Soil Salinity Differences Between Irrigation Drainage Tile and Conventional Seepage Irrigation

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Introduction

Potatoes and cabbages are the major irrigated crops in the Tri-County Agricultural Area (TCAA) located in the Putnam, Flagler and St. Johns counties in northeast Florida (Figure 2). Soil salinity is of significant concern as it affects soil structure and crop yield. One source of elevated soil salinity is irrigation water, which can be exacerbated by low rainfall conditions (Figure 3), as well as type of irrigation practice. Potatoes for instance are moderately tolerant to soil salinity levels and crop yields reduce with increasing salinity levels (Figure 1). Fipps (2003) suggests a 0%, 10%, 25%, and 50% reduction in yield potentials for Ec_e of 1.7 dS/m, 2.5 dS/m, 3.8 dS/m, and 5.9 dS/m respectively. In soils with high salt concentrations, reducing new inputs and leaching salts from the soil is the most efficient means to keep the salinity below the crop tolerance threshold.

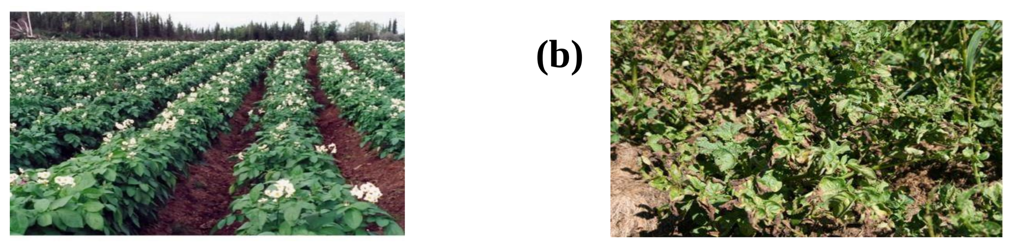

Figure 1. (a) A healthy potato field. (b) Potatoes under salinity stress.

- **Why this research?**

Salinity impacts on potato and vegetable crop production in 2011 and 2012 were significant in the TCAA and resulted in a need to determine what possible alternative irrigation and drainage practices might be viable in this area to reduce soil salinity.

- **Objective and hypothesis**

To determine soil salinity differences between Irrigation Drainage Tile (IDT) and conventional seepage irrigation practices. We hypothesized that IDT, which also provides field drainage will significantly reduce soil salinity compared with conventional seepage irrigation.

- **What is Conventional Seepage Irrigation?**

Conventional seepage irrigation employs the use of water furrows in between crop beds. Furrows are filled with water during irrigation until the water table is raised to a desired level. Considerable evaporation losses and concentration of salts can result from this irrigation technique (Figure 4).

- **What is Irrigation Drainage Tile?**

IDT systems have the capability to both irrigate and drain a field using the same pipe system. Perforated corrugated pipes are installed in the field at desired depths in the soil profile and a control structure is used to manage the height of the water table (Figure 5). Leaching of salts within the soil profile during rain events can help lower soil salinity.

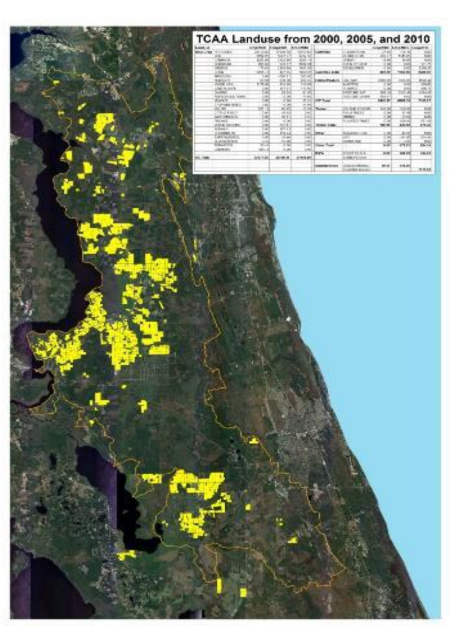

Figure 2. Map showing the extent of the TCAA.

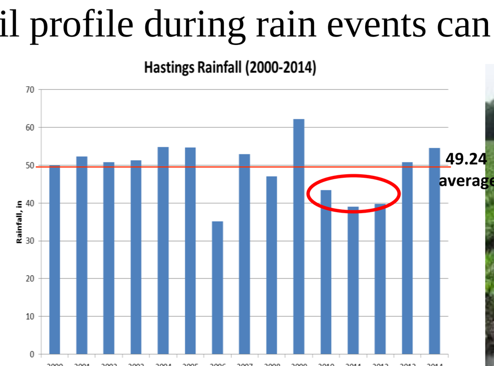

Figure 3. Graph showing low rainfall in 2010-2012

Figure 4. Conventional seepage irrigation

Figure 5. (a) IDT installation pipes. (b). Irridrain control structure http://www.ads-pipe.com/

Methods

Study Site

The TCAA is the hub of potato production in the state of Florida. For this research, six farms located in the region were selected for soil sampling. All farms employed conventional seepage irrigation and IDT systems for crop production during the period of research (Figure 6).

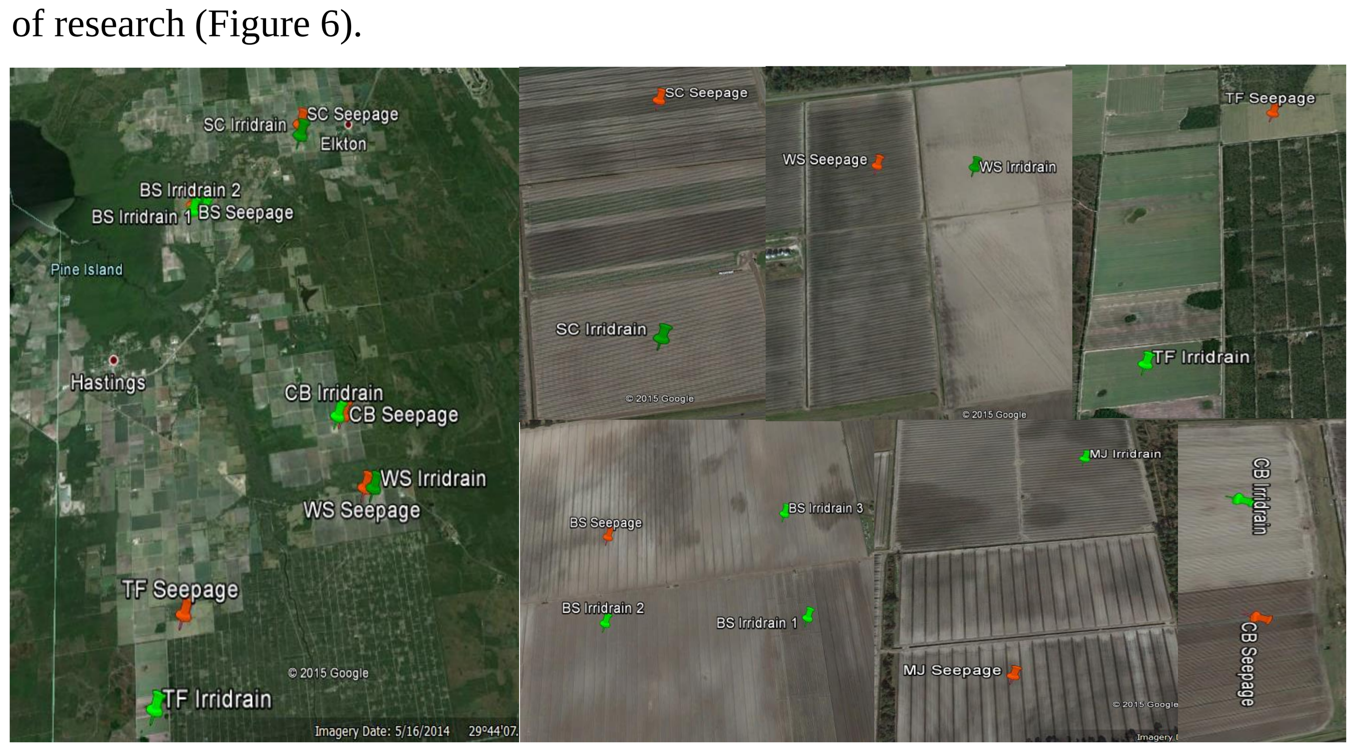

Figure 6. Location of sampling fields

Methods Cont'd

Sampling Design

- Soil samples were collected during the growing season (September 2014 – May 2015) and non-growing season (June 2015 – August 2015).
- Samples were collected at three different distances away from a reference furrow or IDT pipe.
- At the same distances, field zones indicating field water inflow, outflow, and center were sampled.
- At each sampling location, the soil profile was sampled at one foot depth increment up to 4ft (0 – 1 ft, 1 – 2 ft, 2 – 3 ft, and 3 – 4 ft).

Figure 7 show a typical sampling layout for the seepage and IDT system fields. Soil samples were then prepared for measurement of electrical conductivity (EC_e)(dS/m) which estimates the salinity of the soil.

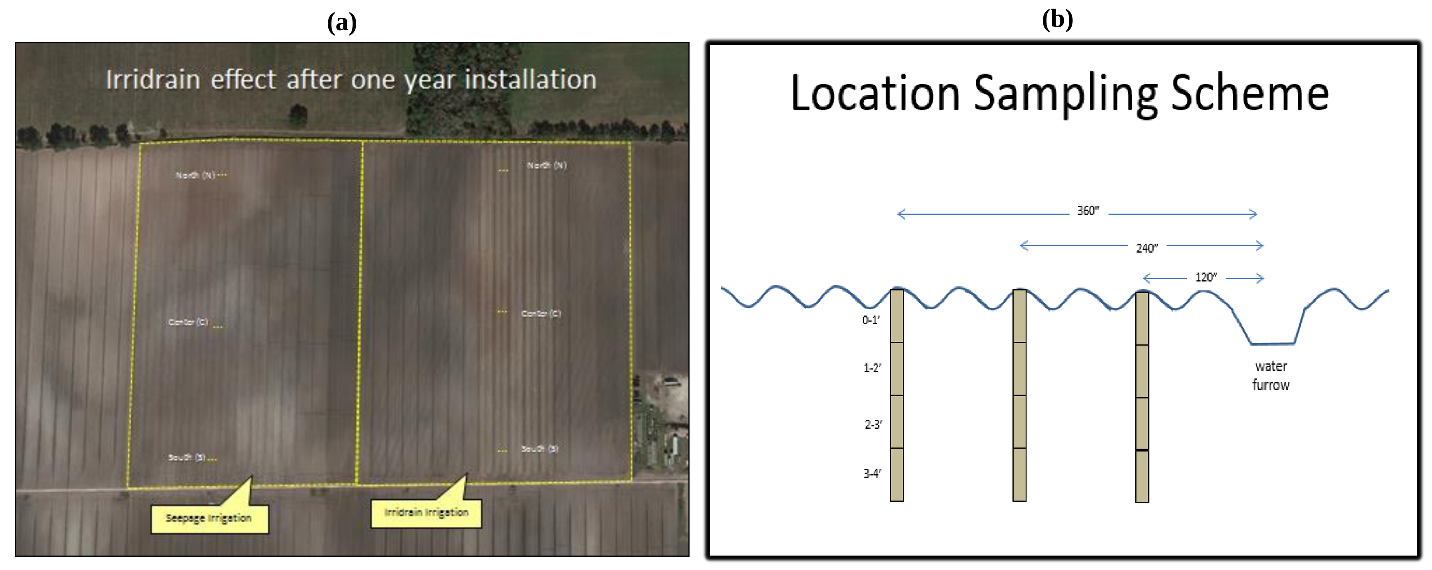

Figure 7. (a) Example layout of in-field soil sampling scheme for electrical conductivity testing. (b) Diagrammatic representation of in-field soil sampling scheme.

Sampling Instruments

Figure 8 show the soil corer, hand auger, cored and augured samples.

Figure 8. (a) Soil Corer (b) Hand Auger (c) Cored samples (d) Augured samples.

Measuring Electrical Conductivity (EC(dS/m))

After samples were collected, soil pastes were prepared from the soil samples (Figure 9), left to equilibrate for at least 24 hours, soil water vacuum extracted into 20 ml scintillation vials (Figure 10), and EC of soil water extract measured with an Accumet conductivity meter and probe (Figure 11).

Figure 9. Soil Paste in cups

Figure 10. Soil water extraction

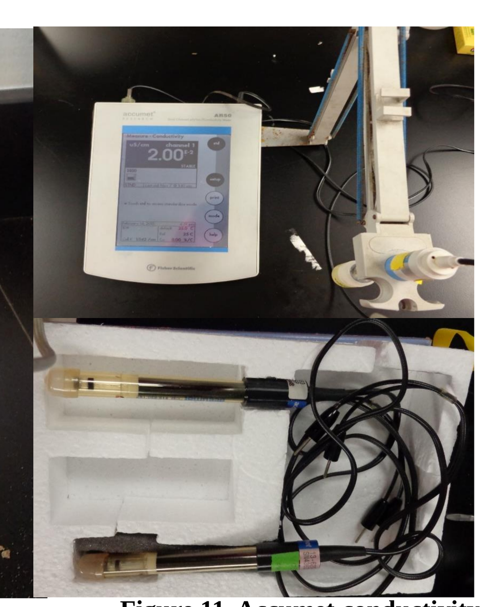

Figure 11. Accumet conductivity meter and probe

Results

- Soil salinity was significantly reduced in the 0-1 ft sampling depth by IDT system in four out of six farms, in both sampling seasons (Figures 12&13).

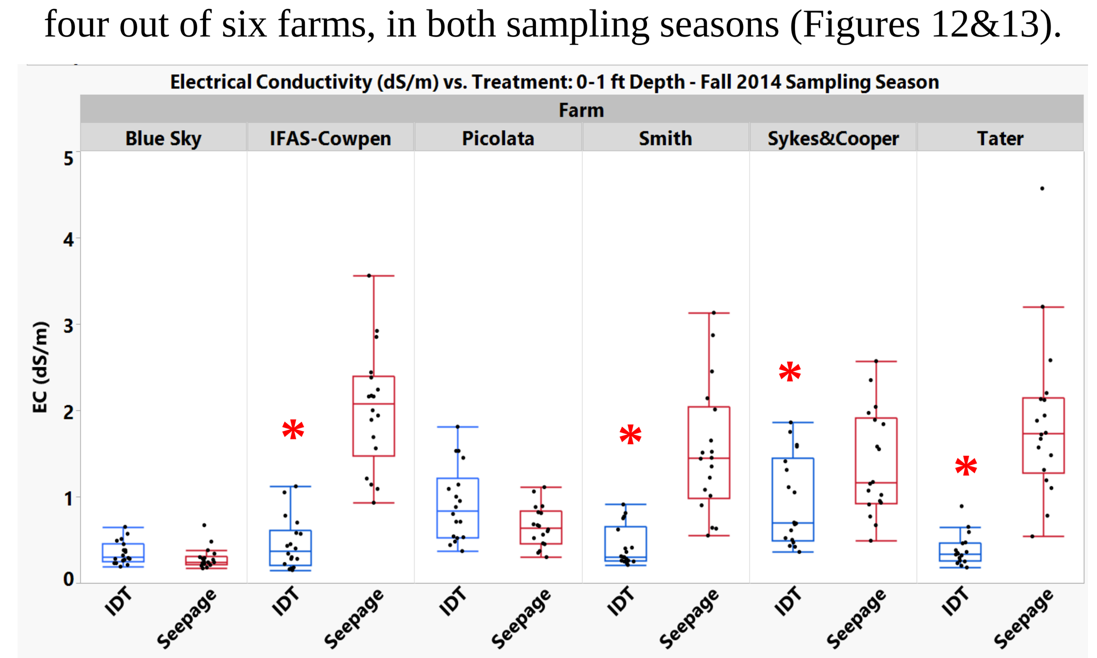

Figure 12. Graph of Electrical conductivity (dS/m) by treatment: 0 - 1 ft Depth – Fall 2014 sampling season.

*** indicates a statistically significant reduction by IDT at alpha level of 0.05.**

Results Cont'd

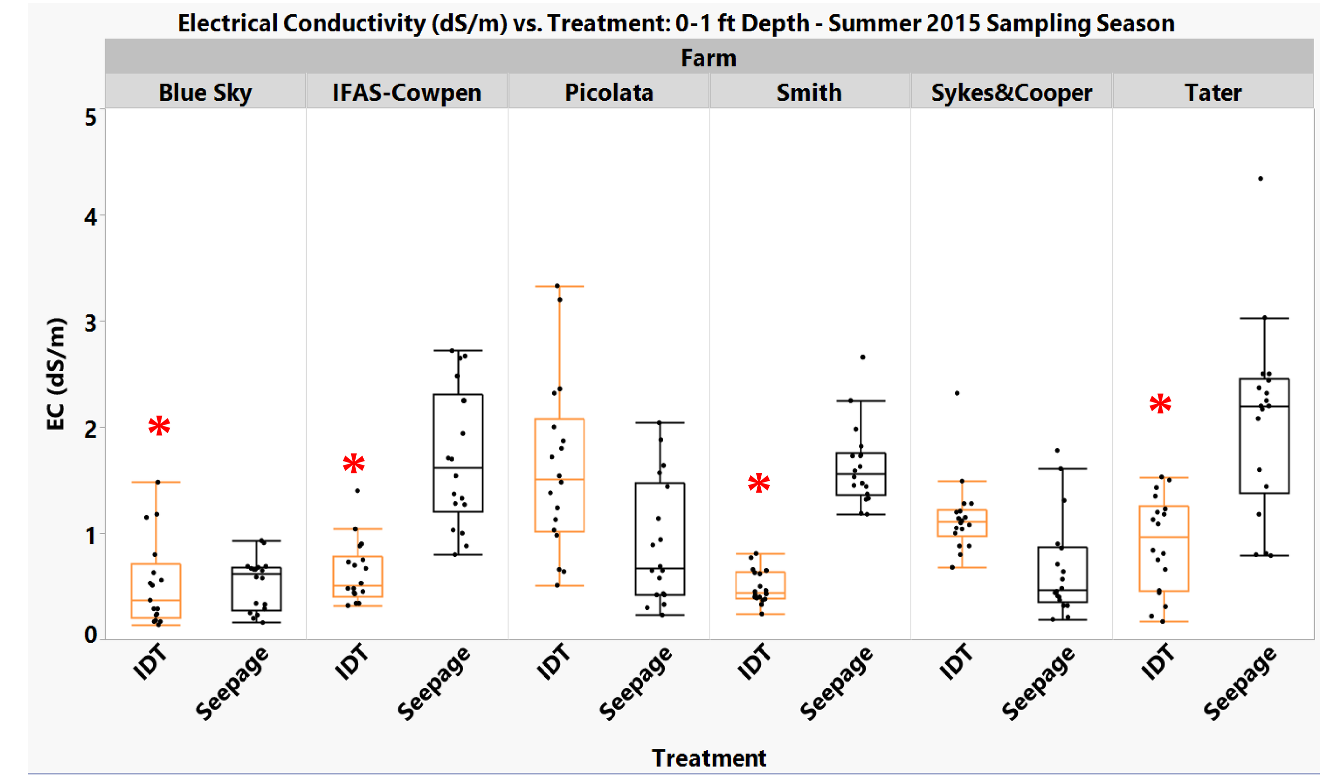

Figure 13. Graph of Electrical conductivity (dS/m) by treatment: 0 - 1 ft Depth – Summer 2015 sampling season.

*** indicates a statistically significant reduction by IDT at alpha level of 0.05.**

- Similar results were obtained for the 1-2 ft depth where IDT significantly reduced soil salinity in three out of the six farms in both sampling seasons (Figures 14&15).

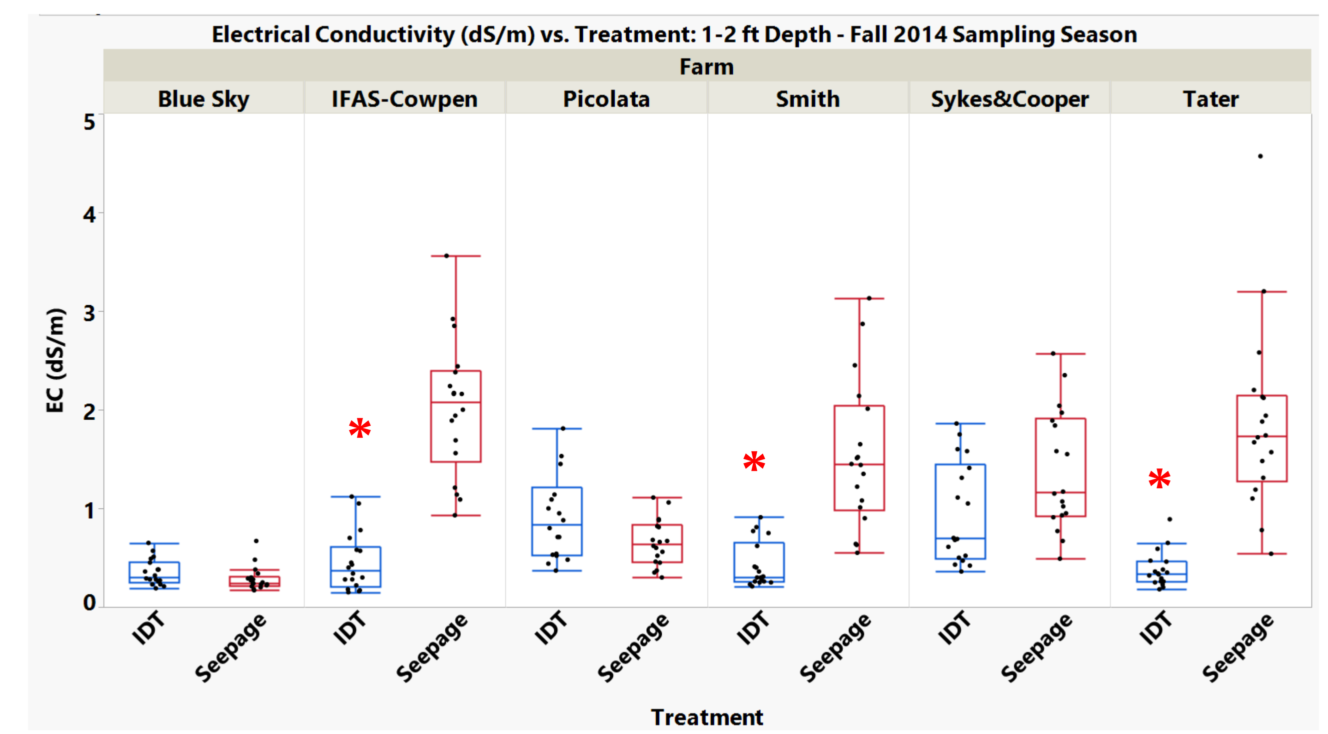

Figure 14. Graph of Electrical conductivity (dS/m) by treatment: 1-2 ft Depth – Fall 2014 sampling season.

*** indicates a statistically significant reduction by IDT at alpha level of 0.05.**

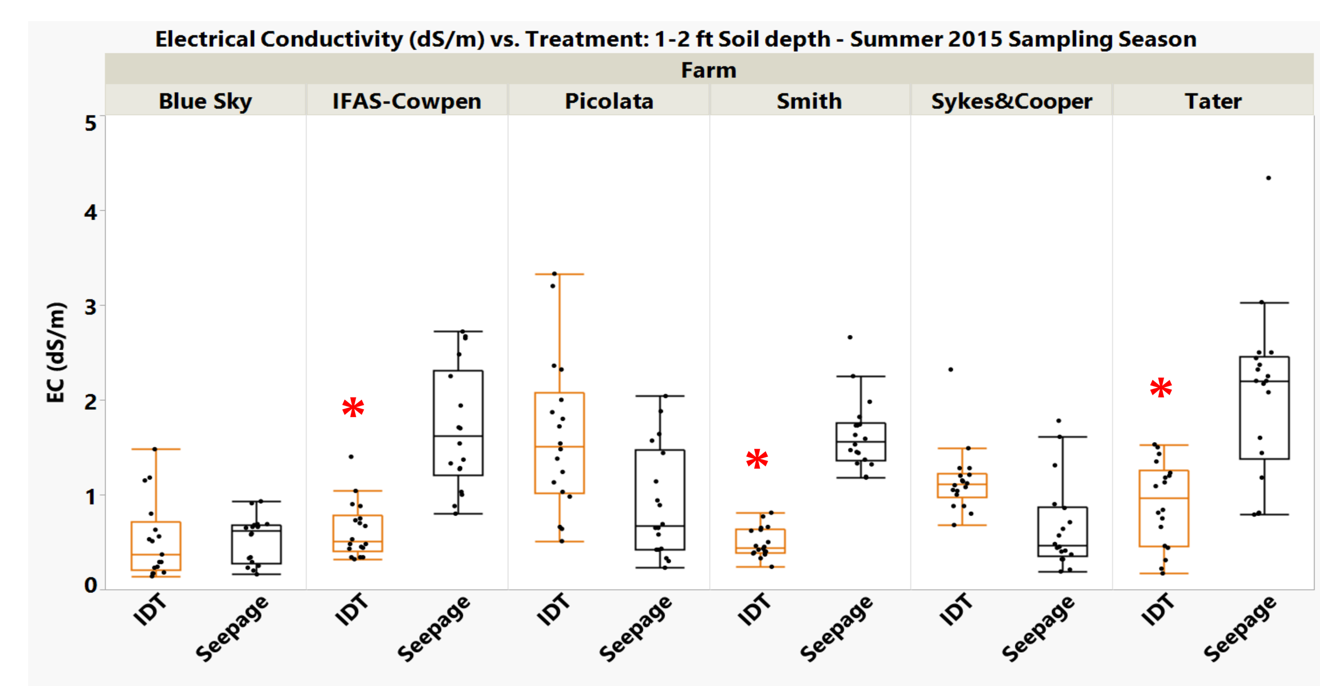

Figure 15. Graph of Electrical conductivity (dS/m) by treatment: 1-2 ft Depth – Summer 2015 sampling season.

*** indicates a statistically significant reduction by IDT at alpha level of 0.05.**

- The overall reduction in soil salinity in all six farms by IDT system was **32.1%** and **39.2%** in the 0-1 and 1-2 ft respectively for the Fall 2014 sampling season, and **6.6%** and **30.1%** in the same depths in the Summer 2015 sampling season (Figures 16&17).

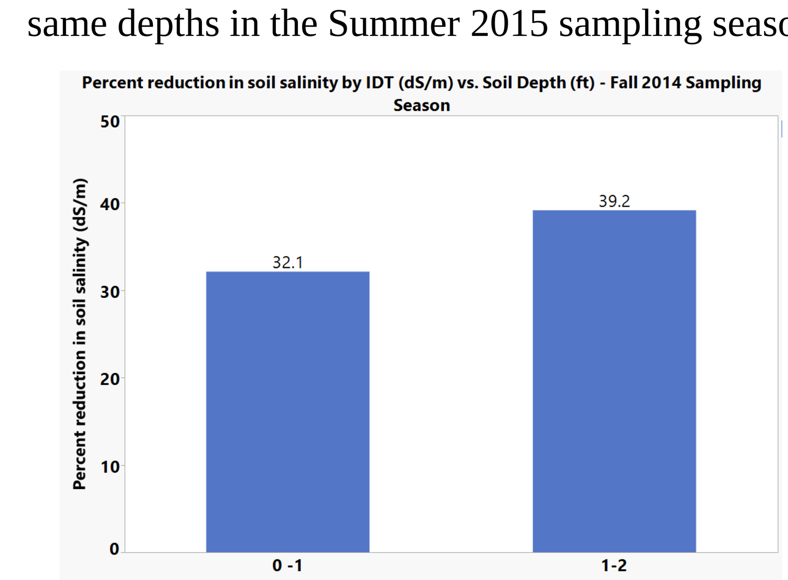

Figure 16. Graph showing the overall reduction in soil salinity by IDT system – Fall 2014 sampling season

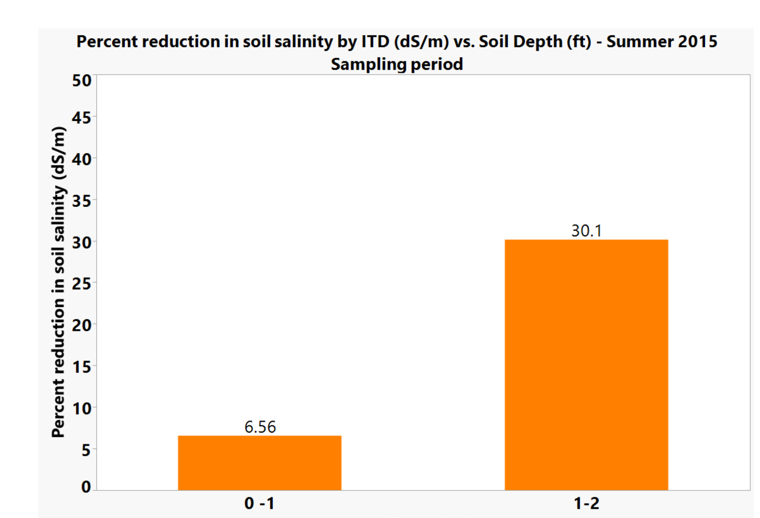

Figure 17. Graph showing the overall reduction in soil salinity by IDT system – Summer 2015 sampling season

Conclusion

This study shows that Irrigation Drainage Tile has a significant potential to reduce soil salinity compared with conventional seepage irrigation on most fields in the Tri County Agricultural Area. Reduced soil salinity is likely the combined effect of lower irrigation demand with IDT thereby reducing total salt inputs to the soil and increased soil leaching potential provided by subsurface drainage. Growers and cost-share funding programs targeting soil salinity should consider use of this practice. Concerns related to potential increases in nutrient movement associated with IDT systems are also being evaluated and entering year two of monitoring. Results of that study are forthcoming.

Acknowledgements

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