Hungary-Serbia
IPA Cross-border Co-operation Programme

HUSBR/1203/221/173 „PLANTTRAIN“

Joint development of higher education and training programmes in plant biology in support of knowledge-based society

CLOSING CONFERENCE

23-24 May, 2016, Novi Sad, Serbia

BOOK OF ABSTRACTS

The project is co-financed by the European Union

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Closing Conference
of the Hungary-Serbia IPA Cross-border Co-operation Programme

“Joint development of higher education and training programmes in plant biology in support of knowledge-based society”
(PLANTTRAIN, ID: HUSBR/1203/221/173)

23-24 May, 2016, Novi Sad, Serbia
Faculty of Agriculture
Trg Dositeja Obradovića 8
21000 Novi Sad,Serbia

Monday, 23 May, 2016

13^{00}-16^{45}: Overview of the scientific results achieved in the exchange program PLANTTRAIN: preparation of a manuscripts based on the scientific results of Serbian and Hungarian PhD students.

16^{45}-17^{15}: **Coffee break**

17^{15}-18^{45}: **Project teem meeting**
Faculty of Agriculture, University of Novi Sad

19^{00}: **Dinner**

Tuesday, 24 May, 2016

9^{00}-9^{30}: **Registration**

9^{30}-9^{45}: **Opening of the Conference, Welcome speech**
Dr. Branko Ćupina
Vice Dean for Science and International Cooperation
Faculty of Agriculture, University of Novi Sad

9^{45}-10^{00}: **Achievements of the Serbian partner**
Dr. Dubravka Štajner
Hungary-Serbia IPA Cross-border Co-operation Programme – “PLANTTRAIN”
Faculty of Agriculture – University of Novi Sad

Chairmans: **Dr. Dubravka Štajner and Dr. Djordje Malenčić**
Faculty of Agriculture – University of Novi Sad

10^{00}-10^{15}: **Dr. Jolán Csiszár,** Zsigmond L, Horváth E, Hurton Á, Bela K, Rigó G, Szabados L
Introduction of AtPPR40 gene into tomato using *Agrobacterium* transformation system

10^{15}-10^{30}: **Krisztina Bela**, Horváth E, Hurton Á, Riyazuddin, Csiszár J
Studies on *Arabidopsis thaliana* glutathione peroxidases

10^{30}-10^{45}: **Dr. Edit Horváth**, Bela K, Ködmön P, Csomor G, Papdi C, Szabados L, Csiszár J
Role of *Arabidopsis thaliana* glutathione transferases in salt- and osmotic stress responses

10^{45}-11^{00}: **Dr. Aleksandra Mišan**
Cereal based products for people diagnosed with metabolic disorder

11^{00}-11^{15}: **Dr. Jovana Šućur,** Gvozdenac S, Anačkov G, Malenčić Đ, Prvulović D
Allelopathic effects of *C. menthifolium* and *S. sclarea* aqueous extracts

11^{15}-11^{45}: **Coffee break**

Chairmans: **Dr. Irma Tari and Dr. Jolán Csiszár**
Department of Plant Biology, University of Szeged

11^{45}-12^{00}: **Dr. Djordje Malenčić**
Phytochemical constituents of *Salvia* species native to South Panonnia

12^{00}-12^{15}: **MSc. Ružica Ždero Pavlović**, Popović B, Štajner D, Blagojević B, Tumbas Šaponjac V
Osmotic stress and phenolic content in young poplar plants

12^{15}-12^{30}: **MSc. Bojana Blagojević**, Popović B, Štajner D, Ždero Pavlović R
Antioxidant capacity of different apricot cultivars

12^{30}-12^{45}: **Dr. Peter Poór**, Kovács J, Szepesi Á, Borbély P, Patyi G, Tari I
Salt stress-induced oxidative stress in ethylene signaling mutant, Never ripe tomato

12^{45}-13^{00}: **MSc. Zoltán Takács**, Czékus Z, Poór P, Borbély P, Tari I
Effect of light on the salicylic-induced oxidative stress in tomato

13^{00}-13^{15}: **Summary**
Dr. Irma Tari and members of Faculty of Agriculture, UNS and Department of Plant Biology, US
Hungary-Serbia IPA Cross-border Co-operation Programme – “PLANTTRAIN”
Department of Plant Biology, University of Szeged

13^{15} **Lunch**

15^{00}-17^{00}: Visit of the phytochemical laboratories at the Faculty of Agriculture: demonstrations of the new laboratorys equippment obtained by IPA financing programs.

17^{00}-19^{00} Walk around the City center

Abstracts of Closing Conference

Dr. Dubravka Štajner

ACHIEVEMENTS OF THE SERBIAN PARTNER

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Mutual work in the frame of the project - Joint development of higher education and training programs in plant biology in support of knowledge based society- PLANTTRAIN- was successful because both sides Hungarian and Serbian collaborated in overcoming difficulties which appeared during the processes of project planning, preparation and implementation. Fortunately we succeeded to overcome all obstacles, and therefore we are here to summarize our experiences and results in the fields of plant biology and biochemistry teaching and investigations. We also believe that project PLANTTRAIN is the new beginning in the development of higher education training programs which could be a solid base for creating a modern approach to plant biology, chemistry and biochemistry studies and teaching. Our task was to bring the new common knowledge's in training programs and educational systems of Department of Plant Biology, Joszef Atilla University of Szeged and Faculty of Agriculture, University of Novi Sad. All activities conducted during the project were devoted to create a new approach to plant biology, chemistry and biochemistry studies, teaching programs and investigations. Our task was also to enable mobility of students from both Universities by creating new educational possibility in the form of trilingual teaching program.

The main achievements obtained by Serbian partner in collaboration with Hungarian partners were fulfilled successfully and are:

1. Participation at the Opening Conference, Szeged 20-12 April 2015.
2. Organizing the seminar and workshops -Antioxidants and oxidative stress in plants- Novi Sad 23-27 May, 2016.
3. Participation at the Seminar and Workshops– Abiotic stress responses of higher plants- Szeged 31.08.-04.09.2015.
4. Student exchange in Szeged and Novi Sad, in September and December 2015.
6. Participation in preparation of trilingual curriculum.
7. Foundation of the Phytochemical Laboratory at the Faculty of Agriculture in Novi Sad.
8. Organizing the Closing Conference, Novi Sad 33-24 May 2016.

Project PLANTTRAIN was the part of Hungary-Serbia IPA Cross-border CO-operation Program funded by EU. We are grateful for moral and financial support obtained from European Union which was of crucial importance for our objectives achievement. Also, we are grateful to our leading partner for unconditional collegiality, collaboration and friendship.

Dr. Jolán Csiszár, Edit Horváth, Ágnes Hurton, Krisztina Bela, Györgyi Mándity, Judit Derdák, Gábor Rigó, Laura Zsigmond

INTRODUCTION OF *AtPPR40* GENE INTO TOMATO USING *AGROBACTERIUM* TRANSFORMATION SYSTEM

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The *Arabidopsis thaliana* mitochondrial pentatricopeptide repeat 40 (PPR40) protein was suggested to represent a signaling link between mitochondrial electron transport and regulation of stress and hormonal responses. Inactivating the *PPR40* gene resulted in enhanced sensitivity to salt, abscisic acid and oxidative stress. Characterization of the *Atppr40-1* mutants revealed that ROS are accumulated and lower ascorbate and dehydroascorbate contents were detected at both cellular and mitochondrial level. Overexpression of *PPR40-1* gene in *Arabidopsis* led to enhanced germination and better plant growth in saline conditions. The PPR40 overexpressing *Arabidopsis* transgenic lines showed reduced lipid peroxidation, lower ascorbate peroxidase (APX) and superoxide dismutase (SOD) activity.

Our aim was to estimate the role of PPR-40 protein in stress responses after introduction of the *AtPPR-40* gene into tomato.

Two tomato cultivars (*Solanum lycopersicum* cv. Moneymaker and cv. Rio Fuego) were chosen for transformation experiments. The vector construction harboring PPR-40 protein coding sequence (pBin19-PPR40-HA) was established. The transformation frequency using the GV3101::pMP90 (C58C1, rif, pMP90 (pTiC58ΔT-DNS), Gm^r) disarmed *Agrobacterium tumefaciens* strains was very low, but the EHA105 (pEHA105) strains harboring pROK2-PPR40-HiA vector resulted in significantly more regenerants. Furthermore, the floral dip method for transformation with *Agrobacterium* was also applied. The presence of *AtPPR40* gene and the protein is verified by using PCR-based and Western blot methods. The propagation of AtPPR40-overexpressing transgenic plants is still under progress. Beside presenting the tomato plant transformation and regeneration systems, the preliminary results of the analysis of stress responses of the transgenic F_1 generation will be also demonstrated.

Krisztina Bela, Edit Horváth, Ágnes Hurton, Riyazuddin, Jolán Csiszár

STUDIES ON *ARABIDOPSIS THALIANA* GLUTATHIONE PEROXIDASES

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Glutathione peroxidases (GPXs) are common enzymes found in animals, fungi and plants. These proteins protect against reactive oxygen species, catalyze reduction of hydrogen peroxide (H_2O_2), organic hydroperoxides and lipid peroxides using glutathione or other reducing components, such as thioredoxin. The plant glutathione peroxidases are mostly similar to animal phospholipid hydroperoxide glutathione peroxidases (PHGPX). These PHGPXs play a very important role in protecting against oxidative damage of membranes. In addition to the possible antioxidant functions, plant GPXs also participate in redox signaling and plant development. The *Arabidopsis thaliana* contains 8 glutathione peroxidase isoemzymes, however their role in plant development and/or stress responses and their exact mechanisms are not well-known.

Our aim was to characterize these Arabidopsis GPX enzymes. The substrate specificity and other enzymatic properties was investigated using recombinant proteins. Other experiments were performed on *Atgpx1-8* T-DNA insertion mutants (SALK_128885C; SALK_082445C; SALK_071176C; SAIL_623_F09; SALK_076628C; WiscDsLox321H10; SALK_072007C; SALK_127691C, respectively).

Based on our preliminary results, affinity of glutathione peroxidases differ to the lipidperoxides and H_2O_2, and it depends on the specific thiorexin cosubstrate as well. In the mutant plants not only the activity of enzymatic antioxidants (glutathione peroxidase, thioredoxin peroxidase, glutathione transferase) changed, but the level and reduction state of non-enzymetic antioxidants, such as glutathione and ascorbate, too. The drought or osmotic stress experiments conducted on *Atgpx1-8* mutants demonstrated that the AtGPX3 and 5 have important roles in the development of seedlings, while the AtGPX2, 4, 6 and 8 especially in the stress responses.

Dr. Edit Horváth, Krisztina Bela, Petra Ködmön, Gábor Csomor, Csaba Papdi, László Szabados, Jolán Csiszár

ROLE OF *ARABIDOPSIS THALIANA* GLUTATHIONE TRANSFERASES IN SALT- AND OSMOTIC STRESS RESPONSES

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Glutathione transferases are a diverse multigene family of plant enzymes which play a role in the detoxification of cytotoxic compounds and in the elimination of reactive oxygen species. The *Arabidopsis thaliana L.* genome contains 57 glutathione transferase genes which were reported to be implicated in abiotic stress responses and in the maintenance of cells redox status. However, the role of individual glutathione transferases (GSTs) in the salt- and osmotic stress responses is not clear yet. While the plant-specific tau (GSTU) GSTs have members with high glutathione-conjugating (GST) and -peroxidase (GPOX) activities and play role in the elimination of excess reactive oxygen species and detoxification of lipid peroxides, the dehydroascorbate reductase (DHAR) group of the GSTs catalyse the reduction of dehydroascorbate (DHA) to ascorbate (AsA) and in this way it can regulate the redox state of the cells. Furthermore, DHARs connect the AsA and glutathione pools because during the catalyzed reaction reduced glutathione (GSH) will be oxidised.

In our experiments GST mutants were used to investigate the role of individual GSTs in short-term salt (NaCl) or osmotic (mannitol) stresses. Viability, reactive oxygen species (ROS) and malondialdehyde content and antioxidant enzyme activities were determined. Furthermore, the effect of mutations on cells' redox state was investigated. We detected changes in the AsA, DHA and glutathione (reduced; GSH and oxidised glutathione; GSSG) contents in *Atgstu19* and *Atdhar1* mutants.

Atdhar1 seedlings had a reduced germination rate, delayed germination and lower DHAR activities compared to the wild type plants under control and stress conditions. Mutation of *AtGSTU24* gene induced less pronounced changes in the investigated parameters. However, the mutation of *AtGSTU19* gene resulted in lower viability of the seedlings both under control and stress conditions. GST activity was also lower in *Atgstu19* seedlings than in the wild type plants throughout the experiments even though this mutant had increased AsA-GSH pools compared to the wild type under salt stress. Our results indicate that both *AtGSTU19* and *AtDHAR1* genes play role in the short-term salt and osmotic stress responses of *Arabidopis thaliana* seedlings.

Dr. Aleksandra Mišan

CEREAL-BASED PRODUCTS DESIGNED FOR PEOPLE DIAGNOSED WITH METABOLIC DISORDER

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With the sedentary lifestyle and unhealthy food trend, health hazards like obesity, diabetes and vascular complications are emerging at epidemic proportions. Hyperlipidaemia, one of the complications of obesity, is a risk factor for cardiovascular diseases, atherosclerosis, coronary heart disease and hypertension. Scientific and statistic data clearly show a connection between dietary regimes and human health.

Regarding that, one of the tools in the management of hyperlipidaemia and other metabolic disorders can be creating functional, innovative, novel and improved food products, as well as food products that address the needs and expectations of consumers with special requirements. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop. In low-income countries cereals are staple food. Although their consumption is moderate and varies, cereal products still present substantial source of food energy in developed nations. With the aim of designing cereal-based products for people diagnosed with hyperlipidaemia, a systematic approach towards the creation of such products has been done. Selected functional components from plant origin, with confirmed biological activity on tested animals, were used for new product formulations. Safe and sensory acceptable products were tested on patients with defined metabolic disorder. Technological process optimization on the production line in the plant was performed after obtained confirmation of the products' effect on the patients.

Cereal-based products have been improved by the substitution of wheat flour with some other type of wholegrain flour or supplementation with the functional components from plant origin. Some of the examples will be presented and discussed.

Dr. Jovana Šućur, Sonja Gvozdenac, Goran Anačkov, Đorđe Malenčić, Dejan Prvulović

ALLELOPATHIC EFFECTS OF *C. MENTHIFOLIUM* AND *S. SCLAREA* AQUEOUS EXTRACTS

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Abstract: Secondary biomolecules of plants are the main agents of biochemical interactions between plants and the environment. It is possible to distinguish the role of secondary biomolecules in alleopathic (plant-plant) activity, plant-insect, plant-microbe, plant-herbivore and others. Application of allelochemicals into agricultural practice may reduce the use of herbicides. Effect of *Salvia sclarea* L. and *Clinopodium menthifolium* (Host) aqueous extracts on lipid peroxidation process, as well as the activity of antioxidant enzymes in leaves and roots of Jimson weed (*Datura stramonium* L.) and soybean (*Glycine max* L.) seedlings were examined 24 h, 72 h and 120 h after the treatment. The second aim was to evaluate effectiveness of aqueous extract as contact toxicant against *Rhyzopertha dominica*. Our results showed that *S. sclarea* aqueous extract induced lipid peroxidation in roots of Jimson weed seedlings 24 h after the treatment. Furthermore, both tested concentrations of *C. menthifolium* aqueous extract induced lipid peroxidation in Jimson weed roots 72 h and 120 h after the treatment. It was observed that *S. sclarea* aqueous extract showed toxic effect against *Rh. dominica*, with high mortality rate (above 95 %).

Dr. Djordje Malenčić

PHYTOCHEMICAL CONSTITUENTS OF *SALVIA* SPECIES NATIVE TO SOUTH PANONNIA

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In this study, four wildgrowing *Salvia* species (*Salvia reflexa* Hornem., *S. nemorosa* L., *S. glutinosa* L. and *S. verticillata* L.) from Vojvodina province (north Serbia) have been selected and phytochemically evaluated. These species are wild growing in the southern parts of the Panonnian plain, and are common to both Hungarian and Serbian flora.

In the biological tests antibacterial and antifungal activities of plant extracts were analysed. Two extracts were used, chloroform and 70% methanol and two standard antiobiotics, as control. Antibacterial effect was studied on two G+ and five G- microorganisms and antimicotic effect was studied on four funghi strains. Both MeOH and CH_3Cl extracts of *S. reflexa* inhibited growth of *Streptococcus pyogenes* and *Escherichia coli*, but the strongest effect was recorded with the MeOH extract in case of *Schigella Flexneri*. This extract showed higher activity compared to standard antibiotics used. MeOH extracts of *S. nemorosa* and *S. glutinosa* also showed antibacterial activity and in the same time, the CH_3Cl extract of *S. glutinosa* showed antifungal effect on *Candida albicans*. Some other test results, such as antioxidant DPPH-test, also pointed to the fact that the plant material was presumably rich in biologically active natural products.

The essential oil content ranged from 0.06-0.14%. The dominant components were sesquiterpene alcohol spatulenol (*S. reflexa*), oxidated sesquiterpene caryophyllene oxide (*S. nemorosa* and *S. glutinosa*) and germacrene D and caryophyllene (*S. verticillata*). Investigation of non-volatile terpene compounds showed the presence of triterpenes ursolic/oleanolic acids in amount of 0.04-0.56%. The total flavonoid content ranged from 310.02-880.74 mg 100 g^{-1} d. m. Ten flavonoid aglycones, flavonoid-glycosides and phenyl-propanoids have been isolated from the 70% MeOH extracts of plants. The dominant phenolic compounds were rosmarinic (RA) and caffeic acid (CA). RA content ranged from 0.48-0.96%, while CA content was significantly lower.

MSc. Ružica Ždero Pavlović, Boris Popović, Štajner Dubravka, Blagojević Bojana, Vesna Tumbas Šaponjac

OSMOTIC STRESS AND PHENOLIC CONTENT IN YOUNG POPLAR PLANTS

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In this study, three poplar genotypes (M1, B 229, and PE 19/66) were grown in hydroponics and after six weeks subjected to 100 and 200 mOsm PEG 6000 during six days. Changes in polyphenol oxidase (PPO) and phenylalanine ammonium lyase (PAL) were determined in roots and leaves of poplar plants after PEG exposure. Polyphenol characterization of leaves and roots were investigated in stressed plants by HPLC analysis. Antioxidant capacity were determined also. All results were subjected to correlation analysis and principal component analysis (PCA). Osmotic stress reduced total phenolic acid content in all samples compared to controls, but it induced significant positive or negative changes in the content of individual phenolic acids both in the roots and leaves. One of the most interesting is the increase of salicylic acid (SA) in the roots of the most tolerant genotype (B 229), and that of p-hydroxy-benzoic acid in the leaves of the same genotype after exposure to 100 mOsm and 200 mOsm osmotic stress, respectively. Genotype B229 also showed the increase of antioxidant capacity and PAL activity in root and leaves under stress what could be the indicator of the adaptability of poplar plants to water stress. Significant positive correlations were obtained between PAL, antioxidant capacity as well as phenolic acids among themselves. The PCA analysis statistically proves the interrelations between the investigated parameters.

MSc. Bojana Blagojević, Boris Popović, Dubravka Štajner, Ružica Ždero Pavlović

ANTIOXIDANT CAPACITY OF DIFFERENT APRICOT CULTIVARS

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Apricot (*Prunus armeniaca* L.) is a hard tree, bearing stone fruit, which is classified under the *Prunus* species of *Prunoidae* subfamily of the *Rosaceae* family. Apricot fruits, with velvety skin and flesh, are consumed all over the world. As a functional food, *P. armeniaca* has become a product of interest in recent years because of its nutritional and health benefits. Apricot is a natural source of polyphenols and other phytochemicals such as β-carotene and ascorbic acid that contribute to its antioxidant activity.

This study investigated antioxidant potential of two apricot cultivars (NS–6, NS rodna) and three selections (SK 3, SK 13a, SK 16a) grown in orchard in Maradik, Serbia. Fruits were collected from 6-year-old trees. Total phenolics, flavonoids, tannins and condensed tannins (proanthocyanidins) were determined in 80% ethanol extracts of peeled and unpeeled dried fruits. Total antioxidant activity was assessed with DPPH and FRAP test.

Extracts of unpeeled fruits of all examined cultivars and selections showed higher antioxidant activity in both DPPH and FRAP tests. Total phenolic content was in a positive correlation with used antioxidant assays. The content of flavonoids, tannins and condensed tannins differed among cultivars and selections depended on sample preparation. Peeled fruits of tested selections had higher content of flavonoids and condensed tannins probably due to their genetic characteristics. These results indicate that other compounds, apart from polyphenols, are also responsible for high antioxidant capacity of investigated fruits.

Dr. Péter Poór, Judit Kovács, Ágnes Szepesi, Péter Borbély, Gábor Patyi, Irma Tari

SALT STRESS-INDUCED OXIDATIVE STRESS IN ETHYLENE SIGNALING MUTANT, NEVER RIPE TOMATO

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The plant hormone, ethylene plays an important regulatory role in the growth and development and in the response of plants to different stresses, such as high salinity.

The aim of this work is to reveal the role of ethylene signalling in the accumulation of various reactive oxygen ($O_2^{\cdot -}$ and H_2O_2) and nitrogen (NO and $ONOO^-$) forms in the root apices of wild type and ethylene receptor mutants and to reveal correlations between their accumulation and cell viability under salt stress.

The sublethal (100 mM) and lethal (250 mM) concentration of NaCl induced ethylene production as well as rapid accumulation of superoxide radical and H_2O_2 in the root tips of tomato (*Solanum lycopersicum* cv. Ailsa Craig) wild type and ethylene receptor mutant, *Never ripe* (*Nr/Nr)* plants. In the wild type plants superoxide accumulation confined to lethal salt concentration while H_2O_2 accumulated more efficiently under sublethal salt stress. However, in *Nr* roots the superoxide production was higher but H_2O_2 level was lower than in the wild type under sublethal salt stress. Production of NO increased significantly under both NaCl treatments in both genotypes especially in mutant plants, while peroxynitrite accumulated significantly under lethal salt stress, which leads to cell death, characterized by the DNA and protein degradation and loss of cell viability. In *Nr* mutants the cell death was induced in the absence of ethylene perception. Although wild type roots could maintain their potassium content under moderate salt stress, K^+ level significantly declined leading to small K^+/Na^+ ratio in *Nr* roots. Thus *Nr* mutants were more sensitive to salt stress than the wild type and the viability of root cells decreased significantly under moderate salt stress. These changes can be attributed to a stronger ionic stress due to the K^+ loss from the root tissues.

Zoltán Takács, Zalán Czékus, Péter Poór, Péter Borbély, Irma Tari

EFFECT OF THE LIGHT ON THE SALICYLIC ACID-INDUCED OXIDATIVE STRESS IN TOMATO

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Salicylic acid (SA) is endogenous signalling molecule mediating local, hypersensitive response (HR) and systemic acquired resistance (SAR) against pathogens and tolerance to biotic stresses. SA accumulation, SA-mediated pathways and host susceptibility to pathogens depend on light.

Polyamines [PAs; (Putrescine, Put; Spermidine, Spd; Spermine, Spm)] are low molecular weight polycations, which also function in plant acclimation. Exogenously applied SA induced PA accumulation and it was able to activate the expression of biosynthetic genes, arginine decarboxylase (*ADC*), ornithine decarboxylase (*ODC*), spermidine synthase (SPDS) and spermine synthase (SPMS). SA signalling or PA catabolism by diamine (DAOs) and polyamine oxidases (PAOs) may induce H_2O_2 production. H_2O_2 in high concentrations is essential mediator of HR and in excess amount it induces cell death. On the other hand it can contribute to the maintenance of cellular redox homeostasis through the activation of antioxidant enzymes and can participate in regulation of other reactive oxygen species (ROS) and nitric oxide (NO). Our work was focused on the effect of sublethal and lethal SA concentrations (0.1 mM or 1 mM, respectively) on PA metabolism in order to reveal the putative contribution of PA metabolism to oxidative stress in tomato leaf tissues under light and dark conditions. Since enzymes scavenging H_2O_2 is controlled by SA we were curious to know how SA exerts a control on antioxidant enzymes in the light and dark environment. The expression of genes involved in PA synthesis (*ADC* and *ODC*, *SPDS* and *SPMS*) exhibited SA concentration and light dependence. While PA biosynthetic genes were highly up-regulated by 1 mM SA, those participating in PA catabolism, *DAOs* and *PAOs* displayed lower expression at 1 mM, but enhanced transcript level at 0.1 mM SA. As a result, Put and Spm content but not that of Spd increased on 1 mM SA application, which proved to be higher in the dark than in the light. From 6 h after treatment, 1 mM SA induced significant NO production in the light but NO level declined under the dark. H_2O_2 content increased at much higher extent at 1 mM SA in the light, however, we did not find temporal coincidence with H_2O_2 accumulation at tissue level and terminal PA catabolism, which suggest that PA catabolism has only partial role in the generation of reactive oxygen species in photosynthesizing tissues. Both SA treatments induced the activity of superoxide dismutase (SOD) and in parallel the expression of *Mn*- and *Cu/Zn-SOD* but not that of *Fe-SOD* in the light. The activity and the expression of catalase (CAT) decreased after SA treatments independently of the illumination. Similarly, peroxidase (POD) activity was also light independent and increased in the presence of 1 mM SA. Ascorbate peroxidase (APX) activity displayed the highest light dependence after both SA treatments however, the expression of *APX* genes increased also in the dark.

We suppose that SA-induced PA metabolism and H_2O_2 contributes to the initiation of defence reactions at 0.1 mM SA treatment, while high SA concentration generates simultaneous increase in ROS and NO production in the light, which induces cell death.

Dr. Irma Tari
and members of Faculty of Agriculture, UNS and Department of Plant Biology, US

SUMMARY

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Two years ago we could not imagine that our late PLANTTRAIN project would be financed and we can launch this great enterprise. Right at the start during the Opening Conference we established good relationship between partner institutions, which persisted to the Closing Conference and will be carried on by young colleagues for the future.

In June 2015 the partners finished the first common seminar and workshops in Novi Sad and the second seminar was organized in September in Szeged. Both of them offered high quality scientific programs for the participants.

In the frame of the exchange program two young researchers from Novi Sad joined in the research work of the Department of Plant Biology in Szeged. They investigated the response of poplar explants to osmotic stress and learned new methods for the separation and determination of antioxidant enzymes in gel. Young scientists from University of Szeged spent a week at Faculty of Agriculture in Novi Sad in December 2015. They also analyzed the activity of antioxidant enzymes in plant tissues. To improve the cooperation between various organisations, Hungarian PhD students visited several important research centres in Novi Sad, namely the Faculty of Technology, FINS-Institute of Food Technology, the Institute of Field and Vegetable Crops in Bački Petrovač and Department for Biotechnology Novi Sad at Rimski Šančevi. Serbian guests in Hungary visited two important research centres in Szeged, Cereal Research Non-Profit Company and Biological Research Centre of Hungarian Academy of Sciences. In the frame of the actions serving sustainable development PhD students visited a biofarm in Novi Sad district and the Institute for Nature Conservation of Vojvodina Province. Similarly, Serbian colleagues made a small excursion in the Botanical Garden of University of Szeged, where the research work is focused on *ex situ* conservation of endemic species. They also visited an exceptional Zoo Park in Szeged, where the animals can live in their natural environment. During this time ten scientific articles supported by the PLANTTRAIN Programme were accepted in high impact journals on the field of oxidative stress and plant stress physiology. Two Hungarian and one Serbian PhD students participating in the project defended PhD theses. All lectures of the proposed curriculum were prepared in English, Serbian and Hungarian languages, which can be a useful scientific basis for our PhD courses in the future.

Last but not least both of the departments purchased very important equipments and chemicals which ensure high level research in the next years. At the Faculty of Agriculture a new analytical laboratory has been established equipped with an UHPLC system, a rotary vacuum concentrator, a liofilisator and a vertical deep freezer. In Szeged we installed a new RT-qPCR for gene expression studies, a gel documentation system, analytical scales, PCs and small laboratory instruments which make the laboratory work easier.

At the end of the project all of the participants agree with the slogan of IPA programmes: “Good neighbours creating common future”.

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