Considerations for Side-Banded Nitrogen Fertilization

C.A. Grant, D.A. Derksen, L.D. Bailey, AAFC- Brandon Research Centre
A.M. Johnston, AAFC- Melfort Experimental Farm
G. Clayton, AAFC-Lacombe Research Centre
G.P. Lafond, AAFC-Indian Head Research Farm

Abstract
Side-band application of nitrogen fertilizer in a one-pass seeding and fertilizing system can improve operational efficiency and conserve soil moisture. However, under some circumstances, seedling damage can result from excessive concentrations of nitrogen coming in contact with the germinating seedling. Risk factors include high nitrogen application rates, use of urea-based fertilizers, wide row spacing leading to low seed-bed utilisation, high pH carbonated soils, soils with low cation exchange capacity and drying conditions after seeding. Loss of separation between seed and fertilizer can also increase potential for damage. Risk can be reduced by use of forms of nitrogen fertilizer other than urea, reducing the rate of nitrogen fertilizer applied, increasing the separation between seed and fertilizer and ensuring that the planned separation is maintained, increasing seed-bed utilisation or selecting another method of nitrogen placement.

Benefits of side-banding

One-pass seeding systems using side-banded applications of fertilizer are becoming increasingly popular on the prairies. These systems can save the producer time, labour and fuel costs, by combining the application of seed and fertilizer in one operation. Avoiding a separate operation for fertilizer banding can lead to a firmer seed-bed and help to conserve critical spring moisture. Side-banding tends to reduce volatile losses of nitrogen, by placing the fertilizer beneath the soil surface and can result in increased fertilizer use efficiency of both nitrogen and phosphorus by reducing contact between the fertilizer and the soil (Follett et al. 1981). Under very deficient situations or in cool or compacted soils, side-banded applications of phosphorus may be superior to pre-seeding band applications where the fertilizer may be further from seed. Side-banding allows the plants to access the fertilizer earlier in the season, when phosphorus, and to some extent nitrogen, can have the greatest impact on plant growth. Some researchers suggest that placing the nitrogen close to the seed may give the crop a competitive advantage over weeds Kirkland and Beckie 1998).

Risks of side-banding

Although side-band applications have many advantages, there may be some risks to this practice. Excess concentrations of nitrogen, particularly urea, in contact with germinating seedlings can lead to seedling damage. This is a frequently observed problem with seed-placed fertilizer. While it has been commonly assumed that separating the seed and fertilizer through side-banding with the 1” by 1” geometry would eliminate problems with seedling toxicity, it appears that this is not always the case.

In studies conducted by Loraine Bailey at Brandon Research Centre, side-banding urea ammonium nitrate an inch to the side and an inch below the seed generally produced good results in canola (Tables 1 and 2). However, in 1995, dry conditions increased the potential for seedling damage and side-banding the N and P led to significant reductions in canola stand. Yield was lower with the side-banded N and P, as compared to a pre-plant band application of N with seed-placed P, when high rates of nitrogen were used. This occurred both on a fine sandy loam and a silty clay soil, but the effects were greater on the dry, coarse-textured soil (Table 1 and 2). It is important to note that there was also a reduction in canola stand with seed-placed P and pre-plant banded N.

Table 1: Effect of rate of side-banded urea fertilizer on plant stand and seed yield of canola at 8-inch row spacing (Fine Sandy Loam, 1995-97).

Nitrogen Rate (kg/ha)	Stand (% of Control)			Seed Yield (kg/ha)		
	1995	1996	1997	1995	1996	1997
0	100	100	100	389	588	648
50	87	133	93	818	844	1005
100	49	106	95	1125	1361	1450
150	49	97	97	866	1202	1420
150-30 (sideband)	22	84	94	953	1775	1120
150-30 (N pre-plant band P seed-placed)	59	67	64	1318	1608	1102

Table 2: Effect of rate of side-banded urea fertilizer on plant stand and seed yield of canola at 8-inch row spacing (Clay Loam, 1995-97).

Nitrogen Rate (kg/ha)	Stand (% of Control)			Seed Yield (kg/ha)		
	1995	1996	1997	1995	1996	1997
0	100	100	100	1509	705	1098
50	94	88	86	1540	1162	1420
100	67	95	94	1704	1308	1650
150	41	68	71	1688	1806	1800
150-30 (sideband)	40	85	79	1385	1839	1903
150-30 (N pre-plant band P seed-placed)	69	85	96	1869	1741	1895

Factors influencing seedling damage

Potential for seedling damage depends on a number of factors including environmental conditions, crop grown, soil type, width of the seed/fertilizer band, row spacing and fertilizer source. Damage may increase with high pH, in the presence of salts or free lime, on light textured soils or soils low in organic matter, cool growing conditions, low soil moisture, or with the use of wide row spacing. Small seeded crops such as flax or canola are more sensitive to seedling damage than crops such as wheat or barley. Urea tends to be more damaging than ammonium nitrate, while urea ammonium nitrate (UAN) tends to be intermediate, since it is a blend of urea and ammonium nitrate. The amount of damage can vary greatly from year to year, depending on the specific conditions at seeding, so a rate which caused no problems one year may cause significant damage the next.

Since the concentration of fertilizer in contact with the seed has a great influence on seedling damage, extra caution must be taken when side-banding is combined with wide row spacing. By increasing row spacing, the concentration of fertilizer present beside the seed-row is increased. With small-seeded crops such as canola or flax, which are sensitive to seed-fertilizer contact, this may lead to seedling toxicity, even where the fertilizer is separated from the seedling by the common 1-inch by 1-inch side-banded pattern. Toxicity may be accentuated if the separation between seed and fertilizer is compromised due to "bounce" of the seed and fertilizer during the seeding operation.

Interim results of Canadian Fertilizer Institute studies

Co-operative studies are being conducted across western Canada evaluating the impact of urea nitrogen timing, placement and row spacing on canola and wheat yield and weed competition. Sites are located at Brandon, Melfort and Beaverlodge. The most consistently effective treatment in this study has been the 9-inch row spacing with side-banded urea application (Table 3).

Table 3: Ranking of seeding and N fertilization systems at three locations (Data courtesy of CFI cooperative study)

Fertilizer Placement	Brandon		Melfort		Beaverlodge	
	Rank	Range	Rank	Range	Rank	Range
Fall Band	2	1-4	5	3-5	1	1-3
Spring Band	3	2-3	4	3-5	2	1-4
9" Side	1	1-3	1	1-4	3	3-5
12" Side	4	1-5	3	1-4	5	2-4
Sweep	5	4-5	2	2-3	3	1-5

In 4 of 7 site years of canola and 2 of 7 site-years of wheat, yield was lower with 12-inch row spacing and side-banded urea nitrogen as compared to the 9-inch row-spacing treatment. The problems with the 12-inch row spacing appear to be due to seedling damage from the side-banded urea. Problems with seedling toxicity are likely to be greater on carbonated, high pH soils, coarse-textured soils, or when dry conditions occur after seeding. High pH carbonated soils are more frequently encountered in the eastern prairies than in more westerly regions.

Table 4: Effect of rate side-banded urea fertilizer on plant stand and seed yield of canola at 9-inch and 12-inch row spacing (Brandon 1998).

Nitrogen Rate (kg/ha)	Stand (Plants/m2)		Seed Yield (kg/ha)	
	9 Inch	12 Inch	9 Inch	12 Inch
0	78.1	60.0	778	699
45	79.0	36.6	1086	922
60	95.5	43.3	1128	944
80	69.3	32.0	973	793
107	91.5	43.0	1149	841
143	82.6	25.0	1149	854

Row-spacing by urea rate studies

Based on initial results of the CFI studies, additional experiments were conducted in 1998 across western Canada at Brandon, Melfort, Lacombe and Swift Current to take a closer look at the effect of row spacing at different rates of urea N. While there was little difference between 9-inch and 12-inch spacing at most of the sites, the 9-inch spacing produced higher stand density and higher yields than the 12-inch spacing at the Brandon location (Table 4). The sensitivity of the Brandon site to seedling damage may relate to the high soil pH and carbonate content at the site, conditions common in the eastern prairies. In contrast, at the Melfort location, while stand density tended to be lower at the 12-inch row spacing, canola yield was not negatively affected (Table 5).

Table 5: Effect of rate side-banded urea fertilizer on plant stand and seed yield of canola at 9-inch and 12-inch row spacing (Melfort 1998).

Nitrogen Rate (kg/ha)	Stand (Plants/m)		Seed Yield (kg/ha)	
	9 Inch	12 Inch	9 Inch	12 Inch
0	128	106	1843	1867
45	126	93	1955	1848
60	112	101	1726	1867
80	117	90	1931	1916
107	109	99	1921	1993
143	115	94	2062	2043

Risk factors and risk reduction

While side-banding nitrogen fertilizer will generally be an effective and safe method of application, it is important to recognize that there are risks associated with the practice. Damage may occur in situations that promote seedling toxicity. Risk factors include high pH carbonated soils, soils with low cation exchange capacity (i.e. coarse textured soils, soils with low organic matter content), drying conditions after seeding, and application on sensitive crops, such as canola or flax. Risk of damage increases at high fertilization rates or when using wide row spacing increases the effective concentration near the seed-row. If the seed-fertilizer separation is not maintained, risk of damage will also be higher. Where risk of damage is considerable, it may be advisable to increase the separation between seed and fertilizer band, to use a less-damaging fertilizer source or to consider an alternate method of fertilizer application.

Studies are continuing across western Canada to more clearly evaluate the impact of row spacing and fertilizer placement on yield, quality and competitive ability of canola and wheat. This should help to clarify factors contributing to damage and develop management practices that will optimize economics of crop production in one-pass seeding systems.

References

Follett, R.H., Murphy, L.S. and Donahue, R.L. 1981. Fertilizers and soil amendments. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 557 pp.

Kirkland, K.J. and Beckie, H.J. 1998. Contribution of nitrogen fertilizer placement to weed management in spring wheat (*Triticum aestivum)*. Weed Tech. 12: 507-514.