Grain Sorghum Yield Response to Slow-Release Nitrogen Fertilizers and Additives

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Introduction

Sorghum is a major crop grown in Texas. Market volatility and increasing costs of nitrogen (N) fertilizer accentuate the need to better manage N fertility applications for grain sorghum production. Though N is required by sorghum in greatest amounts compared to other nutrients, it is subject to biological interactions and loss through leaching, runoff and volatilization. Concerns over potential nutrient contamination of surface and groundwater resources also highlight the need for improved management of N fertilizers.

Slow-release nitrogen fertilizers and/or the addition of compounds which stabilize N in the soil environment may reduce N_2O and other N losses by enhancing plant uptake and overall use efficiency of applied N (Hopkins and LeMonte, 2011). However, these products may only be beneficial in specific situations and only if the total N application rate is reduced by the amount of N saved compared to standard N sources (Schwab and Murdock, 2010). As shown in previous studies, N release rates will largely be governed by type of product and soil temperature (Golden et al., 2007).

Objective

Evaluate selected N slow release and stabilizer products in comparison with conventional, inorganic N sources with regard to rate and placement to optimize the yield of grain sorghum.

Materials & Methods

Grain sorghum hybrid DKS 44-20 was planted on March 28, Pioneer 84G62 on April 4 and DKS 3707 on April 29, 2012 at one study site each in Hill, Hunt and Williamson Counties, respectively (Fig. 1). Experimental design for all studies was a randomized complete block with experimental units replicated five times. Plots were four rows wide with intra-row spacing of 0.76 or 0.97 m and length of 18.3 to 19.8 m.

Treatment strategies for all study sites were based on a yield goal of 5,600 kg/ha and nutrient analyses of soil samples collected during February and March to a 1.22 m depth. Liquid urea ammonium nitrate (UAN, 32-0-0) and granular urea (46-0-0) were used as standard N sources. UAN was coulter applied at rates of 0, 34, 67, 101 and 134 kg N/ha to verify the yield response to supplemental N. UAN with addition of the urease/nitrification inhibitor Agrotain Ultra (Agrotain International) and granular slow-release N products ESN (Agrium) and SuperU (Agrotain International) were surface, dribble applied at 34, 67 and 101 kg N/ha. All plots received subsurface, side-dress banded P at rates recommended by soil test. Nitrogen treatments were side-dress banded at planting in Williamson County and shortly after crop emergence (stage 2) in Hill and Hunt Counties.

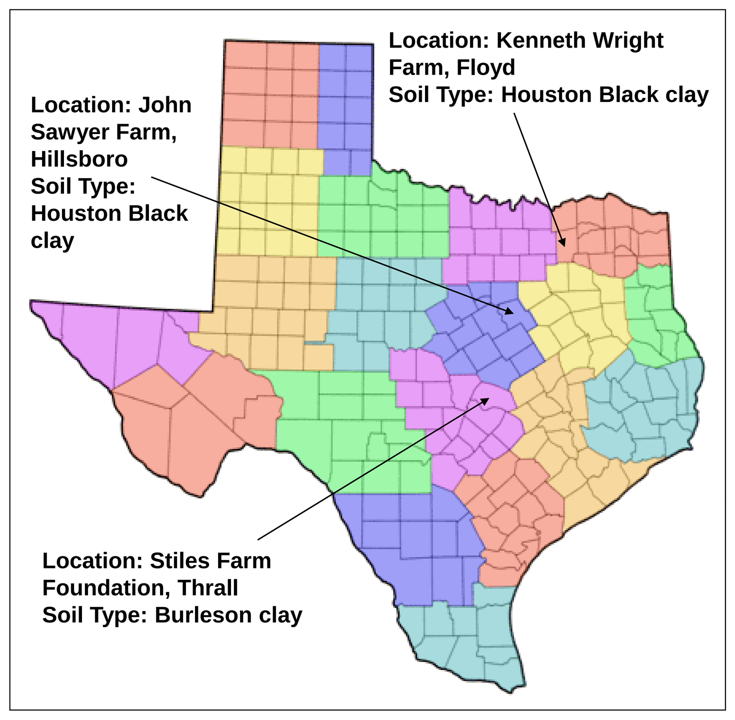

Fig. 1. Location of field studies within the Central Blacklands of Texas.

Uppermost unfolded leaf chlorophyll (SPAD 502, Minolta) was collected at peak flower. Grain yield was determined by hand harvesting 3.05 m from each of two center rows per plot or by machine harvesting the entire plot length. Statistical significance across all measurements was determined by analysis of variance and means separated using Fisher's Protected LSD, where appropriate.

Monthly rainfall accumulation during February and March ranged from similar to 500 percent of long-term averages across study sites. However, percent of average monthly rainfall for April, May and June was 88, 30 and 47, respectively for Hill County, 54, 50 and 23, respectively for Hunt County and 6, 75 and 5, respectively for Williamson County.

Results & Discussion

Yield of grain sorghum increased with increasing rate of applied N as UAN up to 67 kg/ha in Hill and Hunt Counties; whereas, no response was observed to varied rates of applied N in Williamson County (Table 1). The lack of yield response to applied N and elevated CV for the Williamson County site was due primarily to diminished rainfall weeks prior to planting and continuing through flowering.

Table 1. Grain yield response of sorghum to rate of coulter-applied urea ammonium nitrate (UAN) at study sites in Hill, Hunt and Williamson Counties, TX, 2012.

Treatments		Grain Yield†		
Source	N Rate	Hill County	Hunt County	Williamson County
	(kg/ha)	----------------------------(kg/ha)-----------------------		
None	0	5407 c‡	4480 b	2949§
UAN	34	6114 b	4979 b	3367
UAN	67	6835 a	6184 a	3040
UAN	101	6762 a	6435 a	3835
UAN	134	7053 a	6730 a	3260
LSD		410	552	858
CV		4.7	7	19.3

†Grain yield corrected to 14% moisture.
‡Means followed by the same letter within a column were not different according to Protected LSD (P≤0.05).
§Means within this column were not different according to ANOVA F Test (P≤0.05).

No consistent trends were observed for differences in yield between conventional and granular, slow-release N fertilizer sources or the liquid N additive across rates of N fertilizer application at all three of the Central Blacklands locations (Tables 2-4).

Table 2. Effect of surface, dribble-applied urea ammonium nitrate (UAN) without or with urease-nitrification inhibitor, urea, reformulated urea and polymer-coated urea on grain yield of sorghum in Hunt County, TX, 2012.

	Grain Yield†		
N Source	34 kg N/ha	67 kg N/ha	101 kg N/ha
	---------------------------------(kg/ha)----------------------------		
UAN	5358‡	5774	6278
UAN + Agrotain Ultra	5395	5884	6354
Urea	5555	5925	6420
SuperU	5337	6110	6477
ESN	5691	6258	6472
P>(F)	0.407	0.159	0.862
CV	6	5.22	5.26

†Grain yield corrected to 14% moisture.
‡Means within a column were not different according to ANOVA F Test (P≤0.05).

Table 3. Effect of surface, dribble-applied urea ammonium nitrate (UAN) without or with urease-nitrification inhibitor, urea, reformulated urea and polymer-coated urea on grain yield of sorghum in Hill County, TX, 2012.

	Grain Yield†		
N Source	34 kg N/ha	67 kg N/ha	101 kg N/ha
	---------------------------------(kg/ha)----------------------------		
UAN	6343‡	6918	6620
UAN + Agrotain Ultra	6337	6700	6405
Urea	6355	6364	6875
SuperU	6345	6690	6698
ESN	6756	6484	6832
P>(F)	0.594	0.393	0.787
CV	7.57	6.92	9.58

†Grain yield corrected to 14% moisture.
‡Means within a column were not different according to ANOVA F Test (P≤0.05).

Table 4. Effect of surface, dribble-applied urea ammonium nitrate (UAN) without or with urease-nitrification inhibitor, urea, reformulated urea and polymer-coated urea on grain yield of sorghum in Williamson County, TX, 2012.

	Grain Yield†		
N Source	34 kg N/ha	67 kg N/ha	101 kg N/ha
	---------------------------------(kg/ha)----------------------------		
UAN	3481‡	3600	3436
UAN + Agrotain Ultra	3220	3469	3556
Urea	3411	3056	3112
SuperU	3007	3540	3758
ESN	3316	3089	2875
P>(F)	0.936	0.604	0.423
CV	28.31	20.62	23.26

†Grain yield corrected to 14% moisture.
‡Means within a column were not different according to ANOVA F Test (P≤0.05).

Compared to the control or no additional N applied, there were significant effects of N application as UAN on uppermost leaf chlorophyll at flowering in Hill, Hunt and Williamson Counties (Fig. 2). However, there were no differences observed in uppermost leaf chlorophyll readings due to source of N used at each of three rates of N applied (Fig. 3a-c).

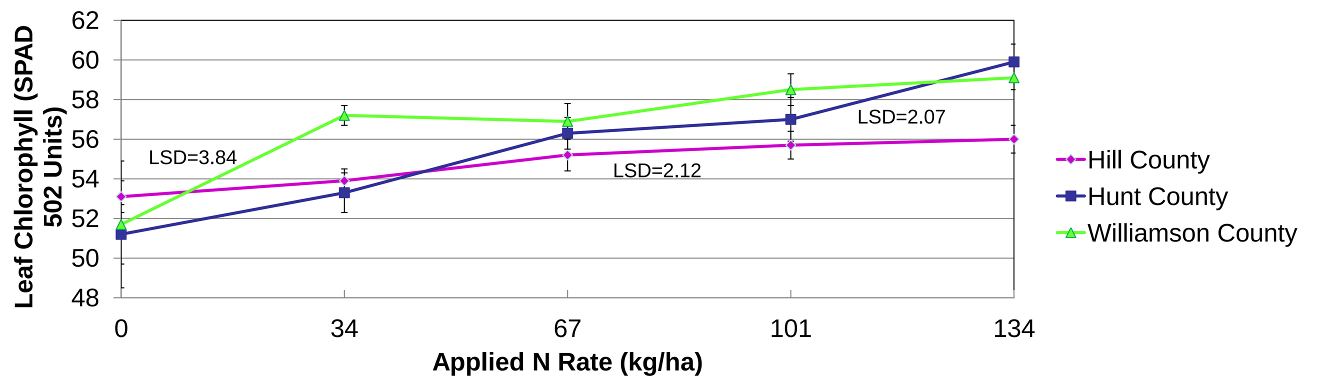

Fig. 2. Effect of applied N rate on uppermost-expanded leaf chlorophyll of grain sorghum grown at three locations in the Central Blacklands of Texas, 2012. Means within a county were significantly different at increased rates of N according to LSD (P≤0.05). Standard error bars represent treatment means.

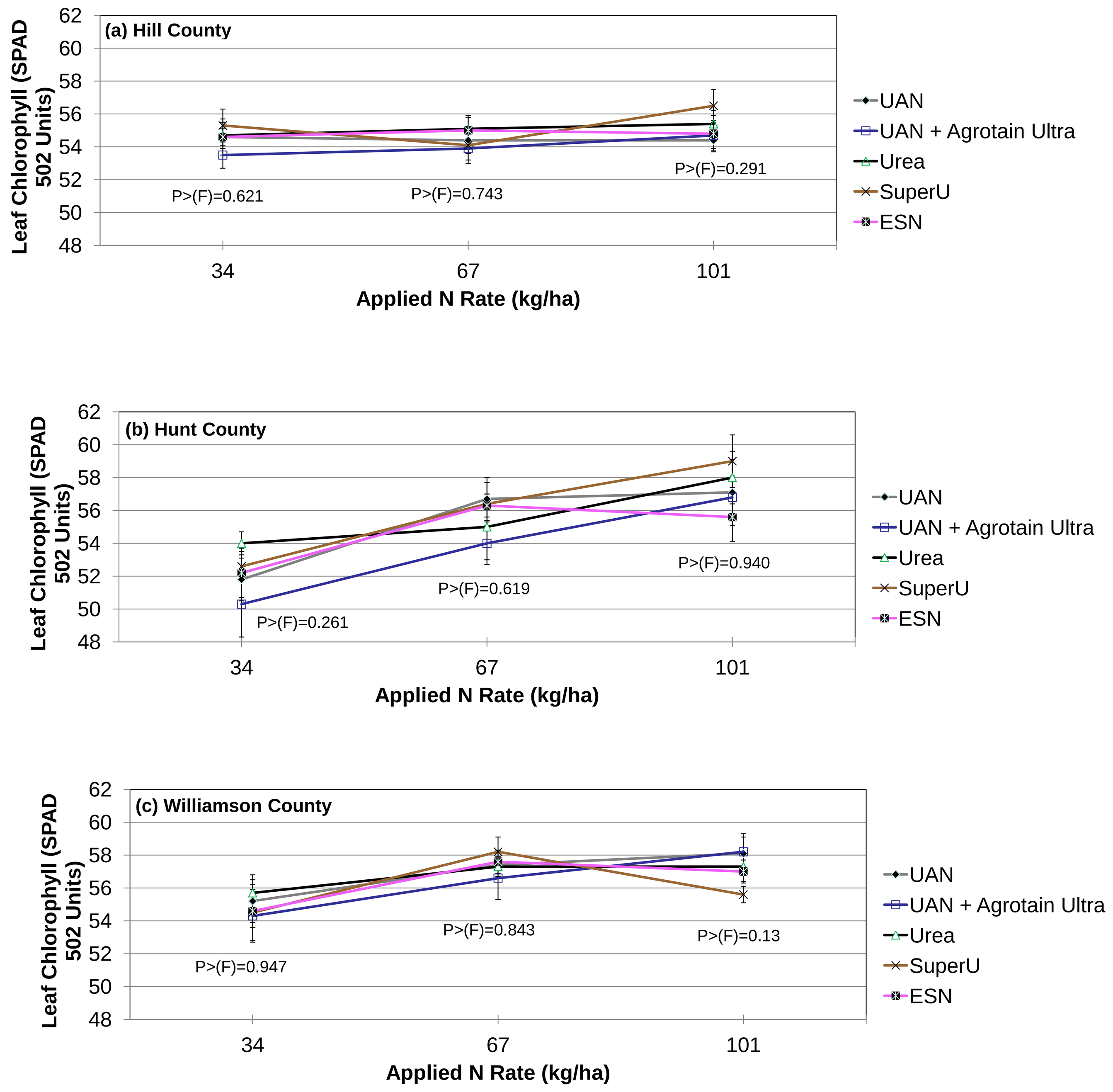

Fig. 3a-c. Uppermost-expanded leaf chlorophyll response of grain sorghum grown in the Central Blacklands of Texas to conventional N sources, conventional N source with urease/nitrification inhibitor and slow-release N sources at three rates of applied N, 2012. Means within a single rate of N were not significantly different according to ANOVA F Test (P≤0.05). Standard error bars represent treatment means.

Summary

- ✓ Yield of grain sorghum and uppermost leaf chlorophyll responded to increased rates of applied N from UAN in two of three locations where seasonal rainfall was more comparable to long-term averages.
- ✓ Applied UAN in combination with a urease–nitrification inhibitor and slow-release, granular N sources had no effect on yield of grain sorghum and uppermost leaf chlorophyll compared to UAN alone or urea.

Acknowledgements

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