Post-Seeding Nitrogen on Spring Wheat and Canola — A Balancing Act

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The positive results obtained from this study would support the recommendation that N fertilizer can be managed more precisely with post-emergent N applications provided that 50% is applied as starter N.

Nitrogen is the most limiting nutrient in crop production on the northern Great Plains. Nitrogen recovery efficiency has been estimated at 47% in the year of application, and 65.5% over the period of five growing seasons (Krupnik et al., 2004). The changes in fertilizer N prices with natural gas price fluctuations have made it a major component for a farmer's crop budget. These economic conditions are stimulating many agronomic questions related to the management practices necessary to achieve higher N use efficiency.

It is well recognized that the highest efficiencies for N fertilizer are obtained when N fertilizers are applied as close as possible to the start of maximum N uptake by the crop, thus reducing the opportunity for losses through leaching, denitrification and immobilization (Mahli et al., 2001). A number of studies were conducted in the last few years to examine more closely the merits of post-emergent N applications using UAN solutions and surface dribble applications as a way to apply N closer to the time of crop needs (Lafond et al., 2004; Holzapfel et al., 2007). The studies showed that this approach was feasible, but was not without risk and was never better than putting all the N fertilizer on at the time of seeding. The studies found that the unpredictability of rainfall increases the risks of surface dribble bands because some rainfall is required to move the fertilizer into the soil. The conclusion was that some N would need to be applied at seeding and the proportion would more than likely be greater than 33% of the recommended N needs.

The objective of this study was to quantify more accurately the risks associated with post-emergent N and to determine how these risks can be reduced. The study examined what proportion of the desired N rate should be applied at seeding, with the balance applied in-crop as liquid UAN in a surface dribble band for three early growth stages in both spring wheat and canola.

Studies were conducted at Indian Head and Scott, Saskatchewan, using no-till management systems. At the Indian Head site, the urea N applied at seeding was mid-row banded between every second row while at Scott the urea N was side-banded to the side and below the seed. Spring wheat and canola were grown over 3 years (2004-06), with the 2006 crop lost due to an August frost at Scott. The treatments involved a no N check, 100% of N as urea in-soil banded at seeding, 67% as urea at seeding, and the remaining 33% as UAN dribble banded at the sixth leaf, start of stem extension, and 5% flowering growth stages for canola, and 1 to 1.5 leaf, 3 to 3.5 leaf and 5 to 5.5 leaf stages for spring wheat. The urea N applied at seeding was lowered to 50% and 33% of the total, with the remaining N, 50% and 67%, respectively, applied as UAN at the above three growth stages. The rates of fertilizer N applied varied each year of this study, depending on the soil residual nitrate-N and the target yield of the wheat and canola crops (**Table 1**). Grain yield for canola and spring wheat are reported here using the mean for the 5 site-years of data.

Studies with canola and spring wheat indicate that N fertilizer can be managed more precisely when some N is applied as starter and some as post-emergent in semiarid regions.

The effects of wheel tracks on canola grain yield were important when the post-emergent N applications were applied at the start of bolting and start of flowering. In **Table 2**, the values in the row for 100% of fertilizer N at seeding indicate a treatment that received all N as an in-soil band at seeding, but was then driven through at the crop leaf stage shown as a means of quantifying the impact of the tractor on the crop. The effect was not significant at the 5 to 6 leaf stage, although there was a tendency for the grain yields to be lower than the at seeding treatment with no wheel tracks. The analysis of variance conducted has taken the effects of wheel tracks into consideration (data not shown).

Table 1. Soil residual nitrate-N and fertilizer N applied to wheat and canola.

Location		2004 Soil N[1]	2004 Fert N	2005 Soil N	2005 Fert N	2006 Soil N	2006 Fert N
		lb/A					
Indian Head	Wheat	57	45	23	83	19	76
	Canola	56	67	39	111	20	95
Scott	Wheat	60	72	49	67	–	–
	Canola	73	67	36	67	–	–

[1] Soil N was nitrate-N determined by modified Kelowna extraction method on a 0 to 24 in. sample.

Abbreviations and notes for this article: N = nitrogen; UAN = urea-ammonium nitrate.

Table 2. Canola response to different proportions of fertilizer N (%) applied at seeding on grain yield (kg/ha).

Fertilizer N at seeding, %	Check, no N	Crop leaf stage			
		At seeding	5-6 leaf	Start of bolting	5% flowering
–	1,747	–	–	–	–
100	–	2,552	2,393a[1]	2,344a[1]	2,210a[1]
67	–	–	2,338a	2,181a	2,013b
50	–	–	2,242a	2,182a	2,009b
33	–	–	2,156b	2,147a	1,981b
0	–	–	2,196b	1,925a	1,789b

[1] Means within a column followed by the same letter are not significantly different ($LSD_{0.05}$) from the mean where all the fertilizer was applied at seeding for each crop stage in that same column This is to take into consideration the negative effects of wheel tracks on grain yield.

Table 3. Spring wheat response to different proportions of fertilizer N (%) applied at seeding on grain yield (kg/ha).

Fertilizer N at seeding, %	Check, no N	Crop leaf stage			
		At seeding	1 to 1.5 leaf	3 to 3.5 leaf	5 to 5.5 leaf
–	2,194c	–	–	–	–
100	–	2,775a[1]	–	–	–
67	–	–	2,726a	2,749a	2,717a
50	–	–	2,666a	2,692a	2,687a
33	–	–	2,661a	2,687a	2,692a
0	–	–	2,530b	2,646a	2,538b

[1]Means followed by the same letter are not significantly different at 5% level from the mean where all fertilizer N was applied at time of seeding. The overall $LSD_{0.05}$ value for the experiment is 167. Note that the check yield was lower than all the other treatments.

There was a positive response to the N fertilizer applied on the canola crop (**Table 2**). At the 5 to 6 leaf stage, putting 50 or 67% of the target N rate at the time of seeding and the balance as a surface dribble did not result in lower grain yields compared with applying all of the fertilizer N at the time of seeding. There was also no difference recorded when the N was applied at the start of bolting although the trend was for lower yields as the proportion of N applied at seeding was reduced. At the start of flowering, a reduction in yield was observed when less than 100% of the targeted N rate was applied at seeding, indicating that delaying any application until flowering reduced yields.

Based on the results, it would appear that as long as at least 50% of the targeted N rate is applied at time of seeding, and the balance post-emergent by the bolting stage, grain yields of canola can be maintained. This not only provides important information for when to apply N in crop, but can be combined with recent developments for using in-crop optical sensors to assess the N status of crops and apply additional N fertilizer where required in the same field operation (i.e. Greenseeker Technology, NTech Industries Inc.).

Spring wheat showed a positive response to N application in this study, with little negative impact recorded when some of the total N was applied at seeding (**Table 3**). Only at the 1 to 1.5 leaf and 5 to 5.5 leaf stages of post-emergence application was a difference recorded, and that was when the entire quantity of N was applied after seeding. It is important to note that none of the treatment yields exceeded that of the treatment where the entire quantity of N was applied at seeding. However, it is an important finding that these wheat crops could have some portion of their N post-emergence applied, as long as some was applied at seeding. This provides the farmer in a semi-arid region the option of delaying N application for a period of time in the spring to assess soil water status and potential for crop yield formation. Varying the timings and application method did not affect wheat grain protein in this study (data not shown).

Based on the results of this study, some starter N needs to be applied at the time of seeding in order to protect yield potential and minimize the risks associated with post-emergent N applications for spring wheat and canola. The best proportion of starter N applied at the time of seeding may be dictated by the agro-ecological zone in question. In the drier zones, more starter N fertilizer may be required in comparison with the wetter zones, less may be required. In our studies, at least 50% should be applied at time of seeding to reduce the risks of post-emergent N applications. For individuals with low tolerance to risk, they may want to consider 66% of their target N at seeding. The positive results obtained from this study indicate that using optical sensors to predict yield potential and supplementing the crop with N to achieve this potential is feasible for Canadian prairie conditions because the risk of post-emergent N applications can greatly be reduced if at least 50% of the N is applied during the seeding operation. BC

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