Objective

Our previous investigation on salt-tolerant Sesbania rostrata Brem. & Oberm. suggested that the higher translocation of Na⁺ and Cl⁻ to shoot is involved in the mechanism to resist salinity stress. The objective of this present study was to obtain more information on the physiological responses in leaves of this plant. Chlorophyll contents and fluorescence yield in leaves were determined by comparing with susceptible species, kidney bean (Phaseolus vulgaris L. cv. Meal). Distribution patterns of Na⁺ and Cl⁻ were investigated more precisely by determining their contents in stem, leaves and 1st – 6th leaves separately.

Materials and Methods

Seedlings of S. rostrata and kidney bean were grown hydroponically with 0, 50, 100 and 150 mM NaCl for 10 days. Leaves were harvested for the measurements. (1) Chlorophyll fluorescence yield (Fv/Fm) was detected by a portable chlorophyll fluorometer. (2) Chlorophyll content: Chlorophyll was extracted by soaking excised intact leaves into 5 ml of dimethyl sulfoxide (DMSO) at 30°C for 1 day in darkness. Absorbance at 648 and 664 nm was recorded using a spectrophotometer. (3) Ions content: Shoots of S. rostrata were divided into stem, leaves and 1st-6th leaves and then dried at 80°C for 48 hr. Half of dried samples were digested with HNO₃. The solutions were used for Na⁺ analysis with an inductively coupled argon plasma atomic emission spectrophotometer. The other half of dried samples was burnt at 500°C for 3 hours. The ash solution was supplied for Cl⁻ analysis with an ion chromatographic analyzer.

Results and Discussion

In S. rostrata, chlorophyll a content decreased slightly by NaCl treatment, but the loss of chlorophyll b was evident. This resulted in the increase of chlorophyll a/b ratio. These results are contrast with those of kidney bean in which the ratio of chlorophyll a/b and total chlorophyll declined markedly as a consequence of decreasing chlorophyll a and b contents. The quantum yield determined by Fv/Fm was unaffected by NaCl in S. rostrata. In contrast, little quenching of the fluorescence was detected at higher than 50 mM NaCl in kidney bean (Table 1). Na⁺ content was greater in leaves than stem when S. rostrata was treated with 150 mM NaCl, but Cl⁻ ion was not different. The distribution analysis of these ions among the 1st-6th leaves showed that Na⁺ ion tended to accumulate in older leaf at the high concentration of NaCl. Cl⁻ content also showed the same tendency, but it was not clear compared with Na⁺ ion (Figure 1).

This finding suggested that strong salinity stress reduced chlorophyll a and inhibited electron transport in Photosystem II. These resulted in growth inhibition, particularly, of susceptible species. Leaf cell of S. rostrata is considered to have some mechanisms, which resist higher concentration of Na⁺ and Cl⁻ ions.
Table 1 Effect of NaCl on chlorophyll content and fluorescence yield in the leaves of Sesbania rostrata and kidney bean 10 days after treatment.

<table>
<thead>
<tr>
<th>NaCl (mM)</th>
<th>Chlorophyll content (µg/g FW)</th>
<th>Chlorophyll fluorescence (Fv/Fm)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Chlorophyll a</td>
<td>Chlorophyll b</td>
</tr>
<tr>
<td>S. rostrata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>156.5±1.9</td>
<td>233.1±3.1</td>
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<tr>
<td>50</td>
<td>157.7±1.0</td>
<td>145.8±13.9</td>
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<td>100</td>
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<td>40.1±1.9</td>
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<tr>
<td>150</td>
<td>135.4±3.0</td>
<td>45.2±1.6</td>
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<tr>
<td>Kidney bean</td>
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<td></td>
</tr>
<tr>
<td>0</td>
<td>79.9±4.4</td>
<td>34.2±1.5</td>
</tr>
<tr>
<td>50</td>
<td>62.2±8.3</td>
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<tr>
<td>100</td>
<td>31.3±3.3</td>
<td>22.0±2.2</td>
</tr>
<tr>
<td>150</td>
<td>10.2±1.3</td>
<td>11.1±0.9</td>
</tr>
</tbody>
</table>

The data are the means of three replicates ± SE.

Figure 1. Distribution of Na⁺ and Cl⁻ in stem and leaves (A&B), and 1ˢᵗ – 6ʰ leaves (C&D) of S. rostrata 10 days after treatment. (C & D, • 150 mM, ▲ 100 mM, ■ 50 mM and ● 0 mM of NaCl) Vertical bars indicate standard errors.