Wheat and Cotton Nitrogen Research in 2005 and 2006

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Rising energy prices and anti-terrorism regulations have affected the cost and availability of types of nitrogen fertilizer for cotton producers. Along the Mississippi River, large amounts of N fertilizer are transported by barges, which are regulated by the U.S. Coast Guard. Because ammonium nitrate can potentially be used for making bombs, urea has become the most common form of the dry nitrogen fertilizer sold to Delta cotton farmers in Missouri. The major drawback of urea compared to ammonium nitrate is the potential of surface-applied urea to volatilize on warm, moist soils.

In 2005, we initiated wheat and cotton experiments at the University of Missouri-Delta Center in Portageville to study methods of reducing urea volatilization. Randomized complete blocks with four replications were used. Tests were located on a Tiptonville silt loam, a well-drained alluvial soil with 1.5% organic matter and 12 meq/100g soil cation exchange capacity. Soybeans were grown in the fields in 2004.

Wheat. Following soybean harvest, the test area was disked and harrowed in mid-October 2004 and 2005. Wheat seed (cv. FFR 556) was drill seeded on 7.5-inch row spacing at 90 lb seed/acre. No nitrogen fertilizer was applied was applied in the fall. Plots were 10 feet wide and 25 feet long.

Spring topdress N fertilizer was intentionally applied in a high-risk soil environment for urea volatilization both years. Two days prior to fertilizer application, rainfall totaling 2.04 inches occurred on March 9, 2006. Maximum air temperature on March 11, the day of application, was 76^{o}F. The next significant rainfall (0.29 inches) occurred on March 13. Treatments included surface broadcast urea with and without an additive (Agrotain^{TM}, N-(n-butyl)thiophosphoric triamide, 4 quarts/ton urea) to reduce volatilization. Treatments containing 32% UAN solution (with and without Agrotain) were sprayed over-the-top with a CO_2 backpack spray and boom. All fertilizer treatment rates were applied at 70 lb N/acre.

Adding Agrotain to urea and UAN solution did not increase wheat yields in 2006 (Table 1). A significant interaction was found between years and fertilizer. The difference is probably due to the rainfall two days after N topdressing in 2006. In 2005, Agrotain added to urea and UAN increased wheat yields by 8 to 17 bushels per acre because no rainfall occurred to push the N into the soil and prevent volatilization on the soil surface.

Cotton. The test site was disked and bedded on 38-inch row spacing in early March. Glyphosate, fluometuron, and pendimethalin herbicides were applied preemergence for weed control before cotton planting. On May 10, 2006, cotton (cv. DeltaPine 444BR) was planted (5 seeds per row foot). Plots were 12.67 feet wide and 40 feet long. Postemergence weed control included hand weeding and glyphosate over-the-top and with a hooded sprayer.

Treatments included surface broadcast urea (80 lb N/acre) with and without an Agrotain additive (4 quarts/ton urea) to reduce volatilization. Urea treatments were applied at cotyledon or 7th node cotton growth stages. Two days after the application at

7th node, a light rainfall event occurred (0.16 inch). No rainfall occurred the next 16 days.

In treatments with N applied at 7th node growth stage, the highest early bloom cotton petiole nitrate were in plots with ammonium nitrate and urea + Agrotain (Table 2). Cotton yields were increased compared to the untreated check but ammonium nitrate and urea + Agrotain were not significantly higher than urea alone. In a test comparing different methods of incorporating urea to prevent volatilization, no significant cotton yield differences were found in 2005 or 2006 (Table 3).

In a third cotton experiment, a fire hose nozzle and water wagon was used to create five levels of soil moisture by applying 0, 0.125, 0.25, 0.375, and 0.50 inches of water before or after urea and urea+Agrotain were broadcast (Figure 1). In 2005 and 2006, no significant yield differences were found between applying irrigation before or after urea was soil broadcast. In 2006, yields averaged across irrigation rates were 1107 lb lint acre^{-1} when water applied before urea application and 1087 lb lint acre^{-1} when water was applied after urea. Treatments with Agrotain averaged 1091 lb lint acre^{-1} compared to 1102 lb lint acre^{-1} without Agrotain. For reasons not completely understood, the rate of irrigation applied significantly affected cotton yield in 2006 (Table 4). Shortly after emergence, the cotton seedlings struggled from hail damage and seedling diseases. Apparently, 0.25-inch of irrigation water at cotyledon growth stage was just enough to optimize early cotton growth without exasperating seedling diseases.

Table 1. Wheat yields from top-dress fertilizers and additive to reduce N volatilization on a Tiptonville silt loam soil at Portageville, Missouri in 2005 and 2006.

Fertilizer	Additive	Wheat yield, bu acre^{-1}	
		2005	2006
None	---	40 c	48b
Am nitrate	---	63 a	60a
Urea	---	54 b	62a
Urea	NBPT§	62 a	60a
UAN 32%	---	44 c	53ab
UAN 32%	NBPT[1]	61 a	52ab

†Minolta SPAD chlorophyll meter readings were collected in the second week in April .
‡Chlorophyll reading and wheat yield values followed by the same letter were not significantly different at the 0.05 probability level.
§NBPT= N-(n-butyl)thiophosphoric triamide (Agrotain™). Agrotain was added 5 quarts/ton dry urea and 2.8 quarts/ton UAN 32%.

Table 2. Early bloom stage cotton petiole nitrate and leaf chlorophyll meter readings as affected by N sources with 80 lb N acre urea applied at 7th node growth stage on Tiptonville silt loam at Portageville, Missouri in 2005 and 2006.

	Petiole NO^{-3}		Chlorophyll meter reading		Lint yield, lb $acre^{-1}$		
Urea applied	2005 †	2006	2005	2006	2005	2006	Mean
None	703 c	10850c	38.7 b	42.7a	807 b	830b	818b
Am nitrate	6700 b	18250a	43.3 a	45.0a	890 ab	887ab	889ab
Urea	12500 a	14500b	43.4 a	43.8a	920 a	939a	929a
Urea+ NBPT‡	6975 b	16500ab	42.8 a	44.4a	937 a	956a	947a

† Petiole nitrate, chlorophyll meter readings and cotton yield values followed by the same letter were not significantly different at the 0.05 probability level. Mean separation was evaluated through a series of pair-wise contrasts among all treatments.
‡ NBPT= N-(n-butyl)thiophosphoric triamide (Agrotain™). Agrotain was added 5 quarts/ton dry urea and 2.8 quarts/ton UAN 32%.

Table 3. Cotton lint yields with different types of mechanical incorporation methods for reducing volatilization of urea and UAN 32% solution and NBPT additive with 80 lb N $acre^{-1}$ on a Tiptonville silt loam soil at Portageville, Missouri in 2005 and 2006.

Fertilizer				Cotton lint, lb/acre §		
source	Additive†	Applied	Method	2005	2006	Mean
Check	--	No nitrogen	---	850	1015	932
Am nitrate	--	First square	Broadcast	895	1046	970
Urea	NBPT	Incorporated ‡	Broadcast	897	1114	1005
Urea	--	Incorporated	Broadcast	872	1126	999
Urea	--	First square	Broadcast	832	1102	967
Urea	NBPT	First square	Broadcast	918	1075	996
Urea	--	First square	Broadcast follow by cult	921	1055	988
Urea	NBPT	First square	Broadcast follow by cult	920	1196	1058
UAN 32%	--	Incorporated	Broadcast	894	1016	955
UAN 32%	NBPT	Incorporated	Broadcast	850	990	920
UAN 32%	--	First square	Coulter	855	1052	953
UAN 32%	NBPT	First square	Coulter	838	1156	997
UAN 32%	--	First square	Dribble between rows	891	1049	970
UAN 32%	NBPT	First square	Dribble between rows	899	1111	1005
UAN 32%	--	First square	Between row follow by cult	827	1169	998
UAN 32%	NBPT	First square	Between row follow by cult	865	1043	954

† NBPT= N-(n-butyl)thiophosphoric triamide (Agrotain™). Agrotain was added 5 quarts/ton dry urea and 2.8 quarts/ton UAN 32%.
‡ Fertilizer was incorporated before planting by disking and rehipping.
§ Cotton yield values were not significantly different at the 0.05 probability level.

Table 4. Cotton yields as affected by irrigation with nitrogen fertilizer broadcast at cotyledon growth stage. Yields from urea fertilizer were averaged across treatments with water applied before and after broadcasting urea and with and without NBPT additive.

Fertilizer	Water, inches	Cotton yield, lb lint acre^{-1}†
None	0	1061 c
Am nitrate	0	1125 ab
Urea	0	1073 b
Urea	0.13	1070 b
Urea	0.25	1174 a
Urea	0.37	1070 b
Urea	0.50	1109 ab

† Cotton yield values followed by the same letter were not significantly different at the 0.05 probability level. Mean separation was evaluated through a series of pair-wise contrasts among all treatments.

Figure 1. Treating cotton plot with water after urea fertilizer application.

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