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# Effects of Salt Stress on Water Content and Photosynthetic Characteristics in *Iris lactea* Var. *Chinensis* Seedlings

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**Abstract:** Water content and photosynthetic characteristics of the seedlings of *Iris lactea* var. *chinensis* under the salt stress were studied in this article. The results showed that water content reduced and water deficit increased in roots and leaves of seedlings under NaCl stress. Besides, stomatal conductance and stomatal limitation changed little after the first reduction, the intercellular $CO_2$ concentration increased before the little change and net photosynthetic rate and transpiration rate dropped directly. Furthermore, water potential and osmotic potential reduced with the increase of salt concentration, but the pressure potential had retained a positive trend and cell turgor had been maintained, which meant that osmoregulation had an important role in the seedlings of *Iris lactea* var. *chinensis* against the salt stress. The study provided a scientific basis for the improvement of saline-alkali soil and urban landscape.

**Key word:** *Iris lactea* · Salt stress · Photosynthetic characteristics · Water content

## INTRODUCTION

Salt stress is one of major factors in constraining crop production. Degree of salinization of approximately 20% agricultural land has been increasing in the world. By 2050, more than 50% arable land will become salinization [1]. *Iris lactea* Pall. var.*chinensis* (Fisch.)Koidz, also known as Ma Lin or Malan flower, which is *Iris* species, have a wide range of distribution across China. It has a strong resistance to water logging, salinity, trampling, poor, pest and disease. It can be used as the saline-alkali soil improvement, desertification control, soil and water conservation on slope protection, parks and roadside green land plants and flowers [2]. It has elegant and blue flowers, with a high ornamental value [3]. In addition, roots, leaves, flowers and seeds of *Iris lactea* have good medicinal value.

Researches on *Iris lactea* are mainly in the cultivation at home and abroad, not much about the research of the resistance. Wang Guiqin has studied the morphological adaptations of *Iris lactea* under salt stress [4]. She insists halophyte *Iris lactea* root has a strong filtering capability as a result of suberization of the outer cortex and inner cortex, so *Iris lactea* is a repellent salt plant. Xu Yufeng, who has studied the physiological characteristics of *Iris lactea* on salt tolerance, concludes that with the increase of the concentration of salinity, in a certain range, osmotic adjustment substances, soluble sugar content, proline content and soluble protein content of *Iris lactea* leaves increase, as well as protective enzyme activity of peroxidase (POD) and superoxide dismutase (SOD) enhance under salt stress [5-6].

By studying water content and photosynthetic characteristics of *Iris lactea* under salt stress in this test, we explored salt tolerance mechanism of *Iris lactea*, which provided not only a scientific basis for *Iris lactea* applicable to the saline-alkali soil improvement and urban landscape, but also some basic information for the further study of plant salt tolerance mechanism.

## MATERIALS AND METHODS

**Species and Site Descriptions:** One-year-old seedlings of Iris lactea Pall. var. chinensis (Fisch.) Koidz were used. They came from the Iris resource garden in Shenyang Botanical Garden.

**Growth Conditions:** Many seedlings of Iris lactea with the similar growth potential. The seedlings were planted into 3 L pots with three-salt nutrient solution [7]. After 3 day's

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adaption, the seedlings were transferred to pots with nutrient solution containing 0, 50, 100, 150 and 200mmol/L respectively. Each treatment had three replications. The pH of the solution was adjusted to 6.0 using dilute $H_2SO_4$ or NaOH. The solution was continuously aerated with compressed air throughout the growing period. Nutrient solution was changed every 2d.

**Determination of the Indicators:** Fresh weight and dry weight were determined by the conventional method. Photosynthetic parameters were measured by CIRAS-1 portable photosynthetic apparatus; water potential, osmotic potential and pressure potential were determined by HR-33T dew point microvolt potentiometer from the U.S. Wescor company.

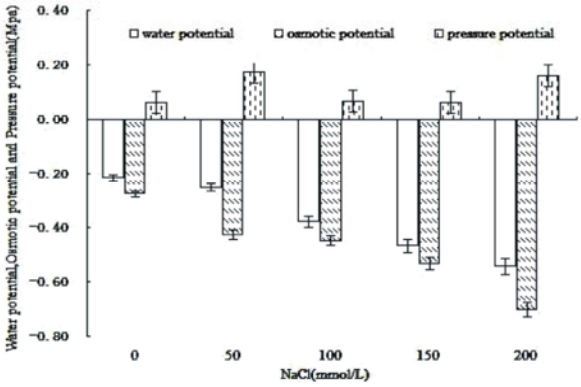


Fig. 1: Effects of NaCl stress on water potential, osmotic potential and pressure potential in *Iris lactea* seedlings

## RESULTS

**Effects of Nacl Stress on Water Potential, Osmotic Potential and Pressure Potential in Iris *Lactea Seedlings*:** With salt concentration increasing, water potential and osmotic potential in seedlings of *Iris lactea* decreased (Fig. 1). At the biggest salt concentration of 200mmol /L, they were reduced by 2.53 times and 2.54 times respectively. However, the pressure potential had remained positive and the cells had maintained turgor, indicating that leaves of *Iris lactea* under salt stress had a certain osmoregulation.

**Effects of NaCl Stress on Water Content and Water Deficit in Iris *Lactea*:** Water content of leaves and roots of *Iris lactea* seedlings decreased with increasing salt concentration. They were 82.4% in leaves and 81.6% in roots under the salt concentration of 200mmol / L. They had a similar downward trend, but the water content of leaves has been more than roots, which indicated that the roots can be as much as possible to transport water from the root to the leaves and to reduce the degree of salt stress damage (Fig. 2). With increasing salt concentration, the water deficit of seedling leaves and roots increased synchronously, demonstrating that salt stress affected water uptake not only the leaves but also the roots (Fig. 2).

**Effect of NaCl Stress on Photosynthetic Characters in Iris Lactea Seedlings:** With salt concentration increasing, stomatal conductance and stomatal limitation value of *Iris lactea* seedlings decreased straight between the NaCl concentration of 0mmol / L and 100mmol / L, respectively 15.19% and 12.98%. If salt concentration increased continuously, the changes were not obvious. Net photosynthetic rate and transpiration rate have been

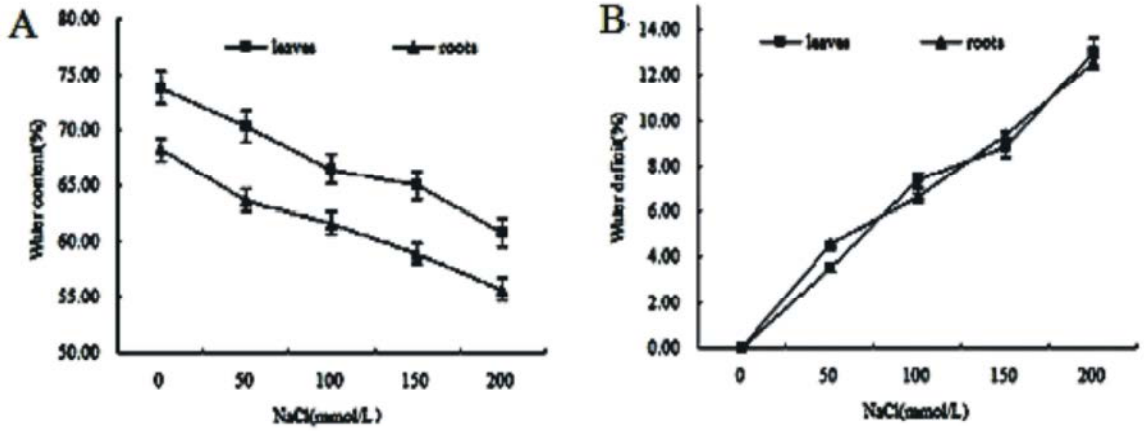


Fig. 2: Effects of NaCl stress on water content and water deficit in *Iris lactea* seedlings

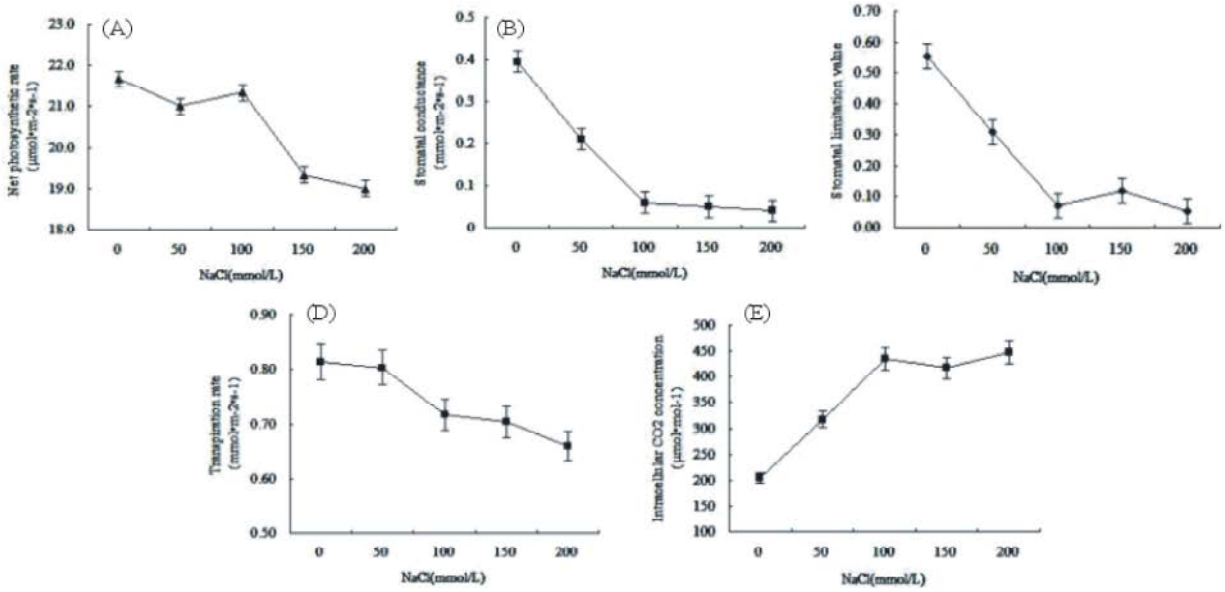


Fig. 3: Effect of NaCl stress on photosynthetic characters in *Iris lactea* seedlings net photosynthetic rate; stomatal conductance; intracellular $CO_2$ concentration; stomatal limitation value; transpiration rate.

lowered, at the NaCl concentration of 200mmol/L respectively 87.7% and81.1%. Intracellular $CO_2$ concentration increased and reached the maximum at 100mmol /L NaCl, about 2.13 times. Also, if salt concentration increased continuously, the changes were not obvious (Fig. 3).

## DISCUSSION

Salt tolerance is a complex process for plants under salt stress and the degree to its salt tolerance is overall performance of metabolism. There are still some limitations if only a single index is used in evaluation of plant salt tolerance. The comprehensive evaluation method can effectively reflect the salt tolerance of different materials [8, 9]. In this study, a comprehensive comparison of indicators on *Iris lactea*l seedlings were done, including water potential, osmotic potential, pressure potential, water content, water deficit and photosynthetic characteristics. This was a certain reference value in the evaluation of *Iris lactea* salt tolerance.

Water potential, osmotic potential and pressure potential of plant cells are important indicators to reflect plant water metabolism, growth, development and stress resistance. Under stress conditions, such as drought, salinity, some plant cells take the initiative to accumulate solute in order to reduce the osmotic potential, increase the water absorption capacity, maintain turgor pressure at a certain extent and protect the cell growth and stomatal opening. This kind of phenomena is called osmotic adjustment. In this study, water potential and osmotic potential of *Iris lactea* seedling reduced with the increasing salt concentration, but the pressure potential has remained positive and the cells have maintained turgor, indicating that leaves of *Iris lactea* to salt stress has a certain osmoregulation. Liu Yu deems that, regardless of halophytes or non-halophytes, the increase of ion concentration in the leaf reduced water potential and the different increase range of the ion concentration in the leaves caused the different reduce degree of water potential under salt stress [10]. Water potential reduction of *Iris lactea* seedlings is not obvious, indicating that this halophyte can make leaves increase ion concentration a little and the large degree of injury was avoided by salt damage.

Water content of *Iris lactea* seedlings leaves and roots decreased with the increasing salt concentration, respectively 82.4% and 81.6% at the salt concentration of 200mmol / L. They had a similar downward trend, but the water content of leaves has been more than roots. Also, with the increasing salt concentration, the water deficit of seedling leaves and roots increased synchronously, indicating that salt stress affected water absorption not only the leaves but also the roots. This result was different with research results of Bai Wen Bo [11]. He believed that the saline alkaline stress may not affect water absorption and utilization of the roots, but the stress will inhibit moisture transportation from

roots to leaves. Leaves water content decreased significantly may be related to absorption features of root and water transport mechanism of plant.

In the effects of the salt stress on the photosynthetic characteristics in *Iris lactea* seedlings, stomatal conductance and stomatal limitation value lowered straight before little change, intracellular $CO_2$ concentration increase before little change and net photosynthetic rate and transpiration rate reduced slowly. The turning point on the net photosynthetic rate, stomatal limitation, stomatal conductance and intracellular $CO_2$ concentration all were NaCl concentration of 100mmol / L, indicating that 100mmol/L NaCl solution is the turning point of *Iris lactea* photosynthetic mechanism. Mechanism of photosynthesis reduced by salt stress has different statements. Some consider that it relates to chloroplast damage, decreasing photosynthesis enzyme activity and toxic substances, but Munns R thinks salinity cause plant growth slack, thereby reducing the photosynthetic area of the individual plants [12]. The mechanism needs a further study.

Under salt stress, the photosynthetic rate of plant reduces [13]. Generally, it is believed that the factors leading to reduce photosynthetic rate contain stomatal limitation and non-stomatal limitation, but which the stomatal factors or non-stomatal factors are has been controversial [14]. Some scholars think it is mainly stomatal limitation and some believe it is non-stomatal limitation. In addition, some propose short-term salt stress is mainly stomatal limitation, later the non-stomatal limitation. Generally, under salt stress, plant photosynthetic rate lowers, stomatal conductance decreases and intracellular $CO_2$ concentration also significantly reduces, mesophyll cells are still active photosynthesis, which is typical of stomatal limitation. To the contrary, if the photosynthetic ability of mesophyll cells decrease, even in lowering stomatal conductance, intercellular CO2 concentration may also increase or unchanged, this is non-stomatal limitation [15]. In this study, photosynthetic rate lowered, stomatal conductance decreased and intracellular $CO_2$ concentration increased, which belonged to the non-stomatal limitation.

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