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# SALINITY MANAGEMENT WITH SUBSURFACE DRIP IRRIGATION

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## Abstract

An experiment with a Subsurface Drip Irrigation system was planned on a Texas farm with salty water to develop design and management recommendations for SDI systems. The objectives of this study were: 1) Compare 8 and 12 in depth, and 40 and 80 in drip spacings when water is salty. 2) Determine if pre-season irrigation can be used to control the soil salinity level on the soil profile when deficit irrigation is practiced on SDI systems. The experiment consisted of a complete randomized experiment with 8 treatments and four replications, with a total of 32 plots. The Duncan test showed some differences between the 40 and 80 in drip spacing. The cotton lint yields, water use efficiency and total gross return were higher for the 40 in drip spacing treatment than the 80 in. The 12 in drip depth also resulted in sligthly higher cotton lint yields and total gross return, than the 8 in. One of the reasons could be since the full requirments of the plant were not met, and the shallower irrigation depth (8 in) produced higher soil evaporation. A similar trend was observed with lower pre-season irrigation depths. One reason it could be that the higher pre-season irrigation depths produced more evaporation.

## Introduction

Water is the main limited resource for the Texas Cotton production. Water aquifers are being exhausted in many areas of the West. Farmers have adapted new agronomic practices such as ultra-narrow, and high frequency to be more efficient and to practice deficit irrigation to remain profitable. One problem is that water has medium to high salt concentrations. Some areas have created salinity problems when deficit irrigation has been practiced. This study is intended to generate recommendations on how to design the system and how to manage water salinity by practicing deficit irrigation with Subsurface Drip Irrigation methods. The problem in arid and semi-arid areas with subsurface drip systems is that some salinity may occur above the tubing since there is no leaching, and leaching only will occur as the result of rain. The accumulation of salts can be a bigger problem during germination. Higher salinity can be found in the top 2 to 3 inches, and it may be influenced by the depth and spacing of the tape, and pre-seasonal irrigation. When irrigation is practiced under water limiting conditions salts will start to build up in the soil. Leaching the salts out of the root zone is the only way to control salinity. Salinity can produce reduction on cotton lint yield, and reduce the profitability of the system. Salty water exist in several regions and the degree of salinization also varies, for example the some wells in the Saint Lawrence area where the experiment was established has an Electrical Conductivity of 4500-5800 micromhos/cm (3200 to 4200 ppm) and a Sodium Adsorption ration of 6.3 to 7. In Coyonosa, Texas the water has an Electrical Conductivity of 3810 micromhos/cm (3250 ppm) and a Sodium Adsorption Ratio of 4. The water in the Pecos Research Station has an Electrical Conductivity of 2680 to 3230 micromhos/cm (approximately 3000 ppm), but a Sodium Adsorption Ration of 8 to 12. Similar salty conditions can be found in some other areas of the TransPecos area, El Paso, and Lubbock, TX. The quality of water, increasing costs and small well capacities, have pushed many farmers to use SDI systems and to apply pre-watering and refill the soil profile before planting. If they do this, it may be easier to leach the salts before planting by applying an extra irrigation, and practice deficit irrigation during the season. In fact many farmers end the growing period with nearly dry soil profiles. With proper placement, drip irrigation may very effective at flushing salts out of the root zone. (Tanji et al., 1996). The objectives of this study were: 1) Compare 8 and 12 in depth, and 40 and 80 in drip spacings when water is salty. 2) Determine if pre-season irrigation can be used to control the soil salinity level on the soil profile when deficit irrigation is practiced on SDI systems.

## Material and methods

A research plot irrigated with a SDI system was installed in Saint Lawrence on a farm where they have salty water to answer these questions and to develop design and management recommendations for SDI systems. The experiment consisted of a complete randomized experiment with 8 treatments and four replications, with a total of 32 plots. Each plot consisted of 4 cotton rows, 950 ft long. The total irrigated area was 9.2 acres. Each treatment represented and area of 1.23 acres. The cotton rows were spaced every 40 in. The treatments were: 1) Every 40 inches drip spacing - 8 in drip depth - 60% pre-irrigation; 2) Every 40 inches drip spacing - 8 in drip depth - 110% pre-irrigation, 3) every 40 inches drip spacing - 12 in drip depth - 60% pre-irrigation, 4) every 40 inches drip spacing - 12 in drip depth - 110% pre-irrigation, 5) every 80 inches drip spacing - 8 in drip depth - 60% pre-irrigation, 6) Every 80 inches drip spacing - 8 in drip depth - 110% pre-irrigation,

7) Every 80 inches drip spacing - 12 in drip depth - 60% pre-irrigation, and 8) Every 80 inches drip spacing - 12 in drip depth - 60% pre-irrigation. The cotton variety Stoneville 1892 was planted on May 14th with a plant density of 54,000 plants per acre. A subsurface drip irrigation system was installad in Glasscock County. The drip system had emitters installed every 24 in and each emitter had a discharge of 0.24 GPH. The system could apply an irrigation depth of 0.06 inches per hour. Nitrogen fertilizer (N32) was applied in two applications: 44 lbs/ac were applied on June 25$^{th}$, and 48 lbs/ac on July 17$^{th}$. The soil was a clay loam soil with good drainage (29% sand, 42% silt, and 29% clay). The data was analyzed with a general linear model (GLM) with mean separation by both Duncan's multiple range test and least square difference (SAS Institute, 1991).

## Results and Conclusions

The pre-season and total irrigation depths are shown in Table 1. The low treatments received 5.1 in during pre-season, and the high treatments received 7.1 in. The highest water depth intended to have higher leaching from the soil profile before planting. After planting the low water treatments received more than the high treatments to end the season with the same total amount of water applied. The reason that some treatments received slighly more water than others is that there were slight fluctuations in the water pump from the wells. We controlled the irrigation times to apply the same amounts of water. An analysis of variance was done to study the effect of drip depth, spacing and water depth on total yield. The analysis indicated that there were statistically differences between treatments. The Duncan test showed some differences between the 40 and 80 in drip spacing. The cotton lint yields, water use efficiency and total gross return were higher for the 40 in treatment as can be seen in Figs. 1, 2, and 3. The 12 in drip depth also resulted in sligthly higher cotton lint yields and total gross return, than the 8 in (Fig. 4 and 5). One of the reasons could be since the full requirments of the plant were not met, and the shallower irrigation depth (8 in) resulted in higher soil evaporation. A similar trend was observed with lower pre-season irrigation depths. One reason it could be that the higher pre-season irrigation depths produced more evaporation. Later the treatments with lower pre-season depths received more water during the season, and were used to meet transpiration demands.

## References

Ayers, R. S. And D.W. Westcot. 1976. Water quality for irrigation and drainage paper no. 29. Food and Agriculture Organizations of the United States. Rome.

Tanji, K.K. 1996. Agricultural salinity assessment and Management. American Society of Civil Engineers. Manuals and reports on engineering practice. Number 71. 619 pp.

Table 1. Water use, cotton lint yield and water use efficiency for different drip spacing, depths and pre-irrigations.

| Treatment | Pre-water Depth in. | Total Depth in. | Lint Yield (pounds/ac) | Irrigation use efficiency (pounds/ac-in) | Total Gross Return |
|---|---|---|---|---|---|
| 40-8-low | 5.1 | 18.5 | 1330 | 72 | 815 |
| 40-8-high | 7.1 | 18.2 | 1247 | 69 | 764 |
| 40-12-low | 5.1 | 17.7 | 1396 | 79 | 843 |
| 40-12-high | 7.1 | 17.8 | 1312 | 74 | 793 |
| 80-8-low | 5.1 | 17.7 | 1094 | 62 | 670 |
| 80-8-high | 7.1 | 17.7 | 1109 | 63 | 685 |
| 80-12-low | 5.1 | 17.6 | 1198 | 68 | 730 |
| 80-12-high | 7.1 | 17.6 | 1133 | 64 | 695 |

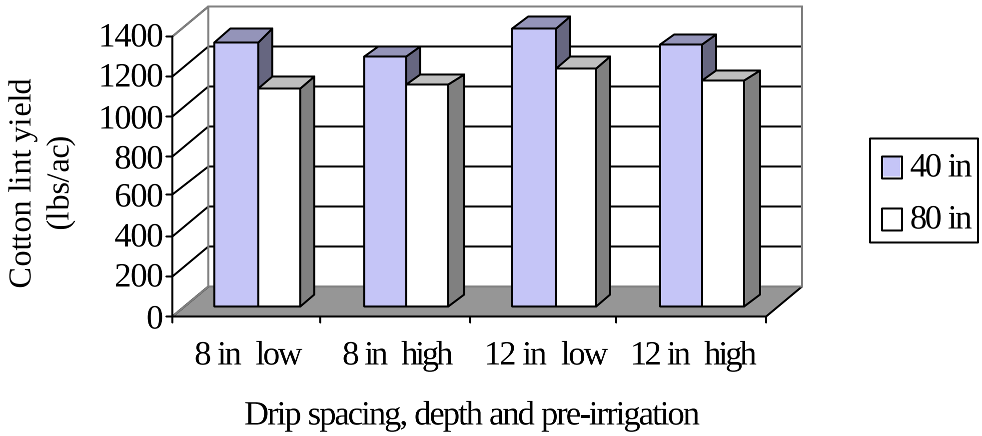


Figure 1. Response of cotton lint yield to drip depth and spacing, and prewater amount. Upton County, TX. 2001.

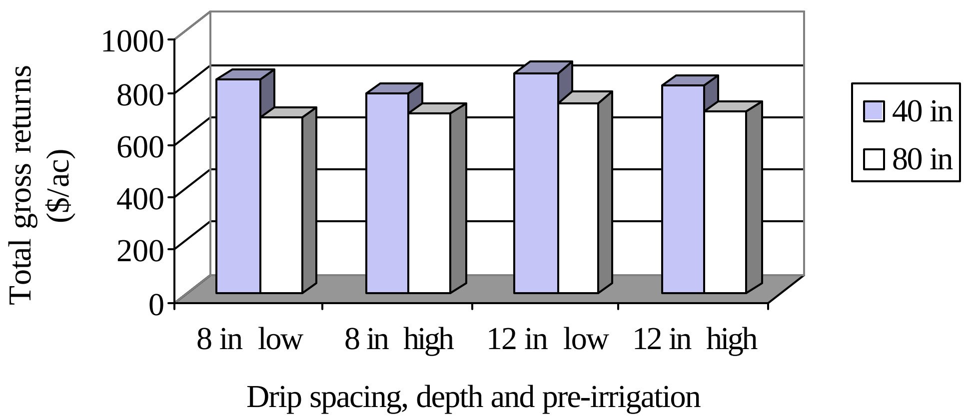


Figure 2. Response of cotton total gross return to drip depth and spacing, and pre-water amount. Upton County, TX. 2001.

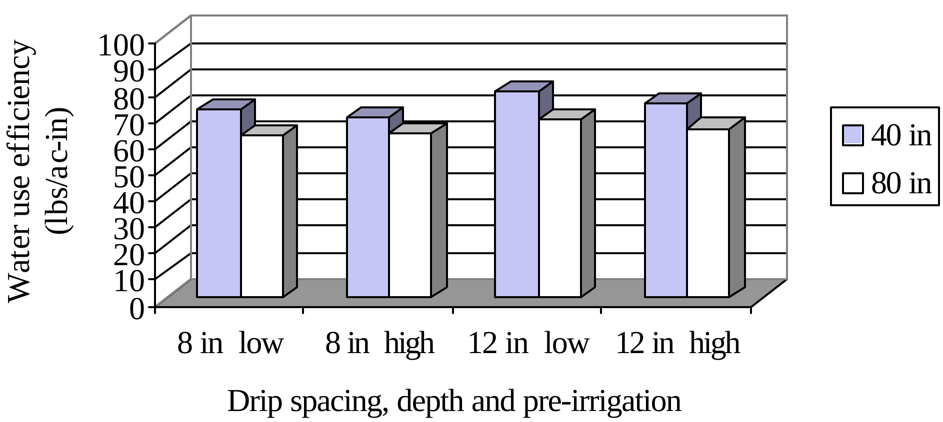


Figure 3. Response of cotton lint yield to drip depth and spacing, and pre-water amount. Upton County, TX. 2001.

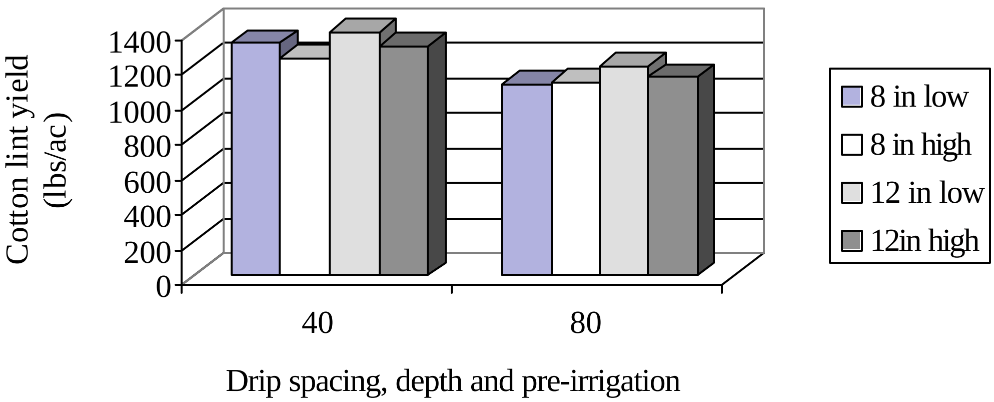


Figure 4. Response of cotton lint yield to different drip depth and spacing, and pre-water amount. Upton County, TX. 2001.

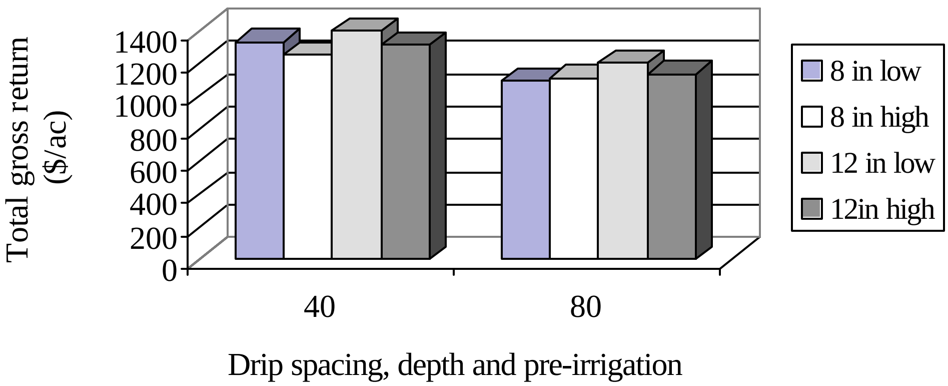


Figure 5. Response of cotton total gross return to different drip depth and spacing, and pre-water amount. Upton County, TX. 2001.