Demonstrating N Fertilizer Options to Maximize Spring Wheat Yield and Protein

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In recent years, there has been an increase in wheat yields with a drop in protein levels as low as 10% leading to a drop in crop value by close to $1.5/bu.

Application of more N fertilizer at seeding
- Increased lodging, yield loss and/or difficulty during harvest
- Leaching
- Volatilization
Figure 1: Relationship between wheat yield (bu/ac) (left) and Lodging (1-10) (right)
Strategies

• Strategies to address drop in protein %
  – Use of several controlled release nitrogen (CRN) fertilizers
  – Grow lodging resistant varieties
  – Grow varieties with higher inherent % protein
Objectives

The objectives of this study were to demonstrate:

- the effects of CRN fertilizers on grain yield and % protein of three spring wheat varieties

- which option or combination of options would be most effective to adopt
Study Sites

**Study sites:** Scott and Melfort

**Study year:** 2015

*Figure 1: Study site characteristics*
Figure 2: Precipitation (left) and Temperature (right) relative to long-term
Experimental Setup

• Experimental Design  
  – 3 x 7 factorial in RCBD with four replications

• Seeding rate: 350 seeds/m$^2$

• N application method  
  – All N blends applied mid-row/side-band at seeding, UAN dribble-band at late flag to early heading

• Herbicide and fungicides  
  – applied according to site operations

• Plot sizes: 2 x 10 m (Scott), 2 x 7 m (Melfort)
Factors

Factor A (Wheat varieties)

1. Lillian
   - Yield (lower)
   - Protein (higher)

2. Goodeve VB
   - Yield (moderate)
   - Protein (moderate)

3. Shaw VB
   - Yield (higher)
   - Protein (lower)

Factor B (N type)

1. Check

2. Urea (100)

3. Urea + ESN (50/50)

4. Urea + ESN (25/75)

5. Urea + Super U (50/50)

6. Urea + Super U (25/75)

7. Urea + UAN (80/20 @ early heading)

   - At 90 kg/ha
Data & Analysis

• Data was collected on
  – Days to Maturity (DTM)
  – Thousand Kernel Weight (TKW)
  – Bushel weight
  – Yield
  – Protein %

• *Combined* data was analysed using PROC MIXED in SAS 9.3

• Treatment means were separated according to Tukey’s HSD and considered significant at $P<0.05$
• Bushel weight, DTM and TKW were all affected by only wheat variety

• Bushel weight
  – Shaw VB > Goodeve VB > Lillian

• DTM
  – Shaw VB > Lillian > Goodeve VB

• TKW
  – Goodeve VB > Lillian = Shaw VB
Both yield ($P = 0.0023$) and protein ($P < 0.0001$) were significantly affected by wheat variety.

Yield
- Shaw VB
- Goodeve VB
- Lillian

Protein
- Shaw VB
- Goodeve VB
- Lillian

**Figure 3:** Effects of wheat varieties on grain yield and protein
Biomass lags behind N uptake and accumulation

Early-season (prior to the boot stage) N uptake affects
- Breakdown residue from previous crop
- Yield (number of head-bearing tillers/unit area, number of kernels/head and size of individual kernels)
  - But has minimal effect on grain protein.

Late-season N has minimal impact on yield because
- Tiller density and kernel number have already been established
- Can improve yield slightly in deficient plants
- However, it can have a significant impact on protein concentrations.

Figure 4: Percent of total biomass and N uptake during the growing season at various wheat growth stages. From: Nitrogen Management for Hard Wheat Protein Enhancement
Growth stage vs timing of application

Figure 5: Appropriate cereal growth stages and N application timing effects on yield and protein. (From: Practices to Increase Wheat Grain Protein)
Both yield ($P<.0001$) and protein ($P<.0001$) were significantly affected by N type.

All N treatments are significantly different from the check
- N fertilizer is essential to achieve acceptable yield

ESN had a slight % protein relative to Super U
- In drought years, Super U could provide a quicker source of N to the plant compared to ESN (McDonald, 2010)

UAN blend had the highest % protein relative to the ESN and Super U
- 20% of the N was applied as liquid UAN at the flag leaf stage rather than at seeding

**Figure 6: Effects of N type on grain yield and protein**
Wheat variety vs site

- Both yield and protein were significantly affected by variety at Melfort but only protein was affected by variety in Scott.

- At Melfort
  - Yield & protein
    - Shaw VB
    - Goodeve VB
    - Lillian

- At Scott
  - Protein
    - Shaw VB
    - Lillian
    - Goodeve VB

Figure 8: Effects of wheat variety on grain yield and protein by site
Conclusions

• When considering only yield, we found no advantage for the CRN fertilizers
  – using untreated granular urea at seeding was as effective as any of the combinations

• The most effective strategy for increasing protein in wheat
  – choose low yielding but high protein varieties and fertilize them adequately with N fertilizer.

• To the grower wondering whether ESN, Super U or UAN pay?
  – UAN overall resulted in the greatest protein %, however, the grower must base their decision based on yield and/or price vs added costs and crop damage from application at flag leaf stage.

• Further trials over several years need to be conducted to see if the different blends of untreated and treated compared to untreated alone is profitable or not.
For more information visit:

www.agriarm.ca

www.westernappliedresearch.com

http://neag.ca
Thank you!!!

Questions and Comments