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Physiological and hydrological changes in *Populus euphratica* seedlings under salinity stress

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ABSTRACT

The effect of salinity stress on stomatal aperture, density, conductance and native embolism rate (PLC%) in the seedlings of *Populus euphratica* were studied in the arid ecosystem of Xinjiang, China. Model experiment was conducted at different concentrations of salt (50, 100, 150, and 200 mM NaCl) with the irrigation water for consequently three months, on two years old seedlings. Salinity stress effected stomatal density; it increased in all salt treated treatments with relation to untreated plant while areas of stomata were reduced significantly. Decrease in length of stomatal openings and area of openness were also observed. The stomatal conductance was decreased from 1st to 3rd month consequently and from 0 mM to 200 mM NaCl in all treatments. It decreased with an increased concentration of salinity, and a similar trend was observed for duration of time. Salinity stress showed impact on native PLC% values. Enhancing and revealing the mechanism of salinity tolerance of *P. euphratica* will extend their application for afforestation on salinized soil and sustainable wood bio-production.

1. Introduction

Populus euphratica is a phreatophytic tree species, able to grow in saline environments, more adaptable in saline soil [1,2], and the best characterized for salt tolerance till date [3–5]. It is unique woody tree for afforestation in arid, semi-arid and in barren lands of China, where it is functioning as a sand stabilizer [6].

The establishment of seedlings in high saline environments is a major challenge for *P. euphratica* afforestation. Salinity responds to modifications in stomatal density, area, shape, size, openness and conductance as well as hydraulic conductivity. Stomatal aperture limited leaf photosynthetic capacity under salinity stress conditions [7]. Stomatal closure reduces leaf transpiration, allowing plant to re-establish the balance between water gain and loss [8]. Research demonstrated that water stress increase stomatal density [9]; similar trends could be visible for salinity stress. Stomatal movements play an important role in regulation of plant water balance and gas exchange. Photosynthesis and growth of plants are largely determined by their hydraulic conductivity [10] as well as by the vulnerability of the xylem to cavitation [11]. Hydraulic conductance and cavitation are the important factors constraining on plants productivity and its survival [12,13].

Therefore, it is an important to understand the salinity effects on *P. euphratica* seedlings growth especially on stomatal aperture, conductance and hydraulic conductivity. Our study on stomata, conductance and hydraulic conductivity provides adaptive understanding required at the time of establishment of *P. euphratica* seedlings in saline environments.

2. Materials and methods

2.1. Plant source and maintenance

One year-old *P. euphratica* seedlings (uniform in width, root radius, height, and trunk diameter) was selected from the nursery located at downstream of Tarim River (41.68°N, 86.06°E), Xinjiang, China and transferred to experimental site (43.46°N, 87.36°E). Seedlings were planted in pots containing native soil and grown for one year by irrigating with tap water. Each pot filled by 25.20 ± 0.09 kg native soils on dry weight basis. At the time of planting the average height of seedlings above the soil was 60 ± 2.68 cm (mean ± SE). The seedlings were randomly divided into five groups for salt treatments (0, 50, 100, 150, 200 mM NaCl). Six replications were used for each treatment and 4 different concentrations of salt (NaCl) were used along with control treatments. Well survived plants were treated by NaCl dissolved with irrigation water. Experimental pots were kept in natural conditions facing low precipitation, and no additional fertilizers were used.

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2.2. Salt treatment

Salt treatment was imposed by irrigation with 1 L of tap water with 50, 100, 150, and 200 mM NaCl once in a week for continually three month. Control plants were irrigated with 1 L of water containing no salt. Salt treatments were commenced by NaCl (Sodium Chloride; MW 58.44 g).

2.3. Sample collection

Samples were collected at end of each month for consequently three months, and immediately transferred to laboratory for analysis. Healthy leaves were chosen for the observation of stomatal aperture (density, area, and size) at 14:00 h each month and uniform stems were used for hydraulic traits measurement. Samples for hydraulic traits

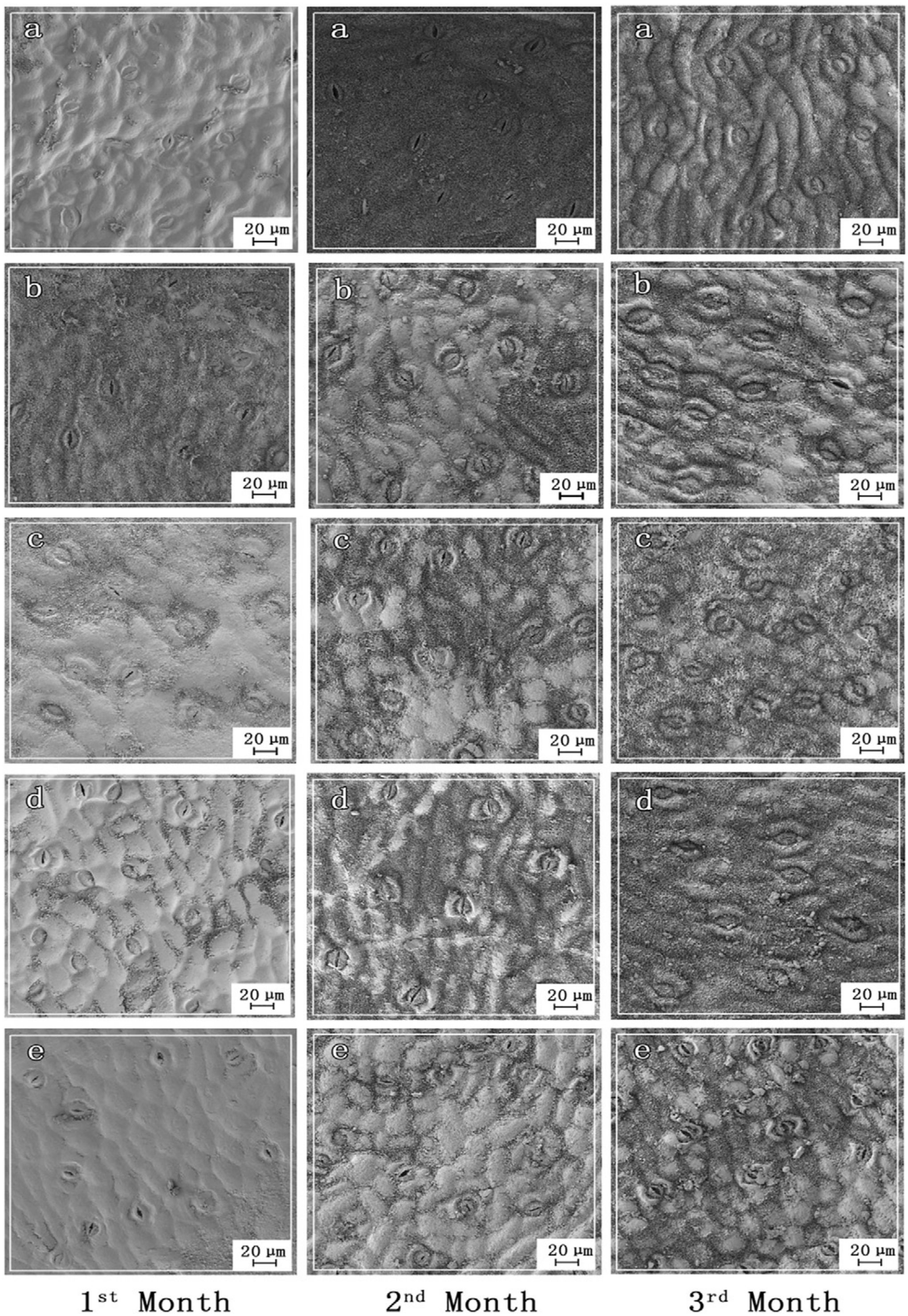

Fig. 1. Effect of salinity on stomatal density on adaxial surface of *P. euphratica* leaf. (a) 0 mM; (b) 50; (c) 100 mM; (d) 150 mM; (e) 200 mM; (circled area, 62,500 μm^2).