Optimizing Nitrogen and Irrgation Timing for Corn Fertigation Applications Using Remote Sensing

Ray Asebedo and David Mengel

Kansas State University

Manhattan, KS

Objectives

- Measure the impact of the relationship between irrigation timing, N rate, and timing of N application with corn grain yield
- Evaluate the potential for developing algorithms designed for fertigation systems

Experimental Design

- Research plots 10’x40’
- Randomized complete block design
- Four replications
- Two irrigated sites at KSU experiment fields
- One flood irrigation site with farmer cooperation in 2012 only

Treatment Protocol, 2012

Treatment	N Source	Starter N	Pre-Plant N	In-Season N Rate	Total N Rate
1	Urea	20	80	0	100
2	Urea	20	160	0	180
3	Urea	20	250	0	270
4	UAN	20	40	40 V4	100
5	UAN	20	80	80 V4	180
6	UAN	20	125	125 V4	270
7	UAN	20	40	Sensor	60+Sensor
8	UAN	20	80	Sensor	100+Sensor
9	UAN	20	125	Sensor	145+Sensor
10	Check	20	N/A	N/A	N/A

Treatment Protocol, 2013-14

Total N Rate Reduced

Treatment	N Source	Starter N	Pre-Plant N	In-Season N Rate	Total N Rate
1	Urea	20	60	0	80
2	Urea	20	120	0	140
3	Urea	20	180	0	200
4	UAN	20	30	30 V4	80
5	UAN	20	60	60 V4	140
6	UAN	20	90	90 V4	200
7	UAN	20	40	Sensor	60+Sensor
8	UAN	20	80	Sensor	100+Sensor
9	UAN	20	120	Sensor	140+Sensor
10	Check	20	N/A	N/A	N/A

Sampling Methods

- 0-6" and 0-24" soil samples prior to planting
- Irrigation scheduling made with KanSched2
- Canopy reflectance measured at multiple growth stages
  - Optical Sensor utilized, Trimble Greenseeker
  - V-10 and R-1
  - Tucker and Mengel(2010) algorithm utilized for sensor based N recommendations
- Harvested with plot combine at KSU Experiment fields. Hand harvested at farmer fields
  - Combine harvest area, 5'x40'
  - Hand harvest area, 5'x17.5'

Site Information, Scandia Station

Year	2012	2013	2014
Soil Type	Crete silt loam	Crete silt loam	Crete silt loam
Previous Crop	Soybeans	Soybeans	Soybeans
Tillage Practice	Ridge Till	Ridge Till	Ridge Till
Corn Hybrid	NA	NA	Pioneer P1602
Plant Population (plants/ac)	30000	29500	33500
Irrigation Type	Lateral	Lateral	Lateral
Planting Date	4/27/2012	5/16/2013	5/5/2014
Second Treatment V-4	6/4/2012	6/19/2013	6/19/2014
Third Treatment V-8 through V-10	6/14/2012	7/3/2013	NA
Last Treatment V-16 through R-1	6/28/2012	NA	8/4/2014
Harvest Date	10/24/2012	11/1/2013	11/11/2014

Site Information, Scandia Site 2

Year	2012
Soil Type	Carr Fine Sandy loam
Previous Crop	Soybeans
Tillage Practice	Ridge Till
Corn Hybrid	NA
Plant Population (plants/ac)	32000
Irrigation Type	Flood
Planting Date	4/27/2012
Second Treatment V-4	6/4/2012
Third Treatment V-8	6/14/2012
Last Treatment V-16	6/26/2012
Harvest Date	9/25/2012

Site Information, Rossville Station

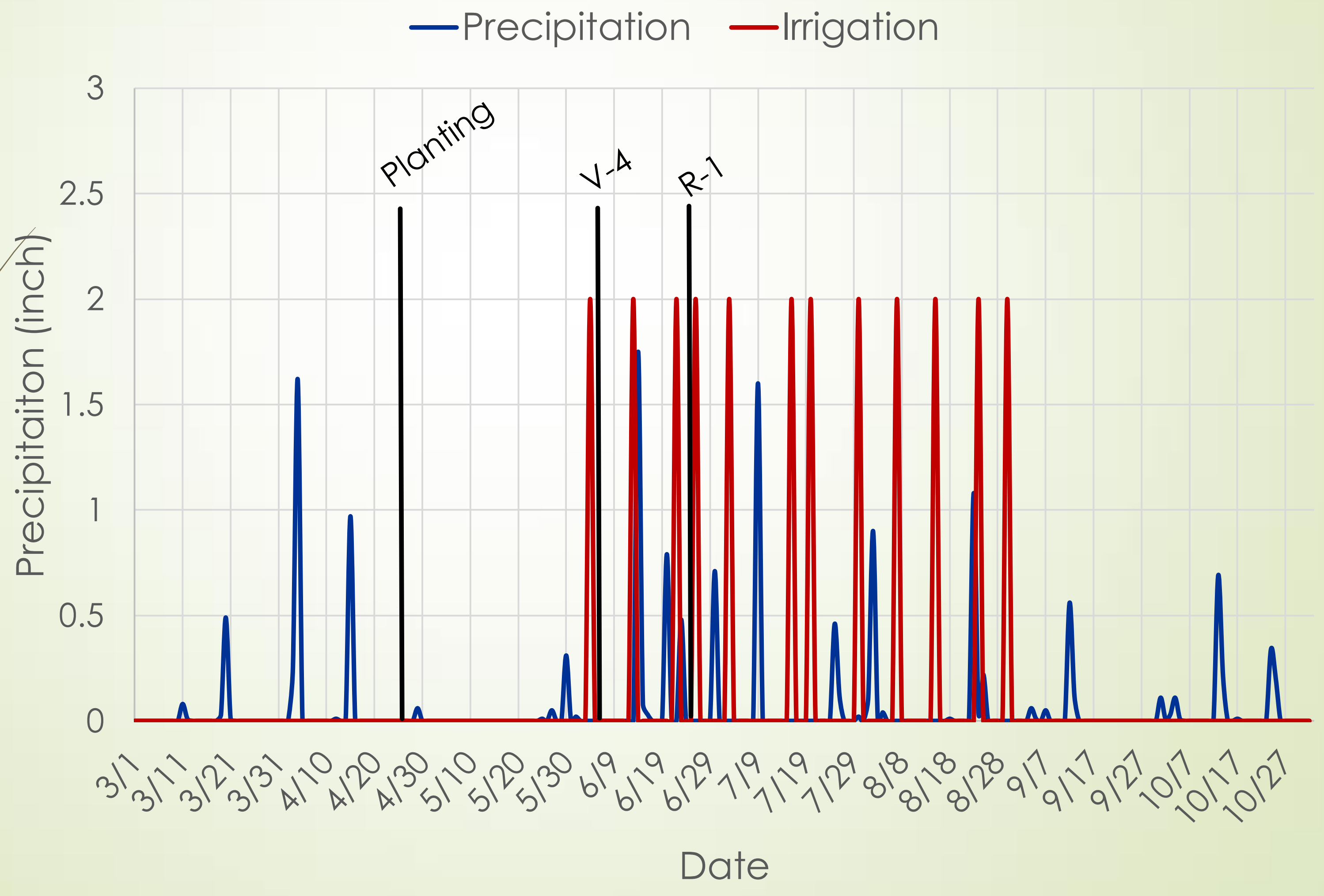
Year	2013	2014
Soil Type	Eudora sandy loam	Eudora sandy loam
Previous Crop	Soybeans	Soybeans
Tillage Practice	Conventional	Conventional
Corn Hybrid	Pioneer 0876	Producers Hybrid 7224 VT3
Plant Population (plants/ac)	32000	32000
Irrigation	Lateral	Lateral
Planting Date	4/29/2013	4/23/2014
Second Treatment V-4	6/3/2013	6/6/2014
Third Treatment V-10	6/25/2013	NA
Last Treatment V-16 through R-1	NA	7/8/2014
Harvest Date	9/23/2013	9/17/2014

Results: By Site and By Year

2012, Scandia Site 2
Farmer Cooperative Field

- Approximately 60 pounds of N per acre was applied through the irrigation water
- Low response to applied N
- Site not utilized after 2012 due to high NO3-N in irrigation water
- Sensor treatments over applied N

2012, Scandia Site 2
Farmer Cooperative Field



2012, Scandia Site 2 Farmer Cooperative Field

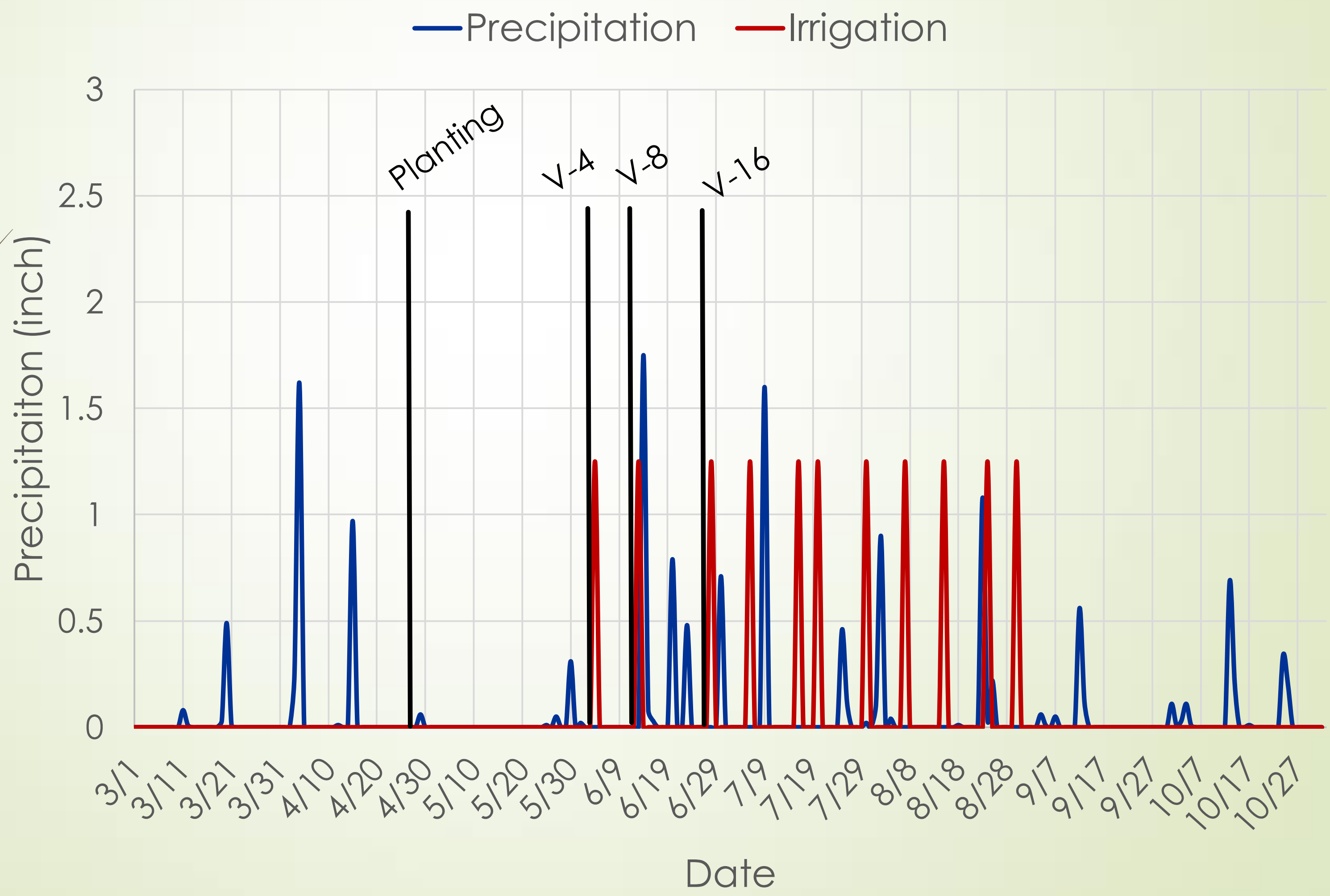
Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
4	Pre-plant/V4	20	40	40	100	209	A
9	Pre-plant/Sensor	20	125	30	175	209	ABC
1	Pre-plant	20	60	0	80	203	ABC
2	Pre-plant	20	140	0	160	201	ABC
3	Pre-plant	20	230	0	250	199	ABC
7	Pre-plant/Sensor	20	40	94	154	199	ABC
8	Pre-plant/Sensor	20	80	86	186	198	ABC
5	Pre-plant/V4	20	80	80	180	197	BC
6	Pre-plant/V4	20	105	105	230	193	C
10	Check	20	0	0	20	193	C

Treatments with same letter are not statistically different at an 0.05 alpha

2012, Scandia Station

- Split N applications Preplant/V-4 achieved highest yield 187 bu/ac at 180 lbs N/ac
- Preplant treatment required 230 lb N/ac to be statistically equal to highest yielding Split treatments
- Sensor treatment with 125 lb N/ac at Preplant was able achieve high yield but overestimated N need to attain it

2012, Scandia Station



2012, Scandia Station

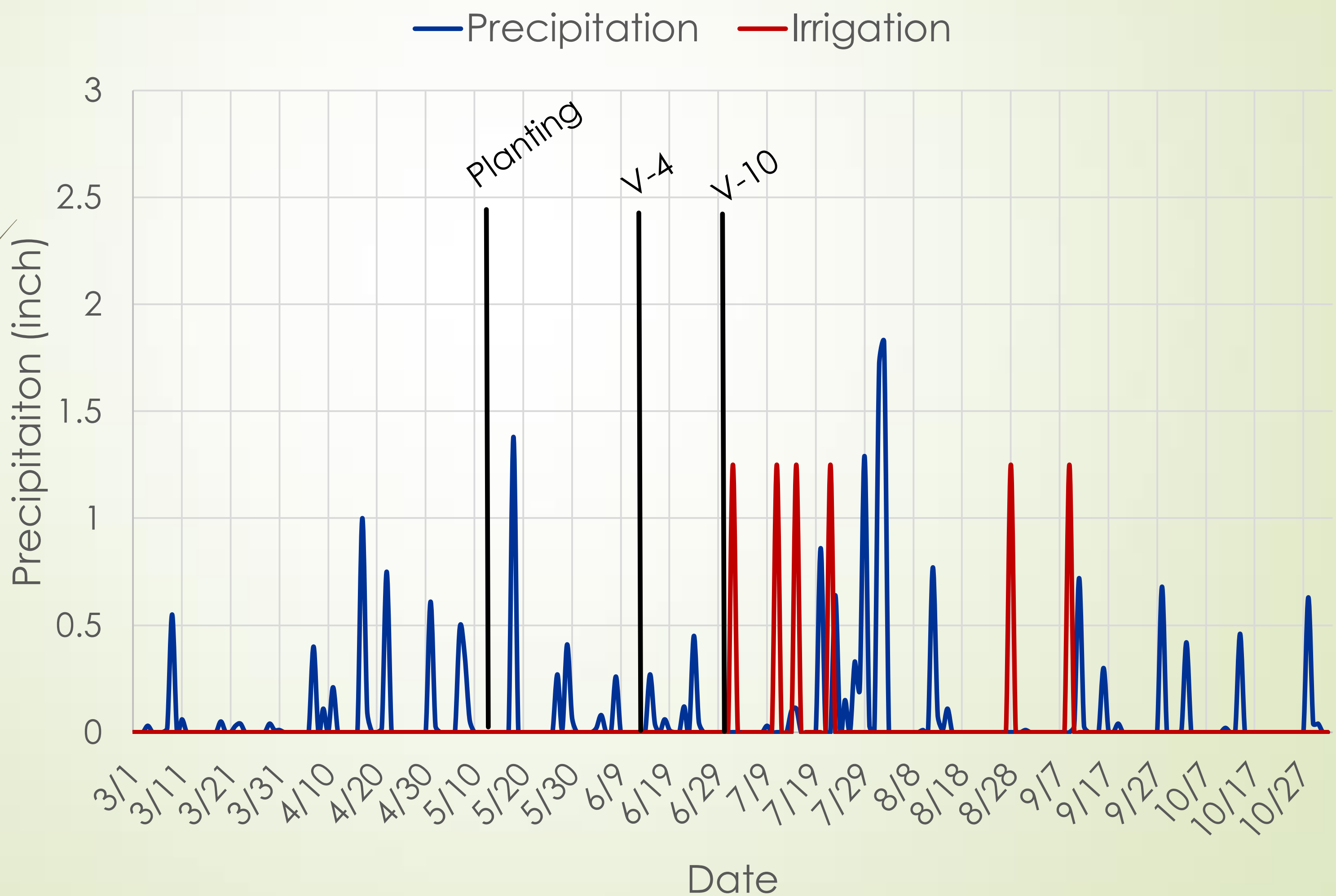
Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
6	Preplant/V4	20	105	105	230	188	A
5	Preplant/V4	20	80	80	180	187	A
3	Preplant	20	230	0	250	185	A
9	Preplant/Sensor	20	125	86	231	185	A
8	Preplant/Sensor	20	80	44	144	173	B
2	Preplant	20	140	0	160	166	BC
7	Preplant/Sensor	20	40	91	151	166	BC
1	Preplant	20	60	0	80	156	C
4	Preplant/V4	20	40	40	100	138	D
10	Check	20	0	0	20	119	E

Treatments with same letter are not statistically different at an 0.05 alpha

2013, Scandia Station

- Overall yields were lower than expected at 179 bu/ac. Expected yields were 250 bu/ac. Likely due to late planting
- Low response to applied N
- Primary response was to total N rate
- Conditions were conducive for mineralization of N
- Sensor treatments achieved highest yield group but overestimated the N requirements

2013, Scandia Station



2013, Scandia Station

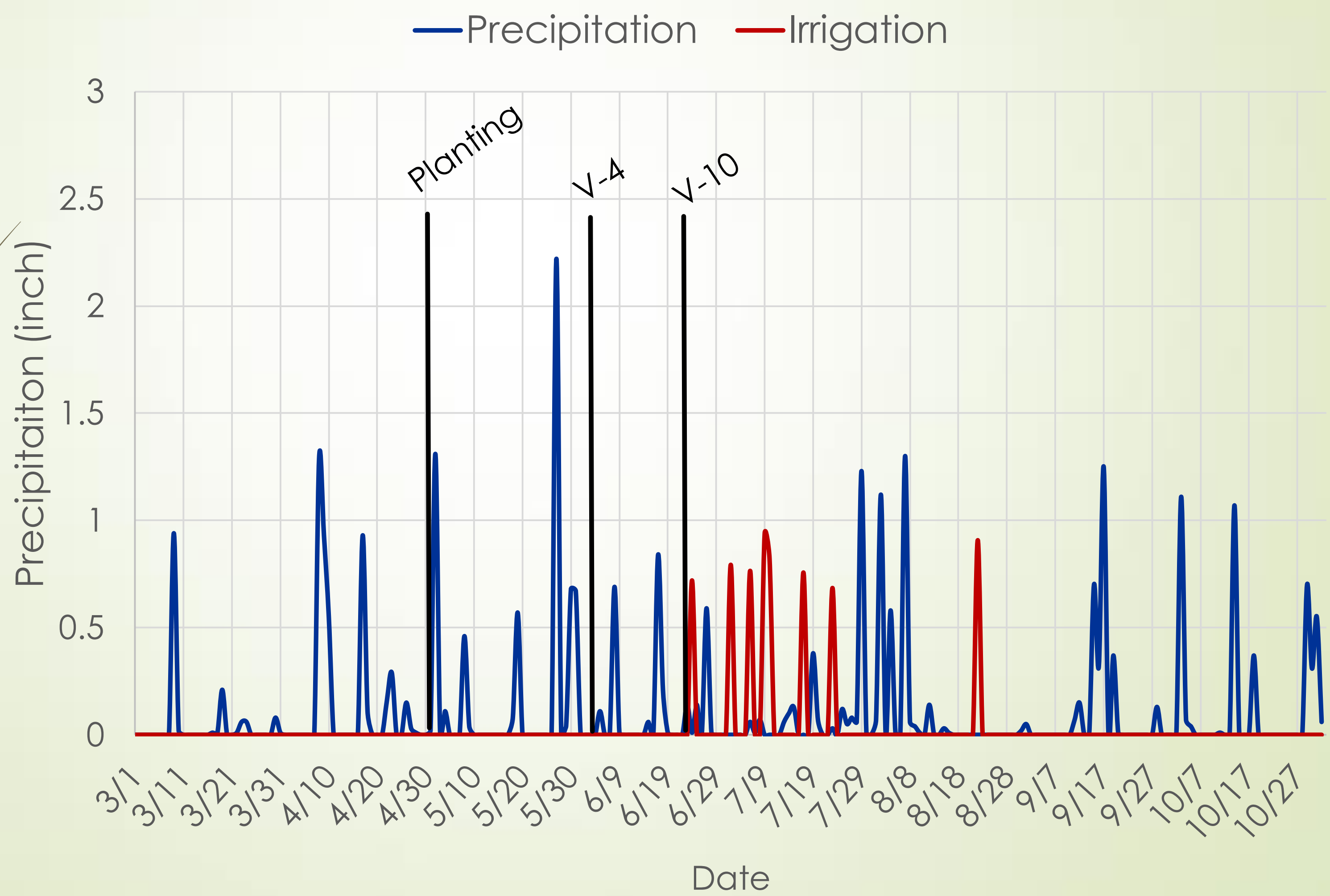
Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
5	Preplant/V4	20	60	60	140	179	A
8	Pre-plant/Sensor	20	80	87	187	177	AB
4	Preplant/V4	20	30	30	80	176	AB
3	Pre-plant	20	180	0	200	173	AB
6	Preplant/V4	20	90	90	200	172	AB
7	Pre-plant/Sensor	20	40	123	183	172	AB
2	Pre-plant	20	120	0	140	170	AB
9	Pre-plant/Sensor	20	120	133	273	169	AB
1	Pre-plant	20	60	0	80	167	B
10	Check	20	0	0	20	149	C

Treatments with same letter are not statistically different at an 0.05 alpha

2013, Rossville Station

- Significant response to applied N
- Soil is a deep sandy loam and incurred frequent leaching events, lowering overall yield ranging from 70-148 bu/ac
- Sensor treatments generated the highest yields but only statistically different from lower rate preplant treatments
- Results indicate fertigation systems may need to make frequent low rate N applications to satisfy N demand despite water requirements being met or exceeded

2013, Rossville Station



2013, Rossville Station

Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
8	Pre-plant/Sensor	0	80	144	224	148	A
7	Pre-plant/Sensor	0	40	212	252	148	A
9	Pre-plant/Sensor	0	120	149	269	144	AB
6	Preplant/V4	0	90	90	180	139	AB
5	Preplant/V4	0	60	60	120	135	ABC
2	Pre-plant	0	120	0	120	127	ABC
3	Pre-plant	0	180	0	180	123	BC
4	Preplant/V4	0	30	30	60	116	CD
1	Pre-plant	0	60	0	60	96	D
10	Check	0	0	0	0	70	E

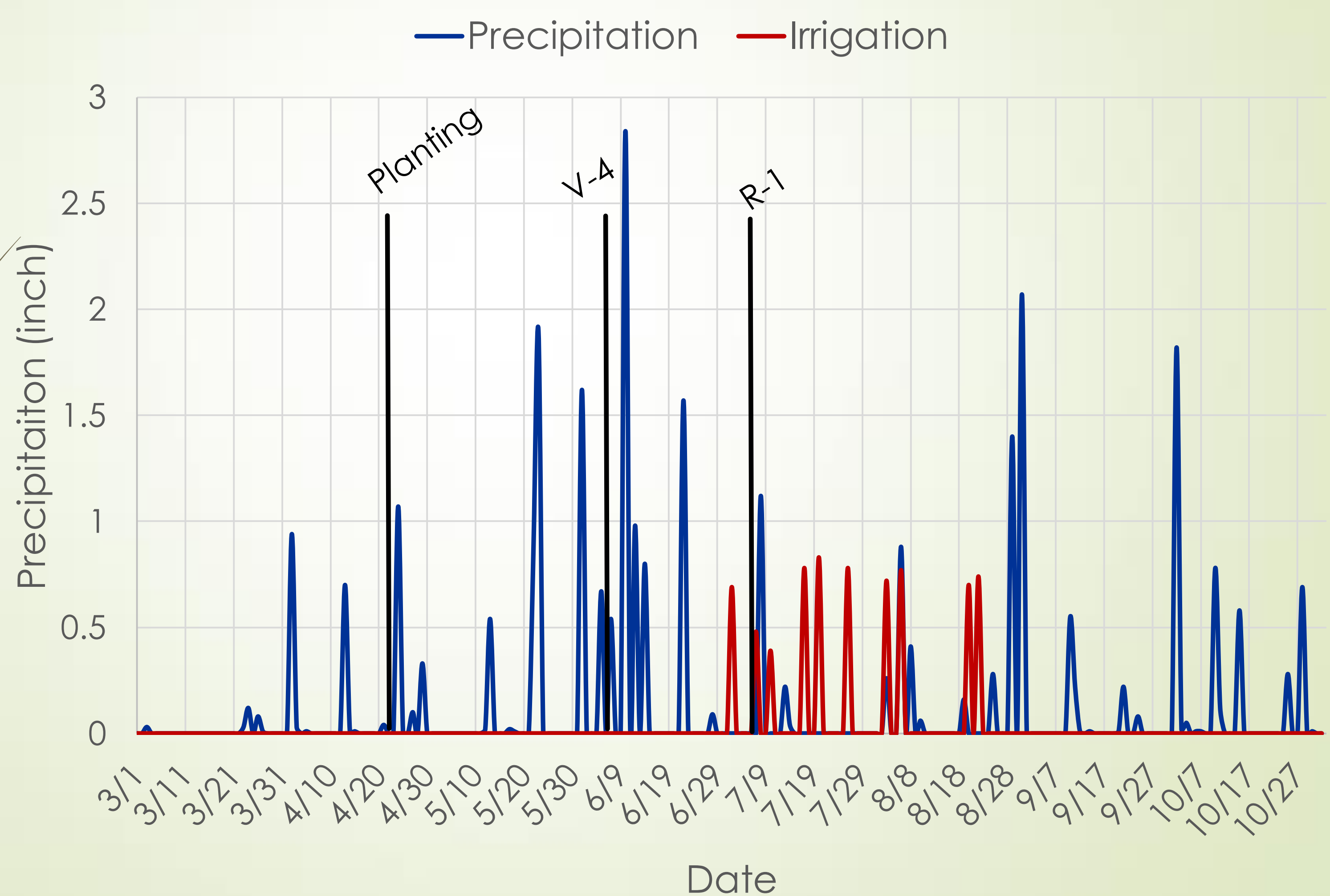
Treatments with same letter are not statistically different at an 0.05 alpha

2014, Rossville Station

- Excellent yields and significant response to N
- Clay lens at 24" to 36" depths held up water in the rooting zone, preventing leaching losses. As a result much higher yields were obtained compared to the 2013 Rossville site 186-257 bu/ac
- Sensor treatments were effective at finding 90% economic optimum, achieving 237 bu/ac from 55 lb of applied N/ac

2014, Rossville Station

2014, Rossville Station



2014, Rossville Station

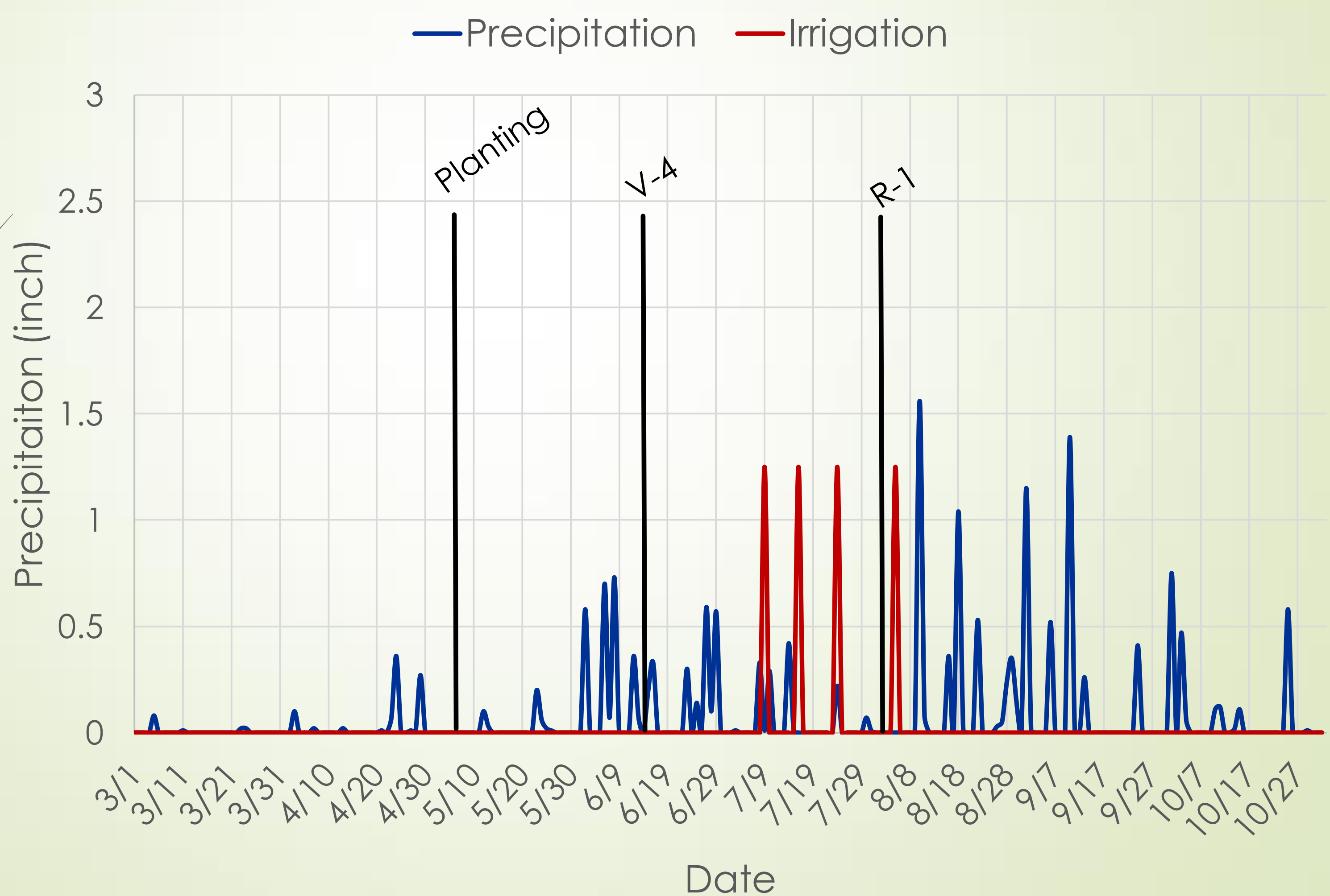
Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
2	Pre-plant	0	120	0	120	257	A
6	Preplant/V4	0	90	90	180	254	AB
5	Preplant/V4	0	60	60	120	248	ABC
3	Pre-plant	0	180	0	180	248	ABC
1	Pre-plant	0	60	0	60	239	ABC
7	Pre-plant/Sensor	0	40	15	55	237	ABC
9	Pre-plant/Sensor	0	120	0	120	228	BC
4	Preplant/V4	0	30	30	60	225	C
8	Pre-plant/Sensor	0	80	0	80	223	C
10	Check	0	0	0	0	186	D

Treatments with same letter are not statistically different at an 0.05 alpha

2014, Scandia Station

- Excellent yields 163-239 bu/ac and significant response to applied N
- Low N loss
- Conducive conditions for mineralized N, resulting in high productivity, 163 bu/ac check
- Sensor treatments were effective at determining the optimum N rate (150 lb N/ac) and achieve high yield 231 bu/ac

2014, Scandia Station



2014, Scandia Station

Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
6	Preplant/V4	0	90	90	180	239	A
3	Pre-plant	0	180	0	180	232	AB
9	Pre-plant/Sensor	0	120	30	150	231	AB
7	Pre-plant/Sensor	0	40	120	160	229	AB
2	Pre-plant	0	120	0	120	223	B
8	Pre-plant/Sensor	0	80	60	140	223	B
5	Preplant/V4	0	60	60	120	218	BC
1	Pre-plant	0	60	0	60	204	C
4	Preplant/V4	0	30	30	60	189	D
10	Check	0	0	0	0	163	E

Treatments with same letter are not statistically different at an 0.05 alpha

Pooled Results

- Significant interaction effect between year (weather),soil type, N rate and N timing.
- N loss and potential mineralized N is completely dependent upon observed weather on a given soil
- Effective N management systems must be able to account for current environmental conditions in order to optimize NUE
- Current Sensor algorithms are not optimized for crop monitoring and prone to overestimating N requirements

Pooled Results

Treatment	Timing Method	Starter N (lb/a)	Preplant N (lb/a)	In-Season N (lb/a)	Total N Applied (lb/a)	Yield (bu/a)	LSD Grouping
6	Preplant/V4	0	95	95	190	198	A
9	Pre-plant/Sensor	0	122	71	193	194	A
5	Preplant/V4	0	67	67	133	194	A
3	Pre-plant	0	197	0	197	193	A
7	Pre-plant/Sensor	0	40	109	149	192	A
2	Pre-plant	0	127	0	127	191	A
8	Pre-plant/Sensor	0	80	70	150	190	A
1	Pre-plant	0	60	0	60	177	B
4	Preplant/V4	0	27	27	53	175	B
10	Check	0	0	0	0	147	C

Treatments with same letter are not statistically different at an 0.05 alpha

Potential for Fertigation and Remote Sensing

- Would be able to conduct crop monitoring throughout the growing season, thus presenting the possibility to determine the optimize N rate and timing for any given soil and year (weather)
- Sensor algorithms must be specifically designed for fertigation systems
- Fertigation systems may need to apply N when water needs have been met or exceeded


Thank You to FFF for
your support.
Question?