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Salt Tolerance of Some New Selections of Warm Season Turfgrasses and Their Salt Tolerance Mechanisms

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Introduction The need for salt-tolerant turfgrasses is increasing because of the turfgrass establishment on highly saline soil in arid and seashore regions or the increased use of saline water for green land irrigation. Many researches indicated that most warm season turfgrasses were high salt tolerance, such as zoysiagrass, seashore paspalum, St. Augustinegrass, and bermudagrass. But the variation of relative salt tolerance among species or cultivars of the same species is often very great. So the evaluation of salt tolerance of new selections of warm season turfgrasses is required before they are applied on saline soil or irrigated with saline water.

Materials and methods The salt tolerance of 54 warm season turfgrasses new selections and cultivars, including 28 zoysiagrass, 22 bermudagrass, 2 centipedegrass, 1 seashore paspalum, and 1 St. Augustinegrass, was studied in a hydroponic culture system in greenhouse. Sodium chloride was gradually added to a basic nutrient solution to obtain final salinity level of 34 $g \cdot L^{-1}$, and then the salinity level was kept for 1 month. The control was a basic nutrient solution with no sodium chloride. Leaf firing percentage (LFP) as an indication of salt injury was investigated when the experiment ended. A pot experiment was conducted to study the growth and physiological responses of four turfgrasses to long-term salt stress, including most salt tolerance *Z. matrella* (L.) Merr. Z123 (ZM) and *P. vaginatum* Sw. P006 (PV), moderate salt tolerance *C. dactylon* (L.) Pers. C291 (CD), and least salt tolerance *Z. japonica* Steud. Z080 (ZJ), which their LFPs in the hydroponic experiment were 6.5, 7.0, 21.3, and 63.8% at 34 $g \cdot L^{-1}$, respectively. Seven salinity levels of irrigation water (0, 5, 10, 20, 30, 40 and 50 $g \cdot L^{-1}$ NaCl) were applied to turfgrasses grown in plastic pots for nine months in greenhouse.

Results and discussion There was significant difference in LFP among species or cultivars of the same species at 34 $g \cdot L^{-1}$. LFP of zoysiagrasses ranged from 2.8 to 63.8%, and averaged 28.2%. Among species of *Zoysia*, the most salt-tolerance ones were *Z. tenuifolia* (6.3%, only one selection in the experiment) and *Z. matrella* (averaged 14.1%), followed by *Z. sinica* (averaged 28.4%) and *Z. japonica* (averaged 31.7%). LFP of bermudagrasses ranged from 14.8% to 83.3%, and averaged 34.6%. *Cynodon dactylon* was more salt tolerance than *C. dactylon* × *C. transvaalensis*, which averaged 32.1% and 39.0%, respectively. Seashore paspalum P006 and St. Augustinegrass S004 were also very salt-tolerance grasses and LFP only reached 7.0% and 15.5%, respectively. Two collections of centipedegrass were salt-sensitive, and LPF averaged 98.1%. In summary, ten turfgrasses (highest LFP) of the most salt tolerance were Z095 (2.8%), Z160 (6.3%), Z123 (6.5%), P006 (7.0%), Z002 (9.5%), Z152 (9.5%), Z075 (13.0%), C747 (14.8%), S004 (15.5%), and Z077 (18.3%). Result of relative salt tolerance of four turfgrasses in the container experiment was consistent to that in the hydroponic experiment. ZM, PV, and CD were able to keep 100% green leaf coverage at 30, 30, and 10 $g \cdot L^{-1}$, respectively, and died at 50, 50, and 30 $g \cdot L^{-1}$, respectively. ZJ was unable to keep 100% green leaf coverage at any salinity, and died at 20 $g \cdot L^{-1}$.

Dry leaf weight, dry shoot weight, shoot length, shoot number, dry rhizome weight, dry root weight, and total dry plant weight were all reduced after nine months salt stress, while more salt-tolerant turfgrasses had higher relative growth under higher salinity. It may be an adaptation response of these turfgrasses to long-term salt stress that the ratio of belowground to aboveground weight were increased, and leaf widths and/or leaf numbers were not almost affected in all turfgrasses after nine months salt stress. Water contents of leaves and roots were not obviously affected by increased salinities. Contents of malondialdehyde (MDA) in leaves of four turfgrasses had some increase as salinity increasing, but the ratio of MDA content of the treated materials to that of the controlled materials did not exceed 1.5 times under the live salinities, which explained that the injuries of cell by salt stress probably were not serious. Contents of chlorophyll a, chlorophyll b, and total chlorophyll were higher at all salinities than that of the control. Contents of Na and Na:K ratio of leaf and root were increased as increased salinities in all turfgrasses, K contents of all turfgrasses were decreased expect PV leaf. In root, PV had a higher Na:K ratio than that of other grasses, however, PV and CD had a lower Na:K ratio in leaf (<1) under salt stress than that of ZM and ZJ (>1). Salt excretion was increased in ZM, ZJ, and CD when salinity was increased, in which ZM has the most powerful salt secretion ability, followed by ZJ and CD. PV showed no salt excretion ability. The growth and physiological responses of four turfgrasses were different to salt stress, which exhibited the different mechanisms for salt tolerance among these turfgrasses.

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