Seedbed Utilisation (SBU)
Calculating Safe Fertiliser Rates

Rohan Rainbow
Senior Research Scientist SARJDI
Operation FerTill™ is a SARDI, Pivot, Flexi-Coil and GRDC research partnership.

Overview:
SBU is the spread pattern of seed and fertiliser relative to row space, expressed as a percentage.

Safe urea N rates in Canola are approximately half that of wheat at the same SBU %. When the SBU % is > 45%, safe N rates become less than half that of wheat.

The impact of dry soil on safe SBU rates is unclear and further research is required t develop safe models. At this stage if soil conditions are dry at seeding, reduce SBU fertiliser rates by up to 50%.

High relative salt P fertiliser should be reduced in rate in the seed row if the common canola plant density of < 50 plants/m^2 is achieved. There is less concern with yield loss due to fertiliser toxicity if > 50-60 plants/m^2 is currently achieved.

Seed Spread Can Change Safe Fertiliser Rates

Seeding equipment used in Australia has changed considerably over the last few years. Most seeding equipment up until recent years have mainly sown on a 6-7" (160-180 mm) row spacing with 4-6"wide shares (100-150 mm) or more recently with narrow soil openers or points giving **a** seed spread of 1-2" (25-50 mm).

Seeding equipment used in conservation farming has tended toward;

- Wider row spacings to improve trash flow and handling of crop stubble residues.
- Narrower seed spread to reduce soil disturbance.

Increased fertiliser concentration in the seed row is a principal problem that has developed as a result of the shift towards conservation farming. There has been an introduction of many new seeding concepts including wider tine row spacings, soil openers that spread the seed as wide as 12" (300 mm) and fertiliser banding systems in the last few years. This now makes it very difficult to give a blanket recommendation for a maximum rate of fertiliser in the seed row (such as 25 kg/ha nitrogen N as urea) for all types of seeding machines.

Many farmers have found that using wider seed spread patterns has enabled more N to be placed in the seed row. Farmers however are concerned that wider seed row spacing and narrow seed spread patterns with narrow points may actually require less N to be placed in the seed row.

This has led to common problems with fertiliser toxicity in the seed row by three main processes;

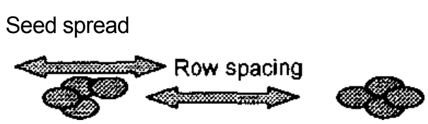
- Toxic chemical effect from ammonia vapour, most likely to occur with urea, mono and di-ammonium phosphates.

- Osmotic or salt effect due to a high concentration of salts produced from a soluble fertiliser dissolving in water. This high salt concentration leads to a transfer of solute or water through the cell membrane of the emerging seedling roots into the salty soil solution, effectively dehydrating the root plant cells, resulting in seedling death.
- Seed desiccation from direct moisture absorption by fertiliser. This would only be a problem in very dry soil conditions.

Seedbed utilisation (SBU) is a risk analysis tool that can be used to determine the potential for emergence damage and crop yield reduction. The lower the SBU %, the higher risk of seed damage and crop loss. This tool first developed in Canada, is extensively used for calculating safe fertiliser concentration in cereal and canola crops.

The SBU formula equates the spread pattern of seed and nitrogen (N) and/or phosphorus (P) relative to row space. It is the amount of seedbed over which the N has been spread expressed as a percentage:

SBU = (spread mm + row spacing mm) x 100



The SBU is a useful tool to be included when changing soil openers or seeding points, and when purchasing equipment and changing seed row widths. These SBU values can be used to calculate approximate maximum tolerance levels to N and P fertiliser based on their relative toxicity effect. Although some soil openers and seeding points will also spread the seed and fertiliser vertically, SBU does not take this into account, since it is recommended that all seed be placed at an even depth for even germination and crop emergence.

Research in South Australia as part of Operation FerTill™ a joint SARD I, Pivot Limited, Flexi-Coil Australia Pty Ltd and GRDC project, has demonstrated how increased N rates can be safely applied in the seed zone of moist soil with an increased SBU % (Figures 1 and 2).

Cereal crops are relatively tolerant to salts from soluble fertiliser in comparison to some pulse crops and in particular canola. Toxic chemical effect from ammonia vapour will occur with urea and ammonium phosphates such as MAP and DAP if tolerated rates are exceeded. Dry soil conditions will reduce seedling tolerance to these fertiliser rates. Limited SBU experiments in wheat in 1999 at Urania and Paskeville in South Australia have shown that high SBU (>40%) with the commonly described ribbon seeding technique, achieves excellent grain yield results compared to one pass banded N.

Use **of** SBU **in Canola Crops**

Canola emergence appears to be very sensitive to current recommended rates of di-ammonium phosphate (DAP at 100 kg/ha) applied in the seed row with an SBU of 20%, reducing crop emergence by up to 60% compared with no fertiliser in the seed row. This occurred in both slightly dry to moist seeding conditions. Canola grain yields were reduced by an average of 0.3 t/ha (11.5%) in slightly calcareous loamy sand, and 0.1 t/ha (7.1%) on a loam soil in the 1997 and 1998 seasons (Table 1). Crop establishment was significantly improved with split or banded DAP.

Figure 1. Effect of SBU and urea placement on wheat establishment Paskeville Field Day site SA 1999

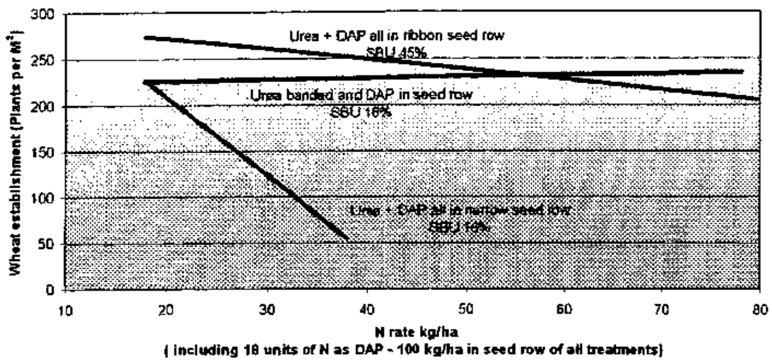


Figure 2. Effect of SBU and urea placement on wheat yield Paskeville Field Day site SA 1999

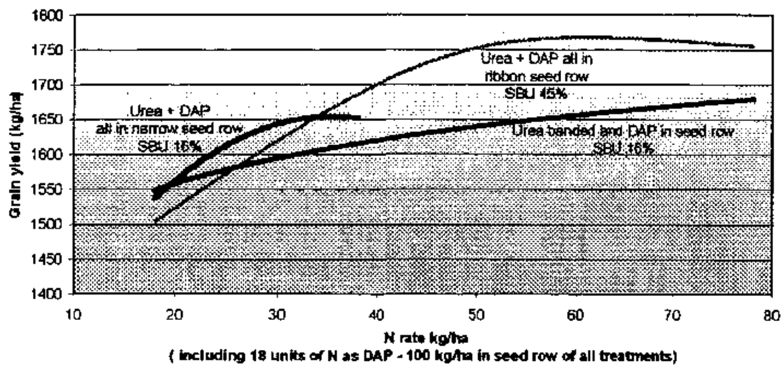


Table 1. Fertiliser placement effect on canola establishment and grain yield in South Australia (SBU 20% soil slightly dry to moist). (Average 1997 to 1998)

	Halbury (alkaline loamy sand)		Hart (alkaline loam)		Marrabel and Mintaro (acid loam and clay respectively)	
fertiliser placement	Emergence (plants/m^2)	Grain yield (t/ha)	Emergence (plants/m^2)	Grain yield "(t/ha)	Emergence (plants/m^2)	Grain yield (t/ha)
4il fertiliser control	103	1.9	86	1.3	93	1.0
-IPK 18:20:0 kg/ha Jl seed row (as DAP)	34	2.1	31	1.3	73	1.6
■IPK 18:20:0 kg/ha all seed o\v + 50 kg N as urea landed	22	2.3	33	1.3	55	1.6
4PK 18:20:0 kg/ha Split 50:50 - seed ow/banded + 50 kg N as irea banded	40	2.6	50	1.4	71	1.7
NIPK 18:20:0 kg/ha all anded + 50 kg N as urea anded	93	2.6	73	1.4	63	1.7

In Canada, it is recommended that no more than 10 kg/ha of P as MAP be placed with the canola seed row with an SBU of 14%. These research results in Australia would support this. More recent Australian research in 1999 has shown that DAP placed in the seed row gave optimum yield results when seeding rates were increased to achieve optimum canola plant density of > 60 plants per square meter, even though significant reductions of up to 50 % of potential plant establishment had occurred. This highlights that if target plant density can be achieved, the problems with fertiliser toxicity in canola have much less impact. Osmotic salt induced fertiliser toxicity does not reduce canola growth rate, but establishment. A higher P rate in the canola seed row will achieve a larger, higher yielding plant as long as adequate plant density is achieved. Significant yield losses from fertiliser toxicity occur when < 40 plants/m^2 is achieved. Increasing seeding rate by up to 50% to rates of 8 kg/ha where osmotic fertiliser toxicity occurs would reduce yield loss, but significantly increase seed costs.

Farmer observations in the field have highlighted P toxicity for loss in canola establishment. Situations observed to date include significant improvement in establishment when P fertiliser is either banded with the urea when seeding or pre-drilling, or broadcast on the soil surface compared to surrounding paddocks.

Dilution of the fertiliser in the seed row using wider seeding points or paired rows has also improved establishment, increasing the seedbed utilisation. Results with mono-ammonium phosphate (MAP) in Victoria have shown a small reduction in canola plant establishment, resulting however in a large reduction in grain yield.

The salt effect or index of fertiliser varies between different products (Table 2). The relative salt index per unit of P indicates the significant impact that a higher salt index can have from using traditional single superphosphate to high analysis ammonium fertilisers.

Table 2. Relative salt index when placed in contact with seed.

Fertiliser (N:P:K)	Salt Index[1]	Relative salt Index[1].kg P^{-1}
Urea	75	Na
DAP (18:20:0)	34	1.7
MAP (10:22:0)	30	1.36
Triple Super (0:20:0)	10	0.5
Single super (0:9:0)	8	0.89

Sail index is determined by comparing the change in osmotic pressure from the fertiliser with the osmotic pressure produced from the same weight of sodium nitrate and expressed as an index (Source: Glendinning, J.S. (1990) Fertilizer Handbook. Australian Fertilizers Limited.)

The general farming industry shift to reduced seed spread widths and wider row spacings has resulted in SBU reducing from around 50% to less than 15%. This in conjunction with using P fertiliser products with a higher salt index, such as DAP, has created significant complexity to placing P fertiliser in the canola seed row.

Salt damage to the canola seedling is caused through osmosis. Osmosis is the diffusion of a solvent, in this case water through a differentially permeable membrane, in this case the plant cell walls of the canola seedling.

Canadian research has shown that the effect of salt damage on the canola root system is greater in a dry soil, as the relative concentration of solutes in the soil water solution increase. The effect of osmotic diffusion across the plant cell wall is also faster in a warm soil, accelerating the rate of salt damage through osmosis. Therefore the worst-case scenario for fertiliser induced salt toxicity is a dry warm soil. High soil salinity levels and background salts such as calcium carbonate could further reduce the salt tolerance levels to a given rate of fertiliser. This tends to explain the greater level of P fertiliser induced toxicity in canola on calcareous soils.

Understanding SBU and the impact of N and P on seedling toxicity can enable farmers to avoid problems with seedling establishment before they occur, particularly with canola. Options can be considered to reduce salt induced P toxicity such as pre-drilling some of the P fertiliser with the urea, the less preferred option of broadcasting N or P, or simply banding all the P fertiliser with the urea in a one pass banding system. It is likely that some farmers may choose to maintain higher SBU levels using wide shares and keeping seed row spacings as narrow as possible to maintain a one pass seeding operation. This will minimise the complexity of the seeding operation and equipment required for some farmers.

Further Information

Rohan Rainbow
SARDI Clare, Phone (08) 8842 3900