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BRIEF COMMUNICATION

NaCl stress in rice seedlings: effects of L-proline, glycinebetaine, L- and D-asparagine on seedling growth

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Abstract

The effect of L-proline, glycinebetaine, L- and D-asparagine on rice seedling growth under NaCl stress was investigated. Glycinebetaine and L-asparagine were not effective in reducing NaCl inhibition in shoot growth of rice seedlings. L-Proline and D-asparagine were found to be able to reduce shoot growth inhibition under NaCl stress. However, L-proline, glycinebetaine, D- and L-asparagine further enhanced NaCl inhibition of root growth.

Key words: *Oryza sativa* L., root length, salinity, shoot length.

Accumulations of proline and glycinebetaine are prominent physiological responses of many higher plants to salinity stress. There are reports that the addition of proline and glycinebetaine to plants counteracts the unfavourable effect of salinity on seedling growth (Bar-Num and Poljakoff-Mayber 1977, Kavi Kishor 1988, Roy *et al.* 1993). In a recent report, Lehle *et al.* (1992) demonstrated that exogenous L- and D-asparagine enhanced NaCl tolerance in *Arabidopsis thaliana*. The present investigation was designed to examine the effects of L-proline, glycinebetaine, L- and D-asparagine on NaCl-inhibition of rice seedling growth.

Rice (*Oryza sativa* L., cv. Taichung Native 1) seeds were sterilized with 2.5 % sodium hypochlorite for 15 min and washed thoroughly with distilled water. These seeds were then germinated in Petri dish (20 cm) containing distilled water at 37 °C under dark condition. After 1-day incubation, uniformly germinated seeds were selected and transferred to Petri dishes (9.0 cm) containing two sheets of Whatman No. 1 filter paper moistened with 10 cm^3 of distilled water or test solutions. Each Petri dish contained 20 germinated seeds. Each treatment was replicated 4 times. The germinated seeds were allowed to grow at 27 °C in darkness and 3 cm^3 of distilled

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water or test solutions was added to each Petri dish on day 3 of the growth. Length of roots and shoots was measured after 5 d in darkness.

Seedling growth was followed by measuring length of roots and shoots of rice seedlings. The growth of shoots in NaCl was significantly improved by L-proline treatment. However, addition of L-proline enhanced the growth inhibition of roots by NaCl (Fig. 1).

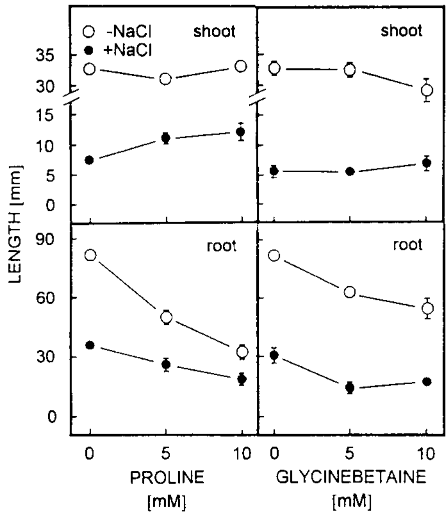

Fig. 1. Effects of L-proline and glycinebetaine on seedling growth of rice under NaCl stress. The concentration of NaCl was 150 mM. Seedling growth was measured after 5 d of treatment. Vertical bars represent standard errors. Only those standard errors larger than symbol size are shown.

Glycinebetaine could not reverse the inhibitory effect of NaCl on shoot growth. Similar to L-proline, glycinebetaine also enhanced the inhibitory effect of NaCl on rice root growth (Fig. 1).

Neither L- nor D-asparagine could reverse the inhibitory effect of NaCl on root growth. In contrast, D-asparagine significantly reversed the inhibitory effect of NaCl on shoot growth (Fig. 2). However, L-asparagine was not effective in reducing NaCl inhibition in shoot growth of rice seedlings (Fig. 2).

Glycinebetaine has been shown to counteract the growth inhibition induced by NaCl (Lone *et al.* 1987). However, the present investigation demonstrated that glycinebetaine did not mitigate NaCl inhibition of rice seedlings. Recently, Pathinasabapathi *et al.* (1993) demonstrated that cultivated and wild rices contained relatively low levels of glycinebetaine [less than 1 μmol g^{-1}(dry mass)], and did not accumulate glycinebetaine in response to salinity or water stress.

L-Proline and D-asparagine were found to be effective in reducing growth inhibition induced by NaCl. However, this response was only observed in shoots. L-Asparagine is the natural substrate for protein synthesis in most plants. In contrast, D-asparagine have been reported to occur naturally in relatively few genera. A major characteristic of reduction of NaCl inhibition on shoot growth of rice seedlings by asparagine is its specificity for D-asparagine. This is in disagreement with the results of Lehle *et al.* (1992), who showed that L- and D-asparagine were equally effective in reducing NaCl inhibition of growth in *Arabidopsis*. This discrepancy is probably due to different species used.

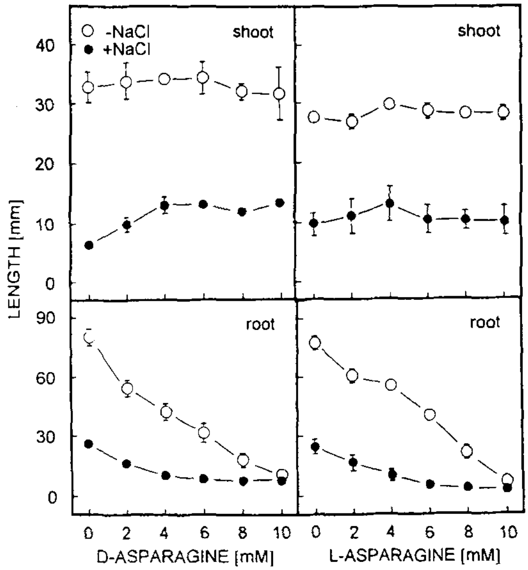

Fig. 2. Effects of D- and L-asparagine on seedling growth of rice under NaCl stress. The concentration of NaCl was 150 mM. Seedling growth was measured after 5 d of treatment. Vertical bars represent standard errors. Only those standard errors larger than symbol size are shown.

Of particular interest is the finding that all the organic solutes tested in the present investigation enhance NaCl-induced inhibition of root growth. This is the first evidence that organic solutes such as L-proline, glycinebetaine, D- and L-asparagine have differential effect on shoot and root growth. It seems that organic solutes investigated in this study may play different roles in regulating shoot and root growth of rice seedlings.

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