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In-crop N application to wheat

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[Editorial Note: This 26-site research study was conducted across the Prairies 20 years ago, but results and lessons learned are still applicable today.]

In-crop application of 14 lbs. N/ac of broadcast ammonium nitrate or foliar-applied UAN were generally equally effective at increasing grain protein content in Canada Western Red Spring wheat, but were not more effective than application of nitrogen (N) at the time of seeding. The increase in protein with in-crop N was not economic at most sites, but might have been if applied to soils with more N deficient conditions or applied at higher N rates.

With today's high yielding wheat varieties, growers are interested in seeing if they can also boost grain protein content in order to capture protein premiums. While this foundational research was conducted 20 years ago, from 1997 to 2000, the results have validity today. Keep in mind that the in-crop rates used were typical of rates at that time. The lessons learned about rates of application, efficiency of N uptake and timing of N application can help guide farmers and agronomists on the practice until in-crop split application research is conducted on today's varieties.

Field experiments were conducted at 26 sites from 1997 to 2000: 11 in southern Alberta, 8 in central Alberta, 2 in northeastern Saskatchewan (Melfort) and 5 in southern Manitoba (Brandon). Three sites in southern Alberta at Lethbridge were irrigated; all other sites were rainfed. Most sites were

located on commercial fields, and all sites were located on cereal or canola stubble. Except for irrigated and Manitoba sites, minimum tillage practices had been in use for at least 5 years.

Urea was banded at seeding at 0, 53, 67, 107, 120 lbs. N/ac. (0, 60, 75, 120 and 135 kg N/ha). At the urea application rates of 53 and 107 lbs. N/ac, N was also applied in-crop at 14 lbs. N/ac (15 kg N/ha) at three growth stages: tillering, boot stage and anthesis by broadcast application of ammonia nitrate (AN) and foliar application of urea ammonium nitrate (UAN). Foliar UAN was applied with a small plot sprayer with UAN diluted by 50% with water. The 14 lbs. N rate was selected to avoid possible leaf burn from foliar UAN applications, and to reflect typical recommendations of that time.

Phosphorus fertilizer was seed-placed at 12 lbs. P/ac (25 lbs. P₂O₅/ac; 13 kg P/ha). When required, potassium (K) and sulphur (S) were also banded prior to seeding.

AC Barrie CWRS wheat was grown at all sites. Row spacing was approximately 8 inches.

Minor effects on yield and protein content

Maximum grain yield was reached at 53 lbs. N/ac at all but two sites. The relatively high soil nitrate-N test values meant that little yield response was seen past the 53 lbs. N rate. As a result, grain yields were unaffected when the N rate at seeding was increased from 53 lbs. to 67 lbs. N, or from 107 to 120 lbs. N/ac.

In-crop N application increased grain protein content at only one site compared with the same rates of N applied at seeding. The average increase in protein content due to in-crop N application was small at 0.32% (range -0.3 to 1.3%) compared with basal N rates, and 0.07% (range -0.28 to 0.52%) compared with the same rates of N applied at seeding.

One of the main factors responsible for the small increase in protein content was the low rate of in-crop N application, coupled with the low N uptake efficiency. The other factor was the low N rate (53 lbs. N/ac) required for maximum yield at most sites. The higher soil levels of available N reduced the benefit of in-crop N application.

Application method significantly affected the increase in grain protein content due to in-crop N application at 4 of 26 sites. Foliar-applied UAN had a greater increase in protein content than broadcast AN at three of these sites, while broadcast AN had a greater increase in protein content at the other site. Application method did not affect protein content increase at the remaining 22 sites.

Application timing significantly affected the increase in grain protein content due to in-crop N application at 8 of 26 sites. At most sites with a significant effect of application timing, increases in protein content tended to increase with later date of application at anthesis. The average increase due to in-crop N application was 0.23% when applied at tillering, 0.34% when applied at the boot stage, and 0.4% when applied at anthesis.

Based on current prices, application of an additional 14 lbs. N/ac at anthesis only provided a positive economic return at 5 of 26 sites, assuming no increase in grain yield. On average, the cost of additional N was \$4 more than the increased value of the grain produced.

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R H McKenzie, E. Bremer, C A Grant, A M Johnston, J. DeMulder, and A B Middleton. 2006. In-crop application effect of nitrogen fertilizer on grain protein concentration of spring wheat in the Canadian prairies. *Canadian Journal of Soil Science*. **86**(3): 565-572. <https://doi.org/10.4141/S05-026>