Boosting Wheat Grain Protein

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With higher than average winter wheat protein discounts, and fairly high spring wheat protein discounts, now is a good time to consider whether to apply additional nitrogen to boost protein. Nitrogen concentration in the flag-leaf (uppermost leaf of the stem) at heading can be measured to determine whether a late-season nitrogen application will boost protein. Based on Montana research, grain protein is likely to increase with late-season nitrogen if the flag-leaf nitrogen concentration at heading is less than 4.2 percent. The lower the flag-leaf nitrogen, the greater the potential response to late season nitrogen, but the more nitrogen that will be required to reach high protein.

The ratio of fertilizer cost to protein discount influences whether applying nitrogen for protein is economically justified at a given flag-leaf concentration (Figure 1). For example, with a 50 cent discount per one percentage point protein and nitrogen at 49 cent per pound, the flag leaf nitrogen concentration needs to be below about 4.0 percent to cover the expense of the fertilizer. If either the protein discount is lower or the cost of fertilizer higher, then the critical flag-leaf nitrogen needs to be lower yet, to justify additional nitrogen.

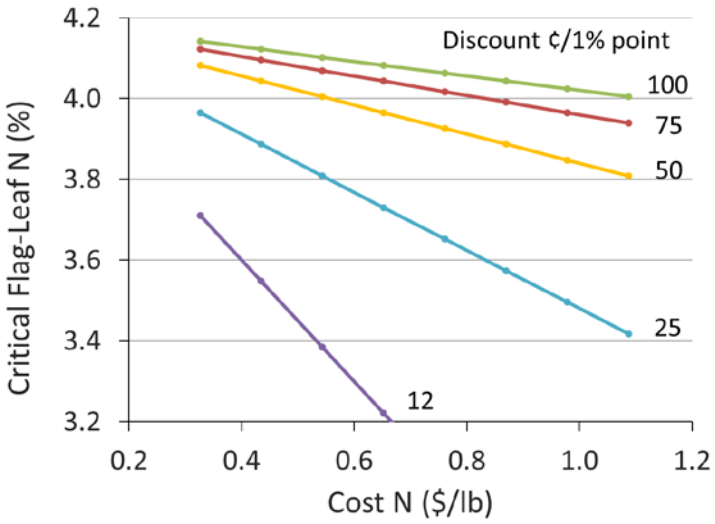

Figure 1. Critical flag-leaf N of irrigated spring wheat relative to protein discount (¢/1% protein) and cost of N ($/lb N) to break even financially. Will likely only want to apply N when actual FLN is substantially below CFLN to reduce risk.

Unfortunately flag-leaf analysis can not tell you how much nitrogen to add, or the final protein level. The higher the yield, the more late-season nitrogen is required to increase protein by a point. For example, 30 pounds nitrogen per acre is expected to boost irrigated wheat protein by about 1 point for a 60 bushel per acre yield, but only 0.5 points for a 120 bushel per acre yield.

There may be a limit to how much late-season nitrogen can be applied to boost protein. An Idaho study found 75 pounds per acre late-season nitrogen on irrigated wheat increased lodging and reduced yield. Also, it is important to use application methods that maximize the amount of nitrogen that gets taken up by the crop.

Applying liquid nitrogen with streamer bars is the best mid to late-season application option to limit stand damage as long as rates are low enough to minimize burn on the leaves that the liquid does hit. Jones suggested that no more than 30 pounds nitrogen per acre of 28 or 32 solution or 45 pounds nitrogen per acre of liquid urea should be applied to minimize burn and yield loss. These limits are more important when streamer bars aren't an option and nitrogen needs to be applied with a flat fan. Burn is generally not a concern with fertigation because of very dilute concentrations of nitrogen.

Little nitrogen is actually taken up through the leaf surface. Foliar nitrogen needs to be washed off the leaf and moved into the soil by a half-inch of water in a single event. This is sometimes doubtful in dryland systems. Adding a surfactant or urease inhibitor (such as Agrotain®) may improve foliar applied urea recovery and protein response, if at least a half-inch of irrigation or rainfall doesn't move the fertilizer from the leaf into the soil. However, these additives may increase risk of leaf burn.

Late-season nitrogen is not guaranteed to increase protein. Studies in South Dakota with winter and spring wheat found foliar nitrogen at flowering increased grain protein 70 percent of the time if the yield goal was exceeded, yet only 23 percent of the time when yield goal was not met.

Response to nitrogen is also dependent on sufficient sulfur. Yellowing upper leaves indicates the crop may be sulfur deficient, whereas nitrogen deficiency shows up as yellowing lower leaves. A foliar application of three to five pounds sulfur per acre as ammonium thiosulfate or ammonium sulfate should correct the problem, but, as with nitrogen fertilizer, liquid sulfur is dependent on sufficient rain or irrigation water to wash the sulfate into the root zone, and it may be getting too late to correct sulfur deficiency especially on winter wheat.

The decision to apply late-season nitrogen to increase protein depends on: 1) whether it can be applied without substantially damaging the crop; and 2) if the expected protein response and discount are sufficiently high to justify the cost of fertilizer and application.

The Soil Scoop "Nitrogen Management for Grain Protein" presents a synopsis of overall management practices to improve grain protein. This and other soil fertility information, is available at http://landresources.montana.edu/soilfertility.