SUBSURFACE DRIP NITROGEN FERTIGATION OF CORN

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Introduction

- Water and fertilizer are expensive inputs for irrigated corn (*Zea mays* L.).
- Subsurface drip irrigation (SDI) systems have a 95 to 99% application efficiency and can decrease net irrigation needs of the crop by 25% (Lamm and Trooien, 2003).
- Nitrogen (N) fertilizer is used more efficiently when applied closer to the time of crop uptake at V8 to V10 (Binder et al., 2000).
- Chlorophyll (SPAD) meters can be used to determine when N is needed by the crop based on leaf greenness, which is correlated to the amount of chlorophyll that is present (Samborski et al., 2009).

Objectives

- To increase yield and efficiency of irrigated corn production by managing N fertilizer through SDI fertigation systems that allow application at later developmental stages
- To evaluate the efficiency of using a SPAD meter to determine N applications

Materials and Methods

- Experiment site: Ashland Bottoms Research Farm, Manhattan, KS
- Belvue (5-18% clay, 15-75% sand) and Eudora silt loam soils (5-18% clay, 10-50% sand)
- Randomized complete block design with four replications
- Plots 8 rows wide (20 ft.) x 200 ft. long
- No-till, soybean-corn-corn rotation
- 114-day relative maturity hybrid, DKC64-69RIB
- Planting dates: May 7, 2014 and April 17, 2015
- Seeding rates: 30,000 seeds acre^{-1} in 2014, 36,000 seeds acre $^{-1}$ in 2015
- Subsurface drip irrigation (SDI) system (Netafim USA, Fresno, CA)
  - Drip tapes 15 in. deep on 30 in. spacing
  - Zones 20 ft. wide x 220 ft. long
- Five fertilization treatments (Table 1)
  - All N applied as 28% UAN: injected just below the surface residue at planting or metered through the SDI system V5-R2

Table 1. Nitrogen application treatments imposed in 2014 and 2015.

Treatment	Starter	At Planting	V5-V10	V11-VT	VT-R2	Total
2014 & 2015	N-P-K	lb N acre^{-1}				
Preplant Surface	20-20-0	160	0	0	0	180
SDI Sidedress	20-20-0	0	90	70	0	180
SDI Sensor (2014)	20-20-0	0	90	70	27	207
SDI Sensor (2015)	20-20-0	0	90	47	40	197
SDI Maximum	20-20-0	0	90	70	40	220
Reference	20-20-0	160	90	70	40	380

- SDI Sensor (SPAD)
  - Readings taken roughly every eight days, V11-R2
  - 20 plants x three readings per plant = 60 readings total for each plot at each reading date
  - Readings taken from topmost expanded leaf before VT, and ear leaf after VT
  - SDI fertigation applied if plot SPAD was < 95% of Reference
  - SDI Sensor plots received one less fertigation than SDI Maximum plots each year (Table 1)
- Center two rows of each plot harvested to determine grain yield: September 19, 2014; September 29, 2015
- Nitrogen Use Efficiency (NUE) calculated as bushels of grain per pound of fertilizer N applied

Materials and Methods cont.

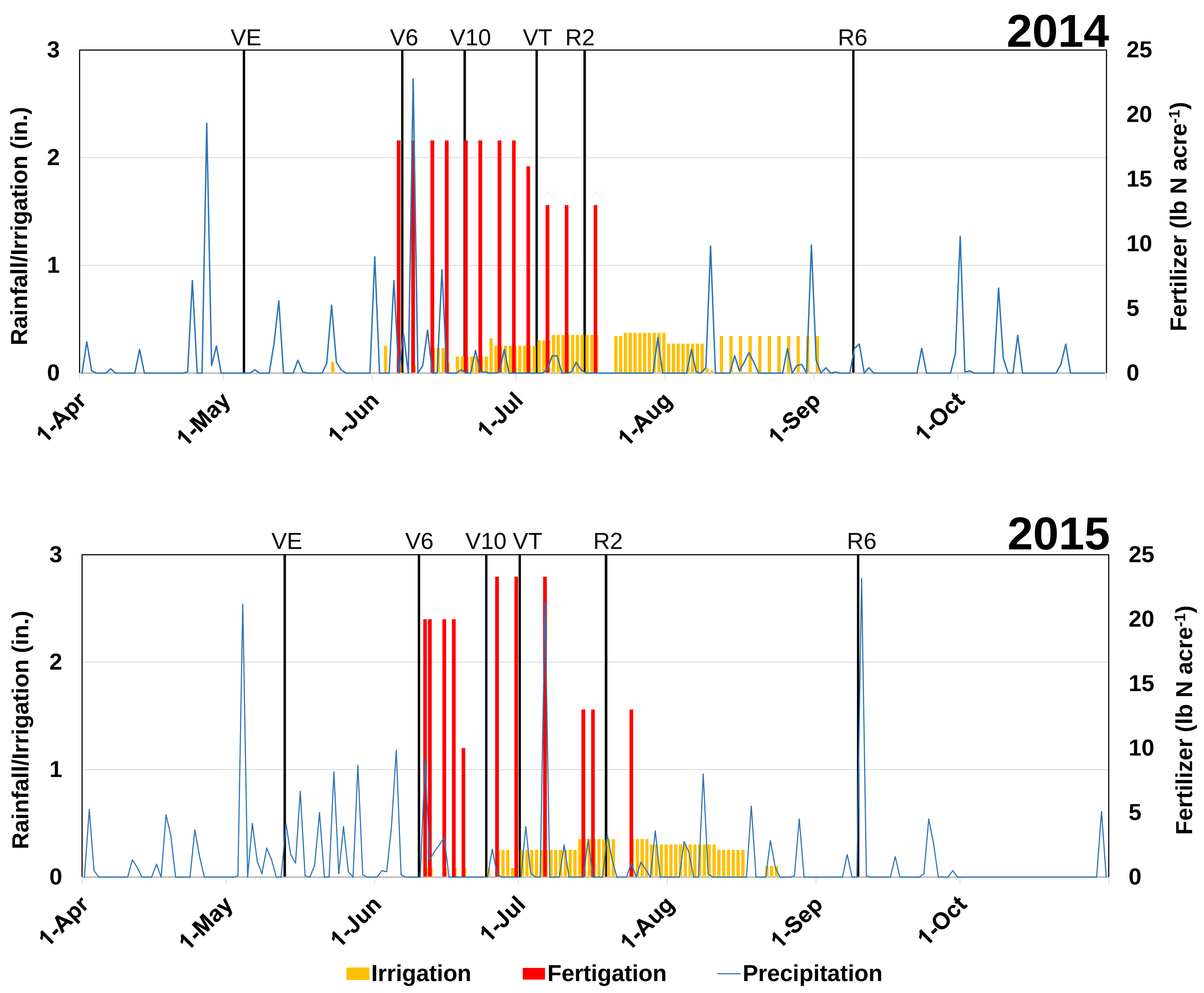

Figure 1. Key corn growth stages and precipitation, irrigation, and fertigation amounts and timing in 2014 and 2015.

- Crop ET: 21.8 in. for 2014, 24.2 in. for 2015
- Net rainfall and irrigation: 20.3 in. for 2014, 18.9 in. for 2015 (Figure 1)

Results

Table 2. Corn response to N application treatments in 2014 and 2015.

Treatment	Days to silk	Grain moisture	Test weight	Seed weight	Grain protein
2014	days	%	lb/bu	seed/lb	%
Preplant Surface	62	17.0	57.5	1016	7.3b
SDI Sidedress	61	17.8	57.7	1090	7.2b
SDI Sensor	62	18.4	57.4	1098	7.2b
SDI Maximum	60	18.6	56.2	1116	8.2a
Reference	63	17.5	57.1	1072	8.1a
2015					
Preplant Surface	84	16.8	56.8b†	1551	7.1b
SDI Sidedress	88	16.9	56.5b	1612	7.0b
SDI Sensor	87	17.1	56.9b	1649	7.1b
SDI Maximum	87	17.1	56.4b	1631	7.3b
Reference	85	17.3	58.0a	1608	8.0a

† Values within a column followed by the same letter are not different α = 0.10.

- Days to silk, harvest grain moisture, and seed weight were not affected by N fertilizer treatments (Table 2)
- Test weight did not respond to N application method and timing in 2014, but was greater for the Reference treatment compared to the other treatments in 2015
- Grain protein increased with greater N applications through early grain fill
  - In 2014, SDI Maximum and Reference treatments had higher grain protein than the Preplant Surface, SDI Sidedress, and SDI Sensor treatments
  - The Reference treatment resulted in higher grain protein in 2015 than the rest of the treatments

Results cont.

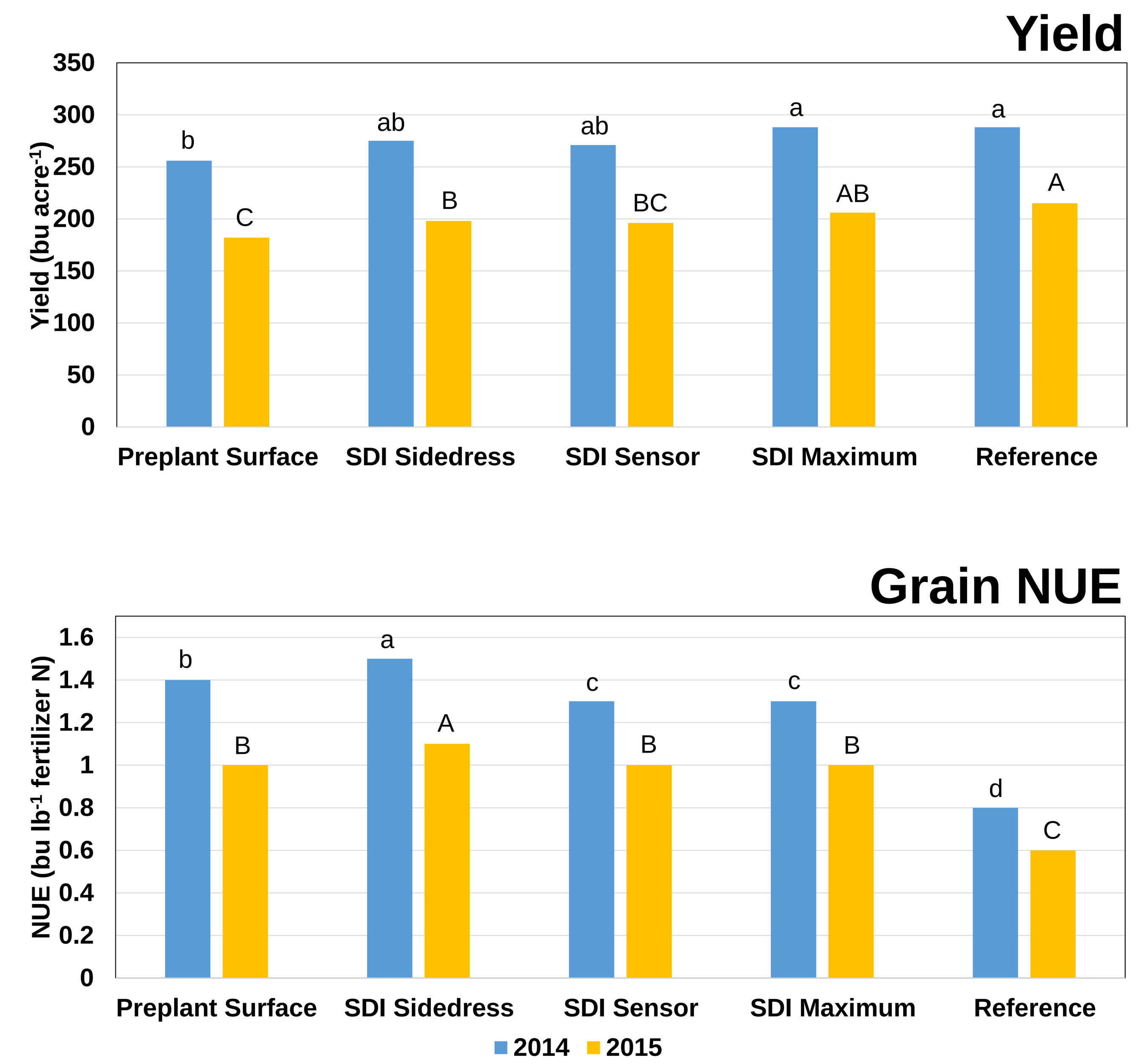

Figure 2. Grain yield (15% moisture) and nitrogen use efficiency of treatments in 2014 and 2015; bars with the same upper or lowercase letter are not different α = 0.10.

- The effect of N fertilizer treatments on yield and fertilizer NUE was relatively consistent across both years (Figure 2)
- Yields and grain NUE were greater in 2014 than in 2015
- Across years, grain yield was greatest in Reference the SDI Maximum treatments and lowest in Preplant Surface
- Grain NUE was greatest in the SDI Sidedress treatment and least in the Reference for both years
- Preplant Surface produced the least grain and had intermediate NUE
- SDI Sidedress had greater yield than Preplant Surface and maximized NUE
- SDI Sensor had intermediate yield and NUE
- SDI Maximum and Reference produced the greatest yields, but fertilizer NUE was similar or reduced compared to Preplant Surface

Conclusions

- Method, timing, and amount of N applied influenced yield and NUE
  - Fertigation through the SDI system improved yields and NUE compared to preplant surface applications of UAN injected below surface reside
  - Applying a greater amount of N through early grain fill increased yield, but NUE was reduced
  - Efficiency of fertilizer N use was maximized when N was applied before the reproductive stages, though yield was not maximized
- Using SPAD meter readings to determine when the crop needed N applications did not improve yield or efficiency of fertilizer use in this study

References/Acknowledgments

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