Innovations in Subsurface Turf Irrigation

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Water is the biggest concern in turf management not only in the Southwest, but also in many parts of the world. Quantity and quality can rarely be maximized for optimum growth and maintenance.
How Bad Is The Drought
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Areas throughout the country are experiencing drought conditions. The situation is particularly disturbing to residents east of the Mississippi, where drought is generally not considered a threat. Some state and local...
Problem

1. Availability
2. Quality
3. Distribution
Approximately 50% of domestic water use during the summer in the Southwest is used for landscape irrigation (Kjelgreen et al., 2000)

Strategies to reduce (irrigation) water use for turf
STRATEGIES TO REDUCE (POTABLE) WATER CONSUMPTION ON TURF

1. Use of adapted low-water use (turf)grass species
2. Irrigation with non-potable water
3. Increase irrigation efficiency
Annual precipitation
New Mexico

USDA Plant Hardiness
Zone Map for New Mexico
New (alternative) turfgrasses

Poa compressa  
Koeleria macrantha  
Festuca longifolia  
(Festuca ovina duriuscula)  
Poa arachnifera x Poa pratensis  
Deschampsia cespitosa  
Puccinella distans  
Cynodon dactylon  
Zoysia japonica  
Paspalum vaginatum  
Distichlis spicata  
Buffalo dactyloloides  
Bouteloua gracilis
Irrigation with non-potable water
STRATEGIES TO REDUCE (POTABLE) WATER CONSUMPTION ON TURF

3. Increase irrigation efficiency
   1. Scheduling, maintenance and troubleshooting
   2. Irrigation based on plant and/or soil water status

3. Improve Water Distribution
   1. External (Irrigation)
   2. Internal (Root zone, Drainage, Amendment, Irrigation, Construction)
Sprinkler Problems
Microirrigation

Above ground
- Drip irrigation (Trickle irrigation)

Below ground
- Drip Irrigation
- Subirrigation

(ASAE Standards, 1996)
Microirrigation

Drip Irrigation
- Line source
  (Precision porous pipe)
- Point source
  (Netafim, Toro)

Subirrigation
- Cellsystem
- ECS
- Pat System, Purr-Wick System
SUBIRRIGATION (SBI)

- Line source system
- Irrigate and drain through one pipe system
- Subgrade sealed by plastic barrier (optional) - “bath tub” analogy
- Sand or sandy root zone mix
- 30 - 40 cm (12” - 16”) deep
- PAT-System, Cellsystem, ECS
Cellsystem
Cellsystem

- Prater Stadium, Vienna
- San Siro Stadium, Milan
- 3 stadiums in Saudi Arabia
- Golf courses and 20+ stadiums in Germany, Austria, Switzerland
Pat-System

✓ Pro Player Stadium, Miami
✓ Turner Field, Atlanta
✓ Dodger Stadium, Los Angeles
✓ University of Texas, Austin
✓ Ohio State Buckeyes
Evaporative Control System
Evaporative Control System
Evaporative Control System

ECS UNDERGROUND IRRIGATION AND DRAINAGE SYSTEM

Patent No. 5,921,711

TRANSPARATION ZONE

GRASS SEED OR SAND BASED SOD

Optional Top Soil

0" - 2"

CAPILLARY ZONE

10" - 12"

Saturated Zone 3"

Bi-directional Water Movement from and into chamber

Root Zone

Transfer Pipe

Open Bottom

TRENCH WIDTH
18" Min. - 10' Max.

Optional Bottom Liner or Tray

WASHED SAND

Medium Sand

11" - 17"

13" - 19" Overall Depth

# 10 Chips

Turf Construction
Structural cross section Details
Evaporative Control System
Evaporative Control System
Microirrigation

Drip Irrigation
- Line source (Precision porous pipe)
- Point source (Netafim, Toro)

Subirrigation
- Cellsystem
- ECS
- Pat System, Purr-Wick System
DRIP IRRIGATION (SDI)

Point source systems:
- Toro (DL 2000)
- Netafim (Techline, Landline)
- Eurodrip

✓ Line source systems:
- Leaky Pipe
- Porous Pipe
SUBSURFACE DRIP IRRIGATION (SDI)

Emitter spacing - depth
✓ Soil type
✓ Grass type (rooting depth)
✓ Water pressure
✓ Elevation changes
fits all shapes
Park Area
Fresno State
Golf courses
Athletic Fields
System Design

Information

1. Water quality
2. Pressure
   - preferably between 15 and 30 psi
3. Flow rate
   - important to determine maximum lateral length of drip lines
System Design

Calculation of maximum lateral length:
✓ Supply flow rate $S_f$: 20 gpm
✓ Emitter flow rate $E_f$: 0.5 gph
✓ Emitter spacing $E_s$: 12"

$$M_{LL} = \frac{S_f \text{ (gph)}}{E_f \text{ (gph)}} \cdot E_s \text{ (ft)} = \frac{20 \cdot 60 \text{ gph}}{0.5 \text{ gph}} \cdot 1 \text{ ft} = 2400 \text{ ft}$$
DRIP IRRIGATION (SDI)
DRIP IRRIGATION (SDI)

Technical Details

Flush Valve and Air Release Valve
Installation
Installation
Installation
Irrigation Water Use

- Irrigated Area: 60’ x 40’ = 2400 ft²
- 1 ft spacing: 2400 emitters
  - 18” spacing: 1800 emitters
  - 24” spacing: 1200 emitters
- Emitter delivery rate: 0.5 gph
- System delivery rate: 2400 x 0.5 gph = 1200 gallons/hour
Irrigation Water Use

✓ Delivery rate: 1200 gph
✓ Irrigated Area: 60’ \times 40’ = 2400 \text{ ft}^2
✓ 1” = 1520 gallons
  1 \text{ acre inch} = 27154 \text{ gallons}
  27154 \times 0.056 = 1520
✓ System run time to apply 1” of water:
  1520/1200 = 1.27 \text{ hours}
  1 \text{ hour 20 minutes}
Does sub-irrigation make a difference?

1. Turf quality
2. Irrigation water use
Does Sub-Irrigation make a Quality Difference?

Sprinkler, maintained by Association

Two year old KB turf

ECS

Sprinkler, maintained by meticulous homeowner

Sprinkler, (same as upper left)
WATER SAVINGS AFTER TWO SEASONS

1468 sq. ft.
ECS area
94,700 Gallons

1495 sq. ft.
Sprinkler area
234,680 Gallons

105”

254”
Water consumption on differently irrigated greens
2003 Irrigation Water Use

May 16 - September 14:
ECS       7.52 mm day\(^{-1}\) (0.3”)    61%
Drip      15.22 mm day\(^{-1}\) (0.6”)    123%
Sprinkler 12.32 mm day\(^{-1}\) (0.5”)    100%
Average daily irrigation June - August

- Sprinkler: 48% increase in 2005
- Sub: 68% increase in 2005
- Drip: 72% increase in 2005
- Drip: 106% increase in 2005
Subsurface or Sprinkler?
Water Quality (Salinity)

✔ Geothermal / saline
  - EC = 3.1-5.0 dS/m
  - SAR = 10.5
  - Total Dissolved Solids = 2050-3220

✔ Potable
  - EC = 0.6-1.2
  - SAR = 1.61
  - Total Dissolved Solids = 413-750
Establishment warm season grasses

Drip saline
Drip potable
Sprinkler saline
Sprinkler potable

Days after seeding (DAS)
% cover

20 40 60 80 100 120 140
Establishment cool season grasses

- Drip saline
- Drip potable
- Sprinkler saline
- Sprinkler potable

% cover vs. Days after seeding (DAS)
Establishment with saline water 150 DAS

- Princess Bermudagrass
- Seaspray Seashore
- SWI 2000 Buffalograss
Salinity Effects on Root Zone
Effect of Irr. System on SAR

Water/Depth

geo 4 geo 8 geo 24 mix 4 mix 8 mix 24 pot 4 pot 8 pot 24

SAR

Drip Spr
Summary

+ SI turf is more drought resistant than sprinkler irrigated turf, it uses water more efficiently, thereby needing less water
+ SI turf shows higher quality
+ SI can lead to (significant) water savings
Summary

+ If SI is economically feasible depends entirely on the amount of water used and on the price of the water.
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Questions?
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