Pore Water Nitrate in Coastal Plains Soils with Corn Production: Impact of Irrigation Scheduling

Gilbert C. Sigua*, Kenneth C. Stone, Philip A. Bauer and Ariel A. Szogi

USDA-ARS, Coastal Plains Soil, Water and Plant Research Center, Florence, South Carolina, USA 29501

*gilbert.sigua@ars.usda.gov

BACKGROUND AND OBJECTIVE

- Irrigation management for maize (*Zea mays* L.) production in the southeastern region of USA is difficult because of the highly variable climate along with typical low water holding capacity and low fertility of the soils. Different types of soils in southeastern coastal USA have different water holding capacities; therefore may require different depths and rates of water application to reach field capacity and minimize potential runoff and/or groundwater leaching of nutrients.
- There is still limited information on the effects of irrigation scheduling and its interaction with nitrogen management on nitrate leaching in humid regions such as the southeastern Coastal Plain.
- A three-year (2012-2014) field study was conducted to evaluate the effects of three irrigation scheduling methods (ISM): Irrigator Pro (IPRO); Normalized Difference Vegetative Index (NDVI); and Soil Water Potentials (SWP) and two rates of N applications (NM) on pore water nitrate in four soil types (ST) with maize production in Coastal Plain Region, USA.

ABSTRACT

- Of the three ISM, IPRO (7.3±1.6 mg L^{-1}) has the lowest concentration of soil pore water nitrate at soil depth below 30 cm compared with NDVI (10.7±2.3 mg L^{-1}) and SWP (10.9±2.1 mg L^{-1});
- Since the IPRO method resulted in lower soil pore water nitrate and phosphate, the results indicate scheduling method may be a way to reduce fertilizer N and P losses to leaching on these soils; and
- Results of our study suggest that irrigation management decision may affect nitrogen for achieving optimum yield while potentially minimizing nutrient losses via leaching. Our strong interest can be attributed to the desire of improving water use efficiency as well as complement management of other crop inputs such as nitrogen for groundwater protection.

MATERIALS AND METHODS

Experimental Treatments/Sample Analysis

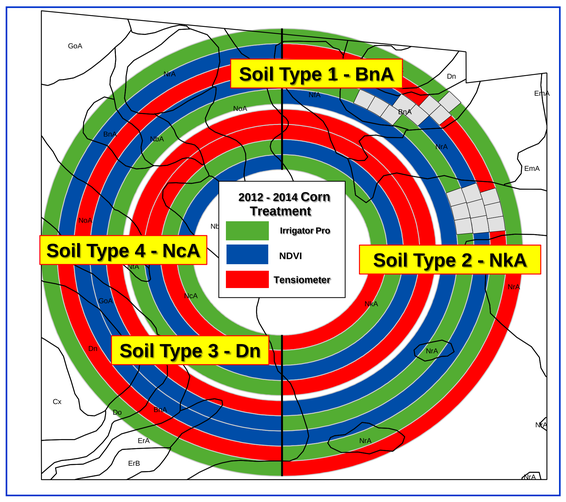
Irrigator Pro(IPRO) | Normalized Difference Vegetative Index | Soil Water Potentials

Irrigation Scheduling Methods:
- Irrigator Pro(IPRO)
- Normalized Difference Vegetative Index (NDVI)
- Soil Water Potentials (SWP)

Levels of Nitrogen Applications:
- 157 kg N/ha (non-irrigated rate)
- 224 kg N/ha (irrigated rate)

Soil Type:
- Bonneau Soil (BnA)
- Norfolk Soil (NkA)
- Dunbar Soil (Dn)
- Noboco Soil (NcA)

Plot Map Showing the Different Soil Types and Irrigation Treatments (Center Pivot)



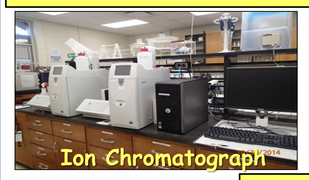
Pore Water Sampling - Suction Lysimeters at two depths: @30 cm and @90 cm

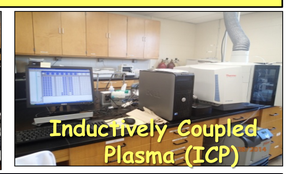
Collecting Soil Samples at Different Stages of Corn Growth and Soil Depths

- V6
- V16
- Silking

Soil Depths:
- 0-15 cm
- 15-30 cm

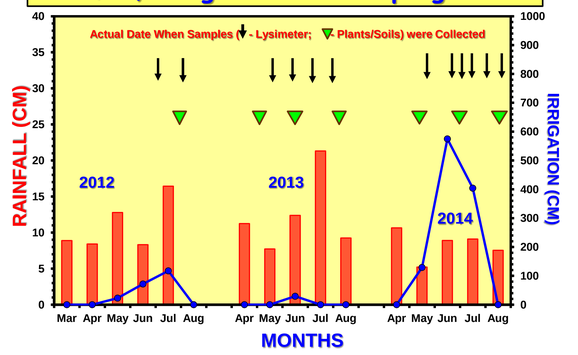
ARS Laboratory Equipment, Florence, SC





Precision (GPS) Corn Planting and Fertilization

Rainfall, Irrigation and Sampling Dates



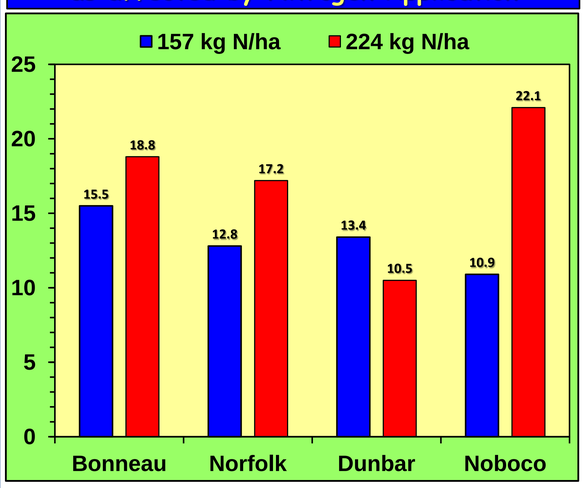
RESULTS

Pore Water Nitrate, corn yield and WUE as affected by different irrigation scheduling, nitrogen and soil types

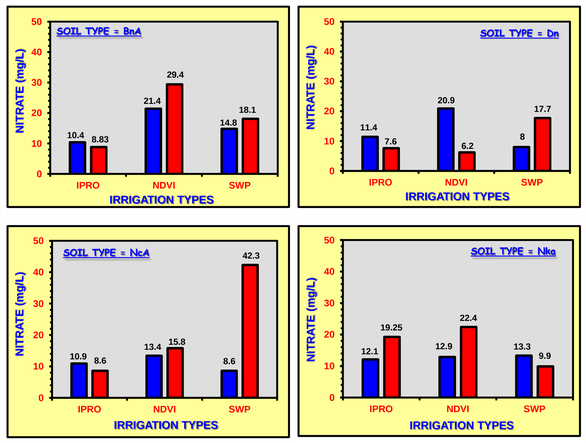
Treatments	Pore Water NO_3 (mg L^{-1})	Yield (Mg ha^{-1})	Water Use Efficiency (kg grain ha^{-1} mm^{-1})
A. Irrigation Method			
1. Irrigator PRO	11.1b*	13.4a	23.3a
2. NDVI	17.9a	13.3a	23.7a
3. SWP	16.5a	12.9a	23.4a
B. Nitrogen			
1. 157 kg N/ha	13.4b	-	-
2. 224 kg N/ha	17.0a	-	-
C. Soil Type			
1. Bonneau (BnA)	17.2a	12.9a	23.0ab
2. Norfolk (NkA)	12.2a	13.2a	23.6ab
3. Dunbar (Dn)	16.5a	12.9a	22.6b
4. Noboco (NcA)	14.8a	13.7a	24.5a

*Means (averaged across years) followed by same letter(s) under each column and sub-heading are not significantly different from each other at p≤0.05.

Pore Water NO_3 (mg L^{-1}) in Four Soil Types as affected by Nitrogen Application



Effects of Irrigation Scheduling on Pore Water Nitrate in Four Soil Types



SUMMARY AND CONCLUSION

A three-year (2012-2014) field study was conducted to compare the effects of three irrigation scheduling methods (ISM: IPRO, NDVI and SWP) and two levels of N (157 and 224 kg N ha^{-1}) on the pore water concentration of nitrate in four soil types of the Coastal Plain, USA. The following conclusions are drawn from this study:

- Based on our three-year study, with different rainfall distribution throughout the corn growing season, our results have shown that each of the three ISMs provided the adequate amount of irrigation water (WUE) to produce good to excellent maize yields for the region;
- Of the three ISM, IPRO (7.3±1.6 mg L^{-1}) has the lowest concentration of soil pore water nitrate at soil depth below 30 cm compared with NDVI (10.7±2.3 mg L^{-1}) and SWP (10.9±2.1 mg L^{-1});
- However, application of 224 kg N/ha yielded greater concentration of soil pore water nitrate when compared with application of 157 kg N/ha; and
- Results of our study suggest that irrigation management decision may affect nitrogen availability for achieving optimum yield while potentially minimizing nutrient losses via leaching.

REFERENCES

Stone, K.C., Bauer, P.J. and Sigua, G.C. 2016. Irrigation management using an expert system, soil water potentials and vegetative indices for spatial applications. Transaction of the ASABE. 59: 941-948.

Sigua, G. C., Stone, K.C., Bauer, P.J., Szogi, A.A., and Shumaker, P.D. 2017. Impact of irrigation scheduling on pore water nitrate and phosphate in Coastal Plain Region, USA with maize production. Agricultural Water Management. 186: 75-85.