In-Season Precision Applications of Fluid Fertilizer to Optimize Cotton Productivity and Nitrogen Use Efficiency

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Objectives

- ✓ Estimate the spatial variations of lint yield, normalized difference vegetation index (NDVI), leaf N concentration, and soil nitrate within a field (2009, 2010, & 2011).
- ✓ Investigate the relationship between lint yield and NDVI, and between leaf N concentration and NDVI (2009, 2010, & 2011).
- ✓ Develop algorithms for variable-rate application of fluid N fertilizer, and compare variable-rate N application with uniform-rate N application in terms of N consumption and lint yield (2011 & 2012).

Experimental Design

- **Location:** UT REC at Milan
- **Duration:** 2011 & 2012
- **N Treatments:** 6
- **Strip plot:** *25’ × 400’*
- **Design:** Randomized complete block (RCB)
- **Replicates:** 3
- **Sub-plot:** *25’ × 50’*
- **Soil Types:** Calloway, Falaya, Grenada, Lexington
- **Initial Soil N:** 3 - 57 ppm

In-Season Fluid N Treatments

Pre-Planting Fertilization: 23 lb N/a + 60 lb P_2O_5/a + 90 lb K_2O/a

1. Zero N
2. Uniform-rate: 50 lb N/a
3. Uniform-rate: 70 lb N/a
4. Variable-rate: 30 to 90 lb N/a based on NDVI
5. Reversed variable-rate: 30 to 90 lb N/a based on NDVI
6. N application rate based on the average NDVI value in each strip plot

Application Timing: Early square - early bloom of UAN

Sampling and Measurements

- Soil nitrate & ammonium in 2 ft. before planting
- Leaf N concentrations, NDVI readings, & plant height (early square, early, mid, & late bloom)
- Lint yield at harvest using a picker equipped with an automatic yield monitor
- Fiber quality: micronaire, strength, length, & uniformity
- Soil nitrate & ammonium after harvest

GreenSeeker RT 200 NDVI Mapping System

Canopy NDVI Map Prior to N Treatments (2011)

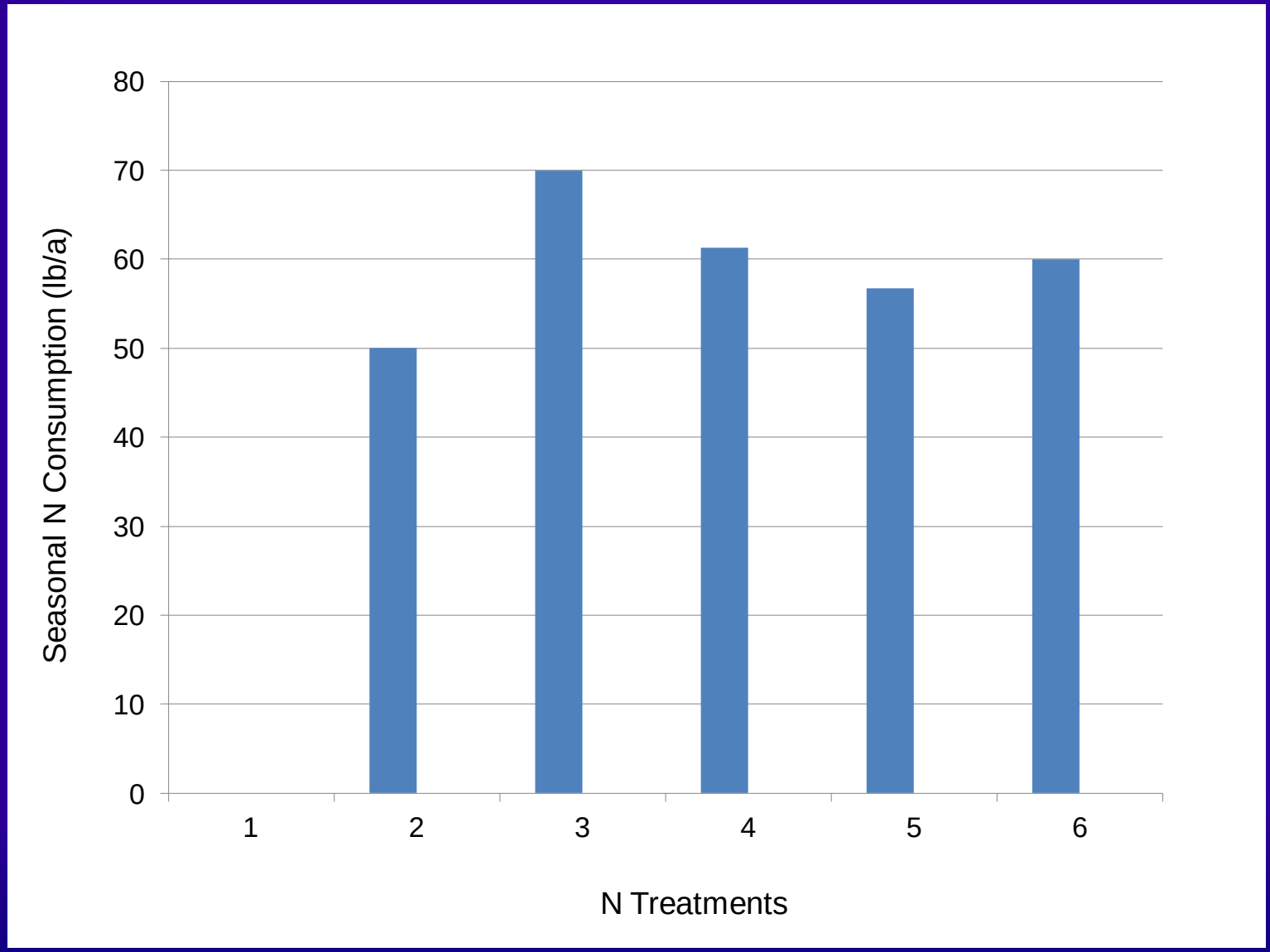
108	208	308	408	508	608	708	808	908	1008	1108	1208	1308	1408	1508	1608	1708	1808
0.29	0.28	0.29	0.29	0.34	0.29	0.38	0.55	0.60	0.61	0.63	0.63	0.55	0.56	0.54	0.56	0.50	0.48
107	207	307	407	507	607	707	807	907	1007	1107	1207	1307	1407	1507	1607	1707	1807
0.28	0.34	0.35	0.45	0.38	0.35	0.41	0.55	0.60	0.55	0.55	0.59	0.56	0.56	0.39	0.38	0.44	0.39
106	206	306	406	506	606	706	806	906	1006	1106	1206	1306	1406	1506	1606	1706	1806
0.48	0.45	0.47	0.49	0.52	0.50	0.51	0.52	0.56	0.53	0.54	0.56	0.52	0.55	0.52	0.53	0.38	0.39
105	205	305	405	505	605	705	805	905	1005	1105	1205	1305	1405	1505	1605	1705	1805
0.45	0.43	0.47	0.44	0.42	0.35	0.44	0.53	0.59	0.61	0.60	0.58	0.50	0.54	0.48	0.39	0.27	0.36
104	204	304	404	504	604	704	804	904	1004	1104	1204	1304	1404	1504	1604	1704	1804
0.29	0.31	0.37	0.31	0.39	0.19	0.42	0.52	0.62	0.61	0.57	0.57	0.37	0.36	0.31	0.34	0.52	0.53
103	203	303	403	503	603	703	803	903	1003	1103	1203	1303	1403	1503	1603	1703	1803
0.27	0.32	0.33	0.32	0.30	0.27	0.37	0.48	0.56	0.36	0.29	0.37	0.37	0.40	0.53	0.58	0.59	0.54
102	202	302	402	502	602	702	802	902	1002	1102	1202	1302	1402	1502	1602	1702	1802
0.32	0.30	0.32	0.25	0.22	0.23	0.34	0.37	0.46	0.53	0.53	0.49	0.56	0.52	0.57	0.53	0.56	0.47
101	201	301	401	501	601	701	801	901	1001	1101	1201	1301	1401	1501	1601	1701	1801
0.23	0.26	0.41	0.49	0.48	0.56	0.53	0.52	0.50	0.53	0.61	0.49	0.54	0.63	0.57	0.55	0.56	0.53

3	4	6	5	2	1	5	2	6	3	4	1	6	5	2	4	1	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

In-Season Fluid N Application Map (2011)

108	208	308	408	508	608	708	808	908	1008	1108	1208	1308	1408	1508	1608	1708	1808
70	90	70	30	50	0	50	50	30	70	30	0	50	90	50	30	0	70
107	207	307	407	507	607	707	807	907	1007	1107	1207	1307	1407	1507	1607	1707	1807
70	90	70	50	50	0	50	50	30	70	30	0	50	90	50	70	0	70
106	206	306	406	506	606	706	806	906	1006	1106	1206	1306	1406	1506	1606	1706	1806
70	70	70	70	50	0	70	50	30	70	50	0	50	90	50	50	0	70
105	205	305	405	505	605	705	805	905	1005	1105	1205	1305	1405	1505	1605	1705	1805
70	70	70	50	50	0	50	50	30	70	30	0	50	70	50	70	0	70
104	204	304	404	504	604	704	804	904	1004	1104	1204	1304	1404	1504	1604	1704	1804
70	90	70	30	50	0	50	50	30	70	30	0	50	30	50	90	0	70
103	203	303	403	503	603	703	803	903	1003	1103	1203	1303	1403	1503	1603	1703	1803
70	90	70	30	50	0	50	50	30	70	90	0	50	50	50	30	0	70
102	202	302	402	502	602	702	802	902	1002	1102	1202	1302	1402	1502	1602	1702	1802
70	90	70	30	50	0	30	50	30	70	50	0	50	70	50	50	0	70
101	201	301	401	501	601	701	801	901	1001	1101	1201	1301	1401	1501	1601	1701	1801
70	90	70	70	50	0	70	50	30	70	30	0	50	90	50	30	0	70
3	4	6	5	2	1	5	2	6	3	4	1	6	5	2	4	1	3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

In-Seasonal Fluid N Consumption (2011 & 2012)



Leaf N Responses to N Treatments

N Treatment	Early Square	Early Bloom	Mid Bloom	Late Bloom
1	4.05	3.83c	3.58c	3.44b
2	4.04	4.08ab	3.68bc	3.69ab
3	4.07	4.17ab	3.84a	3.88a
4	4.13	4.14ab	3.76ab	3.73a
5	4.18	4.23a	3.77ab	3.84a
6	3.96	4.02bc	3.70bc	3.65ab
Sig.	ns	**	**	*

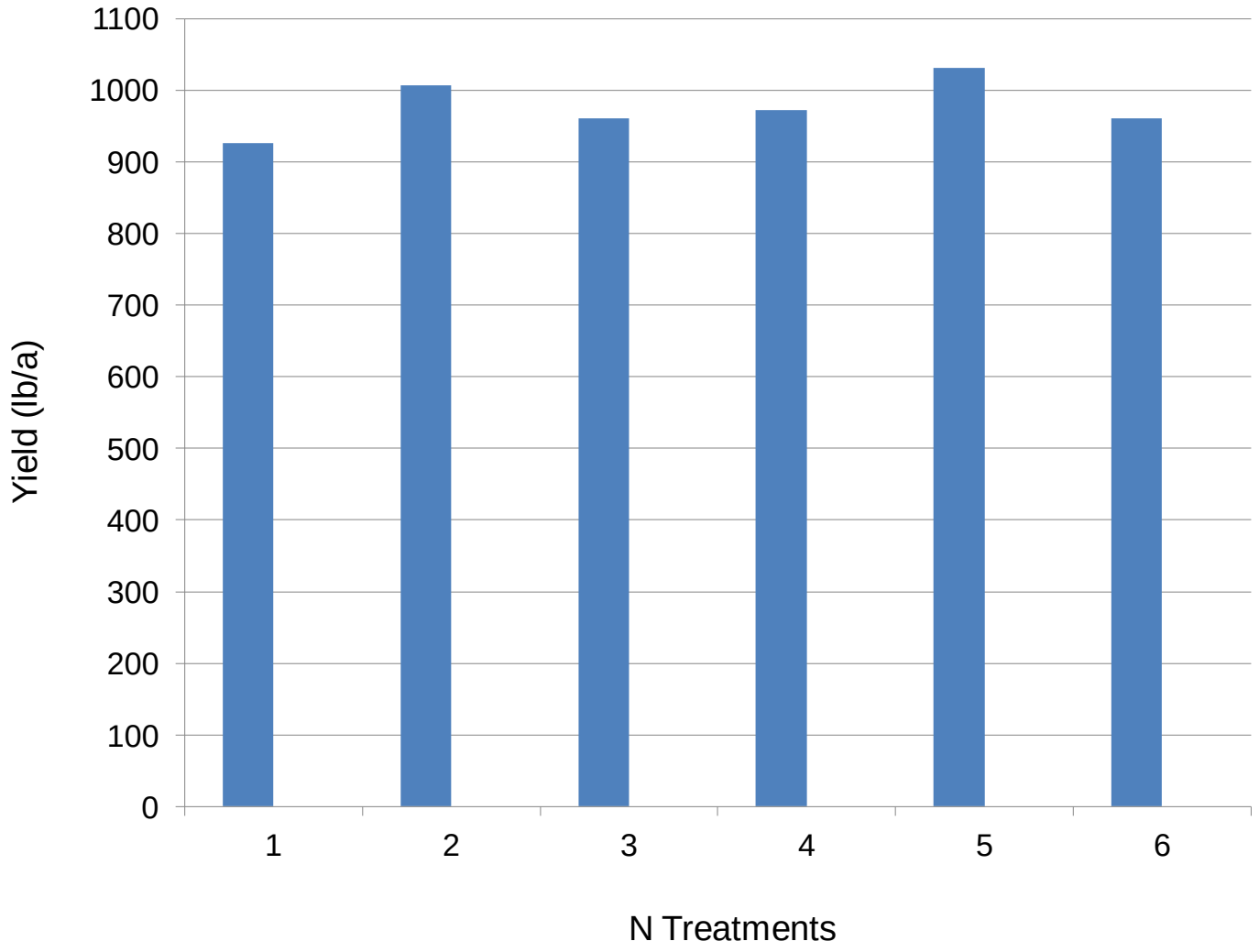
Canopy NDVI Responses to N Treatments

N Treatment	Early Square	Early Bloom	Mid Bloom	Late Bloom
1	0.55	0.69	0.70	0.73
2	0.57	0.70	0.71	0.73
3	0.58	0.70	0.71	0.73
4	0.56	0.69	0.70	0.73
5	0.55	0.70	0.72	0.75
6	0.58	0.68	0.70	0.72
Sig.	ns	ns	ns	ns

Plant Height Responses to N Treatments

N Treatment	Early Square	Early Bloom	Mid Bloom	Late Bloom
1	25.3	32.2b	36.6	38.8
2	26.2	31.9b	36.8	39.6
3	26.5	33.8a	38.3	40.1
4	26.0	32.4b	36.9	39.2
5	25.8	32.0b	36.9	39.6
6	26.2	31.7b	36.5	39.3
Sig.	ns	*	ns	ns

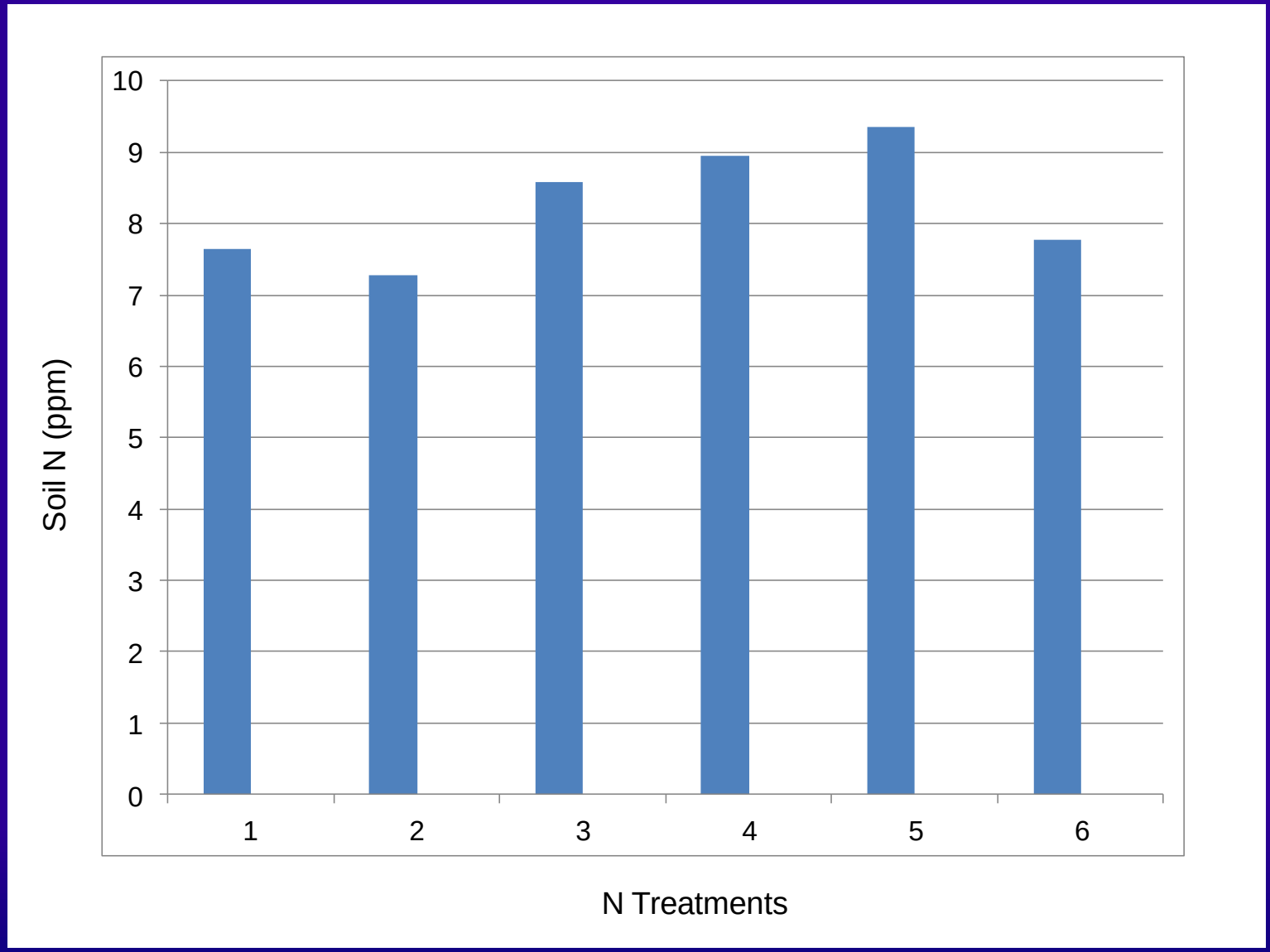
Lint Yield Response to N Treatments



Fiber Quality Responses to N Treatments

N Treatment	Micronaire	Strength	Length	Uniformity
1	4.95	32.9	1.12	83.2
2	4.90	33.3	1.11	83.3
3	4.95	32.2	1.09	82.3
4	4.95	33.0	1.11	82.9
5	4.85	33.1	1.11	83.7
6	5.00	32.2	1.09	82.7
Sig.	ns	ns	ns	ns

Post-Harvest Soil N Responses to N Treatments



USDA NRCS Project

- ✓ Conservation Innovation Grants (CIG)
- ✓ Variable-Rate N Applications on Cotton
- ✓ TN, MO, MS, & LA
- ✓ 10 Locations/yr
- ✓ 2012-2014
- ✓ $700,000

Summary

- ✓ Leaf N concentrations were generally higher under in-season N applications than those under zero N at the early, mid, and late bloom stages.
- ✓ No significant differences in canopy NDVI or plant height were observed at mid or late bloom stage, 20 to 30 days after in-season N applications.
- ✓ Lint yield was not significantly affected by in-season N applications on a field with pre-planting application of about 20 lb N/a in this study.

Summary (Continued)

- ✓ The three variable-rate N algorithms consumed 7 to 11 lb/a more N than the uniform rate of 50 lb N/a, but 9 to 13 lb/a less of N than the uniform rate at 70 lb N/a.
- ✓ It may be difficult to compare in-season variable-rate N applications with traditional uniform-rate N application in terms of their effects on cotton yields on fields with pre-planting N applications.

Acknowledgments

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Thanks!!!

Questions???