Using N Timing to Enhance Yield and NUE in Dryland and Irrigated Corn

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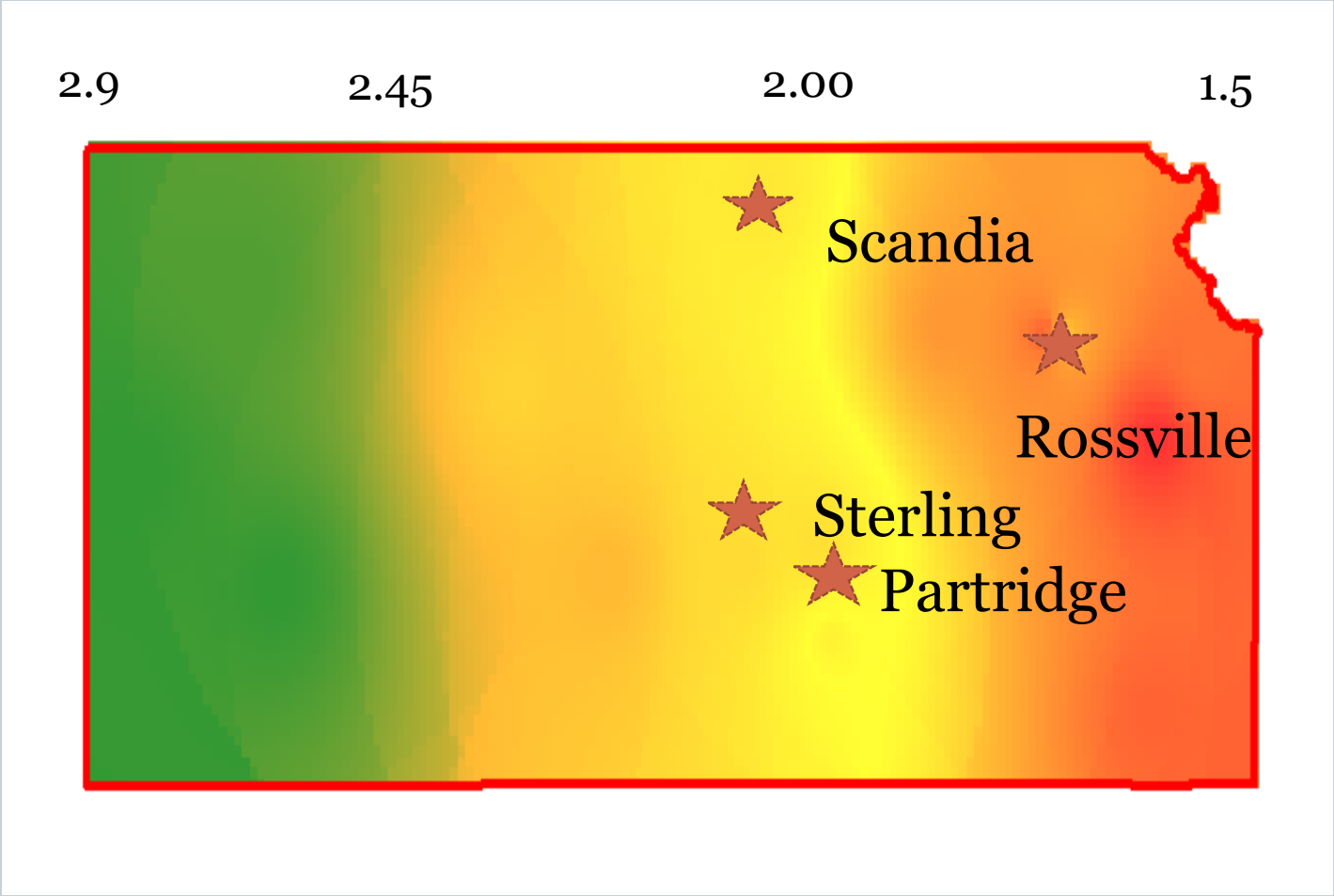
Objectives

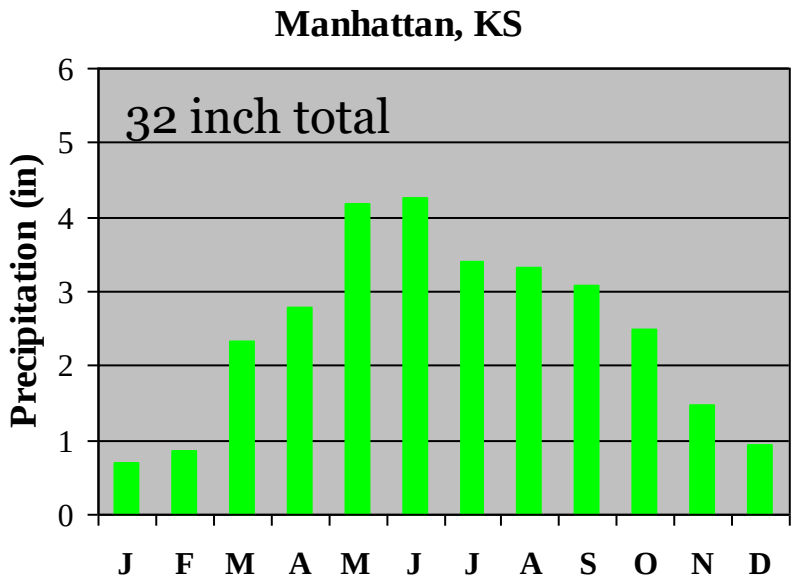
- Measure the impact of soils, weather, and N application timing on optimum N rate, N uptake, NUE and yield in irrigated and dryland corn production.
- Determine if the use of preplanned split application systems, can improve NUE compared to a fixed rate system using current N recommendations applied early in the growing season.
- Look at the use of alternative options to enhance NUE such as coated urea.

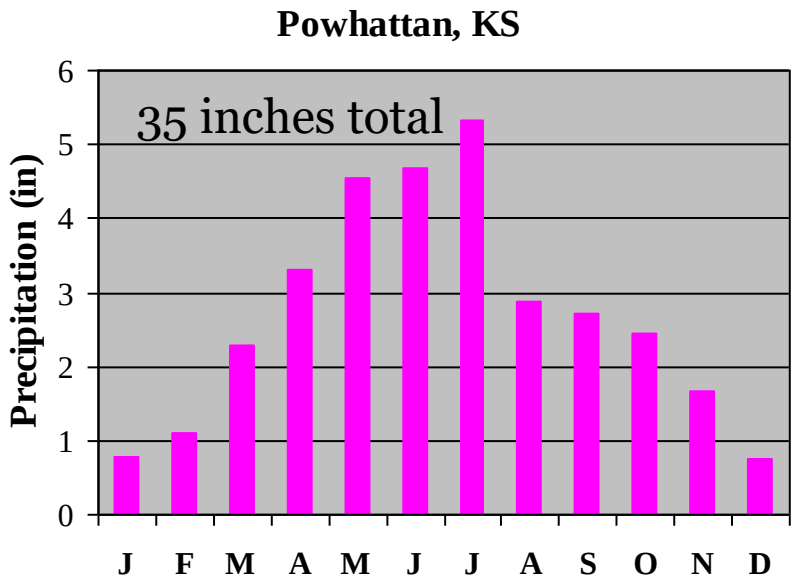
Objectives

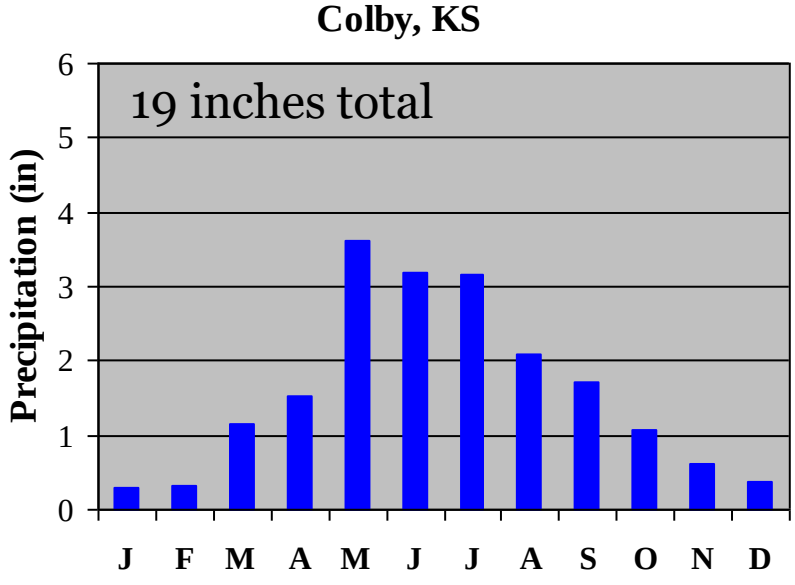
- Look at some alternative methods to estimate potential N needs in late season.
  - Active sensors
  - Spad Meter
  - Agronomists Judgement
- The focus this afternoon will be timing of N applications due to time.

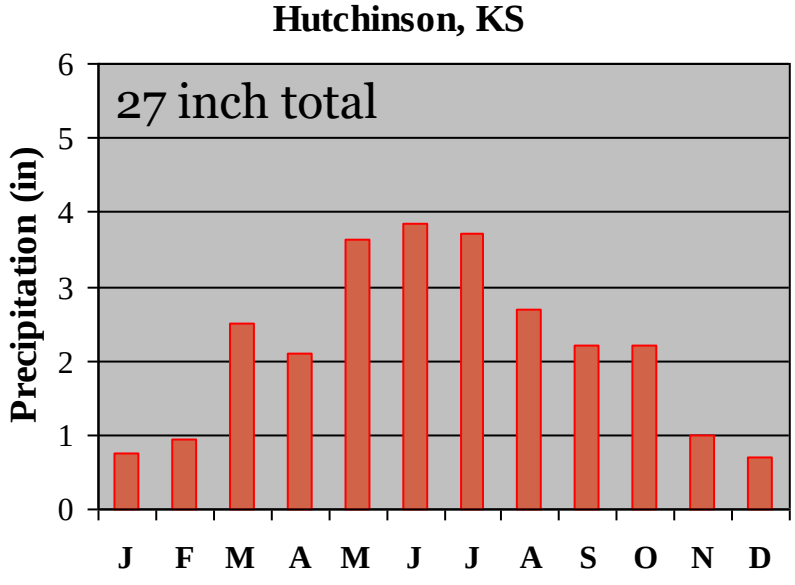
ET:Precip and Locations




Manhattan, KS
32 inch total
Precipitation (in)
0
1
2
3
4
5
6
J F M A M J J A S O N D


Powhattan, KS
35 inches total
Precipitation (in)
0
1
2
3
4
5
6
J F M A M J J A S O N D


Colby, KS
19 inches total
Precipitation (in)
0
1
2
3
4
5
6
J F M A M J J A S O N D


Hutchinson, KS
27 inch total
Precipitation (in)
0
1
2
3
4
5
6
J F M A M J J A S O N D

Experimental Design

- Project was designed to run from 2013 through 2015.
- Three irrigated and one dryland site each year
  - Rossville, NE KS, (near Topeka) Irrigated sandy loam
  - Scandia, NC KS, Irrigated silt loam
  - Partridge/Sterling, irrigated sandy loam
  - Sterling, SC KS, Dryland sandy loam

Experimental Design

- Experimental Design used was a RCB
- Four replications
- Individual Plots size was 10’ x 40’
- Sampling
  - 0-6” and 0-24” soil samples prior to planting
  - Tested for O.M., Mehlich-3 P, K, pH, Zn, NO_3, NH_4, Cl, S
- Canopy reflectance was measured at multiple growth stages.
  - V-4 through R-1
- Ear leaf samples @ R-1 and Whole Plants @ R-5/6
  - 20 ear leaves and 20 whole plants per plot
  - Tested for N content only

Treatments Used

Treatment	Starter N	Early N V2	Sidedress V-6 N	Sidedress V-10 N	R1 N	Total N applied
1	20*	0	0	0	0	20
2	20	60	0	0	0	80
3	20	120	0	0	0	140
4	20	180	0	0	0	200
5	20	0	60	0	0	80
6	20	0	120	0	0	140
7	20	0	180	0	0	200
8	20	0	0	60	0	80
9	20	0	0	120	0	140
10	20	0	0	180	0	200
Sensor E	20	0	0	Sensor	0	20 +
12	20	0	60	0	180	260
13	20	0	60	0	60	140
14	20	0	60	0	120	200
Sensor L	20	0	60	0	Sensor	80 +
16	20	0	60	0	Agronomist	80 +
17 U/ESN	20	0	0	120	0	140

Basic Soil and Site Information

Location	Sterling Dryland	Scandia Irrigated	Rossville Irrigated
Soil Type	Saltcreek and Naron Fine Sandy loams	Crete silt loam	Eudora sandy loam
Irrigation	No	Yes	Yes
Previous Crop	Soybeans	Soybeans	Soybeans
Tillage Practice	No-till	Ridge Till	Conventional

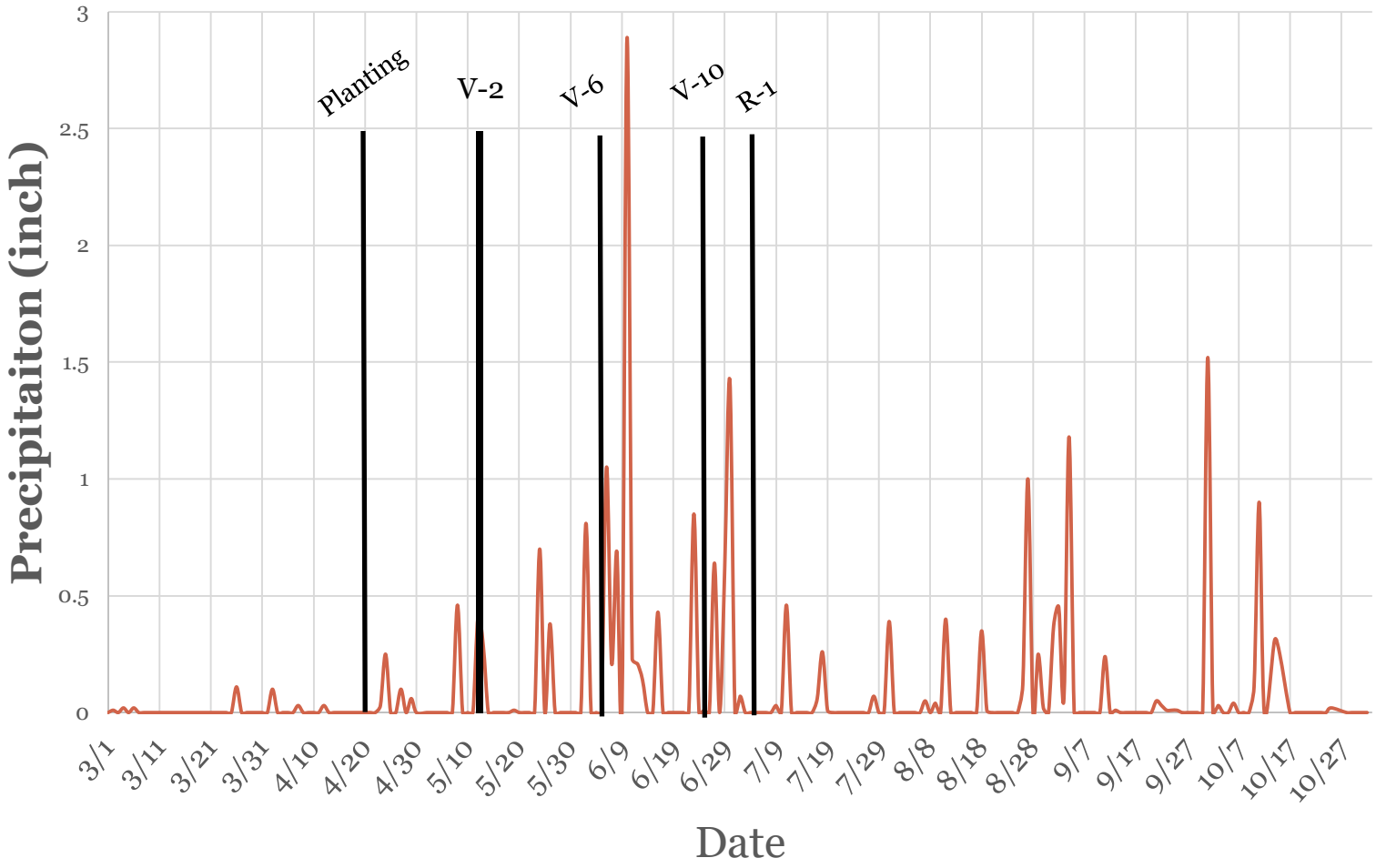
Dates and Management Information: 2014

Location	Sterling Dryland	Scandia Irrigated	Rossville Irrigated
Residual NO_3 lb. N ac^{-1}	26	48	24
Corn Hybrid	Pioneer 35F-50 Refuge	Pioneer P1602	Producers H9138 3000GT
Plant Population plants ac^{-1}	19000	33,500	30,400
Starter Fertilizer	7-23-5-5-0.5	20-20-0	20-20-0
Planting Date	4/20/14	5/5/14	4/23/14
First Treatment at Emergence	5/14/14	5/30/14	4/29/14
Second Treatment V-4	6/6/14	6/16/14	6/6/14
Third Treatment V-10	6/24/14	7/1/14	6/24/14
Last Treatment R-1	7/3/14	8/4/14	7/8/14
Harvest Date	9/1/14	11/11/14	9/17/14

Dates and Management Information: 2015

Location	Sterling Dryland	Scandia Irrigated	Rossville Irrigated
Residual NO_3 lb. N ac^{-1}	109	43	45
Corn Hybrid	Pioneer P0876	Pioneer 33D55	DK 64-49
Plant Population plants ac^{-1}	20,900	32,000	31,700
Starter Fertilizer	41-17-4-4-0.4	20-20-0	none
Planting Date	4/7/15	5/5/14	4/23/14
First Treatment at Emergence to V-2	5/14/14	5/30/14	4/29/14
Second Treatment V-6	6/6/14	6/16/14	6/6/14
Third Treatment V-10	6/24/14	7/1/14	6/24/14
Last Treatment R-1	7/3/14	8/4/14	7/8/14
Harvest Date	9/1/14	11/11/14	9/17/14

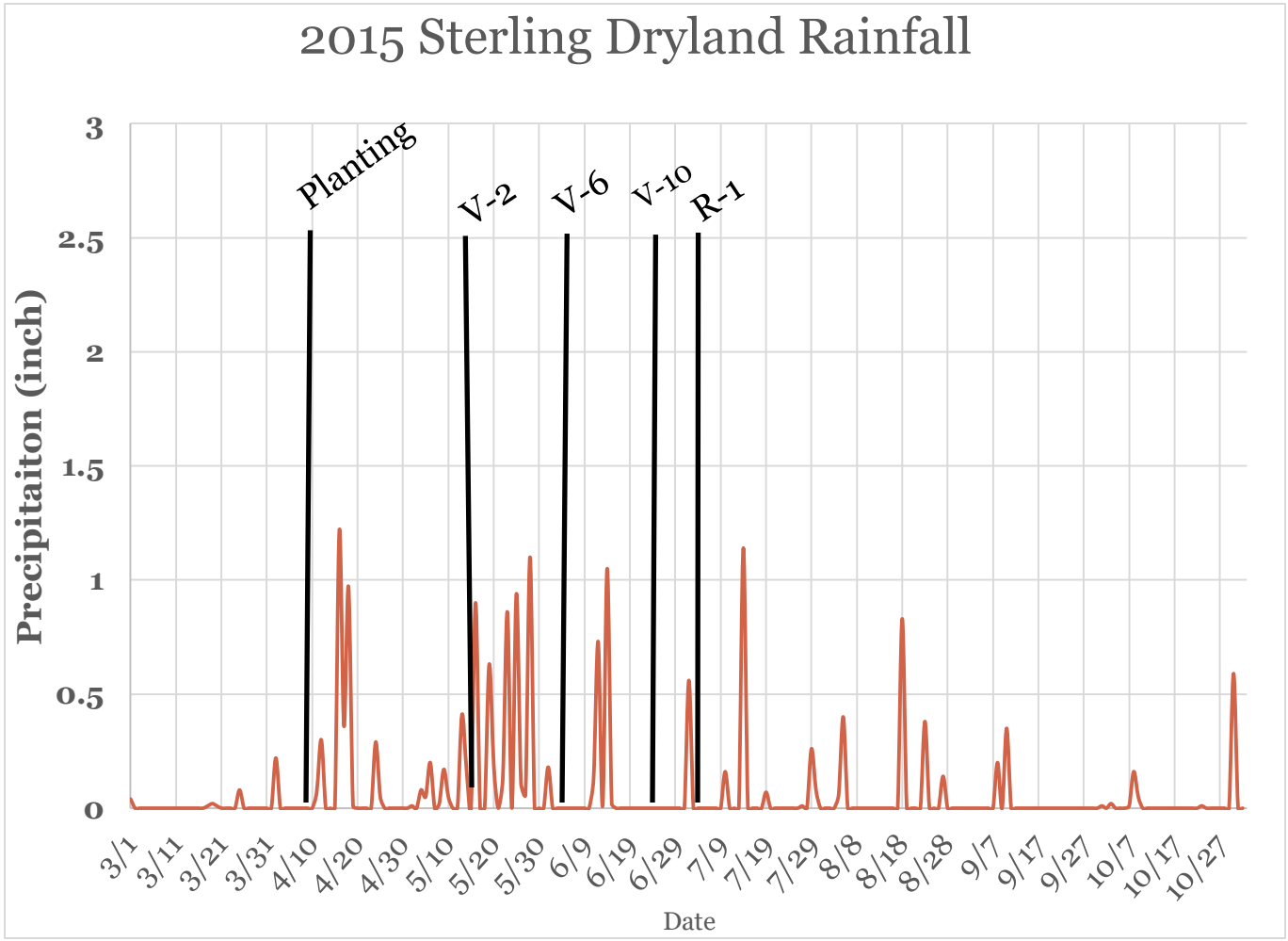
2014 Sterling Rainfall



Effects of Nitrogen application timing on corn grain yield, 2014, dryland, Sterling, KS

Treatment	Starter N	Early N V-2	Sidedress V-6	Sidedress V-10	Late N R1	Total N Applied	2014 Yield
1	7	0	0	0	0	7	144f
2	7	60	0	0	0	67	154bcd
3	7	120	0	0	0	127	155 bcd
5	7	0	60	0	0	67	148 ef
6	7	0	120	0	0	127	160 abc
8	7	0	0	60	0	67	157 abc
9	7	0	0	120	0	127	154 bcd
13	7	0	60	0	60	127	158 abc
14	7	0	60	0	120	187	159 abc
17 U/ESN	7	0	120*	0	0	127	164 a

Residual nitrate at planting = 26 pounds N per acre


2015 Sterling Dryland Rainfall
Precipitaiton (inch)
3
2.5
2
1.5
1
0.5
0
Planting
V-2
V-6
V-10
R-1
3/1
3/11
3/21
3/31
4/10
4/20
4/30
5/10
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
9/27
10/7
10/17
10/27
Date

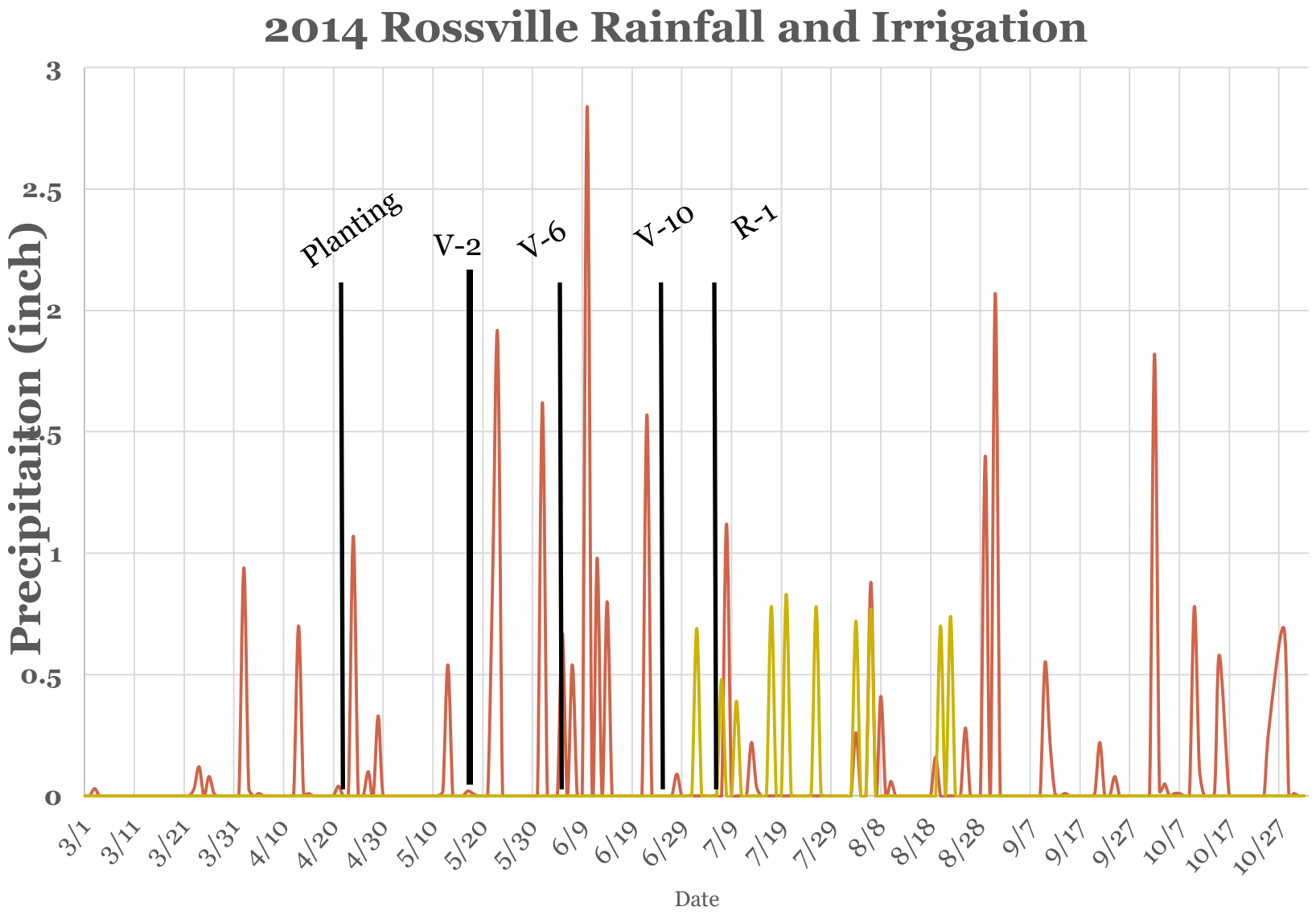
Effects of Nitrogen application timing on corn grain yield, 2015, dryland, Sterling, KS

Treatment	Starter N	Early N V-2	Sidedress V-6	Sidedress V-10	Late N	Total N Applied	2015 Yield
1	41	0	0	0	0	41	139 abc
2	41	60	0	0	0	101	141 ab
3	41	120	0	0	0	161	131 abc
5	41	0	60	0	0	101	131 abc
6	41	0	120	0	0	161	148 ab
8	41	0	0	60	0	101	124 bc
9	41	0	0	120	0	161	135 abc
13	41	0	60	0	60	161	129 abc
14	41	0	60	0	120	221	133 abc
17 U/ESN	41	0	120*	0	0	161	135 abc

Residual nitrate at planting = 109 pounds N per acre

Effects of Nitrogen application timing on corn N Uptake, 2015, dryland, Sterling, KS

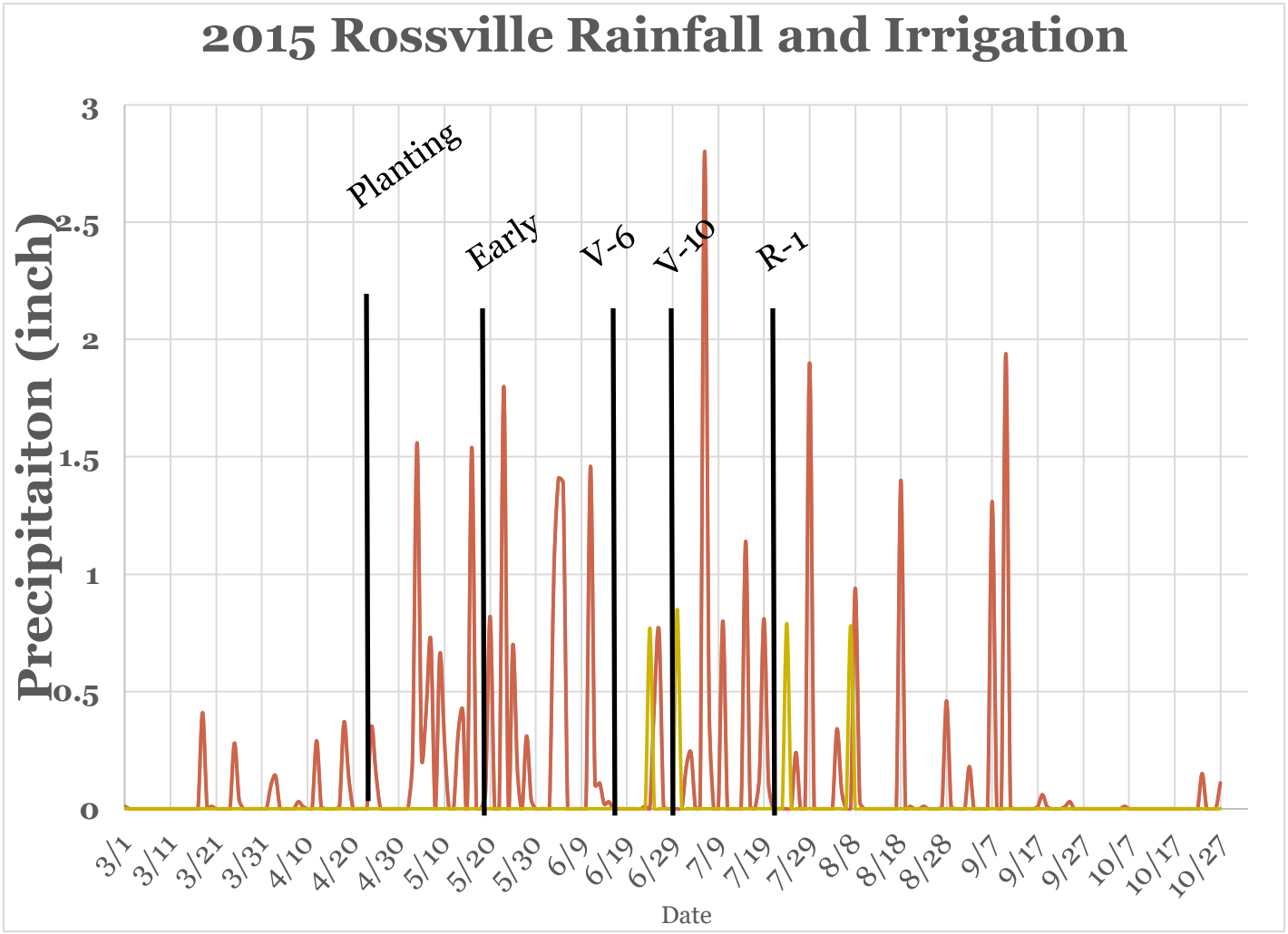
Treatment	Starter N	Early N Sidedress V-2	Sidedress V-6	Sidedress V-10	Late N R1 N	Total N Applied	2015 N Uptake	2015 NUE
1	41	0	0	0	0	41	119 a	-
2	41	60	0	0	0	67	136 a	-
3	41	120	0	0	0	127	112 a	-
5	41	0	60	0	0	67	118 a	-
6	41	0	120	0	0	127	107 a	-
8	41	0	0	60	0	67	121 a	-
9	41	0	0	120	0	127	112 a	-
13	41	0	60	0	60	127	113 a	-
14	41	0	60	0	120	187	125 a	-
17 U/ESN	41	0	120*	0	0	127	108 a	-


2014 Rossville Rainfall and Irrigation
Precipitaiton (inch)
3
2.5
2
1.5
1
0.5
0
Planting
V-2
V-6
V-10
R-1
3/1
3/11
3/21
3/31
4/10
4/20
4/30
5/10
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
9/27
10/7
10/17
10/27
Date

Effects of Nitrogen application timing on corn grain yield, 2014, irrigated, Rossville, KS

Treatment	Starter N	Early N	V-6	V-10	R1 N	Total N Applied	2014 Yield
1	20	0	0	0	0	20	97 e
3	20	120	0	0	0	140	151 dc
4	20	180	0	0	0	200	175 abc
6	20	0	120	0	0	140	168 bc
7	20	0	180	0	0	200	187 ab
9	20	0	0	120	0	140	172 ab
10	20	0	0	180	0	200	188 ab
13	20	0	60	0	60	140	183 ab
14	20	0	60	0	120	200	192 ab
17 U/ESN	20	120	0	0	0	140	186 ab

Residual nitrate at planting = 24 pounds N per acre


2015 Rossville Rainfall and Irrigation
Precipitaiton (inch)
3
2.5
2
1.5
1
0.5
0
Planting
Early
V-6
V-10
R-1
3/1
3/11
3/21
3/31
4/10
4/20
4/30
5/10
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
9/27
10/7
10/17
10/27
Date

Effects of Nitrogen application timing on corn grain yield, 2015, irrigated, Rossville, KS

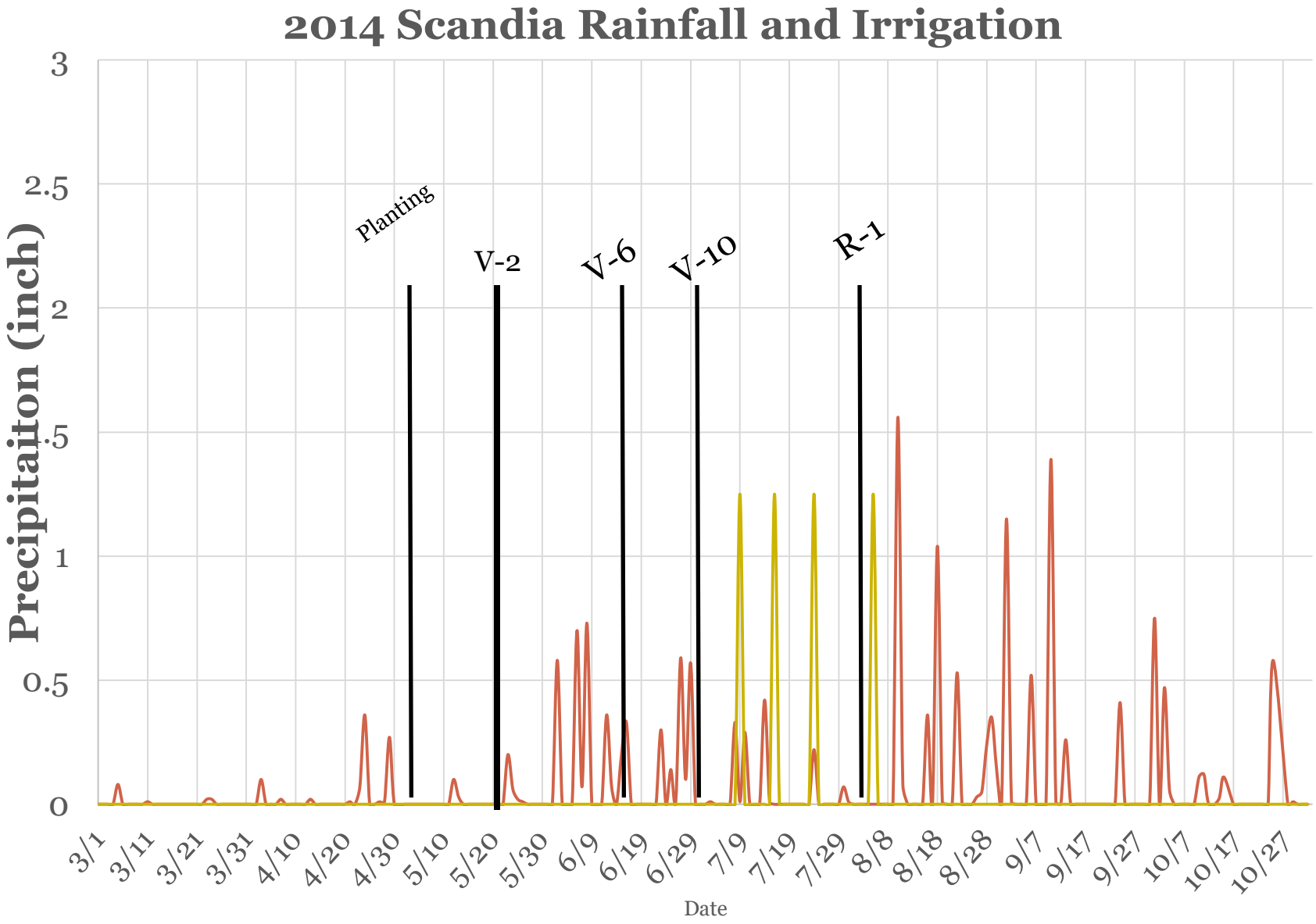
Treatment	Starter N	Early N	Sidedress V-6	V-10	Late R1	Total N Applied	2015 Yield
1	0	0	0	0	0	0	72 h
3	0	120	0	0	0	120	151 cdef
4	0	180	0	0	0	180	153 cde
6	0	0	120	0	0	120	182 ab
7	0	0	180	0	0	180	186 a
9	0	0	0	120	0	120	147 def
10	0	0	0	180	0	180	127 efg
13	0	0	60	0	60	120	186 abcd
14	0	0	60	0	120	180	156bcd
17 U/ESN	0	0	120	0	0	120	178 abc

Residual nitrate at planting = 45 pounds N per acre

Effects of Nitrogen application timing on corn N Uptake, 2015, irrigated, Rossville, KS

Treatment	Starter N	Early N V-2	Side N V-6	Side N V-10	Late N R1	Total N Applied	2015 N Uptake	2015 NUE
1	0	0	0	0	0	20	52 I	-
3	0	120	0	0	0	120	107 abcdef	0.46
4	0	180	0	0	0	180	108 abcde	0.46
6	0	0	120	0	0	120	125 ab	0.61
7	0	0	180	0	0	180	129 a	0.43
9	0	0	0	120	0	120	97 defgh	0.38
10	0	0	0	180	0	180	105 bcdef	0.29
13	0	0	60	0	60	120	117 abcd	0.54
14	0	0	60	0	120	180	103 cdefg	0.28
17 U/ESN	0	0	120*	0	0	120	128 a	0.63

Residual nitrate at planting = 45 pounds N per acre


2014 Scandia Rainfall and Irrigation
Precipitaiton (inch)
3
2.5
2
1.5
1
0.5
0
Planting
V-2
V-6
V-10
R-1
3/1
3/11
3/21
3/31
4/10
4/20
4/30
5/10
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
9/27
10/7
10/17
10/27
Date

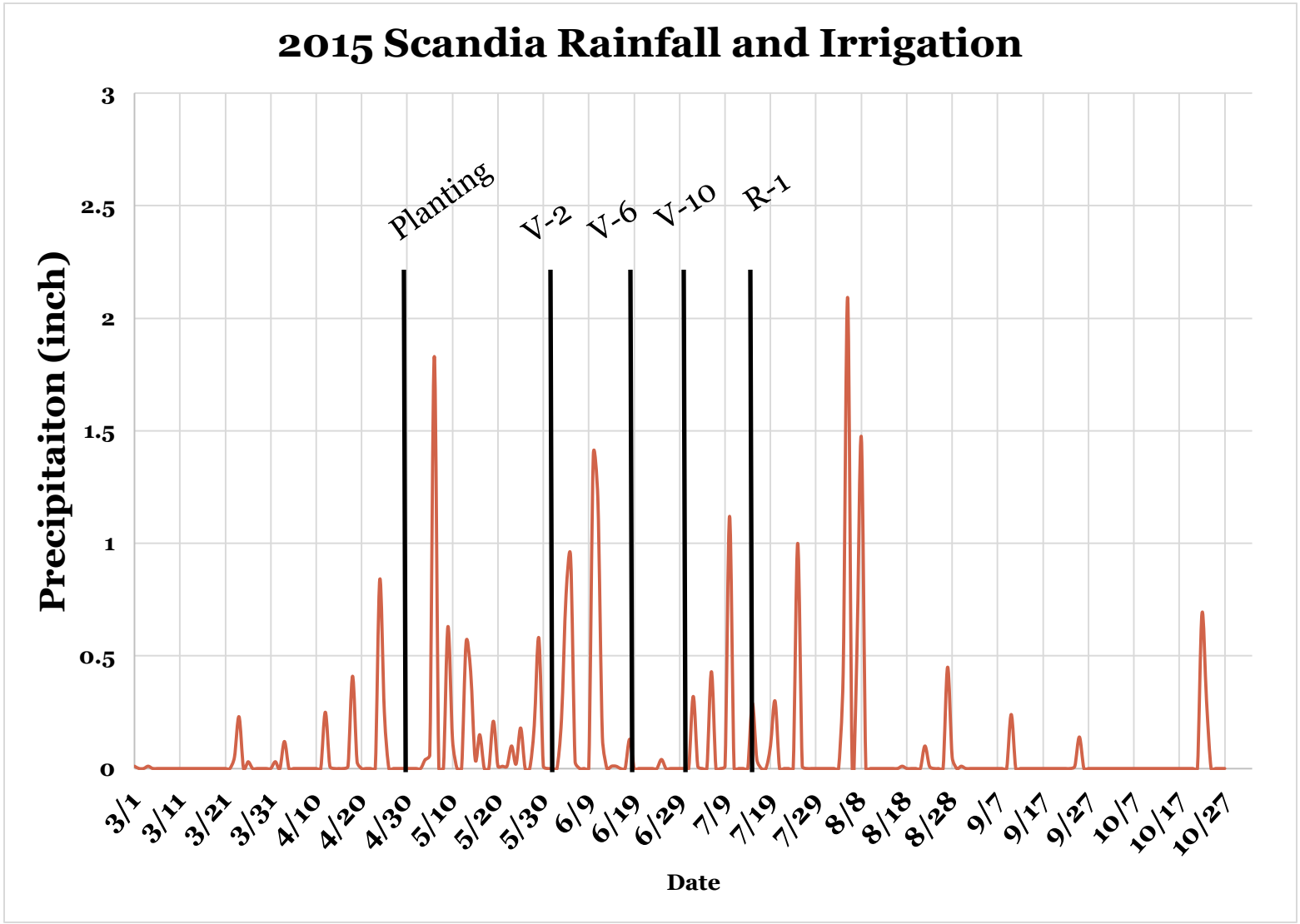
Effects of Nitrogen application timing on corn grain yield, 2014, irrigated, Scandia, KS

Treatment	Starter N	Early N	V-6	V-10	Late N R1	Total N Applied	2014 Yield
1	20	0	0	0	0	20	160 h
3	20	120	0	0	0	140	211 ef
4	20	180	0	0	0	200	216 de
6	20	0	120	0	0	140	229 abc
7	20	0	180	0	0	200	230 ab
9	20	0	0	120	0	140	216 de
10	20	0	0	180	0	200	229 abc
13	20	0	60	0	60	140	218 bcd
14	20	0	60	0	120	200	223 abcd
17 U/ESN	20	0	0	120	0	140	225 abcd

Residual nitrate at planting = 48 pounds N per acre

Effects of Nitrogen application timing on corn N Uptake, 2014, irrigated, Scandia, KS

Treatment	Starter N	Early N V-2	Side N V-6	Side N V-10	Late N R1	Total N Applied	2014 N Uptake	2014 NUE
1	20	0	0	0	0	20	116 g	-
3	20	120	0	0	0	140	160 de	0.37
4	20	180	0	0	0	200	160 de	0.24
6	20	0	120	0	0	140	180 bc	0.53
7	20	0	180	0	0	200	176 bcd	0.50
9	20	0	0	120	0	140	177 bcd	0.51
10	20	0	0	180	0	200	184 ab	0.38
13	20	0	60	0	60	140	174 bcd	0.58
14	20	0	60	0	120	200	180 bc	0.53
17 U/ESN	20	0	120*	0	0	140	181 ab	0.54


2015 Scandia Rainfall and Irrigation
Precipitaiton (inch)
3
2.5
2
1.5
1
0.5
0
Planting
V-2
V-6
V-10
R-1
3/1
3/11
3/21
3/31
4/10
4/20
4/30
5/10
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
9/27
10/7
10/17
10/27
Date

Effects of Nitrogen application timing on corn grain yield, 2015, irrigated, Scandia, KS

Treatment	Starter N	Early N	V-6 N	V-10 N	R1 N	Total N Applied	2015 Yield
1	20	0	0	0	0	20	152 d
3	20	120	0	0	0	140	201 abc
4	20	180	0	0	0	200	217 a
6	20	0	120	0	0	140	216 a
7	20	0	180	0	0	200	208 ab
9	20	0	0	120	0	140	202 abc
10	20	0	0	180	0	200	205 abc
13	20	0	60	0	60	140	187 c
14	20	0	60	0	120	200	212 a
17 U/ESN	20	0	0	120	0	140	202 abc

Residual nitrate at planting = 48 pounds N per acre

Effects of Nitrogen application timing on corn N Uptake, 2015, irrigated, Scandia, KS

Treatment	Starter N	Early N V-2	Side N V-6	Side N V-10	Late N R1	Total N Applied	2015 N Uptake	2015 NUE
1	20	0	0	0	0	20	71 h	-
3	20	120	0	0	0	140	151 cdef	0.66
4	20	180	0	0	0	200	153 cde	0.46
6	20	0	120	0	0	140	182 ab	0.92
7	20	0	180	0	0	200	186 a	0.64
9	20	0	0	120	0	140	147 def	0.63
10	20	0	0	180	0	200	159 abcd	0.49
13	20	0	60	0	60	140	167 abcd	0.80
14	20	0	60	0	120	200	156 bcd	0.47
17 U/ESN	20	0	120*	0	0	140	178 abc	0.89

Observation and Conclusions

- Rainfall patterns were not unusual
  - Early spring is often dry
  - Late May, June and early July are typical high rainfall months
  - Rainfall comes in thunderstorms, so often intense
  - Timing has a history of success but not often done
- Delayed application or split application worked best
  - On both sands and silt loams
  - Use 20-30 pounds of N as starter
  - Apply between V-2 to V-6
- Under irrigation also consider fertigation or a pre-tassel application on sands prone to leaching

Things I would do in the future: both research and production

- Incorporate fertigation concepts with more late applications, especially on coarse textured soils
  - Todays hybrids take up N during grain fill
    - Similar to many of the hybrids we used in the 70's & 80's
  - More applications simulating adding N with the system
  - Use ½ the N early, balance V-16 through early fill.
  - Be willing to adjust N rates in response to environment
- Look at tools to guide the Agronomist on late applications
  - Fired leaf counts: systems exist
  - Chlorophyll meter
  - Sensors???


Questions?
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