Fertilizing Flood-Irrigated Spring Wheat for High Protein

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Introduction
Producing wheat with protein levels above the 14-percent cutoff for price premiums requires balance among yield-determining moisture and nutrients. Wheat utilizes nitrogen (N) to produce biomass and grain to the point where yield is constricted by moisture or other nutrients. It then uses additional N to create protein. Optimizing yield and protein content under irrigation requires precise amounts of water to constrain yield so that excess N is diverted to protein. Irrigating for maximum yield makes achieving 14-percent protein difficult. With unlimited water, wheat requires a huge amount of N to reach its yield potential. None is left over for protein development. The higher the yield, the more N is required to change protein content. But controlling irrigation timing and application rates can be difficult for furrow-irrigated crop production.

Objectives
Our objective was to evaluate options for growing high-protein wheat with current irrigation practices.

Materials and Methods
We conducted the study on furrow-irrigated, deep clay loam soils at the Powell Research and Extension Center during summer 2011 on ‘Alzada’ durum planted at 125 lbs/acre and ‘Volt’ hard red spring (HRS) wheat planted at 100 lbs/acre. Both were planted 1.5 inches deep at a row spacing of seven inches. We supplemented residual soil N based on an early spring soil test to achieve 1.5, 2.3, and 3.2 lbs N/bushel of our 120-bushel/acre yield goal, which amounts to 100, 200, and 300 lbs of N/acre, respectively, on 9- x 20-foot plots replicated four times (128 total plots). Nitrogen was applied as follows:

1. Urea (46% N; 78¢/lb N) all preplant-incorporated (PPI);
2. ESN all PPI (44% N polymer-coated, enhanced-efficiency urea, Agrium Inc.; 88¢/lb N);
3. ½ ESN +(½ from urea + residual) all PPI;
4. Split urea PPI + liquid urea-ammonium-nitrate (UAN; 32% N; 87.5¢/lb N);
5. Late-season urea broadcast at tillering.

Prices are from the Big Horn Co-Op Marketing Association in Powell on May 30, 2012. We also evaluated plots with no added N. We irrigated HRS six times and durum five times. Phosphorus was applied at 25 lbs/acre as MAP.

Results and Discussion
Grain from five of the 128 plots attained 14 percent protein, three of which occurred in
ESN PPI applied to HRS wheat at 300 lbs per acre, which resulted in the only treatment with average protein content over 14 percent. ESN showed promise for durum wheat as well, resulting in significantly higher protein than other treatments, but only at the highest N rates (Fig. 1). Grain protein content responded to N rate across most of the treatments, while grain yield leveled off at 100 lbs added N/acre (1.5 lbs N/bushel yield goal) in most treatments (Fig. 1). Our results indicate that growers who furrow irrigate six times per year stand the best chance of producing wheat with protein levels greater than 14 percent by planting HRS wheat and incorporating N fertilizer prior to planting to provide about 416 lbs N per acre (fertilizer + residual), with ESN providing at least 70 percent of the available N. This amounts to 3.4 lbs N/bushel. These values are based on total N available (residual soil N plus fertilizer N). Reducing irrigation may be more cost effective. This way yield N requirements would be met sooner, leaving more N for protein. Nonetheless, the enhanced-efficiency fertilizer ESN shows promise for wheat with protein levels in excess of 14 percent.

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**Contact Information**

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![Figure 1](image_url)