Salinity, Water Use Efficiency and Yield Under Sprinkler and Surge Irrigation Methods in Pecan Orchards of the West Texas

Girisha Ganjegunte[1], Vijayasatya Chaganti[1], and William Hargrove[2]

1 Texas A&M Agrilife Research, Texas A&M University System, El Paso, TX 79927

2 Center for Environnemental Resource Management, University of Texas at El Paso, TX

- **Corresponding Author**

Girisha Ganjegunte, Ph.D.
Professor
Department of Soil and Crop Sciences
Texas A&M AgriLife Research Center
Texas A&M University System
1380 A&M Circle
El Paso, TX 79927-5020
Ph: (915) 859 1908 ext.21
Fax: (915) 859 1078
E-mail:
GKGANJEGUNTE@ag.tamu.edu

Abstract

In the Trans-Pecos basin that covers parts of New Mexico and Texas, pecan (*Carya illinoinensis* (Wangenh.) K. Koch) is a major irrigated cash crop. Flood irrigation is the dominant method of irrigation to pecan crop and amount of water varies widely within the region ranging from 1.22 to 3.05 m y-1. Elevated salinity is a major challenge to the irrigated agriculture in the region and growers apply excess irrigation by flood method to push the salts below root zone. Consumptive water use for mature pecan crop is far lower than the current irrigation amounts and there may be opportunities to improve water use efficiency to extend freshwater supply by adapting improved irrigation methods such as drip. However, growers are concerned that reduced water application will resulted in salt accumulation in the rootzone. This study conducted in a 1300-acre pecan orchard evaluated the effects of irrigation methods (flood and drip irrigation) on root zone salinity. Results of the study indicated potential for improving water use efficiency without impairing pecan nut yield and increasing soil salinity.

Introduction

Pecan is a major cash crop in the trans-pecos region that covers parts of New Mexico and Texas. It occupies about 15,000 acres or 6000 ha in El Paso County of Texas. The region accounts for about half of the U.S. annual inshell nut production. Border irrigation, a type of flood irrigation wherein water is applied from a field irrigation ditch at its upper end to leveled plots divided by earthen ridges, is the oldest and most common irrigation method used in the region. This method of irrigation can lead to over irrigation and wastage.

Pecan is a salt sensitive crop and has a threshold salinity (measured by soil electrical conductivity, EC) of 3 dS/m. About 80% of the irrigated area in the region is affected by varying degrees of salinity. Thus, pecan growers are generally reluctant to adopt alternative methods of irrigation with higher water use efficiency such as drip or sprinkler due to salinity concerns. This study was conducted to evaluate salinity changes in the effective root-zone of pecan crop under drip and flood (surge) irrigation. The results of this study will be useful to persuade growers to adopt high water use efficient methods such as drip irrigation to extend the availability of precious freshwater in the extremely arid trans-pecos region.

Materials and Methods

- This study was conducted in a 1300 acre pecan orchard in the Far West Texas that has about half of the area under drip and the remaining half under flood irrigation.
- Climate at the study location is considered arid with an annual precipitation of 6 inches and potential evapo-transpiration of 78 inches.
- Dominant soil map units at the study site were Chispa-Chilicotal complex, ad McAllister fine sandy loam.
- Both drip and flood irrigation sites received about 48 inches of water during the growing season (April to October).
- Geospatial electromagnetic induction (EMI) survey was conducted using model EM38 meter before the onset of the study (baseline) and after cotton crop was harvested.
- After the EMI survey, calibration and validation sampling locations were selected using the ESAP-Response Surface Sampling Design (RSSD)
- Baseline and end of the year soil samples from five depths (0–15, 15–30, 30–45, 45–60, and 60–75 cm) were collected, processed and analyzed for texture, pH, EC_e, SAR, major cations (Ca, Mg, K, Na), major anions (Cl, SO_4) and nutrients (N, P, and K).
- Multiple linear regression (MLR) calibration equations included in the ESAP-CALIBRATE module were used to estimate EC_e and SAR values from EMI values.
- Model-generated EC_e and SAR values were imported into the Surfer (ver. 13) and Omni-directional variograms were computed for EC_e and SAR values to determine gridding method (point kriging).
- Validity of the gridding method was determined by residual median absolute deviation, residual standard deviation, and Pearson and Lee's correlation between the measured and the estimated Z.

Study Objectives

Objectives of this study were to evaluate:

- effects of irrigation methods on the rootzone salinity and sodicity
- changes in pecan production and quality under different irrigation methods

Results

Table 1: Irrigation water Quality

	Drip Irrigation		Flood Irrigation	
	Mean	Std. Dev	Mean	Std. Dev
pH	6.99±	0.31	7.23±	0.21
EC (dS/m)	1.14±	0.22	0.52±	0.08
SAR (√mmol/L)	7.96±	1.95	5.50±	2.42
Na (mg/L)	237±	60	112±	34
K (mg/L)	23±	23	16±	13
Mg (mg/L)	19±	25	6±	3
Ca (mg/L)	36±	30	21±	11
NH_4(mg/L)	26.59±	26.67	15.28±	16.57
Cl (mg/L)	103.72±	15.10	18.49±	5.76
NO_3 (mg/L)	14.92±	5.87	6.48±	2.52
PO_4 (mg/L)	36.31±	34.42	6.92±	9.50
SO_4 (mg/L)	162.80±	32.03	45.08±	8.81

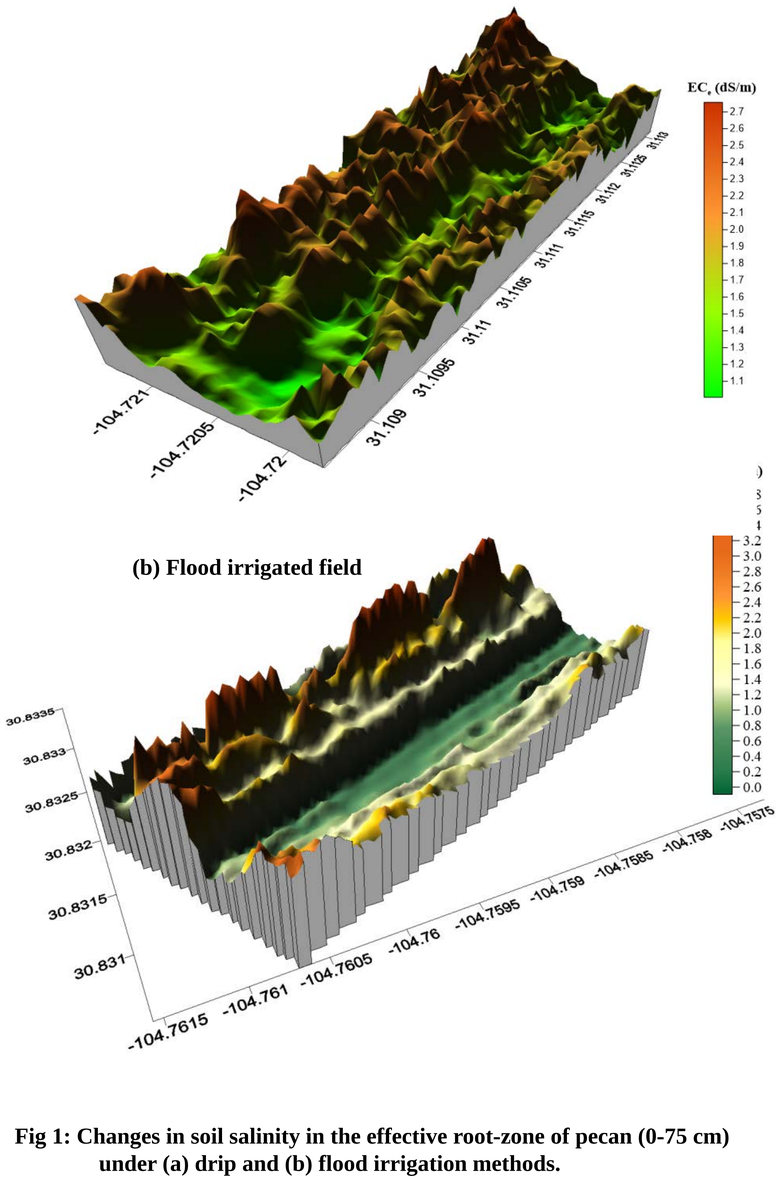

Fig 1: Changes in soil salinity in the effective root-zone of pecan (0-75 cm) under (a) drip and (b) flood irrigation methods.

Summary

- Irrigation water quality was not considered as saline or sodic.
- Elevated levels of N and P in the irrigation water were due to addition of fertilizers.
- Spatial distribution of salinity data obtained from EMI survey indicated that rootzone salinity of flood irrigated fields were higher than that of drip irrigated.
- Although salinity of water used for drip irrigation was numerically higher than that used for flood irrigation, root zone salinity of drip irrigated field was lower than that of flood irrigated site.
- The quality of pecan nuts (size) was superior in drip irrigated fields compared to that in flood irrigated areas.
- However, drip irrigation required more maintenance due to frequent repairs.
- Due to higher down period in drip irrigation, the actual amount of water applied could be lower.
- Pecan nut yields were similar under both irrigation systems, indicating that adoption of drip did not contribute to increased salinity while maintaining yields.

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