Effect of Enhanced Efficiency N Fertilizers and Additives on Leaf N Concentration and Biomass N Content of Grain Sorghum

Coker, D.L., M.L. McFarland and T.L. Provin
Texas A&M AgriLife Extension Service, College Station, TX

Introduction

Grain sorghum is widely grown in Texas and is the second most important crop grown for feed and bio-fuel feedstock in the United States. Improving management of input costs, particularly nitrogen (N) fertilizer, is critical for maintaining the economic viability of sorghum production. Applied N in sorghum cropping systems is subject to biological interactions and loss through leaching, runoff, and volatilization.

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). Previous studies have indicated N release rates are largely 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 for grain sorghum.

Materials & Methods

Grain sorghum hybrid Pioneer 84G62 was planted on April 4 and DKS 3707 on April 29, 2012 at one study site each in Hunt and Williamson Counties, respectively. Experimental design for each study 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 with and without addition of the urease/nitrification inhibitor Agrotain Ultra, granular urea and granular slow-release N products ESN and SuperU were surface, dribble applied at 34, 67 and 101 kg N/ha. Controls or plots with no additional N were included for comparison. All plots received subsurface, side-dress banded P at rates recommended by soil test. Nitrogen treatments were side-dress banded at planting in Williamson and shortly after crop emergence (stage 2) in Hunt Counties (Plate 1).

Plate 1. Applied granular fertilizer on day of surface banding at a field study site in Hunt County, Texas.

Sixteen uppermost unfolded leaves were collected from each plot at peak flower to assess N concentration. Whole-plant biomass samples were collected from a 1.5 m length on each of two yield rows at the soft dough stage. Samples were processed separately as stover and grain for determination of total N. 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 of measurements was determined by analysis of variance and means separated using Tukey's Test where appropriate.

Percent of average monthly rainfall for April, May and June was 54, 50 and 23, respectively, for Hunt County and 6, 75 and 5, respectively, for Williamson County.

Results & Discussion

There were no significant interactions of nitrogen rate with source for any parameter measured. Yield of grain sorghum increased with increasing rate of applied N to 101 kg/ha in Hunt County (Fig. 1a); whereas, no response was observed to varied rates of applied N in Williamson County (Fig. 2a). The lack of yield response to applied N for the Williamson County site was due primarily to diminished rainfall weeks prior to planting and continuing post flower stage. No statistical differences in grain yield were observed across sources of N at either study site (Figs. 1b and 2b).

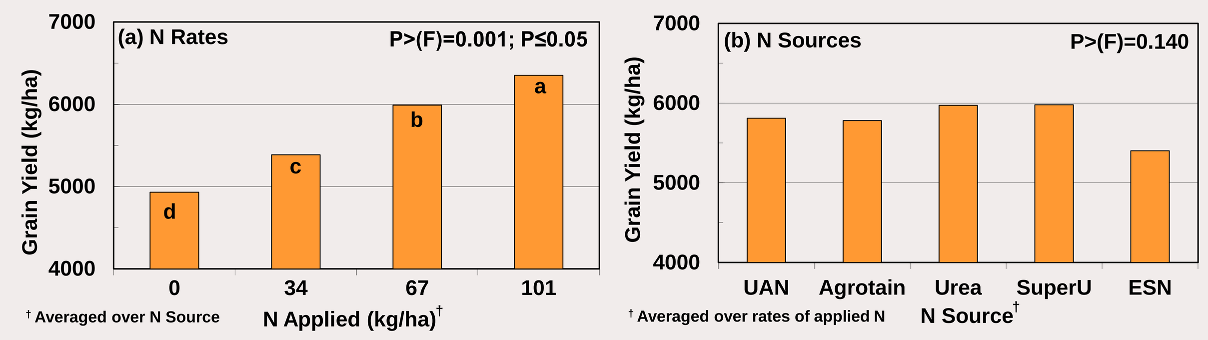

Fig. 1a-b. Effect of applied rates of N averaged over different N sources (a) and applied N sources averaged over rates of N (b) on yield of grain sorghum grown in Hunt County, Texas, 2012. Bars with different letters were significantly different according to Tukey's Test (P≤0.05). Bars without letters were not different according to ANOVA F Test (P≤0.05).

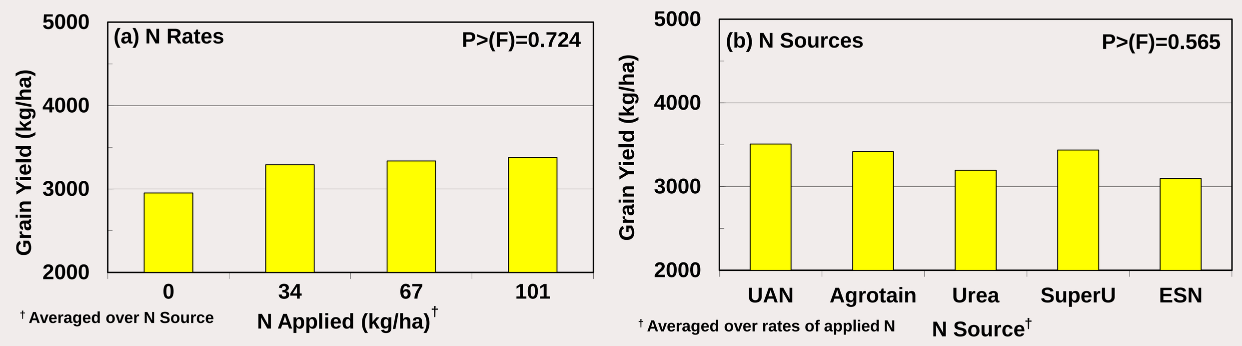

Fig. 2a-b. Effect of applied rates of N averaged over different N sources (a) and applied N sources averaged over rates of N (b) on yield of grain sorghum grown in Williamson County, Texas, 2012. Bars without letters were not different according to ANOVA F Test (P≤0.05).

Pooled over rates of N, leaf N concentration at flowering, and stover, grain and total N content at maturity were the same across dribble-applied UAN, UAN plus additive, urea or granular, slow-release N treatments at both Central Blacklands locations (Tables 2 and 3).

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 leaf nitrogen (N) concentration at flowering and N content of grain sorghum biomass at maturity averaged over rates of applied N, Hunt County, TX, 2012.

N Source	Leaf N Concentration†	Nitrogen Content of Biomass: Stover	Grain	Total
	g/kg	-----------------(kg N/ha)-------------		
UAN	25.6‡	29.6	56.5	86.1
UAN + Agrotain Ultra	25.1	25.2	54.6	79.7
Urea	26.5	27.1	62.3	89.3
SuperU	26.4	27.2	60.2	87.4
ESN	25.6	27.1	61.0	88.1
P>(F)	0.104	0.38	0.423	0.525

† Dry weight basis.
‡ 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 leaf nitrogen (N) concentration at flowering and N content of grain sorghum biomass at maturity averaged over rates of applied N, Williamson County, TX, 2012.

N Source	Leaf N Concentration†	Nitrogen Content of Biomass: Stover	Grain	Total
	g/kg	-----------------(kg N/ha)-------------		
UAN	34.5‡	21.4	49.2	70.7
UAN + Agrotain Ultra	34.5	22.7	53.5	76.2
Urea	34.7	23.3	48.8	72.1
SuperU	34.6	24.2	48.6	72.8
ESN	34.4	20.5	41.2	61.7
P>(F)	0.979	0.84	0.22	0.455

†Dry weight basis.
‡Means within a column were not different according to ANOVA F Test (P≤0.05).

Averaged over N sources, leaf N concentration at flowering responded to increasing rate of applied N up to 101 kg/ha in Hunt County (Fig. 3a). At maturity, stover N content was higher in plots that received 67 kg N/ha compared to 34 kg N/ha or control plots. (Fig. 3b). Grain and total plant N content responded to increasing rate of applied N up to 101 kg/ha (Figs. 3c and d).

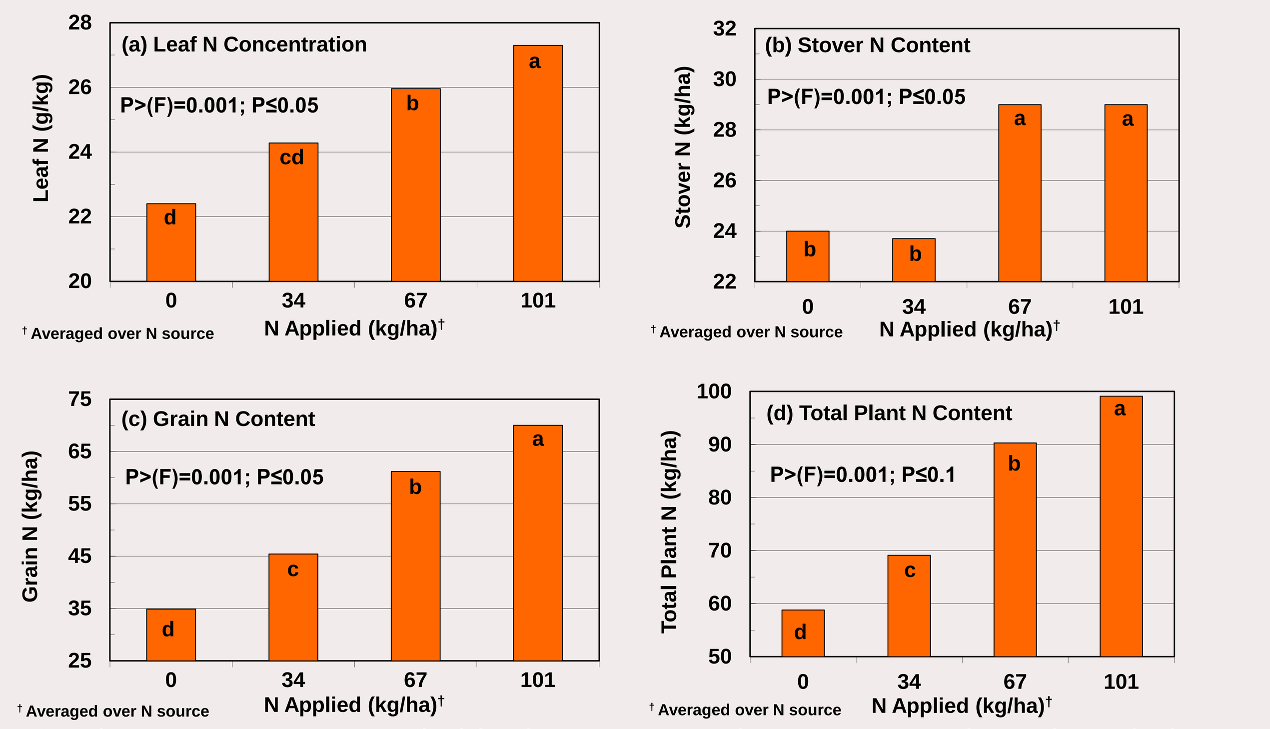

Fig. 3a-d. Uppermost-expanded leaf N concentration, stover, grain and total plant N content response of grain sorghum grown in Hunt County to three applied rates of N averaged over conventional, conventional plus urease-nitrification inhibitor and slow-release N sources in 2012. Bars with the same letters were not significantly different according to Tukey's Test (P≤0.05 or 0.1).

Averaged over N sources, leaf N concentration at flowering responded to rate of applied N up to 67 kg/ha in Williamson County (Fig. 4a). Stover N content varied but was not statistically different across rates of applied N; however, grain and total N content were greater in plots that received 67 kg N/ha compared to control plots (Figs. 4 b-d). Extended hot, dry conditions after flowering likely limited uptake of plant N which would result in a lower N use efficiency at the maximum rate of applied N.

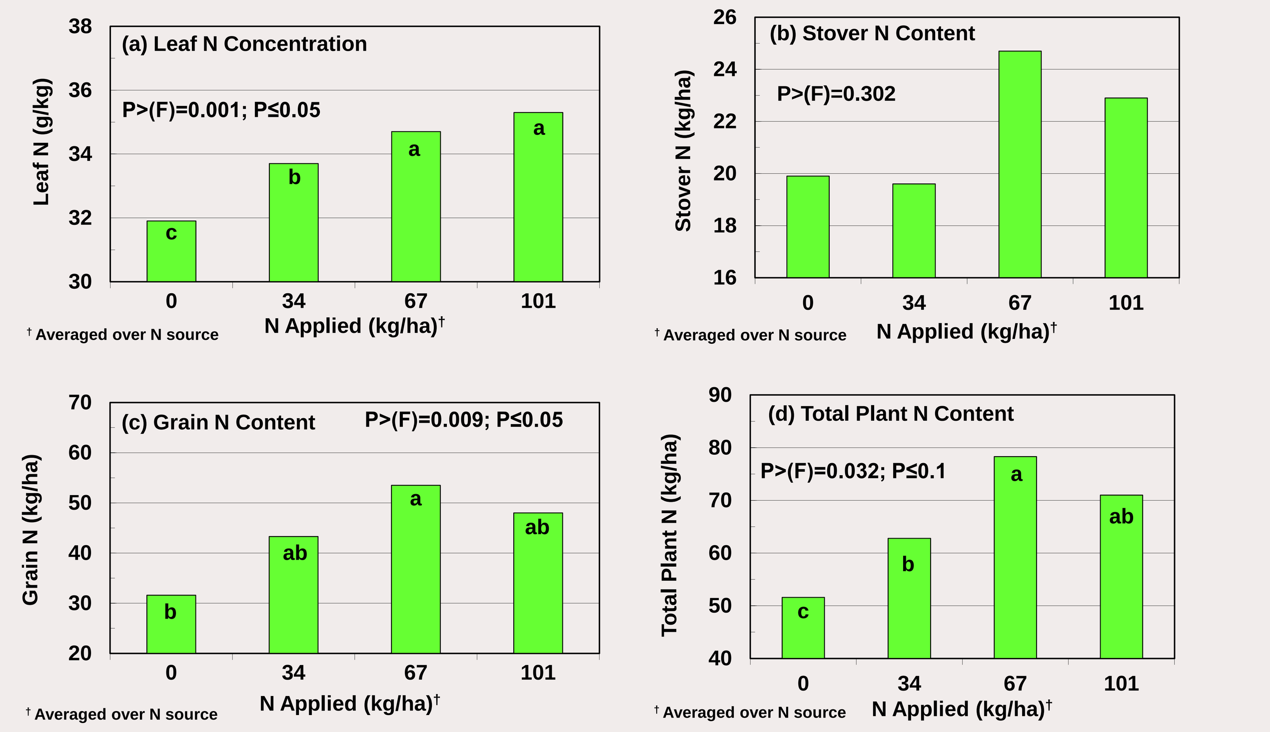

Fig. 4a-d. Response of uppermost-expanded leaf N concentration at flowering, and stover, grain and total plant N content at maturity of grain sorghum grown in Williamson County to three applied rates of N averaged over conventional, conventional plus urease inhibitor and slow-release N sources in 2012. Bars with the same letters were not significantly different according to Tukey's Test (P≤0.05 or 0.1).

Summary

- ✓Leaf N concentration, grain, and total N content of grain sorghum responded to increased rates of surface-applied N in two study locations; this response was reflected in grain yield at one of two locations.
- ✓Surface-applied UAN in combination with a urease inhibitor and slow-release, granular N sources had no effect on yield, leaf N concentration at flowering, and biomass N content at maturity of grain sorghum compared to UAN alone or urea.

Acknowledgements

J.R. Simplot Company, Crop Production Services and KOCH Agronomic Services, LLC for donating N fertilizers and product. The season-long efforts of Russell Sutton and Archie Abrameit are appreciated.

References

Hopkins, B. and J. LeMonte. 2011. Global importance and progress of reducing anthropogenic emmissions of nitrous oxide. *In* ASA-CSSA-SSSA International Annual Meetings Abstracts 253-1, Oct. 16-19, 2011, San Antonio, TX.

Golden, B.R., N.A. Slaton, R.E. DeLong, and R.J. Norman. 2007. Nitrogen release from polymer-coated urea via a buried-bag technique. In ASA-CSSA-SSSA International Annual Meetings Abstracts 224-3, Nov. 4-8, 2007, New Orleans, LA.

Schwab, G.J. and L.W. Murdock. 2010. Nitrogen transformation inhibitors and controlled release urea. University of Kentucky, Cooperative Extension Service, Dept. of Plant and Soil Sciences, AGR-185.