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Hormonal priming: a terrific approach to improve salt tolerance in wheat

Afzal, I., [1]Basra, S.M.A. [1], Cheema, M.A. [2], and Tariq, M.T. [2]

[1]Department of Crop Physiology, University of Agriculture, Faisalabad-38040, Pakistan
[2]Department of Agronomy, University of Agriculture, Faisalabad-38040, Pakistan

Introduction: Wheat production is limited by many abiotic stresses among which salinity is the most important. The adverse effects of soil salinity on plant growth include anomalous changes in physiological, biochemical and metabolic processes (Greenway and Munns, 1980; Tester and Davenport, 2003). Wheat is a plant which tolerates salinity less at germination than during later stages (Sarin and Narayana, 1968). It was hypothesized that priming with horomones could alleviate the adverse effects of salinity on wheat plants (Afzal *et al*., 2006).

Materials and methods: A pot study was conducted in net house to determine the influence of hormonal priming (50 ppm kinetin, 50 ppm salicylic acid, 50 ppm spermine and 50 ppm spermidine) on emergence, yield, antioxidants and ionic content of two wheat (*Triticum aestivum* L.) cultivars SARC-1 (salt tolerant) and MH-97 (salt sensitive) under saline (15 dS m^{-1}) or non-saline (2.58 dS m^{-1}) conditions. Moreover, the anatomical features of primed and non-primed seeds were also investigated with the help of light microscopy

Results: The growth of wheat plants was hampered by salinity stress. But the most of hormonal priming strategies were effective in alleviating the adverse effects of salt stress on wheat plants, however, hormonal priming with salicylic acid (SA) followed by priming with kinetin successfully enhanced seedling vigor by increasing emergence index, decreasing uptake of Na^+ and finally increasing grain yield of both cultivars under normal as well as saline conditions. All the priming treatments significantly affected activities of antioxidant enzymes (SOD and CAT) in both cultivars during stressful environment. On the other hand, SARC-1 had a better protection against reactive oxygen species as shown by increased SOD and CAT activities under salt stress.

Conclusion: It can be concluded that priming with 50 ppm SA followed by 50 ppm kinetin for 12 h maximally improved salt tolerance in both wheat cultivars.

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Effect of manure levels and planting date on qualitative and quantitative yield and yield components of sweet corn (Chase cv) in Miyaneh region

*Shermin Aram, *M.B.Khorshidi, A. Faramarzi
*Islamic Azad University, Miyaneh branch, Miyaneh- Iran
corresponding author: mb.khorshidi@yahoo.com

Introduction: In order to study the effect of planting date and manure levels on qualitative and quantitative yield and yield components of sweet corn cultivar Chase, an experiment was conducted on 2007-2008 in research farm of Islamic Azad University, Miyaneh branch.

Methods: The experiment was RCBD based factorial design in three replications. The first factor involved animal manure (0, 20, 40, 60 ton/ha) and second factor vas contain three plant dates of sowing (20th of April, 9th of May, 30th of May).

Results: Results showed that application of the animal manure and planting date on many qualities which was studied like thousand kernel weight, cob length, fresh grain yield, biological yield, number of total kernel per cob, number of cob row, wet and dry kernel weight, cob diameter, number of kernel per row and seed yield was significant. Comparison of mean data showed that with increasing manure usage, there was an increasing of cob length, thousand kernel weights, number of kernel per row, seed yield, cob diameter, number of cob row, number of total kernel per cob, biological yield, fresh and dry kernel weight. Comparison of the mean showed that date of 20th of April in all of the attributes except the stem diameter, number of leaf above cob, kernel length, was placed at the top. Correlation analysis showed that seed yield have significant positive correlation with number of kernel per row, number of cob row, plant height, cob length, number of total kernel per cob, cob height, cob diameter, wet and dry kernel weight, number of cob per plant, thousand kernel weight, harvest index, biological yield, and fresh grain yield.

Conclusions: Increasing the qualitative and quantitative yield of the sweet corn by application of 60 ton/ha animal manure, and by considering the produced result of the planting date, 20th of April are suitable for plant date sowing in that region.

Ecophysiological conditions of seed dormancy of nonannual weed

A. Bochenek

Department of Plant Physiology and Biotechnology, University of Warmia and Mazury, Oczapowskiego 1A, 10-718 Olsztyn, Poland

Introduction: The main goal of this study was to gain insight into the physiological mechanisms of environmental dormancy regulation in weed seeds from the Asteraceae family, both perennials and species that can be winter annuals, summer annuals, biennials or short-lived perennials.

Methods: There were examined: the seasonal dormancy pattern of seeds in a soil seed bank by means of changes in the hydrotime model parameters, stratification and after-ripening using the population-threshold hydrotime model, response of seeds to fluctuating temperatures, desiccation, light and nitrate set against the changes in the hydrotime model parameters caused by phytohormones and inhibitors of their synthesis, and soluble carbohydrate content in the seeds from a soil seed bank in relation to their sensitivity to hydration-dehydration cycles.

Results: The studied weeds from formed a persistent soil seed bank. Temperature didn't play as important a role in seed dormancy regulation. Seeds in the natural soil bank were in non-deep dormancy during the whole year. Gibberellins were synthesised *de novo* during seed imbibition and seeds exhibited low sensitivity to the exogenous ABA. Hydration-dehydration cycles stimulated the emergence of achenes. Desiccation tolerance in the achenes which were not buried in soil earlier might have been connected with the presence of raffinose but in the seeds buried in soil free cyclitols probably partly took over the function of oligosaccharides in the protection of cell structures from desiccation stress.

Conclusions: Achenes of the species under study, contrary to typical annual species, neither develop very deep dormancy nor terminate it completely in the conditions of a natural soil seed bank. This allows some seeds to survive until the next seasons and others to be ready to take the risk of a fast decrease in dormancy level, dormancy termination and germination if favourable conditions occur. The application of such a strategy is enabled by the high ecophysiological plasticity of these species. It allows them to successfully survive in very variable and often disturbed field, garden, grassland and ruderal environments.

Influence of drought stress during grain filling in agronomic characteristics, grain protein concentration and rheological properties of wheat cultivars

*M. Castro-Derényi, * D. Vázquez

* National Institute for Agriculture Research (INIA), Ruta 50 km 11, Colonia 70000, Uruguay
corresponding autor: mcastro@inia.org.uy

Introduction: Wheat (*Triticum aestivum* L.) plants exposed to water deficit during ripening show altered agronomic and grain quality characteristics. Drought causes yield losses and seasonal variation in quality creating difficulties in the marketing and processing of grain, so improving the genetic adaptation of wheat cultivars to drought stress is an important objective in breeding programs (Richards et al., 2001). Some genotypes have been reported to have a tolerant response and could be used as genetic sources for drought tolerance (López et al, 2003).

Methods: Five spring wheat cultivars from South America and two checks were evaluated in Uruguay. One controlled environment experiment was conducted in a split-plot design with varying timing of drought stress during grain filling.

Results: Agronomic characteristics as kernel number and aerial biomass decreased with drought stress. Significant genotype x treatment interaction with a decreasing effect was detected for root width, thousand kernel weight, and grain yield. No significant effect of drought stress was detected for root length or weight. Rheological properties were affected by drought stress increasing mixograph maximum height (HMX) and mixograph dough mixing time (DMT). Significant genotype x treatment interaction was found for grain protein concentration, HMX and DMT.

Conclusions: Cultivars with stable agronomic and quality characteristics under drought stress were found in this study. They could be used as genetic sources for resistance to this abiotic stress.

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Comparative analysis of barley roots challenged with two Basidiomycete fungi: pathogenic *Rhizoctonia solani* AG-8 and symbiotic *Piriformospora indica*

*J. Fodor, *B.D. Harrach, *L. Király, *B. Barna, **K.-H. Kogel, **P. Schäfer

*Plant Protection Institute, Hungarian Academy of Sciences, Herman Ottó út 15, H-1022 Budapest, Hungary
**Research Centre for Biosystems, Land Use and Nutrition, Justus Liebig University, Heinrich-Buff-Ring 26-32, D-35392 Gießen, Germany
corresponding author: jfod@nki.hu

Rhizoctonia solani AG-8 and *Piriformospora indica*, two plant root-invading Basidiomycete fungi both occupy a wide range of monocot and dicot plants. However, while *R. solani* possesses destructive potential and is responsible for significant yield losses, the latter mediates beneficial effects (e.g. biotic and abiotic stress resistance, biomass and yield increases) to colonized host plants. Thus, both organisms bear considerable significance for agronomical ecosystems. The taxonomical relation between the pathogen and the symbiont provides a unique combination to investigate (i) how a parasitic and a mutualistic fungus colonizes roots of host plants, (ii) to what extent similarities or differences in terms of plant gene expression patterns can be monitored during pathogenic or mutualistic root colonization, as well as (iii) how the antioxidative system is involved in colonization processes. Cytological examinations interconnect molecular and biochemical events associated with early to late colonization stages and cellular plant defense reactions, e.g. accumulation of reactive oxygen species. Therefore, the regulation and activity of selected candidate genes or proteins involved in oxidative stress as well as defense responses are examined by using barley root samples from different time points that cover initial cell penetration up to progressed stages of root colonization.

Why galls are such a fascinating example of plant-insect interaction?

Marian J. Giertych

Institute of Dendrology Polish Academy of Sciences; Parkowa 5; 62-035 Kórnik; Poland

Galls are strange growth on different plant organs. They appear as a consequence of action of other organisms but generally we use the term gall to describe an abnormal yet regular growth caused by insects or mites. Galls are formed on shots, buds, flowers, fruit and in particular on leaves. Mechanisms of gall induction remain little known, and understanding the molecular tools used by insects to manipulate plant development is the Holy Grail of current research on this plant-insect interaction (Stone et al. 2002.). However it is obvious that the process of forming galls is under precise control of the insect. The shape, size and color of galls are recurrent and characteristic for the insect species. Also the place of the galls on leaf blade is very typical for the insect species. An analysis of placement of almost two hundred galls of *Cynips quercusfolii* L. on pedunculate oak (*Quercus robur* L.) leaves indicated that irrespective of leaf size the galls are placed at a fixed distance from leaf edge. The part of leaf blade between the gall and the leaf edge assures appropriate nutrition of the gall tissues and larvae. This part differs from the rest of leaf in chemical composition and structure (specific leaf area [SLA] is significant lower - 124 vs.144 cm^2/g d.wt.). Changes in the leaf metabolism as a consequence of a gall forming on it includes an increase of repellents (phenolic compounds) that deter other herbivorous organisms and pathogens, so that the larva in the gall can complete their growth. We still do not know at which level the insect can control development of the gall. The presence in galls of proteins similar to seed proteins (Schönrogge et al. 2000) suggests that the control is at the level of gene expression, although it cannot be excluded that the interference occurs directly in the gene.

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Change of root system architecture in relation to leaf water potential and gas exchange of maize and triticale seedlings grown in different soil compaction condition

Maciej T. Grzesiak

The *Franciszek Górski* Institute of Plant Physiology. Polish Academy of Sciences, 21 Niezapominajek str., PL 30-239 Cracow, Poland

Introduction: High soil compaction is an abiotic stress factor that damages crop plants because growth of roots is strongly affected by physical factors in soil. Typical responses of plant root system structure to soil compaction include reduction of number and length of roots and restriction of root downward penetration. As acquisition of water and mineral nutrients is primarily determined by distribution of root and would be closely related to water relation and photosynthesis of the plants in exposure to soil compaction. The aim of this study was to evaluate the effects of different levels of soil compaction on plant growth characteristics, number and length of components of root system, leaf water status and gas exchange parameters in the seedlings of triticale and maize.

Methods: Seedlings of maize and triticale were grown in root boxes, which enabled non-destructive isolation of all compartments of the root system. Three levels of soil compaction (1.30 $g \cdot cm^{-3}$ - LSC, 1.47 $g \cdot cm^{-3}$ - MSC, and 1.58 $g \cdot cm^{-3}$ - SSC3) were applied. Daily changes of leaf water potential (ψ), leaf gas exchange parameters were made in 4 hours intervals on 8:00, 12:00, 16:00 and 20:00 h.

Results: The growth under conditions of moderate or severe soil compaction, in comparison to low soil compaction, resulted in decrease in leaf number, dry matter and distribution of roots in soil profile. The soil compaction levels were not influenced on number of seminal and seminal adventitious roots but decrease their total length. Changes in root system architecture under the high soil impedance conditions were also accompanied by daily changes in leaf water potential (ψ), net photosynthesis rate (A), transpiration rate (E), and stomata conductance (gs) and internal concentration of carbon dioxide (CO_{2int}). Highlighting on water relation and gas exchange rate of plants in soil stresses indicate that leaf water status and gas exchange parameters (especially stomata behavior) are influenced through several mechanisms. According to Masle (2002) rootborne signals affect the rate of development in the apical meristem, cell division and cell expansion in the expanding leaves and their induce stomata behavior. Root signals are expected to be electrical and hormonal and are involved in mediating physiological effects.

Conclusions: The studies will encourage improvement of technology for crop production under adverse field conditions and will contribute to the progress of breeding program aiming to improve stress tolerance of crop plants.

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Influence of paclobutrazol and salt stress on a salt-sensitive cultivar of wheat

*, **Sh. Hajihashemi, **K. Kiarostami, **A. Saboora

* Department of Biology, Isfahan University, Isfahan, Iran
**Departments of plant science, Alzahra University, Tehran, Iran
corresponding author: sh_hajihashemi@ymail.com

Introduction: Soil salinity is one of the most important factors that limit crop production in arid and semi-arid regions (Flowers, 1995).

Methods: The objective of the present study was to determine the effect of paclobutrazol (PBZ) and NaCl treatments on a salt-sensitive (Ghods) cultivar of wheat (*Triticum aestivum* L.). Plants were treated with 0, 30, 60 and 90 ppm of PBZ and irrigated with 0, 75, 150 and 225 mM of NaCl.

Results: Data indicated that growth parameters such as net assimilation rate (NAR) and specific leaf weight (SLW) decreased in salt-stressed plants, but the interaction of PBZ and salinity increased them. Salt stress increased leaf area ratio (LAR), but PBZ treatment reduced it. The result of PAGE electrophoresis showed that salt stress decreased protein content of leaves at 225 mM NaCl but PBZ treatment increased it. In response to increasing NaCl level the activity of polyphenol oxidase and peroxidase increased in leaves and roots of plants, with the exception of peroxidase at 225 mM NaCl. Polyphenol oxidase and peroxidase activity significantly increased in PBZ-treated plants.

Conclusions: The PBZ treatment decreased the harmful effects of salt stress with increasing proteins content as osmoprotectant and activity of peroxidase and polyphenol oxidase antioxidant enzymes. PBZ has the potential to increase the productivity of wheat in the saline areas where high salinity limits its production.

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Development of virus infections in plants affected by heavy metals: physiological and epidemiological implications

E.A. Iutinska, A.S. Bysov, O.V. Shevchenko, V.P. Polischuk

Virology Dpt., Taras Shevchenko' Kyiv National University, 64 Volodymyrska st., Kyiv 01033, Ukraine
corresponding author: alexshevchenko@ukr.net

Introduction: Transformed environment is characterized by chemical pollution of ecosystems, and heavy metals (HM) play their significant role. Negative effect of excess of HM on plant physiology is well known. However, monocultivated crops often are seriously endangered by virus infections. Our understanding of the behavior of virus diseases in chemically stressed plants is crucial as shedding light both on issues of virus ecology/epidemiology and alterations of plant physiology influencing the yield.

Methods: We used several plant species which are common models for plant virology: tobacco, potato and tomato. All plants species are systemically invaded by *Tobacco mosaic virus* (TMV) and *Potato virus X* (PVX) we used. Plants were inoculated mechanically at the stage of two true leaves. Virus content in plant tissues was measured by indirect ELISA using specific polyclonal antisera. Chlorophyll concentration was estimated by DMSO technique. Heavy metals (Pb, Zn and Cu) were detected in plant tissues by AAS. Cytoplasmic inclusions of TMV were analyzed via fluorescent microscopy, and the ultrastructure of infected cells – by TEM of ultra-thin layers.

Results: Generally, HM induce the delayed appearance of more severe virus-specific symptoms on infected plants which tend to be more subtle, smaller and diseased. Total chlorophyll content in plants subjected to both stressors was significantly lower. High content of HM in soil and plants invoked huge elevation of virus content, for instance TMV concentration in tobaccos was 2.8-times higher and PVX content in potatoes – 2.5 times higher. HM also induced formation of atypical cytoplasmic inclusions of TMV. TEM study of TMV infection in tobaccos subjected to HM stress revealed that HM invoke ultrastructural changes in organization of virus bodies and structure of cell organelles.

Conclusions: Virus infection in HM-stressed plants tends to progress more aggressively with high virus content, alterations to cell structures and functionality, and pronounced drop in plant productivity. This data raises issues on policies in agriculture and biosafety.

Increasing of ROS and peroxiredoxin and thioredoxin activity in arabidopsis tissue culture under osmotic stress

S. Jadko

Institute of Botany, Tereschenkovskaya St. 2, Kiev, 01601, Ukraine
corresponding author: ukrkiev55@mail.ru

Introduction: Early increasing of reactive oxygen species (ROS) in plant cells occurs under various stresses. These ROS can function as second messengers in mechanism of cell stress respond (Miller G. et al. 2008). It is suppose, that peroxiredoxins (Prx) and thioredoxins (Trx) can act as acceptors and transmitters of these ROS signals (Dietz K.-J., 2008). However, little is known about this mechanism.

Methods: 12 days old arabidopsis tissue culture (ecotype Columbia) of wild type was investigated. The tissue culture grown on MS medium in durk under 24ºC. 30% polyethylene glycol 6000 (PEG) was used for osmotic stress. Chemiluminescence (ChL) intensity for detection of ROS, Prx and Trx activity were measured after 30, 60 and 90 min.

Results: Early increasing of ChL intensity in the arabidopsis tissue culture took place under PEG and it was higher controls on 35% to 30 min. Than the ChL slowly decreased to 60 and 90 min. After early increasing of ROS took place increasing of Prx and Trx activity on 5, 21 and 16% to 30, 60 and 90 min. Ascorbic acid inhibited increasing of ROS and Prx and Trx activity about in 2 times.

Conclusions: Early increasing of ROS in the arabidopsis tissue culture cells took place under osmotic and than these ROS resulted in ROS-dependent induction of Prx and Trx activity. We suppose that such processes can be mostly in mitochondria of the tissue culture.

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Iran sainfoin gene pool evaluation for cold regions of East Azarbaijan

*M.B. Khorshidi, *R. Kanaani, *A. Onnabi, *A. Nasseri, *M. Zabolestani

*East Azarbaijan Agricultural and Natural Resources Research Centre, Khosrowshahr –Iran
corresponding author: mb.khorshidi@yahoo.com

Introduction: Iran is a main gene pool of sainfoin and there are more than 56 species and 27 of them is indigenous of Iran. So it has a high potential resource for breeding and selection new cultivars.

Methods: For early evaluation, 49 sainfoin ecotypes planted and attributes like as days to flowering, leaflet number, node number, peduncle length, flower length, plant height, chlorophyll content, leaf and stem dry weight, and leaf to shoot ratio recorded.

Results: Results showed that there were significant differences on all attributes among ecotypes. 49 seed produced ecotypes planted in Tikmedash in an alpha lattice. Results also showed that there were significant differences on all at-

tributes among ecotypes. Ecotypes 18 and 21 had highest and 42 had the lowest plant height. Ecotypes 10, 8 and 29 were earliest and 40, 41 and 42, were the latest flowering date. Ecotypes 15, 47, 28, 31, and 9 had the highest leaf/stem ratio but 30, 18, 49, 48, 33, 34, and 17 had the least ones. Ecotypes 18, 25, 3, 37, and 47 produced higher dry matter percentage while ecotypes 12, 11, 45, 34, 32, 42, and 28 produced the least dry matter percentage. Two cuts fresh weight showed that ecotypes 37, 32, 2, 5, 23, 34, 49, 35, 7 and 10 produced higher and ecotypes 46,38, 16, 21, 43, 45, 41, and 20 lowest fresh weight. Simultaneous study of dry matter percentage and fresh yield showed that ecotypes 37, 35, 9, 5, 7 13 and 1 had highest value in both attributes. Ecotypes 22, 45, 44, 20, 26, 28, 15, and 48 had lowest value in both attributes. Two year fresh weight showed that ecotypes 2, 10, 7, 37 produced higher amounts beside ecotypes 49, 19, 3, 32, 13 and 9, but ecotypes 21, 38, 45, 43, 29, 26, and 18 produced the least fresh yield. Two year dry weight showed that ecotypes 37 and 49 produced more than 6 ton per Ha, ecotypes 45, 38, 43, 29, and 26 produced more than 5 ton per Ha but ecotypes 45, 38, 43, 29 and 26 produced 2 ton per ha.

Conclusions: Cluster analysis showed that four ecotypes (47, 3, 5, and 37) from cluster no 7 and all ecotypes in cluster no 6 (19, 35, 2, and 49) were the high yield ecotypes. In other word in first cluster, five ecotypes (20, 26, 38, 43, and 33) and in fifth cluster two ecotypes (29 and 21) were the least yield producer. Because of very late bloom and dwarf attributes, ecotype 42 belonged to an independent cluster (cluster 2).

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Two cultivars of wheat give opposite stomatal responses to changes in air temperature

G.R. Kudoyarova

Institute of Biology, Ufa Research Centre, Russia
corresponding author: guzel@anrb.ru

Introduction: Increased air temperatures elevate transpiration-driven demand for water. Plants may minimise any resulting water deficits either by closing stomata or by increasing the volume of water uptake through the roots. We assessed, which of these mechanisms apply in two different wheat cultivars.

Methods: Effect of warming the air by 3 °C was studied in a growth room using 7-day-old seedlings of two cultivars recommended to farmers for growing under wet (Iren) or dry (Kazahstanskaya 10) conditions.

Results: Transpiration increased in plants of Iren and decreased in Kazahastakaya 10 when the air was warmed. In both cultivars, the response was due to the changes in stomatal conductivity which increased in the former and decreased in the latter cultivar. Changes in root system hydraulic conductivity paralleled those of stomatal conductivity; conductivity increasing in 'Iren' and decreasing in 'Kazahastakaya 10'. These stomatal responses could be modified by cooling the shoot base of plants. In plants, which normally kept stomata open when warmed, the cooling treatment reversed the warming response and stomata closed. Since shoot cooling inhibits phloem transport it led to an accumulation of abscisic acid (ABA) in shoots that would normally have been exported to the roots thereby mimicking the inherent behaviour of 'Kazahstanskaya 10'.

Conclusions: The type of stomatal response depended on the pattern of distribution of ABA; its accumulation in roots increasing their hydraulic conductivity while ABA accumulating in shoots closes stomata. Thus, Kazahstanskaya 10 stabilised leaf water deficits by minimizing water use. This was achieved by decreasing root conductivity in association with stomatal closure. In contrast, Iren minimised foliar water deficits by increasing root hydraulic conductivity while keeping stomata more open. This is in accordance with their contrasting behaviour in the field; Iren yielding well under wet conditions with Kazahstanskaya 10 being more tolerant of drought.

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Effects of moderate water deficit on calcium ions distribution in leaf cells of *Sium latifolium*

O.M. Nedukha

Institute of Botany, Tereschenkivska 2, Kiev, 01601, Ukraine
corresponding author: o.nedukha@hotmail.com

Introduction: Previous experiments had shown that moderate water deficit (MWD) affected on ultrastructure of mesophyll and epidermis cells, polysaccharide composition and lignin content in cell walls of *Sium latifolium* at flowering and seedling phase of plant development. We tested the hypothesis that water deficit controls leaf development in different phases of development via modulation of calcium ions distribution in leaf cells.
Methods: Leaves were harvested from two ecological forms of plants (*Sium latifolium L.*): air-water and terrestrial form at budding-flowering and at the beginning of seeds-formation phase. Air-aquatic plants grew in water (along shore of Psel River), and terrestrial plants grew up to 25 meter far from the riverside. The cytochemical method with using of calcium-specific fluorescent dye fluo-4 was used for the study of Ca^{2+} localization in leaf cells. Observations were carried out by the laser confocal microscope LSM 5. The fluorescence intensity of fluo 4-calcium complex for quantitative evaluation of Ca^{2+} was measured by the Pascal program.
Results: We have shown that the localization of calcium ions did not change during MWD in mesophyll cells. Ca^{2+} was revealed in chloroplasts, nuclei, cytoplasm and cell walls of mesophyll cells, and in cell walls of adaxial and abaxial epidermis of leaves independently of growth phase and of plant ecological form. The increase of Ca^{2+} content in chloroplasts and nuclei of mesophyll cells as well as in cell walls of epidermis cells was revealed in water deficit at budding-flowering phase. The decrease of Ca^{2+} content in chloroplasts, cytoplasm and cell walls of mesophyll cells, and in cell walls of epidermis in leaves at seeds-formation phase has been caused by water deficit. The change of Ca^{2+} content in chloroplasts has correlated with chlorophylls content under influence of MWD.

Conclusions: The considerable plasticity in content of calcium ions and in their redistribution in leaf cells during adaptation of *S. latifolium* to influence of moderate water deficit was detected.

Synthetic preparation Methyure protects plants under salt stress conditions

*T. O. Palladina, *O. O. Konturska, *Z. I. Ribchenko, **L. P. Prikazchikova

*Institute of Botany NAS Ukraine, 2 Tereschenkivska, Kyiv 01601
**Institute of Bioorganic Chemistry NAS Ukraine, 1 Murmanska, Kyiv 02094
Corresponding author: tatiana_palladina@ukr.net

Introduction: Salinity is the global problem for agriculture. A lot of efforts are directed on transgenic tolerant forms construction (Zhu, 2006). However it is profitable for the main crop cultures only. Therefore bloactive preparations using for plant salt tolerance increase is on the agenda. It was found that Methyure (2-thio, 6-methyl pyrimidine), tested as plant growth stimulator, ensures maize growth on saline soils (Palladina, 2008). The role of pyrimidine ring side groups for Methyure protective ability has been elucidated via use of four uracile derivates.

Materials and methods: Maize seeds (hybrid Desna SW) were soaked in uracile derivates (10^{-7}M) during a day. 7-day old seedlings grown in water culture were exposed on 0.1N NaCl during 1 or 10 days. Antioxidative activity of uracile derivates has been estimated by use of stable free radical diphenylpicril hydrozyl (DPPH) in vitro.

Results: NaCl induced seedling growth reduction, which was more expressed in roots. All preparations stimulated growth of NaCl- exposed seedlings however effect of the free side group derivate was insignificant. Reactive sulphur presence in 2th position ensured the growth effect of preparations and their antioxidative ability. The best stimulation of both shoot and root growth was demonstrated by Methyure, which contains thio and methyl groups.

Conclusions: Methyure adaptive effect is caused by reactive sulphur presence in its molecule and can be connected with its participation in gene expression processes too.

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Influence of heavy metals on kinetics of proton exchange in isolated chloroplasts

O.V. Polishchuk, N.M. Topchiy, E.K. Zolotareva

M.G. Kholodny Institute of Botany National Academy of Science of Ukraine, Tereschenkivska str. 2, Kiev, 01601, Ukraine
corresponding author: polishch@yandex.ru

Introduction: It was found that Zn, Cu (Jegerschöld, 1999), and Cd (Sigfridsson, 2004) ions can inhibit photosynthetic electron transfer at the acceptor side of PS II, but little is known about their influence on proton uptake. Based on information obtained in bacterial reaction centers (Ädelroth, 2000), it can be assumed that at least some heavy metals can bind to PS II acceptor side and inhibit protonation of the Q_B in higher plants chloroplasts. In order to establish the primary target process of heavy metals inhibitory action, we compared their influence on both initial and stationary rates of electron transfer and proton translocation in chloroplasts.

Methods: Electron transfer rate was determined by oxygen uptake measurement with Clark-type electrode in the presence of 50 μM methyl viologen at photosynthetic photon flux density of 1300 μmol quantam^{-2}s^{-1}. pH changes in reaction medium and transmembrane proton gradient formation were followed with Xe-PAM fluorometer("Walz", Germany) using non-penetrating and penetrating fluorescent pH indicator, respectively.

Results: Light-dependent proton uptake was highly sensitive to heavy metals. Even micromolar concentrations of heavy metals caused significant inhibition of this process and no changes in electron transfer rate and proton gradient formation. Heavy metal-induced changes in the number of protons taken up in the steady-state were accompanied by similar changes in the initial and the stationary proton uptake rate. Addition of 3 mM Zn^{2+} or only 200 μM Cu^{2+} inhibited proton uptake almost completely. At the same time, chloroplasts retained substantial electron transfer and proton gradient formation ability.

Conclusions: Heavy metal ions can decouple light-dependent electron transfer and proton translocation. Proton uptake at reduction of Q_B may be the primary target of heavy metals action. In the presence of heavy metal ions in high concentration, electron transfer may employ terminal acceptor reduction at the level of Q_A, which occurs without any proton uptake.

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Evaluation of P5CS gene over expression using RT-PCR and CAT and APX activities in transgenic tobacco plants

Roya Razavizadeh and Ali Akbar Ehsanpour

Dept of Biology, Faculty of Science, University of Isfahan, Isfahan, Iran
*Corresponding Author: ehsanpou@yahoo.com

Introduction: It has been documented that transgenic plants over-expressing P5CS gene increase concentration of proline and resistance to both drought and salinity stresses (KISHOR et al. 1995). However, whether proline accumulation in transgenic plants resulted in increase stress tolerance through osmotic adjustment or other mechanisms is unknown (SHARP et al. 1996). It is a mather of fact, salinity induces oxidative stress in plants (XIONG & ZHU 2002). Alleviation of oxidative damage by scavenging reactive oxygen species (ROS). The aim of the present study is to evaluate over expression of P5CS gene in transgenic tobacco plant under *in vitro* salt stress and its relationship with proline production and CAT and APX activities in different time course

Methods: Transgenic tobacco plants carrying P5CS gene linked to NpTII gene were treated with 300mM NaCl under in vitro culture. Proline content and level of P5CS gene transcripts were anlysed using semi quantitative RT-PCR after 0, 4, 24 and 48 h post treatment. CAT and APX enzymes activity were also measured.

Result: Salt stress increased proline content after 24 to 48 h. The level of P5CS gene expression was also increased after 24 h post treatment with NaCl. CAT and APX activity was also increased due to salt stress.

Conclusions:. Transgenic tobacco plant over expressing P5CS gene showed high level of salt tolerance (up to 500mM).

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Taxa from colder environments differ in temperature optima of photosynthesis than closely related taxa from warmer sites when co-occurring in common conditions

Piotr Robakowski, Yan Lee[2], Peter B. Reich[1]

[1,2]Dept. of Forest Resources, University of Minnesota, 115 Green Hall, 1530 Cleveland Ave. N. St. Paul, MN 55108-6112, USA
University of Life Science in Poznan, Department of Forestry, Wojska Polskiego 69 St., 60-625 Poznan, Poland
e-mail: pierrot@up.poznan.pl

Introduction: It remains unclear whether taxa originating in different thermal regimes will differ in their photosynthetic temperature optima when compared in a common environment. In the present study, we hypothesized that when compared in a common site: (1) northern provenances of *Acer rubrum* and *Quercus rubra* adapted to lower ambient temperatures will have lower optimal (T_{opt}), minimal (T_{min}) and maximal (T_{max}) temperatures for photosynthesis compared with southern provenances native to warmer locations (2) Photosynthetic temperature responses will differ similarly between *Populus tremuloides* (with a more northern range) and *Populus deltoides* (with a more southern range) in the region where their geographic ranges overlap.

Material and methods: Two experiments were conducted to investigate the temperature responses of (1) *Acer rubrum* and *Quercus rubra* provenances in a common garden, University of Minnesota, and (2) *Populus deltoides* and *Populus tremuloides* along the geographical gradient in the region where both species geographic ranges overlap. From early July to late September 2008 net CO_2 assimilation rates were measured using the LiCor 6400 across a range of leaf temperature to obtain the parabolic curve from which optimal, maximal and minimal temperatures for photosynthesis were calculated.

Results: The comparison between the provenances within *Acer* and *Quercus* supported the hypothesis that those adapted to lower ambient temperature had lower T_{opt}, T_{min} and T_{max} than the provenances from higher ambient temperature. T_{opt} was positively correlated with the mean temperatures of growth season (from May to September) of *Acer rubrum* and *Quercus rubra* provenances, but not with moving average temperatures calculated from 1, 5 or 10 days before the gas exchange measurements. Similarly, in the region of overlapping geographical ranges, *Populus tremuloides* showed lower T_{opt} than *Populus deltoides*. T_{opt} decreased with greater leaf mass to area ratio (LMA) and A_{max}.

Conclusions: Results indicated that photosynthetic temperature responses differed with differences in climate origin for closely related taxa within species and within genera. The provenances or species adapted to lower growth temperatures showed lower T_{opt}, T_{min} and T_{max} compared with closely related taxa adapted to higher temperatures. Such differences suggest that modest climate change may create mismatches between photosynthetic physiology and local climate because taxa are adapted to local rather than range-wide conditions.

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The effect of phosphorus and iron supply on plant growth and ureides production of two soybean cultivars under water stress conditions

V.I. Rotaru

Institute of Genetics and Plant Physiology, Moldavian Academy of Sciences, Chisinau 2002, Republic of Moldova, corresponding author: rotaruvlad@yahoo.com

Introduction: Trofic factor is very important regulator in formation of plant resistance to unfavorable conditions (Gutierrez-Boem,F. and Thomas, G.W., 1998). To investigate the effect of phosphorus (P) and iron (Fe) supply on plant biomass production, nutrient status and ureides concentrations in plant parts pot experiments were conducted in greenhouse with soybean (*Glycine max L.)* cultivars grown in P deficient soil.

Methods: A basal dose of N ($Ca(NO_3)_2x4H_2O$ was applied to all the pots at 50 mg /kg soil. The amount of P (KH_2PO_4) was 100 mg P as sufficient supply and without P application as insufficient supply. Iron was applied as Fe-EDTA at 5 mg/kg soil. Until flowering plants received adequate water supply-70% water holding capacity (WHC). Beginning at flower bud stage the two soil moisture treatments were performed by maintaining pots at normal level of moisture (control) and other set of plants was subjected to 35% WHC as water stress. Plants were harvested after 2 weeks of water stress.

Results: Adequate supply of P and Fe enhanced growth and performance of *Glycine max (L.)-rhizobium* symbiosis. Two soybean genotypes Licurici and Zodiac had a differential response to nutrient application in drought conditions. The exposure of soybean plants to water stress conditions during flowering stage resulted in an essential decrease in growth associated with decrease of nodules number and ureides concentrations. P supply decreased Fe concentration in plants but increased P and nitrogen accumulation. An increase in P supply had essential effect on P partitioning and uptake in plants. Drought reduced capability of plants nutrient absorption. Overall, phosphorus use efficiency (PUE) increased significantly in well watered conditions. Fe supplemental nutrition increased the rate of PUE, especially under normal soil moisture. Phosphorus utilization efficiency showed by Licurici was higher than that of Zodiac on the basis of shoot biomass production.

Conclusions: The results suggest that adequate nutrition of P and Fe significantly increased ureides concentrations and there were not antagonist interaction between nutrients on vegetative growth and nutrient status of soybean genotypes.

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Response of seedlings to soil pollution with PAHs

B. Smreczak, B. Maliszewska-Kordybach

Institute of Soil Science and Plant Cultivation – National Research Institute, Czartoryskich 8, 24-100 Pulawy, Poland corresponding author: bozenas@iung.pulawy.pl

Introduction: Numerous kinds of rapid assays have been developed for testing seedlings response to different kind of stressors e.g soil pollution with polycyclic aromatic hydrocarbons (PAHs). Observed reactions vary widely for different plant species and varieties. The phenomenon is still not recognized sufficiently, although, it is known that physiology of plants at early growth is associated with the quantity and quality of seeds reserves. The aim of the study was to evaluate the effect of seeds characteristics on seedlings response to the pollution of soils with PAHs.

Methods: Sandy soil, freshly polluted with the mixture of four PAH compounds (fluorene+anthracene+pyrene+chrysene) was applied in the studies. Hydrocarbons were dissolved in equal weight portions in dichloromethane and added to the air-dried soil to obtain contamination levels of 1, 10 and 100 mgΣ4PAH/kg, while control samples were amended with the pure solvent. Bioassays with six selected plants: wheat, oat, maize, tomato, bean, and sunflower were performed in the laboratory under natural lightening conditions. Plants (dicotyledonous and monocotyledonous categories) were selected according to differences in content of reserve substances (proteins, lipids and sugars). Effect of PAHs on plant growth was evaluated on the basis of three parameters: root and stem length and dry weight of seedlings.

Results and Conclusions: The results indicated that PAHs present in soil at high concentrations exhibite ecotoxic activity towards plants at early stage of their growth, but seedlings reaction depends on the species. There was no significant difference between dicotyledonous and monocotyledonous category. Seedlings sensitivity to PAHs – as evaluated on the base of the root and stem length decreased as follows: tomato>wheat>bean> maize>oat>sunflower. Plans reaction to lower levels of PAHs was negatively correlated with the seeds lipid content.

Investigation on effects of nitrogen rates on yield, nitrate accumulation and quality of three tomato varieties

*A. R. Sobhany and H. R. Zabihi, M.B. Khorshidi

* Khorasen Razavi Agricultural and Natural Resources Research Centre
corresponding author: alisobhany@yahoo.com

Introduction: In order to investigation on effects of nitrogen on yield, yield components and nitrate accumulation in different tomato varieties, a factorial experiment based on randomized complete block design with 4 replications was conducted in Mashhad station.

Methods: Nitrogen levels were: 0, 150, 200, 250 and 300 kg per hectare nitrogen manure (urea) and tomato varieties were: Mobile, Petoearly ch and Gina vf..

Results: Three varieties had no significant different in yield, yield components and amounts of fruit nitrate. Amounts of nitrogen had significant effects on yield and nitrate contain of fruit. The best yield and nitrate was resulted from 150 kg per hectare nitrogen. pH, brix and amounts of P, K, Fe and Zn was not affected by treatments

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Adjustment of the temperature dependence of photosystem II function upon acclimation of Norway spruce seedlings to different radiation and elevated temperature

V. Špunda, Z. Nosek, E. Řezníčková, P.Teslová, J. Kalina, M. Štroch, M. Navrátil

University of Ostrava, Faculty of Science, 30. dubna 22, 70103 Ostrava, Czech Republic
corresponding author: vladimir.spunda@osu.cz

Introduction: Norway spruce belongs to the species that are sensitive to high-temperature stress and suffer from midday depression of photosynthesis during hot sunny days. However, our previous studies revealed that acclimation of spruce seedlings to high irradiance and elevated temperatures did not induced enhanced PSII photoinhibition. In present study we attempted to elucidate, whether the PSII resistance to high-temperature stress is due to the increased thermal stability of PSII function and shift of the temperature optimum of electron transport reactions to the higher temperatures.

Methods: Norway spruce seedlings (4-years-old) were acclimated to four different irradiance and temperature regimes (11-12 days) inside growth chambers simulating: A, cloudy days with optimum range of temperatures (LI-LT); and B, sunny days with optimum temperature range (HI-LT); C, moderate high-temperature stress (HI-HT); D, severe high-temperature stress (HI-HT2). The measurements of fluorescence-temperarature curve (FTC), temperature dependences of potential efficiencey of PSII photochemistry (F_V/F_M), temperature dependences of efficiency of PSII photochemistry (P) and nonradiative dissipation (D) under moderate and/or saturating irradiances were performed using PAM fluorimeter on linearly-heated detached needles.

Results: FTC parameters indicated a nonsignificant trend of increasing thermal stability of needles acclimated to HI-HT and HI-HT2 conditions. This was confirmed by the temperature dependences of F_V/F_M revealing significantly enhanced stability of PSII photochemistry in dark-adapted HI-HT2 seedlings in comparison with HI-LT ones. Moreover, acclimation to HI-HT2 regime resulted in slight shift of P optimum to higher temperatures and consequently P

was higher than in HI-LT plants at temperatures above 35°C. The positive acclimation of PSII function to elevated temperatures was supported also by the reduced D at the temperatures 35°C and higher.

Conclusions: The mentioned methods confirmed that, particularly acclimation to extremely high temperatures (HI-HT2 conditions) increased the thermal stability of PSII function. The reasons of the unexpectedly high adjustability of the spruce photosynthetic apparatus to high temperatures are discussed.

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Effect of heavy metal ions on electron transfer on the acceptor side of photosystem II

N.M. Topchiy

M.G. Kholodny Institute of Botany, Tereschenkivska str. 2, Kyiv, 01601, Ukraine
nataliya_topchiy@yahoo.co.uk

Introduction: Acceptor side of photosystem II (PSII) is one of the potential targets of heavy metal ions (Me^{2+}) action. Photoreduction of the secondary quinone acceptor Q_B is successfully studied at the bacterial reaction center by using Me^{2+} ions. The peculiarities of Me^{2+} ions binding with acceptor side of PSII in higher plants were investigated insufficiently. The aim of this work was to investigate the action of Cu^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+} and Hg^{2+} ions on the relative content of Q_B-non-reducing PSII with the view of updating of mechanism of Me^{2+} action on the photosynthetic electron transfer between Q_A and Q_B sites.

Methods: Class B chloroplasts were isolated from *Spinacea oleracea* seedlings. Reaction mixture for chloroplasts contained 100 mM sorbitol, 10 mM NaCl, 10 mM tris-HCl and chloride of Me^{2+}. Samples were preincubated in the dark for 5 minute. The content of Q_B-non-reducing PSII centers in chloroplasts of *Spinacea oleracea* was estimated by XE-PAM fluorometer at 40 μmol m^{-2} s^{-1} according to (Tomek, 2003). F_{pl} and F_m levels in chloroplasts suspension were determined after addition of 2mM FeCN and 10 μM DCMU.

Results: Cu^{2+}, Cd^{2+} (50 and 200 μM) and Hg^{2+} (5 and 20 μM) ions induced insignificant the increasing in the content of Q_B-non-reducing PSII centers. Zn^{2+} and Pb^{2+} (50 and 200 μM) ions enhance (more than 25%) the amount of non-active PSII centers.

Conclusions: In the present work, we showed that more electronegative Zn^{2+}, Cd^{2+} and Pb^{2+} inhibit electron transfer between Q_A and Q_B, and more electropositive Cu^{2+} and Hg^{2+} exhibit stimulatory action. One of the possible explanations is that Cu^{2+} and Hg^{2+} may accept electrons from Q_A^- in case if electron transfer between Q_A^- and Q_B is impaired.

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Physiological and anatomical adaptations of *Dianthus carthusianorum* to growth on a Zn-Pb waste heap

M. Wójcik, A. Tukiendorf

Department of Plant Physiology, Institute of Biology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland
Corresponding author: mwojcik@umcs.pl

Introduction: Over a 100-year old Zn-Pb waste heap in Bolesław, southern Poland, is covered with a specific flora adapted to high metal concentration in the soil and to drought conditions due to evolutionary processes. *Dianthus carthusianorum* is one of the dominant plant species found in this area. The aim of this study was to investigate the physiological and anatomical adaptations of this species to growth in the presence of high Zn, Pb and Cd concentrations.

Methods: Ecotypes of *Dianthus carthusianorum* growing on the Zn-Pb waste heap in Bolesław as well as on the unpolluted area of eastern Poland were examined using plants collected from their natural habitats and cultivated hydroponically in the presence of Zn, Pb or Cd. Heavy metal content, glutathione and phytochelatin concentration and organic acid accumulation were determined using ICP-MS, HPLC and spectrophotometrical methods, respectively. The tissue and cell structure and ultrastructure were observed under light and transmission electron microscopy.

Results: Plants growing on a waste heap accumulated on average 574 mg Zn, 9.77 mg Pb and 6.11 mg Cd per kg of dry leaf weight, whereas plants growing on unpolluted sites accumulated respectively 56, 0.47 and 0.37 mg Zn, Pb and Cd per kg of leaf dry weight. Malate concentration was about 2-fold higher in the leaves of the waste heap population but that of citrate was higher in the leaves of the population from the unpolluted region. The glutathione level was higher in the plants growing on the waste heap, however, no phytochelatin accumulation in these plants was found.

Hydroponic experiments confirmed higher metal tolerance of plants originating from the waste heap, although both populations accumulated similar concentrations of metals. Cd, but not Zn and Pb induced accumulation of phytochelatins, higher in the less tolerant population. The concentration of organic acids (citrate and malate) was generally not correlated with Zn, Cd or Pb concentration in the growth medium and was similar in both populations. All the metals examined induced alterations in the root and leaf structure and especially in the chloroplast ultrastructure.

Conclusions: The enhanced tolerance to Zn, Pb or Cd of the waste heap ecotype of *D. carthusianorum* is not based on increased accumulation of phytochelatins or organic acids.

Allelopathic effects of *Convolvulus arvensis* on *Triticum aestivum*

M.Yarnia [1] , E. Farajzadeh [2] , V. Ahmadzadeh[1], N. Nobari[1]

[1]Islamic Azad University, Tabriz branch, Tabriz- Iran
[2]Islamic Azad University, Malekan branch, Malekan- Iran
corresponding author: m.yarnia@yahoo.com & yarnia@iaut.ac.ir

Introduction: Because of abundance and importance of *Convolvulus arvensis* in wheat fields an experiment was conducted in 2007 at Islamic Azad University, Tabriz branch, Agricultural greenhouse and laboratories.

Methods: The experiment was factorial based in three replicates. different parts of *Convolvulus arvensis* in five levels (control, leaf, shoot, root, and flower extract) and different concentration in 4 levels (1:5, 1:10, 1:15, and 1:20)**.**

Results: Anova showed that effect of main factor and interactions on all attributes were significant. All extracts decreased germination components. But root extrac showed highest prohibition. Root extract and other parts at 1:5 concetration inhibit germination at all. Leaf extract decreased radicle and plumole length, seedling dry weight, germination percentage and velocity as 99.41, 96.98, 100, 98.64, and 62.74%, respectively. Anova in green house showed significant effect of some main factors and interactions. In low concentration, leaf extract and in high concentration root extract showed higher effect on attributes. Ýncreasing extract concentration from 1:20 to 1:5 significantly decreased all attributes. Decreasing rate of plant height, spike length, leaf nomber, pedancle length, seed nomber, TKW, and yield in 1:5 to control were 56.99, 50.44, 70,86, 62.4, 76.17, 94.66, and 99.01%, respectively.

Conclusions: Base on this experiment, it can be said that *Convolvulus arvensis* with producing allelopatic chemical materials drasticaly decreased germination, growth and yield of wheat.

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Effect of heavy metal ions on the efficiency of light energy transformaion under photosynthesis

E.K. Zolotareva

M.G.Kholodny Institute of botany, Tereshchenkivska str. 2, Kyiv, 01601, Ukraine
corresponding author: e.zolotareva@mail.ru

Introduction: Conversion of solar energy by alive organisms has till now no adequate thermodynamic description because of an apparent lack of the microscopic reversibility of light absorption and emission. Recently two equivalent, but independent approaches were developed allowed to include the first step of photosynthesis in the canonical description of biochemical processes and apply for their analysis the tools nonequilibrium thermodynamics. The aim of the work was an estimation of thermodynamic coupling and efficiency of process of photosynthetic energy transformation in isolated pea chloroplasts and effects of heavy metals on these processes.

Methods: Pea (*Pisum sativum L.*) plants were grown on hydroponic nutrient media which was supplemented with different concentrations of $CuSO_4$, $CdCl_2$, $ZnCl_2$, and $Ni(NO_3)_2$ from 0.1 mM (control) to 5 mM. The PPFD of the light phase was 400 mmol m-2 s-1. Chlorophyll was estimated by extraction in 80% acetone and its absorbance was measured with a spectrophotometer at 652 nm.Chloroplasts were isolated according to Walker et al., 1980.. Light-induced oxygen exchange was measured by Clark-type electrode. To measure electron transfer rate in isolated chloroplasts 1 mM methylviologen (MV) or 0.4 mM $K_3Fe(CN)_6$ as electron acceptor. Uncoupled electron transfer rates were measured in the same media in the presence of 10 mM NH_4Cl. Photosynthetic efficiency was estimated by determining the ratio of variable-to-maximum fluorescence (Fv/Fm) of dark-adapted leaves with a PAM-fluorometer (Walz, Germany).

Results: Coefficients of thermodynamic coupling (q) and optimal thermodynamics efficiency (η) were calculated on the basis of experimentally determined rates of photosynthetic electron transport (Je), ATP synthesis (Jp), uncoupled transfer of electrons from water to exogenic acceptor MV and transmembrane proton gradient value (ΔpH). All physiological characteristics were determined using isolated pea chloroplasts. It was shown that the value of thermodynamic coupling in chloroplasts was between 0,87 and 0,95, depending on growth conditions. In the same conditions optimum thermodynamic efficiency changed from 0,58 up to 0,64. All tested metals decreased photosynthetic oxygen evolution and affected the efficiency of light energy transformation. The effects of heavy metals increased at longer exposure of plants (more 4 d) to elevated concentration of heavy metals. In the same time the photosynthetic efficiency restored is the heavy metal concentrations did not exceed critical values.

Conclusions: The data support a hypothesis that higher plants have mechanisms protected them from heavy metal impacts.