FIELD RESEARCH WITH N STABILIZERS ADDED TO UAN AND UREA FOR WINTER WHEAT - 2015

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INTRODUCTION

The objective of the fieldwork was to evaluate the effectiveness of Instinct II (encapsulated nitrapyrin; Dow AgroSciences) as a stabilizer against nitrogen loss when added to the solid dry urea or urea-ammonium nitrate (UAN) solution being used in soft red winter wheat production.

MATERIALS AND METHODS

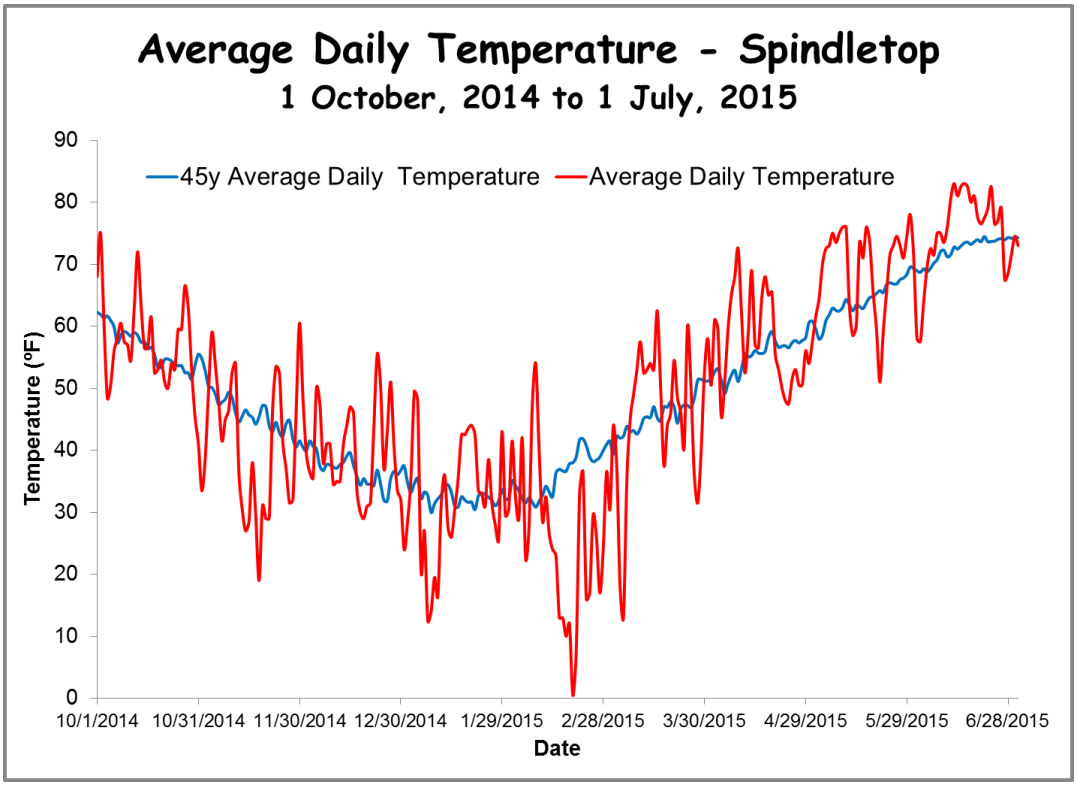
The research protocol called for a total of ten treatments. These consisted of a not N fertilized control and nine treatments, arranged in a 3 by 3 factorial. There were three N rate/Agrotain treatments: 85 lb N/acre without Agrotain; 100 lb N/acre without Agrotain (N-(n-butyl) thiophosphoric triamide); Koch Agronomic Services, LLC); and 100 lb N/acre with Agrotain. The urea was applied to no-till wheat planted into corn residues, while the UAN was applied to no-till wheat established in soybean residues. Both rates of both sources were applied at two different times (40 % at green-up ≈ Feekes 2-3, and 60 % near first joint formation ≈ Feekes 5-6), providing N nutrition to the crop while growing on a soil somewhat prone to N losses (primarily denitrification and volatilization). The Agrotain was applied with the second N application at a rate of 3 qt/ton urea or 1.5 qt/ton UAN. There were three Instinct II treatments: no Instinct II; Instinct II applied with the first N application; and Instinct II applied with the second N application. The Instinct II application rate was 37 fl oz/acre. Table 1 is a summary of the treatments.

There were four replications of each treatment, and each study was laid out in randomized complete blocks. Wheat (cv. Pembroke 2014) was planted in 7 inch rows, without prior tillage (no-tillage), into corn (urea-Instinct II study) and soybean (UAN-Instinct II study) residues at 115 lb seed/acre (13,100 seed/lb), on a Caleast silt loam located at the University of Kentucky's Spindletop research farm near Lexington, KY on 27 October, 2015. Though the soil is well-drained, internal profile permeability is only moderate and the trials were located on a level upland position, making the site prone to wetness. Both pre- and post-emergence herbicides were applied. Weed control was very good. At this location, soil organic matter averages 3.6 %, the cation exchange capacity is around 12.5 meq/100 g, and the surface soil texture is a silt loam. Initial soil test levels for soil fertility parameters (pH, P, K, Zn) were all high, so no maintenance applications of lime and fertilizers were made across the plot areas.

TABLE 1. NITROGEN, AGROTAIN AND INSTINCT II TREATMENTS IN THE 2015 WINTER WHEAT STUDIES.

Treatment Description			
Treatment	**UAN/Urea**	**Agrotain**	**Instinct**
Number	**lb N/acre**	**no/yes**	**timing**
1	0	no	none
2	100	no	none
3	100	no	green up
4	100	no	jointing
5	85	no	none
6	85	no	green up
7	85	no	jointing
8	100	yes	none
9	100	yes	green up
10	100	yes	jointing

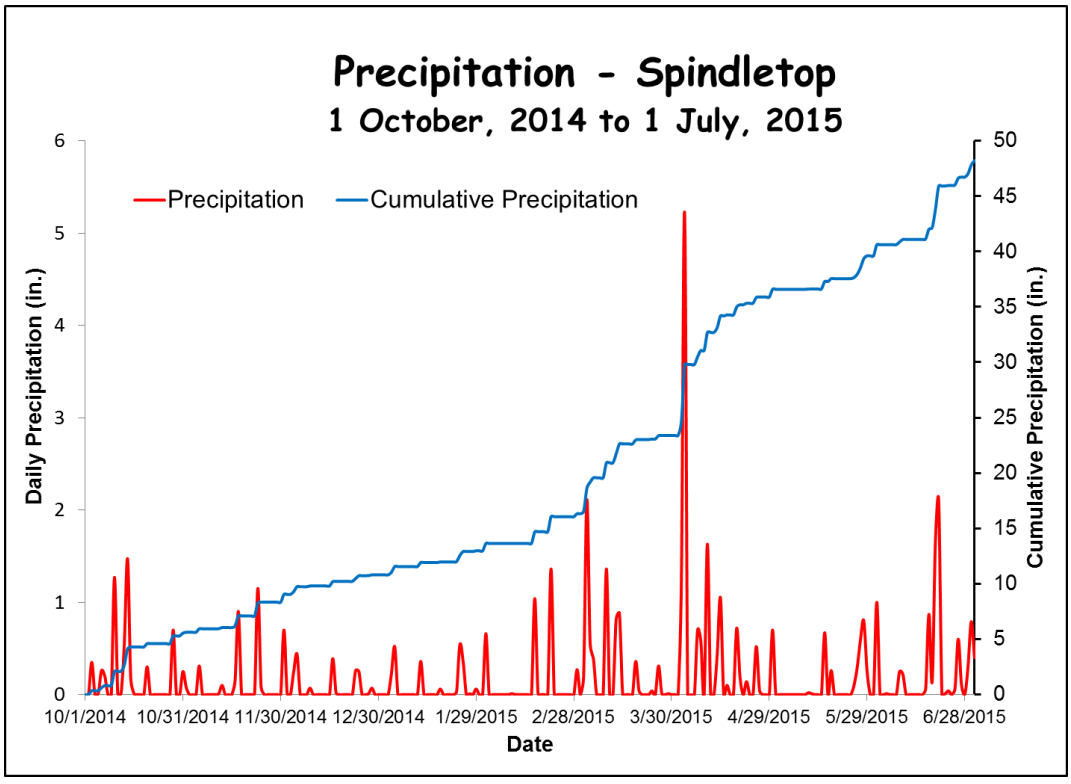
FIGURE 1. AVERAGE DAILY TEMPERATURE, 45 YEAR AVERAGE AND BY DAY, FOR THE STUDY SITE.



The fall-winter 2015-15 wheat production season evidenced several colder than normal periods (middle November; early January; middle February to middle March) that resulted in delayed wheat green up (Figure 1). The first N application was made on 13 April and the second N application was done on 29 April.

Soil conditions at the first N application were wet, due to a recent period (2-10 April) of heavy rainfall (total of 9.3 inches; Figure 2). Soil conditions at the second N application were merely moist and only 3.2 inches of rainfall, on 8 different days, occurred between the first and second N applications (Figure 2). The average daily temperature was 56.5 ^{o}F during this period (Figure 1). In the 21 days subsequent to the second N application there was 1.66 inches of rainfall, on 5 different days and the average daily temperature warmed substantially, to 68 ^{o}F (Figure 1).

FIGURE 2. PRECIPITATION, BY EVENT AND CUMULATIVE, FOR THE STUDY SITE.



Composite (by replicate) soil samples were taken in two depth increments (0 to 1 ft; 1 to 2 ft) on 17 March, prior to any N fertilization. Soil samples were air dried, crushed to pass a 2 mm screen opening, and the ammonium (NH_4-N) and nitrate (NO_3-N) extracted with M KCl prior to determination via automated colorimetry. There was not four weeks between the first and second N applications, so the second soil sampling was done about three weeks subsequent to the second N application, on 19 May. Composite (by plot) soil samples were taken in two depth increments (0 to 1 ft; 1 to 2 ft) from all plots. Soil samples were processed and analyzed for ammonium (NH_4-N) and nitrate (NO_3-N) as described previously. The season turned dry, and this, combined with clayey subsoil, prohibited later soil sampling.

TABLE 2. WHEAT AFTER CORN UREA-INSTINCT II TRIAL: EXTRACTABLE AMMONIUM (NH_4-N) AND NITRATE (NO_3-N) CONCENTRATIONS (MEAN±ONE STANDARD DEVIATION) ON 17 MARCH AND 19 MAY.

			----0 to 1 ft----		----1 to 2 ft----	
			NH_4-N	NO_3-N	NH_4-N	NO_3-N
N Rate lb N/A	Agrotain no/yes	Instinct Timing	----------ppm N----------			
---------- samples taken 17 March ----------						
0	no	none	2.2±1.4	2.1±0.5	1.5±0.2	1.3±0.4
---------- samples taken 19 May ----------						
0	no	none	5.2±2.2[B]	2.7±2.8[B]	4.3±2.6[A]	1.9±3.8[A]
85	no	-	9.0±5.5[A]	10.8±7.4[A]	4.2±1.7[A]	1.0±1.1[A]
100	no	-	8.4±2.7[A]	11.4±6.2[A]	4.1±0.8[A]	1.3±1.4[A]
100	yes	-	11.4±7.0[A]	14.6±9.3[A]	4.9±2.4[A]	1.1±0.9[A]
-	-	none	10.6±7.9[A]	14.2±9.0[A]	5.0±2.5[A]	1.2±1.0[A]
-	-	green up	9.2±3.9[A]	9.4±4.4[A]	4.1±1.3[A]	0.9±0.7[A]
-	-	jointing	9.1±3.7[A]	13.2±8.5[A]	4.1±1.0[A]	1.2±1.6[A]

[A,B]Mean values followed by the same footnote letter are not significantly different at the 90% level of confidence.

Chlorophyll meter (Minolta SPAD 502) readings on flag leaves were taken after flowering (29 May). The plots were harvested with a small plot combine on 28 June. All grain was collected from the central 7 rows of each plot, oven dried to constant mass, and weighed. Weights were used to calculate yields, which were corrected to uniform harvest moisture (13.5%). A grain subsample was taken from each plot's harvest and grain N concentration was determined using Kjeldahl digestion and automated colorimetry.

RESULTS AND DISCUSSION

In both studies, the variation in ammonium-N and nitrate-N within any one treatment, in both depth increments, was high, as indicated by standard deviation values (Tables 2 and 3). Soil ammonium-N and nitrate-N levels were low (Tables 2 and 3) at the time of the first soil

sampling (17 March). Where wheat followed corn (Table 2), nitrate-N totaled about 14 lb N/acre in the top 2 feet of the soil profile, and ammonium-N totaled about 15 lb N/acre. Where wheat followed soybean (Table 3), nitrate-N totaled about 16 lb N/acre, while ammonium-N totaled about 11 lb N/acre.

On 19 May, at the time of the second soil sampling, soil ammonium-N and nitrate-N were still low in the not N-fertilized controls (Tables 2 and 3), totaling about 56 lb N/acre where wheat followed corn and 34 lb N/acre where wheat followed soybean. Much less inorganic N was found at the deeper sample depth, in both studies (Tables 2 and 3). There was little rainfall after 13 April (Figure 2) to cause inorganic N movement.

In the 0 to 1 ft depth increment, the control plots contained significantly less inorganic N than N fertilized plots, in both studies. In the 1 to 2 ft depth increment of the urea study where wheat followed corn, control plot inorganic N levels were not significantly different from those found in N fertilized plots (Table 2). A different result was observed in the 1 to 2 ft depth increment of the UAN study where wheat followed soybean. There, the control plot nitrate-N level was significantly less than some of the N fertilizer and Instinct II treatments, though ammonium N levels were not significantly different (Table 3).

TABLE 3. WHEAT AFTER SOYBEAN UAN-INSTINCT II TRIAL: EXTRACTABLE AMMONIUM (NH_4-N) AND NITRATE (NO_3-N) CONCENTRATIONS (MEAN±ONE STANDARD DEVIATION) ON 17 MARCH AND 19 MAY.

			----0 to 1 ft----		----1 to 2 ft----	
			NH_4-N	NO_3-N	NH_4-N	NO_3-N
N Rate lb N/A	Agrotain no/yes	Instinct Timing	----------ppm N----------			
---------- samples taken 17 March ----------						
0	no	none	1.6±0.04	1.9±0.9	1.2±0.1	2.0±0.1
---------- samples taken 19 May ----------						
0	no	none	3.5±0.7[C]	1.8±1.0[B]	3.1±1.0[B]	0.2±0.1[A]
85	no	-	13.2±8.2[B]	25.4±20.0[A]	4.1±1.5[B]	1.4±2.0[A]
100	no	-	10.2±8.2[B]	20.1±14.3[A]	4.3±1.5[B]	2.1±3.0[A]
100	yes	-	21.6±17.3[A]	23.1±11.2[A]	7.4±3.5[A]	2.6±1.9[A]
-	-	none	14.1±10.3[A]	24.9±19.0[A]	4.6±1.4[B]	2.7±3.2[A]
-	-	green up	16.9±14.5[A]	23.2±12.1[A]	4.9±3.0[B]	1.3±1.0[A]
-	-	jointing	14.0±13.7[A]	20.4±15.1[A]	6.4±3.3[A]	2.1±2.2[A]

[A,B]Mean values followed by the same footnote letter are not significantly different at the 90% level of confidence.

In the urea-wheat following corn study, there was a trend for greater average ammonium-N levels, in both depth increments, across the three treatments where Agrotain was applied (Table 2). This trend improved to statistical significance in the UAN-wheat following soybean study (Table 3). Soil nitrate-N concentrations exhibited a similar trend in the 0 to 1 ft depth increment of the urea-wheat after corn study (Table 2) and in the 1 to 2 ft depth increment of the UAN-wheat after soybean study (Table 3), but none of these differences were so large as to be statistically significant. The main effect of the Instinct II treatments did not manifest any trend in soil ammonium-N and nitrate-N concentrations in the urea-wheat after corn study (Table 2). In the UAN-wheat after soybean study, there was a positive impact of the second Instinct II application on soil ammonium-N concentrations in the 1 to 2 ft depth increment (Table 3). The factorial analysis (3 N rate/Agrotain use treatments by 3 Instinct II rate/timing treatments) found no significant interactions among the main effects on soil ammonium-N or nitrate-N concentrations, at either sample depth, in either study.

In both field trials, the flag leaf SPAD meter readings clearly distinguished the not N fertilized control from the N fertilized treatments, but there were no differences among the N fertilized treatments, in either study (Tables 4 and 5). The factorial analysis (3 N rate/Agrotain use treatments by 3 Instinct II rate/timing treatments) found no significant interactions among the main effects on flag leaf SPAD meter readings, in either study.

Grain N concentrations exhibited a response pattern similar to that of SPAD meter values (Tables 4 and 5). Again, grain N was lowest in the control, but there was no difference in grain N among the N fertilized treatments, in either study. The factorial analysis (3 N rate/Agrotain use treatments by 3 Instinct II rate/timing treatments) found no significant interactions among the main effects on grain N concentrations, in either study.

TABLE 4. WHEAT AFTER CORN UREA-INSTINCT II TRIAL: SPAD METER READINGS, GRAIN YIELD, GRAIN N CONCENTRATION AND GRAIN N REMOVAL.

N Rate	Agrotain	Instinct Timing	SPAD reading	Grain Yield	Grain N	Grain N Removal
lb N/A	no/yes			bu/A	%	lb N/A
0	no	none	41.9±1.4^{B}	33.1±2.8^{C}	1.8±0.1^{B}	31.5±1.2^{C}
85	no	-	53.4±2.0^{A}	71.1±8.1^{B}	2.3±0.1^{A}	83.2±8.5^{B}
100	no	-	53.8±1.3^{A}	73.0±8.4^{AB}	2.3±0.1^{A}	88.6±8.2^{A}
100	yes	-	53.1±1.6^{A}	77.3±7.1^{A}	2.3±0.1^{A}	90.6±6.4^{A}
-	-	none	53.7±1.4^{A}	71.9±7.6^{B}	2.3±0.1^{A}	86.7±6.6^{AB}
-	-	green up	53.5±2.1^{A}	73.9±7.9^{AB}	2.3±0.1^{A}	87.5±9.2^{A}
-	-	jointing	53.1±1.4^{A}	75.6±9.0^{AB}	2.3±0.1^{A}	88.2±9.2^{A}

^{A,B,C}Mean values followed by the same footnote letter are not significantly different at the 90% level of confidence.

Grain yield and grain N removal followed a similar pattern of response to the treatments, due to the fact that the two variables are confounded. In the urea-wheat after corn study (Table 4), both yield and N removal were significantly lower in the not N fertilized control than in any of the N fertilized treatments. There was a positive yield response to the greater N rate, when treated with Agrotain. Further, there was a generally positive response to the use of Instinct II, especially the second Instinct II timing (Table 4). The factorial analysis (3 N rate/Agrotain use treatments by 3 Instinct II rate/timing treatments) found no significant interactions among the main effects on grain yield or grain N removal in the urea-wheat after corn study.

TABLE 5. WHEAT AFTER SOYBEAN UAN-INSTINCT II TRIAL: SPAD METER READINGS, GRAIN YIELD, GRAIN N CONCENTRATION AND GRAIN N REMOVAL.

N Rate	Agrotain	Instinct Timing	SPAD reading	Grain Yield	Grain N	Grain N Removal
lb N/A	no/yes			bu/A	%	lb N/A
0	no	none	40.9±0.5^{B}	47.6±9.0^{C}	1.8±0.1^{B}	43.5±6.9^{C}
85	no	-	51.0±1.6^{A}	80.5±6.3^{B}	2.1±0.1^{A}	87.9±6.9^{B}
100	no	-	51.5±2.2^{A}	82.2±7.5^{B}	2.2±0.2^{A}	91.4±10.3^{AB}
100	yes	-	50.9±2.0^{A}	85.7±6.6^{A}	2.2±0.2^{A}	96.1±5.0^{A}
-	-	none	51.1±2.2^{A}	83.1±9.6^{AB}	2.1±0.1^{A}	91.8±9.0^{AB}
-	-	green up	51.5±1.9^{A}	83.0±6.0^{AB}	2.1±0.3^{A}	91.9±10.2^{AB}
-	-	jointing	50.8±1.6^{A}	82.3±5.1^{B}	2.1±0.1^{A}	91.7±5.4^{AB}

^{A,B,C}Mean values followed by the same footnote letter are not significantly different at the 90% level of confidence.

In the UAN wheat after soybean study, both yield and N removal were again significantly lower in the not N fertilized control than in any of the N fertilized treatments (Table 5). There was a positive yield response to the greater N rate, when treated with Agrotain. However, there was no response to the use of Instinct II (Table 5). The factorial analysis (3 N rate/Agrotain use treatments by 3 Instinct II rate/timing treatments) found no significant interactions among the main effects on grain yield or grain N removal in the UAN-wheat after soybean study.

CONCLUSION

In these two studies, there was evidence of a general benefit to added N nutrition, some greater benefit to the use of Agrotain with N fertilization of no-till wheat after both corn and soybean, and some smaller benefit to the use of Instinct II with N fertilization of no-till wheat after corn. The positive response to Agrotain, in both rotations, was likely due to generally favorable conditions for N volatilization losses. The difference in response to Instinct II - a positive response where wheat followed corn but no response where wheat followed soybean - could be due to greater soil denitrification loss potential (wetter soil) under the heavy corn residues. The lack of a statistically significant response between N rates of 85 and 100 lb N/acre was likely due to the small difference in N rate (only 15 lb N/acre) and insufficient replication.

ACKNOWLEDGEMENT

The study was supported by Dow AgroSciences and the University of Kentucky Agricultural Experiment Station.