

17 01

The effect of lead on polyamine content in *Helianthus annuus* plants

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The effect of different concentrations of lead was investigated in two different ways in the leaves of *Helianthus annuus* plants. In the first way, removed leaf discs from 5-weeks old plants were floated in 0.05, 0.25, 2.50 and 5.00 mM PbNO₃ solutions for 2, 4 and 6 days. In addition, the chlorophyll content and the activity of peroxidase enzyme which are the parameters of stress conditions in plants were also measured. In this experimental series, a decrease was determined in polyamine and chlorophyll contents and in the peroxidase activity in leaf discs which were treated with different concentrations of lead. In the second experimental series, one half of the upper leaves of 5-weeks old plants were used for lead treatments, while the other half for control. In half leaf experiments, lead in 0.05, 1.25 and 5.00 mM concentrations were sprayed to the both sides of the half leaves. According to the results of the half leaf experiments, 0.05, 1.25 and 5.00 mM lead treatments increased the putrescine content in 27, 15 and 9 % respectively. On the other hand, chlorophyll content and the activity of peroxidase enzyme were decreased with the treatments of lead.

17 02

Influence of Cd-stress on the thermosensitivity of photosynthesis of two barley cultivars

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The thermosensitivity of the photosynthetic apparatus of two barley cultivars - Obzor and Hemus - endured Cd-stress was investigated. As a criteria the changes in chlorophyll fluorescence parameters were used. The leaf discs were incubated 3 min at definite temperature in the range 25-50°C.

It was shown that control and stressed plants of both cultivars have different thermosensitivity being higher in Hemus. It was also found that thermostability of Cd-stressed plants of both cultivars is lower than the controls. The temperature of 50% inhibition of the variable fluorescence and the F_v/F_m ratio in these plants was about 1.5-2°C lower than in their controls.

17 03

Relationship between proline content and resistance to low temperature in several winter wheat cultivars

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Changes in free proline content in the leaves and roots were measured during cold hardening at 2 °C of three winter wheat cultivars differing in freezing resistance. There were investigated, also, the relationship between proline content variation, thermostability of membranes and cold resistance depending on period of cold hardening, in eight winter wheats. During the first weeks three cold hardening proline levels increased more in leaves than in the roots and decreased after five weeks of cold hardening at 2 °C. During cold hardening at 2 °C high level of proline content was found in cold resistance genotypes than in the sensible one. Proline levels have been found to be closely correlated to membranes thermostability and freezing resistance in winter wheat genotypes studied. The results have indicated the possibility to use proline content as a biochemical marker for selecting tolerant winter wheat genotypes after 14-21 d of cold hardening at 2 °C.

17 04

Respiration in plants from contrasting environments

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An important aspect of the growth and survival of plants in contrasting environments is the rate of net carbon gain. While photosynthesis is a fundamental component of net carbon gain, a parameter that is often over-looked is the rate of carbon loss via respiration (a process that can result in the loss of 50% of the photosynthate produced daily in plants). The degree to which respiration decreases net carbon gain will be determined by several factors, including the efficiency of energy production (e.g. the contribution of the alternative pathway to total respiration) and the efficiency of energy usage (e.g. the proportion of respiratory energy that is allocated to growth, maintenance and ion uptake). Therefore, to understand the role respiration plays in determining net carbon gain (and survival) in plants from contrasting environments, it is critical that we obtain information on several aspects of the respiratory metabolism.. This talk will review what is known about respiration in plants from contrasting environments, in particular the relationship between respiration and growth in plants from warm and cold environments.

17 05

Enzyme assays: catalase, peroxidase and superoxide dismutase in sunflower (*Helianthus annuus* L.) under salt, osmotic and heavy metal stresses

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The antioxidant enzymes have significant importance in cell protection and plant tolerance against environmental stresses.

The effects of salinity (200 mOsm NaCl), osmotic (200 mOsm PEG) and heavy metal (100 μ M Cadmium) stresses on plant antioxidant defence were studied. Catalase, guaiacol peroxidase and superoxide dismutase (SOD) levels were measured in the leaves and roots of two sunflower cultivars: Viki (stress tolerant) and Blumix (less tolerant). Catalase activity was higher in leaves. Compared with the control, catalase level increased under salt and osmotic stresses, and decreased under Cd treatment. Guaiacol peroxidase and SOD were higher in roots. The salt, osmotic and Cd stresses brought about elevation in peroxidase activity in leaves and roots from both cultivars. SOD activity slightly increased under salinity. A higher increase was found under osmotic treatment of Viki roots.

Our results indicate an increasing tendency in antioxidant enzyme activities under the above mentioned stresses, with differences between the two cultivars. The study may have applicability in plant breeding programs, for detection and selection of tolerant cultivars.

17 06

Synthetic pyrethroides affect physiological processes in cell cultures from higher plants

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In recent years many different types of herbicides have been developed, tested and investigated both as plant protection chemicals in practical agriculture and as inhibitors in plant physiological research. Other substances with plant protective properties like insecticides and fungicides have largely been neglected as far as their effect on plants i.e. their phytotoxicity is concerned. Therefore, and for ecological reasons in general, physiological substances (from nature) deserve specific interest. In the present work we investigated the effect of synthetic pyrethroides on cell cultures from higher plants (*Lycopersicon peruvianum*). Permethrin, Fenvalerat and Deltamethrin have an impact on various physiological processes. Fluorescence emission, distinct parts of the electron transport chain and absorption spectroscopy were investigated in dependence on the concentration of the applied pyrethroid. Thus, it appears that the 'Kautsky-effect' usually observed in the kinetics of the fluorescence emission curve is drastically decreased with the maximum fluorescence yield being substantially increased upon addition of the pyrethroid insecticides. Photosynthetic electron transport reactions like the H_2O -MV-Mehler reaction and the Ferricyanide-driven Hill reaction are strongly inhibited, whereas typical PS I reactions remain completely unaffected. Thus, these insecticides have herbicidal properties which are analyzed and discussed.

S259

17 07

Cd accumulation in roots and effects of Cd on growth of different plants

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The aim of this research was to obtain some information about Cd accumulation and the effects of Cd on growth of different plant species. Hydroponic cultures of young seedlings of *Ailanthus altissima*, *Lycopersicon esculentum*, *Zea mays*, *Picea abies* and *Vigna radiata* have been set up in a phytotron chamber. They were exposed to 6 different concentrations of Cd (10, 30, 50, 100, 200 and 500 μM Cd) for 2 weeks. During the experimental period, shoot heights, root lengths were measured and the general condition and appearance of the plants were registered. At the end of the experiment, roots of the seedlings were harvested and dried, fresh weights and dry weights were measured. The Cd content of the wet digested root samples were determined using AAS. In our results, the highest Cd contents (on a dry weight basis) were found in *L.esculentum* and *V.radiata* roots followed by *A.altissima*, *Z.mays* and *P.abies*. General symptoms of Cd toxicity appeared as chlorosis or necrosis, reduced growth, reduced fresh and dry weights in all plants but in different levels. *V.radiata* was very sensitive and damaged even at the lowest levels of Cd (10 μM Cd).

17 08

Osmotic acclimation of the Antarctic green alga *Prasiola crispa* investigated by *in vivo* ^{31}P NMR

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The response of the marine macroalga *Prasiola crispa* to exposure to ionic and nonionic osmotica in the range of 1 to 8 Osmol was investigated using *in vivo* ^{31}P nuclear magnetic resonance spectroscopy (NMR). Time courses of the phosphorous spectra under salt and PEG (polyethylene glycol) stress were compared with photosynthesis and respiration measurements. During ionic and nonionic stress decomplexation of divalent cations and hydrolysis of the polyphosphates were observed. Under salt stress the cytoplasmic inorganic phosphate and the NTP levels decreased in the *in vivo* ^{31}P NMR spectra followed by a cytoplasmic acidification whereas under PEG stress we measured an increase of cytoplasmic inorganic phosphate. At concentrations above 4 Osmol inorganic phosphate was extruded. Returning to control conditions the NTP levels and polyphosphates recovered within 1 hour. During these treatments the photosynthesis and respiration rates were effectively inhibited. After salt stress the recovery of the photosynthesis and respiration rates is slower than after PEG stress. We suppose that under salt stress the cells achieve osmotic acclimation and extrude the toxic ions, therefore the algae consume more energy than under nonionic stress.

17 09

The dependence of growth rate on the synthesis of low molecular mass heat shock proteins in maize lines under enhanced temperature**G. BOROVSKY, L. VORONOVA and V. VOINIKOV***Siberian Institute of Plant Physiology and Biochemistry, Siberian Branch of the Russian Academy of Sciences, Irkutsk-33, P.O. Box 1243, Irkutsk, 664033, Russia*

The interspecies genetic variability was found in the seedlings of inbred maize (*Zea mays* L.) lines in the study of their growth rate in enhanced temperature. A series of low molecular mass heat shock proteins was analyzed. A correlation between the changes in the synthesis of two low molecular mass proteins (29 and 16 kDa) under the heat shock and the ability of maize lines to grow intensively under the high temperature was found. The synthesis of these proteins was enhanced after 12 h heat shock. Thus, the relation of these proteins to thermoadaptation of maize has been assumed.

17 10

Effect of paclobutrazol (PBZ) on growth, response of plants on chilling temperature and fruiting of sweet pepper**E. BOROWSKI, L. KOZŁOWSKA***Department of Plant Physiology, Agricultural University, Akademicka 15, 20-934 Lublin, Poland*

Application of paclobutrazol at 0, 2, 5, 10 mg l⁻¹ by pots drench inhibited growth of plants, however, the leaves of sweet pepper treated by the PBZ showed thicker leaf blades, higher content of chlorophyll, electrolytes and water strongly bound in tissue, lower percent index of chilling injury of leaf discs at temperature of 0 - 1°C. However, final crops of fruit from plants treated by PBZ was significantly lower than from control. In other experiment both control plants and treated by PBZ were placed for 0, 2, 4, 6 d in growth chamber at temperature 0 - 1°C. Subsequently after different chilling period, plants were sprayed with GA₃ solution twice. Obtained results confirmed higher resistance of plants treated by PBZ on chilling injury (0 - 1°C), simultaneously limitation of PBZ activity due to GA₃ application considerably increased fruiting of sweet pepper.

17 11

Sun-shade adaptations of grapevine leaves**B. BOTOS-BÁLO, Gy. VÁRADI and I. HAPP****Research Institute of Viticulture and Enology, University of Horticulture and Food Industries,
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One of the most important requirements of high wine quality is well exposed leaves and clusters to the sun. In dense canopies leaves may be partly or totally shaded. Thin canopies may suffer from photoinhibition. In field experiments "ideal" and "dense" canopy structure of Chardonnay vines was described by Pinot Quadrat analysis. Light interception (PAR) of well exposed to shaded leaf layers was recorded. Characteristics fluorescence induction curves showed shade adaptation of the lower leaf layers. Leaf water potential data correlated well with leaf exposure. Sun and shade adaptation resulted in a remarkable difference in the xanthophyll pool. Zeaxanthin plays an important role in energy dissipation mechanism under high light stress.

17 12

The Fe leaching from at the long-term NPK application in vineyards**V.M. BUSUIOC and S.I. TOMA***Institute of Plant Physiology, Padurilor 22, Kishinev 277002, Moldova*

In a long-term field experiment the leaching of mobile Fe compounds from upper soil layers to lower ones and, hence, loss for grape plants at the application of high NPK doses was established. Under the influence of the long-term annual NPK application in the soil layer deeper than 200 cm, the content of Fe increased by 1.5 - 2.0 times. With the aid of the correlation analysis the Fe change character along soil layers depending on NPK doses was determined. The conclusion of the necessity of the corresponding fertilizer system elaboration which allows the maintenance of the nutritive element concentration in soil optimal for plants was drawn. Annual feeding of grapevine with mineral fertilizers of more than 90 kg/ha NPK is not reasonable.

17 13

Tiller roots as sensors of water stress in wheat**C.E. CABEZA and J.F. LEDENT***Laboratoire d'Ecologie des Grandes Cultures, Université Catholique de Louvain, Place Croix du Sud 2, 1348 Louvain-la-Neuve, Belgium*

The roots of the first or the second primary tiller of wheat plants were subjected to stress (OS : osmotic stress and EA : exposure to air) and then excised (48 h later) or were excised from the beginning of experiments. The remainder of the root system was immersed in nutrient solution. Leaf elongation rate (L), leaf water potential (LWP), stomatal conductance (Gs) and photosynthetic rate (P) were measured on the last expanded leaves of the main shoot (MS) and tillers 24, 48 and 72 h after the treatments started. L and LPW of MS and tillers were not affected. OS applied to the tiller roots reduced Gs and P in the tiller and in the MS leaves. Effects increased with time. EA treatment did not affect Gs nor P on the tiller but P was reduced and Gs increased in MS leaves. Removal of tiller root performed at the beginning of treatments had no effects. Root excision after 48 h of OS brought an increase of Gs and P in the MS leaves to the level of the control plants. To the opposite, in the case of EA, a reduction of Gs in the MS leaves was observed. The stressed roots of tillers seem to be the origin of signals which can affect Gs or P.

17 14

Adaptation of cucumber transpiration to air humidity stress - Stomatal resistance modeling**S. CHAMONT***Station d'Agronomie, INRA, BP81, 33883 Villenave d'Ornon Cedex, France*

Cucumber stomata are very sensitive to climatic conditions. Therefore, they are a good parameter for greenhouse on-line climate control. Modeling stomatal aperture as a function of global radiation gives a good explanation of stomatal resistance. Quantification of the effect of vapour pressure deficit is more difficult. There is an inverse relation of vapour pressure deficit on the diurnal pattern of cucumber stomatal resistance. In the same way, plant stomata submitted to high evaporative demand (2.2 kPa) are more sensitive to cloudy events than those of plants grown under low evaporative demand (1 kPa). This probably means a synergistic effect of radiation level and evaporative demand on stomatal aperture. Optimization function of plant gas exchange rate, in greenhouse crop growth models, by maximising photosynthesis at a particular average rate of transpiration is necessary for a good prediction of daily dry matter production.

17 15

Influence of methyl jasmonate on lipid and protein content in green algae cultivated at different temperatures

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The green algae *Scenedesmus incrassatulus* R-83 were treated with methyl jasmonate (JA-Me) in a concentration of 1.10^{-5} M. JA-Me enhanced lipid content at optimal temperatures of cultivation, while at extreme temperatures the changes were insignificant as compared to the control. JA-Me induced an increase of palmitic acid and at the same time reduced the share of palmitoleic, oleic and linolenic acids at high temperatures (30 °C, 35 °C). Proteins were increased but the most important effect of JA-Me is at the highest temperatures. The results show that JA-Me has a positive effect on the adaptation ability of green algae to stress temperatures.

17 16

Changes in root anatomy of two wild grass species induced by extreme soil acidity

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Nodal roots of *Nardus stricta* L. and *Deschampsia flexuosa* L. grown in the field conditions, with soil pH 5.4 (control, undisturbed meadow) and pH 2.7 (polluted, stress conditions) were investigated. Soil analyses did not show toxic heavy metal concentrations but a significantly lower Ca content, in the polluted soil. Cross section areas of the root, cortex, stele, and xylem vessels as well as numbers of late and early metaxylem were evaluated.

With the exception of root cortex in *D. flexuosa*, the cross section areas of all anatomical parameters were significantly reduced in the roots of both species growing in the locality with soil pH 2.7. From the reduced area of xylem vessels the reduction in root conductivity can be anticipated. The decrease in total area of xylem vessel elements was lower in the roots of *D. flexuosa*, in which also preservation of cortex area was observed. Such responses may be related to a higher tolerance observed with this grass species.

17 17

The effect of ammonia fumigation at different temperatures on growth and nitrogen metabolism in winter wheat

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Winter wheat plants (*Triticum aestivum* cv. Urban) were fumigated with 0 or 1 $\mu\text{l/l}$ NH_3 for 1 week at 18.5°C and subsequently for 1 week at 4°C. Growth, total nitrogen, proteins, amino acids, ammonium and nitrate content of the shoot were determined at certain time intervals. At 18.5°C NH_3 fumigation lead to a small increase in biomass production. The nitrate and protein content were increased with respectively 10 and 15%, whereas the other nitrogen pools did not change upon fumigation. After lowering the temperature to 4°C, growth stopped and ammonium and amino acid content of the NH_3 fumigated plants raised to a two times higher content compared to the control plants. Protein and nitrate content were not affected by fumigation. The total nitrogen content in the fumigated plants ended up with a 15% higher content as in the control plants. Fumigation with ammonia did not lead to visual damage of the plants. From this experiment it can be concluded that reducing growth by low temperatures leads to an accumulation of ammonium and amino acids since NH_3 cannot be metabolized anymore.

17 18

The expression of an additional dehydroascorbate reducing enzyme in *Dasypyrum villosum* seedlings induced by water stress conditions.

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Dry seeds are devoid of ascorbate and contain a small amount of dehydroascorbate (DHA); DHA reductase, which is present in the seed, plays a key role during the early stages of germination. Its activity is essential as it provides a limited ascorbate pool necessary until consistent ascorbate biosynthesis starts after several hours of germination. In the subsequent stages of the plant development DHA reductase activity is clearly less relevant.

Ascorbate recycling by DHA reduction becomes very important for plant growth under ascorbate deficiency or imbalanced AA/DHA ratio conditions. Here we report that a wild species of Triticinae, *Dasypyrum villosum*, grown under water stress, produces seedlings with enhanced capability to enzymatically reduce DHA. The presence of a supplementary DHA reducing enzyme can be demonstrated with a non denaturing PAGE. In addition, data here reported show that the capability to enhance DHA reduction as a response to stress conditions is particularly evident in the most advanced monocots.

S265

17 19

Phenol content variation in water and salt stressed natural populations of *Dactylis glomerata* L.

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Phenols have been used as stress indicators and also have a chemotaxonomical significance in *Dactylis glomerata* L. Seeds from six coastal natural *D. glomerata* populations from Galicia (NW Spain) and Portugal were sampled and potted in glasshouse. A series of experiments was performed, with three salt stress levels (2,5; 5 and 10 g/l NaCl) and three hydric availability levels (by Manitol addition 0,1; 0,2 and 0,3 M).

Phenols were identified and quantified by means of Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC). There were clear differences among mature and young plants. Experimental treatments, specially hydric stress also affected the phenolic content.

In mature plants cinnamic esthers and glycosides are abundant (specially caffeic acid), while in young plants cinnamic and benzoic free acids (p-coumaric, ferulic, vainillinic and p-Hydroxybenzoic acids) are predominant.

Stress treatments affected mainly the quantities of phenols present, increasing in salinity treatments and soft and moderate hydric stress. It seems that aldehydes suffer an increase in water stress.

17 20

Germination ecophysiology in hard-seeded fire following plants

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Hard-seeded plants constitute a major component of the post-fire flora in Mediterranean ecosystems. In the present study germination mechanisms are investigated in the following species: *Calicotome villosa*, *Spartium junceum*, *Anthyllis hermanniae*, *Scorpiurus muricatus*, *Hippocrepis unisiliquosa*, *Convolvulus elegantissimus*, *Rhus coriaria*, *Cistus creticus* and *Fumana thymifolia*. All species are characterized by a primary dormancy due to the water-impermeable (hard) seed coat. Germinability of untreated seeds is generally low (0-20%, *Spartium junceum* 44%). Breakage of dormancy is achieved through mechanical scarification of the seed coat with the technique of seed immersion in boiling water for a few seconds (optimal duration: 2-60 s). This laboratory simulation of fire heat results in an impressive enhancement of germination (almost 100% in most cases). With the exception of *Rhus coriaria* (whose seeds show an additional embryo dormancy which can be released by a subsequent, prolonged stratification treatment), in all the species tested, induction by thermal scarification is by far the most important factor of germination behaviour since it results in optimal germinability at a broad temperature range and under various light regimes.

17 21

Cs-tolerant cell line of *Nicotiana plumbaginifolia* resistant to LiCl, NaCl and KCl

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The Cs-tolerant (Cs^t) cell line of *N. plumbaginifolia* was obtained by stepwise selection on medium containing 5-30 mM CsCl. Comparative estimate of growth of the control (Cs^s) and Cs^t lines based on the increase of the fresh weight of their calli were made. Necrosis of the Cs^s line took place at 30 mM CsCl, while under the given conditions the growth rate (GR) of Cs^t line was maintained at 30% of the control level. We observed 20-25% increase in sensitivity of both Cs^t and Cs^s lines to CsCl during their growth in the presence of 100 µM buthionine sulfoximine. We also estimated, that the GR of Cs^t line in the presence of 70 mM LiCl, 150 mM of KCl became 22% and 18% respectively, while Cs^s line given the same conditions underwent necrosis. Application of 110 mM of NaCl into the medium decreased the GR of Cs^t line to 35% and those of the Cs^s to 8-10%. 20 mM NaCl accounted for an 25-30% increase in growth of Cs^t but not of Cs^s lines. The results thus obtained suggest the existence of common mechanisms of tolerance of *N. plumbaginifolia* towards toxic concentrations of LiCl, NaCl, KCl and CsCl. The fact that glutathione or phytochelatins have roles to play in Cs-tolerance is not to be ruled out.

17 22

Effect of the sodium chloride on oxygen diffusion barrier and carbohydrates content in *Lupinus albus* cv. Multolupa nodules

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The effect of different NaCl concentrations on the structure and functioning of the oxygen diffusion barrier in lupin nodules was studied over a 6 d period. These changes were also correlated with alterations in carbohydrate metabolism, leghemoglobin content and enzymes related to protection against oxidative damage. Oxygen Diffusion resistance increased with 50 and 100 mM NaCl but showed some recovery when 150 mM was applied for 6 d. These effects were paralleled by changes in glycoprotein content of the nodules, as determined by immunogold localization and western blot analysis. Increases in NaCl also caused decreases in starch and increases in sucrose content, suggesting an osmotic regulation. These changes were linked to a decrease in sucrose synthase activity.

Leghemoglobin content decreased with saline stress but the enzymes that protect leghemoglobin against oxidative damage were not affected, with the exception of SOD which decreased by 30% at 150 mM for 6 d. This indicates that superoxide radicals could be involved in the toxicity of NaCl.

S267

17 23

Influence of low dose radiation on protease inhibitor and proteases in cereals**I.A. FILONICK***Institute of biology Dnepropetrovsk State University, Gagarin av., 72, Dnepropetrovsk, 320625, Ukraine*

Considerable pollution of environment deteriorates the quality of agricultural products. Low doses of chronic irradiation, caused by Chernobyl disaster, influences negatively growth and development of plants, their phytoimmunity. It's the reason for investigation of the action of this factor on the biochemical processes in high plants. Influence of low dose radiation in Chernobyl zone on the activity of protease inhibitors and proteases (pH 7.7) in seeds of cereals (wheat, rye, maize) was studied. The decrease of protease inhibitors activity and the activation of proteolytic enzymes were found in ripe seeds of cereals, grown under the chronic irradiation. It's known, that protease inhibitors in high plants except their participation in the activity regulation of own endogenous enzymes can execute protecting functions. The decrease of protease inhibitors activity in cereal seeds under low dose radiation effect may reflect the decrease of plant immunity. The changes of protease inhibitors and proteases activities can be used as biotests of low doses of chronic irradiation action on plants. It was the matter of interest for prognosis of consequences of the effect of this negative factor of environment on cereals.

17 24

Carbohydrate accumulation in pea plants subjected to drought under different regimes of N-nutrition**S. FRECHILLA, M. ROYUELA, C. ARRESE-IGOR and P. M. APARICIO-TEJO***Dpto. de Ciencias del Medio Natural, Universidad Pública de Navarra, E-31006 Pamplona, Spain.*

A common plant response to water stress is osmotic adjustment for maintaining cell turgor. Solutes known to accumulate upon water stress and to contribute to osmotic adjustment are inorganic ions, organic acids, carbohydrates and free amino acids. We investigated the changes of soluble carbohydrates in roots and shoots of pea plants subjected to drought under two regimes of N-nutrition: dinitrogen fixation or nitrate assimilation.

Plants of pea (*Pisum sativum* L.) were grown with nitrate (20 mM) or inoculated with *Rhizobium leguminosarum* bv *viciae*. After 4 weeks growth, water stress was imposed by withholding water for 15 days. Water stress induced an accumulation of total soluble carbohydrates in all organs of stressed-plants, although the main accumulation was detected in roots. The response was influenced by the nitrogen source, so that the higher accumulation was observed in fixing-plants. Sucrose and reducing sugars were the carbohydrates involved in osmotic adjustment, except in shoots of nitrate-fed plants, where sucrose was the only accumulated carbohydrate.

17 25

Ni-malate complex in roots and xylem fluids of a Ni-hyperaccumulator species.

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Phytochemical studies on several Ni-hyperaccumulator species have shown that in leaf extracts Ni is associated with organic acids. In *Alyssum bertolonii* Desv., a species of Tuscan ultramafics which hyperaccumulates Ni in the aerials parts, high concentrations of malic and malonic acids have been observed in the leaves. In this work the presence of a Ni-malate complex has been identified by HPLC analysis in root sap extracts and in xylem fluids. This suggests that Ni-malate is involved in the long-distance transport of Ni to the aerial parts. The activity of some enzymes implicated in malic acid metabolism has been investigated in roots and leaves. Increasing Ni uptake did not affect enzyme activity.

17 26

Acclimatory responses to radiation environment in some grasses colonizing deforested areas

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Three different approaches were used in quantification of shade tolerance of some perennial grasses: (a) nondestructive estimation of their relative growth rate (RGR), (b) analysis of photosynthetic and respiratory characteristics of individual organs, (c) measurement and calculation of the whole plant carbon balance over the 24 h cycle. The plants were grown in extremely low photosynthetic photon flux (PPF, $25 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), and at moderately high PPF ($200 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). Fully acclimated plants of both species grew successfully at low PPF treatment with RGR about 20 to $40 \text{ mg}\cdot\text{g}^{-1}\cdot\text{d}^{-1}$, and increased their RGR three to five times immediately after transfer to high PPF. Lowered respiration rate and increased specific leaf area were the most powerful mechanisms in acclimation to low PPF. Variation in the net photosynthetic rates per unit leaf area did not contribute significantly to acclimation.

S269

17 27

Influence of chronic irradiation after Chernobyl nuclear accident on the most important processes in plants**N.V. GONCHAROVA, V.V. SHEVERDOV, I.V. ZHEBRAKOVA***Institute of Radiobiology, Academy of Sciences, Zhodinskaya 2, 220600 Minsk, Republic Belarus*

Plant vegetation is rather sensitive to any pollution of the environment. The efficiency of photosynthetic apparatus is characterized by such properties as photochemical activity of chloroplasts, cyclic photophosphorylation and activity of ribulosebiphosphate carboxylase (RuBPC). These characteristics are used to show the state of plant growth under increased background radiation. We have found a tendency to an increase of chlorophyll content and reduction in the concentration of soluble protein. Regular features, concerning photochemical reactions, are similar to activity of RuBPC. Low hydrolytic activity of chlorophyllase, that is an enzyme of chlorophyll degradation, testifies high activity of the photosynthetic apparatus of plants growing under increased background radiation conditions.

17 28

Search for allelopathic regulators of plant growth and development**V.P.GRAKHOV and V.G.KOZEKO***Central Botanical Garden, Academy of Sciences,
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Allelochemicals which carry interactions between plants are now under intensive study. New conception in this field is the consideration of allelochemicals as ecological biochemical regulators of plant growth, development and renewal. The general principle of such regulation lies in the fact that working physiological program set can be switched by allelopathically active substances. Each plant species may be characterized with own allelopathic autoregulators and related mechanisms of such regulation. Using our experimental approaches the experimental data on Canada thistle (*Cirsium arvense* (L.) Scop.) allelochemicals had been obtained. They influence mainly the growth of creeping roots and the formation of adventitious buds and as a result the spatial distribution of next vegetative shoots. The substances considered as autoregulation factors were detected by HPLC and found both in soil samples under different densities of vegetating plants and hydroponic culture nutrient solutions.

Effects of Cd on leaf cuticular lipids of sugar beet.

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High internal Cd concentration in sugar beet increases the leaf transpiration rate. The reason must be affected leaf cuticle since Cd causes stomata closure. Of that reason the Cd effect on the leaf cuticular lipids ("wax") was investigated. The epicuticular lipids (leaf surface) and the intracuticular lipids (in the cuticle) was extracted (10 sek and 3 h, respectively, in chloroform) from primary leaves of plants cultivated in 0 and 10 μM CdCl_2 for 4 weeks. The lipids contained alcohols, alkanes and fatty acids and were analysed by means of gas chromatography. Cadmium decreased the length of the carbon chains of the lipids and increased the ration of polar:unpolar lipids. The epicuticular lipids are more affected than the intra cuticular ones. It is proposed that Cd inhibits some elongation steps within the elongation-decarboxylation mechanism during the synthesis of leaf cuticular lipids.

Adaptation of *Pisum sativum* energetic and antioxidant systems by action of acidic gases

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We were searching the activity of the main enzymes of the phosphoric metabolism from 10-days living plants *Pisum sativum* affecting them different doses of HF (0.005 mg/m^3 0.025 mg/m^3) in our experiments. The decrease activities of the acid phosphates on 37%, 50%, 55%; the alkaline phosphates on 51%, 57%, 60%; the ATP-ase on 38%, 49%, 52% and ADP-ase on 24%, 51%, 60% while 4, 8, 24 hours fumigation by HF in concentration 0.005 mg/m^3 . The high concentration of HF (0.025 mg/m^3) reduce the activities of this enzymes on 51%, 58%, 60%; on 60%, 65%, 68%; on 50%, 70%, 80% accordingly. The activity of polyphenoloxidase was increased in all case on the average of 24%. Catalase and peroxidase activity were inhibited on 30-40%. The obtained data shows that alkaline phosphates is the link of phosphoric metabolism which early susceptible to fluorine pollution. Obviously it is connected with inhibition the ADP- and ATP-ases activities and with decreasing of the rate of phosphoric residuum of ATP. The result of analysis exposed the activity of ADP- and ATP-ases is directly proportional depended to the HF concentration and for the fumigation time. During the long fumigation the ADP-ase activity is inhibited stronger than ATP-ase activity.

17 31

Effects of long-term anoxia on carbohydrate metabolism in rice seedlings

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The metabolism of carbohydrates was investigated in rice seedlings grown under anoxia. Two phases can be recognized in the utilization of carbohydrates: during the first days of germination under anoxia, the metabolism of sugars is mainly degradative while, after the induction of α -amylase has taken place, the increased presence of glucose and sucrose indicates that both starch degradation and sucrose synthesis are taking place. The analysis of the enzymes involved in carbohydrate metabolism indicates that anoxic rice seedlings possess a set of enzymes allowing the efficient metabolization of starch and sucrose to fructose 6-phosphate. We propose that cytosolic sucrose metabolization in anoxic rice seedlings takes place exclusively through a sucrose synthase pathway with nucleoside diphosphate kinase allowing the cycling of uridylylates needed for the operation of this pathway.

17 32

Seed dispersal, germination and flowering strategies of winter desert annual plants of the Negev desert

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Typical to many deserts receiving winter rains are very hot, dry summers and small, unpredictable amounts and distribution of rain in winter. Therefore, the length of the growing season is unpredictable.

The majority of seeds produced are consumed by desert creatures. Two strategies of seed dispersal and germination have developed. (1) The 'opportunistic' strategy in which tiny, dustlike seeds are dispersed after maturation and 'escape' from consumption. Seeds germinate after as little as 10mm of precipitation, giving no chance of seedling survival unless followed by further rainfalls. (2) The 'cautious' strategy by which the small number of relatively large seeds produced are protected by the woody parts of the dead mother plant. The seeds either germinate *in situ* or are dispersed by rain. A portion of these seeds germinate only after enough precipitation for development of the seedlings.

The flowering time of winter desert annuals may ensure seed maturation before summer. (1) In facultative long day plants, the later seeds germinate in the season, the longer the daylength and the earlier the flowering and seed maturation. (2) In daylength independant plants, flowers appear after a relatively short time. The longer the suitable conditions for growth, the more flowers and seeds produced.

S272

17 33

Effect of temperature on stomatal responses to ABA and CO₂ in *Bellis perennis* L.

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Epidermal strips from *Bellis perennis* L. were incubated in the light, in 10 mol m⁻³ MES + 50 mol m⁻³ KCl, at pH 6.15, for 1 - 4 hours. A constant temperature from a range of 5 - 40 °C was maintained throughout, and the strips exposed to 0 - 10⁻¹ mol m⁻³ ABA and 0 - 700 ppm CO₂. It was found that inhibition of stomatal opening due to ABA and CO₂ was dependent on temperature. At 10 °C, low concentrations of ABA and CO₂ stimulated stomatal opening. Stomatal inhibition due to ABA increased with increasing temperature up to 30 °C; stomatal sensitivity to CO₂ was optimal at 20 °C, declining at higher temperatures. Porometry measurements on whole plants showed that at low temperatures (5 °C) an increase in atmospheric CO₂ concentration from 350 ppm to 600 ppm had no effect on stomatal conductance in either well-watered or water-stressed plants.

17 34

Inhibition and acclimation of photosynthesis under ultraviolet-B radiation in liverworts

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Conocephalum conicum, grown in the absence of UV-B, was irradiated with monochromatic light of 312 nm wavelength, at a flux density of 14 W/m². Photosynthetic oxygen evolution was completely inhibited within less than 1 h under this condition. The ratio of variable over maximum chlorophyll fluorescence at room temperature, F_v/F_m , was linearly related to O₂-evolution. Hence, F_v/F_m was suitable for a rapid probing of photosynthetic efficiency. Chlorophyll fluorescence at 77 K indicated that only photosystem II was inhibited during irradiation. 24 h after UV-B irradiance, a complete recovery of O₂ evolution occurred. Repetitive UV-B irradiance for 30 min per day over a period of 11 days induced a complete tolerance for the applied UV-B flux density. The mechanisms underlying the acquisition of UV-B tolerance were studied.

S273

17 35

A new comparison of dark respiration rates of northern and of temperate plants**T.I. IVANOVA and O.S. YUDINA***Komarov Botanical Institute, RAS, Prof. Popov Str. 2, St. Petersburg, 197376, Russia*

It is well documented that adaptation to low temperature conditions causes compensatory increase of respiration rate. Thus the respiration rate (RR) of Arctic plants is higher than that of the temperate ones at the same temperature (Ivanova and Vaskovsky 1976). However it was shown for the RR expressed on the dry mass basis, while the biomass composition of plants from different habitats varies. More correct would be comparisons of RR calculated per unit of protein content. We made such comparisons on plants from northern and temperate habitats. The RR values of Arctic plants measured on the Wrangel Island (71° N) and at the Kola Peninsula (68° N) at the mean temperatures of the corresponding habitats (10 °C and 15 °C) were 0.15 and 0.14). While the temperate plants demonstrated RR as high as 2.3 (25 °C). Comparison of plants species of the same genera from different habitats has shown that RR of Wrangel Island plants are higher than those of the Kola Peninsula but lower than the RR of temperate plants. These data arise the problems of the energy supply of proteins in plants of different growth conditions.

17 36

Early events in acclimation of herbaceous plants to low temperature**A. KACPERSKA***Institute of Plant Experimental Biology, Warsaw University,
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Prolonged exposure of chilling-resistant plants to cold results in adjustment of plant growth and metabolism to low temperature conditions and in an increased resistance of plant tissues to freezing temperatures. The process, known as acclimation of plants to cold, proceeds in stages, depended on the sequential action of chilling (>0°C) and freezing (-3°C to -5°C) temperatures. In each stage the "reaction" phase and the "restitution" phase can be distinguished. In the reaction phase a reversible membrane destabilization, associated with hydrolysis of polyphosphoinositides to inositol phosphates, was observed. On the other hand, pronounced decrease of water potential, accompanied by accumulation of abscisic acid, took place in tissues responding to low temperature treatments. Possible interrelations between these phenomena and their role in cold acclimation process will be discussed.

17 37

Reproductive phenology and reproductive output in threatened plants of Cyprus.

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Nineteen rare and threatened plant species of Cyprus are characterized by the Bern Convention on the conservation of European wildlife and natural habitats as strictly protected. Within the framework of a research project concerning the reproductive biology of these plants, data are presented on the reproductive phenology (timing, duration and synchrony of events such as flowering, fruiting, seed dispersal and germination) and reproductive output of the following species: *Origanum cordifolium*, *Phlomis brevibracteata*, *Phlomis cypria*, *Alyssum akamasicum*, *Pinguicula crystallina*, *Astragalus macrocarpus* ssp. *lefkarensis*, *Crocus cyprius*, *Crocus hartmannianus*, *Chionodoxa lochiaie*, *Scilla morrisii*, *Tulipa cypria*, and *Ophrys kotschyi*. The phenomenon of bradychory was observed in *O. cordifolium*, *P. brevibracteata*, *P. cypria* and *A. akamasicum*. Reproductive success in terms of contribution to future regeneration and defined as the proportion of the actual to the theoretically estimated maximum seed output was determined. *T. cypria*, *O. kotschyi*, *C. lochiaie* and *A. macrocarpus* ssp. *lefkarensis* have very low reproductive success (sometimes close to 0%) due to limitations occurring mostly between flowering and fruiting.

17 38

The influence of cold acclimation on the fatty acid composition of plasma membrane lipids and frost-resistance of winter wheat

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Suggesting the plasma membrane (PM) was the place of primary freezing injury and the question of the role of fatty acid unsaturation of membrane lipids had not been yet decided finally we studied the fatty acid composition of PM lipids of winter wheat during cold acclimation in connection with frost-resistance of seedlings. The research carried out on two contrasting varieties: high frost-resistant - Myronovskaya 808 and low frost-resistant - Carybo. Plasma membrane fractions were isolated from stem part of non acclimated (control) and acclimated at 2 C for 1,2,3,4 and 7 days winter wheat seedlings. The result of cold acclimation is the content increasing of unsaturated fatty acids of PM lipids. The frost-resistant variety's unsaturated fatty acids sum has changed from 28,9 (control) to 78,3 mole % in seven days of cold acclimation and low frost-resisting variety's from 20,8 to 55,9 mole % accordingly. The investigated increasing of unsaturation of fatty acids of PM lipids degree were mainly due to linolenic acid which achieved 28,8 (Carybo) and 47,2 mole % (Myronovskaya 808). The increasing of unsaturation of fatty acids of PM lipids degree accompanied the raising of frost-resisting ability of winter wheat seedlings after freezing. Thus, changing the duration of cold acclimation made possible to influence on the fatty acid composition of PM lipids and frost-resistance of winter wheat seedlings.

S275

17 39

On the nature of different frost resistance of winter rye and wheat plants**S. V. KLIMOV, T.I. TRUNOVA***Timiryazev Institute of Plant Physiology, Russian Academy of Sciences,
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The seedlings of winter wheat (*Triticum aestivum* L.) cv. Voskhod 2 and winter rye (*Secale cereale* L.) cv. Mironovskaya were hardened at 2°C, at light of 2.5 klx and 16-h photoperiod during 10 days. The ratio of light-saturated true photosynthesis to dark respiration for rye plants was 40% higher as compared to wheat plants. By the end of hardening, this ratios increased for both species in 2-3-fold. Cold hardening of both wheat and rye induced an increase in cytoplasm volume, in chloroplast volume, in the number of plastoglobules, in sugars, lipids, and soluble proteins amounts in the leaf tissues. The ratios of high mol wt polypeptides to low mol wt ones, of lipids to membrane proteins, of phospholipids to sterols, and of saturated to unsaturated fatty acids were increased due to hardening.

17 40

ABA, IAA and cytokinin accumulation under temperature stresses by *Triticum aestivum* L.**L. V. KOSAKIVSKA* and E. V. MAIDEBURA*****N.G. Kholodny Institute of Botany, Academy of Sciences, Tereshchenkivska 2, 252601, GSP,
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ABA, IAA and cytokinin contents in roots and leaves of 7-d-old seedlings of four *Triticum aestivum* L. cultivars, having different hardness degrees, were studied using enzyme immunoassay. The plants were subjected to 2-h cold (2 °C) and heat (40 °C) stresses. The level of certain endogenous phytohormones and their balance were determined to be cultivar specific in the seedlings of the cultivars monitored. The correlation between cold-resistance of a cultivar and its capability for accumulation of great amounts of endogenous ABA in roots and cytokinin in leaves was shown. Additionally, direct dependence of heat-resistance degree of a cultivar and its ability for generation of significant amounts of ABA and IAA in the leaves and cytokinin in the roots under heat shock was detected. The role of certain endogenous phytohormones and their balance in development of plant resistance to temperature stresses will be discussed.

17 41

Modification of ^{133}Cs uptake under the influence of different factors**O.P. KOSTYUK, A.N. MIKHEEV and Yu.A. KUTLAKHMEDOV***Kiev University, Kiev, Ukraine*

Modification of ^{133}Cs uptake by pea was studied after treatment of seeds by $^{133}\text{CsCl}$ solution, and after hyperthermic treatment of seedlings. In control plants, maximum amount of ^{133}Cs was found in the tip of the main root; the correlation factor for its ^{133}Cs activity and for the ^{133}Cs activity of whole root was higher than 0.9. The ^{133}Cs distribution did not change under the influence of the factors studied. Thus, it is possible to investigate the ^{133}Cs uptake and its modification under the influence of various factors, in the tip of the root. From this we can predict the total ^{133}Cs uptake by the roots and by the stems.

17 42

Adaptive modification of the rate of Hill reaction and photophosphorylation in the series hygrophytes - mesophytes - xerophytes**J.I. KOZLOVA, V.G. REUTSKY***Institute of Experimental Botany, Academy of Sciences of Belarus, Skorina St. 27, Minsk 220733, Belarus*

The dependence of stimulation of the Hill reaction (the Warburg effect) and phosphorylation by CO_2 on the ecological belonging of plants is established. The rate of Hill reaction was accelerated in the presence of CO_2 in the reaction medium. The acceleration was as follows: eight- to tenfold for the hygrophytes, two- to threefold for the mesophytes and 1.5-fold for the xerophytes. In the chloroplasts of several xerophytes the presence of CO_2 in the reaction medium inhibits the above reactions. The established regularity indicates the presence of a mechanism of the evolutionary adaptation of the photo-dependent reactions of photosynthesis to the environmental conditions. In the series hygrophytes - mesophytes - xerophytes the share of energy taken away from the Calvin-Benson cycle water homeostasis increased. It may be one of the causes of lesser productivity of the drought-resistant species.

17 43

Calculation of the critical level of the pollution of agricultural lands depending on soil agrochemical type**A.P. KRAVETZ and Y.A. PAVLENCO***Institute of Cell Biology and Genetic Engineering, Academy of Sciences, 31/17 Vasilkovska st., Kiev 252022, Ukraine*

Biological and chemical mobility of any pollution including radioactive pollution is determined by agrochemical type of soil. Different mobility of pollution is grounds different levels of structural pollution all trophical chains to begin with land of diverse agrochemical types. Thus, level land pollution formed critical dose from intake with ration radionuclides is different for different type of soils. After all this calculation can be used in solution of opposite problem - estimation of admitted critical levels of pollutions for any type of soils. This calculation (algorithm) was realized as combination a spreadsheet form with Quattro Pro version 4.0 with diverse and vast radiobiological and radioecological information, and dynamic mathematic model migration of pollution in systems "soil-plant". Calculation of critical level soil pollution have been realized for seven main type soil White Russian and Ukrainian Wooded district.

17 44

Cell wall changes in winter rape leaves exposed to low temperatures**M. KUBACKA and A. KACPERSKA***Laboratory of Plant Resistance Physiology, Institute of Plant Experimental Biology, University of Warsaw, Krakowskie Przedmieście 26/28, 00-927 Warsaw, Poland*

Prolonged (21 days) exposure of winter rape (*Brassica napus* L. var. *oleifera* L. cv. Jantar) plants to 2 °C resulted in the increased resistance of leaves from - 5.2 °C to 10.8 °C. This was associated with a two-fold increase in the cell wall content in the leaves. Cold treatment resulted also in the modification of cell wall composition: contents of pectins and hemicelluloses increased whereas that of cellulose was not modified. Freezing treatment resulted in the decrease of hemicellulose content, due to the loss of pentoses and hexoses. The above observations point to the possible role a cell wall in the cold acclimation process.

17 45

Germination calendar of weeds

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In the years 1950 - 1994, I noted the germination of field weeds in cultures and in fields in Brno, Moravská Třebová and in other places in Moravia. 450 weed species I grouped according to their germination dates into 7 groupes: - A: germinating in winter and in early spring before 15 March - 16 species occurring mostly in winter crops biennial fodder crops, e.g. *Sisymbrium sophia*, *Galeopsis tetrahit* - B: germinating at the beginning of spring immediately after the sowing of spring crops 15 March - 15 April - 17 species, e.g. *Avena fatua* - C: germinating in the second half of April and at the beginning of May - 22 species occurring mostly in hoeing cultures, e.g. *Plantago major* - CD: 34 species, e.g. *Amaranthus lividus* - D: germinating in late May and in June - 101 species, the most numerous group, e.g. *Myosoton aquaticum*, often perennial species - E: germinating in June and in autumn - 21 species, e.g. *Portulaca oleracea*, *Rumex acetosella* - F: germinating in the whole vegetation period, 85 species, e.g. *Ranunculus repens* - G: germinating in autumn, 30 species, e.g. *Camelina mic*.

17 46

Search of stress tolerant genes in plants.

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Evolutionary adaptation of plants is accompanied with the formation of tolerant systems to the simultaneous action of unfavorable natural factors. On the bases of these lies functioning of stress tolerant genes. We studied adaptation of plants to high and low temperature, drought and salinity. Results of Northern hybridization plasmid pCE54 with poly(A)-RNA soybean showed that heat shock gene encoding HSP 27 selectively expressed as a result of the effect of high and low temperatures. Adaptation of plants to high temperatures and water deficit actively expressed genes encoding one and the same polypeptides with MM 70 and 80 kD, identical to corresponding HSPs. Our results on cross-adaptation of cotton plants to high temperatures and salinity made it possible for us to shown a functioning of systems of tolerance to the simultaneous effect of two factors. The cotton plants responded to the subsequent of heat shock and salinity with a quick output of ethylene, accumulation of prolin and putrescine and also induction of synthesis of osmotin-like protein. HSP-system did not activate. This data has made it possible to consider over production of prolin genes and genes which contorls levels of regulators under stress conditions as stress tolerant genes.

17 47

Cadmium tolerans in *Salix*.

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The differences in tolerance to Cd in different clones of *Salix* were investigated.

About 100 clones of *Salix viminalis* were screened for Cd tolerance in 0, 1, 3, 7 and 10 μM CdCl_2 and 100 μM $\text{Ca}(\text{NO}_3)_2$ for 20 days. The tolerance was measured as affected length and weight of roots and shoots. The concentration of Cd in root and shoot was also measured. The tolerance was analysed on both internal and external Cd concentration and the clones were compared at 7 μM Cd. Three kinds of tolerance were found;

- a; exclusion of Cd at uptake or exudation of Cd from roots, lowering the Cd concentration in the plants.
- b; concentrating Cd in the roots, probably by binding to eg. phytochelatins or accumulation in the vacuol of root cells, causing inactivation of Cd in the roots.
- c; increasing the transport of Cd to and accumulation of Cd in the shoot, which decreasing the concentration and thus the effect of Cd in the roots.

17 48

Interactions between water stress and peanut photosynthesisJ.A.LAUREANO², P.S.CAMPOS¹, J.R.RAMALHO³, F.C.LIDON⁴, M.E.GUEDES³ and M.C.MATOS¹

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Plants of *Arachis hypogaea* cvs 57-422, 73-30 and CG-835 were grown in glasshouse, kept under stress 60 days after germination and then rewatered. During water stress, RWC decrease differed in all cvs, whereas basal fluorescence (F_0) increased, showing an enhanced fluorescence emission by the excited Chl a molecules and therefore suggesting the occurrence of disfunctions in the reaction centers of PSII. The opposite was observed after rehydration. The estimation of quantum yield of non-cyclic electron transport (Φ_{N}) decreased in all cvs, suggesting a reduction of photosynthetic electron transport rates. Non-photochemical quenching (q_N) did not vary during all the experimental period, probably suggesting that the amount of energy dissipated by non-photochemical processes is minimal. Yet photochemical quenching (q_P) changed, indicating that the fraction of the absorbed energy by PSII used in electron transport further changed after rehydration. The Rubisco activity expressed at a leaf area basis seems to increase at low levels of water stress being affected only at very low values of relative water content.

17 49

Limiting steps on peanut photosynthesis triggered by water deficit

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Most of peanut produced in Angola and other African countries comes from small farmers, with low economic resources, for which irrigation and cultural practices to reduce the effect of drought are quite unaccessible. Dryness is one of the main factors interfering with growth and development reducing productivity of these plants. In this context the increasing and the stabilization of productivity relies on the use of drought resistant cultivars. In this study, drought was induced by withholding irrigation in potted plants of *Arachis hypogaea* grown in a glasshouse under natural light conditions. Drought effects were measured at the end of 21, 35 and 37 days after stopping irrigation and after rehydration, on CO₂ saturated rate of photosynthesis, F_v/F_m , photosystems activity and the amount of chlorophyll. Results suggest that A_{max} , F_v/F_m and photosynthetic electron flux decrease under water deficit, being the activity of PSII more affected than that of PSI. After irrigation recovering was observed for all the parameters under study.

17 50

The dark respiration of *Empetrum hermaphroditum* in Lapland reservation (Kola peninsula)

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Respiration rate (RR), growth rate and assimilate translocation were studied in the current year shoots during the first half of July 1990 at two forest sites: at a dry site (*Picetum empetroso-myrtillosum*) and at a moist site (*Pinetum sphagnosum*). Oxygen uptake was measured by means of Kuperman method (see Kuperman & Khitrovo, 1977) in the dark at 20°C. ¹⁴C was applied as ¹⁴CO₂ during the photosynthesis. It was shown that the relative growth rate of the shoots at the moist site was about 70 mg g dry wt⁻¹ day⁻¹, while at the dry site the dry mass of the shoots had not increased. The RR values of the young shoots of *E. hermaphroditum* were similar at both sites and equalled 1700 mkl O₂ g dry wt⁻¹ h⁻¹. In the shoots of plants from the dry site the decrease of the amount of ¹⁴C-label during 24 h after the entry exceeded that found in the shoots of moist site. The data obtained suggest that in the compared shoots the respiration energy was differently distributed: in the growing shoots (at moist site) it was used in growth, maintenance and translocation processes, while in the non-growing shoots respiration supplied mainly the maintenance processes and the activated assimilate translocation.

S281

17 51

Effects of water stress in endogenous ABA and IAA in *Rosmarinus officinalis* and *Lavandula stoechas* L.

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Changes in endogenous ABA in IAA concentrations in *Rosmarinus officinalis* L. and *Lavandula stoechas* L. plants subjected to water stress by withholding water have been studied. The water stress treatments were imposed for periods of: four, five, six and seven days to *Rosmarinus* and for two, three and four days to *Lavandula*. *Rosmarinus* is a very resistant plant to water stress at least until seven days and no changes in endogenous ABA can be detected. *Lavandula* is a more sensitive plant which shows an increase in ABA with maximum values at three days of stress; after then, the ABA content decrease. This behaviour appears to be related to the RWC (%) and would indicate that ABA allows these plants to react to water stress situations. No effects of water stress on endogenous IAA in both species have been observed.

17 52

Transpiration of Canarian Laurel Forest trees under spring and early summer conditions in Tenerife

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Diurnal courses of microclimate, leaf resistance and transpiration rate were measured porometrically at the laurel forest site of Aqua García, Tenerife. Young and mature sun and shade leaves of *Laurus*, *Persea*, *Myrica*, and *Ilex* were studied. Transpiration was controlled chiefly by evaporative conditions indicating a poorly developed stomatal control of water losses. Leaf age, position within the canopy, and species peculiarities influence leaf conductance levels. Probably the laurel forest trees are restricted to moist and humid environments for reasons of insufficient stomatal control of water loss.

17 53

Influence of different light and UV-B conditions on photosynthesis of *Lolium perenne* and *Trifolium pratense* under field conditions

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Plants of *Lolium perenne* and *Trifolium pratense* were grown in the field at three locations, which differ in altitude and climate: a) Neuherberg (500 m); b) basis of Mount Wank near Garmisch (800 m), top of Mt. Wank (1700 m). One third of the plants were covered with window glass ($T_{50\%}=342\text{nm}$), one third with acrylic glass ($T_{50\%}=292\text{ nm}$), the last third remained without cover under natural light conditions. We studied net photosynthesis, pigment contents, chlorophyll fluorescence, thylakoid membrane proteins and chlorophyll protein complexes.

Pigment contents showed significant differences between locations, independent of UV-B-expositions. However, these expositions influenced photosynthesis measured as oxygen evolution, chlorophyll fluorescence (Kautsky), and protein composition of the thylakoids. The two photosystems and light harvesting complexes were differently changed by the treatments, stronger than by altitude.

The physiological responses were more pronounced in *Trifolium* compared to *Lolium*, but did not change overall growth of plants during the vegetation period.

17 54

Growth and dry mass partitioning in *Smyrniun perfoliatum* L.

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Smyrniun perfoliatum L. (family Apiaceae) is autochthonous species in Slovakia presently endangered. It is a biennial plant that forms storage tap root, morphological different leaves (compound leaves of the rosette, basal compound leaves, upper simple amplexicaul leaves and bracts) and a large inflorescence.

Relative growth rate and dry mass partitioning into the shoot and root were established by growth analysis in the second year of ontogenesis. Our results (net assimilation rate, relative growth rate of both, leaf and shoot, leaf weight ratio, specific leaf area, shoot:root ratio) indicate that *Smyrniun perfoliatum* L. could be characterized as a fast growing species which rapidly increases in size and occupies a large space in the early phase of the growing season.

17 55

Phytochelatins production in *Silene italica* Pers.

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Heavy metals induce in several plants the production of metal-binding peptides, namely phytochelatins. These compounds are considered to play a role in detoxification of excess metals. The aim of this work is to evaluate if *Silene italica*, a Ni-tolerant species, has the capacity to produce phytochelatins. The Ni and Cd effects have been compared. High concentration of Cd induced the production of phytochelatins. A Cd-containing fraction with a low molecular weight was isolated by gel-filtration. The analysis of this fraction showed the presence of glutamic acid, cysteine and glycine. The same molecules were not separated from plants treated with Ni.

17 56

The influence of water stress and low temperatures on the state of some protein enzyme systems of grapevine with various frost and drought resistance

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The biochemical response of the plants studied on the action of the above mentioned conditions is uniformly expressed in the intensification of the activity of electrophoretically easily mobile isoenzymes of peroxidase with Rf of 0.75 and 0.81, and of the whole enzyme, in the activity decrease of acid and alkaline phosphatases, and in the appearance and disappearance of a number of easily soluble proteins with both high and low molecular mass.

17 57

Influence of elevated CO₂ and nutrient supply on growth and nutrient uptake of *Agrostis capillaris*.**R. M. NEWBERY***Biological Sciences Division, Lancaster University, Lancaster LA1 4YQ England*

Agrostis capillaris, an upland grass species, was grown at two concentrations of CO₂ (ambient air and ambient air enriched with 250 ppm CO₂). The effects of elevated CO₂ on plant growth, morphology, nutrient requirements, uptake rates and tissue concentrations were investigated at 3 different levels of N, P and K.

A. capillaris showed a positive growth response to elevated CO₂. Plant shoot weight was enhanced due to increases in leaf and tiller number and there was an overall increase in average leaf number per tiller, whilst root growth showed no significant trends. There were no interactions between response to elevated CO₂ and nutrient supply, even at the lowest N and P supplies.

An imbalance between C-fixation and nutrient acquisition was observed, with uptake of N, P and K not increasing in line with growth at elevated CO₂, even at adequate nutrient supplies. Nevertheless shoot N and P concentrations were maintained similar to those in ambient air, probably due to internal redistribution, whilst shoot %K declined. The plant's requirements for N or P did not change but there was a large increase in the plant's demand for K, which is postulated to relate to osmoregulatory changes within the plant.

17 58

Photosynthetic activity of kiwifruit leaves (*Actinidia deliciosa*) with regard to the male and female origin**R. OLAH*,** and E. MASAROVIČOVÁ*****FB-Biologie, Botanik, Philipps-Universität Marburg, K. Frisch Strasse, 35043 Marburg/Lahn, Germany***Department of Plant Physiology Comenius University, Mlynská dolina B-2, 842 15 Bratislava, Slovak Republik***

Adult leaves of male and female kiwifruit plants (*Actinidia deliciosa* [A. Chev.] C.F. Liang et A. R. Ferguson, var. *deliciosa*, cv. Hayward) grown in natural conditions were analysed.

The quantitative parameters of irradiance response curves for CO₂ uptake, the values of respiration rate, chlorophyll content, assimilation number and photosynthetic productivity were estimated for the both sex. Statistically higher values of the net photosynthetic rate, saturating irradiance and photosynthetic productivity were found in the leaves of female plants. We suggest that these photosynthetic characteristics may be used for potential sex determination.

17 59

Responses of maize roots to copper stress

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Changes in the morphology, physiology and ultrastructure of root systems of *Zea mays* cv. Aris under various Cu-treatments were investigated. A progressive decrease of root length and biomass with increasing Cu in nutrient solution was observed. The roots accumulated significantly higher amounts of Cu than the above ground parts. Significant reduction of mineral content (Ca, Fe, K) occurred in the higher Cu external concentration. The higher concentration of Cu (80 μ M) induced serious damage to the cells of root epidermis. In the rest of the root, the effects of Cu varied within the same tissues. Thus, there were cortical or stelar cells with disintegrated cytoplasm, next to the cells with well preserved plasmalemma, tonoplast, and cytoplasm including the cell organelles. Multi-lamellar bodies inside the vacuoles indicate an increased activity in digestion of the cytoplasmic components under Cu stress. Deposits of a less dense and less compact material were found behind the plasmalemma, associated with the cell wall as well as accumulation of dense material attached to the cell walls was observed. It seemed that particularly the cells with such deposits in their walls revealed serious damage to the cytoplasm. However, the root ultrastructure has been affected less than its morphology and physiology. The occurrence of well preserved cells may contribute to the development of a resistance strategy of maize roots to Cu toxicity.

17 60

Photosynthesis, morphological characteristics and polyamine content variations in natural population of *Holcus lanatus* L. Effects of salt stress.

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Samples of *Holcus lanatus* L. in natural populations from the O Morrazo and Cies Islands Peninsulas were collected, following the known climatic gradient that characterizes this small area of the Galician coast (NW Spain). A salt stress assay was carried out in a greenhouse in plants in "fertil pots" with expanded perlite, watering them with Hoagland & Arnon solution containing 1.5% NaCl. Cloned plants watered with the same nutrient solution were used as a control. After three weeks of treatment photosynthesis was measured with a LI-COR 6200 analyzer and biometric data was collected for the length and breadth of the leaves developed during the experiment. The leaves were cut and stored at -80°C. The polyamines Putrescine (PUT) and Spermidine (SPD) as well as their decomposition product Diaminopropane (DAP) were determined in *H. lanatus* leaves by TLC (Tiburcio y col., 1985). These results, together with those from photosynthesis and the biometric study were tested by ANOVA, ANCOVA and LSD-tests of multiple and mean comparison with the SPSS PC+ programme.

Significant effects due to salinity were seen on the photosynthetic rate, leaf size and wet/dry weight ratios, as well as statistical interaction between groups of populations and treatments. In general, DAP content variations were observed in the distinct populations as well as a decrease in SPD content of leaves subjected to salt stress.

Variations in stomatal aperture and the relationship between transpiration rate and CO₂ fixation rate

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An apparently linear relationship between transpiration rate E and CO₂ fixation rate A is sometimes observed if stomatal apertures vary due to external or internal influences. The regression line has often a positive intercept with the E axis. However, since no significant transpiration would occur at complete stomatal closure a description of the relationship between E and A by a curve through the origin does appear more appropriate than that of a straight line. According to Cowan and Troughton (1971) an equation describing a concave hyperbola can be used. Curves for the relationship between E and A obtained after chilling bean leaves, after excising a maize leaf, and during ontogeny of wheat seedlings are given as examples. Theoretically, concave curve shapes can be explained either by simultaneous effects on stomata and photosynthetic capacity or by stomatal patchiness.

Different types of limitation of C₄ photosynthesis by phosphoenolpyruvate and ribulose-1,5-bisphosphate carboxylation

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Net CO₂ uptake rate (A) of C₄ plants is determined by phosphoenolpyruvate (PEP) as well as by ribulose-1,5-bisphosphate (RuBP) carboxylation. Both reactions may be limited by either enzyme activity or substrate regeneration rate. The resulting four possible types of limitation of the overall process are considered by an intercellular transport model of C₄ photosynthesis which is applied to CO₂ gas exchange data obtained with a maize leaf at widely varying irradiances (I) and intercellular CO₂ concentrations (c_i). Thus, at given values of I and c_i the respective type of limitation can be identified. The fitting of data by the model is considerably improved by introducing two additional parameters which describe co-limitation of carboxylating reactions by enzyme activity and substrate regeneration rate. In particular, in $A(c_i)$ response curves at low irradiances the gradual transition from an initial steep slope at low c_i to saturating rates at higher c_i can be explained by co-limitation by PEP carboxylase activity and PEP regeneration rate. At low irradiances, RuBP carboxylation is thought to be limited by substrate regeneration rate at all c_i .

17 63

Light and nitrogen distribution in plants

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Plants in dense vegetations have a light gradient across their height. The light gradient causes a parallel gradient in leaf nitrogen content, which enhances whole plant photosynthesis per unit nitrogen compared to a uniform distribution of nitrogen. The mechanism of perception of the differences in PFD across a plant and transduction to nitrogen distribution between leaves has been investigated.

Shading one of a pair of primary bean leaves caused a decrease in nitrogen content. The role of photosynthetic rate in this decrease was investigated by varying CO₂ concentration around a leaf while keeping PFD constant. Leaf nitrogen decreased with increasing CO₂, and thus photosynthetic rate. The role of transpiration rate was investigated by varying water vapour deficit around a leaf. Leaf nitrogen decreased with decreasing transpiration rate to a similar extent as caused by shading. The results of these experiments support the hypothesis that nitrogen distribution in non-uniform light distribution is regulated by transpiration rate, possibly through cytokinins in the transpiration stream.

17 64

The role of sulphur in detoxication of cadmium in sugar beet (*Beta vulgaris* L.) plants

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The presence of heavy metals in plants has a negative effect on the metabolic processes, particularly on the protein biosynthesis, activity of enzymes *etc.* There are several ways by which the plants can reduce these negative effects. One of the possibilities, and this hypothesis has recently become very popular, is that heavy metals form chelates with the sulphur-rich proteins. Taking this into account we investigated the cadmium effect on protein biosynthesis and activity of nitrogen metabolism enzymes in the sugar beet plants grown under different supply of sulphur. The results showed that the presence of sulphur in the investigated concentrations caused a reduction of the negative effect of cadmium on the protein biosynthesis and activity of nitrogen assimilation enzymes in the investigated plants.

17 65

Evaluation of plants injury by ozone

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A plants response to O_3 depends on its concentration and duration of exposure, and is characterized by S-shaped curve. Our method developed for analysis of dose curve allows to explain the pattern of experimental S-shaped dose curve. It has been also established that primary damages can spread on three types of molecular targets affected in different ranges of O_3 doses and make different contribution to plant damages. The results of these investigations confirmed our assumption that lipids are one of the possible targets for O_3 . Present intensification of lipids peroxide oxidation related directly to increased pollutant concentration. The data of accumulation product of lipids peroxide oxidation indicate that antioxidation system play a definite role in the protection mechanism of plants. Besides the polymorphic lipid over-molecular structures transitions are assumed to take part in reactions of the plant protection to O_3 . Many things are not yet clear and this problem requires further investigation.

17 66

Heat shock affects polysome pattern in lupine roots

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The effect of a heat shock (HS) on the level of polysomes and their translational activity *in vitro* was investigated. Polysomes were isolated from intact lupine roots following HS treatment. In roots exposed to 39 °C for 20 min the polysome level was reduced by 10 % and in those stressed for 2 h by 40 % as compared to the control. It is correlated with translational activity of polysomes which after 2 h of stress was 50 % lower than that in control. During recovery from HS the polysome level increased rapidly in the first hour. After 12 h of incubation at growth temperature, the polysomes were only 10 % lower than control, but their translational activity remains lower which indicates irreversible heat damage of the protein synthesizing machinery. *In vitro* translation products of polysomes from heat shocked roots consisted of a set of heavily labelled polypeptides with M_r 90, 76 and 70 kDa, which were found to be identical to those synthesized *in vivo* in roots subjected to HS. Lupine roots were also treated with other stressing factors such as lead, cooper, salinity and low temperature (48 h). All these factors affected polysome formation and activity, however to less degree than in heat shocked roots.

17 67

Chronic low dose irradiation as a stress factor for plants

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Chronic irradiation in low doses can be a strong stress factor, which affects plants. The role of this influence has increased after Chornobyl accident. Possible changes in the DNA structure and proteins content of *Zea mays* leaves were studied after low dose irradiation. Plants were grown at different parts of 10km Chornobyl zone. External exposure dose levels were 1 mR/h (I) and 40 mR/h (II) at these lots. Samples were collected in 40 and 70 days after planting. Polypeptide analyses were carried out by electrophoresis, the changes of the proteins content were shown. Relative content of the individual polypeptides was dose-depended. The content of certain proteins was found to decrease in the leaves from first lot and to increase in the plants from the second lot. A number of changes such as an intensification of separate bands and modification of mobility of some restriction fragments has been observed after analysis of DNA restriction digests. Gene *cox1* was used as a probe for Southern-hybridization. In the case of hybridization of HaeIII restriction digests of DNA from the most irradiated plants additional 4.6 kb band has been detected. We suppose that changes detected in irradiated plant genome point to loss of restriction sites or to amplification of some parts of the genome. These results testify that chronic irradiation in low doses can affect the cell metabolism as well as stability of genome of somatic cells.

17 68

Stress protein synthesis in root apices of *Zea mays* and *Pisum sativum* in the ^{137}Cs presence

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Stress proteins synthesis has been investigated in the root apices of *Zea mays* L. and *Pisum sativum* L. plants, which were grown in water culture with low ^{137}Cs concentration (4.5×10^4 Bk/l). It was shown, that accumulation coefficient is higher for apices on comparison with another parts of roots. Both the ^{137}Cs accumulation by the root apices and its stress proteins synthesis in dynamics for seven days have been studied. The roots apices accumulation coefficients were about 2.0×10^4 and its accumulation doses were about 0.2 Gy a week. Comparison of the stress proteins induction was studied both at high temperature (41° C, 2 hours) treatment of root apices and in the presence of low ^{137}Cs concentration in the water culture. It was observed, that some stress proteins, which were found out at high temperature stress, were characteristic for root apices in the presence ^{137}Cs . Apparently, some stress proteins are nonspecific stress proteins, synthesised both at high temperature and at the ^{137}Cs presence, but there are some proteins, which are specific at γ -irradiation action only.

17 69

The stress-stimulated 16 kDa polypeptide from lupine roots has properties of cytosolic Cu, Zn-superoxide dismutase

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The 16 kDa polypeptide was isolated from lead-treated lupin roots, purified by DEAE-Sephacel chromatography and electroeluted from polyakrylamide gel following electrophoresis. The pure protein was used to produce antibody and it was found that the 16 kDa polypeptide cross-reacted specifically with its own antiserum as well as with antibody against Cu, Zn-superoxide dismutase (SOD) from spinach seeds. Electrophoresis of extracts from roots exposed to various stressing factors followed by electroblotting on nitrocellulose membrane and immunodetection with antibodies either against lupin 16 kDa polypeptide or spinach Cu, Zn-SOD showed that both antisera specifically reacted with the 16 kDa region in all variants, however, strongest cross-reaction was observed in case heavy metals and nitrate. It seems that there are common responses of plant cells to diversity of environmental stresses that all enhance free radical production, which in turn stimulate the superoxide dismutase - the main scavenging enzyme of active oxygen.

17 70

Adaptation of the perennial grass, *Stipa tenacissima*, to environmental stress

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Stipa tenacissima L. is a perennial tussock grass which occupies extensive areas in south-eastern Spain where, because of low rainfall, high temperatures and irradiances, the environment is extreme. We tested the ability of *Stipa* to use pulses of resources for growth, and its adaptation to drought, in a field experiment in which we monitored growth and gas exchange of watered and unwatered plants in mid-summer. Stomatal conductance and photosynthetic rate doubled, and leaf elongation resumed when droughted plants were watered. Fluorescence (F_0 & F_v) decreased with watering and the efficiency of photosystem II was higher than in unwatered plants. Water stress, on the other hand, decreased gas exchange, increased fluorescence, and stopped leaf elongation. We conclude that photoprotective mechanisms and very low diffusive conductance substantially reduce photosynthetic rate during drought, and that *Stipa* can respond opportunistically to single rainfall events.

S291

17 71

Relationship between phase transitions in liposomes from microsomal membranes and freeze-dehydration injury in *Picea abies* cells

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Primordial shoots of Norway spruce are tolerant to freeze-dehydration stress at -18 °C for 10 days, or freezing to -20 °C, but susceptible to freeze-dehydration treatment for 40 days of freezing to -30 °C for 2 h. Gel to liquid-crystalline transition temperature (T_m) of liposomes of microsomal membranes was investigated. Membranes from primordial freeze-dehydrated for 10 or 40 days exhibited T_m at 10 °C and 59 °C, respectively. However liposomes from frozen primordial cells to -20 °C and -30 °C, exhibited T_m at 10 °C and 22 °C, respectively. The increase in T_m was associated with a decrease in the phospholipid, protein, -SH group content, and positive correlation with membrane permeability.

17 72

Comparative study of enzymic and photochemical lignin

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Lignin is important constitutive and functional part of the plant cell walls. Peroxidase-catalyzed formation of lignin has been known before. In this work we studied lignin formed as the end product of UV-irradiation of coniferyl alcohol (CA). We compared Raman and ^1H NMR spectra of this photochemical lignin and lignin formed by enzymic polymerization of CA. We also compared images of both lignins obtained on a Scanning tunneling microscope (STM). We found the similarities between some general parts of both spectra for two lignins, but also the differences in the fine structure of particular parts of spectra. STM images of two lignins show general similarities in the structural pattern between two lignins, the observed structure of enzymic lignin being more pronounced. The differences between two lignins are possibly caused by the different ways of polymerization of CA during the formation of these lignins.

17 73

Seed germination, seedling survival and adult plants photosynthesis in two populations of *D. glomerata* L. at several salt levels

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Two geographically close but ecologically different areas from the Vigo Estuary (NW Spain) were sampled. Each area is characterized by presenting known gradients of various bioclimatic types such as mean annual rain fall, free bioclimatic intensity, Giaccobe modified summer drying index, etc. Apart from one area being an insular coastal area and the other an interior mountain area they are found at the extremes of the aforementioned climatic gradients. Seeds were collected as well as adult plants from natural *D. glomerata* L. populations in July 1993. The grains of each population were subjected to germination tests in Petri dishes at 25°C in the dark and at different salinity level. A germination count was carried out at three successive times.

The germinated seeds in the control test were transferred to a perlite and nutritive Hoagland & Arnon solution for rooting and start of their development. Twenty-day-old seedlings from both populations were seeded in flower pots with commercial soil and their survivals were observed through time at nine different salinities and one control salinity. Stems were also individualized in the adult plant pool of each population and they were randomly planted with ten stems per pot. Eight salt stress treatments were carried out by watering with different NaCl solutions and a control solution. The photosynthetic rate in the treated groups and populations was measured during the last part of the experiment and thus other parameters of ecophysiological interest were determined.

17 74

Abnormalities of Spruce plants from Chernobyl zone

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The influence of chronic irradiation on genome and morphological changeability of spruce plants was studied. The experiments were carried out in the 30-km zone of Chernobyl Nuclear Power Station. The level of external γ -radiation was from 1 to 30 mR/h at different experimental lots. It was observed, that plants from this region have many morphological abnormalities. So, morphological features of some conifer species become similar to another species. For example, spruce needles change their length, become longer during some vegetation periods. DNA from such modified needles was studied. It was shown, that there are some changes in this DNA examined by restriction fragment length polymorphism method and Southern hybridization. Restriction enzymes Hae III, BamH I, EcoR I and Pst I were used for restriction analyses. The soybean β -tubulin gene was used as labeled probe for hybridization. It was supposed, that chronic irradiation with dose level close to natural background one could be viewed as extremely efficient mutagen. It is suggested, that this action of chronic irradiation could realize by several possible mechanisms, such as modification of DNA by enzymes, direct damage of DNA by radiation, or inhibition of repair systems.

S293

17 75

The effects of water deficit on carbon assimilation and partitioning of recent assimilates in field-grown sunflower (*Helianthus annuus* L.) leaves

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Plant of two differently drought tolerant sunflower (*Helianthus annuus* L.) hybrids (NS-H-26 and NS-H-43) were grown in the field. Control plants were grown on the plot that was irrigated to the optimal soil capacity. Water stress was imposed by protecting plants at another plot with a removable cover. Photosynthesis, content and composition of assimilates (carbohydrates) were determined in the leaves at the upper part of a plant in the course of flowering and seed filling stages. Carbon dioxide assimilation was measured by the application of gas exchange technique, leaf water potential was measured using a pressure chamber, content and composition of carbohydrates were determined by HPLC method. The results were expressed as a function of relative water content and leaf water potential. Our data show the decrease in the rate of CO₂ assimilation at lower leaf water potentials, mostly due to the decreased stomatal conductance, and other non-stomatal factors. (see poster by Panković et.al.). Content and composition of carbohydrates varied in analyzed sunflower leaves depending on the time of the day, genotype and water stress treatment.

17 76

Citrus growth and leaf gas-exchange responses to seismic and wind stress.

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Growth and leaf gas-exchange responses in one year old plants of *Citrus sinensis* (L) Osbeck x *C. reticulata* Blanco, cv *Ellendale* and *C. sinensis* (L) Osbeck cv *Newhall* to wind and seismic stress were studied in a controlled environment wind tunnel. Thirty days of seismic stress applied for five minutes consistently reduced 67 and 44% of height, 69 and 22% of number of leaves and 57 and 46% of diameter of branches of *Newhall* and *Ellendale* respectively, while trunk diameter increased 52% in *Newhall* and decreased 10% in *Ellendale* compared with plants receiving no seismic stress. Seven days of wind speeds between 2 and 50 km.h⁻¹ during 12 h.day⁻¹ did not promote any significant differences in height, number of leaves and trunk diameter among wind speeds or varieties, but stomatal conductance and transpiration rate were always higher in *Newhall* than in *Ellendale*, and wind speed produced a significant reduction in both parameters in *Ellendale*, while in *Newhall* did not. The results suggest that wind may reduce citrus growth, at least partially, by influencing leaf gas-exchange or by the mechanical stress associated with wind, and that *Newhall* is more sensitive than *Ellendale* to this abiotic stress.

17 77

UV-B induced DNA-degradation in *Euglena gracilis* is mediated by the activation of metallo-dependent nucleases

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Irradiation of *Euglena gracilis* with artificial UV-B in the range of hours reduced the amount of large DNA, extractable from immobilized *Euglena* cells, significantly in comparison to non-irradiated controls. This effect was cancelled by a substantial reduction of the ion concentration in the extracellular medium, i.e. the substitution of the culture medium by Tris-buffered agarose. Moreover, *in vitro* degradation of large DNA isolated from non-immobilized cells could be demonstrated for crude protein extracts isolated from non-irradiated or UV-B irradiated *Euglena* cells. Nuclease activity was found for both the crude protein extract and purified nucleases; i.e., in both cases two protein bands were obtained on an SDS-DNA gel with an apparent molecular mass of 26 and 40 kDa and their nuclease activity could be inhibited by the specific nuclease inhibitors, aurintricarboxylic acid and ATP, applied at a concentration as low as 10^{-8} M. Moreover, nuclease activity showed a strong dependence on the pH with an optimum around 4.5 and the ion composition of the extracellular medium. For Ca^{2+} a strong stimulating effect could be shown with an optimum around 10^{-4} M, whereas nuclease activity decreased dramatically in the presence of the calmodulin inhibitors, trifluoperazine and N(6-aminohexyl)-5-chloro-1-naphthalenesulfonamide, or Mg^{2+} , but Zn^{2+} or Mn^{2+} enhanced nuclease activity, significantly.

17 78

Lead-affected RNA metabolism in greening barley leaves

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Detached barley leaves supplied with PbCl_2 via transpiration stream exhibited enhanced rates of RNA synthesis. This effect was observed during greening of etiolated leaves after 6 hours of light exposition in the presence of PbCl_2 in conc. 100 mg/dm^3 . The lead-enhanced incorporation of ^{14}C -uracil into RNA reached 130% - 200% of water control. It was shown by electrophoretic fractionation (PAGE) of labelled RNA that lead-enhanced precursor incorporation concerned mainly 23S and 16S rRNA while the synthesis of other rRNA species was also stimulated to some extent. Stimulatory effect of PbCl_2 on labelled precursor incorporation into RNA was accompanied by decrease in RNase activity.

17 79

Transport properties of cuticular waxes: Ecophysiological relevance for cuticular water permeability

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In situations of severe water deficiency, when stomata are closed, leaves of higher plants are essentially protected by the plant cuticle from uncontrolled water loss. The plant cuticle is a heterogeneous, extracellular biopolymer, consisting of amorphous cutin, which in turn forms the lipophilic matrix for the deposition of cuticular waxes. In order to investigate the transport properties of cuticular waxes in more detail, a new method has been developed, which allowed the determination of diffusion coefficients of radioactively labelled probes (here: ^{14}C -labelled stearic acid) within isolated and subsequently reconstituted cuticular waxes. Diffusion coefficients measured for cuticular waxes of about 15 different plant species were closely correlated to water permeabilities of isolated, astomatous cuticular membranes of the same plant species. This demonstrates that permeability properties of the composite plant cuticles are essentially established by the transport properties of cuticular waxes. Measuring diffusion coefficients in isolated cuticular waxes of about 15 further plant species revealed ecophysiological adaptations of the transport properties of cuticular waxes: lowest diffusion coefficients were observed with succulents from arid areas, intermediate values were measured for waxes from evergreen plants from semi-arid areas, and highest diffusion coefficients occurred with fruits and summer-green plants naturally growing in areas with temperate climate.

17 80

Ecophysiological aspects of light-induced bioelectrogenesis of higher plants

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Some regularities of changes of light-induced electrogenic characteristics of several maize lines and hybrids are analyzed under various water stress action. Plant testing has been performed by means of rhythmical light in the range of periods from some seconds to 1 h. The essential changes in amplitude and frequency parameters have been obtained. The most characteristic of such changes is the shift in resonance frequency of responding reactions. The same shift was minimal for genotypes characterizing the tolerance to water deficit. Analogous changes have been detected under application of the toxic doses of various herbicides. Possible mechanisms of phenomena obtained were analyzed. Application of kinetics of light-induced bioelectric relations for the development of the simple and convenient methods of estimation of plant tolerance to the unfavourable environmental conditions and creation of the effective procedures of diagnostics of the optimal doses of chemical regulators is proposed.

About Water Relations Complexity (WRC)

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The main objects in Mongolian plant communities were 32 species of grass plants. The following parameters of water regime were measured: the transpiration rate, the saturation deficit, water content, and the cell sap osmotic pressure. The processing and generalization of Mongolian field data permitted to come to the following conclusions. It was shown that the changes of different parameters of the plants water regime are strictly interconnected under the certain conditions. This interconnection we named as water relations complexity (WRC). We found that the relations between water regime elements, on the one hand, and among the above mentioned water regime elements and environment factors, on the other, are strengthening under the water deficient conditions. The WRC increases under water stress proves that plants compensate the deficiency of soil water by more rational functioning, leading to minimization of water loss. Species capable of maintaining low transpiration rate and low water content without any damage possess higher relative competitive ability as they use the available soil water more efficiently.

Amino acids of senescing leaves of maize

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High productivity of tropical grasses such as maize and sorghum is explained by possibility to make reassimilation of nitrogen of leaves. During senescence large quantity of amine nitrogen comes from upper leaves of maize to grain. Dynamic of free amino acid pool had a characteristic maximum approximately from 20 to 36 days after pollination in leaves of all investigated genetic forms of maize except opaque-2 forms, which is necessary for additional osmotic potential at this period for transport of assimilates to grain. Absence of maximum due to decrease of free proline (in 5-7 times) in flag leaves of opaque-2 maize in comparison with normal line may show a significant role of proline in complex system of long distance transport and in creation of adaptive potential of a plant. We found a great correlation interactions between free GABA and major protein amino acids of senescing leaves of maize. Taking into account role of GABA in animal organisms, we supposed, that this free amino acid may take part in the process of aminoacylation of tRNA and synthesis of "mistaking" proteins, thus increasing proteolysis and influx of amino acids to grain. Such supposition may explain the increasing of harvest by treating of upper leaves with some compounds and opens the way to increase the productivity of cereals.

17 83

Influence of cadmium on *Chlorella vulgaris* cells' ability of division

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Influence of cadmium on *Chlorella vulgaris* Beij.1980 cells' ability of division was studied with the microcolony method on synchronic culture of A-8 strain. Cadmium in concentrations 0.01, 0.1, or 1.0 mg/l was added to the culture reared on Kuhl-Lorenz medium at the beginning (t=0h) and during the cycle of cells development (t=0h, 4h, or 8h). About 60% of mother cells (L type) preserved the genetically determined ability to form 8 aplanospores (D type) over the whole light phase (t=0-10h), if cadmium in the lowest concentration was added at t=0h. Under higher cadmium concentrations the share of cells capable to form 8-spores microcolonies lowered, while there increased the share of microcolonies made up of 4 or 2 aplanospores and cells incapable of division. Maximal suppression of *C. vulgaris* ability of division was observed when cadmium was added to the culture at t=2h and at t=4h. In the same variants there was observed the greatest variation in values of Growth Multiplication Factor (GMF) index (from 3.3 to 7.2). Minimal variability in GMF values and cells distribution according to number of spores were observed in variants, where cadmium was added at t=8h.

17 84

Electrolyte leakage differences between poikilohydric and homoiohydric species of *Gesneriaceae*

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Comparative measurements of the electrolyte efflux were carried out in homoiohydric *Saintpaulia ionantha* Wendl. as well as in poikilohydric *Ramonda serbica* Panč. and *R. nathaliae* Panč. & Petrov. from the same family of *Gesneriaceae*, in order to establish both the membrane tolerance to water stress, and the ability of stressed cells to repair their membranes. Changes in cell membrane permeability, resulting in the increase of ion conductivity, is one of the first indication that the protoplasm fine structure in plant cell is disturbed. The experiments were performed with plants exposed to the water stress caused by PEG 600. The conductivity of the solutions was measured by the method of Vasquez-Tello et al. (1990), with the conductometer HI 8733 (HANNA), and the electrolyte leakages were expressed by the Injury Index (I_d %).

The great degree of solute leakage of the east-african desiccation-intolerant (homoiohydric) *Saintpaulia ionantha* point to the loss of membrane integrity structure under water stress. Conversely, the Balkan endemites *Ramonda serbica* and *R. nathaliae* show high resistance to water stress due to the drought avoidance mechanisms. The both plants exhibited relatively low I_d , the stabilization of the solute leakage and consequently, the cell recovery processes.

S298

17 85

Cadmium signaling in plant cell

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The molecular mechanism(s) of cadmium signal transduction to a plant cell have not been fully identified yet. The possible role of inositol(1,4,5) triphosphate (IP₃) and polyamines (PA) in this process is discussed. Changes in the concentration of IP₃, PA and antioxidative capacity of cell in potato (*Solanum tuberosum* L.) tuber discs, in response to short-term action of cadmium (0.01 and 1 mM) were investigated. Two cultivars, Bintje and Bzura with different cadmium tolerance were examined. The induced IP₃ and PA signals and the changes in activities of SOD and ascorbate peroxidase were characteristic for each of these materials.

17 86

Some aspects of maize drought resistance

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Water stress, is a important yield limiting factor in maize crops in Romania. Therefore identification of drought tolerant genotypes and their use in breeding programmes would be very desirable. In this study have been investigated 17 maize hybrids differing in their drought tolerance, in field drought conditions, concerning the water content, electrical resistance stability index (ERSI) and turgescens stability index (TSI) of foliar tissue in their different vegetative stages. The results have clearly demonstrated the relationship between the seed yield and size of ERSI and TSI, especially in drought conditions.

17 87

The ecophysiology of seed germination in Mediterranean plants

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The Mediterranean environment is characterised by a marked seasonality of water availability, mild temperatures during the wet period, ample sunlight and a hot and dry season with frequent wildfires. Seed germination is generally manifested at "cool" temperatures (10-20 °C) which are naturally met at the first part of the wet season. The germination rate is usually slow, presumably as an adaptation against the early transitional, alternately wet and dry, onset of the rainy season. The various light regimes likely to be encountered by germinating seeds may be arranged in three main types: high irradiance white light (sunlight in open or disturbed ecosystems, e.g. coastal or burned ecosystems), natural light enriched to a varying extent with far-red (light transmitted through plant canopy in more or less closed vegetation) and darkness (for seeds buried in the soil). According to their germination responses towards the various light regimes, Mediterranean plants may be divided into four groups (absolute light requiring seeds, far-red inhibited, white light photoinhibited and light indifferent seeds). Another major feature shared by numerous legumes and rockroses, in particular, is hardseededness by which many fire following plants detect the postfire environment.

17 88

High CO₂ and photorespiratory enzymes : rapid decline of catalase in pea leaves.

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Pea plants were grown in environmental chambers in either normal air (340 $\mu\text{L CO}_2 \text{ L}^{-1}$) or in CO₂-enriched atmospheres (1000 and 4000 $\mu\text{L CO}_2 \text{ L}^{-1}$) which inhibited photorespiration to different extent. We determined photosynthetic and photorespiratory gas exchanges, biomass production, enzyme activities and abundances.

Concerning enzyme levels, the specific activity of most of the photorespiratory and photosynthetic enzymes studied (rubisco, glycolate oxidase, hydroxypyruvate reductase, glutamine synthetase) did not change while phosphoglycolate phosphatase increased in high CO₂. In contrast, catalase activity was 30% lower in 2 week-old plants acclimated to 4800 $\mu\text{L CO}_2 \text{ L}^{-1}$. It decreased by 33 and 50% in leaves acclimated to ambient air (during 1 week) then transferred to 1000 and 4800 $\mu\text{L CO}_2 \text{ L}^{-1}$ respectively and kept there during 1 week. Diminution was observed on the first day after transfer in high CO₂ and increased during the following days. The low catalase activity was accompanied by a loss of catalase protein (immunoblot) but no change in the isoform pattern (IEF) was observed.

The decline of catalase is correlated to the degree of atmospheric CO₂-enrichment. This suggests that the flux through the photorespiratory cycle regulates the level of catalase in pea leaves. This is in agreement with other experiments showing the high sensitiveness of catalase to environmental conditions. Nevertheless, alternative hypotheses can be put forward to explain this phenomenon and we now investigate the change of catalase turnover and gene expression in low photorespiratory conditions with experiments using labelled precursors of catalase and a c-DNA probe.

17 89

Simultaneous application of CO₂ and UV-B radiation (280-320 nm) to *Vicia faba*: II UV-B effects on growth and physiology

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Material and methods as in poster A.J. Visser *et al.* The applied biologically effective UV-B (UVB_{BE}) doses were 0, 6, 10 and 15 kJ m⁻² day⁻¹. These irradiation levels simulate up to 44% stratospheric ozone depletion during summertime in The Netherlands (52°N). *Vicia faba* appeared to be highly sensitive to UV-B irradiation. At the final harvest, the effect of UV-B irradiation on total plant biomass was different at low and high CO₂: at ambient CO₂ total biomass was reduced up to 48%, while it was reduced up to 55% at elevated CO₂. Under ambient CO₂ specific leaf area (SLA) decreased with increasing UV-B irradiation levels, while there was no effect on SLA under elevated CO₂. Leaf weight ratio (LWR) was decreased by the highest UV-B level both at low and high CO₂. Consequently, leaf area ratio (LAR) was decreased by UV-B irradiation. Root weight ratio (RWR) was also reduced by UV-B. At ambient CO₂ this effect occurred under lower UVB_{BE} levels compared to the elevated CO₂ treatment. UV-B effects on growth will also be discussed in terms of photosynthesis and leaf optical properties.

17 90

Biological activity of dark and light coloured soil fungi in a degraded environment in Karkonosze mountains

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Studies were carried out in five botanic biotopes in Karkonosze over an autumn and a spring. Biological activity of dark (melanine-containing) and light coloured soil fungi was studied.

The following characteristics were used to evaluate the biological activity of both groups of fungi: the amount of spores in 1 g of soil, species abundance of dark and light coloured fungi, number of dominants, and cellulolytic activity studied with the method of weighing. Soil pH and content of sulphur were considered in evaluation.

Results of the study lead us to the conclusion that biological activity of the fungi, which is expressed in physiological, structural, and ecological changes, is influenced by ecological factors, for example, vegetation season, temperature, humidity, and pH, as well as uneven environment pollution in Karkonosze connected with the heterogeneity of plant cover. We suppose that abundance and cellulolytic activity of dark coloured soil fungi can be used as indicators of environment pollution.

S301

17 91

Wax deposition and anatomical characteristics in *Cynodon dactylon* subjected to water stress

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The effect of water stress on the epicuticular waxes deposition was studied throughout the growth season on *Cynodon dactylon* sward. The increase of waxes observed by withholding water would be related to the ability of plant to cope with stress. Otherwise a seasonal modification of waxes structure was evidenced. Besides the main effects observed in response to water stress, as reduction of leaf thickness, intercellular spaces, distance between vascular bundle and size of mesophyll cells; it would be emphasized among others features, a different behaviour between the abaxial and adaxial stomata, an increase of cell wall thickness in bundle sheath cells. An earlier effect of water stress on mesophyll cells chloroplasts was an increase of peripheral reticulum; however, in bundle sheath cells the first effect observed was an starch increase. All these modifications would contribute to the plant adaptation characteristics.

17 92

An analysis of growth and water use efficiency of ten *Triticum aestivum* L. cultivars

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In this study we investigated how allocation of biomass influences growth and water use efficiency. We used 10 wheat cultivars from a mediterranean environment, grown in pots in a climate room, at a high soil water content.

Differences in growth rate between the cultivars were attributed to differences in net assimilation rate. There was no correlation between water use efficiency and relative growth rate. A high water use efficiency was achieved by a low rate of water use, which depended on the rate of water loss per unit leaf area and the rate of water uptake per unit root weight. It was not related to the amount of biomass allocated to leaves or roots. Differences in plant water use efficiency were related to differences in photosynthetic water use efficiency, caused by variation in stomatal conductance rather than in photosynthesis. Photosynthetic water use efficiency increased with an increased allocation of biomass to the leaves.

These results show that a high water use efficiency is not necessarily associated with a low growth rate.

S302

17 93

Sulfur metabolism as a factor in the detoxification of SO₂ in *Arabidopsis thaliana*

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Arabidopsis thaliana cv. Landsberg was grown at different atmospheric SO₂ concentrations ranging from 0 up to 800 nl·l⁻¹ during the total life cycle. At different time intervals shoots were harvested and biomass production, relative growth rate and dry matter content were determined. SO₂ exposure for 25 days resulted in a 41% increase of biomass production on fresh weight basis whereas dry matter content was decreased to 30% with increasing SO₂ concentration. No visible injuries could be observed within the used range of SO₂ concentration. Water soluble non-protein sulfhydryl, SO₄²⁻, and total sulfur contents of the shoot were determined to examine the effect of the extra sulfur supply from the atmosphere to the sulfur metabolism of the plant. Deviding the total sulfur content in anorganic and organic sulfur compounds it should be possible to examine the role of metabolism in the detoxification of SO₂.

17 94

Respiratory energy requirements of fast- and slow-growing species in relation to growth

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In young vegetatively growing plants, up to 70% of the carbon fixed daily in photosynthesis is respired again, the exact amount depending on species and growth conditions. When measured at an optimal nitrogen supply, fast-growing species from nutrient-rich environments tend to have higher rates of both leaf and root respiration per unit of weight than slow-growing species from nutrient-poor environments. These differences between species tend to disappear when the plants are grown at a low supply of nitrogen. In this paper we will analyze differences in respiration between fast- and slow-growing species in terms of the specific respiratory energy costs involved in 1) maintenance of electrochemical gradients across membranes 2) protein turnover, 3) biosynthesis and 4) ion uptake and in terms of the rates of these processes. Finally, the impact of differences in these processes on the total carbon budget of fast- and slow-growing species will be analyzed under steady-state and non-steady-state nitrogen supply conditions, using a simulation model as described in Plant & Soil (1993, 155/156: 183-186).

S303

17 95

Induces UV-B radiation oxidative damage in pea leaves?

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Detached pea leaves were subjected for up to 8 hour to supplementary UV-B radiation in ambient (21% oxygen), oxygen enriched (60%) or oxygen depleted (2%) air. The effect of oxygen concentration on UV-B induced changes in in vivo chloroplast functioning was studied by measuring the half time of the relaxation of the electrochromic shift and the efficiency of Photosystem II. UV-B caused a similar decrease of both parameters at different oxygen concentrations. In addition membrane damage in relation to UV-B radiation and oxygen concentration was assessed by measuring lipid peroxidation and electrolyte leakage. UV-B induced an increase of lipid peroxidation which appeared to be a secondary effect because it occurred mainly after exposure to UV-B. Electrolyte leakage was enhanced by supplementary UV-B. Neither lipid peroxidation nor electrolyte leakage was influenced by oxygen concentration. It is concluded that UV-B induced damage was not affected by oxygen concentration between 2 and 60 percent and that an involvement of photo-oxidative reactions in UV-B induced damage seems less probable.

17 96

Carbon isotope discrimination in *Quercus ilex* resprouting vegetation after fire and tree-fell.

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Resprouting vegetation after fire and tree-fell, common disturbances of the mediterranean forest, show particular characteristics which account for its rapid growth and increased photosynthesis rates. The combined determination of carbon isotope discrimination (Δ), gas-exchange rates and RuBPCase activity in leaves throughout one year after disturbance, enabled us to differentiate between stomatal and non-stomatal limitants of photosynthesis. No differences were observed between resprouts for the parameters measured. In resprouts, Δ was lower and photosynthesis, transpiration and leaf conductance were higher with respect to the original vegetation before disturbance. Increased N, soluble protein content and RuBPCase activity suggest that mesophyll activity is the main factor determining CO_2 assimilation in the resprouts.

17 97

Maintenance respiration in leaves of woody species differing in life-span**R. VILLAR and J. MERINO***Departamento de Biología Vegetal y Ecología, Universidad de Sevilla, Apdo 1095, 41080 Sevilla, Spain*

Maintenance respiration in leaves of 26 woody species, typical for mediterranean ecosystem of S.W. Spain has been studied. Potted plants were grown in greenhouse during 3 years. Maintenance respiration was estimated as the respiration (CO_2 basis) of mature leaves at 20°C . The leaves were classified as evergreen (12 - 24 months life-span), semi-deciduous (5 - 12 months) and deciduous (4 - 8 months). Maintenance respiration, in a dry mass basis, was associated negatively with leaf life-span. Evergreen leaves showed a maintenance respiration ($3.5 \pm 1.1 \text{ nmol CO}_2 \text{ g}^{-1} \text{ s}^{-1}$) lower than deciduous leaves ($6.1 \pm 2.1 \text{ CO}_2 \text{ nmol g}^{-1} \text{ s}^{-1}$) and semi-deciduous leaves ($6.4 \pm 2.3 \text{ nmol CO}_2 \text{ g}^{-1} \text{ s}^{-1}$). Maintenance respiration was positively related to nitrogen concentration, water content and specific leaf area. However, there was no difference in maintenance respiration between deciduous and evergreen leaves, on area basis, because of the differences in specific leaf area within species.

17 98

A study on the removal and recovery of chromium from solution by a bacterial biomass**GY. VINCZE, J. VALLNER, S. BALAZSY, A. BALOGH and F. KISS***Gy. Bessenyei Teacher's Training College, Sóstói út 31/b, 4401 Nyíregyháza, Hungary*

Strains of chromium tolerant bacteria were isolated from a heavy metal contaminated sludge. The strains were identified according to their biochemical and physiological properties as *Pseudomonas*. Some of the strains can grow, with a reduced rate, on chromium(VI) containing media and some of them are totally inhibited in their growth. The presence of chromium makes the lag period longer, from 4 up to 36 hours depending on the concentration of chromium, but the growth of the cells is not entirely inhibited, as after 48 hours the culture reaches the exponential phase at even 250 ppm concentration. The concentrations of chromium(VI) which inhibit 50 % rate of the growth of strains were determined: these values are 115-180 ppm. The concentration of chromium(VI) in the media is decreased with 15-20 ppm in presence of 10^9 cells. The ability of growth of strains on chromium(VI) containing media and the ability of reduction of chromium are independent of each other. The chromium eliminated from the solution is converted to a lower valency state: chromium(III). This form of chromium is not detectable from the media. After an ultrasonic disintegration of the cells the chromium(III) was found in the cell wall fraction. The bound form of chromium can be recovered more or less with different chemicals. The best percentages of recovery is achieved with higher concentration of sodium-hydroxid solution.

S305

17 99

Simultaneous application of CO₂ and UV-B radiation (280-320 nm) to *Vicia faba*: I CO₂ effects on growth and physiology

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Vicia faba plants were grown for forty days under ambient (380 μ l.l⁻¹) and elevated (750 μ l.l⁻¹) CO₂ concentrations and 4 levels of UV-B irradiation. Experiments were conducted in a greenhouse. Four harvests were performed in time. At the final harvest the stimulation of biomass production caused by elevated CO₂ was different under the various UV-B levels (19 to 63%). These differences will be discussed in terms of photosynthesis and growth analysis. Some morphological characteristics (leaf area, plant length and number of flowers) were altered by elevated CO₂. Stimulation of leaf area through CO₂-enrichment was modified by UV-B (11 to 60%). There was no effect of CO₂ on UV absorbing compounds. Finally CO₂ effects on the interception of photosynthetic active radiation by the leaf will be discussed in terms of reflection, absorption and transmission.

17 100

Effect of alachlore, low temperature and drought on maize plant

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Effects of alachlore (10⁻⁴ M), low temperature (10°C) and drought (7 days) on some morphologically-physiological parameters in the maize inbred line ZPL-82/9 were studied. Plants were grown in a growth chamber up to 3-leaf stage. Alachlore was applied at planting. Besides, seed germination, as a test of resistance to drought was evaluated. Seed germinated on the alachlore solution (10°C) and the solution of highly concentrated sucrose (11.9%). Length, weight and DM weight of shoot and root, leaf area and leaf sugar content were observed. Obtained results point out that all investigated parameters affected maize plant. The highest growth inhibition, as well as DM weight of shoots were measured on a variant of alachlore at low temperature. This difference was lower in root. A high difference in DM weight of root was found in the same variant (alachlore-low temperature). A sugar content decreases in all variants in comparison to the control.

Influence of chronic irradiation on protecting system of *Zea mays* with different genetic type

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The glutathione-associated enzymes plays a major role incellular defense from free radical and in maintenance of thiol-disulfide status of plants. The oxidative stress, such as ionizing radiation, causes change of these enzymes activities. In this study it was examined the effect of chronic irradiation in small doses on the activity of glutathione-S-transferase (GST) and glutathione peroxidase (GP) in seeds of different genetic type of *Zea Mays* such as cv.W64A +/- and cv.64A 02/02 from Chernobyl zone. The GST level activity in chernobil seeds. Statistically increases on 59% and 18% accordingly. Glutathione peroxidase activity increases on 20% and 215% as compared with control. Gamma-glutamyltranspeptidase activity decrease on 20% and 35% accordingly. Obtain data suggest that the determination of these enzymes activity in seeds of *Zea Mays* can serve as a good test of tolerance different genetic type of plants for damage action of ionizing radiation in small doses.