2006 Conference Proceedings

7-18-2006

Appraising Salinity Hazard to Landscape Plants and Soils Irrigated with Moderately Saline Water

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Abstracts of presentations given on Tuesday, 18 July 2006, in session 2 of the UCOWR Conference.

APPRAISING SALINITY HAZARD TO LANDSCAPE PLANTS AND SOILS IRRIGATED WITH MODERATELY SALINE WATER

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ABSTRACT

Water planners and managers are faced with the increasing needs to utilize nonpotable water for irrigating urban landscapes in water-shortage areas of the arid West. However, existing guidelines for assessing suitability of water for irrigation is rather broad. This paper presents updated guidelines based on the experience in west Texas and southern New Mexico where water of relatively high salinity (1000 – 3000 mg L^{-1}) is used for landscape irrigation. Salinity hazard to landscape plants occurs through two different processes: foliar absorption of salts when plants are sprayed with sprinklers, and another through soil salinization. Foliar damage is widespread among broadleaf trees and shrubs, and occurs in sensitive plants when Na or Cl concentrations reach 150 mg L^{-1}. When the concentration reaches 200 to 300 mg L^{-1}, it affects nearly all deciduous trees, but not pines and junipers. This problem can be minimized through modification of sprinklers to low trajectory or to non-sprinkling types, otherwise through appropriate plant selection. Plant damage caused by soil salinization is also species–dependent, and occurs primarily in salt sensitive or moderately sensitive species. It is difficult to predict this form of salt damage from water quality data alone. Soil salinization potential has to be evaluated first, then the projected soil salinity can be compared against the threshold soil salinity for maintaining intended plant species. Projection of soil salinity must incorporate types of soils and landscape involved, besides quality of water. The projection can be made with reasonable accuracy in Entisols using several methods presented in this paper, but not adequately in Aridsols containing a calcic horizon. The appraisal of soil salinization potential is complicated by the potential soil permeability reduction caused by elevated sodicity or gypsum precipitation from irrigation with gypsic water. Landscape management capability directly affects the ability to regulate soil salinity, thus actual salinity hazard to plants and soils.

INTRODUCTION

In water-shortage areas of the arid West, it is sensible to utilize nonpotable water for irrigation. However, the guidelines needed for assessing salinity hazard to landscape plants and soils have not been adequately developed. The guidelines developed in California, for example, states that landscape uses of water containing 500 to 2000 mg L^{-1} of dissolved salts may cause 'moderate' salt problems, and that the impact of sodicity (expressed by the sodium adsorption ratio) should be evaluated by considering salinity of irrigation water (Westcot and Ayers, 1984). These guidelines are conceptually valid, but require additional details to be useful. The guidelines recommended by the US Golf Association (USGA, 1994) are more specific, indicating that water containing dissolved salts in excess of 1000 mg L^{-1} or the sodium adsorption ratio (SAR) greater than 6 should not be used for irrigation, except under special circ-

[1] - This paper was presented at the 2006 Annual Conference of UNW Council on Water Resource held in Santa Fe, New Mexico, July 18 – 20.

umstances. The Texas regulation covering industrial effluent specifies that the SAR of the soils irrigated with the wastewater, including cooling tower blowdown, shall not exceed 10 (TAC 210).

We surveyed golf courses, parks and sports fields where water of elevated salinity is used for irrigation in west Texas and southern New Mexico (Table 1). The type of water used does not necessarily conform to the guidelines mentioned above. Reclaimed water in the Rio Grande Basin (designated as RW-ELP in the table), for example, has the SAR value of as high as 12, yet it has been used successfully in most parts, and poorly in some other part. Salinity of ground water or reclaimed water used for golf course irrigation in west Texas and southern New Mexico usually exceeds the USGA guidelines of 1000 mg L^{-1}, and reaches as high as 3000 mg L^{-1} in some cases. However, these high salt water sources contain large amounts of Ca and SO_4, which originate from geological deposits. The concentration of Na in this saline water is low, although Cl concentrations can be higher. This type of high salinity water has been used for many years in west Texas with varying degrees of success. These examples indicate that the guidelines for landscape use of water with elevated salinity need to be elaborated.

Table 1. Examples of quality of water used for landscape irrigation in west Texas and southern New Mexico.

Saline Water Category	TDS	EC	SAR	Na	Ca	Mg	Cl	SO_4
Basins	mg L^{-1}	dS m^{-1}	---------------------------------mg L^{-1}-----------------------------------					
Moderate Salt Levels (750 - 1500 mg L^{-1})								
Rio Grande (PT-ELP)	700	1.1	4.4	156	69	16	143	245
Tularosa (PT-ALM)	789	1.3	2.0	72	120	35	110	301
Rio Grande (RW-ELP)	1120	2.1	12.1	350	45	5.0	325	231
Pecos (SW-ACM)	1345	1.7	0.8	56	330	38	71	846
Tularosa (RW-ALM)	1550	2.6	5.0	305	162	59	437	431
Moderately High Salt Levels (1500 - 2500 mg L^{-1})								
Rio Grande (GW-ELP)	1600	2.8	16.8	514	47	15	490	380
Colorado (RW-OD)	1775	2.5	4.3	356	144	78	640	430
Colorado (GW-MDL)	2220	3.5	3.2	261	248	146	653	813
Very High Salt Levels (> 2500 mg L^{-1})								
Rio Grande (GW-ELP)	2580	3.5	9.1	543	219	51	552	790
Colorado (GW-MDL)	2745	4.3	4.3	384	277	208	568	1400
Pecos (SW-AT)	3075	4.4	4.4	405	475	99	621	1383

[1] - PT: Potable water, RW: reclaimed water, SW: surface water, GW: ground water

[2] - Solubility of gypsum ($CaSO_4 \cdot 2H_2O$) is 2400 mg L^{-1} or 1932 mg L^{-1} if $2H_2O$ is excluded, and yield 560 mg Ca L^{-1}, and 1370 mg SO4 L^{-1}.

The purpose of this paper is to present updated guidelines for assessing salinity hazard to landscape plants and soils when moderately saline water is used for irrigating golf course and urban landscapes. The guidelines were developed based on the experience in west Texas and southern New Mexico where the annual precipitation ranges from 200 to 300 mm, and the annual pan evaporation is around 2500 mm. These guidelines have not yet been tested in other states.

LANDSCAPE PLANT DAMAGE

Salts usually cause plant damage through foliar salt adsorption or through soil salinization. Plant damage caused by foliar salt adsorption is acute, and is more wide-spread than plant damage caused by soil salinization.

Foliar Salt Adsorption and Leaf Damage: Plant leaves are highly active, not only engaging in adsorption of carbon dioxide (CO_2), but also water, nutrients, and salts. Several studies have shown that plant leaves, unlike roots, do not have the capability to exclude salts, while absorbing water through leaves (Maas et al., 1982b). This does not imply that all salt elements are equally damaging. Sodium (Na) and chloride (Cl) ions are usually more hazardous to plants than Calcium (Ca). Adsorption of Ca, along with HCO_3 and SO_4 are also curtailed, because these ions precipitate readily as calcium carbonate ($CaCO_3$) or gypsum ($CaSO_4 \cdot 2H_2O$). The role of Mg in foliar salt adsorption is not well understood, but it can facilitate increased salt adsorption, as Mg salts are highly hydroscopic.

Several reports indicate that night irrigation causes less damage than day irrigation (Busch and Turner, 1967). Salt adsorption is reduced with stomata closure and with reducing temperatures. Increasing the cycle of wetting increases foliar salt adsorption. In contrast, increasing the duration of irrigation per day may not measurably increase foliar salt adsorption (Maas et al., 1982a). Increasing wind does not seem to increase foliar salt adsorption, and in fact, wind strong enough to blow off water droplets from leaves can actually reduce salt adsorption. Lowering humidity seems to reduce salt adsorption, as high rates of water evaporation accelerate salt precipitation (Grattan, et al., 1981).

The major difference in salt adsorption seems to occur due to the difference in leaf morphology. Many of the broadleaf trees and shrubs which are sensitive to salts, such as Sycamore (*Populus plantanous*) and Locust (*Gleditsia sp.*) absorb salts without accumulation of salts on the leaves. Some plants, such as Silverberry (*Elaeagnus pungens.*) have a water adsorptive surface, and easily sustain leaf injuries, whereas plants with waxy leaves retain little water on the leaf surface, thus limiting salt adsorption. Most conifers are slow to adsorb salts, except for a few species, such as Arborvitae (*Thuja sp.*) and Arizona Cyrpess (*Cupressus arizonica*). Pines and junipers absorb salt very slowly (Townsend and Kwolek, 1987).

Foliar damage caused by salt absorption through foliar can occur at Na or Cl concentrations as low as 150 mg/L^{-1} in sensitive species such as *Vinca*, *Nandina* and *Rosa* when sprinkler-irrigated daily (Miyamoto and White, 2002). Foliar damage of trees also appear at Cl concentrations as low as 200 mg/L^{-1} in sensitive species, such as Pecans, *Populus* and

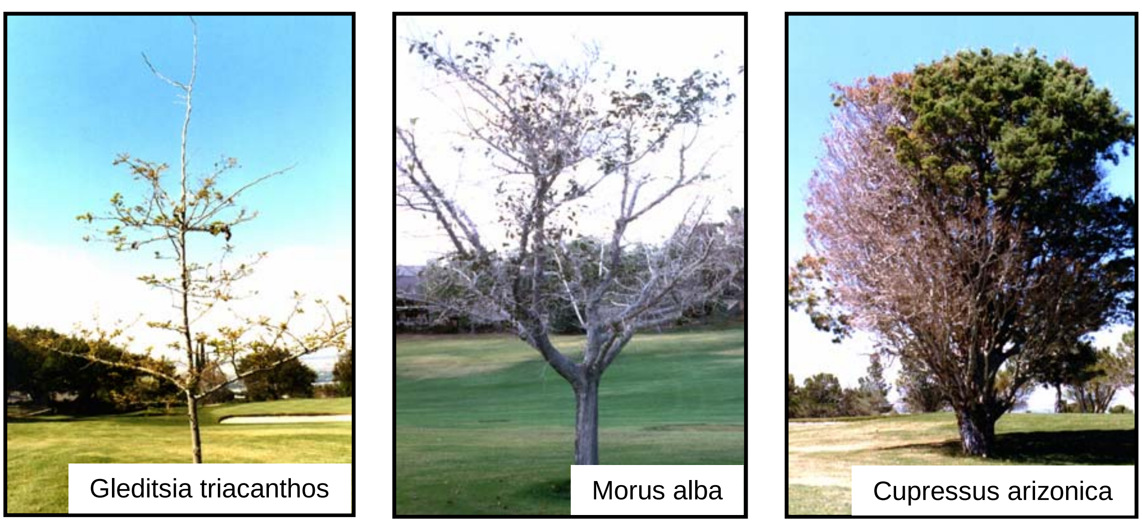

Fig. 1. Foilar damage in Honey Locust (Gleditsia triacanthos), Mulberry (Morus alba), and Arizona Cypress (Cupressus arizonica).

Plantanous species. The extent of leaf damage increases significantly when Cl concentrations increase from 150 to 200 mg/L^{-1}. Figure 1 shows three examples of foliar damage when the leaves are sprinkled daily with water containing 350 mg/L^{-1} of Na and 325 mg L^{-1} of Cl. The information on plant tolerance to saline water sprinkling is available in Miyamoto and White (2002), and Miyamoto et al. (2004b) for the species commonly used in the Southwest.

Leaf damage occurs as a result of salt adsorption from sprinkler-applied water. Therefore, one of the most effective methods of reducing this form of plant damage is to reduce direct sprinkling onto the leaves. In large trees, this can be accomplished by using low trajectory or under-canopy sprinklers (Ornelas and Miyamoto, 2003). This option, however, may not work in shrubs, low profile trees or small transplants. Changing sprinkler heads to non-sprinkling types may be necessary in such cases. Changing plant species is an alternative in some cases.

Plant Damage Caused by Soil Salinization: Plant roots have the ability to limit or to exclude uptake of salts better than plant leaves. This improves resistance to salt injury. However, the tolerance to salts is highly dependant of plant species, and is classified into five categories by the US Salinity Laboratory (Maas, 1990). There are sensitive (0 – 3 dS m^{-1}), moderately sensitive (3 – 6 dS m^{-1}), moderately tolerant (6 – 8 dS m^{-1}), tolerant (8 – 10 dS m^{-1}), and highly tolerant (>10 dS m^{-1}). The soil salinity shown in parenthesis is to be determined in the soil saturation extract (USSL, 1954). The parameters for expressing plant performance under salt stress have been a matter of conjecture. The Salinity Laboratory proposed to use the threshold soil salinity which causes a 50% growth reduction or foliar salt damage on at least 25% of the leaves. In the case of turf, we used a 25% reduction in growth, instead of the conventional 50% reduction, with an assumption that turf is used in high foot-traffic areas, such as sports field and public parks, where the rate of growth is important. Landscape plants considered sensitive or moderately sensitive are the ones which are likely to be affected by the use of water with elevated salinity, and the lists are available in Bernstein et al. (1972), Mass (1990), Harivandi, et al. (1992), and Miyamoto et al. (2004a) and (2004b). The threshold salt tolerance values serve as a target for soil salinity control. For example, soil salinity should be kept below 3 or 6 dS m^{-1} in the soil saturation extract if salt sensitive or moderately sensitive plants are to be maintained.

IMPACT ON SOIL AGGREGATE AND PERMEABILITY

When saline water is used for irrigation, it is imperative to maintain soil permeability for water infiltration and drainage. Soil aggregate breakdown and soil particle dispersion induced by high sodicity have been a concern. Soil pore plugging caused by gypsum precipitation is another when irrigation water is gypsic.

***Sodicity on Soil Aggregate and Permeability*:** Sodium ions are known to accentuate aggregate slaking and dispersion (e.g., Abu-Sharar, et. al., 1987; Frenkel, et. al., 1978), and are incorporated into water quality guidelines developed in California, where soils often consist of young structurally weak Entisols. The guidelines were then adopted by many other states, but with little or no attention to the difference in soil types or water quality.

Fig 2 shows examples of aggregate reduction in Harkey silty clay loam, a typical Entisol of the Rio Grande and the Pecos River Basins, and Hoban silty clay loam, a typical Aridisol of west Texas. Note that aggregate stability decreased with decreasing salinity and increasing the SAR of the suspension, and the aggregated fraction was higher in Hoban silty clay loam. Stability was measured with a pipette method after dry soil samples were soaked overnight. It also shows that clay particle dispersion (< 2 μm) did not occur unless salinity decreased to 5 mmol$_c$ L^{-1}. This observation is consistent with an earlier report by Shainberg et al. (1981), indicating that clay dispersion was observed when salinity was less than 1 dS m^{-1} (or 10 mmol$_c$ L^{-1}) in several Entisols found in California.

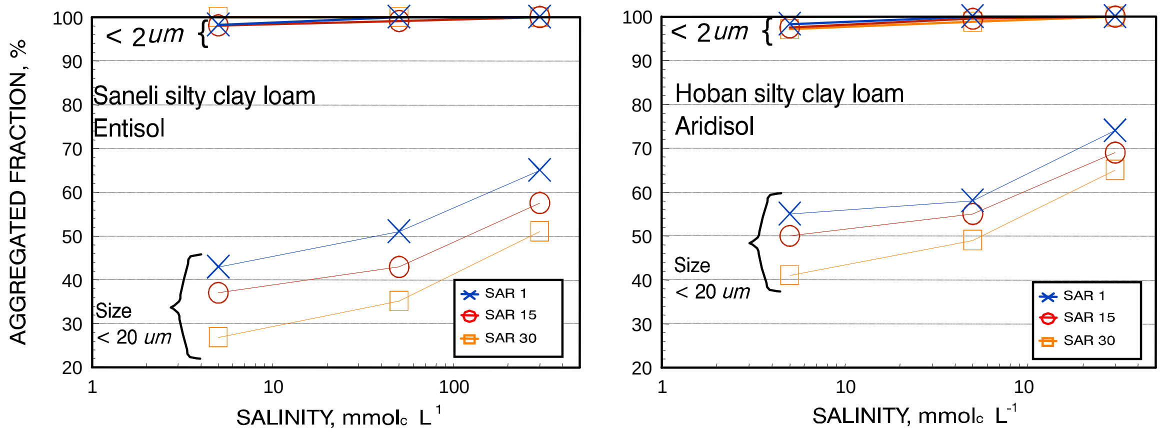

Fig. 2. Aggregated fractions of soil particles less than 2 and 20 *um* as affected by salinity and sodicity of suspension containing Saneli s.c. loam or Hoban s. c. loam.

The above observations indicate that clay particle dispersion is likely to occur when water of low salinity, such as rain water, is applied to the soil. Table 2 shows the concentration of suspended clay particles in drainage water when potted soils to a depth of 12 cm was leached with 3.4 cm of distilled water after having irrigated with the specified types of water for more than 10 times. The highest concentration of dispersed clay particles was observed in Harkey silt loam (Entisol) irrigated with the city water having low salinity (680 mg L^{-1}). Del Norte loam is shallow upland soil developed over a petro-calcic horizon, and Hueco sandy loam, another Aridisol rich in Al and Fe oxide, presented little dispersion. No suspended solid was detected in drainage water from any of the tested soils when irrigated with the specified water sources, including the $CaCl_2$ solution.

Table 2. Suspended solids and salinity of drainage water following distilled water applications of 3.4 cm on three soils irrigated with various types of water[1]-.

	Rio Grande		City Water		Recl. A		Recl. B		$CaCl_2$
Salinity (dS m^{-1})	0.8		0.8		1.4		2.2		2.2
Sodicity (SAR)	3.5		4.4		6.5		11.2		0
Irrig No.	16	27	16	27	16	27	16	27	16
Suspended Solids of Drainage Water (mg L^{-1})									
Harkey silt loam	20	0	180	100	100	50	70	10	0
Del Norte loam	20	20	100	10	20	30	30	40	0
Hueco sandy loam	0	10	10	10	5	0	5	0	0

[1]-The quantity of drainage averaged 1.5 cm per irrigation.

The effect of sodicity on water infiltration is most pronounced under saturated flow, and decreases under unsaturated flow (Russo and Bresler, 1977). During ponded leaching, soil sodicity as low as 10% (expressed as the exchangeable sodium percentage) can cause a severe reduction in water intake rate and rates of salt leaching (e.g. Miyamoto and Enriquez, 1990). This phenomenon is often associated with aggregate slaking which is maximum under a positive hydraulic pressure, and is minimal under the negative hydraulic pressure (Emerson, 1984).

During the initial phase of water infiltration, the negative hydraulic pressure prevails, except at or near the soil surface where slaking as well as dispersion takes place.

The prevailing irrigation scheduling over turfgrass ranges from 6 mm per day to 20 mm per every three days. Figure 3 shows the time duration required to infiltrate 1.7 cm of water when applied once or twice a week to the soils with no turf cover. Irrigation was initiated when the soil moisture storage had decreased by 50% of the holding capacity. The infiltration time was measured by applying the calibrated amount of water on the concaved soil surface. The difference in infiltration time among the water sources was relatively small, except when distilled water was applied during the 10^{th}, 16^{th} and 27^{th} irrigation (marked by an arrow). Note that reclaimed water with elevated salinity and sodicity (SAR of 11) provided faster infiltration than the city water with the low salinity and low sodicity (SAR of 4.4). This may indicate that water infiltration at the initial stage responds primarily to salinity, but not to the tested range of sodicity (< 12). These findings are consistent with the trends observed with aggregate stability (Fig. 2), and clay dispersion (Table 2).

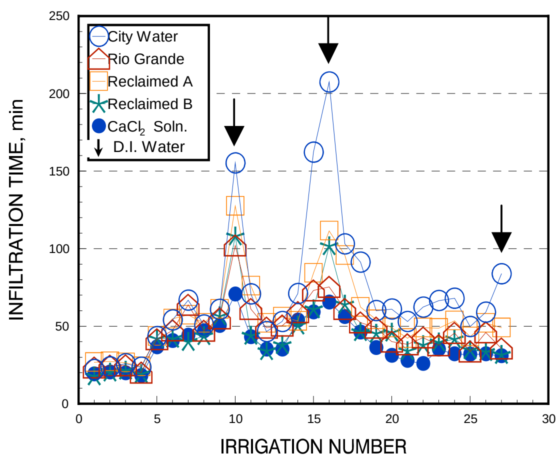

Fig. 3A. The time required for 1.7 cm of specified solutions to infiltrate into Harkey loam, entisol.

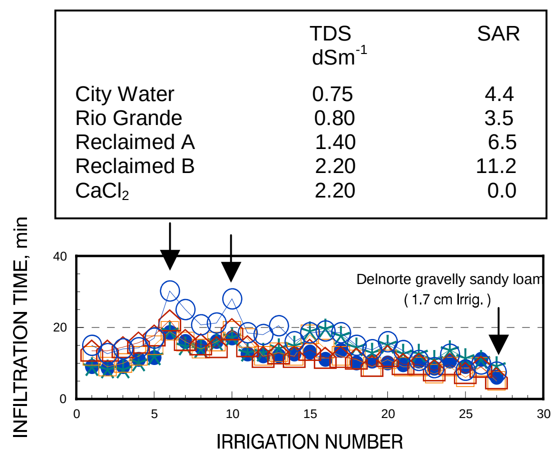

Fig. 3B. The time required for 1.7 cm of specified solutions to infiltrate into Del norte gravelly sandy loam, ardisol.

Gypsum Precipitation and Pore Plugging**:** It was noted earlier that water resources of the Southwest is often rich in Ca and SO_4 (Table 1). The quantity of Ca which may precipitate as $CaCO_3$ is usually less than 1 ton/ha/year, and can be reduced by the action of roots which releases CO_2 (Robbins, 1986). In gypsic water, however, the quantity of salts which precipitate as gypsum can be as large as 24 tons/ha/year for an assumed irrigation of 1.5 m per year at the leaching fraction of 1/3. At a bulk density of 2.3 kg/L, the gypsum solid volume can be as large as 10 m^3/ha. Fig. 4 shows an example of gypsum precipitation on a putting green and in soil profile.

It is difficult at present to estimate the impact of gypsum precipitation on soil permeability. An indication from a laboratory soil column study is that the saturated hydraulic conductivity of sandy loam can be reduced by half when 10% of the pore space is filled with powdery gypsum (Keren et al., 1980). Another uncertainty is the depth of gypsum precipitation. If it forms on the surface, 10 m^3 of gypsum can cover 1 ha of the ground surface at a thickness of 1 mm in solid fraction or 2 mm as a powdery substance. Surface precipitation of gypsum usually takes place in low spots where runoff accumulates and evaporates (Fig. 4). When gypsum precipitates to a soil layer thickness of 10 cm, 10 m^3 of gypsum per ha may occupy 5% of the pore space when applied to 1 ha. Some of the golf courses irrigated with gypsic water are reporting "soggy" turf conditions, an indication of reduced drainage.

Fig. 4. Gypsum precipitation on the putting green and in the soil irrigated with gypsic water.

APPRAISING SOIL SALINIZATION POTENTIAL

Given the water with known salinity, the most frequently asked question is if the water can be used for irrigation without causing soil salinization or plant damage. One of the most widely used equations to address this question is the steady–state salt balance

$$EC_w D_w = EC_d D_d \qquad (1)$$

where EC_w and EC_d are the salinity of irrigation and drainage water, D_w and D_d are the depth of irrigation and drainage, respectively.

Another widely used equation assumes that salinity of the root zone can be expressed by the means of EC_w and EC_d (e.g. Rhodes, 1974).

$$EC_e = \left(\frac{FM}{SWC}\right)\left(\frac{nEC_w + EC_d}{1+n}\right) \qquad (2)$$

where EC_e is the salinity of the soil saturation extract, FM is the field capacity or field moisture, SWC is the saturation water content, and n is a matching factor to estimate the mean soil salinity from EC_w and EC_d. If salinity of the root zone is equal to the mean of EC_w and EC_d, n is unity. In most well-drained sandy soils, n can be taken as 2 (Rhoades, 1974).

Three different methods are currently available for estimating ECe, all stem from Eqs. (1) and (2), and are introduced below.

***Soil Salinity from Estimated Leaching Fraction*:** Rewriting Eq. (1)

$$D_d / D_w = (D_w - ET) / D_w = EC_w / EC_d = LF \qquad (3)$$

where ET is the evapotranspiration, and LF is the leaching fraction. Eq. (3) provides the estimate of EC_d needed to compute EC_e. Inserting Eq. (3) into Eq. (2),

$$EC_e = \left(\frac{FM}{SWC}\right)\left(\frac{n + D_w / (CD_w - ET)}{1 + n}\right) EC_w \tag{4}$$

The ratio of FM/SWC is relatively independent of soils, and ranges from 0.40 to 0.50. The values for n range from 1 to 2. When LF is 0.1, or D_w/(DW-ET) is 10, EC_e would be 1.6 to 2.0 times EC_w, at an assumed n of 2. For n = 1 (applies to clayey soil), EC_e would be 2.2 to 2.75 times EC_w. When LF is ¼, EC_e is approximately equal to EC_w at n = 2. In any case, EC_e would increase in proportion to EC_w as long as LF is fixed in given soil.

The actual soil salinity observed at golf courses and regional parks, however, did not conform to the linear relationship between EC_e and EC_w (Fig. 5). These turf areas have been irrigated using an automated sprinkler control equipped with a weater–based ET feedback system. Yet, only three golf courses fell on or near the line of $EC_e = EC_w$. In all other cases, soil salinity had no relationship with EC_w. Since the quantity of water appears to be about the same (because it is weather–based), poor permeability of the soils, instead of shortage of irrigation, may be impairing salt leaching.

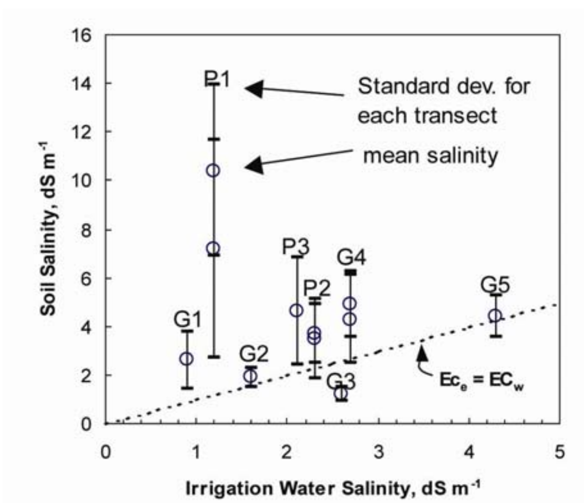

Fig. 5. Mean soil salinity and the standard deviation as related to salinity of irrigation water at eight sites.

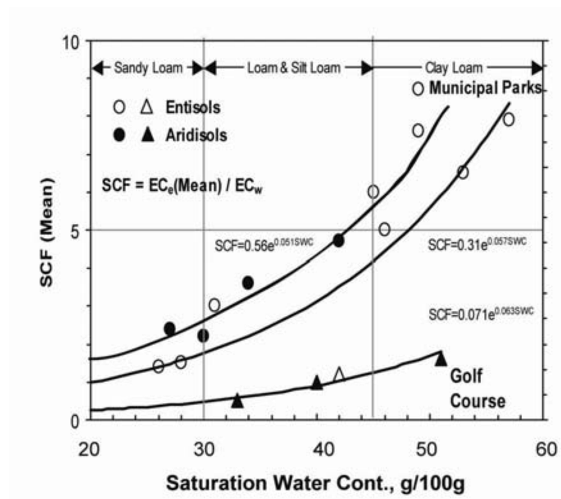

Fig. 6. The salt concentration factor (SCF) as related to the saturation water content or soil textural classes.

Soil Salinity Projection from Soil Properties: Several methods are available for estimating soil salinity levels using EC_w and soil properties. A simple empirical method developed by Miyamoto and Chacon (2006) uses the salt concentration factor (SCF) defined as

$$SCF = EC_e / EC_w = aExp[bSWC] \tag{5}$$

where SWC is the saturation water content, a measure of soil textural classes, and a and b are empirical coefficients. The application of Eq. (5) to golf course and municipal parks in west Texas are shown in Fig. 6. Each data point represents means of soil salinity determined to the full length of fairways at sampling intervals of 7.5 to 9 m along a transect.

Eq. (5) is related to Eq. (4) at low SWC (or sandy soils). The SCF of golf course at SWC of 35 and 45 ml/100 g, are, for example, 0.64 and 1.2, respectively. The mean value of 0.92 coincides approximately with the $EC_e = EC_w$ shown in Fig. 5. The figure also shows that the SCF increases exponentially with increasing SWC into clay loam category. The SCF is considerably higher at municipal parks where the soil is subject to severe compaction. The traditional equation, Eq. (4) can not account for these elevated levels of soil salinity even when irrigation scheduling is similar. This is because ET, in reality, is not fixed, but can increase considerably in soils with poor water infiltration or drainage. By the same token, Eq. (5) is empirical, thus calibration would be required for different project areas. Equation (5) can not be used for assessing soil salinization potential in Aridisols containing a petrocalcic horizon which limits water infiltration and/or drainage. The method appropriate for Aridisols with a calcic horizon is yet to be developed.

According to Fig. 6, the projected soil salinity should not overly exceed EC_w in golf courses established on sandy soils and irrigated with the leaching fraction of no less than ¼. Salinity of most reclaimed municipal effluent rarely exceeds 2.5 dS m^{-1} (Table 1). The projected soil salinity would be 1.6 to 3.0 dS m^{-1} in well-drained sandy soils. This means that even salt sensitive plants (< 3 dS m^{-1}) can be grown. However, a safety margin should be provided since soil salinity is spatially variable with the coefficient of variability averaging around 30% (Miyamoto et al., 2005). This means that the actual salinity in a significant portion of the sampled area would have soil salinity ranging from 2 to 4 dS m^{-1}, instead of 1.6 to 3.0 dS m^{-1}. The use of salt sensitive plants should be avoided for this reason. At the same time, there is no need to bring in highly salt tolerant plants for irrigation with reclaimed municipal effluent. In fact, aggressive salt tolerant plants usually show excessive growth, thus resulting in higher landscape maintenance costs, especially when reclaimed water with elevated nitrogen levels is used.

Soil Salinity Projection from Soil Test: Soil samples should be tested for salinity and the saturation water content, for example, by a method shown in Rhoades and Miyamoto (1990). The results can be used to calibrate Eq. (5) or to compute the leaching fraction by rewriting Eq. (4)

$$LF = \left[(EC_e / EC_w)(SWC / FM)(1 + n) - n \right]^{-1} \qquad (6)$$

Once LF is estimated by Eq. (6), it can be substituted to $(D_w - ET)/D_w$ of Eq. (4), and EC_e can be estimated for the projected salinity of irrigation water. If existing irrigation scheduling is to be maintained, the soil salinity can be projected simply by multiplying the EC_w ratio to the existing EC_e.

Care should be taken when the projection is made by assuming greater leaching by increasing irrigation. When the soil consists of clay or containing a calcic horizon, increasing irrigation does not necessarily increase LF, but can increase ET, as the applied water stays near the soil surface.

***Soil Salinity Projection for Landscaped Areas*:** Soil salinity prediction mentioned above applies to simple turf areas or flat golf course fairways. In complex upscale landscapes, all types of plants co-exist, and irrigation systems are set based primarily on their water requirements. When landscape plants with vastly different salt tolerance are planted side by side under a set of irrigation rotation unit, differential growth appears, especially when irrigated with reclaimed municipal effluent rich in nitrogen and other nutrient elements. Typically, aggressive salt tolerant plants show excessive growth, and growth of sensitive species curtails. This evolutionary process usually becomes apparent in a season or two, unless irrigation systems and/or management are modified. Soil salinization potential should be assessed on the basis of individual irrigation block and/or landscape zone.

ALTERING SOIL SALINIZATION POTENTIAL

Increasing irrigation depths can lower soil salinization potential when the soil is well-drained and sandy. Additional water control valves are also needed when diverse plant species with vastly different salt tolerance are planted on one irrigation rotation block. When the subsoil permeability is limited, increasing irrigation can increase salt problems. It will require measures to increase soil permeability. When soils are compacted, but sandy, conventional aerifying equipment can improve soil permeability, thus salt leaching. This type of equipment, however, can not improve subsoil permeability. Heavy duty subsoilers and vigorous soil preparation are needed to improve permeability of clayey soils or of a calcic horizon. Unfortunately, these measures are beyond the capability of ordinary landscape maintenance units. The actual control of soil salinity depends on landscape management capability, but not the equations shown for appraisal.

ACKNOWLEDGEMENT

This material is based on work supported in part by the Cooperative State Research, Education and Extension Service, USDA under Agreement No. 4280001, El Paso Water Utilities, and the Bureau of Reclamation.

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