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研究论文

NaCl胁迫下星星草幼苗MDA含量与膜透性及叶绿素荧光参数之间的关系

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摘要 星星草幼苗在不同浓度NaCl胁迫处理7d后，测定了叶绿素荧光参数、MDA含量和叶片电解质外渗率。结果表明，在低浓度NaCl（小于1.2%）胁迫下，星星草幼苗叶绿体MDA含量随胁迫强度的增强而降低，而在高浓度NaCl（1.2%～2.4%）胁迫下则相反。在低浓度NaCl（小于1.2%）胁迫下，*Fv/Fm*（PSⅡ原初光能转化效率）、*Fv/Fo*（表PSⅡ潜在活性）、*Fv′/Fm′*（类囊体能化时PSⅡ固有效率）和qP(荧光光化学淬灭效率)随着胁迫强度的增强而增高，而在高浓度NaCl（1.2%～2.4%）胁迫下则随着胁迫强度的增强而降低；而*qNP*(荧光非光化学淬灭效率)和HDR（热耗散速率）却随着胁迫强度的增强而增高。ΦPSⅡ(PSⅡ实际光化学效率) 在低浓度NaCl（小于0.4%）胁迫下随着胁迫强度增强而升高， 在0.4%～1.6%之间迅速下降，大于1.6%时，ΦPSⅡ又迅速升高。 *Fv/Fm*、*Fv/Fo*、*Fv′/Fm′*和*qP*均随着MDA含量的增高而降低，而*EL*(叶片电解质外渗率)、*qNP*和HDR在MDA含量较低的范围(0.9753～1.1901μmol•g^{-1}FW)内均减小，在MDA含量较高的范围(1.3080～1.8518μmol•g^{-1}FW)内，均迅速增大。ΦPSⅡ在MDA含量较低范围(0.9753～1.0953μmol•g^{-1}FW)内时上升，但变化不大，随着MDA含量的增高(在1.1172～1.1901μmol•g^{-1}FW)范围内迅速降低，但当MDA含量进一步增高时(在1.3080～1.8518μmol•g^{-1}FW)范围内又迅速升高。这些结果表明，星星草幼苗的荧光参数具体的变化规律与盐胁迫强度和幼苗细胞膜的受损伤程度密切相关，即低浓度NaCl胁迫（小于1.2%）下，星星草幼苗由于活性氧的增加而发生膜脂过氧化可能主要通过体内较高活性的保护酶系统来清除，而高浓度NaCl胁迫（大于1.2%）下，星星草幼苗可能具有与其它植物不同的保护机制，即可能主要通过增加qNP(荧光非光化学淬灭效率)、HDR（热耗散速率）耗散过剩的光能和提高ΦPSⅡ增强假循环式光合磷酸化过程，消耗掉多余的能量，以保护光合器官免受过剩光能的损伤，从而减轻膜脂过氧化作用。

关键词 星星草；盐胁迫；MDA含量；电解质外谱率；叶绿素；荧光参数

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Relationships among MDA content, plasma membrane permeability and the chlorophyll fluorescence parameters of *Puccinellia tenuiflora* seedlings under NaCl stress

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Abstract In order to study the mathematic relationship between changes of the chlorophyll fluore

scence parameters of P. tenuiflora seedlings and the fine regulation mechanism of metabolism of cell membrane stability under salt stress, electrolyte leakage rate (EL) using relatively electrical conductivity method and malondialdehyde (MDA) content using the thiobarbituric acid method relating to cell membrane stability were determined as the variable of physiological parameters that could reflect the status of physiological system or injury extent by stress, and the fluorescence parameters such as Fv/Fm、*Fv/Fo*、*qP*、*Fv′/Fm′*、ΦPSⅡ、HDR and qNP were also determined by the method of fluorescence induction kinetics with FMS2- facilitative Fluorescence Monitoring System under normal condition and different degrees of NaCl stress (0.4%,0.8%,1.2%,1.6%,2%,2.4%) after 7d. The result showed that MDA content decreased a little under low NaCl stress (less than 1.2%), then increased significantly with increasing of NaCl concentration (more than 1.2%). Among the chlorophyll fluorescence parameters, Fv/Fo、*Fv/Fm*、 *Fv′/Fm′* and qP took a similar trend of increasing firstly then decreasing with the increasing of NaCl concentration, but qNP and HDR increased with the increasing of NaCl concentration accordingly. At the same time, ΦPSⅡ increased slightly under low NaCl stress(less than 0.4％), then decreased significantly, finally increased fastly. The result also showed that with increases in MDA content, Fv/Fo、*Fv/Fm*、*qP* and *Fv′/Fm′* decreased accordingly, however, EL decreased slightly firstly in MDA content(0.9753～1.1901μmol•g^{-1}FW), then increased significantly with the increasing of MDA content(1.3080～1.8518μmol•g^{-1}FW), showing the similar trend of qNP and HDR. On the other hand, ΦPSⅡ displayed ascending trend during MDA content (0.9753～1.0953μmol•g^{-1}FW), then showed descending trend during MDA content （1.1172～1.1901μmol•g^{-1}FW）, finally increased fastly with the increasing of MDA content（1.3080～1.8518μmol•g^{-1}FW）. The change value could visually characterize the extent of injury of physiological system of plant under salt stress, and the quantitative relationship between the MDA content、EL and the chlorophyll fluorescence parameters probably was the reflection that chlorophyll fluorescence parameters were closely related to membrane lipid peroxidation and plasma membrane permeability of the P. tenuiflora seedlings. It could be concluded that membrane lipid peroxidation of P. tenuiflora, which resulted from the augment of active oxygen, could be mainly eliminated by highly active antioxidant enzymes system under low NaCl concentration(less than 1.2%); while the safeguard mechanism of P. tenuiflora could be different from that of other plants under midst NaCl concentration(more than 1.2%), they dissipated surplus light energy mainly via two approaches: one is to increase light energy absorbance by light-harvesting pigment that used in non-photochemical quenching coefficient (*qNP*) and heat dissipation rate (*HDR*), the other is to increase actually photochemical efficiency of PSⅡ in the light (ΦPSⅡ), building up pseudo\|cyclic photophosphorylation. By these ways does P. tenuiflora protect photosynthetic apparatus from the damage of surplus of light energy, thus reduce membrane-lipid peroxidation.

Key words Puccinellia tenuiflora； NaCl stress； electrolyte leakage rate (EL) _ MDA content； fluorescence parameters

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