which detected on interstitial region of long arm of chromosome #3. As well as, 5S rDNA co-localized with 45S rDNA. A high frequency of variation in number of 45S rDNA loci was detected in L. hansonii. Based on ecological, morphological and cytogenetic analysis, these results could serve information of understanding of evolutionary evidence in *Lilium* taxa.

L4

Morphological and Microsatellite Analysis of Putative Natural Hybrid Population between *Lilium japonicum* and *L. auratum* in Izu Peninsula, Japan

S. Yamamoto[1], Y. Yamagiwa[2] , Z. Inaba[2] and T. Handa[3]

[1]Graduate School of Agriculture Meiji University, Kawasaki, Japan 214-8571
[2]Shizuoka Research Institute of Agriculture and Forestry, Izu Agricultural Research Center, Inatori, Higashi-izu, Shizuoka, Japan 413-0411
[3] School of Agriculture Meiji University, Kawasaki , Japan 214-8571

Abstract
Lilium japonicum and *L. auratum* are endemic Japanese lilies, and have been used for parents in breeding of oriental hybrid lilies. L. japonicum has pink or white coloured funnel like flowers without spots, and is distributed mainly in the western part of Japan which includes Honshu (main island), Shikoku (west island) and Kyushu (south-west island). L. auratum has larger flowers with white tepals, yellow stripes and red spots, and is distributed on the eastern side of Honshu in Japan. The natural hybridization of these two species occurs only at the edge of their distribution which is on the South of Izu peninsula of Honshu main island.. It is suggested that putative hybrids can be classified into three types by their morphological characters; *L. japonicum* type, intermediate type and *L. auratum* type, however their genetic structure has not been revealed yet. In this study, 6 wild populations of these lilies were investigated by morphological and genetic analysis. Principal component analysis by using ten morphological characters revealed large morphological diversity within putative hybrids. Five SSR markers are used for microsatellite analysis, and a Bayesian clustering approach was implemented by Structure analysis. In the Bayesian clustering *L. japonicum* was assigned to cluster I and *L. auratum* was assigned to cluster II. Putative hybrids were assigned to cluster I and II. These results indicate that putative hybrid populations consist of introgressed mixture between 2 species.

L5

Investigation and Cultivation of *Lilium cernuum* from Northeast China

Y.H. Li, H.Y. Xiao and Q.L. Liu

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Beijing 100193, China

Abstract
In order to understand the resource status and utilize the resources of *Lilium cernuum*, we have investigated the habitat, associated plants, populations and morphological characters of *L. cernuum* in Linjiang City, Baishan Prefecture, Jilin Province and Kuandian County, Dandong Prefecture, Liaoning Province of China. Wild bulbs of *L. cernuum* from Wohu Mountain, Linjiang City were introduced and cultivated in Beijing. The results indicated that the *L. cernuum* is distributed in all the investigated sites including Dianshita Mountain, Dahu Mountain and Zhenzhu Villa in Linjiang, and Dapushi River, Huabo Mountain and Xiaohu River in Kuandian. *L.cernuum* had strong adaptability and diversified habitats such as glade, forest understory, roadside shrub, ridge and cliff. There were rich associated plants including *Quercus mongolica*, *Lespedeza bicolor*, *Atractylodes japonica* and *Fraxinus chinensis* in both Linjiang and Kuandian. The native Linjiang population was stable while that of Kuandian was increasing type. There are some morphological differences between polulations in Linjiang and Kuandian. Plants in the Linjiang population had higher stem of 44-70cm and 34-53 leaves with 10-12 cm length and 1.80-1.82 mm wide. In the Kuandian population, plants had lower stem of 32-65 cm, 33-66 leaves with 10-13 cm length and 1.79-1.84 mm wide. There were 1-3 flowers in the raceme inflorescences which first flowering on July 10th 2012 in Linjiang, and 1-2 flowers in the raceme or umbel inflorescences that first opened on July 3rd 2013 in Kuandian. Fifty-nine plants emerged from 170 wild bulbs planted in Lvgezhuang Village, Changping District, Beijing on May 23, 2012 with the survival rate 34.7%. Under introduction conditions, the average stem height was 52 cm, leaves number is 48, with average 8 cm length and 2.08 mm wide. Although the stem height was not changed, leaf was 4 cm shorter and 0.2 mm wider than that in the original site. Nineteen flowers opened on June 16, 2013, 15 days earlier than the flowering in natural population with the flowering rate 11.2%. The individual flower bloomed for 3-4 days, and the whole population was flowering 21 days. We assume that temperature might be the key factor affecting the flowering, which contributes to an excellent prospect of commercialization of flower industry. This research provided the germplasm basis for the industrialization of wild lilies in China**.**

L6

Investigation, Evaluation and Molecular Phylogeny of the Genus *Lilium* Resources Native to China

Yun-Peng Du, Zhong-Xuan Wang, Yu-Qin Lian, Xue Gao, Heng-Bin He, Gui-Xia Jia

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National Engineering Research Center for Flowers,
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Abstract:
China is known as an important distribution center for the genus *Lilium*. This study was conducted to provide a comprehensive evaluation of *Lilium* distribution in China based on analytical hierarchy process (AHP) utilizing 16 indicator characteristics. Besides, to resolve specific controversial or uncertain nodes in the phylogeny of *Lilium*, especially with respect to species native to China, we present a comprehensive phylogeny derived from nuclear ribosomal DNA for 214 samples representing 98 species and 5 varieties, including 44 species and 5 varieties native to China. Results showed that a total of 27 species and 3 varieties were found to exist in the main centers of *Lilium* distribution in China; these species were identified and classified based on their morphological characteristics. The differences, mainly in flower colour within the same species, were investigated, which may be representative of new natural varieties or ecotypes. *L. dauricum* received the highest AHP scores, indicating that it was the species best suited for sustained exploitation. In addition, *L. henryi*, *L. rosthornii*, *L. tsingtauense*, *L. concolor* var. *pulchellum*, *L. lancifolium*, and species with trumpet–shaped flowers also showed better potential for exploitation than other species. In the phylogenetic tree obtained by maximum parsimony (PAUP) and maximum likelihood (RaxML) analyses, the samples were divided into four major groups. Our results suggest that subsect. 5c Comber should be classified into the true subsect. 5c and sect. *Lophophorum*. And the latter was divided into three subsections (subsect. *Lophophorum* I, subsect. *Lophophorum* II, and subsect. *Lophophorum* III). Based on molecular phylogenetic analysis and fluorescence *in situ* hybridization, we report that *L. henryi and L. rosthornii* are closely related, and we propose their classification into subsect. *Leucolirion* 6a. Our results support Comber's subdivision of sect. *Leucolirion*, which was primarily based on bulb colour. Chinese species were divided into five sections: *Martagon*, *Archelirion*, *Leucolirion*, *Sinomartagon*, and *Lophophorum*. This study provides references regarding the effective exploitation and use of wild *Lilium* resources and contributes to an understanding of the phylogeny, origin and classification of *Lilium*.

L7

Flower Biology in *Lilium*: Achievements and Research Challenges

R. Kamenetsky

Institute of Plant Sciences,

ARO, The Volcani Center,
Bet-Dagan, Israel

Abstract
Flowering involves a variety of molecular, physiological, and biochemical mechanisms regulating the proper timing and correct development of the reproductive organs. Sensing and integration of the external cues (temperature, photoperiod, irradiance, and stress) by the plant are necessary for the optimal timing of flowering during the year, for synchronized flowering within a population, and for successful seed development. Therefore, horticultural manipulations aimed at directing flowering to specific periods usually make use of these cues. In geophytes, florogenesis can be divided into several consecutive steps: induction, initiation, differentiation (organogenesis), maturation and growth of floral organs, anthesis and senescence. A major distinction can be made between the geophytes in which flower initiation takes place within the bulb during the "dormancy" period prior to growth ("Tulip type"), and those in which flowering is initiated during active growth, following the development of several leaves ("Lily type"). The commercial cultivars of *L. longiflorum* require low temperatures and a long photoperiod for florogenesis. Although breeding of commercially important hybrids has great commercial value, only limited data are available on molecular regulation of flowering. To date, two basic strategies have been used to isolate genes involved in florogenesis. The first is based on sequence homology between species. Numerous homologues of genes from model plants have recently been isolated from geophytes. The second approach is broader and involves the determination of a large number of genes, using cDNA libraries and isolation of the genes expressed in specific tissue locations or physiological states. Recently, next generation sequencing (NGS) technology has been used to sequence the transcriptomes (RNA-seq) of lily cultivars. Investigations in the coming decade are expected to improve our understanding of this process, thus contributing to the development of breeding techniques and the production of new hybrids.

L8

Molecular cloning, characterization and expression pattern of 9-cis-epoxycarotenoid dioxygenase (NCED) from *Lilium longiflorum*

Narges Mojtahedi[1,2], Jun-ichiro Masuda[1,3], Youkio Ozaki[4], Kiyohide Kojima[5], Fumitaka Chino[5], Michikazu Hiramatsu[1], Hiroshi Okubo[1]

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[2]Present address: Agriculture Biotechnology Research Institute of Iran (ABRII), Seed and Plant Improvement Institutes Campus, Mahdasht Road, P. O. Box 31535-1897, Karaj, Iran
[3]Present address: Graduate School of Life and Environmental Science, University of Tsukuba, Tennodai 1-1-1, Tsukuba Ibaraki, 305-8572
[4] Faculty of Agriculture, Kyushu University, Fukuoka 811-2307, Japan
[5] Faculty of Agriculture, Niigata University, Niigata 950-2181, Japan

Abstract
It was proved that northern *Lilium longiflorum* populations of the Ryukyu Archipelago have deep dormancy and it was induced by high temperature in summer, while southern ecotypes and *L. formosanum* have no dormancy. Plastid-localized 9-epoxy carotenoid dioxygenase (*NCED*) gene is involved in the abscisic acid (ABA) biosynthetic pathway in higher plants. *NCED* gene was cloned and its role in the bulb dormancy of those populations was investigated. *NCED* gene was cloned from the leaves of Kikaijima (LKI) population as the northern ecotype of the Ryukyu Archipelago, Japan. Then, its expression pattern in the leaves of LKI and Pitouchiao (LPI) populations, Taiwan and a domesticated *L. formosanum* population in Fukuoka, Japan (FFU) were investigated in June, August, October and December. ABA quantification was done using LCMS (2010EV-Shimadzu).
The nucleotide sequence length of *NCED* gene which was cloned form the leaves of *L. longiflorum* were around 2301 bp. The high homology of *NCED* gene from *L. longiflorum* with the same gene in other plants showed that 9-epoxy carotenoid dioxygenase (*NCED*) as a key enzyme during ABA biosynthesis process mostly conserved along the evolution of angiosperms. LKI had the highest expression of 9-*cis*-epoxy carotenoid dioxygenase (*NCED*) in August, while FFU were the lowest. The higher expression of *NCED* in the middle of summer in dormant population is related to high amount of endogenous ABA. It is possible to conclude that dormancy induction was initiated by ABA accumulation in dormant type of *L. longiflorum*, which is induced by high temperature.

L9

Analysis of Flavonoid-Biosynthesis Gene Expression in the Flowers of Major Lily Cultivars

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Abstract
Flavonoids biosynthesis pathway mostly determines the flower colour phenotypes in plants. This study was carried out to determine the presence and expression rates of the flavonoids biosynthesis-related genes in major lily cultivars. Primers of major colour genes were prepared by comparing the homologous genes of other species like sorghum, onion, and rice, and used for RT- PCR of eight lily cultivars. The results of transcriptional rate analyses showed that, in pink-flowering lily cultivars like, 'Pirax', red-flowering cultivar 'Atika', yellow-flowering cultivar 'Gironde', and white cultivar 'Siberia', all the genes tested were expressed. However, F3'H and DFR genes were not expressed in yellow-flowering cultivar 'Yelloween'. In white-flowering cultivars 'Samarinde' 'Richmond' and 'White Elegance', gene expressions varied among cultivars, especially in the genes CHS, F3H and ANS. We assume that the results on the presence and/or expression rates of the major flavonoid-biosynthesis genes shall be useful in the hybridization and transformation breeding in lilies for flower colour modification.

L10

Rhythmic Changes in the Metabolic Network of Lily Flowers

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Abstract
Flower scent is an important ornamental trait, which also play an important role in attracting insects for pollination. Currently there are some reports on the formation and regulation of floral scent, and find the rhythmic release of flower scent, but up till now little is known about how plant control metabolic network of flower scent attracting pollinator more efficient. Lily is an important ornamental plant around the world. Among the main cultivated varieties are the most *Lilium* "Oriental Hybrids", *Lilium* "Oriental-Trumpet Hybrid" and *Lilium longiflorum* show rhythmic release of flower scent. *Lilium* 'Siberia', which have strong flower scent and show rhythmic release of flower scent, were used materials to investigate the difference of expression profile. The flower petals were harvested at 16:00 and 04:00, in that time flower scent highest and lowest respectively. A total 29,837 high-quality unigenes (transcripts) using Trinity software were obtained. Genes up-regulated during daytime were enriched in functions related to terpenoid backbone, phenylpropanoid biosynthesis, sucrose metabolism, plant circadian rhythm and plant hormone signal transduction, whereas down-regulated genes were enriched in processes involved in alpha-linolenic acid metabolism, starch and sucrose metabolism, plant hormone signal transduction. By the method of RT-qPCR a few genes related with circadian rhythm were tested in continuous 72 hours. Our results showed that in daytime plant circadian rhythm related genes FKF1 and GI were up-regulated genes, but CK2β1, CK2β2, WNK1 and sucrose metabolism related hexokinase and α-glucan phosphorylase genes were down-regulated genes, but at nighttime the results are in reverse. These data will provide new insights to the floral scent and circadian rhythm research of lily.

L11

Role of *LoAAT1* in Volatile Esters Formation and its Rhythm Release in Oriental Lily 'Siberia' Flowers

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Abstract:
Lilium 'Siberia' is the main cultivated variety of Oriental lily in China, whose flower is big and white with strong aroma. Volatile esters are the main aroma components in *Lilium* 'Siberia'. The alcohol acyltransferase is key end enzyme in volatile ester biosynthesis pathway. In this study, by using RT-PCR and RACE techniques the full length of alcohol acyltransferase gene (*LoAAT1*) was cloned from *Lilium* 'Siberia' petals, and their expression were investigated. Our results show the LoAAT1 mRNA expression only found in the flower organ. In different flower development stage and different varieties with different aroma the flower LoAAT1 mRNA expression levels are consistent with the levels of methyl benzoate and ethyl benzoate, which are the main aroma components. Depressing the expression of *LoAAT1* induced by RNA interference resulted in the decrease of ethyl benzoate, methyl benzoate, ethyl caproate and ethyl butyrate release. *In vitro LoAAT1* recombinant protein can catalyzes benzoyl coenzyme A and hexanoyl coenzyme A react with short chain alcohols such as methanol and ethanol, and alkane alcohol such as hexyl alcohol to produce the corresponding product, but cannot catalyze the reaction with terpene alcohol, and also cannot catalyze all the reactions with acetyl coenzyme A as substrate. Leaves of tobacco plant transformed with sense *LoAAT1* can release new esters such as ethyl benzoate and methyl benzoate which do not appear in wild-type tobacco. In the natural photoperiod conditions, the release of flower ethyl benzoate and methyl benzoate show a daily rhythm with peak at 16:00 and foot at 04:00. Dark treatment significantly reduce the release of ethyl benzoate and methyl benzoate and vanish their release rhythm, but does not affect the release of ethyl caproate and ethyl butyrate. Interestingly dark treatment maintain *LoAAT1* expression at low levels and also vanish the rhythm of *LoAAT1* expression. Out result show *LoAAT1* is a key gene controlling the biosynthesis of esters such as ethyl benzoate in lily. The protein LoAAT1 coded by this gene is able to catalyze the reaction with many substrates. Environmental light can affect the release of ethyl benzoate and methyl benzoate through regulation of *LoAAT1* expression. The *LoAAT1* gene can be used as a targets for further research on the regulatory network of lily ester aroma biosynthesis.

L12

Studying the vernalization response of *Lilium longiflorum* with RNA-seq data

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Abstract
In lily (*Lilium longiflorum*), bulb vernalization is not only an obligatory requirement for flowering, but also the most important factor affecting flowering time and flower quality. However, the molecular regulation of the response to vernalization and of floral transition remains largely unclear. Evidence, mainly obtained from other plant species, indicates that there is a conserved pattern regulating the vernalization response, namely a floral repressor inhibited by cold exposure. Yet, the number of genes involved in the process and the interactions between them differs among species. We aimed to study the molecular regulation of the vernalization response in *L. longiflorum*. To this purpose, meristems of lily bulbs were collected during several weeks of cold exposure at 4^{o}C (0, 2, 5, 7 and 9 weeks). A differential expression approach was then used to identify candidate genes involved in the vernalization response by performing RNA high-throughput sequencing with each specimen. A de-novo assembled transcriptome yielded about 120,000 transcripts, 70,000 annotated open reading frames (ORFs) and 42,000 genes. Differential expression analysis revealed profound changes in the levels of gene expression among the 5 time points during cold exposure. We identified statistically significant changes and grouped genes into clusters showing similar patterns. We also researched the association between functional categories or pathways and expression levels. This study provides insights into the molecular regulation of vernalization in lily, and addresses fundamental questions regarding the conservation of the vernalization response among higher plants.

L13

Postharvest of *Lilium:* Experiment to Industry Adaptation

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Abstract
While lilies are the 4th cut flower in the world and an important potted plant, much remains to be discovered about their postharvest physiology and characteristics. Lilies have two main postharvest issues: floral longevity and foliar chlorosis. Inclusion of sugar in the vase solution invariably improves flower life (individual flowers and the entire inflorescence), but sometimes increases leaf yellowing.
Aside from possibilities in breeding longer lasting cultivars, a number of technologies have emerged for maximizing postharvest quality, among them refrigeration, application of gibberellin-containing hormones and anti-ethylene treatments (for both pot plants and cut flowers) and inclusion of carbohydrates in cut flower vase solutions.
We have found that storage temperature differentially influences bud life based on bud age at the time of storage: warmer storage temperatures (e.g, 7°C vs. 1°C) are beneficial in promoting opening of smaller buds, but often detrimental to life of larger (older) buds. During postharvest evaluation, an analysis of the extent of leaf senescence should also be made, as leaf chlorosis, (commonly associated with cold storage), is often more limiting to display life than flower senescence *per se*. Gibberellin (GA_{4+7}) is routinely used in industry to combat leaf chlorosis in both potted plants (as a foliar spray) and cut flowers (as a postharvest pulse).
After petal expansion, lily flowers generally have low sensitivity to ethylene, but as developing buds they are usually highly sensitive to ethylene. By protecting young, sensitive buds, the anti-ethylene action molecule 1-MCP (1-methylcyclopropene) can play an important role in maximizing lily display life, especially in situations of exogenous ethylene contamination.
Chilling injury is not widely recognized in lilies. Leaf chlorosis that develops during or rapidly after cold storage (prior to marketing) is an example of chilling injury. Another example is the development of necrotic spots in unopened buds during postharvest cold storage of certain Oriental hybrid cultivars.

L14

Production and Cultivation of Lilies in China

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Abstract

In this paper, the status of lily industry, such as cut-flower production, bulb production, edible lily production status, in mainland China is summarized. The lily flower yield in 2012 amounted to more than 600 million stems. This is the estimation from some companies of bulb trade in China, and we don't have the accurate data from the government. It was estimated that the import quantity of lily bulb of mainland China in 2012, including from the Netherlands and the south hemisphere, was more than 200 million. In mainland China, at present time, lily flower production is mainly distributed at six provinces, Yunnan, Liaoning, Zhejiang, Guangdong, Jiangsu, and Fujian, and this situation has been sustained a couple of years. Among the six provinces, Yunnan is number one, and Liaoning is number two.

Because of the distinctive environmental conditions, including the climate, soil and water, between north and south China, the equipments and some detailed techniques for cut lily production are quite different. Therefore, it has been formed two technology systems, the north China system and South China system.

The total area of lily bulb production in China is still not so clear. It is estimated that lily bulb produced domestically is about 60 million in 2012 in mainland China. Many Chinese lily growers just re-use the bulbs for one or two years, sometimes even three or four years in some region. There are mainly two methods of treatment for reusing lily bulbs after flowering.

Edible lilies are a small branch of lily industry in China, but not very popular on the world. There are mainly three lily species, or varieties used for food with their bulbs in China. They are Lanzhou lily (*Lilium davidii* var. *unicolor*), which was mainly grown in the region around Lanzhou, Gansu province, Longya lily (*L. brownii*), which was mainly grown at Hunan and Jiangxi province, and Yixing lily (*L. lancifolium*), which was mainly grown in Jiangsu province.

L15

Production of Lily (*Lilium*) Bulbs and Cut Flowers in Liaoning Province of Northeast China

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Abstract
After analyzing the general developing trend of the world flower industry at present, the author concentrates specifically on the Liaoning lily (*Lilium*) flower industry, with particular focus on the status of the lily industry in the whole country; the production and trade of lily cut flowers; the production and trade of lily bulbs; and lilies (*Lilium*) native to Liaoning province. There are many advantages for Liaoning to realize the sustainable development of the lily flower industry as demonstrated in this report, such as the richness in germplasm resources, low labour costs, favorable climate, and abundant governmental investment in agriculture. In summary, Liaoning province, as the biggest bulbous-flower breeding and propagation production base in China, plays a significant role in national flower industry.

L16

Effect of NPK on growth and yield attributes of Oriental lily 'Merostar'

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Abstract
The aim of this study was to evaluate the response of NPK, nutrients on growth and yield of oriental lily. This experiment was laid according to RCBD (Randomized Complete Block Design) with four replications. Garden soil enriched with FYM was used as growing medium. The study was made by application of different concentrations of NPK 17:17:17, 10:10:15, 15:15:10 and control respectively. As compared to other treatments, concentration of NPK 10:10:15 gave the best results regarding vegetative and floral characteristics as well as yield parameters of oriental lily i.e. sprouting percentage, plant height, leaf area, fresh and dry weight of plants, fresh and dry weight of flowers, number of flowers per plant, stem diameter, days to flowering, bulb size and bulb weight etc.

L17

The effect of ABA synthesis inhibitor “fluridone” on cut flower quality of Oriental hybrid lily “Sorbonne”

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Abstract

Fluridone is an ABA synthesis inhibitor in laboratory and used as a herbicide in agriculture, it can influence many physiological processes in plants. In this work, whether fluridone had promoting effect on cut flower quality or not had been investigated. The bulbs of “Sorbonne“ were treated with 20mg/L fluridone immediately after harvest and clean, then stored in 4℃ cold room. Thirty fluridone-treated bulbs were planted each time in greenhouse in 10-day interval for 5 times from the 30th day after treatment with bulbs that were not treated with fluridone as control. Bulbs were sampled every 10 days after fluridone treatment for 8 times and the bulb shoots were collected to analyze the phytohormone in them by HPLC. The plant height, quantity of flower bud and the flower diameter was observed. The average plant height of fluridone-treated lily planted 50 days after treatment ranked the first with a height of 64.9cm which was significantly higher ($P < 0.05$ than that of CK (57.7cm). So did the flower bud quantity, which was 4.7 per plant in fluridone treatment and 3.9 in CK. There was no significant difference between the treatment and CK, which ranged from 17.5cm to 18.0cm. The results of endogenous phytohormone analysis showed that GA_3 concentration of fluridone treatment was lower than that of CK and the trend of them was similar, but the GA_3 peak of fluridone treatment appeared in the 70th day while CK appeared in the 60th day. IAA concentration of both the treatment and CK showed no regular pattern. ABA concentration of the fluridone treatment and CK had no difference in the first three samples, but from the 4th to the 8th samples, the ABA concentration of fluridone treatment was lower than that of CK. It was inferred that the promoting effect of fluridone on cut flower quality of “Sorbonne” was due to the phytohormone change in bulbs which led to prolonged dormancy. The exact reason needs further investigation.

L18

Effect of different planting seasons and fertigation levels on flower yield and quality of Asiatic hybrid *Lilium* cultivars

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Abstract
A field experiment was carried out during three successive seasons at M/s. Balaji Flowers, Devashola Estate, The Nilgiris by the Dept. of Floriculture and Landscaping, Tamil Nadu Agricultural University to evaluate Asiatic hybrid *Lilium* cultivars with different level of fertigation on growth and yield parameters. The overall plant growth, days taken for bud initiation, flower shoot length and flower yield were found to be maximum in plants grown under T_7 fertigation treatment in summer season compared to other fertigation level and seasons. Among cultivars, 'Pollyanna' showed increase in flower shoot length, number of flower buds, diameter of flower and flower yield during summer season. The other cultivars, *viz*., 'Navona', 'Black Out' and 'Tresor' also exhibited higher flower yield in all the three seasons. Hence it has been observed that there is no significant difference among the three seasons for yield parameters with respect to the best treatments.

L19

Molecular Breeding of *Lilium*

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Abstract

Lily breeding has become an important economic activity in the last 50 years. Within this period breeding has changed from making end-products that were mainly interspecific hybrids from the section Sinomartagon to polyploid hybrids that are derived from intersectional crosses. Especially the Longiflorum × Asiatic hybrids or LA hybrids and the Oriental × Trumpets or OT hybrids have become dominant combinations in breeding because of their superior performance over Asiatic and Oriental hybrids.

Molecular breeding utilises the information of markers linked to genes of interest to develop more efficient selection strategies in what is called Marker Assisted Selection. Molecular breeding is of particular importance when desired traits are difficult to phenotype (*e.g.* due to environmental variation influencing the trait), when simultaneous combinations of several genes are needed (*e.g.* quantitative resistance genes or yield) or in a combination of the two situations. The use of markers for breeding has become an integrated part of the breeding schemes in many of the world's important food crops. Especially the development of massive parallel sequencing methods known under the collective term Next Generation Sequencing (NGS sequencing) and the availability of high throughput marker systems have revolutionized the possibilities for molecular breeding.

In most ornamental crops, and also in lily that is a model crop for research in interspecific hybridisation and cytogenetic, molecular breeding has not been implemented in actual breeding yet. Nevertheless there are some promising developments in research that are presented in this paper.

L20

Molecular Cytogenetics in *Lilium* Breeding

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Abstract

In horticulture, interspecific hybridization is one of the most important tools to achieve genetic variation; this is especially true when it comes to ornamental crops, where it is always necessary to introduce new traits, such as flower colour, petal shapes, stem size and strength, longevity, disease resistances and more. However, to maintain such traits in the progeny is necessary to introgress the genes of the alien species into the gene pool of the receptor species. To accomplish this, first sterility must be overcome, because, as a general rule, interspecific hybrids tend to be sterile. Mitotic polyploidization is a useful technique to come to such end, but the use of unreduced gametes is preferred because recombination occurs between the parental genomes and introgression might be achieved. Here it is described i) the production of interspecific, intersectional lily hybrids, obtained through the use special pollination techniques combined with ovary- and embryo-rescue techniques, in crosses of distantly related lily hybrids, cultivars and species from different taxonomical sections (*L. longiflorum* × Asiatic hybrids (LA), *L. longiflorum* × Oriental hybrids (LO), *L. longiflorum* × *L. rubellum* (LR), *L. longiflorum* × *L. henryi* (LH), *L. henryi* × *L. candidum* (HC), *L. auratum* × *L. henryi* (AuH), *L. martagon* × Asiatic hybrids (MA), Oriental hybrids × Asiatic hybrids (OA), Oriental hybrids × Trumpet hybrids (OT) and Oriental hybrids × *L. pardalinum* (OP)); ii) the use of molecular Genomic *In Situ* Hybridization (GISH) to depict the mechanisms of *2n* gamete formation and their use for the production of sexual polyploids; iii) the utilization of allotriploid BC_1 progenies in introgression breeding and iv) the application of N_2O to induce the formation of unreduced gametes in sterile lily hybrids.

L21

Selection of *Lilium* Oriental Cultivar‘Red Guiyang’with Fusarium-resistance

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Abstract

A new *Lilium* oriental cultivar‘Red Guiyang’with a high degree of Fusarium-resistance, was obtained from selection in crosses of tetraploid and diploid genotypes followed by screening for Fusarium resistance in a greenhouse. Cytological study showed that the cultivar was diploid, the chromosome number was about 24. Ploidy identified with flow cytometry was also at the near diploid level. The new cultivar named Guiyang proved ot be a good cut flower. The flower color is red with white edge, the stigma colour is slightly green, the stem colour is green with purple spots.

L22

GISH investigation of crossover events during meiosis of interspecific hybrids of lily

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Abstract
Crossover not only establishes proper segregation of homologous/homoeologous chromosomes during meiosis I, but also promotes genetic diversity though creating new recombination of maternal and paternal alleles, which is essential for introgression breeding. In this paper, crossovers between non-sister chromatids were observed during meiosis of interspecific hybrids of *Lilium longiflorum* × Asiatic (LA) using genomic in situ hybridization (GISH). Results showed that different types of crossing over events, viz. single, two strand double, three strand double, four strand double crossovers, occurred between non-sister chromatids during meiosis of selected interspecific lily hybrids. From an analysis of a total of 637 pairs of half-bivalents it was evident that a large majority (65 %) was two strand single crossovers, 5.5 % were two strands double, 3.0 % three strand double, 9.3 % four strand double and 17.3 % were multiple crossing over events. In one specific genotype which showed the existence of a reciprocal translocation, the frequency of multiple crossovers was relatively high, which might alter the map distances of markers on the translocated chromosomes.

L23

Enhancing the heat tolerance of lily plants by Agrobacterium mediated transformation

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Abstract
The Oriental-trumpet OT hybrid lily "Belladonna", had been transformed with a *cod*A gene, from *Arthrobacter globiformis*, encoding for choline oxidase that stimulates Glycinebetaine (GB) synthesis by *Agrobacterium*. Thin cell layer (TCL) bulb scales were co-cultivated with *Agrobacterium tumefaciens* strain EHA101, harbored a binary vector pCAMBIA1301 carrying the hygromycin phosphotransferase, choline oxidase (Cod A) and intron-containing β-glucuronidase(GUS) encoding genes respectively. Some hygromycin-resistant (Hygr) cultured bulblets obtained from TCL bulb scales developed into plantlets in regulator-free growth medium. These plantlets were verified to be transgenic by GUS histo-chemical assay, revert transcription- PCR and GB detection analysis. In the i*n vitro* heat tolerance testings, the *cod*A-transgenic bulblets' scales induced new bulblets faster and at higher frequency than those of wild-type ones at high temperature.

L24

Aneuploidy in Lily Breeding

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Abstract
Unlike euploids which containing one or several whole chromosome sets, aneuploids can have chromosome numbers either greater or smaller than their euploids. Species of lilies are diploid (2n = 2*x* = 24). They are the source of modern lily cultivars. When you check chromosome numbers of commercial lily cultivars, you can also observe that many of them are triploid (2n = 3*x* = 36) or tetraploid (2n = 4*x* = 48). Numerous cases of lily hybridization show that it is not so difficult to obtain aneuploid lilies when you hybridize triploids with diploid/tetraploids, i.e., 3*x* x 2*x*/4*x*, though triploid lilies are usually male sterile. This is different from other polygonum-type plants in which 3*x* x 2*x*/4*x* crosses usually produce diploid or tetraploid. The reason for the difference is that endosperm of 3*x* x 2*x*/4*x* is euploid (7*x*/8*x*) in *Lilium* due to the Fritillaria-type embryo sac. The aneuploids could generate many variations in morphological and biological traits, and lily can be multiplied with tissue culture and scaling. Therefore, aneuploids can be a potential in lily breeding.

L25

Development, Selection and Propagation of Interspecific Hybrids of *Lilium*

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Abstract

In breeding programs of ornamental crops, interspecific hybridization is one of the most important way to introduce new genetic variation. The sexual barriers hampering interspecific hybridization have been distinguished into pre-fertilization and post-fertilization barriers. A breeding program on *Lilium* was carried out in Symplitaly project to overcome barriers of interspecific incompatibility and to originate hybrids with new ornamental traits (shape, size and colour of flower) and suitable to the Italian environment (tolerance to low temperatures and scarce light). Several crosses among Oriental hybrids, *L. longiflorum* OT hybrids, LA hybrids, Asiatic hybrids and wild species were made by using cut-style method. Ovary and ovule culture has been applied to overcome post-zygotic barriers. Fourteen days after pollination ovaries were cut and *in vitro* cultivated using two different substrates respectively with NAA 1 mg/L and IAA 0.5 mg/L. After 50-60 days more swollen ovules were taken out from ovary and cultivated on two substrates, with IBA 0.5 mg/L and NAA 0.1 mg/L, for 120-180 days. To confirm the hybrid origin of new bulblets, RAPD and SSR markers methods have been tested.

According the project, *in vitro* bulblet propagation of *Lilium* has been studied using an automated balloon type bubble bioreactor. In fact scaling-up in bioreactors and reduction in manual handling could provide an efficient and economic system for *in vitro* multiplication of bulb plants. Two different culture methods were compared: continuous immersion and temporary immersion in liquid medium (ebb and flood system). Results revealed that morphological traits and biomass accumulation were more efficient when culturing was performed under continuous immersion.

L26

Research advances on *Lilium lancifolium* Thunb. In China

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Abstract

L. lancifolium Thunb. (tiger lily*; L. tigrinum*) is widely distributed and extensively used in China. It has valuable characteristics such as cold tolerance, strong vigor, resistance to virus and *Fusarium*, which are attractive to lily breeders and growers. Some researchers obtained seeds from triploid *L. lancifolium*, commonly believed to be sterile. Comparison of karyotype between *L. leichtlinii var. maximowixaii* and *L. lancifolium* showed that the two species were not close relatives. Cytogenetical and morphological analysis revealed the genetic diversity lying among different wild population of *L. lancifolium*. In order to develop new hybrids between *L. lancifolium* and other crossing parents, crossed were made and embryo rescue techniques were adopted. Also a start was made with the development of molecular markers. An AFLP reaction system was established to assist breeding programmes. Propagation methods were also studied for further application of *L. lancifolium*. With all the advances and advantages of *L. lancifolium*, a new breeding object aiming at making greening lily hybrids with the ability of cold tolerance, *Fusarium* and virus resistance, self-propagation and land covering were proposed.

L27

The PVP Status of *Lilium* in China, The Netherlands and rest of the World

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Abstract
The Plant Breeders' Rights (PBR) applications for genus *Lilium* in the main countries as in The Netherlands, USA, New Zealand, and Chile, China reflect the development status with respect to breeding and innovation of the lily industry. In China, the Protection for New Variety of Plant (PVP) started from April 23, 1999 while China became the member state of UPOV, and the first lily PBR case was from Holland in 2002. Upon PBR application and granting of *Lilium*, we can evaluate the development of lily breeding and bulb production. The Netherlands is the leading country in the lily industry and dominate the lily breeding in the world, whereas China starts a new pursuit for lily but has a low developing status in lily breeding.Genetic diversity and structure of *Lilium pumilum* DC. In southeast of Qinghai-Tibet plateau

L28

Plant Regeneration and Cryopreservation of *Lilium*

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Abstract
Lilium is globally one of the most economically important ornamental crops used for flowers, medicine and food. Availability of efficient plant regeneration is necessary for micropropagation, genetic transformation, cryopreservation and production of virus-free plant material of *Lilium*. In this study, wide-spectrum protocols of plant regeneration via somatic embryogenesis from bulblet transverse thin cell layers (tTCLs) and via organogenesis from leaf segments were successfully established in *Lilium*. For somatic embryogenesis, 85.0, 75.3, 67.6, 27.8 and 25.0% of embryogenic callus induction frequencies (ECIFs) were obtained in five genotypes including *L. Longiflorum*, *L. longiflorum* × Oriental 'Triumphator', *L.* Oriental hybrid 'Siberia', *L.* Asiatic hybrid 'Elite' and *L. davidii* var. *unicolor*, respectively. For organogenesis, similarly high shoot regeneration frequencies (SRFs) at 92-100% and a high number (4.7-7.0) of shoots per segment were obtained in 6 genotypes including *L.* Oriental hybrid 'Siberia', *L. davidii* var. unicolor, *L.* × *formolongi*, *L.* Asiatic hybrids 'Elite' and 'Pollyanna' and *L. longiflorum* × Oriental 'Triumphator'. Shoot tips of adventitious shoots derived from leaf segments of these *Lilium* genotypes were cryopreserved by droplet-vitrification. Shoot regrowth and somatic embryogenesis could be obtained in cryopreserved shoot tips, depending on post-culture conditions. Assessments of genetic integrity in regenerants from somatic embryogenesis, organogenesis and cryopreserved shoot tips by ISSR revealed that they were genetically stable. Data reported here have potential applications to genetic transformation, cryopreservation and production of virus-free plant material of *Lilium* by cryotherapy.

L29

In vitro regeneration techniques for conservation of Shirui Lily (*Lilium mackliniae*)

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Abstract
Shirui lily (*Lilium mackliniae*), a rare endangered Asiatic lily species, hails from the Shirui peak of Siroi hill range in Ukhrul district of Manipur, India. This species was identified by Frank Kingdon-Ward in 1946 and was named in the honour of his wife Jean Kingdon Ward (nee Macklin) in 1949. Shirui lily has been declared as the "State Flower of Manipur" by the Government of Manipur, India since March, 1989. In the meanwhile, this rare species has already been recorded in the 'Red Data Book' of 'Indian Plants: Volume I' and is now at the verge of its extinction due to uncontrolled trampling and plucking by the human intrusions. Hence, there is an urgent need of scientific and policy interventions to save this beautiful endangered species through resource conservation. Micropropagation is an effective and efficient tool to conserve the rare species in a sustainable way. An attempt has been made in the present investigation to establish an efficient *in vitro* regeneration protocol in *L. mackliniae* for its conservation. The nodal explants, florets and leaves of *L. mackliniae* were cultured in Murashige and Skoog basal medium supplemented with various phytohormones. The media supplemented with either 0.5mg/l benzyladenine (BA) or 0.5mg/l BA along with 0.5mg/l napthalene acetic acid (NAA) resulted in multiple shoot proliferation. Rooting of *in vitro* plantlets was established in 1/2 MS containing 0.5mg/l NAA. The hydroponics containing Hoagland's solutions was found promising for hardening while compared with hydroponics containing MS and sucrose. *In vitro* cultured leaves and floret explants showed great ability to induce callus in MS medium containing different concentrations of 2,4-D supplemented with 0.2% gelrite. The callus growth was significantly higher at 2-3 mg/l 2,4-D and resulted in multiple shootlets. This worth mentioning report on *in vitro* regeneration of *L. mackliniae* will be helpful to prevent the perceived loss of biodiversity through mass propagation of the genetic resources of this rare endangered species.

L30

Induction of Embryogenic Callus and Floral Organ Organogenesis Derived from Callus of *Lilium* Oriental 'Sorbonne'

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Abstract

Floral explants of *Lilium* Oriental 'Sorbonne' produce embryogenic callus on a Murashige and Skoog (MS) medium with different concentrations of 2,4-dichlorophenoxyacetic (2,4-D) and 6-benzyladenine (BA). Nurse culture is used when inducing callus from filaments and regeneration ability of callus is examined.

Floral organ organogenesis is discovered in all the explants including style, petal, pedicel and filament (with anther) although at a low rate. Especially when it comes to filament, a relative complete flower forms after cultured for 120 days, of which floral organ organogenesis starts at the 70^{th} day. Adjustment of media formula and light conditions keeps the flower alive for 70 days before totally withering and producing regenerated plantlets. These results could be a supplement to studies on flowering of geophytes *in vitro.*

In terms of callus induction and plant regeneration for genetic improvement of lily, style and pedicel are found to give the highest frequency of callus induction rate of 96%-100%. The style gave the biggest callus cluster size after cultured for 4 months, which reaches a diameter of 9.81 mm. The pedicel showed the highest regeneration and proliferation rate of plantlets. These results indicate that pedicel and style may be an alternative or even a better choice compared to filament for inducing callus from floral organs. Anther and ovary development *in vitro* is also examined. Scanning electron microscope examination indicates that pollen grain is malformed and seeds are wizened.

L31

In vitro Selection for *Fusarium* Resistant Oriental Lily Mutants Using Culture Filtrate of the Fungal Agent

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Abstract
In this study, callus cultures derived from *in vitro* scales of Oriental lily 'Casa Blanca' susceptible to *Fusarium oxysporum* f. sp. Lilii were successfully used for in vitro selection for developing resistance to this pathogenic fungus. The suitable induction callus medium is a MS supplemented with a hormone combination of TDZ 0.05mg/L and Picloram 2mg/L. The callus was added to different concentrations of culture filtrate of *F. oxysporum* to determine appropriate culture filtrate concentration to be used for disease-resistant selection. And this stock is feasible as selective agent for screening for *F. oxysporum* wilt resistance. Resistant cell lines were selected by culturing calli on MS medium supplemented with growth regulators and containing 80% concentrations of culture filtrate of *F. oxysporum*. 7.0% calli regenerated shoots on MS medium supplemented with different concentrations of naphthalene acetic acid (NAA) and benzyladenine (BA). Morphologically, the selected regenerants could be grouped in two kinds of mutants. It is certificated the selected regenerants were mutated through measuring leaf length, leaf width, leaf index and chromosome analysis. The selected clones were moderate resistant to *Fusarium* bulb rot.

L32

Developments in the control of lily diseases

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Abstract
No crop is free of diseases, and this is true for both commercial lily bulb and flower production and garden/park plantings. Several threats are present that can influence lily growth, yield and ornamental value and the more we grow this crop the more we have to deal with diseases. For a widely-planted crop like the lily, research is done all over the world in regard to disease and disease control. In this paper a literature review is combined with up-to-date grower information. The main diseases are: viruses, for example: *lily symptomless virus* (LSV), *lily mottle virus* (LmoV) and *plantago asiatica mosaic virus* (PlAMV); fungal diseases like *Botrytis, Fusarium, Phytophtora, Pythium, Penicillium* and *Rhizoctonia solani*; root rot caused by nematodes (*Pratylenchus penetrans*); insects like aphids and the lily leaf beetles (*Lilioceris lilii*) and mites (*Rhizoglyphus robini*). Several other diseases and disorders can occur during propagation, storage and growing of lily bulbs. In this article the main diseases and disorders are discussed along with their control measures. Known and new knowledge or control measures of diseases and disorders are described. There is a trend toward control without the use of chemicals, e.g. optimisation of the hot water treatment, fostering soil life, stimulation of biodiversity in the field, and biological control. But also control strategies have become more practical such as growing virus free stocks and using decision support systems.

L33

Effectiveness of Reduced-risk and Biocontrol Products in Controlling Fire on Lilies

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Abstract
Fungicides are an important tool used in the management of *Botrytis elliptica* on lilies. During 2011, 2012 and 2013, trials were conducted to determine the effectiveness of several reduced-risk and biocontrol fungicides in controlling *B. elliptica* on field-grown 'Elite' or 'London' Asiatic hybrid lilies. A total of 13 fungicides and an untreated check were included in these trials. Fungicides included iprodione (Chipco 26019 N/G), chlorothalonil (Daconil Weather Stik), fluoxastrobin (Disarm 480 SC), fludioxonil (Medallion 50WP), cyprodinil + fludioxonil (Palladium 62.5WG), pyraclostrobin + boscalid (Pageant 38 WG), thyme oil (Proud 3), extract of *R*eynoutria *sachalinensis* (Regalia), tebuconazole (Torque 3.6SC), metconazole (Tourney 50WDG), triticonazole (Trinity 2SC), fenpyrazamine (V10135 SC), and hydrogen dioxide + peroxyacetic acid (ZeroTol 2.0). Treatments were applied on 7, 10, or 14 day intervals with a CO_2 sprayer equipped with an 8002 LP TEE-Jet nozzle at 1.1 kg/cm^2 in the equivalent of 935.4 liters of water/ha. Applications were made during a 2 to 3 month period during the growing season and the experimental design was a randomized complete block with each treatment applied to a 0.9 m long section of row in each of five blocks. Results from these trials indicated that three fungicides, pyraclostrobin + boscalid, fludioxonil, and cyprodinil + fludioxonil, consistently reduced disease development. Of these, pyraclostrobin + boscalid was the most effective. Applications of the other products included in the trials were ineffective or inconsistent in controlling *B. elliptica* on lilies.

L34

Screening and Characterization of Plant Growth-Promoting Rhizobacteria Containing ACC Deaminase from Lily Soil and Roots

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Abstract

h. aminocyclopropane-1-carboxylate (ACC) deaminase-containing plant growth-promoting rhizobacteria (PGPR) catalyses the conversion of ACC, the immediate precursor of ethylene in higher plants, into ammonia and α-ketobutyrate. Reduced levels of ACC reduces the synthesis of endogenous ethylene, which reduce the negative effects of ethylene. Five PGPR strains containing ACC deaminase were screened from lily soil and roots using ACC as the sole nitrogen source. On the basis of their growth, morphological and microscopic cell properties and 16S rDNA sequence analysis, the results showed that three strains were identified as *Erwinia* and one as *Chryseobacterium* among four strains from the soil and one from lily roots as *Acinetobacter*. Some differences in ACC deaminase activities among all isolated strains were found. It is suggested that ACC deaminase-containing PGPR strains existed not only in lily cultivated soil, but also in lily roots. It could be a cost-effective, environment-friendly and promising potential strategy to reduce flower bud abscission, promote stem elongation, improve quality and production in lily. It can alleviate biotic and abiotic stresses and ensure sustainable agriculture, especially for ethylene-sensitive flowers, fruits and crops.

L35

Construction of LmoV and CMV Binary Virus Resistant RNAi Vector and transformation into *Lilium*

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Abstract: The purpose of this research was to probe the possibility of producing transgenic *Lilium* for multi-viral resistance via RNA-interference (RNAi). 428 bp fragment of coat protein gene (*CP*) from *lily mottle virus* (LmoV) and 295 bp fragment of *2b* gene from *Cucumber mosaic virus* (CMV) were obtained from infected lily by RT-PCR, and then they were spliced into one fusion fragment by overlap PCR. The fusion fragment was inserted into both sides of intron of pFGC5941 in forwards and reverse way. The RNAi vector was introduced into *Agrobacterium tumefaciens* EHA105 bydirect transferring, and then the target fragment was introduced into *Lilium* Oriental 'Sorbonne' by sonication-assisted Agrobacterium-mediated transformation (SAAT). Transgenic plants obtained by tissue culture were confirmed by PCR. Twenty lily plants were obtained and confirmed by PCR. To further confirm the transgenic result, southern blot analysis and resistance assay of the transgenic plants will be done. The RNAi vector was constructed successfully, and it preliminarily proved that target fragment was introduced into the lily.

L36

Impacts of salt and low temperature stresses on lily (*Lilium* 'Oriental Hybrid' *var.* Siberia) photosynthesis incorporated with models

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Abstract

Salt and low temperature is stressful on cut flower production of lily especially in greenhouses with substrate cultivation in China. It would be helpful for growers to investigate the impacts of these two factors on lily photosynthesis, plant growth and quality of cut flowers, and quantify the relationships among them. In this paper, a simulative salt stress experiment was conducted using variety 'Siberia' in Gaolan county of China in 2011. There were three salt stress rates at 0.2%, 0.4% and 0.8% plus check 0% as four treatments applying to plants respectively in spring and autumn. The characteristics of photosynthesis, growth indexes and cut flower quality were measured to clarify the lilies' responses to salt stress. In addition, based on weather condition, observations at varying photosynthesis were investigated after low temperature stress respectively in sunny and cloudy day in Longde county of China in 2011. The results showed that photosynthetic light compensation point (LCP), light saturation point (LSP), net photosynthesis rate (Pn), stomatal conductance (Gs) and intercellular CO_2 concentration (Ci), were decreased by increased salt stress as well as for chlorophyll content, leaf area, plant height and dry biomass, especially decreased buds and increased bud abortion rate significantly in consequence of reducing cut flower quality. Furthermore, the research indicated that salt was more stressful on lily in early stage than in late stage (bud emerging). The relationship between net photosynthesis rate and temperature presented a quadratic curve model and Pn reached a peak value around 25℃. By continuous cloudy days, the temperature in greenhouses dropped companying with lower CO_2 concentration inside greenhouses than outside greenhouses further resulted in a low rate of photosynthesis. Accumulative effects hurt plant growth with a long time low temperature. Even after the temperature of greenhouse raised up with sunny days, the lilies were still at a low rate of photosynthesis. A simulative study by stress-off and stress-on showed that Pn had a close relationship with Gs, photosynthetic active radiation (PAR), Ci, leaf vapor pressure difference (VPD) and chlorophyll content. The model of photosynthesis coupling with Gs reflected a significant correlation (R^2=0.8677) established by those indexes.

L37

An Investigation of Fungal Pathogens Causing Wilt Disease on Lanzhou Lily (*Lilium davidii var. unicolor*)

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Abstract : An investigation was performed to access the pathogen causing serious wilt disease on Lanzhou lily in central region of Gansu province. Lanzhou lily planting fields from 12 main cultivation places in Lanzhou City and Linxia Prefecture have been investigated and sampled, from Nov 2012 to Aug 2013. Infected plants shown symptoms of brown curled and wilted leaves plus black spots on the leaves, and these symptoms became more serious from the top to the root on the plant. The diseased roots turned to dark brown, wilted and rotted. 5 morphologic different fungi isolates have been found on root and leaves respectively. ITS fragment sequencing and BLAST analysis shown isolates form roots are *Fusarium oxysporum* and *Penicillium verruculosum*, *Alternaria alternate* are from leaves, whereas *F. tricinctum* were isolated on both. All above isolates were tested for their pathogenicity on tissue culture seedlings of Lanzhou lily. Preliminary results shown *F. tricinctum* could cause wilt symptom on tissue culture seedlings. Further pot culture and field experiments for adult plant are expected to confirm the true pathogen for the wilt disease.

7. Abstracts of posters

P1

The resource center and germplasm databank of Taiwan native *Lilium*

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Taiwan is located at 121 degrees east longitude, north latitude 23.5 degrees, and has an area of 36,000 square kilometer. The island of Taiwan is surrounded by the sea and the highest point is Yu Shan (Jade Mountain) at 3,952 meters. There are five native *Lilium* in Taiwan: *Lilium formosanum* Wallace is endemic and widely spread from seacoast to mountain. *Lilium longiflorum* Thunb. *Var*. *scabrum* distributed in the east coast, northeastern coast and eastern parts of the island. *Lilium speciosum* Thunb. *Var*. *gloriosoides* Baker were found on rocky slope in mountain below 600 meters in northern Taiwan. *Lilium callosum* Siebold et Zucc. As extinct species and only found in two location in the western habitats in Taiwan during past 100 years. *Lilium brownii* F. E. Brown ex Miellez just located in Kinmen and Matsu islands near the Mainland China. The goal of this resource center and germplasm databank of Taiwan Native *Lilium* is to preserve, propagate and served as academic exchange platform of Taiwan native Lilium plants to researchers. Until now, 102 bulbs and 132 capsules with seeds were collected from native habitats and stored in the germplasm databank. In addition, 78 bulbs were propagated by scale cutting and 36 bulbs were micro propagated by scale culture *in vitro*. More academic exchanges and research studies will be held through this germplasm databank and knowledge about *Lilium* species could be enhanced in the future.

P2

Development of *in vitro* growth media of oriental hybrid lily bulblets on 'Siberia' and 'Sorbonne'

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Abstract
In this research, we tried to develop the *in vitro* growth media for thickening of bulblets on oriental lily hybrid cultivars. In past experiments, it was analyzed the amount of consumption about various components of MS media depending on *in vitro* culture periods. Two *in vitro* growth media were developed for 'Siberia' and 'Sorbonne', respectively. 16 modified culture media were tested and compared with MS media. Changing of pH and EC was analyzed. Remained positive and negative ions components in media were analyzed by ion-chromatograph after 30, 60, 90 and 120 days of *in vitro* culture periods, respectively. Various characteristics of growing bulblets were surveyed according to culture periods. On *in vitro* culture of 'Siberia', B-4 media was very excellent than MS media including 9% sucrose. The final bulb circumference in B-4 media was 4.07cm. That was more big 18.6%, compared to average circumference in MS media. Fresh bulb weight after in vitro culture was 1.18g. That was more heavy 63.9%, compared to average fresh weight in MS media. So, B-4 media were applied for a patent for fast growth media of *in vitro* culture on 'Siberia' cultivar. On *in vitro* culture of 'Sorbonne', D-4 media was very excellent than MS media. The final bulb circumference in D-4 media was 4.18cm. That was more big 17.4%, compared to average circumference in MS media. Fresh bulb weight after in vitro culture was 1.18g. That was more heavy 68.6%, compared to average fresh weight in MS media. So, D-4 media was applied for a patent for fast growth media of *in vitro* culture on 'Sorbonne' cultivar.

P3

Development of new upfacing *Lilium* cultivar for commercial production in Israel

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Abstract
Lily is one of the most important crops worldwide, with constantly increasing demand for new cultivars. Lilies from various genetic groups are important component in the flower assortment in Israel. Currently, Easter lily is grown on more than 35 hectares, and about 14 million stems are exported annually to Europe and in the domestic markets. Marketing period of the Easter lily for export from Israel lasts from December to April. In addition, market niche for the Israeli lily flowers exists from October to December. Common cultivars of Easter lily are characterized by down-facing flowers, and there is a great demand for up-facing flowers in the market.
Recent program for breeding of new lily varieties in Israel includes development of large assortment of *Lilium longiflorum* adapted to production in regions with warm climate, as well as *Lilium* x *formolongi* with up-facing flowers, suitable for the international and domestic markets.
Selection for up-facing genotypes was applied on seedlings of *L.* x *formolongi* since 2007. Four types of flower shapes were defined, with special attention on the number of flowers in the inflorescence, foliage arrangement, sensitivity to *Botrytis* and postharvest vase life. After five years of selection an excellent clone was chosen and registration process is currently under way.

P4

Registration of lily cultivars or cultivar groups

Donald Duncan

International Registrar for cultivated plants (including lilies)
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Abstract
Since 1958, the Royal Horticultural Society has acted on behalf of the International Society for Horticultural Science as International Cultivar Registration Authority for lilies (*Lilium* L.): see http://www.rhs.org.uk/Plants/Plant-science/Plant-registration/Lily. The registration scheme aims for uniformity, accuracy and stability in cultivated plant nomenclature, mainly by ensuring that new cultivar or Group names conform to the *International Code of Nomenclature for Cultivated Plants* and by seeking to minimize potential confusion caused by use of multiple epithets for the same plant or plant Group, re-use of epithets for different lilies, or poorly defined names. Although voluntary, the scheme is used by breeders across the world: currently some 150-200 new cultivars are registered each year. In recent years lily breeding has clearly begun to burgeon in the People's Republic of China, so presenting a poster at the 3rd International Lily Symposium in Zhangzhou would provide the International Lily Registrar with an invaluable and timely opportunity to explain the scheme to those currently unfamiliar with it and also to meet personally with some of the Chinese breeders who are already using it.

P5

Trait analysis of Lily F1 hybrids genetic variation

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Abstract

Lily is one of the world's major varieties of cut flowers, occupying an important role in international flower production. In this study, field statistics were done on Asiatic hybrid lily seedlings obtained through conventional cross-breeding, screening out seven new progeny varieties of special colors, in which F1 of Asiatic hybrid strains $A_6 \times A_5$ had more superior strains.

ISSR markers were conducted on seven Lily parents and 155 F1 hybrid materials. Seven polymorphic primers which could amplify clear band pattern were screened out from 99 primers. 254 DNA fragments were totally amplified. The size of those DNA fragments was from 100 to 2000bp, among which there were 171 polymorphic bands. The polymorphic rate was 67.32% with an average of 24.43 DNA fragments per primer. There was significant difference of amplified polymorphic loci which was from 0.33 to 0.85. Cluster analysis was acted on $A_3 \times A_4$, the results showed that genetic similarity coefficient between the 9^{th} and maternal plant was 0.7000, showing marked tendency to maternal genetic characteristics, and the remaining 19 plant tended to paternal relatives, the largest genetic similarity coefficient was 0.6666, the overall tendency was to the female parent first and to the male after. Genetic diversity, relevance and principal component analysis on 14 indicators of morphological shape were carried out on 89 F1 generation and their parents. The results suggested, differences in plant height, bulb circumference, leaf length, leaf width, inner perianth length, anther length, anther width, filament length, style length, bud number between F1 generation and parents were highly significant to 1% level; difference in corolla diameter between F1generation and female parent was significant to 5% level while male parent to 1% level; difference in inner perianth length between F1 generation and female was highly significant to 1% level while male parent to 5% level; there was not significant difference in outer tepal length and width between F1 generation and parent, showing larger heterosis generally.

P6

Postharvest evaluation of oriental Lily for extending the vase life.

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Abstract

Lily is one of the most fascinating bulbous crops grown all over the world for cut flower. A study was conducted to evaluate the postharvest of *Lilium longiflorum* L. in response to different holding and pulsing solutions for extending vase life. Freshly harvested cut stems were dipped in different concentration of Cobalt chloride, sucrose and 8-HQS for 24 hrs along with control (Distilled water). Results concluded that Cobalt Chloride ($5x\ 10^{-4}$ M) holding solution gave best results for relative fresh weight and vase solution uptake. While in pulsing maximum relative fresh weight were recorded in 500 mgL^{-1} 8-HQS and maximum vase uptake were recorded at 200 mg L^{-1} 8-HQS.

P7

Cytogenetic Analysis of Asiatic Lily Cultivars and Their Hybrids Using Fluorescence *In Situ* Hybridization

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Abstract
Two Asiatic lily cultivars ‘Golden Horn’, ‘Pollyanna’, and their six progenies were analyzed using fluorescence *in situ* hybridization (FISH) with 45S rDNA as probe. It was shown that five progenies were diploid (2n=2x=24), one progeny was triploid (2n=3x=36), We observed a total of 11 hybridization signals on chromosome No 1, 2, 3, 4, 7 and 11 in ‘Golden Horn’, 10 hybridization signals occurred on chromosome No 1, 2, 4, 6, 7 and 11 in ‘Pollyanna’. 45S rDNA loci were variable on chromosome No 3 and 6 of these two cultivars. Chromosome No 3 in ‘Golden Horn’ contained two 45S rDNA loci which were observed at the centromere and long arm, while 45S rDNA locus on chromosome No 6 in ‘Pollyanna’ was on the long arm. In addition, 45S rDNA loci on chromosome No 1 and 7 were located near the centromere, on chromosome No 2 the signals were near the secondary constriction and on chromosome No 4 and 11 were on the long arm. There were either 9 or 11 45S rDNA loci in the five diploid hybrids, and there were 15 loci in the triploid progeny. FISH detection of 45S rDNA clearly showed that all 45S rDNA signals in four progenies (GHP16, GHP142, GHP223, GHP245) were coming from ‘Golden Horn’ and ‘Pollyanna’, respectively.

P8

Variation in 45S rDNA sites in *L. hansonii*

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Abstract

The center of origin of genus *Lilium* is said to be in Korea and its adjacent country which is Manchuria. Korea has the most diverse and one of the major habitats of different *Lilium* species. There are about twelve (12) native lily species found in different mountainous areas in the country such as *L. hansonii*, *L. tsingtauense*, and *L. distichum* which belongs to section Martagon. *L. tigrinum*, *L. leichtlinii*, *L. concolor*, *L. callosum*, *L. amabile*, *L. cernuum*, *L. pumilum*, and *L. dauricum* belonging to Sinomartagon section and *L. formosanum* that includes in section Leucolirion. Among the different species, *L. hansonii* is the most primitive in the genus *Lilium.* This native species of *Lilium* is endemic to Korea wherein it naturally grows only in the mountains of Ulleung Island. It is located and distributed between 300 to 1,000m above sea level and grows under deciduous and evergreen trees. In terms of its morphological characteristics, the shape of the bulb is ovoid-globular or sub-globular and has a color of yellowish white. It develops many yellow flowers with brown spots in the tepals and with unfavorable odor. The basic chromosome number of *L. hansonii* is 2n = 2x =24. The detailed karyotype analysis of *L. hansonii* was constructed based on Fluorescence in situ Hybridization (FISH) using 5S rDNA and 45S rDNA probes. There were three types of 45S rDNA signal patterns observed such as 15, 16, and 17 signals. Paired 45S rDNA signals are commonly observed from chromosome #1, 2, 3, 4, 5, 10, and 11. Different number of 45S rDNA signal patterns was detected from chromosome #6 and 7. There were no signals observed in chromosome #6 and only one signal from chromosome #7 in first type(15 signals). In the case of second type (16 signals), there were no signals found in chromosome #6 but there were two signals in chromosome #7. On the other hand, in the third type (17 signals) one signal was detected from chromosome #6 and two from chromosome #7. This study will served as evolutionary evidence of section Martagon that is necessary for further researches using this species.

P9

Influence of Pre-shooting Temperature and Duration on Big Bulb Sizes for Enhancing Cut Flower Quality of *Lilium* Oriental Hybrid 'Siberia'

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Abstract

Recently summer production of oriental hybrid lilies for export has been increased in higher elevation land in Korea. However lily cultivation in high temperature season has problems such as short stems, reduced number of flower buds, and short inflorescence length. Optimum temperature is 10-12°C for all lily groups. But high soil temperature during growth phase of vernalized bulbs to flower initiation reduces plant height and leaf quality, and produces physiological flower bud blindness, because stem roots cannot develop well. Therefore bulb size for cut flower production during summer season of *Lilium* oriental hybrids needs lager than that of other seasons. The temperature and period of pre-plant holding with big bulbs before planting were studied in an effort to improve quality of 'Siberia' oriental hybrid lilies. Bulbs used in this experiment were harvested in November 2011, and stored at -1.0°C before treatment. Bulbs were placed in bottom of boxes with wet peat moss surrounding them and treated with three temperatures. Bulb circumference and weight used in this experiment were 16 cm(45-65g), 18 cm (70-88g), 20 cm (89-110g), 22 cm (113-139g), and 24 cm (155-170g). The bulbs held at 2°C for 7, 14 and 21 days, and then at 5°C for 7 days (6 June, 2012) and 14 days(13 June), and then at 12°C for 14 days (27 June) before planting (27 June) in Gangneung (a high land, 600m above sea level). When bulb circumference 18 cm held at 2°C for 0 days, 5°C for 7 days, and then 12°C for 14 days, bulb circumference 20 cm held at 2°C for 7 days, 5°C for 7 days and then 12°C for 14 days, bulb circumference 22 cm held at 2°C for 14 days, 5°C for 14 days and then 12°C for 14 days, and bulb circumference 24 cm held at 2°C for 14 days, 5°C for 7 days and then 12°C for 14 days before planting, the length and weight of harvested stems increased. And ratio of flower stalk was effective 25-27%, and the days to harvest was faster 10 days than control. The number of flower reduced about one flower, and physiological flower bud blindness was reduced by 0% as compared with controls.

P10

Breeding of Oriental Hybrid ‘Star Morning’ with Pink Color in Genus *Lilium*

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Abstract

Oriental lily ‘Star Morning’ was bred by crossing between oriental lily ‘Mediteranee’ characterized in pink color and oriental lily ‘Alma Ata’ characterized in white color for the purpose of getting new cultivar characterizing upright flower type, resistance against leaf scorch in 1999. It was first selected by seedling and bulb cultivation in 2007. It was conducted by 2^{nd}~3^{rd} selection, characteristics investigation and bulb production during 2008~2009, and carried out growing test as natural culture during 2010~2012.

The flower had pink color and no spot. The flower size was middle and the flower shape was upright type like umbrella. It was shown high dense planting adaptability because the leaf was short and wide. The flowering period was the first ten days of July as medium maturing cultivar. ‘Star Morning’ had green stem color, resistance against leaf scorch and leaf blight, and strength in bulb growth and propagation. There was no cultivating problem under appropriate ventilation, alimentation, water management and periodic disease and insect pest control (*leaf bright*, *aphid*).

P11

Comparison of transgenes stability in *Lilium longiflorum* plantlets following ten years of sub-culturing of transgenic and non-transgenic callus cultures

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Abstract
Sixteen years ago our lab initiated a project of genetic transformation of *Lilium longiflorum* by microprojectile-acceleration method in order to produce pollen-less flowers. Hundreds of transgenic plants were obtained and grown in a greenhouse. These plants contained the target gene *rol* B under the control of *lat* 52 promoter as well as the selective gene *npt*II, and a reporter GUS gene *uid*A both driven by the CaMV 35S promoter. Analysis of the crosses between transgenic and non-transgenic lily plants was performed with seven parental combinations. Due to regulations update, transgenic plants could no longer grow in the greenhouse, and were thus maintained in callus cultures established from bulb-scale segments of five of these parental plant lines. At the following years these transgenic lines retained kanamycin resistance and GUS specific reaction but did not sustain their regeneration potential. The presence of the transgenes: *npt*II, *rol* B and *uid*A in the cells was confirmed at the DNA and mRNA levels, using PCR and RT-PCR. This was true up to ten years of sub-culturing. Recently a protocol was developed to allow plantlet regeneration from all of these transgenic and two non-transgenic callus cultures. PCR and RT-PCR were performed to confirm the presence of the target genes in the callus culture lines, and regenerating plantlets. The advantages and pitfalls of this long-term storage approach for *L. longiflorum* are discussed.

P12

Induction of viable 2n pollen in sterile Oriental × Trumpet lily hybrids

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Abstract
In order to induce viable 2n pollen from highly sterile diploid OT (Oriental × Trumpet) lily hybrids, N_2O was used to treat flower buds of four diploid sterile OT cultivars (Nymph, Gluhwein, Yelloween, Shocking) at different meiotic stages. After N_2O treatment, two out of the four highly sterile OT hybrids (Nymph and Gluhwein) exhibited not only higher flower fertility percentage but also higher pollen germination. One genotype (Yelloween) exhibited high pollen germination but low flower fertility percentage. In all cases, flower fertility percentage and mean pollen germination were higher in the 48 hour treatment than that in the 24 hours treatment. In the case of 72 hours treatment, most flower buds or plants were damaged whereas undamaged flowers showed aberrant anthers at flowering time. It indicated that 48 hours N_2O treatment is optimal and 72 hours N_2O treatment is too long for lily. The results also showed that prophase I – metaphase I is the optimal meiotic stage for 2n pollen induction by N_2O treatment in lily hybrids.

P13

Lilium research and breeding in SEADC

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Abstract
Sino-Europe Agricultural Development Centre (SEADC) was founded in November, 2011, which was jointly advocated by Wageningen University & Research Center (WUR), International Association of Horticultural Producers (AIPH), and Sino-Europe Technological Promotion Center (SETPC). As a research centre, SEADC focuses on research, breeding and seed (bulb) production of ornamental and vegetable crops, introduces modern agricultural technology to improve the horticulture industry in Fujian Province. SEADC has established a firm cooperation with a few institute and universities, such as TNO the Netherlands, WUR, Fuzhou University, Fujian Agriculture and Forestry University, Fujian University of Traditional Chinese Medicine and so on. SEADC started lily research and breeding since 2012. Firstly, a few rare lily species native to China, as well as commercial cultivars, are collected and being protected both in tissue culture and greenhouse; secondly, a few attempts have been tried to transfer desirable traits to recipient cultivars, and cut-style pollination, embryo rescue and chromosome doubling techniques are used in the breeding process; thirdly, a few selections have been bred and 3 candidate cultivars are being tested by the Office for the Protection of New Varieties of Plants, MOA, P.R. China; Fourthly, bulb propagation both by in vivo and in vitro scaling is being done and bulblets are being planted in a few places with higher elevation, commercial bulbs are expected within 2-3 years.

P14

Establishment of a micropropagation protocol for *Lilium martagon*, an Italian protected species.

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Abstract
Lilium martagon is a wild species with high ornamental value that is widely spread in Europe and Asia but that become rare in Italy for the severe human collection and that is for this included in the list of total regional protection in Liguria and Piedmont. A protocol for seed germination was studied some years ago for seed bank germplasm ex situ conservation; the possibility to propagate in vitro the species increases the protection level and permitted to set up re-introduction programs.
Several seeds were sterilized with sodium hypochlorite and germinated in vitro onto agarised media evaluating the presence or absence of macro and microelements and the growth ability after germination with or without excision of cotyledons and roots. Some seedlings were cloned and a sufficient number of bulblets was produced in order to perform micropropagation experiments.
The trials considered the presence of several concentration of IBA, the environmental temperature, increasing concentration of sucrose in the medium and after 150 days intervals data about the weight increment, the diameter, the propagation rate and other morphological indicators were collected and evaluated. The plant material showed a slow growth with a scarce multiplication rate of axillary bulblets but they were morphologically complete and give rise to complete plants that were transferred to soil without acclimatization problems.

P15

Inheritance mode of bulb dormancy in F_1 progenies between *Lilium formosanum* and *Lilium longiflorum*

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Abstract
One-year-old seedlings of the northern *L. longiflorum* of the Ryukyu Archipelago populations have deep dormancy in summer, whereas those of the southern populations of *L. longiflorum* and *L. formosanum* show lack or reduction of dormancy. Dormancy status of the F_1 progenies of intraspecific hybrids among *L. longiflorum* with different degree of dormancy and interspecific hybrids between *L. formosanum* and *L. longiflorum* was studied under the same environmental conditions.
Three populations of *L. longiflorum*, Yakushima (LYA) and Kikai Jima (LKI) in the Ryukyu Archipelago, Japan and Pitouchiao (LPI), Taiwan and two populations of *L. formosanum*, Wulai (FW**U**), Taiwan and Fukuoka (FFU), Japan were used. The inter- and intra-specific cross hybridization started immediately after flowering. Flowers of female plants were emasculated 2 days before anthesis. Pollination was carried out 2 days after anthesis and mature capsules were harvested 2 months after pollination. The seeds of F_1 progenies were cultured in November 2010 and 2011 using cell tray in (16/8 h photoperiod, 70% humidity, 15°C) incubators till transplanting in the following May in the open field. Weekly leaf number of at least 10 individuals was measured for all populations.
Hybrids of FFU×FWU, FFU×LPI, and FWU×LPI cross combinations showed the highest growth rate among all F_1 progenies. Those cross combinations also showed higher growth rate compared with their parent, while other cross combinations had slower growth rates than those in the parents. Since FFU, FWU and LPI are categorized as non-dormant populations and LKI and LYA as northern most populations with deep dormancy, the bulb dormancy seems to be dominantly expressed in the F_1 progenies.

P16

Performance of Asiatic *Lilium* hybrids under hill zone of Karnataka

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Abstract

An experiment was carried out to evaluate the Asiatic lily hybrids for their suitability at the College of Horticulture, Mudigere, Chikamagalur district of Karnataka under hill zone which is characterized by annual average rainfall of 2477.30 mm with temperature range from 14-30^0 C. The station is located at 13.13^0 N to 75.63^0 E with an elevation of 915 MSL. The soil is red sandy loam with pH range of 4.8-6.0. The experiment consisted of 7 Asiatic lily hybrids *viz*., Levi (Pink and White), Turrondot (Orange), Gironde (Yellow), Navona (White), Pollyanna (yellow with variegated throat), Pavia (Yellow big size) and Tressor (Pink) grown under shade net conditions in Randomized block design replicated thrice. The bulbs were procured from private agency and planted during middle of October. Significant differences were observed among the hybrids for their growth and flowering. The height of plants differed significantly and maximum plant height was recorded in the hybrid Tresor (67.11cm) followed by Pavia (62.78cm) and the lowest plant height was recorded in Levi (48.00 cm). The number of leaves per plant was maximum in the hybrid Tresor (157.89) followed by Pollyanna (141.89). The leaf length was maximum in the hybrid Tresor (8.61 cm) which was followed by Pavia (8.38 cm) and while the hybrid Gironde recorded least leaf length (5.45 cm). Flowering parameters differed significantly among the hybrids. The maximum number of buds per plant was in the hybrid Gironde (6.08), while the bud length and bud diameter were maximum in Pavia (9.30cm and 9.41 cm, respectively) and on the other hand maximum bud girth (23.56 mm) was recorded in Turrondot and the maximum bud weight (40.29 g) was noticed in the hybrid Levi. The performance of Asiatic hybrid Tresor was significantly better over other hybrids under evaluation.

P17

Characteristics of OA hybrid lily acquired by using cut style pollination and ovule culture

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Abstract
Oriental lily varieties have dominated the worldwide flower market because of beautiful shape, strong fragrance, and big white and pink flower color. However, it is not diverse flower color and has long breeding generation and bulb production period. To reduce the strong fragrance and bulb production period, expand the flower color of Oriental lilies, it has been crossed Asiatic lilies. Among diverse OA crossing combination, the OA hybrid was only obtained between Oriental 'Casablanca' with white colored and Asiatic 'Sgl pepper' with red colored at RDA, in 2005. OA hybrid flowers have dark pink with small dark spots, weak fragrance, and upward-facing flower shape. Flower size and plant height of that is shorter than parents. Pollen is sterile. Ploidy level is diploid.

P18

Effect of cold treatments on carbohydrate spectrum changes and growth patterns in accessions of *Lilium ledebourii*'s bulbs

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Abstract
This research was conducted to understand sugar mobilization α-amylase enzyme activity and effective factors on germination, growth and percentage of flowering in *Lilium ledebourii*'s bulb, during vernalization period. Three accessions were collected from Rudbar, Kelardasht and Ardebil regions. The period of vernalization was 5 and 10 weeks and vernalization temperature was 3 and 9 °C. Bulb's Starch, glucose, fructose, sucrose, total sugar and α-amylase enzyme activity were measured in first, second, fourth, eighth and tenth weeks of vernalization. Results indicated carbohydrates and α-amylase enzyme conversions in 3°C and 10 weeks had the best output. Also, temperature and duration of vernalization didn't demonstrate substantial relation between growth rate and flowering percentage. Effective factors on flowering were type of accession and bulbs weight.

P19

Effect of post-harvest treatments of sucrose, 8 – HQ and Nanosilver on the physiological and biochemical changes of cut *Lilium* flowers during vase life period

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Abstract
An investigation was undertaken on the effect of certain preservatives *viz*., sucrose, 8 – HQ and Nanosilver on the physiological and biochemical changes of cut *Lilium* flowers during vase life period. The results of the investigation revealed that the use of these preservatives in combination is a must to improve the quality, flower opening and vase life. The application of sucrose, 8 – HQ and Nanosilver (NS) in the vase solution significantly reduced the number of microbial colonies with the passing of time, there by the water conductance through the xylem vessels increased. Among the treatments imposed the concentration of NS 75 ppm + 8 – HQ 150 ppm + sucrose 2 per cent proved as the best treatment by exhibiting less PLW (12.92 per cent), membrane integrity (17.30 per cent), POD (0.022, 0.025 and 0.03) and increase in the flower diameter (17.82 cm) , vase life (17.84 days) and number of opened flowers.

P20

Genetic diversity and structure of *Lilium pumilum* DC. In southeast of Qinghai-Tibet plateau

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Abstract:
Lilium pumilum DC., also called 'Coral lily', is a valuable species distributed in the Qinghai-Tibet plateau. The aim of this study was to investigate the genetic diversity and distribution pattern of *L. pumilum* populations in southeast region of Qinghai-Tibet plateau. To know the influence of eco-geographical factors and propose possible conservation measures. Interspecific simple sequence repeat (ISSR) markers were developed for 28 *L. pumilum* populations. Observed and expected heterozygosity (Nei's gene diversity) were calculated using Popgene. Genetic structure was inferred by Unweighted Pair Group Method for Arithmetic Averages (UPGMA) analysis as well as model based program STRUCTURE and principle coordinate analysis (PcoA). Analysis of molecular variance (AMOVA) was performed to validate the population structure and the influence of eco-geographical factors. Fifteen selected primers generated a total of 147 polymorphic bands. The genetic diversity was low within populations (average *He*=0.193), but much higher at the species level (*He*=0.3842). UPGMA analysis divided the populations into 4 groups. Both STRUCTURE and PcoA results supported the clustering of 4 genetic differentiated groups. Genetic differentiation among groups accounted for 34.3% of the total variance. High overall population differentiation (F_{ST}= 0.5182) indicated the populations are isolated. In accordance, there is no association between genetic and geographic distances. As the major eco-geographical factors, annual mean precipitation and mean temperature explained 14.0% and 11.5% of the total variance, respectively. Conclusions: *L. pumilum* shows a wide and fragmented distribution in Qinghai-Tibet plateau. Considering the low within-population and high species level of genetic diversity, it is recommended to first protect habitats and maintain the genetic diversity in each population.

P21

Lily Production and Breeding in the Northern Vietnam

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Abstract

In Vietnam, lily is one of the highest economic value flowers and ranked fourth place, just after Chrysanthemum, Rose and Gladiolus. In north of Vietnam, the lily production areas were about 3,1ha in 2007 and increased to 8,4ha in 2009 and reached 17ha in 2011. Every year, nearly all of lily bulbs for cut flower and potted plant production are imported from the Netherlands. The number of imported bulbs in 2007 was 544 million bulbs. In 2009 this number had increased to 1.5million bulbs and doubled to 3 million bulbs in 2011. Especially, in 2012, the number of imported lily bulbs rose to approximately 30 million bulbs. The lily cultivars were grown commonly such as Oriental-hybrids, Asiatic-hybrids, OT-hybrids and LA-hybrids. These hybrids was also used in breeding programs in order to creat some new lily varieties adapted for Vietnam's climate and environmental condition. We carried out the intraspecific crosses, for example Oriental 'Sorbonne x Siberia', *L.* X*formolongi* 'Raizan' x *L.longiflorum* Thunb. The interspecific crosses included OTO and OOT-hybrids, *L.* X*formolongi* 'Raizan' x *Lilium poinalei* Gagnepain. The cut-style pollination and embryo rescue technique was used to overcome pre-and post fertilization barriers. However, we only have lily hybrids through embryo rescue and evaluated these plantlets in greenhouses.

P22

Floral Scent Composition of *Lilium regale* Wilson

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Abstract
Flower scent is a crucial strategy that plants use to attract pollinators and ensure plant reproductive success. *Lilium regale* Wilson is endemic to the southern part of China, with funnelform and especially fragrant flowers. To determine the scent characteristics of *L. regale* flowers, volatile compounds were trapped on Tenax GR adsorbent and analyzed by gas chromatography-mass spectrometry (GC/MS) using a direct thermal desorption method. The results showed that monoterpenoids and benzenoids dominated the floral scent. The important volatiles (>5%) in nocturnal emission were 1,8-cineole, methyl benzoate, and α-pinene, with smaller amounts (1-5%) of limonene, sabinene, linalool, β-pinene, (*E*)-β-ocimene, and 2-phenylethyl acetate. Floral volatiles showed a nocturnal maximum emission pattern, with higher volatile levels emitted during the night.

P23

Development of Polymorphic Simple Sequence Repeats Markers in *L. regale* by Magnesphere

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Abstract: SSRs is one of molecular markers technology based on DNA length polymorphism and an efficient tool for population genetic studies and primary genetic linkage maps construction. The objective of this work is to seek SSR markers for *L. regale*. The AFLP fragments from *L. regale* Genomic DNA were concentrated by Magnesphere method, the SSR containing sequences were obtained, cloned into PMD-18T vectors and transformed into *E. coil*, two SSR-enriched libraries (AG and GT) were constructed. The Clone-PCR method was used to screen positive clones, 192, 48 clones were screened in AG and GT libraries respectively, 109 and 9 SSR-containing sequences were obtained, and the concentration rate of them were 56.8% and 16.7%. The result showed that the concentration rate of AG-enriched library is higher than GT-enriched library. After sequences analyzing, 42 pairs of SSR primers were designed successfully.

P24

Cytological Observations of Hybrid Progenies from OS x O and OT x O of Lilies

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Abstract
Using the methods of in vitro fertilization and embryo rescue, an interspecific lily hybrid was obtained from cross of Lilium Oriental 'Ruyi'(O) × L. sulphureum(S)(OS hybrids). Further crosses were made utilizing the OS lily × 'Siberia', OT lily 'Manissa' × 'Siberia'. Cytological observation of F1 hybrids produced from OS × OO showed that triploid plants were obtained and its chromosome number is 2n = 3x = 36, aneuploid plants were obtained and its chromosome number varied from 16-48 from OT × OO. However, chromosome number variations were also observed among the vegetatively propagated progenies of these triploid plants from OS×OO. Some plants reverted to diploid level during culture. In the majority of vegetatively propagated progenies from OS × OO and OT × OO, their mitosis were regular, but some abnormal phenomena, such as unequal division, chromosome bridges, lagging chromosomes, and multiple nuclei were observed. These abnormal phenomena during mitosis may be one of the mechanisms of producing chromosome number and structure variations among the vegetative descendants derived from the OS × OO and OT × OO. These results implied that the new type of germplasm can be created for breeding from OS × OO and OT × OO, even from the vegetative descendants derived from the OS × OO and OT × OO.

P25

Study on lily introgression breeding using allotriploids as maternal parents in interploid hybridizations

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Triploid is usually sterile because it has abnormal meiosis and mainly produces aneuploid gametes with wide range of chromosomes1. Based on hybidizations in Lily breeding, most triploid lilies can be used as female parents to cross with diploid or tetraploid ones while the triploids are completely male sterile. The reason for that is that *Lilium* have Fritillaria-type embryo sac. In this research, Triploid OT lily cultivars (OTO) as female parents were crosses with Oriental and Trumpet lilies , respectively. Cut style pollination, normal hand pollination and embyo rescue were used. Genomic in situ hybridization were used to analyze the progenies. The fruits and endosperm of OTO × OO apparently developed quite well, but those of OTO× TT develop poorly. Progenies of OTO × OO were aneuploid based by GISH. Genome composition of the endosperm of OTO × OO crosses are 5O+2T respectively by theoretical analysis.Based on the process of Fritillaria-embryo sac formation, the ploidy level of secondary nucleus is invariably twice as its smatic cell 4. *Lilium* have Fritillaria-embryo sac. So, the genome composition of endosperm of AA × AA, OTO × OO, LAA × AA, LAA × AAAA, LAA × LALA, AOA × AA, AOA × OAOA, and LLO × LLTT is 5A, 5O+2T, 5A+2L, 6A+2L, 5A+3L, 5A+2O, 5A+3O and 5L+2O+T respectively. As the endosperm of AA × AA, LL × LL, OO × OO, LAA × AA, LAA × AAAA and OTO ×OO may develop well and each has at least 5 same genomes. The present research confirmed the hypothesis “Five same genomes of endosperm is essential of its develpment in *Lilium*”.

P26

Effect of N_2O on flowering characteristics and anther Structure in *Formolongi*×Asiatic interspecific *Lilium* hybrids

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Abstract
Interspecific hybrids are useful for increasing genetic diversity within short evolutionary time scales and for increasing the levels of heterozygosity and hybrid vigor. However, interspecific hybrids obtained by remote interspecific crosses are mostly sterile. Nitrous oxide gas (N_2O) is used to induce zygotes polyploidized and 2n pollen to obtain fertile. Although several methods could be used to induce 2n pollen formation, such as treatment with N_2O, trifluralin, colchicine, and varying temperature, the advantage of using N_2O is that the plants are not damaged. In this study, the effects of N_2O on flowering characteristics and anther structure in *Lilium* interspecific hybrids were investigated. Two genotypes of *Formolongi* × Asiatic *Lilium* F1 hybrids (2n = 2x = 24) obtained from the National Institute of Horticultural & Herbal Science (Suwon, South Korea) were used in this study. F1 hybrids with flower bud sizes ranging from 15 mm to 20 mm were treated using 10% N_2O in a gas cylinder for 24 h. Flower abscission and anther degeneration occurred after N_2O treatment. In the N_2O treated flowers, the stamen lengths were short and the pollen sizes varied. No significant differences in flower sizes were observed between the control and N_2O treatments. At 1 week after N_2O treatment, N_2O treatment resulted in abnormal tapetum formation compared to the control. Moreover, parenchyma cell size of the anthers under N_2O treatment was larger than that under the control.

P27

In Vitro Conservation of Wild Lily

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Wild lily species (*Lilium* spp.) contain desirable traits, e.g. resistance to diseases, colour, fragrance etc., which served as essential sources for lily cultivars breeding. Growing lily bulbs in the field was adopted as the main way for wild lily germplasm conservation. However, lily is vulnerable to the inappropriate maintenance and the precious genetic resources will lost at last. Meanwhile, some species are in danger due to destruction of its natural habitats. Therefore, new approaches aiming to lily resources conservation need to be improved and explored. Conservation *in vitro* of five lily species, *L. lancifolium*, *L. leichtlinii* var. *maximowiczii*, *L. pumilum*, *L. duchartrei*, *L. concolor* var. *pulchellum* was developed in this study. After directly inducing the bulblets from the explants, all of the studied five lily species can be realized short-term preservation using subculture in basic MS medium at the normal condition (temperature is 23 ± 2 ℃ , illumination intensity is $40\mu mol \cdot m^{-2} \cdot s^{-1}$ and illumination duration is $14h \cdot d^{-1}$). At normal condition, *L. leichtlinii* var. *maximowiczii* plantlets grew slowly on the MS medium added with $90g \cdot l^{-1}$ sucrose and another $30g \cdot l^{-1}$ mannitol, and can be conserved at least 6 month without subculture. These conserved plantlets returned to normal growth in basic MS medium and induced bulblets in induction medium. For long-term cryopreservation by vitrification, *L. lancifolium* shoot-tips were cut from the *in vitro* bulbs, and treated with loading solution for 20 min. Then, the shoot-tips were immersed into the PVS_2 solution at 0 ℃ for 100 min. before plunging into liquid nitrogen. Followed by a rapid water bath, the shoot-tips were washed in unloading solution for 10 min. twice. *L. lancifolium* shoot-tips can recover in dark and regrow on the hormone-free medium.

This study was focussed on *in vitro* conservation of five wild lily species. All of the studied species can be *in vitro* conserved for short-term conservation by normal subculture, restrict-growth conservation for medium-term, and cryopreservation for long-term, and these technologies that were used will enable more lily species conservation *in vitro* in the future.

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Phenolic Property and Antioxidant Capacity of Bulb Extracts of several *Lilium* Species Native to China

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Abstract
Lily (*Lilium*) is an important ornamental plant for cut flower and pot plant industries worldwide. Because of the variation in colour, pattern and shape attracts many consumers, lily forms a flourishing commercial market. Compared with lily flower, its bulb is also an important organ, which is extensively used as food and traditional Chinese medicine for many centuries in China and eastern Asia. Bulbs of five wild *Lilium* species (*L. regale*, *L. concolor*, *L. pumilum*, *L. leucanthum*, and *L. lancifolium*), which are native to China, and an edible cultivar *L. davidii* var. *unicolor* were evaluated for phenolic composition and antioxidant capacity by using six assays, including DPPH free radical scavenging activity, ABTS radical scavenging capacity, cupric-reducing antioxidant capacity, metal chelating capacity, lipid peroxidation inhibition and hydroxyl radical scavenging activity. The results showed that the contents of total phenolics and antioxidant activities of the wild *Lilium* species were significantly higher than those of *L. davidii* var. *unicolor*. Furthermore, there was a significant dose-effect relationship between the contents of lily bulb extracts and their antioxidant activities. High-performance liquid chromatography (HPLC) analysis revealed that rutin and kaempferol were the major phenolic components, and the *p*-coumaric acid was the major phenolic acids in all bulb extracts tested. In addition, the phenolic compounds of bulbs from tested *Lilium* species exhibited a significant positive correlation with antioxidant capacity, and the positive correlation among these different methods was also identified. Comprehensive evaluation on antioxidant property of *Lilium* species revealed that the antioxidant quality of wild *Lilium* species bulbs were higher than *L. davidii* var. *unicolor*. These strongly suggest that wild lily bulb may serve as a potential source of natural antioxidant for food and pharmaceutical application.

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A Brief Introduction of Plant Quarantine for PFPs in China

Xiamen Entry & Exit Inspection and Quarantine Bureau (CIQ – Xiamen)

The presentation will introduce the plant quarantine system in China, which consists of the organizations, the Law and Regulations, and the quarantine procedures, and will focus on the quarantine of imported plants for planting (PFPs). AQSIQ as a ministerial department directly under the State Council, is the headquarters of 35 CIQ bureaus across 31 provinces in mainland China (except for Taiwan, Hong Kong and Macao), about 280 branches or offices, more 500 laboratories located in different ports and goods distributing centers.
As the member of WTO, a contracting party of IPPC and an official party of APPPC, China developed plant quarantine policies, methods and procedures in accordance with the SPS and TBT rules, as well as suggestions, guides and standards specified or recommended in IPPC. The policy, law and regulations of plant quarantine in China include the lists of Regulated Articles, Prohibited Articles, Quarantine Pest (for importing and exporting; Agricultural and Forestry), and Prohibited Articles carried by post or by passenger.
Import Permit (IP) of importing PFPs from MOA, SFA or AQSIQ is required. All the PFPs shall be imported through assigned ports since April, 2010. For no-assigned ports, it will be refused to accept the application. Upon arrival of PFPs, apply in advance (seven days prior to entry), with documentations such as Declaration form, IP, the phytosanitary certificate from original countries, and trade contracts etc. On-spots Quarantine, preventive disinfections, store under the supervision. Detection and identification at laboratory for the PFPs, specified in the list of QP, bilateral quarantine protocol, trade contracts or agreements. According to IP requirement, the imported PFPs would be isolated quarantine for 1 or 2 years (or growth cycles), survey and monitoring.
If QP(s) or any other pests considered as harmful through PRA, on the spot, or at lab, or during isolated quarantine, the imported PFPs shall be rejected, destructed (killing) and inactivated of harmful organism (by disinfections or fumigation).

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