Role of Root to Avoid Salt Stress in Sago palm (*Metroxylon sagu* Rottb.)

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ABSTRACT

Sago palm, a starch producing palm, grows in swampy and peaty soils. Since sago palm can grow in brackish water areas, it is considered to be salt-resistant. Ion concentrations in different plant parts and some physiological features under NaCl treatment (342mM) were measured to investigate salt resistance of sago palm. Under the NaCl treatment for one month, sago palm maintained a low Na^+ concentration in the leaflets at higher leaf positions by storing Na^+ mainly in the roots and the petioles at lower leaf positions. The Na^+ concentrations in the adventitious roots were lower in the stele than in the cortex under the NaCl treatment, which suggested the existence of a mechanism in the endodermis to restrict excessive influx of Na^+ from the cortex into the stele. From X-ray micro-analysis, the dense distribution of Na in the adventitious root was found around its endodermis. The change in the Na^+ concentration in the roots and leaves did not affect K^+ distribution to the leaves. Regardless of the decrease in transpiration rate and slight delay new leaf emergence with the treatment, there was no significant difference in dry matter weight of leaves. It was therefore considered that the nature of salt resistance of sago palm might consist of salt avoidance by mechanical restriction of excessive Na^+-distribution to the cortex.
KEYWORDS: adventitious root, endodermis, Na^+, NaCl treatment, sago palm, X-ray micro-analysis

1. INTRODUCTION

Sago palm distributed in the Malay Archipelago grows in swampy and peaty soils where no major crops can grow without drainage or soil improvement. This palm species stores a large amount of starch in the trunk, approximately 300kgDW per tree. Sago palm is one of the most important plants for sustainable agriculture and rural development in swampy areas because its carbohydrate can be further processed into various basic raw materials for food, animal feed, industrial uses and alternative energy. Since sago palm is distributed and can grow in brackish water areas, it is considered to be salt-resistant. We found that sago palm maintained a low Na^+ concentration in the leaflets, which was attributed to a high Na^+ storage capacity in roots and petioles at lower positions under NaCl treatment (Ehara et al. 2008). In the present report, we investigated the absorption and distribution of Na^+ and some other ions in the leaves at different positions and that in different parts of roots as well as some physiological characteristics under NaCl treatment to elucidate physiological and structural aspects of the salt resistance mechanism.

2. MATERIALS AND METHODS

The seedlings at the 8th leaf stage that were transplanted, one each, to a plastic pot filled with vermiculite were sued. The culture solution [36.5 $(NH_4)_2SO_4$, 54.7 $MgSO_4$, 18.3 KNO_3, 36.5 $Ca(NO_3)_2$, 18.2 KH_2PO_4 and 3.9 FeO_3 (μM)] containing 342mM NaCl (2%) was used in the NaCl treatment. The solution with or without NaCl was supplied for three plants each of the treatment and control for one month in mid summer, 2004 in Tsu. Transpiration was measured by weighing the whole pot. Chlorophyll and ion concentrations in plant tissues were measured by the usual method. The transverse sections of adventitious root were used for X-ray micro-analysis.

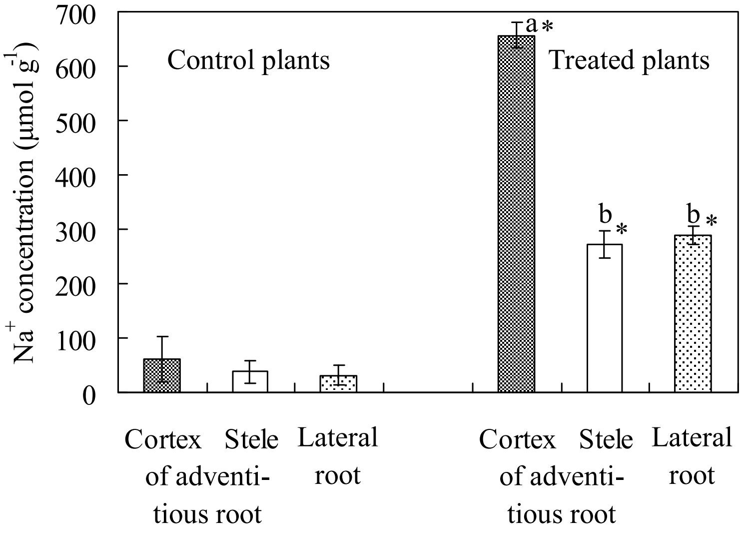

Figure 1. Na^+ concentration in different parts of roots (from Ehara et al. 2008). Vertical lines indicate S.D. (n=3). Different letters in the figure indicate significant differences at different parts within the treated plants at the 0.05 probability level, according to the Tukey-Kramer test. Asterisks indicate significant difference in each part between the control and treated plants at the 0.05 probability level, according to the Student's *t*-test.

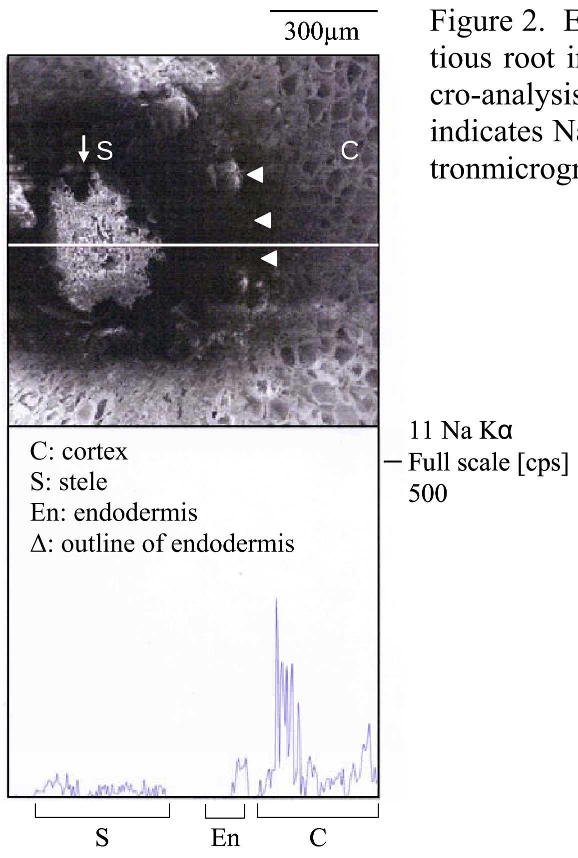

Figure 2. Electronmicrograph of transverse section of adventitious root in a treated plant and Na distribution by X-ray micro-analysis (from Ehara et al. 2008). The lower figure indicates Na distribution along the solid line in the upper electronmicrograph.

3. RESULTS AND DISCUSSION

Sago palm maintained a low Na^+ concentration in the leaflets of active leaves by storing Na^+ mainly in the roots and the petioles at lower positions. The Na^+ concentrations in the adventitious roots were lower in the stele than in the cortex under the NaCl treatment (Figure 1), which suggested that the endodermis possessed a mechanism to restrict excessive influx of Na^+ from the cortex into the stele. Based on X-ray micro-analysis, the dense distribution of Na was observed around its endodermis (Figure 2). The changes in the Na^+ concentration in the roots and leaves did not affect the K^+ distribution to the leaflets and petioles. The effect of the increase of the Na^+ concentration in the seedlings on Ca^{2+} and Mg^{2+} distribution to the leaflets was small. Regardless of the remarkable decrease in the transpiration rate and slight delay in new leaf emergence with the NaCl treatment, there was no significant difference in dry weight of the leaflets and petiole at each position. It was, therefore, considered that salt resistance of sago palm might be due to salt avoidance by mechanical restriction of excessive Na^+-distribution to the cortex.

REFERENCE

Ehara, H., H. Shibata, W. Prathumyot, H. Naito and H. Miyake. 2008. Absorption and distribution of Na^+, Cl^- and some other ions and physiological features of sago palm under salt stress. Trop. Agr. Devlop. 52: 7 - 16 .