CONTROLLED RELEASE NITROGEN FERTILIZERS FOR 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 year of a three year study, results indicate on silt soils a controlled release liquid fertilizer performed best. On clay soils, the superior treatment was the granular controlled release. On sand soils the tradition urea split application 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 year 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 and the price per acre of each treatment 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.

Gross and net returns to producers were calculated based on Commodity Credit Corporation Cotton loan base rate for respective years crop of White Upland Cotton warehoused in Missouri ($0.5235/lb lint) with allowances made for fiber quality. Input costs were computed using fertilizer prices found during each respective. Input costs were calculated and compared to net & gross returns for each recommendation.

Statistical analyses of the data were preformed for each individual year and location with ARM.

Results and Discussion

Silt: As shown in table 5, the one year yield results on silt soil show a good response to the three Nfusion + UAN treatments. Although the results are not statistically different, there are significantly higher yields and prices per acres. The results show no difference in fiber quality throughout the different treatments. Table 2 illustrates the 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.

Clay: In table 6, the yield results on clay soil show that ESN and the area standard of 60 lbs urea pre-plant followed by 60 lbs urea sidedress are the superior treatments. The results show 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.

Sand: 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.

Acknowledgement

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

	Treatment	$ / trt
1	Untreated Check	0
2	120 UAN pre-plant	46.88
3	60 UAN pre-plant + 60 UAN PHS	51.88
4	120 N (20% NFusion + 80% UAN) pre-plant	49.32
5	120 N (25% NFusion + 75% UAN) pre-plant	49.97
6	120 N (50% NFusion + 50% UAN) pre-plant	52.92
7	120 urea pre-plant	50.05
8	60 urea pre-plant + 60 urea PHS	55.05
9	120 ESN pre-plant	65.87
10	90 ESN + 30 urea pre-plant	61.91
11	60 ESN + 60 urea pre-plant	57.95

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

		NO3	NO3	NO3	NO3
		7/1/2010	7/15/2010	8/1/2010	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	NO3	NO3
		7/1/2010	7/15/2010	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	NO3
		7/1/2010	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, fiber quality, and price per acre from the Portageville, MO silt trial.

		Yield	**Turnout**	**Mic**	**length**	**Unif**	**Str**	**Elong**	**Rd**	**+b**	**Leaf**	**$/lb**	**$/Ac**
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*	0.5450 *a*	587.83 *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*	0.5400 *a*	640.17 *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*	0.5468 *a*	641.03 *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*	0.5440 *a*	688.31 *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*	0.5570 *a*	685.25 *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*	0.5518 *a*	675.13 *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*	0.5451 *a*	664.16 *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*	0.5440 *a*	607.89 *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*	0.5405 *a*	614.42 *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*	0.5385 *a*	635.15 *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*	0.5379 *a*	626.29 *a*
LSD (P=.05)		160.6	0.02	0.172	0.0232	1.02	1.008	0.308	1.152	0.26	1.1	0.02185	87.057
Standard Deviation		111.2	0.02	0.119	0.016	0.705	0.697	0.213	0.797	0.18	0.7	0.01511	60.204
CV		9.49	4.4	2.37	1.35	0.84	1.98	3	1.06	2.04	26	2.77	9.37
Grand Mean		1171.7	0.36	5.01	1.18	84.27	35.25	7.1	75.06	8.83	2.9	0.54	642.33

Table 6. Yield, fiber quality, and price per acre from the Portageville, MO clay trial.

		Yield	Turn out	Mic	Length	Unif	Str	Elon	Rd	+b	Leaf	$/lb	$/Ac
1	Untreated Check	349 *e*	41 *a*	4.9 *a*	1.15 *e*	83.4 *a*	32.1 *c*	7.1 *a*	77.2 *ab*	8.0 *b*	2 *ab*	0.5521 *a*	193.05 *e*
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*	0.5518 *a*	271.43 *de*
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*	0.5488 *a*	273.27 *de*
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*	0.5508 *a*	265.18 *de*
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*	0.5573 *a*	342.86 *bcd*
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*	0.5525 *a*	302.84 *cd*
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*	0.5555 *a*	381.14 *abc*
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*	0.5500 *a*	406.12 *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*	0.5553 *a*	414.19 *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*	0.5473 *a*	410.93 *ab*
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*	0.5514 *a*	462.39 *a*
LSD (P=.05)		156.9	0.04	0.144	0.0148	0.696	1.1	0.203	0.809	0.247	0.98	0.017541	87.813
Standard Deviation		108.7	0.03	0.1	0.0103	0.482	0.762	0.14	0.56	0.171	0.68	0.012148	60.816
CV		17.75	7.25	2.01	0.88	0.58	2.3	2	0.72	2.09	28.3	2.2	17.97
Grand Mean		612.35	0.39	4.97	1.16	83.74	33.12	7.01	77.41	8.22	2.41	0.55	338.49

Table 7. Yield, fiber quality, and price per acre from the Clarkton, MO sand trial.

		Yield	Turnout	Mic	Length	Unif	Str	Elong	Rd	+b	Leaf	$/lb	$/Ac
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*	0.5343 *d*	399.12 *b*
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*	0.5435 *cd*	577.53 *ab*
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*	0.5479 *bcd*	551.62 *ab*
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*	0.5429 *cd*	514.95 *ab*
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*	0.5468 *bcd*	568.46 *ab*
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*	0.5493 *bc*	587.16 *ab*
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*	0.5560 *abc*	490.60 *ab*
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*	0.5588 *ab*	654.33 *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*	0.5608 *ab*	513.41 *ab*
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*	0.5480 *bcd*	461.54 *b*
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*	0.5644 *a*	445.57 *b*
LSD (P=.05)		297.7	0.051	0.265	0.0252	0.897	1.106	0.28	0.692	0.364	1.31	0.012988	163.39
Standard Deviation		206.2	0.036	0.183	0.0174	0.622	0.766	0.19	0.479	0.252	0.91	0.008995	113.158
CV		21.65	9.33	3.67	1.52	0.75	2.34	2.83	0.62	2.85	38.1	1.63	21.59
Grand Mean		952.24	0.38	4.99	1.15	83.32	32.72	6.87	76.72	8.84	2.39	0.55	524.03