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学　位　論　文　要　旨

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題目:Study on physiological and adaptational responses of turfgrasses to salinity stress
（シバの塩ストレスに対する生理および適応応答に関する研究）

Increased need for salt-tolerant turfgrasses continues due to increased use of recycled saline water for turfgrass irrigation in the arid and semiarid regions. Turfgrasses growing on saline environments suffer from salinity stress. This study was conducted to determine the salinity tolerance, growth and physiological responses of Kentucky bluegrass (KBG), Tall fescue (TF) and four bermudagrass cultivars (Riviera, Blackjack, Savannah and Sundevil 2). KBG and TF were subjected to 0, 50, 100, 150 and 200 mmol L^{-1} NaCl and bermudagrass cultivars were treated with 0, 100, 200, 300, and 400 mmol L^{-1} NaCl. Salinity tolerance was assessed according to the turf quality, leaf firing and relative shoot growth. The ranking of salinity tolerance was bermudagrass > Tall fescue > Kentucky bluegrass. Salinity tolerance among Bermudagrass cultivars was Riviera > Blackjack > Savannah > Sundevil 2. KBG, TF and bermudagrass cultivars exhibited differential physiological and adaptational response to salinity stress.

Maintenance of relatively stable root growth of TF and root growth stimulation of bermudagrass was a potential adaptive mechanism for salinity tolerance. The most salt-tolerant Riviera has the most significant root growth under moderately salinity among bermudagrass cultivars. Root growth stimulation can increase in root/shoot ratios, and therefore increase in water absorption/transpiration area to resist saline osmotic stress.

Complete osmotic adjustment was observed in all turfgrasses studied in this study. Saline ions (Na^+ and Cl^-) were predominant solute for osmotic adjustment. These saline ions regulation may be one of key mechanisms of salinity tolerance in turfgrasses. The Na^+ and Cl^- concentrations in root were higher than those in shoot or leaf in all turfgrasses. The root Na^+/shoot Na^+ ratio of TF was higher than that of KBG. The root Na^+/leaf Na^+ ratio of Riviera was the highest among bermudagrass cultivars. Root plays an important role in limiting the transport of Na^+ to the shoot in turfgrass. The exclusion of saline ions from shoot reduces the toxicity to plant growth, which associate with salinity tolerance of turfgrasses studied in this study.

Salt-sensitive KBG had higher shoot and root Na^+ and Cl^- concentrations than moderately salt-tolerant TF. The least salt-tolerant Sundevil 2 maintained the highest leaf and root Na^+ and Cl^- concentrations among four bermudagrass cultivars. KBG typically accumulated saline ions for osmotic adjustment. TF had better salt tolerance than KBG due to maintain a lower level of Na^+ and Cl^- in conjunction with the accumulation of enough total soluble sugars to make osmotic adjustment. Bermudagrass could regulate leaf and root Na^+ and Cl^- at low level by saline ion excretion via leaf salt glands. Salinity tolerance of bermudagrass cultivars was correlated to salt gland excretion efficiency. The different ionic concentrations in KBG, TF and bermudagrass had an apparent relationship to salinity tolerance in turfgrasses.

Uptake and accumulation of K^+ and selectivity for K^+ over Na^+ might play an important role in salinity tolerance. The K^+/Na^+ ratios in the shoots and roots of KBG decreased significantly as salinity increased. However, under salt stress those of TF were significantly higher than those of KBG. This result indicates that TF had a better selectivity for K^+ over Na^+ than KBG via roots and transporting K^+ from roots to shoots under salt stress. In bermudagrass cultivars, Riviera maintained the highest leaf K^+/Na^+ ratio at all salinity levels, indicating a strong capacity for the selectivity for K^+ over Na^+ under salinity stress.

In addition, TF accumulated higher level of total soluble sugar for osmotic potential in the cytoplasm. TF exhibited a better antioxidant defense system against oxidative stress and lipid peroxidation by maintaining higher antioxidant activities.

In conclusion, developing salt-tolerant turfgrasses has become imperative as increase in recycled water irrigation. Turfgrasses have developed various survival mechanisms in response to salinity stress and showed a wide range in salinity tolerance. Salinity tolerance was related to inhibit the accumulation of Na^+ and Cl^-, which helps to maintain ion balance; and accumulate sugars, which decrease the osmotic potential of the cytoplasm; keep lower MDA and higher antioxidative enzyme activities, which improve the oxidative stress and lipid peroxidation. A thorough knowledge of the salinity tolerance mechanisms might be useful for developing salt-tolerant turfgrasses.