Fertilizer Management in Direct Seeding Systems

By T.L. Roberts and J.T. Harapiak

Direct seeding is the most common form of soil conservation used in the Canadian Prairies. In contrast to the restrictive conditions of no-till farming (such as no tillage prior to seeding and minimum tillage at seeding), direct seeders do not till in the spring before planting.

Direct seeding systems range from high disturbance systems that disrupt the entire soil surface to low disturbance systems with minimal soil disruption. Developments of air seeders and air drills have driven the successful adoption of this technology.

Although many farmers practicing direct seeding apply some of their fertilizer in the fall, there is increasing interest in applying all needed nutrients in a one-pass seeding and fertilizer operation in the spring. However, management of high rates of seed applied fertilizer, especially nitrogen (N), often discourage farmers from adopting a one-pass production system. This has prompted considerable research to determine how much fertilizer can be safely applied with the seed in small grains and oilseeds.

Germination damage from seed-placed fertilizer will vary with season and climatic conditions as well as from field to field or within fields, depending on soil variability or properties. High rates of fertilizer can be safely placed with the seed if seedbed moisture is good. Increasing the separation between seed and fertilizer through higher seedbed utilization (SBU) or precision placement of fertilizer will further increase the margin of safety.

Fertilizer Management

Old recommendations suggested that seed row N should not exceed 40 lb/A as ammonium nitrate, or 25 lb/A as urea. And, seed row N plus K_2O should not exceed 40 lb/A. These recommendations were appropriate for seeding equipment, which placed seed and fertilizer in close contact, but are not applicable for today's seeders which cause some scatter between seed and fertilizer, or which can precisely place fertilizer away from the seed.

Many factors influence how much fertilizer can be safely applied with the seed. These include: row spacing, SBU, soil texture, moisture, organic matter, soil variability, fertilizer placement, seed furrow opener, source, and crop. The rate of fertilizer that can safely be applied in the seed row decreases as row spacing increases and SBU decreases. Seedbed utilization is a measure of the amount of soil used for applying fertilizer. It is calculated as follows:

$$\% \text{ SBU} = \frac{\text{width of seed row}}{\text{row spacing}} \times 100$$

Heavier textured soil tolerates more seed row N because the increased cation exchange and water holding capacity reduce ammonia toxicity.

TABLE 1. Approximate safe rates of urea N (lb N/A) that can be applied with the seed of cereal grains.

	1 inch spread Row spacing			2 inch spread Row spacing			3 inch spread Row spacing		
	6″	9″	12″	6″	9″	12″	6″	9″	12″
	% SBU			% SBU			% SBU		
Soil texture	**17**	**11**	**8**	**33**	**22**	**17**	**50**	**33**	**25**
Light (sandy loam)	20	15	15	30	25	20	40	30	25
Medium (loam to clay loam)	30	25	20	40	35	30	50	40	35
Heavy (clay to heavy clay)	35	30	30	50	40	35	60	50	40

Table 1 shows the Saskatchewan guidelines for urea that may be safely applied with the seed of cereals. Application rates for ammonium nitrate may be increased by about 25 percent. Ammonium nitrate is less damaging to the seed than urea. It has a higher salt index, but does not add to ammonia toxicity. These guidelines are approximations only. They assume seedbed soil moisture is good to excellent.

Higher rates of N may be tolerated if conditions are good (i.e., high cation exchange capacity and excellent seedbed moisture). North Dakota recommendations suggest maximum seed row N can range from 60 to 100 lb/A when using an air seeder (60 to 100 percent SBU) in a heavy textured soil.

Seedbed moisture is critical for safe application of fertilizer at the time of seeding. Small seeded crops like canola are especially sensitive, particularly when soil conditions are less than optimal and SBU is low (**Figure 1**). Spreading seed and fertilizer over more of the seedbed can partially compensate for low soil moisture with wheat and barley, but less so with canola.

High rates of seed row N not only reduce stand, but increase the risk of delayed maturity. Prairie research has consistently shown that when seed row N exceeds 30 lb/A and SBU is low, maturity of grain crops may be delayed 3 to 5 days, and under unfavorable harvest conditions, a 5 day delay could extend to two weeks. Cereals can tolerate a small amount of stand loss with little impact on maturity, however, once 15 percent of the stand is lost, the risk of delayed maturity becomes unacceptable.

Seed-placed urea is more damaging to cereals than ammonium nitrate, except at

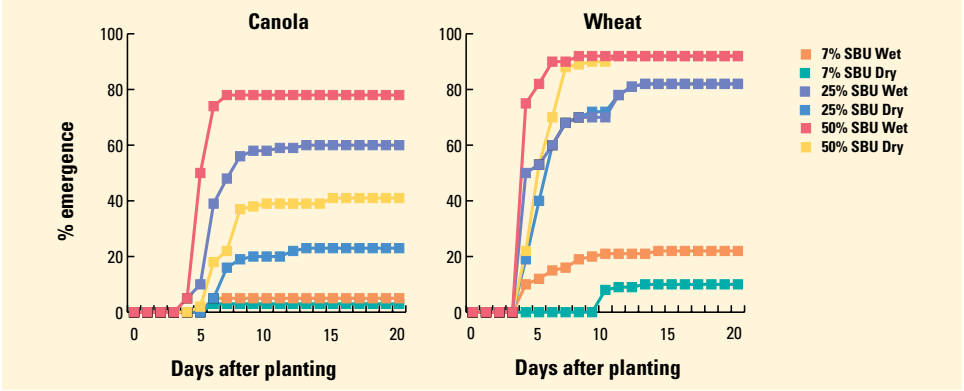

Figure 1. Seed-placed urea (60 lb N/A) reduces emergence under dry soil conditions and low SBU (Alberta data).

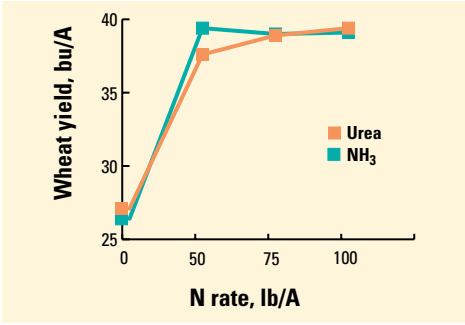

Figure 2. Wheat responds to side banded urea and NH_3 application in Alberta and Saskatchewan.

high SBU. Both are equally damaging to canola. Farmers are also interested in using anhydrous ammonia (NH_3) in direct seeding operations, but it was never considered feasible because of the high risk of germination damage from the ammonia. However, several Alberta and Saskatchewan trials show that NH_3 produces comparable results to urea, when it is precision placed (**Figure 2**). These trials were done with a commercial air seeder (Conserva-Pak™) with side band openers on 12 inch spacing. The fertilizer was placed 1 to 2 inches to the side and 1 to 2 inches below the seed. Caution should be used when precision placing fertilizers with side band openers, because opener wear can affect seed and fertilizer separation.

While most of the concern in one pass direct seeding is with N, farmers also seed place phosphorus (P), potassium (K) and sulfur (S). The effect of seed-placed P and K on wheat germination in the growth chamber is shown in **Figure 3A.** Both P and K reduced wheat emergence at rates above 40 lb/A, but only at rates greater than 80 lb/A were differences great. Canola did not tolerate any seed-placed fertilizer. Alberta field studies suggest small grains will tolerate 45 lb P_2O_5/A as monoammonium phosphate, 60 lb K_2O/A as potassium chloride and 30 lb S/A as ammonium sulfate, even when using a low SBU. Canola, however, is more sensitive than cereals, particularly to seed-placed ammonium sulfate.

Figure 3B illustrates the tolerance of wheat to seed-placed fertilizer blends containing N, P, K and S. Applying high rates of a 13-14-15-12 did not prevent germination, but did reduce and delay germination by several days. Wheat could tolerate up to 100 lb/A of the blend before emergence declined to less than 80 percent, but canola (data not shown), could only tolerate rates to 50 lb/A before serious germination problems occurred. BC

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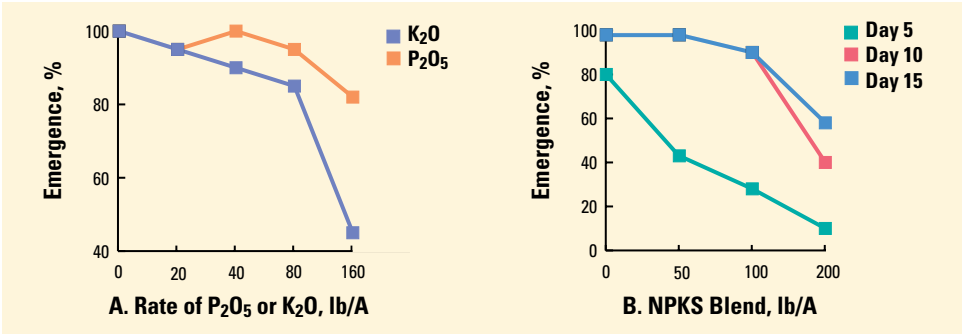

Figure 3. High rates of seed-placed (17% SBU) KCl and MAP and blended ammonium sulfate, MAP and KCl reduced and delayed wheat emergence in a clay loam Saskatchewan soil.