Effect of Salinity Level & Irrigation Type on the Establishment Rate & Winter Survival of Turfgrasses

Casey Johnson and Bernd Leinauer

Problem

Despite the economic importance and continued public demand for turf areas, the current potable water shortages in the Southwest clearly set limits on expectations and water consumption available for landscape irrigation. To reduce the amount of potable water used in landscape irrigation as part of a water conservation plan, effluent water or low quality groundwater that does not meet standards for human consumption could be used. An estimated 75% of the groundwater in New Mexico is saline or brackish and considered unusable for human consumption.

Study

A long-term study is underway at New Mexico State University's golf course to investigate the establishment, sustainability, and quality of cool and warm season grasses in the desert southwest when irrigated with saline water. Given the delayed development and growth of turfgrasses when irrigated with saline water, the study was designed to determine if the growing season in the arid southwest (plant hardiness zone 8) is long enough for turfgrasses irrigated with saline water to establish, survive winter, and maintain acceptable quality. In addition, the effect of saline water in combination with different irrigation types (sprinkler irrigation and subsurface drip irrigation) on establishment and quality of warm and cool season grasses will be assessed. To our knowledge, there are no published studies that have investigated the effect of water quality and irrigation type on plant stand establishment, plant stand quality, irrigation uniformity, and soil chemical properties of turf root zones. The combination of 1) the use of turfgrasses that are adapted to the climatic and soil conditions in the desert southwest, 2) the use of high saline water for irrigation, and 3) irrigation through microsystems, could reduce use of potable water for turf irrigation while not affecting turf performance.

The objectives of this study are to determine if 1) non-potable, saline ground water can be used for warm and cool season turfgrass establishment in the desert southwest [USDA climate zone 8a], 2) if adequate turf quality can be achieved by using subsurface irrigation, 3) salinity effects on winter survival, 4) long-term effects of salinity and irrigation type on turf quality, 5) measure the long-term and yearly cyclical effects of soil salinity at various depths when using multiple irrigation water salinity levels in combination with irrigation systems, and 6) study ionic changes below the rootzone to predict contamination of shallow groundwater.

Material and Methods

Experimental plots are located at New Mexico State University Golf Course in Las Cruces, NM. The area was seeded on a sandy loam soil with the cool-season grasses on January 20, 2004 while warm season grasses were seeded on April 14, 2004. Cool season grasses included hybrid Texas bluegrass [*Poa arachnifera* x *pratensis*] cultivars 'Thermal Blue' and 'SRX2TK95', tall fescue [*Festuca arundinacea*] cultivars 'Southeast' and 'Tar Heel II', perennial ryegrass [*Lolium perenne*] cultivars 'Brightstar SLT' and 'Catalina', alkaligrass [*Puccinellia distans*] cultivars 'Salty' and 'Fults', and fine fescue [*Festuca rubra*] cultivar 'Dawson'. The warm-season grasses included bermudagrass [*Cynodon dactylon*] cvs. 'Numex Sahara', 'Princess', 'Riviera', and 'Transcontinental', zoysiagrass [*Zoysia japonica*] cvs. 'De Anza' and 'Companion', buffalograss [*Buchloe dactyloides*] cvs. 'SWI2000' and 'UC Verde', saltgrass [*Distichlis spicata*] cvs. 'A138' and 'DT16', and seashore paspalum [*Paspalum vaginatum*] cvs. 'Seaspray' and 'Seadwarf'. Individual plots measured 2 m x 2 m. Cool season plots were mowed at 7.5 cm and warm season at 5 cm.

The establishment study consisted of three treatment factors: grasses (2 levels), irrigation water salinity (3 levels) and irrigation delivery systems (2 levels). The irrigation water salinity treatment levels consisted of potable water, high saline water, and a 50/50 blended mix. The EC of the potable water treatment was 0.6-1.2 dS/m, high saline (geothermal) 3.1-5.0 dS/m, and the 50/50 blended mix ranged from 2.0-3.0 dS/m. The irrigation delivery systems consisted of sprinkler irrigation (walla walla mp rotators) and subsurface drip (precision porous pipe). Sprinklers (operating at 200 KPa) were streaming rotators with large droplet size, reducing the amount of water lost to evaporation. The subsurface drip system (operating at 200 KPa) consisted of a porous emitterless pipe to deliver water. The research area (36 m x 70 m) was designed as a complete randomized split-plot design. Each main plot consisted of one irrigation type (sprinkler or subsurface drip) and one of the three water salinity levels. Each of the six main plots measured 17 m by 7 m. Warm and cool season turfgrasses (split-plot factor) were grouped separately so that the two groups could be administered with different water regimes. All treatment factors were replicated three times.

Data Collection:

To quantify establishment rate of individual turfgrass plots, two digital images of 2 m x 2 m subplots were collected biweekly from each plot after seedlings became visible. Pictures were taken using a digital camera attached to a frame that insured the same plot location each time pictures were taken.

The process used to determine the percent green cover of a digital image included: (i) acquiring an image with digital photography, (ii) creating a standard value to define green, and (iii) analyzing each picture with a digital image analysis program (Sigmascan) to count the number of green pixels in each digital image. All digital images in this study were taken with a Sony 4.0 megapixel cybershot. Images were collected in JPEG format, with an image size 640 x 480. Combining the two images per plot taken biweekly produced a total of 1280 x 960 pixels. A rigid PVC stand was constructed to maintain the same 1m height, making it possible to record images from the exact same location every two weeks and track progression of establishment for exactly the same location.

The average percent green cover was calculated using SigmaScan Pro version 5.0 software. The entire image was analyzed with each pixel individually selected to determine if its color fit into the defined green range. There were two sections of the spectrum defined as green with color threshold values of (i) hue 30-50, saturation 10-40 and (ii) hue 50-140, saturation 10-100. Through visual examination, it was determined that these two sections of the hue/saturation/brightness chart contained all of the possible ranges of green contained across the 21 cultivars of turfgrass included in the study. The hue/saturation/brightness numbers were kept consistent, because of the regular sunshine and limited cloud cover in Las Cruces, NM.

Maintenance:

Fertilization: A total of 40.6 g/m^2-N, 24.4 g/m^2-P_2O_5, and 28.3 g/m^2-K_2O were applied during establishment.
Irrigation: Sprinkler and subsurface drip irrigation systems were run multiple times daily to maintain adequate soil moisture
Mowing: Twice a week at 6.5 cm as grasses began establishing.

Results and Discussion

Water Quality:

High saline water significantly delayed and reduced establishment rate when compared to potable and 50/50 water for most species. Of the cool season grasses, alkaligrass cv. 'Salty' established best for all 3 water qualities. Within the warm season grasses, seashore paspalum cvs. 'Seadwarf' and 'Seaspray' performed the best followed by the bermudagrasses. Grasses performed equally well at all water qualities. Salinity did not harm the tested saltgrasses, however both cultivars 'A138' and 'DT16' were slow to establish.

Irrigation type:

Irrigation type (sprinkler vs. subsurface drip) did not affect ground cover of cool season grasses when matching any of the 3 water qualities or warm season grasses irrigated with saline water when averaged over the entire establishment period. If coverage data is averaged over the entire establishment period, warm season sprinkler irrigated grasses established faster when irrigated with potable and 50/50 water compared to subsurface drip irrigated warm season grasses of matching water quality. 150 days after seeding, ground cover of cool season turfgrasses drip irrigated with 50/50 and high saline water was significant compared to cool season turfgrasses sprinkler irrigated with the matching water qualities. Coverage after 150 days of establishment was also significantly lower for warm season grasses drip irrigated with potable and 50/50 water compared to sprinkler irrigated grasses (Figs. 1 and 2).

Figure 1: Establishment of cool season grasses with two irrigation types (sprinkler and subsurface) and three salinity levels (saline, potable and 50/50 mix). Data pooled over 9 cool season turfgrasses.

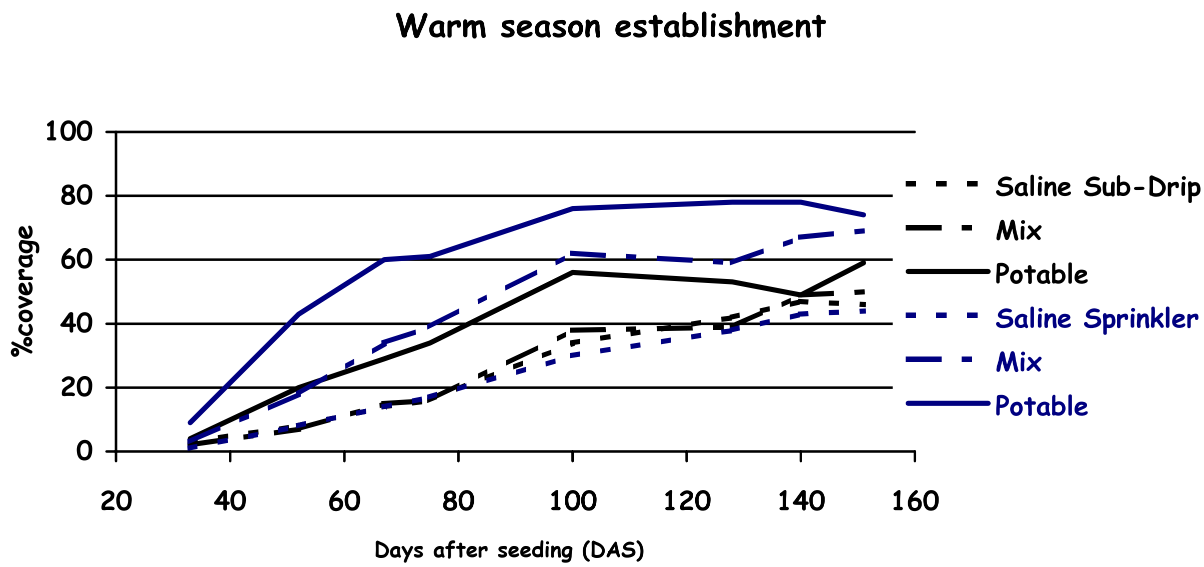
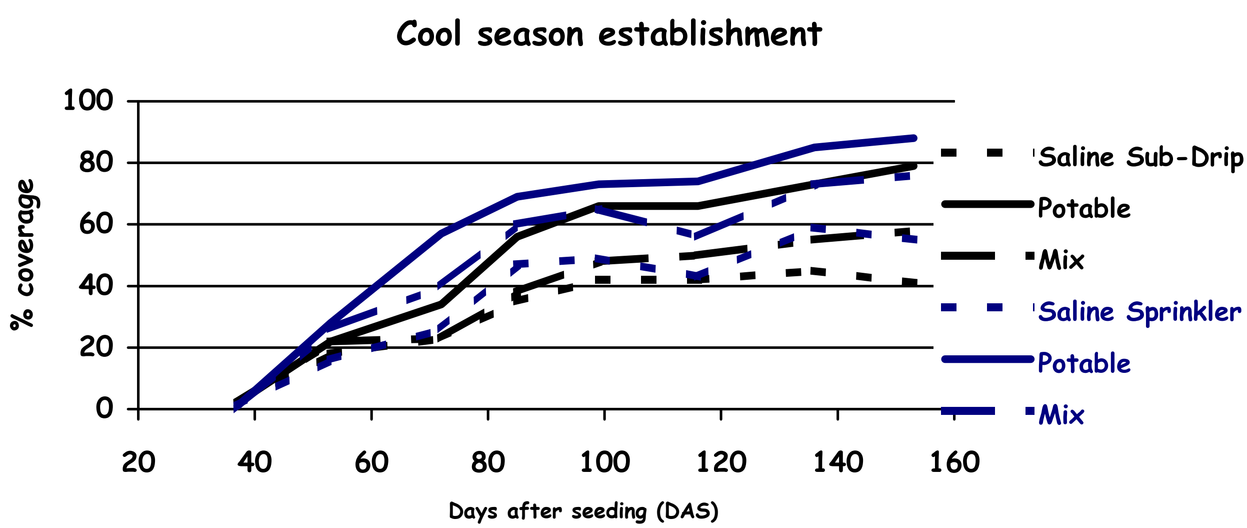


Figure 2: Establishment of warm season grasses with two irrigation types (sprinkler and subsurface) and three salinity levels (saline, potable, and 50/50 mix). Data pooled over 12 warm season turfgrasses.



Turfgrasses:

Table 1 lists percent ground cover of cool and warm season grasses after 150 days of establishment when irrigated with saline ground water. Both cultivars of Seashore paspalum (Seadwarf and Seaspray) and Alkaligrass cv. Salty had significantly greater ground cover 150 days after seeding compared to the other tested grasses. Both hybrid Texas bluegrasses had poorest coverage of all grasses 150 days after seeding under saline irrigation.

Table 1: Percent ground cover 150 days after seeding for cool and warm season grasses under drip and sprinkler irrigation with saline water. (Numbers followed by the same letter are not significantly different ($p < 0.05$) based on Fisher's protected LSD)

Cool Season Grasses	Irrigation Type		Warm Season Grasses	Irrigation Type	
	Drip	Sprinkler		Drip	Sprinkler
Salty	78a	88a	Seadwarf	75abc	74abcd
Southeast	72ab	43b	Seaspray	85a	81ab
Tar Heel II	50b	72ab	A138	62abcde	35fghi
Brightstar SLT	56ab	68a	DT16	70abcde	33fghi
Catalina	49bc	62b	Princess	60bcde	32fghi
Dawson	34cd	70ab	Riviera	50defg	79ab
Thermal blue	19d	54bc	Sahara	54cdef	76abc
SRX2TK95	15d	34cd	Transcontinental	50defg	55cdef
			Companion	8jk	6jk
			SWI 2000	1k	6jk
			UC Verde	12ijk	2jk

Conclusions

- No significant difference in establishment rate between irrigation systems (subsurface drip vs. sprinkler) when using the same level of water quality for cool season grasses over the entire establishment period.
- Warm season grasses established faster with sprinkler irrigation than subsurface drip when using the same water quality averaged over the entire period of the establishment study. Differences between cool and warm season establishment rates when using different water delivery systems may be due to different seeding times.
- Salinity greatly reduces the establishment rate for cool and warm season grasses.
- Salt tolerant turfgrasses such as Alkaligrass, Seashore paspalum, Bermudagrass, and Saltgrass can be successfully established with high saline groundwater.
- Subsurface drip irrigation in combination with high saline ground water appears to improve establishment only for the warm season grasses.
- Differences in salinity tolerance can be greater between cultivars within a single species than previously reported species differences. More work must be done to identify salt tolerant cultivars.

- Sprinkler systems and potable water may be the easiest way to grow turf now, but alternative combinations of water quality, irrigation methods, and species/cultivar selection are becoming increasingly important!