By Dr. Yaling Qian

Irrigating with **recycled wastewater**

RAPID POPULATION GROWTH in arid and semiarid regions of the U.S. continues to place increasing demand on finite and limited water supplies. Many cities and districts are struggling to balance water use among municipal, industrial, agricultural, and recreational users. Along with an increase in fresh water demand, comes an increase in the volume of wastewater generated.

Treated wastewater is the only water resource increasing as other sources dwindle. Reuse of treated wastewater for turf and landscape irrigation is often viewed as one way to maximize the existing urban water resources. In addition to the growing concerns of the future water supply, the more stringent wastewater discharge standards make use of recycled wastewater increasingly attractive.

To date, the contribution of water reuse to water conservation varies by location. Water reuse satisfied 25% of the water demand in Israel, for example, where 66% of total treated sewage is reused. Water reuse is expected to reach 10% to 13% of water demand in the next few years in Australia and California. Throughout the US, large volumes of municipal recycled water is being used to irrigate athletic fields, golf courses, community parks, cemeteries, schoolyards, roadsides, street medians, industrial and residential landscapes, and other urban landscape sites.

Based on data from the Department of Public Health and Environment, Water Quality Control Commission there are about 10 permitted recycled wastewater facilities in Colorado that can treat and deliver about 56 million gallons of effluent water every day for reuse purposes. We conducted a survey of landscape managers who use recycled wastewater. Survey results indicated that cost was not the driving force for landscapes to use RWW. Rather the availability and reliability of the water were rated as the two main reasons for using RWW for irrigation.

Since 2003, research was conducted at Colorado State University with two objectives: To assess variability of chemical properties of recycled wastewater in the Front Range of Colorado, and to evaluate landscape soils and plants that are currently under recycled wastewater irrigation.

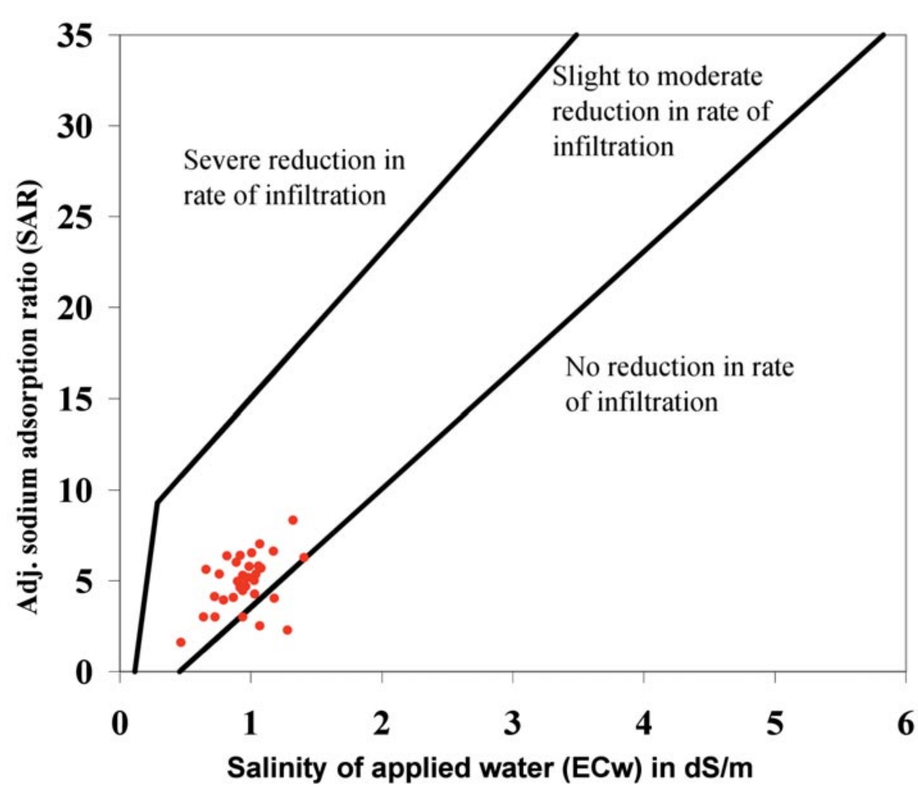
Understanding the responses of urban landscape plants and soils to recycled wastewater irrigation and identifying proper management practices are critical to the long-term success of this practice.

Water quality

Recycled wastewater samples were collected from irrigation ponds and sprinkler outlets on landscape sites. Water testing results of about 50 RWW samples collected from six landscape sites were reviewed for suitability in landscape irrigation based on irrigation water quality guidelines.

The average electrical conductivity (EC) of more than 50 recycled wastewater samples from six reuse sites was 0.84 dS/m and the range was 0.47 to 1.32 dS/m. An electrical conductivity higher than 0.75 dS/m indicates the water may impose negative effects on salt-sensitive plants. Periodic leaching of salts is required to mitigate the potential salinity problem.

Adjusted sodium absorption ratio (SAR) of recycled wastewater from reuse sites ranged from 1.6 to 8.3. Based on the interactive effect of salinity and sodicity on soil infiltration and percolation, most of the water samples collected showed



slight to moderate effects on soil infiltration and permeability (see figure). Long-term and continued use of water with a high adjusted-SAR may lead to a reduction of soil infiltration and permeability on fine texture soil. Additional management (such as Ca product topdressing or amendments and frequent aerification) is needed to mitigate these effects.

One of the other concerns of recycled wastewater irrigation is the presence of high levels of particular ions (sodium, chloride, and boron) that are toxic to some trees and shrubs. With sprinkler irrigation, sodium and chloride frequently accumulate by direct adsorption through the leaves that are moistened. Sodium and chloride toxicity could occur on sensitive plants when their concentrations in irrigation water exceed 70 and 100 mg/L, respectively. The average sodium concentration of more than 50 water samples collected was 99 mg/L, ranging from 30 to 170 mg/L. The average chloride concentration was 95 mg/L. Chloride leaches easily through the soil profile and chloride toxicity to turf and landscape plants should be minimal if soil is well drained and salts are regularly leached. However, if the sites have poor drainage, soil percolation is impaired or limited, or have a shallow water table present, chloride applied over time can accumulate to a toxic level.

In all cases, the water samples met or exceeded the regulations in regard of E. coli count as defined in the state regulations, therefore the water is suitable for landscape irrigation.

Soil

To assess recycled wastewater irrigation on the long-term changes of soil, we compiled soil test data from landscape sites that have relatively fine texture soil (clay loam and loam soil). Among sites, six had been irrigated exclusively with domestic RWW 8 - 33 years. The other six with similar turf species, age ranges, and soil textures had used surface water (average EC = 0.23 dS m-1) for irrigation. Our results indicated that soils (sampled to 11.4 cm) from sites where RWW was used for 8-33 years exhibited higher concentrations of extractable Na, B, and P. Compared to sites irrigated with surface water, sites irrigated with RWW exhibited higher EC and higher sodium adsorption ratio (SAR) of saturated paste extract.

However, the accumulation of salts in the soil profile is not a function of water salinity alone. The rate at which salts accumulate to potentially toxic levels in a soil also depends on the amount of water applied annually, annual precipitation (rain plus snow), and a particular soil's physical/chemical characteristics. Good permeability and drainage allow a turfgrass manager to leach excessive salt from the rootzone by periodic heavy irrigations. For example, water with an ECiw of 1.0 dSm-1 may be successfully used on grass grown on sandy soil with good drainage, but may result in salt buildup in the rootzone if used to irrigate the same grass grown on a clay soil or soil with limited drainage.

Sand-based sports field amplify the soil structure that allows such relatively straight forward salinity management. Only careful management can prevent deleterious salt accumulation in a soil irrigated with high ECiw water. Soil physical characteristics and drainage, both important factors in determining rootzone salinity, must also be considered in determining the suitability of a given recycled irrigation water.

Plants

Generally, turfgrasses, including Kentucky bluegrass, had a good appearance, showing salinity damage only on a few sites with poor drainage, heavy soil structure, or shallow water table. However, chronic decline of salt sensitive trees were observed under long-term RWW irrigation (> 8 years). Ponderosa pines grown on sites irrigated with RWW for 8-33 years exhibited higher needle burn symptoms than those grown on sites irrigated with surface water. Tissue analysis indicated that ponderosa pine needles collected from sites receiving RWW greater sodium, chloride, and boron concentrations than samples collected from the control sites. Stepwise regression analysis revealed that the level of needle burn was largely influenced by leaf tissue sodium concentration. Tissue Ca level and K/Na ratio were negatively associated with needle burn symptoms, suggesting that calcium amendment and K addition may help mitigate the needle burn syndrome in ponderosa pine caused by high Na+ in the tissue.

The project indicated that both problems and opportunities exist in using RWW for landscape irrigation. The use of recycled wastewater for irrigation in urban landscapes is a powerful means of water conservation and nutrient recycling, thereby reducing the demands of freshwater and mitigating pollution of surface and ground water. However, potential problems associated with recycled wastewater irrigation exist. Salts (especially the relatively high Na+ and high EC) in the treated wastewater were associated with needle burn symptoms observed in ponderosa pines subjected to RWW irrigation. The significantly higher soil SAR in RWW-irrigated sites compared to surface water irrigated sites provided reason for concern about possible long-term reductions in soil hydraulic conductivity and infiltration rate in soil with high clay content, although these levels were not high enough to result in short-term soil deterioration.

This information is useful to landscape planners and managers to determine what should be monitored and what proactive steps should be taken to minimize any negative effects during planning and managing landscapes receiving recycled wastewater. Understanding the responses of urban landscape plants and soils to recycled wastewater irrigation and identifying proper management practices are critical to the long-term success of the water reuse practice. ■

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