12 01

Characterization of NADH Fe^{3+}-EDTA reductase of maize roots

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Iron starved dicotyledonous plants undergo several modification aimed at increasing iron assimilation, including enhanced plasma-membrane linked redox activities in roots (1). Monocots are known to regulate their iron requirement mainly by release of phytosiderophores. However a plasma-membrane associated Fe^{3+}-chelate reductase activity exists in maize and is modulated by iron starvation. This increase is partly a consequence of the more abundant plasma membrane material found as part of an iron starvation syndrome affecting also root morphology (fresh mass +30 %). Molecular mass determinations of solubilized plasma-membrane or microsomes by means of FPLC size-exclusion chromatography identify a 210 kDa protein in both control and stressed material solubilized with 2 % (m/v) lysophophatidylcholine. This protein appears to be very sensitive to freezing-thawing, high salt and dilution. After exposure to such conditions the activity is partially recovered (25 %) associated to 43 and 26 kDa forms tentatively identified as subunits of the 210 kDa (see also refs. 2,3). Other detergents directly give rise to such low molecular mass forms. These are also found in the supernatant fraction.

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12 02

Formation of root epidermal transfer cells in *Plantago lanceolata* L.

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Ultrastructural changes in root cells induced by iron deficiency or by application of the auxin analogue 2,4-dichlorphenoxyacetic acid (2,4-D) has been investigated. When subjected to iron starvation, root epidermis cells exhibited increased FeEDTA reduction capacity. In iron deficient plants FeEDTA reduction was further stimulated by micromolar concentrations of $CrCl_3$. Root sections showing enhanced FeEDTA reduction rates were determined by gel-staining with ferrozine as ferrous scavenger. These regions were analyzed by means of electron microscopy with respect to the development of transfer cells, characterized by dense cytoplasm, cell wall protuberances and enhanced number of mitochondria.
Formation of transfer cells did not occur in iron sufficient roots. However, the differentiation of these cells was induced by the application of 2,4-D (10^{-7} M) in +Fe grown plants, without affecting the FeEDTA reduction capacity. This finding is taken as support that a change in hormonal balance triggers the differentiation of epidermal root cells. No positive correlation between the FeEDTA reduction rates and the amount of transfer cells could be established. It is suggested, that the increase in FeEDTA reduction capacity and the development of transfer cells runs parallel but separate courses.

12 03

Evaluation of wheat cultivars root traits at standard pH (6.5) and low pH (4.5) and higher concentration of aluminium ions

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Winter wheat cultivars Atlas 66 and Zdar were cultivated (18 photoperiod, 25 °C) in the sand and in the water culture with two types of nutrient solution (pH 6.5 and pH 4.5) and with 25 ppm of aluminium ions. After one week of cultivation the root system was sampled. The morphology was analysed by the image analyser LUCIA-D and the total length, surface area and number of root tips were determined. The higher degree of tolerance was at cv. Atlas 66. In both cultivars the largest differences of measured root traits were at water culture. Cv. Zdar has the higher number of lateral root tips. While primordia of lateral roots of more tolerant cv. Atlas 66 continue in their growth, in the case of cv. Zdar primordia stopped their growth very early, which resulted in inhibition of total root length. The image analysis give a lot of new information about morphology of roots in different types of environment which are useful for physiological interpretation of results and plant breeding.

12 04

Nitrate uptake kinetics in roots of uninduced *Citrus* rootstock (Troyer citrange)

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Nitrate transport by roots of two-months old uninduced intact *Citrus* (Troyer citrange) seedlings was studied. Net uptake of NO_3^- was measured by following the depletion of the ions from the nutrient solutions. We have observed that nitrate absorption by *Citrus* is biphasic. At low external NO_3^- concentrations, the roots of uninduced *Citrus* seedlings (Troyer citrange) possessed a constitutive low concentration uptake system. This high affinity transport system (HATS) followed Michaelis-Menten kinetics and approached saturation close to 100 μM, with a K_m value of approximately 40 μM. Nitrate influx in the high concentration range (> 1 mM) by the low affinity transport system (LATS) is also saturable with respect to nitrate concentration. Probably nitrate uptake by LATS may occur via NO_3^- specific channels.

12 05

Factors effecting N,P,K utilization efficiency in winter Triticale plants

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Genotypic differences in absorption and utilization of mineral nutrients may be exploited to improve efficiency of fertilizer use or to obtain higher productivity on nutrients deficient soils. In a preliminary study we have described variations in the biomass production and N,P,K utilization efficiency among 49 winter triticale lines and cultivars.

The objective of this work was to determine the reasons for these differences. Nutrient culture experiments were carried out under controlled conditions (climatic chambers). The relationship between stage of growth, hanges in plant parameters and nutrient uptake properties were investigated in 21 winter triticale genotypes.

The genotypes studied differed in: shoot and root growth rate, root length, nutrient uptake and influx rate into roots, ratio of ion transport to shoot, nutrient accumulation and utilization efficiency during 30 days of vegetation. Among genotypes with high nutrient efficiency differences in nutrient uptake strategy were observed; e.g. in one group of efficiency genotypes longer roots were associated with lower uptake and influx rate, while in others group of genotypes shorter roots are associated with higher uptake and influx rate. The combination of both longer roots and high nutrients uptake and influx rate was not found in any of the genotypes studied.

12 06

Translocation and sucrose metabolism in bean roots as affected by phosphate deficiency

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Bean plants *(Phaseolus vulgaris)* were cultured for 2 weeks on phosphate sufficient (+P) and phosphate deficient (-P) medium. Phosphate deficiency increased ^{14}C assimilate translocation from the shoot to the root. In water soluble fraction extracted from the roots, sugars labelling was higher in -P than in +P roots, whereas the labelling of amino acids and organic acids was the same. Phosphate deficiency increased sucrose, glucose and fructose content of the roots, but had little effect on activities of sucrose hydrolyzing enzymes (acid and alkaline invertases).

12 07

IAA effect on the composition in glycosylated and non-glycosylated polypeptides of *Lupinus albus* roots

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Auxins are known to affect several plant developmental processes, one of these being root differentiation.

In this work we have studied the root development of *Lupinus albus in vitro* and used the normal *in vivo* roots as a control. The polypeptide analysis by SDS-PAGE revealed that the patterns of glycosylated and non glycosylated polypeptides along the root axis were similar for both *in vitro* and *in vivo* systems. The roots in culture were differentially affected by the IAA concentration of the medium, the main morphological effect being the inhibition of root elongation. We have found that a group of glycosylated polypeptides with molecular weights between 42 and 45 kDa was more abundant under high IAA concentrations. Curiously, this group was also more prominent at the differentiated zone of roots from both systems studied. Evidences obtained by cellular fractionation suggested that this group of polypeptides is located at the cell wall. If so, we may be in presence of glycosylated polypeptides that are markers of root differentiation and whose presence is enhanced by IAA. The promotion of differentiation is eventually connected to inhibition of root elongation.

Further studies are being performed in order to identify the function of these polypeptides.

12 08

The influence of salinity on growth, nitrogen metabolism and root HCO_3^- incorporation in *Lycopersicon esculentum*

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The influence of 0, 100 and 200 mM NaCl on the growth and N metabolism of hydroponically grown tomato plants was investigated. Reduced growth of the salinized compared to non-salinized plants was associated with lower specific leaf areas in salinized plants. The uptake of NO_3^- from the root solution was inhibited by salinity. Nitrate concentrations in the tissue and the *in situ* nitrate reductase activities of the leaves were lower in salinized than non-salinized plants. This was associated with lower NO_3^- and higher reduced-N concentrations in the xylem sap, indicating increased reduction of NO_3^- within the root. Dark incorporation of inorganic carbon by the root was measured by an $H^{14}CO_3^-$ pulse followed by separation of the products of incorporation on ion exchange resins. The rate of $H^{14}CO_3^-$ incorporation was ca. 2-fold higher in non-salinized than in salinized plants. In salinized plants there was a large diversion of the products of $H^{14}CO_3^-$ incorporation within the roots to amino acids while the non-salinized plants diverted relatively more ^{14}C into the synthesis of organic acids. It was concluded that HCO_3^- incorporation within the roots may provide an anaplerotic source of carbon for root-based assimilation of NO_3^- into amino acids.

12 09

Hormonal regulation of potassium and nitrate ions uptake by wheat seedlings

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Experiments were performed with 7-days wheat plants. Within day sampling for hormone analysis was carried out each hour in parallel with nitrate and potassium ions uptake measurements. Oscillation of hormone content was shown during illumination period, hormone concentration changes in shoots and roots taking place synchronously.
Rhythmic changes of nitrate and potassium ions uptake demonstrated within day period correlated with each other. In some cases the increase in ions uptake was shown to follow hormone concentration increase. These results are in accordance with literature data showing promotive influence of exogenous ABA on ions uptake.
The results suggest hormonal regulation of ion uptake.

12 10

Effect of chelators on lead, iron and potassium uptake and interactions

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Interactive effect of chelators (EDTA, citrate) and Pb were investigated on the adsorption and uptake of K and Fe by wheat and cucumber plants, respectively. Although Pb is taken up by plants in significant amounts, moreover its effect greatly depends on the chelator supplied. While Pb with citrate considerably inhibits growth, it may even stimulate it to a certain extent with EDTA. K (^{86}Rb) uptake of wheat roots is inhibited by Pb in the presence of citrate and EDTA or as well as without chelator. In cucumber, K uptake is inhibited by Pb with citrate in the culture solution but the inhibition is not well expressed with EDTA. In cucumber iron uptake ^{59}Fe citrate was inhibited but from ^{59}Fe EDTA it was stimulated by Pb. In wheat roots several fold increase in iron adsorption from ^{59}Fe EDTA was found in the presence of Pb compared to its control and to ^{59}Fe citrate and $^{59}FeCl_3$. This might be due to the differences in the stability constants of Pb- and Fe-complexes formed with EDTA and citrate, respectively.

12 11

NMR studies of manganese uptake and of manganese pretreated plants

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Exposing a plant tissue to the paramagnetic ion Mn^{2+} usually leads to a differential effect on the linewidth of the cytoplasmic and vacuolar inorganic phosphate (P_i) signals in the *in vivo* ^{31}P nuclear magnetic resonance (NMR) spectrum. This spectroscopic effect provides the basis for a sensitive quantitative analysis of the free Mn^{2+} pools in the tissue as well as permitting the design of experiments that would otherwise be complicated by interference between the cytoplasmic and vacuolar P_i signals. When the quantitative analysis was applied to maize root tissues, it was found that the tissue could maintain a low concentration of free Mn^{2+} in the cytoplasm during manganese uptake and that there was a non-equilibrium distribution of the ion between the cytoplasm and the vacuole. Typically exposure to Mn^{2+} in the range 10-100 μM resulted in a submicromolar pool of Mn^{2+} in the cytoplasm and under these conditions the movement of manganese out of the cytoplasm, whether across the plasma membrane or the tonoplast, was energy consuming. Results of this kind establish a similarity between the subcellular distribution of manganese and calcium and thus lend some support to the suggestion that manganese might have control functions in cells. Irrespective of this speculation, the selective linebroadening of the vacuolar P_i signal can be used to eliminate the signal under conditions where an increase in the vacuolar pH would lead to the masking of the cytoplasmic P_i signal and this technique has been used to provide a novel demonstration of the reversibility of the pH effect on ethanol production under anoxia.

12 12

Effects of ammonium and nitrate nutrition on growth and water relations of *Lycopersicon esculentum*

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The effects of three levels of ammonium and nitrate on leaf photosynthetic rates, biomass allocation and water relations of tomato plants were studied. The leaf photosynthetic rate was positively correlated with nutrient nitrate concentrations and negatively correlated with nutrient ammonium concentrations. Ammonium up to 6 mM in the nutrient solutions inhibited water uptake and reduced leaf water potential of the plants. The leaf photosynthetic rates with ammonium nutrition were 30% to 50% of those with nitrate nutrition. The reduction of leaf photosynthetic rate with ammonium nutrition was closely correlated with ammonium accumulation in the leaves and stomatal closure at high transpiration rates. The plants supplied with 6 and 10 mM ammonium showed two fold higher leaf weight ratios than those of plants supplied with either 3 to 10 mM nitrate or 3 mM ammonium nutrition. This caused in an imbalance between water uptake, transport and transpiration which resulted in water stress in the plants. The reasons for the reduction of leaf photosynthesis and water stress of the plants supplied with ammonium nutrition will be discussed.

12 13

Chromium-induced inhibition of ethylene evolution in bean (*Phaseolus vulgaris*) leaves

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The influence of chromium on ethylene formation in bean plants was investigated. Leaf discs floated on CrO_4^{2-} or Cr^{3+} showed an inhibition of ethylene synthesis from endogenous ACC as did plants cultured in presence of CrO_4^{2-}. Chromium ions supplied either to plants in the nutrient solution or to floating leaf discs showed an increased conversion of ethylene from exogenous ACC. In trifoliolate leaves exposed to 10 µM CrO_4^{2-} a significant decrease of ethylene production form endogenous ACC was observed while a substantial increase of ethylene production was found. These results suggest that the inhibition of ethylene production by Cr rather was due to metabolic alterations leading to decreased ACC availability than to a breakdown of membrane integrity.

12 14

Properties of maize root mitochondria from plants grown on different nitrogen sources

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It is known that high ammonia level is toxic for plant tissue. Mitochondria may be involved in detoxification by increasing respiration rate to prevent the accumulation of metabolites that could be toxic. We investigated some key-enzymes involved in carbon and nitrogen metabolism and respiration rate of maize root mitochondria. Maize plants were grown on nutrient solution containing nitrogen as 14.4 mM nitrate ± 7.2 mM ammonia. Mitochondria were isolated from root tissue in 4-leaf stage and purified on Percoll gradient. It was observed that the amount of mitochondrial protein as well as respiration rate were increased in the presence of ammonia. Consequently, the activities of all investigated enzymes: ICD, GDH, GPT and proline oxidase calculated per fresh weight of root, were increased. On the other hand, the increase in specific activities of GDH and GPT suggests their role in detoxification of ammonia by stimulation of NH_4+ incorporation in glutamate and alanine.

12 15

The stress effect of cupric sulphate on growth processes of *Agrostis stolonifera* L.

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The effect of various concentrations of Cu^{2+} ions applied as $CuSO_4$ in nutrient medium (3, 10, 50, 100, 400 mg l^{-1}) on growth processes of *Agrostis stolonifera* L. during two weeks were studied. High concentration of Cu^{2+} markedly inhibited growth of roots. This inhibition correlated with changes in the level of abscisic acid and free cytokinins. Absorption of Cu^{2+} by the plants correlated with concentration of $CuSO_4$ in nutrient solution.

12 16

Water uptake from soil profile and water stress in maize plants

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The effect of soil drying on root growth and water uptake were investigated in the generative phase of maize plants. The method of large horizontally divided lysimeters was used. Water uptake was calculated from the changes of soil suction pressure, using digital equipment with plaster bloks. Under conditions of unlimited water uptake along the rooting soil profile (control), 51.4 % of water uptake of the total plant water uptake during season, was realized by the roots in the 0-33 cm zone , 42.6 % in the 33-66 cm zone, and only 6.6 % in the 66-99 cm zone. After the application of drought downward the whole rooting soil profile 0-99 cm, the distribution of root dry matter increased evidently, from 11.4 % (control) to 22.4 % in the soil zone 66-99 cm, and water uptake also increased from 6.6 % to 20.6 %. Similar situation in root dry matter distribution occured in the experiment with drought induced in the zones 0-66 cm, but not in the zone 66-99 cm with unlimited water supply. Here, the dry matter distribution increased from 11.4 % to 24.4 %, while the water uptake increased substantially from 6.6 % to 45.3 %. The development of compensation roots in deep and more wet soil zones manifested the mechanisms of drought-avoidance.

12 17

Effect of lead on the activities of some enzymes of nitrogen metabolism in sugar beet

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Heavy metal stress causes multiple direct and indirect effects on physiological processes in plants. The affinity of heavy metals for side-chain ligands of proteins suggests that enzymes are among the first molecules with which heavy metals interfere in plants. Heavy metals can either inactivate some enzymes or increase their activity. We studied the effect of 10^{-5} and 10^{-3} mol(Pb) l^{-1} on the activity of some enzymes of nitrogen metabolism in roots and above-ground parts of young sugar beet plants grown as water cultures. The results showed that the concentration of lead increased significantly, particularly in root. The mass of the above-ground part remained unchanged, while the mass of root decreased. The activity of nitrate reductase and glutamine synthetase significantly decreased in the above-ground part, while the content of nitrates in above-ground parts and roots and the portion of soluble proteins in shoots increased. The studied concentrations of lead had the lowest effect on the activity of glutamate dehydrogenase and on the portion of total nitrogen. Bearing in mind the fact that nitrogen assimilation enzymes contain amino acids rich in sulphur, our results support previous results that heavy metals affect firstly the function of SH groups and S-S bonds of enzymes.

12 18

Effect of heavy metals on isoenzyme polymorphism of wheat

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Phytotoxic effect of excess heavy metal concentration occurs due to the interference of those elements in cellular metabolism inactivating some enzymes or increasing the activity of others. Heavy metals may cause changes on structural and regulatory genes which are responsible for biosynthesis of different enzymes. According to that, electrophoresis of GOT-2, GOT-3, SOD, ADH-1, AADH-1, ACO-1, ACO-2, SHDH-1, PX and total proteins in shoot and root of wheat seedlings exposed to zinc, cadmium and lead were studied.
According to the results obtained, it can be concluded as follows:
- the number of peroxidase bands increased in seedlings exposed to cadmium,
- increased intensities of AADH-1 bands were found in seedlings exposed to cadmium, and of ADH-1 bands to lead,
- decreased intensity of SOD bands was found in seedlings exposed to cadmium and zinc,
- a large amount of polymorphism (number of bands as well as staining intensity) was detected in total proteins.

12 19

Comparison studies on the soluble and plasma membrane associated nitrate reductase from *Cucumis sativus* (L.)

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The biochemical comparison between two forms of nitrate reductase from cucumber roots: the soluble enzyme and the plasma membrane - associated one was made. Soluble nitrate reductase was purificated on the blue - Sepharose 4B. The nitrate reductase bounded with plasma membrane was isolated from cucumber roots by a partition in two phase system. The molecular weight of native enzyme estimated with HPLC and gel electrophoresis was 240 kDa and 116 kDa for soluble and membrane - bounded enzyme respectively. Temperature induced phase separation in Triton X-114 indicated a huge difference in hydrophobicity of a plasma membrane - bound nitrate reductase and soluble form of enzyme. Some differences were also observed in partial activities of plasma membrane nitrate reductase and soluble nitrate reductase. On the other hand, experiments with polyclonal antiserum raised against the native nitrate reductase showed no differences in the immunological properties of both forms of nitrate reductase. Above results indicated that in cucumber roots two different forms of the nitrate reductase are present.

12 20

Influence of NaCl on water relations and mineral nutrition of the sugar beet and the sea beet

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The responses of plants to salinity - or to other types of water stress - are of widespread importance in agriculture, and considerable effort has been dedicated to their study. The *Chenopodiaceae* contain in comparison to other plant families many salt and water stress resistant representatives and one of them is the sugar beet. However, this plant is far less tolerant to a low water potential or high NaCl concentrations in the soil solution as its ancestor the sea beet. In order to acquire more insight in the genetic resources of the sea beet for breeding of a higher salt and drought resistance in the sugar beet we started with comparing studies. Plants of both subspecies were grown on a full strength nutrient solution containing either 40 mM or 15 µM NaCl (control) on gravel culture. We studied several physiological parameters on tissue level to reflect the reaction to NaCl treatment as there were *e.g.* the growth, the mineral composition (Na, K, Cl, Mg, Ca and Cl), the sugar content, the chlorophyll content, the osmotic potential (ψ_s) and the density of extracted sap. Beside the measurement of the water relations (pressure potential, half-time of water exchange, volume, modulus of elasticity in single storage cells, samples of the vacuolar sap (50 - 80 pl) were taken with a modified pressure probe. these samples were also used for the measurement of the ψ_s and the composition of organic and inorganic solutes with osmometry, X-ray microanalyses and fluorescence-emission techniques.

12 21

Effects of salinity and osmotic stress on the cation composition in sunflower (*Helianthus annuus* L.) and wheat (*Triticum aestivum* L.)

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The tolerance of agricultural interesting crops to drought and salinity stress is an important factor to choose between cultivars. Under these conditions plants can reduce their internal water potential by accumulating inorganic ions. Alterations in micro element uptake, mainly by competition with Ca^{2+}, can be explained as a response to this stress.
To investigate this, two sunflower cultivars, Viki (stress tolerant) and Blumix (less tolerant), and two wheat cultivars, Tiszatáj (stress tolerant) and Kata (less tolerant) were treated for 72 hours with an osmotic stress (200 mOsm PEG) and a salinity stress (200 mOsm NaCl). Na^+, K^+, Ca^{2+} and Mg^{2+} contents were measured by AAS, and Cu^{2+}, Fe^{2+}, Mn^{2+} and Zn^{2+} by ICP-AES.
The results show that in case of salt treatment all elements except Na^+ decreased where PEG had the opposite effect: only Na^+ did not increase. Stress tolerant cultivars excluded the Na^+ from the shoot with higher efficiency but showed no major differences in other elements.

12 22

Growth rate of plants as affected by the distribution of nitrate reduction activity

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Growth rates of plants seem to be related to the distribution of nitrate reduction and assimilation activities in the plants. Fast growth rates are characteristic of plants which transport almost all the nitrate taken up by the roots to the shoots, where reduction takes place. Slow growing plants reduce relatively more nitrate in their roots, transporting little nitrate to the shoot.
Nitrate reduction is energetically more demanding for the root than for the shoot, due to a limited availability of carbohydrates. Nitrate assimilation in the root results in poor root growth and, consequently, a diminished capacity to satisfy shoot demands for mineral nutrients and water. Regulation of xylem loading of nitrate may play an important role in this phenomenon.
Environmental stress conditions, such as salinity, slow down growth. This is accompanied by decreased transport of nitrate to the shoot and enhanced assimilation of nitrogen in the root resulting in high reducedN/nitrate in the xylem sap. Genotypes of tomato and barley with low growth rates exhibited enhanced root assimilation of nitrate as compared to their wild types.

12 23

Nitrate reductase activity and free amino acid content in sugar beet depending on the molybdenum and boron supply of plants and humidity conditions

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Boron and, especially, molybdenum, (sand and soil culture) are shown to maintain nitrate reductase activity in leaves and root crops at a higher level at environmental moisture deficiency. Under water stress these microelements enhance the content of glutaminic acid and glutamine in leaves and root crops, while the total content of free amino acids reduces. Molybdenum application results in a more intensive staining of nitrate reductase isoforms with the relative electrophoretic mobility of 0.24 - 0.26 and 0.56 - 0.60. The role of these microelements in the increase of plant resistance to the unfavourable humidity factor is discussed.

12 24

Calcium-induced modification of copper toxicity in rice (*Oryza sativa* L.) seedlings

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Seedlings of rice cv. NIAB 6 were grown for 15 days under controlled environment conditions in a buffered nutrient solution, pH 5.5, containing 1, 8, 16 and 32 μM $CuSO_4$ and, at each of these concentrations, 1, 5 and 10 mM $CaCl_2$. Compared to the seedlings at 1 mM $CaCl_2$ in combination with all $CuSO_4$ treatments, 5 mM $CaCl_2$ decreased Cu toxicity as indicated by greater root length and root dry weight. Total chlorophyll per g fresh weight of the uppermost fully-expanded leaves was found to be higher in seedlings in the presence of 5 mM $CaCl_2$ in all $CuSO_4$ treatments compared to seedlings grown in 1mM and 10 mM $CaCl_2$ in combination with $CuSO_4$.
A measurement was made of the amount of K^+ leakage from intact roots immersed for 16 h in 5 mM $CaCl_2$ and in 8 μM $CuSO_4$ ± 5 mM $CaCl_2$. The presence of 5 mM $CaCl_2$ reduced the leakage due to 8 μM $CuSO_4$ by 50%. Leakage in 5 mM $CaCl_2$ was negligible. Lipid-peroxidation products accumulated in roots immersed in $CaCl_2$ solutions and in roots immersed in $CuSO_4$ solutions.

12 25

Influence of aluminium toxicity on cytokinins in bean plants

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Injury of root tips by Al is thought to inhibit cytokinin export from roots to shoots. To verify this hypothesis, we analysed the influence of a highly toxic Al concentrations (sum of monomeric Al species 127 μM) on the levels of zeatin riboside (ZR) and dihydrozeatin riboside (DHZR) in roots, stems and leaves of two bean (*Phaseolus vulgaris*) cultivars growing in continuously flowing nutrient solution (pH 4.5). The Al treatment caused severe inhibition of root elongation in both cultivars. Cultivar Strike was more affected by both Al-induced mineral nutrient disorders and Al-induced alterations of leaf water relationships than cultivar Contender. In both cultivars Al significantly increased the concentration of ribosylated cytokinins and in leaves a more than three times higher level of these cytokinins was found than in controls. Our results suggest that Al affects plants not by inducting deficiency of cytokinins but by some other factor necessary for the manifestation of cytokinin action.

12 26

Root as the regulator of transport processes in a higher plant water exchange system (HPWES)

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A root plays a double role in HPWES: *1*) it renders passive hydraulic resistance to transpiration flow (R) and *2*) it carries out active uptake of ions from ambient solution ($+\Delta\pi$). At constant evaporation rate value R determines a water threads tension in xylem and value ($+\Delta\pi$) determines degree of lowering of this tension. The higher $\Delta\pi(t)$ value (in dynamic), the stronger a hydraulic wave pulse propagating along HPWES from the root up to the stomata (lower engine, LE), the stronger an increase of stomatal aperture and transpiration rate (upper engine, UE). Hence a direct connection (DC) exists between LE and UE, that becomes brighter with increasing of water threads tension, *i.e.* when R is high. Conditions which increase DC enhance also positive feedback between LE and UE. It means that when R increases, a role of forced O_2-diffusion through then root increases too, simultaneously with the transpiration flow increase. In this case an active uptake of ions ($+\Delta\pi$) connected with breathing becomes dependent on transpiration, which causes the onset of autooscillating water transport regime with a period 20 - 80 min. The mechanism controlling the R value consist perhaps in synthesis of some phenolic compounds lowering the root hydraulic conductivity. Series of experiments comfirming given above conception was carried out using the phytomonitoring approach.

12 27

The multiphase kinetics of phosphate uptake by plant roots

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The uptake and accumulation of phosphate ions by cells of plant roots are taken as a function of chemical and biochemical processes. In an experiment with native intact maize roots affected by different phosphorus concentration in the external solution (from 0.0001 to 50 mM), the multiphasic character of the kinetics of phosphate uptake has been stated. The character of kinetics for the uptake of phosphate is analogous to the kinetics of the enzymatic reactions described by the Michaelis-Menten equation. The single phases are characterized by the different values of K_m and V_{max}. The results showing the possibility of conformative changes of ATP-ase depending on phosphate concentration, indicate that at certain critical levels of ion concentration the system of transport ATP-ases and ionogenic pump systems pass through the different conformative changes with the change of the values K_m and V_{max}.

12 28

The functional loads to the root cells are inductors of superoxide radical generation

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Generation of active oxygen forms is one of the early metabolic cell reactions in response to stress. According to our data it is direct correlation between the superoxide radical generation and physiological state of root cells. The cutting off root from seedling induces the strenghening of superoxide generation in the beginning period (1-2 hours after the cutting. It is "alarm" phase according to G.Selje.) After 6 hours incubation of roots the $O_2^{\bullet -}$ production is lowered in two times (the adaptation phase). It is proposed that the cutting off root from seedling provokes the cell transition to the active state which is accompanied by superoxide production. Double functional load to the root cells (the cutting off root plus critical concentration of Ca^{2+} ions - 10 mM) evokes the powerful stimulation of superoxide generation (until 300 per cent). One of the reasons of this fact may be the surplus Ca^{2+} influx in cells which launchs the system of superoxide generation. Ca^{2+}-effect is prevented unsignifically by the Ca^{2+}-channels blocker verapamil. On the other hand it is known the Ca^{2+} ions are lowered the membrane permeability and one of the response reactions to this phenomena is the strenghening of superoxide generation (factor labilizating of membrane structure). It is confirmed by data about the intensification of $O_2^{\bullet -}$ generation with addition of membrane stabilizator - gadolinium ions.

12 29

Metabolic responses to anaerobic media conditions in roots of *Carex pseudocyperus* L. as affected by different nitrogen supply

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The effects of different nitrogen sources (NO_3^-, NO_3^-/NH_4^+, NH_4^+) on the adenylate energy charge and $NADH/NAD^+$ - ratios was studied in relation to nitrate reduction and fermentative activity in roots of *Carex pseudocyperus* L. after 24 hours of aerobic (>270 x 10^{-3} mol m^{-3} O_2) and anaerobic (<2 x 10^{-3} mol m^{-3} O_2) conditions of the nutrient solutions.
Although *C. pseudocyperus* shows ability for oxygen transport from shoot to root, metabolic responses were observed after transfer to anaerobic nutrient solution. The adenylate energy charge decreased by 16.8% in the presence of 3 mol m^{-3} nitrate, 25.5% under supply of 2 mol m^{-3} nitrate + 1 mol m^{-3} ammonium and 31.5% in the presence of solely 3 mol m^{-3} ammonium. $NADH/NAD^+$ - ratios increased by 217% under nitrate supply, 263% in the presence of nitrate + ammonium and 278% with ammonium as solely nitrogen source. While *in vitro* nitrate reductase activity was enhanced by 313%, *in vitro* alcohol dehydrogenase activity increased about 7-fold under anaerobic conditions of the nutrient solution. Under *in vivo* conditions a competetion for NADH between nitrate reductase and alcohol dehydrogenase might occur as nitrite accumulation increased and ethanol production drecreased under anaerobic media conditions.

12 30

Mineral nutrition of tissue cultured plantlets

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The nutritional requirements and the factors that affect nutrient uptake and growth of plants *in vitro* have rarely been studied in detail and are still poorly understood. The nutritional situation of tissue cultured plants might be summarised as follows. Tissues, lacking roots, are transferred to an agar-based media, containing mineral nutrients. Initially, at the start of the sub-culture interval, tissues are small in size, and have the capacity for exponential growth. Nutrient concentrations are high. Over the sub-culture interval relative growth rate declines, nutrients are taken up, and there may develop a situation of either deficiency, or at least of a less than optimal concentration at the plant-media boundary, such that growth rate is reduced. Using *Delphinium* and *Hosta* we are addressing the following questions:
a) What is the mechanism of uptake?
b) Is uptake proportional to growth rate?
c) Does luxury consumption occur over the first part of the sub- culture interval?
d) Over an extended period does media depletion lead to one or more ions becoming limiting?

12 31

The structural peculiarities of germinated barley caryopses formed at different temperature

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During maturation of barley caryopses at low temperatures (10 °C) the proliferation, the growth of cells and the degree of forming some embryo organs are changed. The modification of special organization of embryo growth under the conditions of low temperature maturation in comparison with 20 °C ones slows the inhibition of the cell growth in length, strengthening transverse one in the apical part of the root pole, stimulation of the transit part, stem apex and the youngest embryo leaves, and the inhibition of coleoptile growth as well. The altered structure of caryopses influences on processes of the initial growth of embryos during germination. The transition of the embryo root cells to extension in basal part and to division in apical one and the stem pole organ growth take start later, in embryos maturated at temperature of 10 °C. The resumption of the cell growth in different organs and embryo zones at germination delays the later the more the sizes of these parts exceed similar ones maturated under optimal temperature conditions.

12 32

Nitrate accumulation and its role in ionic status of plants

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Nitrate accumulation in tomato, lettuce and red beet grown in hydroponic culture was studied in relation with NO_3^- role in ionic balance maintenance in plants. The ratio NO_3^- /total sum of cations measured by use of ion–specific electrodes and flame photometry was shown to decrease from 0.4–0.6 in stems and petioles to 0.05–0.3 in leaf blades depending on plant species. When varying NO_3^- and/or other ions concentration in nutrient solution nitrate level in shoots and roots was found to decrease up to 3 times through its substitution for other mineral (chiefly Cl^-) or organic anions without essential changing in the sum of cations. NO_3^- replacement by NH_4^+ resulted in more severe NO_3^- level reduction in plants accompanied by ionic status disturbance (i. e. other mineral anions accumulation and main cations and organic anions level decreasing). The disturbance observed was shown to be mainly due to the root zone acidification and could be effectively removed with media suitable neutralization. It is concluded that NO_3^- is indispensable mineral anion playing a role in ionic and pH homeostasis of plants. The ways of nitrate limitation in plants ought to be in accordance with the maintenance of optimal mineral to organic anion ratio in leaves determining plant biomass productivity.

12 33

NR and NiR activities in wheat seedlings exposed to nitrite

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Nitrate reductase (NR) and nitrite reductase (NiR) activities were measured in different test system, using nitrite as additional or sole N-source. NR appears to be responsive to metabolic and physiological status of plants and has often been used as a reporter to indicate stress or other changes in plant physiology including the diurnal variation of metabolic activity. NR and NiR are both inducible by NO_3^-. Unlike NO_3^- uptake, NO_2^- uptake by higher plants has been scarcely studied. Nitrite appears as very active substance in plant metabolism, the importance of this compound in plants lies in its effect on growth (morphogenesis), and hormonal status, too. The interference of external nitrite with NR activity was examined. In low concentrations nitrite enhanced *in vivo* NR activity, in higher concentrations acted as inhibitor, and caused approximately 50 % loss of enzyme activity. NiR was positively affected. The effect of nitrite showed a strong pH dependence. Effect of nitrite, applied as the only N-source, on induction of NR and NiR activity, was studied in organs of 7-day-old wheat seedlings. Only low levels or no NR activity can be detected. Low concentrations of nitrite caused increase in NR activity measured in leaves, compared to the N-free values. In higher concentrations, nitrite inhibited the appearance of NR. The effect of nitrite was influenced by varying pH. In acidic environment nitrite showed only harmful effect on NR activity of leaves.

12 34

Effect of sulphur on nitrogen assimilation in young sugar beet plants (*Beta vulgaris* L.)

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Sulphur is a structural constituent of amino acids and several coenzymes and prosthetic groups, such as ferredoxine, which are important for nitrogen assimilation. The objective of the paper was to study the effect of sulphur on key enzymes of nitrogen: nitrate reductase, glutamine synthetase and glutamate dehydrogenase in the above-ground part of young sugar beet plants. The method of water cultures was applied and the effect of -S, 1.0 and 3.0 mMS/l was studied.

The results obtained show that the studied concentrations of sulphur significantly increased its content in the above-ground part and the mass of dry matter of the above-ground part.

The activity of nitrate reductase, glutamine synthetase, glutamate dehydrogenase and the content of soluble proteins increased increasing the concentration of sulphur in the nutrient medium while the portion of nitrates significantly decreased. The studied concentrations of sulphur had no significant effect on the content of total nitrogen.

The results obtained indicate the significant function of sulphur in nitrogen metabolism and potential production of food containing low nitrate concentration with good supply of plants with sulphur.

12 35

Photosynthetic DM increment as a measure of NO_3^- or NH_4^+ assimilation in maize and sunflower leaves

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A leaf discs method was used to measure photosynthetic dry matter increment in leaves of maize and sunflower plants growing 16 days in water cultures with 7mM NO_3^--N and following 16 days with or without N-supply. Dist. water, 3mM NO_3^- or NH_4^+ solutions were used as irrigation medium for leaf discs during light exposition. NO_3^- and NH_4^+ solutions had little effect in fully N-supplied plants. In N-starved maize plants DM increase reached after 8 h light exposition 15% and less and after 24 h 26% with dist. water and NO_3^- solution while 54% with NH_4^+ solution. In N-starved sunflower plants DM increment reached after 8 h light exposition 37% and less and after 24 h 50% with dist. water and NH_4^+ solution while 62% with NO_3^- solution. A positive contribution of longer light exposition to higher photosynthetic DM increase connected with NO_3^- or NH_4^+ assimilation reflected probably preceeding accumulation of involved enzymes.

12 36

A model of the transformation of assimilated carbon in the source photosynthetic tissues

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A model of functional integration of the processes of transformation of assimilated carbon in the source photosynthetic tissues has been proposed. This model is based on the differences of the turnover time of the fundamental metabolic pools of the dark modified respiration in the light (80 min) and photorespiration (1-2 min). On each level of integration only one component of total respiration functioned. Each level was characterized by:

1. specific time period of the regulation of the processes;
2. system of metabolic pools, which was formed by summing up of carbon flows;
3. distribution of substrate flows;
4. transport system, which realize export of the terminal products to the next level of integration system.

Thus each level presents a source and a sink of the assimilated carbon.

12 37

Changes in the N-metabolism of spring wheat under different levels of nitrates in the nutrient solution

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Ten-day-old plants of spring wheat were grown in Hoagland's solution with 3 doses of N in the form of NO_3^-. Each variant had three subvariants: no N, with KNO_3, and with $K^{15}NO_3$. The various nitrate levels were reflected in biomass production. The higher the level of nitrates in the nutrient solution, the higher the biomass production in the aboveground parts and in roots. NO_3^- uptaken from the nutrient solution by the plant was the same as in variants with lower NO_3^- levels (N_1 and N_2), while the significantly highest level of free NO_3^- was found in the N_3 variant. All subvariants had the same level of free NH_4^+. The isotopic ^{15}N enrichment in the plant increased with the amount of N transported to the plant. The $^{15}NH_4^+$ enrichment reflected the level of reduction of absorbed nitrates. The relationship between absorbed nitrates and NR activity, level of proteins and saccharides in the stage of the 4th and 5th leaf is also given.

12 38

Copper binding ligands in *Phylodendron tuxla*

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Phylodendron tuxla leaf explants were exposed to copper concentrations varying from 0 to 20 ppm. Cytosolic fractions analyzed for copper binding ligands by size excluding chromatography (Sephadex G-50 and Superose 12) and atomic absorption spectrophotometry. Most of the additional copper taken by the plantlets was associated to the postmicromal fraction. In this soluble fraction, copper was bound exclusively to low molecular mass fractions (<500 daltons) which coelute as glutathione. However, further separation in Sephadex G-15 resolved copper in three different components, and only a minor fraction coeluted as copper-glutathione. The possible role of these components in copper metabolism and protection against copper toxicity will be discussed.

12 39

Effect of various forms of nitrogen fertilizers and methods of their application on nitrates level in French bean pods

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The purpose of investigations was to estimate the influence of two forms of nitrogen fertilizers (NH_4 and NO_3) and their application by different methods on two French bean cultivars pods yield and its biological quality. Two types of soil and *Rhizobium phaseoli* inoculation were considered in the experiment. In the obtained plant material a total and marketable yield, dry matter and reducing sugars contents, as well as total protein and nitrate level were determined. The results of chemical analyses showed that only in the case of cultivation of bean on light soil, the low nitrate content, not exceeding 250 mg kg^{-1}(f.m.) (*i.e.* content of nitrates permissive for baby food production) was found in the yield. Out of various treatments the best results in respect to nitrates level were obtained in pods of French bean cultivated on soil inoculated with *Rhizobium* and fertilized with NH_4 nitrogen, using a placement fertilization technique.

12 40

Regulation of nitrate reductase activity in *nar*-mutant lines of barley Chlo-19 and Chlo-29

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Barley seedlings the cultivars Winer (wild type), Chlo-19 (*nar*-mutant, nitrate reductase deficient) and Chlo-29 (another *nar*-mutant, different from Chlo-19), were grown hydroponically in the absence of nitrogen or in the presence of nitrate (0.015 mM or 4 mM) for 2 weeks. Nitrate fed *nar*-mutant plants showed 10% of the wild type *in vitro* nitrate reductase activity (NRA) when grown under 600 mE m^{-2} s^{-1}. This inducible nitrate reductase in the mutants was sufficient to support growth of the *nar*-mutants in nitrate as the only N-source. Mutant plants expressed NAD(P)H-dependent NRA both in the shoots and in the roots. Under low photon flux (150 mE m^{-2} s^{-1}) Chlo-19 and Chlo-29 showed a root NRA more active than in the wild type. We conclude that mutant limitations of shoot NRA in barley plants can trigger at least two different compensation mechanisms involving: (a) enhanced biosynthesis of the minor form of NR (NADPH-NR) in shoots and (b) an enhanced relative participation of root NR in overall plant nitrate assimilation. Nitrogen starved plants expressed low but detectable NADH-NR. In this case, differences between the genotypes in NRA were not as obvious as in nitrate-fed plants. We suggest the existence in barley plants of a constitutive NR which was not effected by mutation.

12 41

Transmembrane Cu(II) reduction by roots of *Silene vulgaris* and *Agrostis capillaris*

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Under copper-toxic conditions, plants usually develop chlorosis, conceivably due to competition between Cu(II) and Fe(III) for electrons from transmembrane reductases or binding sites of transmembrane carriers, or, in case of grasses, siderophores. In this study we measured transmembrane Cu(II) reduction by roots of Fe-sufficient and Fe-deficient *Silene vulgaris* and *A. capillaris*, both with and without Fe(III) carboxylates in the bathing solution. Roots of Fe-sufficient plants of both species reduced Cu(II)BCDS (40 μM) at a rate of 0.75 $\mu mol.h^{-1}.g^{-1}$ FW, approximately. Fe-deficiency increased the rate in *S. vulgaris* (up to 3.8 $\mu mol.h^{-1}.g^{-1}$ FW, the increase being proportional to the roots' Fe(III)EDTA reduction capacity), but not in *A. capillaris*. Cu(II)BCDS reduction was almost completely suppressed by $Fe(CN)_6^{3-}$ (100 μM), but unaffected by Fe(III)EDTA (100 μM), Fe(III)citrate (100 μM), or Fe(III)EDDHA (100 μM). Free Cu(II) ions (40 μM) were reduced exclusively by roots of Fe-deficient *S. vulgaris* (up to 2.1 $\mu mol.h^{-1}.g^{-1}$ FW, the rate being proportional to the roots' Fe(III)EDTA reduction capacity). Free Cu(II) reduction was almost completely suppressed by Fe(III)EDTA (100 μM) and Fe(III)citrate (100 μM), but not or hardly by Fe(III)EDDHA (100 μM). Reduction of Fe(III)EDTA (20 μM) and Fe(III)citrate (20 μM), which was only appreciable in Fe-deficient *S. vulgaris*, was unaffected by free Cu(II) (40 μM). Reduction of Fe(III)EDDHA (20 μM) was almost completely arrested by free Cu(II) (40 μM). It is concluded that free Cu(II) is reduced by the "turbo reductase", which is induced by iron starvation, except in grasses, but not by the constitutive "standard reductase", whereas Cu(II)BCDS is reduced by both systems. It is unlikely that Cu-induced chlorosis is due to scavenging of electrons from transmembrane Fe(III) reductases by Cu(II) ions, possibly except in systems where Fe(III)EDDHA is used as an iron source.

12 42

Ferric reduction by roots of *Plantago lanceolata* L.

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Root-mediated reduction of extracytoplasmatic acceptors by hydroponically grown *Plantago lanceolata* L. plants has been investigated using oxidants differing in their midpoint potentials. The application of the auxin analog 2,4-D stimulated ferricyanide reduction activity but did not affect the reduction of FeEDTA. Deprivation of an iron source caused an increase in capacity to reduce both FeEDTA and ferricyanide without changes in the substrate affinity. Iron stress-induced reduction activity was inhibited by various protein modifiers, including SH reagents and inhibitors of the plasma membrane-bound H^+-ATPase. Normalization of the iron status by resupply of iron resulted in a differential decrease of FeEDTA and ferricyanide reduction activity resembling the rates of +Fe grown plants after 48 h. A similar shift in redox activities was evident after application of the translation inhibitor cycloheximide (half-time ≈1 h). The decrease in activity was not due to an inhibition of the production of reducing equivalents, as the NAD(P)H pool size was not lowered during the time-course of the experiment. The mechanisms regulating the electron transport activities will be discussed.

12 43

Studies of nitrate pools in soybean (*Glycine max.* L. Merr) roots affected by different temperatures

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On the basis of nitrate content and anaerobic nitrite production an attempt for investigation of the relationships between storage (SP) and metabolic (MP) nitrate pools in soybean roots in response to high (39 °C) and low (4 °C) temperatures was carried out. It was shown, that at the vegetation beginning under 25 °C in roots the MP predominated. With age, the ratio of SP size to MP rised. 24 h exposure to temperatures was connected with nitrates redistribution in research pools. In roots affected by temperatures some increase of SP was shown, more visible during cold influence. MP sizes were lower in comparison with 25 °C. With appearence of nitrogenous compounds powerful acceptor - pods, reaction for temperature influence was accompanied by increase of MP size in comparison with 25 °C. The data are discussed in relation to possible regulation of MP and SP size and its role in nitrogen assimilation by soybean plants.

12 44

Interactions between aluminium and root temperature in wheat

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In the real world plant roots are often subjected to low root zone temperatures (RZT). We investigated what effects aluminium (Al) may have on the activity of roots at four RZTs (10°-25°C) in two wheat cultivars (cv. Kadett and cv. WW 20299; the latter known to be more sensitive to Al than cv. Kadett). The plants were grown in water culture at pH 4.1 with mineral nutrients supplied in pace with consumption to avoid complications from high concentrations of macronutrients in combination with Al. Al accumulated less in roots at low RZT in both cvs. resulting in less hampered root growth. RZT or Al had no influence on transport of K^+ to shoots. The concentration of K^+ in roots however, increased at both low RZT and at high Al levels. With Al the concentration of phosphate (PO) increased in roots but decreased in shoots but apparently not down to critical levels. The transport of Ca^{2+} to shoots decreased at low RZT and even more by adding Al. The reduction of shoot growth of both cvs. correlated with the concentration of Ca^{2+} in shoots. We suggest that reduced root growth due to low RZT or to Al may lower the Ca^{2+} level in shoots and subsequently reduce shoot growth.

12 45

Cucumber seedlings roots responses to aluminium

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Two Polish cultivars of cucumber seedlings, Monastyrski and Polan F 1 were investigated. Seedlings were grown in a solution culture with Al 5-40 mg x dm^{-3}./initial pH 4,7/. Roots responses of Monastyrski and Polan F1 cultivars to Al were different. In cv.Polan F1 roots growing in 5-20 mg x dm^{-3} Al, stimulation of mitotic activity of root meristem and elongation of tip root and lateral roots were observed. Callose deposition in cell walls of primary bark was noticed. Al was deposited irregularly on epidermis of ripe zones of the root. In meristematic zones of the root Al was not identified. At the level of 30-40 mg x dm^{-3} Al, symptoms of toxic activity of Al were observed. In cv.Monastyrski stimulative effect of Al was not noticed. At the level of 10 mg x dm^{-3} Al, reduction of mitotic division and inhibition of elongation growth were observed. There were also morphological, anatomical and cytological damages of the root. Callose was not identified. Al was localized both in meristematic and in ripe zones of the root.

12 46

Sodium and potassium accumulation and fluxes under moderate salinity in two tomato cultivars differing in salt tolerance

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The magnitude of sodium and potassium fluxes in two *Lycopersicon esculentum* cultivars (Ace and Edkawi) which differ in salt tolerance was evaluated in plants grown for 10 days in aerated Hoagland solution with the addition of 25 or 100 mM NaCl. Ion accumulation in different plant parts, ion concentration in xylem exudate, transpiration and membrane leakiness were measured. Both cultivars responded very similarly to this level of salinity in terms of growth and no conspicuous differences in membrane leakiness were observed. Net uptake rates were calculated from ion contents data. Potassium uptake rates were lower in salinized plants than in controls, especially in cv. Ace. Potassium/sodium selectivity ratios were much higher in Edkawi than in Ace, and higher in shoot uptake rates than in xylem exudate. This indicates Edakwi has a higher capacity to retain potassium under salinity, a character which could contribute to its salt-tolerance.

12 47

Influence of N-deficiency on the transpiration, potassium ions uptake and ABA content in wheat plants

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Wheat plants were grown under conditions of N-sufficiency or N-deficiency. We registered the level of transpiration, potassium ions uptake and ABA content. N-deficient plants were shown to transpire more water than control plants during within day period of transpiration maximum. Concurrently the plants deprived of N-nutrient had lower level of transpiration than control plants during the period of transpiration minimum. Activation of potassium ions uptake in the N-deficient plants took place before the increase of transpiration level of the same plants. ABA content in the N-deficient plants was shown to be higher than in control plants both in shoots and roots. The role of ABA in the regulation of stomatal conductance and processes of potassium ions uptake by plant roots is discussed.

12 48

Influence of new iron-content compound on metabolism of grape plants

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Chlorosis is a widely spread disease in viticulture. It leads to drastic decrease in crop quantity and quality and plantation life duration. A few preparations reducing disease harm are known, but they are insufficiently effective. A new preparation was created in the Moldavian Academy of Sciences. During laboratory and field tests it essentially influenced basic metabolic processes in vine (chlorophyll and leaf sugar concentration, photosynthetic rate / nutrition element correlation), leaf surface state, shoot growth and ripeness, crop capacity, *etc.* The action of the new combination was compared with well-known antichlorotic preparations. By duration action and efficacy it surpasses them. The new preparation use results in plantation restoration.

12 49

Cellular and subcellular distribution of zinc in leaves of *Thlaspi caerulescens*

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The cellular and subcellular distribution of Zn was investigated by X-ray microanalysis in leaves of *Thlaspi caerulescens*, that can hyperaccumulate this metal. Plants were exposed to either 10 or 100 μM Zn for 9 weeks. Total leaf Zn concentrations were 4 and 6.2 mg g^{-1}, respectively. In leaves from both treatments, Zn concentrations were higher in epidermal and subepidermal cells than in the mesophyll. Lowest Zn concentrations were found in vascular parenchyma cells. Zn mainly accumulated in vacuoles and, to a lesser extent, in the apoplast. In leaves of plants exposed to 100 μM Zn, the highest Zn concentrations [13 600 μg g^{-1} (d.m.)] were detected in globular crystals in vacuoles of epidermal and subepidermal cells. Both the high Zn/P element ratios found in these crystals and the absence of Mg indicate that, in contrast to other plant species, myo-inositol hexaphosphate (phytate) is not the main storage form of Zn in *Thlaspi caerulescens*.

12 50

Effect of trace element nutrition on carbohydrate metabolism in chlorotic vine plants

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The influence of Fe, Mn, Zn salt solution on the qualitative and quantitative composition of sugars, starch and hemicellulose accumulation in bush organs affected with chlorosis was studied. The trace elements enhance accumulation of sucrose and fructose in leaves and fructose in berry, the qualitative compositive of sugars being unchanged. Withdrawal of assimilates is increased under the influence of Mn and Zn. More intensive starch and hemicellulose accumulation in perennial organs treated with trace elements solutions results in increasing the frost resistance and productivity of chlorosis affected vine bushes.

12 51

The effect of respiratory inhibitors on *Zea mays* L. trans-root electrical potential difference

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The trans-root electrical potential difference (TRP) arising across excised roots has been shown to comprise a number of components originating at different sites in the root and being due to the existence of a number of different electrogenic mechanisms. We have examined the effect of KCN and SHAM on TRP of excised maize roots, bathed in the lower part by a flowing solution. The excised end of the root was held by a small chamber containing 2 ml of optimized composition (± sucrose). Inhibitors were added to the upper and lower solution. The effect of the inhibitors shows a differential effect on the TRP, demonstrating that different metabolic mechanisms are supplying energy to various electrogenic sites. The results argue in favor of the existence of an axial electrogenic mechanism linked to the sucrose metabolism and the energetical status of the root.

12 52

Varietal differences of pea in the activity of nitrogen assimilating enzymes and yielding, depending on nitrogen nutrition

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In pot experiments activity of nitrogenase and nitrate reductase as well as yield of two pea varieties depending on nitrogen nutrition (N_2+mineral N or mostly N_2) was investigated. Variety Koral was characterized by a higher nitrogenase activity than variety Ramir. Ammonium nitrate (800 mg N per pot - 5 plants) decreased nitrogenase activity in both varieties (especially at budding stage) and increased nitrate reductase activity. Nitrate reductase activity in the leaves of the Ramir variety was higher at both nitrogen treatments, as compared to that of Koral one, but especially in the control (only 20 mg N in NH_4NO_3 + fixed N_2). At both nitrogen treatments var. Koral yielded better than var. Ramir. However the last one gave higher yield increase due to the mineral nitrogen treatment.

12 53

Impact of air pollution upon physiologically active roots of Scots pine

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Results of long-term studies of impact of industrial air pollution (SO_2, dust of Ni, Cu, Co) on structure, distribution in soil and state of pine root systems in the European North are given. Special attention is paid to thin root fraction. It was established that mild technogenic pollution causes at first acceleration of growth, development of physiologically active roots and appearance of mycorrhiza of various types. Simultaneously outgrowths on sucking roots and mycoplast formation of 25 - 30 cm^3 takes place and more which results in rise of absorption surface. Alongwith accumulation in soil industrial wastes damage of root apexes occurs and dying off mycorhize caps and thin roots. As a result of this absorption surface of root system decreases and as a sequence water and mineral supply drops considerably. Under the impact of high levels of contamination not only thin sucking and conductive roots dye off but all root system is suffered.

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Kinetic response of NO_3^- uptake system to internal nitrate concentration

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The kinetic parameters of the NO_3^- uptake system in roots of 9-days old corn seedlings (*Zea mays L.* R-811) were studied. Ion-selective electrodes were used to a computer-controlled determination the depletion of NO_3^- from solution 1 mM KNO_3 + 1mM $CaSO_4$. Uptake rate analyses were performed using computerized curve-fitting techniques. NO_3^- uptake capacity of plants, grown on solution containing 1mM $CaSO_4$ increased during 6 hours of contact with 10 mkM NO_3^-. Induced roots have lower Km (13,45 ± 4,37 mkM) and higher Vmax (8,50 ± 0,37 mkM/g·h) then uninduced (Km value was 38,8 ± 9,1 mM and Vmax - 6,78 ± 0,41 mkM/g·h). It is suggested that full expression of the nitrate transport system was dependent upon synthesis of the carrier with high affinity. The effect of different NO_3^- intracellular levels on Michaelis-Menten kinetic parameters was studied after 12 h exposure plants to 0.1, 1 and 10 mM KNO_3. Vmax values decreased and Km values increased as root NO_3^- concentration increased. Changes in kinetic parameters are interpreted in context of involvement internal NO_3^- in induction transport system and postinductional regulation of NO_3^- uptake.

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Effects of nitrite and nitrate on potassium uptake of rice seedlings at different pH values

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The effects of sodium nitrite and sodium nitrate on the K^+ uptake in the roots of rice (*Oryza sattva* L.) seedlings were studied at different pH values. A decrease of the pH of the external solution led to an increased inhibitory effect of nitrite ion on the K^+ uptake of roots. Higher concentration of nitrite at low pH caused striking decrease in K^+ content too. The reverse was true, however, in the case of Na^+ content. When nitrate ion was present in the uptake solution, marked changes were neither observed in the K^+ uptake nor in the K^+ content of the roots. Parallel efflux studies show that at lower pH higher concentrations of nitrite caused significant increase in the K^+ leakage of the roots. Our results strongly suggest a distinct role of nitrite ion in plasma membrane damage at low pH. The combined effects of nitrite exposure on mineral nutrition of plants will also be discussed.