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Nitrogen management strategies for winter wheat

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Split applications of N usually provided the maximum yield and protein, particularly with Agrotain or SuperU.

This study consisted of two experiments each conducted at five sites across western Canada at Brandon, Manitoba, Hallonquist (south of Swift Current), Saskatchewan, and Lethbridge and Lacombe, Alberta to assess the impact of nitrogen (N) fertilizer type and time of application on yield and protein content of winter wheat.

Experiment 1 included AC Radiant hard red winter wheat and CDC Ptarmigan soft white winter wheat. Nitrogen time of application treatments included 100 per cent side-band, 100 per cent spring-broadcast, and 50 per cent side-band+50 per cent spring-broadcast. Nitrogen formulations included urea, urea + urease inhibitor (Agrotain), urea+ urease + nitrification inhibitor (Super U), polymer-coated urea (Environmentally Smart Nitrogen; ESN), and urea ammonium nitrate (28-0-0; UAN).

In Experiment 2, Agrotain and CDC Ptarmigan treatments were removed and additional application methods included 100 per cent fall side-band, 50 per cent side-band+50 per cent late fall broadcast, 50 per cent side-band+50 per cent early spring broadcast, 50 per cent side-band+50 per cent mid-spring broadcast, and 50 per cent side-band+50 per cent late spring broadcast.

Each experiment received an N fertilizer rate of 80% of soil test recommendations. All plots received a blanket application of other macronutrients as recommended by soil tests. Experiment 2 also included a control N treatment with no fertilizer applied.

Split application maximized yield and protein

In Experiment 1, the average yield of AC Radiant was 67 bushels per acre (4.5 tonnes/ha) and 75 bushels per acre (5.05 tonnes/ha) for CDC Ptarmigan. All placement, timing and fertilizer types produced similar yield and net returns, with a few exceptions.

Spring broadcast ESN produced lower yields with both varieties, which was expected since the polymer coating does not degrade fast enough to allow early spring uptake of N. Yields with 100% spring broadcast urea were slightly inferior to other application forms but higher than ESN spring broadcast.

A similar trend was observed for net returns, except that urea, because of its lower cost, had similar net returns compared to the enhanced efficiency fertilizers. The exception was the lower net return with ESN spring broadcasts.

Experiment 2 was conducted to examine a greater range of split application dates with AC Radiant only. AC Radiant had an average yield of 56 bushels per acre (3.74 tonnes/ha).

In Experiment 2, there were few differences in yield and net return between urea type, placement and timing, with a few exceptions (Table 6). Side-band plus late spring broadcast ESN resulted in lower yield, protein, agronomic efficiency and net return relative to SuperU and urea. Again, this was expected because of the slow spring release of ESN. UAN also had inferior agronomic efficiency and yield compared to the urea-coated products.

Table 6. Mean winter wheat responses to N fertilizer form by placement/timing interaction for data collected from Experiment 2 (AC Radiant) sites in MB, SK, and AB, Canada, from fall 2006 to 2010.

Variable[a]	ESN	Urea	SuperU®	$LSD_{0.05}$
Yield (Mg ha^{-1})				
Sb	3.77	3.74	3.76	0.20
Sb + BC Early Spring	3.74	3.78	3.70	—
Sb + BC Fall	3.65	3.65	3.73	—
Sb + BC Late Spring	3.64	3.84	3.93	—
Sb + BC Mid Spring	3.76	3.72	3.72	—
Kernel weight (mg)				
Sb	37.1	37.0	37.3	0.7
Sb + BC Early Spring	37.9	37.4	37.0	—
Sb + BC Fall	37.0	37.3	37.1	—
Sb + BC Late Spring	37.7	37.3	37.3	—
Sb + BC Mid Spring	37.7	37.4	37.2	—
Protein concentration (g kg^{-1})				
Sb	105	106	107	4
Sb + BC Early Spring	107	105	108	—
Sb + BC Fall	103	102	103	—
Sb + BC Late Spring	104	107	110	—
Sb + BC Mid Spring	107	105	107	—
Protein yield (Mg ha^{-1})				
Sb	0.403	0.413	0.416	0.031
Sb + BC Early Spring	0.426	0.418	0.421	—
Sb + BC Fall	0.389	0.390	0.404	—
Sb + BC Late Spring	0.392	0.431	0.448	—
Sb + BC Mid Spring	0.426	0.411	0.424	—
Agronomic efficiency [kg ha^{-1} (kg N ha^{-1})$^{-1}$]				
Sb	5.25	5.08	5.23	1.04
Sb + BC Early Spring	5.12	5.31	4.91	—
Sb + BC Fall	4.62	4.66	5.04	—
Sb + BC Late Spring	4.57	5.62	6.11	—
Sb + BC Mid Spring	5.22	5.01	5.02	—
Net returns (CAN$ ha^{-1})				
Sb	808	814	812	47
Sb + BC Early Spring	810	830	804	—
Sb + BC Fall	785	795	807	—
Sb + BC Late Spring	782	840	850	—
Sb + BC Mid Spring	818	815	808	—

[a]Sb represents side-banded and BC represents spring-broadcast N fertilizer application, which are part of a split application with N side-banded at seeding.

Applicable across soil zones

The wide range of environmental conditions resulted in a fairly diverse set of site–years that was representative of growing conditions for winter wheat in western Canada. The researchers didn't find productivity, quality, efficiency, or profitability of winter wheat differed across soil zones regardless of urea type, placement or timing. However, urea and UAN appeared to be most sensitive to environmental variation among sites.

Based on the results of the two experiments, the researchers concluded that Agrotain and SuperU may be applied during seeding operations and (or) broadcast in-crop the next spring with reasonably low risk that there would be any yield-related penalty relative to a more typical urea side-banded treatment at the time of seeding. The results also suggest that split applications of N might be most efficient for yield and protein optimization when combined with an enhanced efficiency urea product, particularly with urease or urease + nitrification inhibitors.

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