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## Citric acid accumulation of *Puccinellia tenuiflora* is a specific adaptive response to alkaline stress

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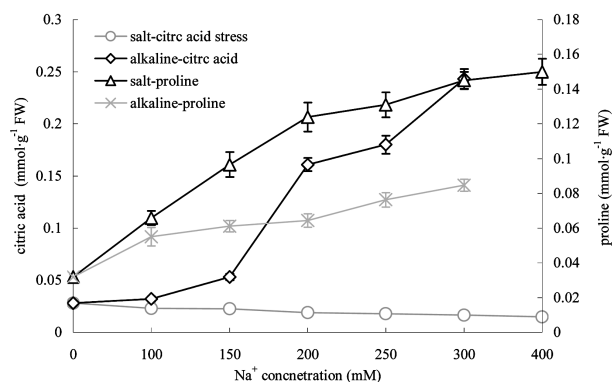
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**Key words :** *Puccinellia tenuiflora*, saline stress, alkaline stress, organic acid, citric acid, proline

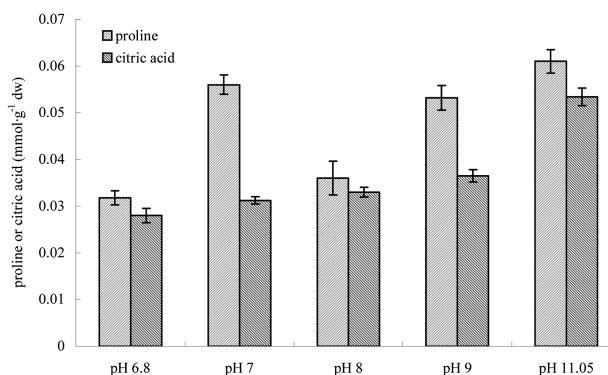
**Introduction** *Puccinellia tenuiflora* is typical forages found in saline-alkaline habitats of Songnen Grassland. Owing to the special osmregulation, the species could survive in high pH conditions. In order to understand the physiologic characteristic of *P. tenuiflora* alkali tolerance, citric acid accumulation under the alkaline stress was studied.

**Materials and methods** These treatments were divided randomly into 15 groups (3 replicates per group). One group was used as the control (CK). Five groups were treated with Na<sub>2</sub>CO<sub>3</sub> solutions. Six groups were treated with NaCl solutions with concentrations. The remaining 3 groups were treated with 100 mmol l<sup>-1</sup> Na<sub>2</sub>CO<sub>3</sub> solutions, which were neutralized pH7, pH8 and pH9 using 85% H<sub>3</sub>PO<sub>4</sub>. Proline concentration was determined according to Bates *et al.* (1973). The concentration of total organic acid was determined according to Jing and Ding (1981), and citric acid was determined using the pentabromoacetone method adapted from Shi and Yin (1993).

**Results** Citric acid concentrations of *P. tenuiflora* increased with increasing stress strength by Na<sub>2</sub>CO<sub>3</sub> ( $p < 0.05$ ,  $R = 0.967$ ). Under NaCl stress, citric acid concentration decreased slightly ( $p > 0.05$ ) with increasing stress strength (Figure 1). Changes in the concentration of citric acid and total organic acid with increasing stress strength were almost parallel in the alkaline stressed seedlings of *P. tenuiflora* (data not shown). The proline concentration of *P. tenuiflora* also increased with the increases of NaCl and Na<sub>2</sub>CO<sub>3</sub>. In neutralization treatments, citric acid concentrations of *P. tenuiflora* decreased with decreasing pH value ( $p < 0.05$ ,  $R = 0.963$ ). Proline concentration of changed irregularly with pH value decreasing.



**Figure 1** Comparison of citric acid and proline accumulation between salt stress and alkaline stress in *P. tenuiflora*.



**Figure 2** Effects of neutralization on the concentrations of proline and citric acid in *P. tenuiflora*.

**Conclusions** Under alkaline stress, the organic acid metabolism of *P. tenuiflora* was changed, mainly due to the accumulation of citric acid. The citric acid accumulation was a specific physiological response to alkaline stress. The proline accumulation was physiological response to osmotic stress and the primary physiological significance of proline accumulation was osmotic adjustment.

### Reference

Shi, D. C., and Yin, L. J. (1993). Difference between salt (NaCl) and alkaline (Na<sub>2</sub>CO<sub>3</sub>) stresses on *Puccinellia tenuiflora* (Griseb.) Scribn. et Merr. plants. *Acta Botanica Sinica*, 35: 144-149. (in Chinese).