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Article

Exploring Nitric Oxide as a Regulator in Salt Tolerance: Insights into Photosynthetic Efficiency in Maize

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Abstract: The growing issue of salinity is a significant threat to global agriculture, affecting diverse regions worldwide. Nitric oxide (NO) serves as an essential signal molecule in regulating photosynthetic performance under physiological and stress conditions. The present study reveals the protective effects of different concentrations (0–300 μM) of sodium nitroprusside (SNP, a donor of NO) on the functions of the main complexes within the photosynthetic apparatus of maize (*Zea mays* L. Kerala) under salt stress (150 mM NaCl). The data showed that SNP alleviates salt-induced oxidative stress and prevents changes in the fluidity of thylakoid membranes (Laurdan GP) and energy redistribution between the two photosystems (77K chlorophyll fluorescence ratio F_{735}/F_{685}). Chlorophyll fluorescence measurements demonstrated that the foliar spray with SNP under salt stress prevents the decline of photosystem II (PSII) open reaction centers (qP) and improves their efficiency (Φ_{exc}), thereby influencing Q_A^- reoxidation. The data also revealed that SNP protects the rate constants for two pathways of Q_A^- reoxidation (k_1 and k_2) from the changes caused by NaCl treatment alone. Additionally, there is a predominance of Q_A^- interaction with plastoquinone in comparison to the recombination of electrons in $Q_A^- Q_B^-$ with the oxygen-evolving complex (OEC). The analysis of flash oxygen evolution showed that SNP treatment prevents a salt-induced 10% increase in PSII centers in the S_0 state, i.e., protects the initial S_0-S_1 state distribution, and the modification of the Mn cluster in the OEC. Moreover, this study demonstrates that SNP-induced defense occurs on both the donor and acceptor sides of the PSII, leading to the protection of overall photosystems performance (PI_{ABS}) and efficient electron transfer from the PSII donor side to the reduction of PSI end electron acceptors (PI_{total}). This study clearly shows that the optimal protection under salt stress occurs at approximately 50–63 nmoles NO/g FW in leaves, corresponding to foliar spray with 50–150 μM SNP.

Keywords: chlorophyll fluorescence; photosystem II; oxygen-evolving complex; photosynthetic function; membrane fluidity






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Article

Impact of Sodium Nitroprusside on the Photosynthetic Performance of Maize and Sorghum

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Abstract: Nitric oxide (NO) is an important molecule in regulating plant growth, development and photosynthetic performance. This study investigates the impact of varying concentrations (0–300 μM) of sodium nitroprusside (SNP, a donor of NO) on the functions of the photosynthetic apparatus in sorghum (*Sorghum bicolor* L. Albanus) and maize (*Zea mays* L. Kerala) under physiological conditions. Analysis of the chlorophyll fluorescence signals (using PAM and the JIP-test) revealed an increased amount of open PSII reaction centers (qP increased), but it did not affect the number of active reaction centers per PSII antenna chlorophyll (RC/ABS). In addition, the smaller SNP concentrations (up to 150 μM) alleviated the interaction of Q_A with plastoquinone in maize, while at 300 μM it predominates the electron recombination on $Q_A Q_B^-$, with the oxidized S_2 (or S_3) states of oxygen evolving in complex ways in both studied plant species. At the same time, SNP application stimulated the electron flux-reducing end electron acceptors at the PSI acceptor side per reaction center (RE_o/RC increased up to 26%) and the probability of their reduction (ϕRo increased up to 20%). An increase in MDA (by about 30%) and H_2O_2 contents was registered only at the highest SNP concentration (300 μM). At this concentration, SNP differentially affected the amount of $P700^+$ in studied plant species, i.e., it increased (by 10%) in maize but decreased (by 16%) in sorghum. The effects of SNP on the functions of the photosynthetic apparatus were accompanied by an increase in carotenoid content in both studied plants. Additionally, data revealed that SNP-induced changes in the photosynthetic apparatus differed between maize and sorghum, suggesting species specificity for SNP's impact on plants.



Keywords: chlorophyll fluorescence; JIP parameters; nitric oxide; photosystem I; photosystem II; photosynthetic performance



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Article

Protective Effects of Sodium Nitroprusside on Photosynthetic Performance of *Sorghum bicolor* L. under Salt Stress

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Abstract: In this study, the impacts of the foliar application of different sodium nitroprusside (SNP, as a donor of nitric oxide) concentrations (0–300 μM) on two sorghum varieties (*Sorghum bicolor* L. Albanus and *Sorghum bicolor* L. Shamal) under salt stress (150 mM NaCl) were investigated. The data revealed that salinity leads to an increase in oxidative stress markers and damage of the membrane integrity, accompanied by a decrease in the chlorophyll content, the open photosystem II (PSII) centers, and the performance indexes (PI_{ABS} and PI_{total}), as well as having an influence on the electron flux reducing photosystem I (PSI) end acceptors (REo/RC). Spraying with SNP alleviated the NaCl toxicity on the photosynthetic functions; the protection was concentration-dependent, and greater in Shamal than in Albanus, i.e., variety specific. Furthermore, the experimental results revealed that the degree of SNP protection under salt stress also depends on the endogenous nitric oxide (NO) amount in leaves, the number of active reaction centers per PSII antenna chlorophylls, the enhanced electron flux reducing end acceptors at the acceptor side of PSI, as well as the stimulation of the cyclic electron transport around PSI. The results showed better protection in both varieties of sorghum for SNP concentrations up to 150 μM , which corresponds to about a 50% increase in the endogenous NO leaf content in comparison to the control plants. Our study provides valuable insight into the molecular mechanisms underlying SNP-induced salt tolerance in sorghum varieties and might be a practical approach to correcting salt intolerance.




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Keywords: NaCl treatment; nitric oxide; photosynthesis; JIP test; chlorophyll fluorescence; membrane damage; P700 photooxidation



Article

Assessment of the Photosynthetic Apparatus Functions by Chlorophyll Fluorescence and P_{700} Absorbance in C3 and C4 Plants under Physiological Conditions and under Salt Stress

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Abstract: Functions of the photosynthetic apparatus of C3 (*Pisum sativum* L.) and C4 (*Zea mays* L.) plants under physiological conditions and after treatment with different NaCl concentrations (0–200 mM) were investigated using chlorophyll a fluorescence (pulse-amplitude-modulated (PAM) and JIP test) and P_{700} photooxidation measurement. Data revealed lower density of the photosynthetic structures (RC/CS₀), larger relative size of the plastoquinone (PQ) pool (N) and higher electron transport capacity and photosynthetic rate (parameter R_{Fd}) in C4 than in C3 plants. Furthermore, the differences were observed between the two studied species in the parameters characterizing the possibility of reduction in the photosystem (PSI) end acceptors (RE₀/RC, RE₀/CS₀ and δR_0). Data revealed that NaCl treatment caused a decrease in the density of the photosynthetic structures and relative size of the PQ pool as well as decrease in the electron transport to the PSI end electron acceptors and the probability of their reduction as well as an increase in the thermal dissipation. The effects were stronger in pea than in maize. The enhanced energy losses after high salt treatment in maize were mainly from the increase in the regulated energy losses (Φ_{NPQ}), while in pea from the increase in non-regulated energy losses (Φ_{NO}). The reduction in the electron transport from Q_A to the PSI end electron acceptors influenced PSI activity. Analysis of the P_{700} photooxidation and its decay kinetics revealed an influence of two PSI populations in pea after treatment with 150 mM and 200 mM NaCl, while in maize the negligible changes were registered only at 200 mM NaCl. The experimental results clearly show less salt tolerance of pea than maize.


Keywords: NaCl treatment; JIP test; PAM chlorophyll fluorescence; pea; photooxidation of P_{700} ; maize



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Article

Different Sensitivity Levels of the Photosynthetic Apparatus in *Zea mays* L. and *Sorghum bicolor* L. under Salt Stress

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Abstract: The impacts of different NaCl concentrations (0–250 mM) on the photosynthesis of new hybrid lines of maize (*Zea mays* L. Kerala) and sorghum (*Sorghum bicolor* L. Shamal) were investigated. Salt-induced changes in the functions of photosynthetic apparatus were assessed using chlorophyll *a* fluorescence (PAM and OJIP test) and P_{700} photooxidation. Greater differences between the studied species in response to salinization were observed at 150 mM and 200 mM NaCl. The data revealed the stronger influence of maize in comparison to sorghum on the amount of closed PSII centers (1-qp) and their efficiency (Φ_{exc}), as well as on the effective quantum yield of the photochemical energy conversion of PSII (Φ_{PSII}). Changes in the effective antenna size of PSII (ABS/RC), the electron flux per active reaction center (REo/RC) and the electron transport flux further Q_A (ETo/RC) were also registered. These changes in primary PSII photochemistry influenced the electron transport rate (ETR) and photosynthetic rate (parameter R_{Fd}), with the impacts being stronger in maize than sorghum. Moreover, the lowering of the electron transport rate from Q_A to the PSI end electron acceptors (REo/RC) and the probability of their reduction (φ_{Ro}) altered the PSI photochemical activity, which influenced photooxidation of P_{700} and its decay kinetics. The pigment content and stress markers of oxidative damage were also determined. The data revealed a better salt tolerance of sorghum than maize, associated with the structural alterations in the photosynthetic membranes and the stimulation of the cyclic electron flow around PSI at higher NaCl concentrations. The relationships between the decreased pigment content, increased levels of stress markers and different inhibition levels of the function of both photosystems are discussed.



Citation: Stefanov, M.A.; Rashkov, G.D.; Yotsova, E.K.; Borisova, P.B.; Dobrikova, A.G.; Apostolova, E.L. Different Sensitivity Levels of the Photosynthetic Apparatus in *Zea mays* L. and *Sorghum bicolor* L. under Salt Stress. *Plants* **2021**, *10*, 1469. <https://doi.org/10.3390/plants10071469>

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Keywords: NaCl treatment; OJIP test; PAM chlorophyll fluorescence; photosynthesis; pigment composition; stress markers

Article

Sensitivity of the Photosynthetic Apparatus in Maize and Sorghum under Different Drought Levels

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Abstract: Drought is one of the main environmental stress factors affecting plant growth and yield. The impact of different PEG concentrations on the photosynthetic performance of maize (*Zea mays* L. Mayflower) and sorghum (*Sorghum bicolor* L. Foehn) was investigated. The activity of the photosynthetic apparatus was assessed using chlorophyll fluorescence (PAM and JIP test) and photooxidation of P_{700} . The data revealed that water deficiency decreased the photochemical quenching (qP), the ratio of photochemical to nonphotochemical processes (Fv/Fo), the effective quantum yield of the photochemical energy conversion in PSII (Φ_{PSII}), the rate of the electron transport (ETR), and the performance indexes PI_{total} and PI_{ABS} , as the impact was stronger in sorghum than in maize and depended on drought level. The PSI photochemistry (P_{700} photooxidation) in sorghum was inhibited after the application of all studied drought levels, while in maize, it was registered only after treatment with higher PEG concentrations (30% and 40%). Enhanced regulated energy losses (Φ_{NPQ}) and activation of the state transition under drought were also observed in maize, while in sorghum, an increase mainly in nonregulated energy losses (Φ_{NO}). A decrease in pigment content and relative water content and an increase in membrane damage were also registered after PEG treatment. The experimental results showed better drought tolerance of maize than sorghum. This study provides new information about the role of regulated energy losses and state transition for the protection of the photosynthetic apparatus under drought and might be a practical approach to the determination of the drought tolerance of plants.



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Sensitivity of the Photosynthetic Apparatus in Maize and Sorghum under Different Drought Levels.

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Keywords: chlorophyll fluorescence; PEG treatment; P_{700} photooxidation; pigment composition; membrane injury; maize; sorghum; relative water content



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Impact of foliar spray of zinc oxide nanoparticles on the photosynthesis of *Pisum sativum* L. under salt stress

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ABSTRACT

This study investigates the impacts of zinc oxide nanoparticles: bare (ZnO NPs) and ZnO NPs coated with silicon shell (ZnO-Si NPs), on *Pisum sativum* L. under physiological and salt stress conditions. The experimental results revealed that the foliar spray with ZnO-Si NPs and 200 mg/L ZnO NPs did not influence the stomata structure, the membrane integrity, and the functions of both photosystems under physiological conditions, while 400 mg/L ZnO-Si NPs had beneficial effects on the effective quantum yield of photosystem II (PSII) and the photochemistry of photosystem I (PSI). On the contrary, small phytotoxic effects were registered after spraying with 400 mg/L ZnO NPs accompanied by stimulation of the cyclic electron flow around PSI and an increase of the non-photochemical quenching (NPQ). The results also showed that both types of NPs (with exception of 400 mg/L ZnO NPs) decrease the negative effects of 100 mM NaCl on the photochemistry of PSI (P700 photooxidation) and PSII (qp, Fv/Fm, Fv/Fo, Φ_{PSII} , Φ_{exc}), as well as on the pigment content, stomata closure and membrane integrity. The protective effect was stronger after spraying with ZnO-Si NPs in comparison to ZnO NPs, which could be due to the presence of Si coating shell. The role of Si shell is discussed.



Article

Impact of Salinity on the Energy Transfer between Pigment–Protein Complexes in Photosynthetic Apparatus, Functions of the Oxygen-Evolving Complex and Photochemical Activities of Photosystem II and Photosystem I in Two *Paulownia* Lines

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Abstract: The present study shows the effect of salinity on the functions of thylakoid membranes from two hybrid lines of *Paulownia*: *Paulownia tomentosa* × *fortunei* and *Paulownia elongata* × *elongata*, grown in a Hoagland solution with two NaCl concentrations (100 and 150 mM) and different exposure times (10 and 25 days). We observed inhibition of the photochemical activities of photosystem I (DCPIH₂ → MV) and photosystem II (H₂O → BQ) only after the short treatment (10 days) with the higher NaCl concentration. Data also revealed alterations in the energy transfer between pigment–protein complexes (fluorescence emission ratios F_{735}/F_{685} and F_{695}/F_{685}), the kinetic parameters of the oxygen-evolving reactions (initial S₀–S₁ state distribution, misses (α), double hits (β) and blocked centers (S_B)). Moreover, the experimental results showed that after prolonged treatment with NaCl *Paulownia tomentosa* × *fortunei* adapted to the higher concentration of NaCl (150 mM), while this concentration is lethal for *Paulownia elongata* × *elongata*. This study demonstrated the relationship between the salt-induced inhibition of the photochemistry of both photosystems and the salt-induced changes in the energy transfer between the pigment–protein complexes and the alterations in the Mn cluster of the oxygen-evolving complex under salt stress.

Keywords: electron transport; low-temperature chlorophyll fluorescence; thylakoid membranes; NaCl treatment



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Research article

Effects of salinity on the photosynthetic apparatus of two *Paulownia* lines

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ABSTRACT

The effects of soil salinity on the functional activity of photosynthetic apparatus and pigment composition of two *Paulownia* lines (*Paulownia tomentosa* × *fortunei* and *Paulownia elongata* × *elongata*) were investigated. PAM chlorophyll fluorescence measurements revealed that salinity leads to: (i) an increase of the photochemical quenching coefficient (qP) and the linear electron transport rate (ETR) in both lines of *Paulownia*, while the maximum quantum yield of the primary photochemistry of PSII in the dark adapted state (F_v/F_m) was unaffected; (ii) improved the efficiency of the photochemical energy conversion (Φ_{PSII}); (iii) an impact on the chlorophyll fluorescence decrease ratio (R_{Fd}), which correlates to the net CO₂ assimilation rate; (iv) an impact on Q_A^- reoxidation. The analysis of the kinetics of P700⁺ reduction upon turning off far-red irradiation revealed that salinization lead to a delay of the cyclic electron transport around PSI in both studied lines as the effect on this process is more pronounced in *P. tomentosa* × *fortunei* than in (in comparison with) *P. elongata* × *elongata*. The present experimental results suggested high salt tolerance of the studied lines *Paulownia*, but *P. tomentosa* × *fortunei* is more tolerant to salinity than *P. elongata* × *elongata*. Molecular mechanisms involved in the *Paulownia* response to the soil salinity are discussed.

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Research article

Effects of exogenous 24-epibrassinolide on the photosynthetic membranes under non-stress conditions



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ABSTRACT

In the present work the effects of exogenous 24-epibrassinolide (EBR) on functional and structural characteristics of the thylakoid membranes under non-stress conditions were evaluated 48 h after spraying of pea plants with different concentrations of EBR (0.01, 0.1 and 1.0 mg.L⁻¹). The results show that the application of 0.1 mg.L⁻¹ EBR has the most pronounced effect on the studied characteristics of the photosynthetic membranes. The observed changes in 540 nm light scattering and in the calorimetric transitions suggest alterations in the structural organization of the thylakoid membranes after EBR treatment, which in turn influence the kinetics of oxygen evolution, accelerate the electron transport rate, increase the effective quantum yield of photosystem II and the photochemical quenching. The EBR-induced changes in the photosynthetic membranes are most probably involved in the stress tolerance of plants.

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Temperature sensitivity of photosystem II in isolated thylakoid membranes from fluridone-treated pea leaves

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Abstract: High temperature-induced changes in the photosystem II (PSII) activity of thylakoid membranes isolated from pea (*Pisum sativum* L. 'Ran') plants treated with low (10^{-8} M) and high (10^{-7} M) concentrations of fluridone were investigated. Pulse amplitude modulated (PAM) chlorophyll fluorescence and photosynthetic oxygen evolution (measured by polarographic oxygen rate electrode) were used to estimate the effect of high temperature on the functional activity of PSII. Higher temperature treatments lead to stronger inhibition of the flash oxygen evolution than the primary photochemistry of PSII (F_v/F_m). The inhibitory effect of higher temperature on the PSII α centers is stronger than on the PSII β centers. The heat-induced damage in the PSII α centers as well as in the donor side of all PSII centers (PSII α and PSII β) is accentuated by fluridone.

Key words: Fluridone, PAM chlorophyll fluorescence, photosynthetic oxygen evolution, PSII α centers, PSII β centers, carotenoids

DIFFERENTIAL RESPONSE OF THE PHOTOSYNTHETIC
APPARATUS OF ANTARCTIC ALGAE *SYNECHOCYSTIS*
SALINA (CYANOPHYTA) AND *CHLORELLA VULGARIS*
(CHLOROPHYTA) TO UV-B RADIATION

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Minkova*, Nezabravka Nikolaeva, Georgi Rashkov

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Abstract

The sensitivity of the photosynthetic apparatus of Antarctic *Synechocystis salina* and *Chlorella vulgaris* after UV-B irradiation was compared. Our results clearly demonstrate that UV-B induced changes in the energy transfer between chlorophyll-protein complexes, primary photochemistry of photosystem II and photosynthetic oxygen evolution, are stronger influenced in the cyanobacterium *Synechocystis salina* than that in the green alga *Chlorella vulgaris*.

Key words: UV-B, photosynthetic apparatus, photosynthetic oxygen evolution, *Synechocystis salina*, *Chlorella vulgaris*



ARTICLE

Microalgae Improve the Photosynthetic Performance of Rice Seedlings (*Oryza sativa* L.) under Physiological Conditions and Cadmium Stress

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ABSTRACT

The aim of this study was to assess the impact of the microalgae *Chlorella vulgaris* on the rice seedlings at physiological conditions and under cadmium (Cd) stress. We examined the effects of *C. vulgaris* in the nutrient solution on rice seedlings grown hydroponically in the presence and the absence of 150 μM CdCl_2 , using the low (77 K) temperature and pulse amplitude modulated (PAM) chlorophyll fluorescence, P700 photooxidation measurements, photochemical activities of both photosystems, kinetic parameters of oxygen evolution, oxidative stress markers (MDA, H_2O_2 and proline), pigment content, growth parameters and Cd accumulation. Data revealed that the application *C. vulgaris* not only stimulates growth and improves the functions of photosynthetic apparatus under physiological conditions, but also reduces the toxic effect of Cd on rice seedlings. Furthermore, the presence of the green microalgae in the nutrient solution of the rice seedlings during Cd exposure, significantly improved the growth, photochemical activities of both photosystems, the kinetic parameters of the oxygen-evolving reactions, pigment content and decreased lipid peroxidation, H_2O_2 and proline content. Data showed that the alleviation of Cd-induced effects in rice seedlings is a result of the Cd sorption by microalgae, as well as the reduced Cd accumulation in the roots and its translocation from the roots to the shoots.

KEYWORDS

Chlorella vulgaris; growth parameters; low temperature chlorophyll fluorescence; PAM chlorophyll fluorescence; photosynthesis; rice; stress markers

Effects of Salt Stress on the Photosynthesis of Maize and Sorghum

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Abstract. In this study, the effects of salt stress on the photosynthetic processes in sorghum (*Sorghum bicolor* L. *Albanus concep*) and maize (*Zea mays* L. *Mayflower*) were compared. The plants were grown in half-strength Hoagland solutions containing different NaCl concentrations (0, 50, 150 and 250 mM NaCl) for 6 days. Pulse Amplitude Modulated chlorophyll fluorescence, photooxidation of P_{700} and pigment analysis were used for characterization of the salinity effects on the studied plants. The treatment of plants with the high concentrations of NaCl led to an inhibition of the chlorophyll fluorescence parameters like the photochemical quenching, the rate of photosynthesis and the linear electron transport in sorghum and maize. All these changes corresponded to decrease in the pigment content and changes in chlorophyll *a/b* ratio. The analysis of the P_{700} photooxidation revealed that the photosystem I photochemistry was inhibited at the highest NaCl concentration in both studied plants. Data also revealed that sorghum is more sensitive to salt stress than maize. The reasons for different effects of salt stress on the maize and sorghum are described.

Key words: chlorophyll fluorescence, pigment content, salt stress, sorghum, maize.



Influence of the sanosil-induced oxidative stress on the photosynthetic apparatus of different strains of green algae and cyanobacteria

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Abstract Photosynthetic oxygen evolution (measured by polarographic oxygen rate electrode) and pulse amplitude modulated chlorophyll fluorescence were used to assess the effect of sanosil-induced oxidative stress on photosystem II (PSII) in the green alga *Chlorella vulgaris* and the cyanobacterium *Synechocystis salina* isolated from Antarctic and mesophilic environments. This study revealed a relatively stronger influence of sanosil (especially its main component, hydrogen peroxide) on the donor site (oxygen evolving complex) compared to the acceptor side of the PSII in both green algae and cyanobacteria. The inhibition of the oxygen evolution results mainly from a decrease in the fast operating PSII centers. In addition, the obtained data showed that the effects of the oxidative stress on the cyanobacterium and the green alga strongly depend on the antenna size of PSII.




Keywords Hydrogen peroxide · Oxidative stress · PAM chlorophyll fluorescence · Photosynthetic oxygen evolution · Sanosil

Introduction

Oxidative stress leads to inhibition of the photosynthesis and respiration processes and thus influences the growth of the photosynthetic organisms. This stress is the result of disturbance in the balance between the production of reactive oxygen species (ROS) and antioxidant defenses. The balance between the formation and elimination of ROS is an important aspect of the prevention of photo-oxidative damage of the photosynthetic apparatus (Arora et al. 2002; Pospíšil 2014). A common feature of extreme environmental stress factors is their potential to increase production of ROS, such as singlet oxygen ($^1\text{O}_2$), superoxide anion (O_2^-), hydroxyl radical (OH^\cdot) and hydrogen peroxide (H_2O_2), which can induce functional and/or structural modification of the photosynthetic membranes (Arora et al. 2002). In photosynthetic membranes ROS are formed when light absorbed by chlorophylls exceeds the light utilized by photosynthetic apparatus (Pospíšil 2012). Although ROS are mainly produced by photosystem I, the production of

Article

Changes in Photosystem II Complex and Physiological Activities in Pea and Maize Plants in Response to Salt Stress

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Abstract: Salt stress significantly impacts the functions of the photosynthetic apparatus, with varying degrees of damage to its components. Photosystem II (PSII) is more sensitive to environmental stresses, including salinity, than photosystem I (PSI). This study investigated the effects of different salinity levels (0 to 200 mM NaCl) on the PSII complex in isolated thylakoid membranes from hydroponically grown pea (*Pisum sativum* L.) and maize (*Zea mays* L.) plants treated with NaCl for 5 days. The data revealed that salt stress inhibits the photochemical activity of PSII ($H_2O \rightarrow BQ$), affecting the energy transfer between the pigment–protein complexes of PSII (as indicated by the fluorescence emission ratio F_{695}/F_{685}), Q_A reoxidation, and the function of the oxygen-evolving complex (OEC). These processes were more significantly affected in pea than in maize under salinity. Analysis of the oxygen evolution curves after flashes and continuous illumination showed a stronger influence on the PSII α than PSII β centers. The inhibition of oxygen evolution was associated with an increase in misses (α), double hits (β), and blocked centers (S_B) and a decrease in the rate constant of turnover of PSII reaction centers (K_D). Salinity had different effects on the two pathways of Q_A reoxidation in maize and pea. In maize, the electron flow from Q_A^- to plastoquinone was dominant after treatment with higher NaCl concentrations (150 mM and 200 mM), while in pea, the electron recombination on $Q_A Q_B^-$ with oxidized S_2 (or S_3) of the OEC was more pronounced. Analysis of the 77 K fluorescence emission spectra revealed changes in the ratio of the light-harvesting complex of PSII (LHCII) monomers and trimers to LHCII aggregates after salt treatment. There was also a decrease in pigment composition and an increase in oxidative stress markers, membrane injury index, antioxidant activity (FRAP assay), and antiradical activity (DPPH assay). These effects were more pronounced in pea than in maize after treatment with higher NaCl concentrations (150 mM–200 mM). This study provides insights into how salinity influences the processes in the donor and acceptor sides of PSII in plants with different salt sensitivity.



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