CONTROLLED RELEASE N FERTILIZERS FOR MISSOURI COTTON PRODUCTION

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Abstract

Liquid and granular controlled release fertilizers were compared to traditional fertilizers on three cotton soil types. In the first two years of a three year study, results indicate on silt soils a controlled release liquid fertilizer and the treatments with split applications performed best. On clay soils, the superior treatment was the granular controlled release. On sand soils the tradition urea split application and the granular slow release fertilizer produced the highest yields.

Introduction

Supplemental nitrogen fertilization is often required to maximize cotton production in Missouri. A common cotton production system is to apply 60 lbs N/a pre-plant followed by 60 lbs N/a at pinhead square. With increasing labor and fuel costs cotton producers are looking for ways to save money. It would be desirable to apply the entire N needed pre-plant and save subsequent fuel and labor costs associated with mid-season N applications. Our previous research at the Delta Center has clearly shown that there is a yield penalty with all pre-plant N programs and that this is great enough to overcome the increased costs of split applications.

Controlled release N fertilizers have the possibility to overcome the yield penalty of all pre-plant systems while saving cotton producers the time and expense of mid-season applications. True controlled release fertilizers make use of either chemicals or physical barriers, which delay the availability of nitrogen in the soil system. In these ways the applied nitrogen is protected from potential losses until the plant needs it. A drawback of controlled release fertilizers is that this availability must be synchronized to plant needs.

Two controlled release N fertilizers, one liquid (Nfusion, Georgia Pacific Inc.) and one granular (ESN, Agrium, Inc.) are currently being marketed for agricultural production. Both of these products have been formulated and optimized for corn production. These products are more expensive than traditional N fertilizers, costing about $0.10 more per lb of N.

The objective is to evaluate the effectiveness controlled release N fertilizers relative to pre-plant and split nitrogen fertilizer programs for Missouri cotton production and investigate which, if any cotton soil type is most suited to profitable controlled release N fertilizer use.

Materials and Methods

This report covers the first two years of a continuing three year study. The experiment was conducted at three locations representing the major cotton soil types of Southeast Missouri (sand, silt loam, & gumbo). The soil type at the sand area was a Bosket fine sandy loam (fine-loamy, mixed, thermic Mollic Hapludalf), at the silt loam area a Tiptonville silt loam soil (fine-loamy, mixed, thermic Typic Argiudolls), and the gumbo area Sharkey clay (very fine, montmorillonitic, thermic Vertic Haplaquept) soil. At each location ten treatments of ESN, Nfusion, UAN, urea and combinations were checked against the area standard of 60 lbs N preplant and 60 lbs sidedress of urea. A list of the treatments can be found in Table 1. The experiment will be replicated four times in a randomized complete block.

Cotton was planted at each location in May. It was subsequently cultivated using the standard cultural practices for weed and insect control for producing irrigated cotton in Missouri. The cotton plots were defoliated in mid September of and harvested in October. The resulting seed-cotton was ginned and lint turnout percentage calculated. The resulting cotton lint was then analyzed for the fiber quality properties: micronaire, length, strength, uniformity, color grade and trash percentage. These fiber quality properties were determined at the International Textile Research Center in Lubbock Texas using high volume instrument analysis.
Statistical analyses of the data were preformed for each individual year and location with ARM.

Results

Silt: As shown in table 5, the 2010 yield results on silt soil show a good response to the three Nfusion + UAN treatments, although the results are not statistically different. Table 2 illustrates the 2010 nitrate levels in the petioles. The untreated check with no N applied and treatment 6, 120 lbs N with 50% of N from Nfusion and 50% from UAN, fall below the critical N levels after cutout on the August 17 test date. All treatments are above the critical level of N throughout the season. In 2011 both area standards, split application of UAN and urea, yielded the highest; however, none of the controlled release fertilizers treatments, liquid and granular, were significantly different. The results show no difference in fiber quality throughout the different treatments in 2010. In 2011 the untreated check did have a higher micronaire; however, it was not in discount range according to the 2011 loan chart.

Clay: In table 7, the yield results on clay soil in 2010 show that ESN and the area standard of 60 lbs urea pre-plant followed by 60 lbs urea sidedress are the superior treatments. There is no difference in fiber quality throughout the different treatments. Table 3 illustrates the nitrate levels in petioles. Expectedly, all treatments except the untreated check are above the critical levels of N. On the July 15 test date, the ESN treatments (9, 10, and 11) and the area standard of 60 lbs urea pre-plant followed by 60 lbs urea sidedress (treatment 8) have the highest ppm of N. The slow release N in treatments 9, 10, and 11 were also the highest yielding treatments. The results suggest that from petiole test dates July 1 and July 15 the slow release N was activated. In table 8, the 2011 yield results show treatment 11, 60 lbs ESN with 60 lbs urea preplant is the superior treatment. The area standard of split application of urea also yielded high with no significant difference to the highest yielding treatment.

Sand: In 2010 the highest yielder in the sandy soil trial is treatment 8, the area standard 60 lbs urea preplant and 60 lbs urea sidedress. The UAN and Nfusion + UAN treatments also did well. The ESN treatment did not perform well on sandy soils although the July 15 petiole nitrate levels do not show deficiencies in the ESN treatments. In 2011, the Clarkton location had a hail storm on May 28; as a result all yields were low. Treatment 10, 90 ESN + 30 urea applied pre-plant, was the highest yielder. The 120 UAN pre-plant was the lowest yielding treatment. All other treatments were not significantly different.

Acknowledgement

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Table 1. Trial treatments and price per acre of each treatment.

	Treatment
1	Untreated Check
2	120 UAN pre-plant
3	60 UAN pre-plant + 60 UAN PHS
4	120 N (20% NFusion + 80% UAN) pre-plant
5	120 N (25% NFusion + 75% UAN) pre-plant
6	120 N (50% NFusion + 50% UAN) pre-plant
7	120 urea pre-plant
8	60 urea pre-plant + 60 urea PHS
9	120 ESN pre-plant
10	90 ESN + 30 urea pre-plant
11	60 ESN + 60 urea pre-plant

Table 2. Petiole nitrate results from the Portageville, MO silt trial.

	NO3 7/1/2010	NO3 7/15/2010	NO3 8/1/2010	NO3 8/17/2010
1 Untreated Check	37350 *ab*	33875 *a*	7963 *d*	1837 *cd*
2 120 UAN pre-plant	39350 *ab*	32250 *a*	8468 *cd*	2003 *bcd*
3 60 UAN pre-plant + 60 UAN PHS	41900 *a*	37150 *a*	11585 *a-d*	4350 *a*
4 24 NFusion + 96 UAN pre-plant	36000 *b*	34875 *a*	9715 *a-d*	2298 *bcd*
5 30 NFusion + 90 UAN pre-plant	41075 *ab*	34650 *a*	10160 *a-d*	2068 *bcd*
6 60 NFusion + 60 UAN pre-plant	38100 *ab*	33250 *a*	9480 *bcd*	1048 *d*
7 120 urea pre-plant	38875 *ab*	32675 *a*	10900 *a-d*	2137 *bcd*
8 60 urea pre-plant + 60 ureaPHS	38375 *ab*	38425 *a*	12300 *ab*	3565 *abc*
9 120 ESN pre-plant	39650 *ab*	35025 *a*	13250 *a*	3710 *ab*
10 90 ESN + 30 urea pre-plant	38850 *ab*	38725 *a*	12145 *abc*	3433 *abc*
11 60 ESN + 60 urea pre-plant	39550 *ab*	36125 *a*	12400 *ab*	2853 *a-d*
LSD (P=.05)	4909.91	5603.9	3235.87	1622.3
Standard Deviation	3400.42	3881.05	2241.04	1106.21
CV	8.72	11.03	20.83	41.53
Grand Mean	39006.82	35184.1	10760.45	2663.79

Table 3. Petiole nitrate results from the Portageville, MO clay trial.

	NO3 7/1/2010	NO3 7/15/2010	NO3 8/1/2010
1 Untreated Check	3756 *b*	2921 *f*	264 *a*
2 120 UAN pre-plant	6173 *ab*	9148 *de*	231 *a*
3 60 UAN pre-plant + 60 UAN PHS	7045 *ab*	7558 *ef*	211 *a*
4 24 NFusion + 96 UAN pre-plant	5505 *ab*	11438 *b-e*	199 *a*
5 30 NFusion + 90 UAN pre-plant	8009 *ab*	8338 *def*	210 *a*
6 60 NFusion + 60 UAN pre-plant	6528 *ab*	9430 *cde*	207 *a*
7 120 urea pre-plant	10377 *a*	15500 *bc*	212 *a*
8 60 urea pre-plant + 60 ureaPHS	9458 *a*	16650 *ab*	202 *a*
9 120 ESN pre-plant	7589 *ab*	16890 *ab*	221 *a*
10 90 ESN + 30 urea pre-plant	7863 *ab*	14208 *bcd*	219 *a*
11 60 ESN + 60 urea pre-plant	8523 *ab*	21850 *a*	248 *a*
LSD (P=.05)	4215.77	5622.18	55.37
Standard Deviation	2915.4	3893.72	38.35
CV	39.68	31.98	17.41
Grand Mean	7347.52	12175.3	220.23

Table 4. Petiole nitrate results from the Clarkton, MO sand trial.

	NO3 7/1/2010	NO3 7/15/2010
1 Untreated Check	14320 *b*	2388 *c*
2 120 UAN pre-plant	16550 *ab*	12013 *b*
3 60 UAN pre-plant + 60 UAN PHS	23575 *ab*	9533 *b*
4 24 NFusion + 96 UAN pre-plant	19925 *ab*	9840 *b*
5 30 NFusion + 90 UAN pre-plant	25050 *a*	10145 *b*
6 60 NFusion + 60 UAN pre-plant	22550 *ab*	11593 *b*
7 120 urea pre-plant	22150 *ab*	12888 *b*
8 60 urea pre-plant + 60 ureaPHS	21650 *ab*	24175 *a*
9 120 ESN pre-plant	23625 *ab*	14638 *b*
10 90 ESN + 30 urea pre-plant	25600 *a*	10665 *b*
11 60 ESN + 60 urea pre-plant	23600 *ab*	11238 *b*
LSD (P=.05)	8654.18	6900.05
Standard Deviation	5993.57	4778.72
CV	27.63	40.71
Grand Mean	21690.46	11737.55

Table 5. Yield and fiber quality from the 2010 Portageville, MO silt trial.

	Yield	**Turnout**	**Mic**	**length**	**Unif**	**Str**	**Elong**	**Rd**	**+b**	**Leaf**
1 Untreated Check	1082 *a*	35 *a*	5.0 *a*	1.19 *ab*	84.3 *a*	36.1 *a*	6.9 *b*	75.1 *a*	8.9 *abc*	3 *a*
2 120 UAN pre-plant	1185 *a*	36 *a*	5.0 *a*	1.20 *ab*	84.2 *a*	35.4 *ab*	7.0 *ab*	75.2 *a*	8.6 *c*	3 *a*
3 60 UAN pre-plant + 60 UAN PHS	1174 *a*	36 *a*	5.0 *a*	1.20 *a*	84.5 *a*	35.3 *ab*	7.1 *ab*	74.8 *a*	9.1 *a*	3 *a*
4 24 NFusion + 96 UAN pre-plant	1266 *a*	36 *a*	5.0 *a*	1.19 *ab*	84.3 *a*	35.3 *ab*	7.2 *ab*	75.6 *a*	8.9 *abc*	4 *a*
5 30 NFusion + 90 UAN pre-plant	1230 *a*	36 *a*	5.0 *a*	1.18 *ab*	84.4 *a*	35.2 *ab*	7.0 *ab*	75.5 *a*	8.8 *bc*	3 *a*
6 60 NFusion + 60 UAN pre-plant	1224 *a*	37 *a*	5.0 *a*	1.18 *ab*	84.6 *a*	35.7 *ab*	7.0 *ab*	75.4 *a*	8.7 *bc*	3 *a*
7 120 urea pre-plant	1218 *a*	37 *a*	5.0 *a*	1.19 *ab*	84.2 *a*	34.9 *ab*	7.2 *ab*	74.7 *a*	9.0 *ab*	3 *a*
8 60 urea pre-plant + 60 ureaPHS	1118 *a*	36 *a*	5.0 *a*	1.19 *ab*	84.2 *a*	35.4 *ab*	7.1 *ab*	75.3 *a*	8.9 *abc*	3 *a*
9 120 ESN pre-plant	1138 *a*	36 *a*	5.1 *a*	1.19 *ab*	84.6 *a*	34.9 *ab*	7.2 *ab*	74.9 *a*	9.0 *ab*	3 *a*
10 90 ESN + 30 urea pre-plant	1096 *a*	36 *a*	5.1 *a*	1.18 *ab*	83.8 *a*	35.1 *ab*	7.2 *ab*	74.6 *a*	8.6 *c*	2 *a*
11 60 ESN + 60 urea pre-plant	1160 *a*	37 *a*	5.0 *a*	1.17 *b*	84.0 *a*	34.6 *b*	7.3 *a*	74.6 *a*	8.8 *bc*	3 *a*
LSD (P=.05)	160.6	0.02	0.172	0.0232	1.02	1.008	0.308	1.152	0.26	1.1
Standard Deviation	111.2	0.02	0.119	0.016	0.705	0.697	0.213	0.797	0.18	0.7
CV	9.49	4.4	2.37	1.35	0.84	1.98	3	1.06	2.04	26
Grand Mean	1171.7	0.36	5.01	1.18	84.27	35.25	7.1	75.06	8.83	2.9

Table 6. Yield and fiber quality from the 2011 Portageville, MO silt trial.

		Yield		Turnout		Mic		Length		Unif		Streng		Elon		Rd		+b		Leaf	
1	Untreated Check	1230	*c*	36	*a*	4.4	*a*	1.20	*b*	83.7	*a*	34.0	*ab*	6.5	*a*	77.1	*a*	7.3	*b*	7	*a*
2	120 UAN pre-plant	1308	*abc*	35	*a*	3.7	*b*	1.21	*ab*	82.8	*a*	34.3	*a*	6.5	*a*	78.0	*a*	7.5	*ab*	5	*a*
3	60 UAN pre-plant + 60 UAN PHS	1394	*a*	36	*a*	3.9	*b*	1.22	*a*	83.6	*a*	34.0	*ab*	6.4	*a*	77.5	*a*	7.4	*ab*	6	*a*
4	120 N (20% NFusion + 80% UAN)	1291	*abc*	34	*a*	3.6	*b*	1.21	*ab*	82.8	*a*	32.8	*b*	6.4	*a*	76.4	*a*	7.6	*ab*	7	*a*
5	120 N (25% NFusion + 75% UAN)	1361	*abc*	35	*a*	3.7	*b*	1.21	*ab*	83.2	*a*	33.9	*ab*	6.5	*a*	77.8	*a*	7.4	*ab*	6	*a*
6	120 N (50% NFusion + 50% UAN)	1313	*abc*	35	*a*	3.7	*b*	1.21	*ab*	83.0	*a*	34.2	*a*	6.5	*a*	77.0	*a*	7.4	*ab*	7	*a*
7	120 urea pre-plant	1246	*bc*	35	*a*	3.6	*b*	1.22	*a*	83.7	*a*	33.9	*ab*	6.5	*a*	77.7	*a*	7.6	*ab*	6	*a*
8	60 urea pre-plant + 60 ureaPHS	1369	*ab*	35	*a*	3.7	*b*	1.22	*a*	83.7	*a*	33.8	*ab*	6.5	*a*	77.8	*a*	7.7	*ab*	6	*a*
9	120 ESN pre-plant	1355	*abc*	35	*a*	3.8	*b*	1.22	*a*	83.3	*a*	33.3	*ab*	6.2	*a*	77.3	*a*	7.7	*a*	5	*a*
#	90 ESN + 30 urea pre-plant	1310	*abc*	35	*a*	3.6	*b*	1.23	*a*	83.8	*a*	33.3	*ab*	6.6	*a*	77.6	*a*	7.6	*ab*	6	*a*
#	60 ESN + 60 urea pre-plant	1305	*abc*	35	*a*	3.6	*b*	1.22	*a*	83.4	*a*	33.6	*ab*	6.2	*a*	77.2	*a*	7.5	*ab*	6	*a*
LSD (P=.05)		116.5		0.018		0.31		0.0169		0.89		1.078		0.283		1.508		0.346		1.4	
Standard Deviation		80.7		0.013		0.21		0.0117		0.616		0.747		0.196		1.045		0.239		1	
CV		6.13		3.62		5.68		0.96		0.74		2.21		3.06		1.35		3.2		17	
Grand Mean		1316.45		0.35		3.75		1.21		83.36		33.72		6.41		77.38		7.49		5.8	

Table 7. Yield and fiber quality from the 2010 Portageville, MO clay trial.

	Yield	Turnout	Mic	Length	Unif	Str	Elon	Rd	+b	Leaf
1 Untreated Check	349 *e*	41 *a*	4.9 *a*	□□□ *e*	83.4 *a*	32.1 *c*	7.1 *a*	77.2 *ab*	8.0 *b*	2 *ab*
2 120 UAN pre-plant	493 *de*	40 *a*	5.0 *a*	1.15 *e*	83.9 *a*	32.5 *bc*	7.1 *a*	77.9 *a*	8.2 *ab*	2 *ab*
3 60 UAN pre-plant + 60 UAN PHS	493 *de*	40 *a*	5.0 *a*	1.16 *cde*	83.7 *a*	32.8 *abc*	7.0 *a*	77.4 *ab*	8.2 *ab*	3 *a*
4 24 NFusion + 96 UAN pre-plant	482 *de*	41 *a*	5.0 *a*	1.16 *de*	83.6 *a*	32.6 *abc*	7.1 *a*	77.8 *a*	8.3 *ab*	2 *ab*
5 30 NFusion + 90 UAN pre-plant	613 *bcd*	39 *a*	5.0 *a*	1.16 *b-e*	83.8 *a*	32.8 *abc*	7.0 *a*	77.2 *ab*	8.3 *ab*	2 *ab*
6 60 NFusion + 60 UAN pre-plant	549 *cd*	38 *a*	5.0 *a*	1.15 *e*	83.4 *a*	33.1 *abc*	7.0 *a*	77.5 *ab*	8.1 *ab*	2 *b*
7 120 urea pre-plant	686 *abc*	38 *a*	5.0 *a*	1.18 *ab*	84.0 *a*	33.8 *ab*	7.0 *a*	77.1 *ab*	8.3 *ab*	3 *ab*
8 60 urea pre-plant + 60 ureaPHS	739 *ab*	39 *a*	5.0 *a*	1.17 *bcd*	83.9 *a*	33.6 *ab*	7.0 *a*	77.6 *ab*	8.2 *ab*	3 *ab*
9 120 ESN pre-plant	744 *ab*	39 *a*	4.9 *a*	1.17 *abc*	83.8 *a*	33.7 *ab*	7.0 *a*	77.6 *ab*	8.3 *a*	3 *ab*
10 90 ESN + 30 urea pre-plant	747 *ab*	39 *a*	5.0 *a*	1.16 *b-e*	83.8 *a*	33.6 *ab*	7.0 *a*	77.6 *ab*	8.3 *a*	3 *a*
11 60 ESN + 60 urea pre-plant	839 *a*	37 *a*	4.9 *a*	1.19 *a*	84.0 *a*	33.8 *a*	7.0 *a*	76.7 *b*	8.3 *ab*	3 *ab*
LSD (P=.05)	156.9	0.04	0.144	0.0148	0.696	1.1	0.203	0.809	0.247	0.98
Standard Deviation	108.7	0.03	0.1	0.0103	0.482	0.762	0.14	0.56	0.171	0.68
CV	17.75	7.25	2.01	0.88	0.58	2.3	2	0.72	2.09	28.3
Grand Mean	612.35	0.39	4.97	1.16	83.74	33.12	7.01	77.41	8.22	2.41

Table 8. Yield and fiber quality from the 2011 Portageville, MO clay trial.

		Yield		Turnout		Mic		Length		Unif		Streng		Elon		Rd		+b		Leaf	
1	Untreated Check	691	*d*	38	*a*	4.4	*a*	1.17	*b*	82.9	*a*	34.2	*a*	6.6	*a*	76.7	*a*	7.4	*b*	7	*a*
2	120 UAN pre-plant	875	*cd*	38	*a*	4.4	*a*	1.19	*ab*	83.0	*a*	34.7	*a*	6.5	*a*	76.8	*a*	7.6	*ab*	6	*a*
3	60 UAN pre-plant + 60 UAN PHS	873	*cd*	38	*a*	4.4	*a*	1.17	*b*	83.0	*a*	33.9	*a*	6.4	*a*	76.8	*a*	7.5	*ab*	7	*a*
4	120 N (20% NFusion + 80% UAN)	1015	*abc*	37	*a*	4.4	*a*	1.20	*a*	83.3	*a*	34.1	*a*	6.5	*a*	77.0	*a*	7.6	*ab*	6	*a*
5	120 N (25% NFusion + 75% UAN)	1009	*abc*	38	*a*	4.4	*a*	1.20	*a*	83.5	*a*	34.9	*a*	6.7	*a*	77.1	*a*	7.7	*ab*	5	*a*
6	120 N (50% NFusion + 50% UAN)	887	*bcd*	38	*a*	4.4	*a*	1.18	*ab*	83.2	*a*	35.3	*a*	6.4	*a*	77.1	*a*	7.8	*a*	6	*a*
7	120 urea pre-plant	1140	*ab*	37	*a*	4.2	*a*	1.19	*ab*	82.8	*a*	34.6	*a*	6.5	*a*	77.1	*a*	7.8	*a*	5	*a*
8	60 urea pre-plant + 60 ureaPHS	1202	*a*	38	*a*	4.3	*a*	1.20	*a*	82.8	*a*	34.5	*a*	6.5	*a*	76.8	*a*	7.6	*ab*	6	*a*
9	120 ESN pre-plant	1085	*abc*	36	*a*	4.3	*a*	1.20	*a*	83.5	*a*	34.4	*a*	6.3	*a*	76.7	*a*	7.6	*ab*	7	*a*
10	90 ESN + 30 urea pre-plant	1104	*abc*	37	*a*	4.2	*a*	1.20	*a*	83.2	*a*	34.6	*a*	6.4	*a*	76.9	*a*	7.7	*ab*	6	*a*
11	60 ESN + 60 urea pre-plant	1252	*a*	38	*a*	4.4	*a*	1.20	*a*	82.7	*a*	34.3	*a*	6.5	*a*	76.8	*a*	7.8	*a*	6	*a*
LSD (P=.05)		226.8		0.02		0.288		0.0183		0.94		1.21		0.309		1.127		0.341		2	
Standard Deviation		156.8		0.014		0.199		0.0127		0.65		0.837		0.214		0.779		0.236		1	
CV		15.5		3.66		4.59		1.07		0.78		2.43		3.31		1.01		3.09		17	
Grand Mean		1012.14		0.38		4.34		1.19		83.07		34.49		6.46		76.89		7.62		6	

Table 9. Yield and fiber quality from the 2010 Clarkton, MO sand trial.

	Yield	Turnout	Mic	Length	Unif	Str	Elong	Rd	+b	Leaf
1 Untreated Check	747 *b*	42 *a*	5.4 *a*	1.12 *b*	82.6 *b*	30.8 *c*	6.9 *a*	77.3 *a*	8.7 *b*	2 *a*
2 120 UAN pre-plant	1062 *ab*	38 *ab*	5.2 *ab*	1.14 *ab*	83.2 *ab*	32.2 *b*	6.9 *a*	76.7 *ab*	8.7 *b*	3 *a*
3 60 UAN pre-plant + 60 UAN PHS	1009 *ab*	39 *a*	5.0 *b*	1.13 *ab*	83.0 *ab*	32.2 *b*	6.9 *a*	76.8 *ab*	8.8 *ab*	2 *a*
4 24 NFusion + 96 UAN pre-plant	948 *ab*	38 *ab*	5.2 *ab*	1.14 *ab*	82.9 *ab*	32.7 *ab*	6.9 *a*	77.3 *a*	8.8 *ab*	2 *a*
5 30 NFusion + 90 UAN pre-plant	1040 *ab*	40 *a*	5.1 *b*	1.16 *a*	84.0 *a*	32.8 *ab*	6.9 *a*	76.6 *ab*	8.8 *ab*	2 *a*
6 60 NFusion + 60 UAN pre-plant	1068 *ab*	39 *a*	5.1 *b*	1.15 *ab*	83.3 *ab*	33.0 *ab*	6.9 *a*	76.4 *b*	8.9 *ab*	3 *a*
7 120 urea pre-plant	881 *ab*	36 *ab*	4.9 *bc*	1.16 *a*	83.6 *ab*	33.4 *ab*	6.8 *a*	76.9 *ab*	9.0 *ab*	2 *a*
8 60 urea pre-plant + 60 ureaPHS	1174 *a*	39 *a*	4.7 *c*	1.16 *a*	83.6 *ab*	33.4 *ab*	6.7 *a*	76.6 *ab*	9.1 *a*	3 *a*
9 120 ESN pre-plant	912 *ab*	33 *b*	4.9 *bc*	1.15 *a*	83.2 *ab*	32.6 *b*	7.0 *a*	76.4 *b*	8.9 *ab*	2 *a*
10 90 ESN + 30 urea pre-plant	845 *ab*	38 *ab*	5.0 *b*	1.16 *a*	83.9 *a*	33.1 *ab*	6.9 *a*	76.6 *ab*	8.8 *ab*	3 *a*
11 60 ESN + 60 urea pre-plant	789 *b*	37 *ab*	4.6 *c*	1.15 *a*	83.4 *ab*	33.9 *a*	6.8 *a*	76.7 *ab*	8.9 *ab*	3 *a*
LSD (P=.05)	297.7	0.051	0.265	0.0252	0.897	1.106	0.28	0.692	0.364	1.31
Standard Deviation	206.2	0.036	0.183	0.0174	0.622	0.766	0.19	0.479	0.252	0.91
CV	21.65	9.33	3.67	1.52	0.75	2.34	2.83	0.62	2.85	38.1
Grand Mean	952.24	0.38	4.99	1.15	83.32	32.72	6.87	76.72	8.84	2.39

Table 10. Yield and fiber quality from the 2011 Clarkton, MO sand trial.

		Yield	Turnout	Mic	Length	Unif	Stren	Elon	Rd	+b	Leaf
1	Untreated Check	577 *ab*	40 *a*	4.2 *ab*	1.15 *ab*	82.1 *a*	33.3 *ab*	7.6 *a*	75.2 *b*	8.3 *a*	6 *a*
2	120 UAN pre-plant	438 *b*	39 *a*	4.0 *ab*	1.13 *b*	82.6 *a*	32.9 *ab*	7.5 *a*	77.9 *ab*	8.3 *a*	5 *a*
3	60 UAN pre-plant + 60 UAN PHS	538 *ab*	40 *a*	4.2 *ab*	1.16 *ab*	83.0 *a*	32.5 *b*	7.8 *a*	78.2 *a*	8.3 *a*	5 *a*
4	120 N (20% NFusion + 80% UAN)	630 *ab*	38 *a*	4.3 *ab*	1.18 *a*	83.0 *a*	34.1 *ab*	7.6 *a*	77.5 *ab*	8.4 *a*	5 *a*
5	120 N (25% NFusion + 75% UAN)	613 *ab*	38 *a*	4.1 *ab*	1.16 *ab*	82.8 *a*	32.8 *ab*	7.5 *a*	77.9 *ab*	8.3 *a*	5 *a*
6	120 N (50% NFusion + 50% UAN)	482 *ab*	38 *a*	3.8 *b*	1.17 *a*	82.3 *a*	32.8 *ab*	7.5 *a*	78.1 *a*	8.4 *a*	5 *a*
7	120 urea pre-plant	705 *ab*	38 *a*	4.1 *ab*	1.17 *a*	82.8 *a*	34.9 *a*	7.4 *a*	77.7 *ab*	8.5 *a*	5 *a*
8	60 urea pre-plant + 60 ureaPHS	633 *ab*	38 *a*	3.9 *ab*	1.16 *a*	82.7 *a*	32.9 *ab*	7.4 *a*	77.3 *ab*	8.4 *a*	5 *a*
9	120 ESN pre-plant	786 *ab*	40 *a*	4.6 *a*	1.16 *a*	82.9 *a*	33.5 *ab*	7.7 *a*	77.1 *ab*	8.4 *a*	5 *a*
10	90 ESN + 30 urea pre-plant	828 *a*	38 *a*	4.5 *a*	1.17 *a*	83.2 *a*	34.5 *ab*	7.5 *a*	77.8 *ab*	8.3 *a*	4 *a*
11	60 ESN + 60 urea pre-plant	680 *ab*	38 *a*	4.2 *ab*	1.17 *a*	83.1 *a*	33.4 *ab*	7.7 *a*	77.4 *ab*	8.4 *a*	5 *a*
LSD (P=.05)		328	0.024	0.634	0.0247	1.081	2.078	0.367	2.36	0.258	2
Standard Deviation		227.2	0.017	0.439	0.0171	0.749	1.439	0.254	1.635	0.179	1.4
CV		36.16	4.32	10.55	1.48	0.9	4.31	3.36	2.11	2.14	29
Grand Mean		628.32	0.38	4.17	1.16	82.77	33.4	7.56	77.44	8.35	4.8