

# Can Protein Levels Be Economically Increased?

*Initial trials evaluated on winter wheat at two stages.*

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**Summary:** Across both locations no evident trends in grain yields developed but trends were found in grain protein results. Lack of response in yield due to late-season applications of N is not unexpected, especially considering the environment. Extreme heat and drought during the spring and summer drew soil moisture from depth, likely contributing a great deal of additional  $\text{NO}_3$  during periods of stem elongation through grain fill. As is often the case in field experiments, no final conclusions can be drawn from a single year's worth of data.



One result from the 2010 hard red winter wheat harvest was an increase of discussions on protein values across the southern great plains. The crop garnered relatively low protein values for several reasons, many of which were directly related to the weather patterns and environmental conditions. The question that many in industry and production were asking was whether protein levels could be economically increased. It has been documented that late-season nitrogen (N) application (pre- and post-anthesis) can indeed increase protein, a practice that is common in the production of spring wheat. In a 2002 field study by Woolfolk, et al., it was reported that when UAN and ammonium sulfate were applied to winter wheat pre- and post-flowering, grain N concentration was increased. Agricultural producers are regularly presented with a multitude of products that boast improved yields, protein, or efficiency. One such product is the low-salt, controlled-release specialty N fertilizer. This product is sold in large volume to be applied at flag leaf with a fungicide in an effort to increase yield, but is

also used elsewhere to increase grain protein. The work performed in 2002 did not evaluate N applications prior to pre-anthesis nor did the experiment evaluate N rates as low as what is being recommended. It showed increased protein values using traditional fertilizer sources, resulting in minimal to no tissue damage. However, treatments were applied in the cool of the morning to ensure minimum burn. This is not practical on a large scale, and reduced leaf burn is one of the selling points of the low-salt products. In addition, there has been a great deal of recent discussion about the functionality of the additional N present in the grain as a result of post-anthesis applications.

## Trial specifics

This trial evaluated the use of foliar N applications on winter wheat at two stages: flag leaf and post-flowering, using both a traditional and specialty source. Nitrogen rate also was evaluated to determine impact of N on yield and quality.

This is important, as the 2002 study mentioned above reported there was a linear response to N rate up to 34 kg N ha<sup>-1</sup>, while also cautioning that most low salt N fertilizers are not

being recommended at rates of more than 18 L ha<sup>-1</sup> or 7.6 kg N ha<sup>-1</sup>.

Liquid UAN was used in this study as the traditional N source, a caveat, however, in that both N sources were applied mixed with water to achieve a flow rate of 93.8 l/ha. This was done in an effort to reduce the potential for tissue damage when N is applied midday. The low-salt product used was a controlled released liquid fertilizer produced for agricultural use, containing only N and readily available in Oklahoma, in this case as CoRoN 25-0-0.

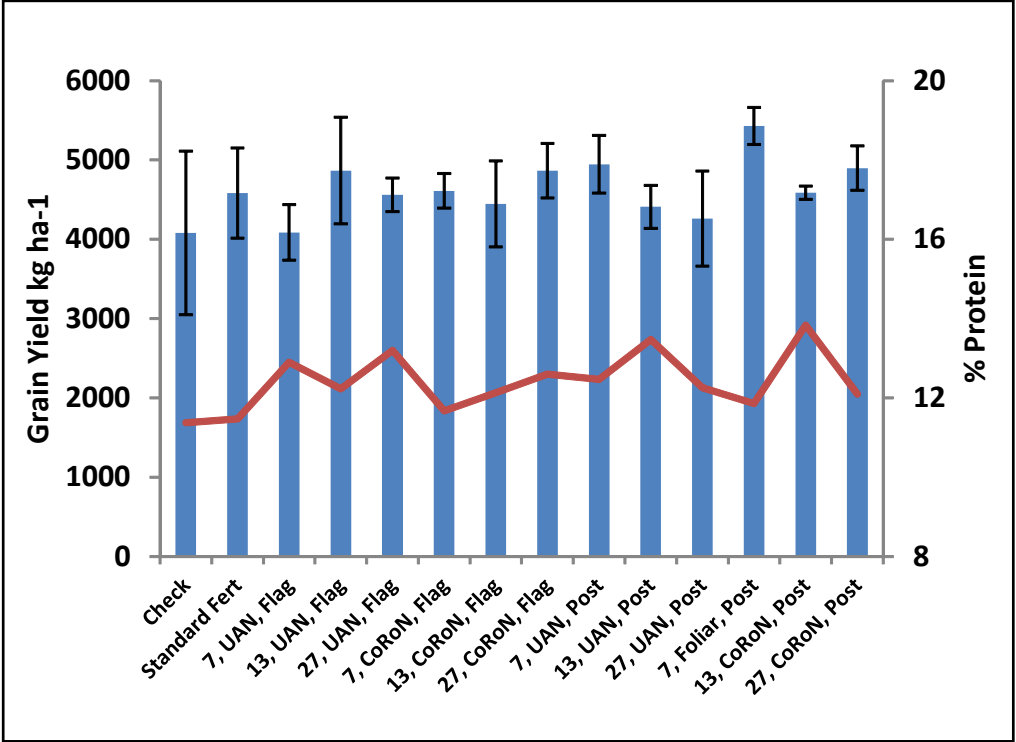
The trials were established at two locations, Lahoma and LCB, and consisted of 14 treatments arranged in a RCBD. Table 1 shows treatment structure. At harvest, a sub-sample of grain was collected from each plot and sent to the USDA ARS Baking and Milling Lab in Manhattan, KS for evaluation of treatment impact on quality.

## Lahoma

**Yields.** The Lahoma location had been fallowed the previous season, which helps explain the extremely high yields, compared to the rest of the region. At this location treatment mean yields ranged from 4,000 to

Treatment	Rate (kg N ha <sup>-1</sup> )	Source	Timing
1	Check	Unfertilized Check	
2	Rec Fert <sup>\$</sup>		
3	6.7	UAN	Flag Leaf
4	13.4	UAN	Flag Leaf
5	26.8	UAN	Flag Leaf
6	6.7	CoRoN	Flag Leaf
7	13.4	CoRoN	Flag Leaf
8	26.8	CoRoN	Flag Leaf
9	6.7	UAN	Post Anthesis
10	13.4	UAN	Post Anthesis
11	26.8	UAN	Post Anthesis
12	6.7	CoRoN	Post Anthesis
13	13.4	CoRoN	Post Anthesis
14	26.8	CoRoN	Post Anthesis

**Table 1.** Treatment structure for the impact of foliar N on baking and milling qualities of hard red winter wheat. Standard fertility quality is based on yield goal recommendations and soil test results. The yield goal N rates at Lahoma and LCB were 112 kg N ha<sup>-1</sup> and 84 kg N ha<sup>-1</sup>, respectively.



**Figure 1.** Grain yield (kg ha<sup>-1</sup>) and protein percentage results from Lahoma, OK location. Error bars represent standard error of each treatment. Treatment titles shown as: nitrogen rate in kg N ha<sup>-1</sup>, nitrogen source, and application timing.

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5,400 kg ha<sup>-1</sup>. However, there was a great deal of variation across treatments so no significant difference was seen in yields. The coefficient of variation of the yields was 18. No main effects of interactions were significant.

**Protein.** Analysis of protein showed no significant difference in protein values across treatments. The treatments receiving 13.4 kg N ha<sup>-1</sup> post-anthesis achieved the highest protein values. There was a significant rate by time interaction at p of .095. Yield and protein results are shown in Figure 1.

**Mixing tolerance** is a ranked value with a score from 0-6; values above 3 are preferred. The results from the Lahoma wheat samples showed significant differences across treatments. Three treatments fell below the industry preferences: 27 kg N ha<sup>-1</sup> CoRoN post-anthesis, 13 kg N ha<sup>-1</sup> CoRoN flag leaf, and check. The treatments receiving 13.4 kg N ha<sup>-1</sup> post-anthesis and the 7 kg N ha<sup>-1</sup> UAN at flag leaf had the highest mixing tolerance scores (Figure 2). Source was significant at .0013, with UAN at 3.67 and CoRoN at 2.94. Also rate by time interaction was significant at .0091.

**Loaf volume.** The hard winter wheat Quality Targets Committee gives a recommended target Loaf Volume of 850 cc or greater. At the Lahoma location only one treatment yielded a Loaf Volume sufficient to meet the committee’s recommendation of 13 kg N ha<sup>-1</sup> CoRoN applied post anthesis (Figure 3). There was no significant main effect or interactions with the Loaf Volume data from Lahoma.

**LCB**

**Yields.** The Lake Carl Blackwell (LCB) location is near Stillwater and situated on a lower class of soils that will typically have lower yields than the Lahaoma site. The 2011 harvest resulted in yields ranging from 1,700 to 2,200 kg ha<sup>-1</sup>. There was no significant difference in yields across treatments, however the check and standard fertility treatments did result in the lowest yields (Figure 4).

**Protein** data from LCB showed results of which could be considered expected. Standard fertility significantly increased protein above

the check while all foliar N treatments increased protein above the level of standard practice. Five of the six treatments with the highest protein levels were the foliar applications made at post-anthesis. The treatment of 27 kg N ha<sup>-1</sup> UAN post-anthesis resulted in a 1 percent increase in protein over the standard fertility treatment. Time as a main effect was significant at a .101.

**Mixing tolerance.** While protein levels at LCB were quite good (14.5 to 15.5 percent), all of the treatments yielded a below par mixing tolerance with scores ranging from 1.3 to 2.0. Neither significant differences nor trends were found across the mixing tolerance data (Figure 5).

**Loaf volume.** As with the protein data, five of the six treatments with the greatest loaf volumes included applied post-anthesis (Figure 6). All treatments receiving fertilizer increased the volume above the recommended level of 850 cc. Additionally, all treatments receiving foliar N have loaf volumes greater than the standard fertility. While there was no significant difference between the standard fertility and 27

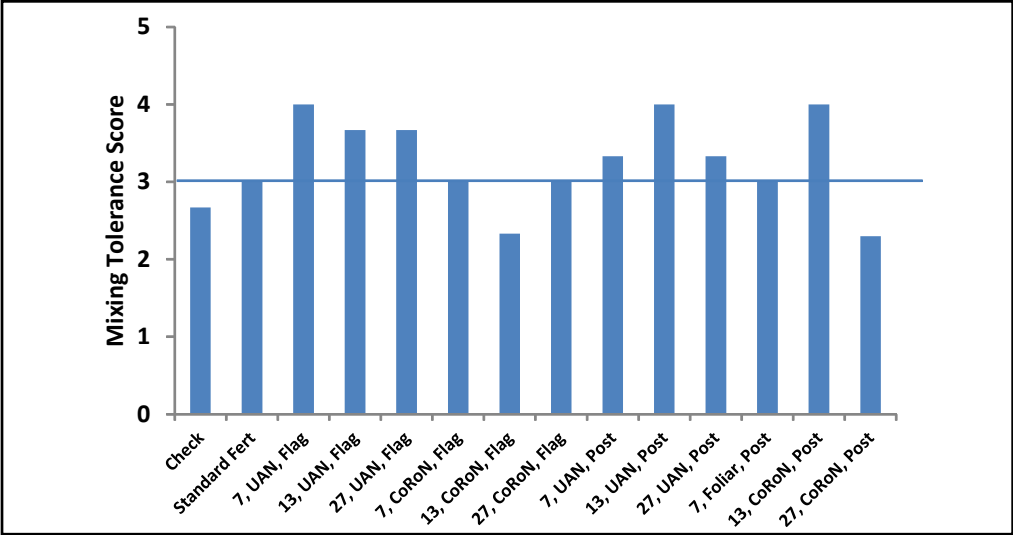
“Late-season nitrogen can indeed increase protein.”

kg N ha<sup>-1</sup> UAN post-anthesis, the late application did increase volume by 55 cc.

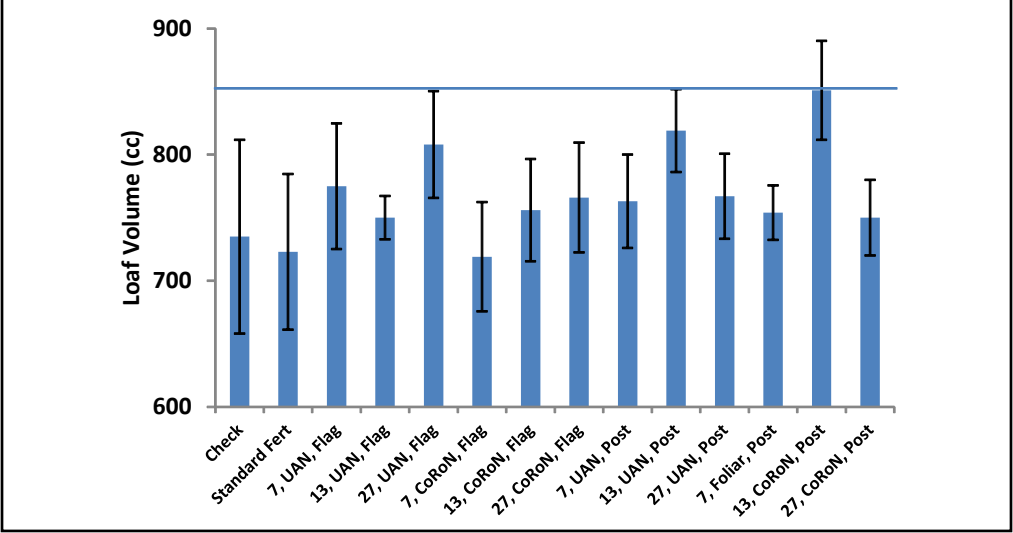
**What’s ahead**

A note on procedures is that at both locations all foliar treatments were applied midday. On the day of application, daily average temperatures ranged from 60 to 75° F with temperature at application ranging between 75 and 85° F. Even with the high temperatures, no leaf burn was observed from any of the N applications.

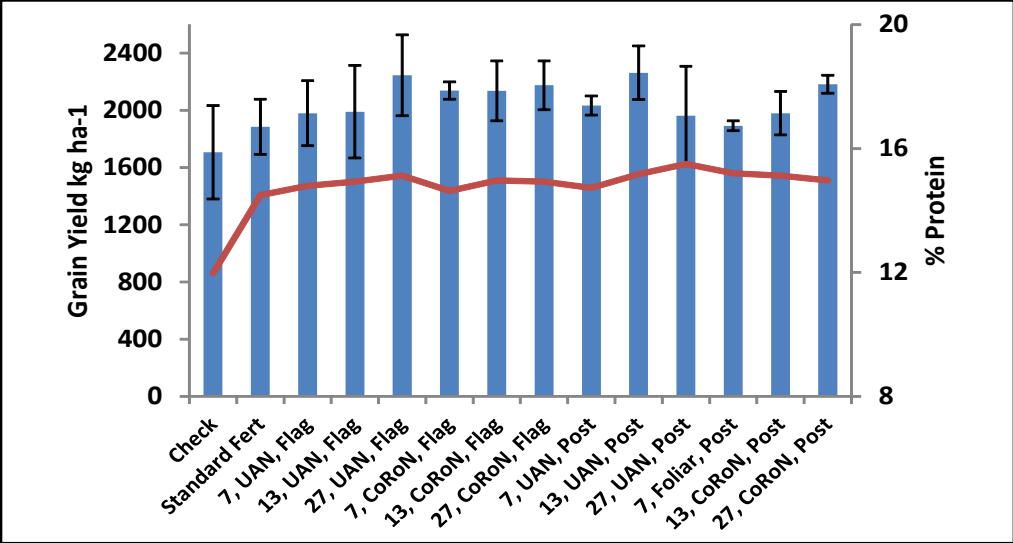
Across both locations, no evident trends in grain yields developed but trends were found in the grain protein results. Lack of response in yield due to late-season applications of N is not unexpected, especially considering the environment.



**Figure 2.** Mixing Tolerance Score results from the grain collected at the Lahoma, OK location. Hard winter wheat Quality Targets Committee recommends a target value of 3 or greater. The horizontal blue line shows the recommended level. Treatment titles shown as nitrogen rate in kg N ha<sup>-1</sup>, nitrogen source, and application timing.



**Figure 3.** Loaf Volume, measured in cc, results from the grain collected at the Lahoma, OK location. Error bars represent standard error of each treatment. Hard winter wheat Quality Targets Committee recommends a target value of 850 cc or greater. The horizontal blue line shows the recommended level. Treatment titles shown as nitrogen rate in kg N ha<sup>-1</sup>, nitrogen source, and application timing.



**Figure 4.** Grain yield and protein percentage results from the LCB, OK location. Error bars represent standard error of each treatment. Treatment titles shown as nitrogen rate in kg N ha<sup>-1</sup>, nitrogen source, and application timing.

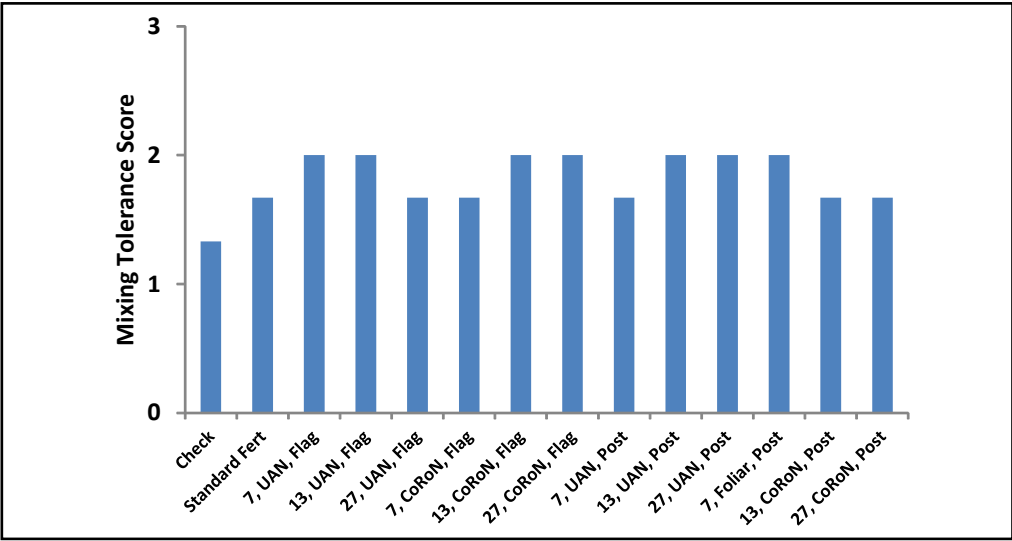
Extreme heat and drought during the spring and summer drew soil moisture from depth, likely contributing a great deal of additional NO<sub>3</sub> during periods of stem elongation through grain fill. The lack of consistent grain protein results from the Lahoma location tends to support this hypothesis.

While there was significant difference in mixing tolerance scores across treatments at Lahoma, no conclusions can be drawn on which timing rate or source may lead to an improved score above the standard fertility treatment.

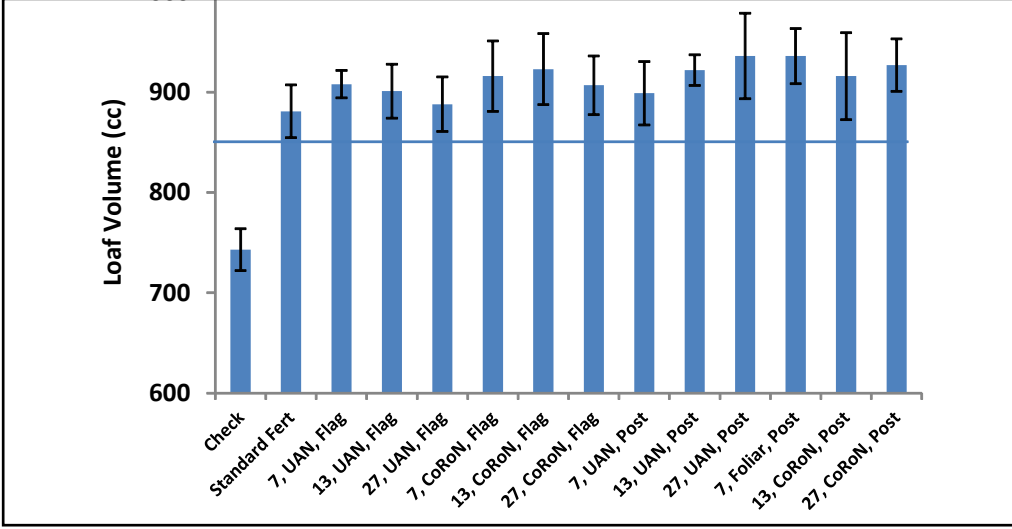
Loaf Volume results were very positive and indicated a potential increase in volume with foliar applied N. While results were not consistent across sites, the data do suggest that N applied post-anthesis may lead to a higher likelihood of volume increase.

The 2011-2012 winter wheat crop is in the ground with a good stand at both locations. The forthcoming results are highly anticipated as an added year of data will likely lead to a better understanding.

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**Figure 5.** Mixing Tolerance Score results from the grain collected at the LCB, OK location. Hard winter wheat Quality Targets Committee recommends a target value of 3 or greater. The horizontal line shows the recommended level. Treatment titles shown as nitrogen rate in kg N ha<sup>-1</sup>, nitrogen source, and application timing.



**Figure 6.** Loaf Volume, measured in cc, results from the grain collected at the LCB, OK location. Hard winter wheat Quality Targets Committee recommends a target value of 850 cc or greater. The horizontal blue line shows the recommended level. Error bars represent standard error of each treatment. Treatment titles shown as nitrogen rate of kg N ha<sup>-1</sup>, nitrogen source, and application timing.

# FFF Celebration Draws Capacity Crowd

30th anniversary of research arm of fluid fertilizer industry celebrated.

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Members of the agricultural industry from the United States and overseas attended this year's 21st Annual Fluid Forum to celebrate the 30th anniversary of the Fluid Fertilizer Foundation, the research arm of the fluid fertilizer industry. A Saturday meeting of the FFF's Research and Education Committee and a Sunday morning meeting of the FFF's Board of Directors preceded the arrival of attendees. A crowd of 188 arriving registrants were then treated to a Sunday evening reception featuring a broad array of gourmet delights.

The opening Monday morning sessions began with an avant-garde panel dating back to the early NFSA/FFF days and forward (Ed Krysl, Larry Murphy, Raun Lohry, Ned van Buren, and Julian Smith) giving their reflections on the grit and determination that put fluid fertilizer technology on the world map and advanced its use via the FFF's 5 million dollars in donations to university and other agency researchers over the past 30 years. They went back in time,



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