## PROGRAM

### Sunday, 11 September

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:00</td>
<td>Registration and Poster set up</td>
</tr>
<tr>
<td>19:00-21:30</td>
<td>Welcome reception</td>
</tr>
</tbody>
</table>

### Monday, 12 September

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30</td>
<td>Registration</td>
</tr>
<tr>
<td>8:30-9:30</td>
<td>Opening Session</td>
</tr>
<tr>
<td>Chair: Sergio Lanteri</td>
<td></td>
</tr>
<tr>
<td>Lajos Helyes, Katalin Ertesy-Peregí</td>
<td>Welcome on behalf of the Hungarian Local Organizers</td>
</tr>
<tr>
<td>Jaime Prohens</td>
<td>Welcome by the EUCARPIA Representative</td>
</tr>
<tr>
<td>Véronique Lefebvre</td>
<td>Alain Palloix commemorative lecture</td>
</tr>
<tr>
<td>Miklós Fári</td>
<td>Szent-Györgyi Memorial Lecture</td>
</tr>
<tr>
<td>Father of vitamin C, Albert Szent-Györgyi (1893-1986) and his time. Science, creativity and society behind a Nobel Prize winner (1937)</td>
<td></td>
</tr>
<tr>
<td>9:30-10:45</td>
<td>Session 1 – Breeding Strategies</td>
</tr>
<tr>
<td>Chairs: Paul Bosland, Giuseppe L. Rotino</td>
<td></td>
</tr>
<tr>
<td>9:30-9:45</td>
<td>Jaime Prohens</td>
</tr>
<tr>
<td>Utilization of crop wild relatives in eggplant pre-breeding for adaptation to climate change</td>
<td></td>
</tr>
<tr>
<td>9:45-10:00</td>
<td>Gábor Palotás</td>
</tr>
</tbody>
</table>
| New hot interspecific hybrid variety between *Capsicum annuum* L. and *Capsicum chinense* Jacq,
10:00-10:15
Sanjeet Kumar
Male sterility research in peppers at AVRDC – The World Vegetable Center

10:15-10:30
Dario Danjevic
Sweet pepper breeding against bacterial spot (Xanthomonas euvesicatoria) in Serbia

10:30-10:45
Miklós Fári
What kind of root should a pepper plant have?

10:45-11:10
Coffee break and Poster viewing

11:10-11:55
Session 1—Breeding Strategies (ctd.)
Chairs: Paul Bosland, Giuseppe L. Rotino

11:10-11:25
Roeland E. Voorrips
Aphid resistance in a Capsicum collection

11:25-11:40
Pál Salamon
Symptoms caused by Tomato spotted wilt virus (TSWV) in Pepper (Capsicum spp.) and marker assisted selection of TSWV resistant pepper lines for hybrid constructions

11:40-11:55
István Tóbiás
Evergreen question: Whether Tobamoviruses are transmitted via pepper seeds or not?

12:00-12:45
Session 2—Growing and Seed Production
Chair: Zsuzsanna Füstös

12:00-12:15
Katalin Ertsey-Peregi
Sweet pepper (Capsicum annuum L.) growing on a basis of thermal water with respect of protection the natural environment

12:15-12:30
John Damicone
Biology and management of bacterial spot of pepper in Oklahoma, United States

12:30-12:45
András Kovács
Short evaluation of eggplant production and variety usage in Romania

12:45-14:30
Lunch

14:30-14:50
Gathering in the lobby for the technical visit

15:00-19:30
Technical visits
- Pepper and eggplant trials (ZKI)
- Pepper processing plant (UNIVER)
Open field trip

19:30-22:30
Traditional folklore dinner

Tuesday, 13 September

8:30-10:00
Session 3—Genetic Resources
Chairs: Jaime Prohens, Marie-Christine Daunay

8:30-8:45
Marie-Christine Daunay
Eggplant resistance to bacterial wilt and to Fusarium wilt: Is there a link?

8:45-9:00
Zsuzsanna Füstös
Study of morphological characteristics of eggplant (Solanum melongena L.) varieties

9:00-9:15
Claudio Dal Zovo
Wild Capsicum in the area of the Amboró National Park in Bolivia

9:15-9:30
John Samuels
Solanum insanum L. (Solanaceae): Linnaean species or introgressed hybrid?

9:30-9:45
Olga Babak
Development of DNA-markers to fruit quality genes of sweet pepper (Capsicum annuum L.)

9:45-10:00
Rosana Rodrigues
A breeding program for resistance to anthracnose in sweet and chili pepper

10:00-10:15
François Villeneuve
Screening of solanaceous wild relatives for graft affinity with eggplant (Solanum melongena L.)
<table>
<thead>
<tr>
<th>Time</th>
<th>Session 3 – Genetic Resources (ctd.)</th>
<th>Session 5 – Molecular Genetics and Biotechnologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:15-10:40</td>
<td>Coffee break and Poster viewing</td>
<td>Lunch and Poster viewing</td>
</tr>
<tr>
<td>10:40-11:40</td>
<td>Session 3 – Genetic Resources (ctd.)</td>
<td>Session 5 – Molecular Genetics and Biotechnologies</td>
</tr>
<tr>
<td></td>
<td>Chairs: Jaime Prohens, Marie-Christine Daunay</td>
<td>Chairs: Sergio Lanteri, Anikó Gémes Juhász</td>
</tr>
<tr>
<td>10:40-10:55</td>
<td>Awang Maharjaya</td>
<td>14:45-15:00</td>
</tr>
<tr>
<td></td>
<td>Antixenosis and antibiotics based resistance of chilli pepper to melon aphid</td>
<td>Ezio Portis</td>
</tr>
<tr>
<td>10:55-11:10</td>
<td>Orarat Mongkolporn</td>
<td>15:00-15:15</td>
</tr>
<tr>
<td></td>
<td>Genetic diversity of Thai native chilli using diversity arrays technology</td>
<td>Zoltán Kristóf</td>
</tr>
<tr>
<td>11:10-11:25</td>
<td>Lucie Tamisier</td>
<td>15:15-15:30</td>
</tr>
<tr>
<td></td>
<td>Quantitative trait loci in pepper genome control the effective population size of two RNA viruses at inoculation</td>
<td>Giuseppe L. Rotino</td>
</tr>
<tr>
<td>11:25-11:40</td>
<td>Helena Stavělíková</td>
<td>15:30-15:45</td>
</tr>
<tr>
<td></td>
<td>Germplasm of pepper (Capsicum annuum L.) in Czech Republic</td>
<td>Rodrigo A. VALVERDE</td>
</tr>
<tr>
<td>11:40-12:55</td>
<td>Session 4 – Physiology and Nutritional Value</td>
<td>Interactions between Bell pepper endornavirus, bell pepper, and acute plant viruses</td>
</tr>
<tr>
<td></td>
<td>Chair: Lajos Helyes</td>
<td>15:45-16:00</td>
</tr>
<tr>
<td>11:40-11:55</td>
<td>Zsuzsanna Füstös</td>
<td>Santiago Vilanova</td>
</tr>
<tr>
<td></td>
<td>The nutrition value and storage of eggplant (Solanum melongena L.) varieties</td>
<td>The transcriptomes of Solanum inçanum and S. aethiopicum provide information of relevance for common eggplant breeding</td>
</tr>
<tr>
<td>11:55-12:10</td>
<td>L. Kutalmis Kutsal</td>
<td>16:00-16:15</td>
</tr>
<tr>
<td></td>
<td>Effects of mychorriz on pepper plant growth parameters and nutrient uptake under salinity stress</td>
<td>Sylvia E. Salgon</td>
</tr>
<tr>
<td>12:10-12:25</td>
<td>Kietsuda Luengwilai</td>
<td>16:15-16:30</td>
</tr>
<tr>
<td></td>
<td>Does anthracnose resistance associate with cuticle characteristics and spore attachament?</td>
<td>Yoshiyuki Tanaka</td>
</tr>
<tr>
<td>12:25-12:40</td>
<td>Ozlem Altuntas</td>
<td>Multiple mutated putative aminotransferase alleles contribute to low pungency and capsinoid biosynthesis in Capsicum chinense</td>
</tr>
<tr>
<td>12:40-12:55</td>
<td>Lajos Helyes</td>
<td>16:30-16:50</td>
</tr>
<tr>
<td></td>
<td>Correlation between carotenoid components of chilli pepper fruits and VIS/NIR reflectance</td>
<td>Coffee break</td>
</tr>
<tr>
<td>13:00-14:45</td>
<td>Lunch and Poster viewing</td>
<td>16:50-19:30</td>
</tr>
<tr>
<td>14:45-16:15</td>
<td>Session 5 – Molecular Genetics and Biotechnologies</td>
<td>Optional cultural program</td>
</tr>
<tr>
<td></td>
<td>Chairs: Sergio Lanteri, Anikó Gémes Juhász</td>
<td>Gala dinner</td>
</tr>
</tbody>
</table>
Wednesday, 14 September

8:30-10:30 Poster session
Chair: Katalin Ertsey-Peregi

10:30-10:45 Coffee break

10:45-11:45 Session 5 – Molecular Genetics and Biotechnologies (ctd.)
Chairs: Sergio Lanteri, Anikó Gémes Juhász

10:45-11:00 Laura Toppino
QTLs mapping for *Fusarium oxysporum* and *Verticillium dahliae* resistance in eggplant (*Solanum melongena* L.)*
germplasm

11:00-11:15 Pasquale Tripodi
Genotyping by sequencing for population structure and genome-wide association analysis for fruit shape and size in pepper (*C. annuum* L.)*
germplasm

11:15-11:30 Jana Leide
Cutun deficiency of bell pepper (*Capsicum annuum* L.) results in gluey berries

11:30-11:45 Hatira Taskin
Comparison of pepper genotypes originated from Turkey and the other countries for anther culture response

11:45-12:15 Conclusion and closing

12:15-14:00 Lunch

14:30- Optional post-conference tours

---

**LIST OF POSTERS**

**Session 1 – Breeding Strategies**

<table>
<thead>
<tr>
<th>Poster number</th>
<th>Presenting author</th>
<th>Title of poster</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1-01</td>
<td>András Andrásfalvy</td>
<td>István Túri – The innovative pepper breeder</td>
</tr>
<tr>
<td>P1-02</td>
<td>Andrea Moór</td>
<td>Lambert Angeli, pioneering breeder of the first white, sweet variety of bell pepper was born a hundred years ago</td>
</tr>
<tr>
<td>P1-03</td>
<td>Zoltán Timár</td>
<td>The life and work of a paprika breeder Ferenc Márkus</td>
</tr>
<tr>
<td>P1-04</td>
<td>Saadet Bıyıkkalaca</td>
<td>Investigation of obtaining fertile <em>S. melongena × S. torvum</em> hybrid populations</td>
</tr>
<tr>
<td>P1-05</td>
<td>Ros Caridad</td>
<td>Could quantitative resistance increase the durability of major genes conferring nematode resistance in pepper?</td>
</tr>
<tr>
<td>P1-06</td>
<td>Dilek Kandemir</td>
<td>Determination of reaction of <em>Solanum aethiопium</em> and <em>Solanum incaum</em> genotypes against <em>Fusarium oxysporum f. sp. melongene</em></td>
</tr>
<tr>
<td>P1-07</td>
<td>Gábor Palotás</td>
<td>20 years of non-hypersensitive, non-specific, recessive resistance in pepper – review</td>
</tr>
<tr>
<td>P1-08</td>
<td>Mariola Plazas</td>
<td>Screening for drought tolerance in eggplant relatives and interspecific hybrids</td>
</tr>
<tr>
<td>P1-09</td>
<td>Claudia Ribeiro</td>
<td>Breeding Calabrian pepper lines (<em>Capsicum annuum</em> L.) for Brazilian agriculture from <em>sui generis</em> introduction of germplasm</td>
</tr>
<tr>
<td>P1-10</td>
<td>Claudia Ribeiro</td>
<td>Synthesis of a base population of Habanero chile pepper and initial assessment of derived F1 lines (<em>Capsicum chinense</em>)</td>
</tr>
<tr>
<td>P1-11</td>
<td>Attila Rózsás</td>
<td>Conservation, landscape and home garden varieties in South part of Hungary</td>
</tr>
<tr>
<td>P1-12</td>
<td>Zsolt Sági</td>
<td>Higher quality traits – breeding strategies in pepper</td>
</tr>
<tr>
<td>P1-13</td>
<td>Csaba Sebesi</td>
<td>High quality apple peppers for the canning industry</td>
</tr>
<tr>
<td>P1-14</td>
<td>Olga Timina</td>
<td>Breeding use of <em>Capsicum annuum</em> L. mutant gene pool</td>
</tr>
<tr>
<td>P1-15</td>
<td>Péter Varró</td>
<td>Breeding of a high yielding white waxy hibriz XKI 113485 for the Mediterranean region</td>
</tr>
<tr>
<td>P1-16</td>
<td>Lajos Zatykó</td>
<td>The role of general and specific combining abilities in pepper hybrid breeding</td>
</tr>
</tbody>
</table>
P4-08
5,5'-dicapsiate: Product of the oxidation of capsiate by cationic peroxidases from pepper (Capsicum annuum L.)
Alberto Lema, Teresa Martínez-Cortés, Ana Garces, Cristina Mallor, Oreto Fayos, Gerardo F. Barbero, Cristina Silvar, Federico Pomar

P4-09
Phenylpropanoid biosynthesis and regulation in Solanum melongena cv. "Lunga Napoletana"

P4-10
Exogenous 6-benzylaminopurine application protects eggplant seedling against low temperature-induced oxidative stress
Xuezia Wu, Lian Yong

SESSION 5
Molecular genetics and biotechnology

P5-01
Identification of Capsicum pentatricopeptide repeats via in-silico analysis provides insights into fertility restoration
Derek W. Barchenger, Joseph I. Said, Franchesca A. Ortega, Paul W. Bosland

P5-02
Fine mapping of the Me7 gene controlling resistance to Root-Knot Nematode (Meloidogyne incognita) in chili pepper
Amorrrat Changkwian, Ji-Woong Han, Joung-Ho Lee, Gyung-Ja Choi and Byoung-Cheol Kang

P5-03
Plant genetic background increasing the efficiency and durability of major resistance genes to root knot nematodes can be resolved into a few resistance QTLs
A. Barbary, C. Dijian-Caporalino, P. Castagnone-Sereno, N. Marteu, A. Fazari, B. Caromel, A. Palloix

P5-04
Highly efficient genome doubling method for haploid paprika (Capsicum annuum L.) plants
Aniko Gémesné Juhász, Zoltán Krisóf

P5-05
Isolation and characterization of pepper genes involved in CMV-P1 infection
Yeaseong Ha, Joung-Ho Lee, Yoomi Choi, Min-Young Kang, JeeNa Hwang, Won-Hee Kang, Jin-Kyung Kwon and Byoung-Cheol Kang

P5-06
Genetic mapping of the Powdery Mildew Resistance (PMRI) gene in pepper (Capsicum annuum L.)
Jinkwan Jo, Wonhee Kang, Gyung JaChoi, Jin-Kyung Kwon and Byoung-Cheol Kang
P5-05

Isolation and characterization of pepper genes involved in CMV-P1 infection

Yeasong Ha, Joung-Ho Lee, Yoomi Choi, Min-Young Kang, JeeNa Hwang, Won-Hee Kang, Jin-Kyung Kwon and Byoung-Cheol Kang

Department of Plant Science, Plant Genomics and Breeding Institute and Vegetable Breeding Research Center, College of Agriculture and Life Sciences, Seoul National University, Seoul, Republic of Korea

Abstract

*Capsicum annuum* 'Bukang' is a resistant variety to *Cucumber mosaic virus* isolate-P0 (CMV-P0). CMV-P1 can overcome the CMV resistance of 'Bukang' due to mutations in Helicase (Hel) domain of CMV RNA1. To identify host factors involved in CMV-P1 infection, a yeast two-hybrid system derived from *C. annuum* 'Bukang' cDNA library was used. A total of 156 potential clones interacting with the CMV-P1 RNA helicase domain were isolated. These clones were confirmed by β-galactosidase filter lift assay, PCR screening and sequence analysis. Then, we narrowed the ten candidate host genes which are related to virus infection, replication or virus movement. To elucidate functions of these candidate genes, each gene was silenced by virus induced gene silencing in *Nicotiana benthamiana*. The silenced plants were then inoculated with green fluorescent protein (GFP) tagged CMV-P1. Virus accumulations in silenced plants were assessed by monitoring GFP fluorescence and enzyme-linked immunosorbent assay (ELISA). Among ten genes, silencing of *formate dehydrogenase* (FDH) or *calreticulin-3* (CRT3) resulted in weak GFP signals of CMV-P1 in the inoculated or upper leaves. These results suggested that FDH and CRT3 are essential for CMV infection in plants. The importance of FDH and CRT3 in CMV-P1 accumulation was also validated by the accumulation level of CMV coat protein confirmed by ELISA.

Altogether, these results demonstrate that FDH and CRT3 are required for CMV-P1 infection in plants.

**Keywords:** *Capsicum annuum, Cucumber mosaic virus, host factor, virus resistance, formate dehydrogenase, calreticulin-3*
ISOLATION AND CHARACTERIZATION OF PEPPER GENES INVOLVED IN CMV-P1 INFECTION

Yeasong Ha1, Jong-Hoe Lee1, Yoomi Choi1, Min-Young Kang1, JeeNa Hwang1, Won-Hee Kang1, Jin-Kyung Kwon1 and Byoung-Cheol Kang2

1Department of Plant Science, Plant Genomics and Breeding Institute, and Vegetable Breeding Research Center, College of Agriculture and Life Sciences, Seoul National University, Seoul 151-921, Republic of Korea

ABSTRACT

Capsicum annuum ‘Bukang’ is a resistant variety to Cucumber mosaic virus isolate P-1 (CMV-P1). CMV-P1 can overcome the virus resistance of ‘Bukang’ due to mutations in Helicase (H) domain of CMV-P1. To identify host proteins involved in CMV-P1 infection, yeast two-hybrid system was employed to interact with CMV-P1 RNA1 helicase domain. The potential interacting proteins were isolated and analyzed by Real-Time PCR and CMV-P1 infection test.

INTRODUCTION

Viruses are intimately associated with and completely dependent on their host, and interaction with host requires for infection cycles. Mutations in host factors may abolish the infection (Whitman et al., 2004). For this reason, host factors have been studied in various plants and viruses. For example, TpIGL which interacts with the CMV la and la2 controls CMV multiplication in tobacco plants (Bhat et al., 2001). And NTL7 which directly interacts with CMV la protein plays an important role in the regulation of CMV replication and/or movement (Kan et al., 2001). The CMV has the broadest host range among plant viruses. One of the CMV resistance sources C. annuum ‘Bukang’, which is resistant to CMV-P1 (CMV-Kor and CMV-Fey). C. annuum ‘Bukang’ contains a single dominant resistance gene, Cm1 (Kang et al., 2010) which suppresses the systemic infection of CMV-P1 strain. Recently, a new strain CMV-P1 breaking the Cm1 resistance was isolated in South Korea.

To identify which RNA gene is involved in breaking the Cm1, chromatic CMV viruses were constructed by combining CMV-P1, Cm1-P1 and Cm1-P1 CMV genes (Kang et al., 2011). 224 new CMV-P1 RNA1 helicase domain has been implicated to play a role in viral replication and systemic infection (Kang et al., 2011).

In this study, we tried to identify host genes that interact with CMV-P1 helicase domain using a yeast two-hybrid system. To validate requirement of selected host genes in CMV-P1 infection, selected genes were silenced using VHS and silenced plants were challenged with CMV-P1 harboring the green fluorescent protein (GFP). Late virus accumulation in silenced plants was assessed by measuring GFP fluorescence and anyone-linked clone was identified (ELISA). Through these steps it was revealed that formate dehydrogenase and calreticulin-3 precursor are essential host genes required for CMV-P1 infection.

OBJECTIVES

To isolate and characterize host factors interacting with CMV-P1 RNA1 helicase domain from C. annuum ‘Bukang’

To identify of CMV-P1 infection mechanism in C. annuum ‘Bukang’

To engineer of CMV resistance using the host factors

MATERIALS & METHODS

Yeast two-hybrid screening

Primer was designed based on CMV-P1 RNA1 helicase domain sequence. To construct the bait vector, CMV-P1 RNA1 helicase domain was amplified using the primer (Table 1), and inserted into pBD-GAL4 vector (Agilent Technologies, Santa Clara, CA, USA) as a bait. The bait vector (pBD-GAL4 CMV-P1 was transfected into yeast strain Y2H (Martinez-Bueno et al., 2005) which contains the bait vector (pBD-GAL4 CMV-P1) was co-transfected with pAD-GAL4 vector (Agilent Technologies, Santa Clara, CA, USA) as a prey vector. Yeast were grown on SD/-LIA plates containing 1mg/mL 5-bromo-4-chloro-3-indolyl-β-D-galactoside filter lift assay. The color of 82 candidate clones was changed to blue (Table 1).

To identify the infection aspect of CMV-P1, they were inoculated in N. benthamiana. Phytoene desaturase (PDS)-silenced plants were used as a silencing control. As expected, the silencing of PDS resulted in photo-blaclking at 10 to 12 dpi. To check the level of silencing, red fluorescence signal was reconstructed in silencing leaves. For this, leaf discs were collected at 10 to 12 dpi and observed under confocal laser scanning microscope (CLSM). When plants were infected with CMV-P1, fluorescence signal was attenuated in silenced leaves but was not changed in control leaves.

To identify the infection aspect of CMV-P1, they were inoculated in N. benthamiana. Phytoene desaturase (PDS)-silenced plants were used as a silencing control. As expected, the silencing of PDS resulted in photo-blaclking at 10 to 12 dpi. To check the level of silencing, red fluorescence signal was reconstructed in silencing leaves. For this, leaf discs were collected at 10 to 12 dpi and observed under confocal laser scanning microscope (CLSM). When plants were infected with CMV-P1, fluorescence signal was attenuated in silenced leaves but was not changed in control leaves.

Isolation of candidate genes

Candidate genes were isolated by colony PCR for 82 candidate clones. 80 candidate genes were amplified, and were used for sequence analysis. Then, we narrowed the ten candidate genes which are related to virus infection, replication or transcription. To visualize functions of these candidate genes, each gene was silenced by virus induced gene silencing in N. benthamiana. The silenced plants were challenged with CMV-P1, and their viability and anyone-linked clone was identified (ELISA).

Table 1. Summary of screening host genes interacting with the CMV-P1 helicase domain

Table 2. List of candidate genes interacting with the CMV-P1 helicase domain

REFERENCE


ACKNOWLEDGEMENT

This research was supported by Golden Seed Project (2130834-04-C0008), Ministry of Agriculture, Food and Rural Affairs (MAFRA), Ministry of Ocean and Fisheries (MOF), Rural Development Administration (RDA) and Korea Forest Service (KFS), Republic of Korea.