

FERTILISER TOXICITY

FACT SHEET

Care with fertiliser and seed placement

Increased row spacing and zero-till seeding can result in more fertiliser being placed in the seeding row, causing damage to emerging seedlings. This risk can be reduced by increasing the spread of seed and fertiliser in the row, reducing in-furrow fertiliser rates or separating seed and fertiliser bands.

KEY POINTS

- Care must be taken to separate fertiliser and seed to prevent damage to emerging seedlings.
- Crops vary in their tolerance to fertiliser and fertilisers vary in toxicity.
- Seeding systems with narrow seed spread, wide row spacing and no seed/fertiliser separation are more susceptible to toxicity.
- There is greater potential for damage when high fertiliser rates are used, especially in lighter soil types or cooler, drier seeding conditions.
- Seed bed utilisation is a method of quantifying safe fertiliser rates for different seeding systems (see page 3).

PHOTO: EMMA LEONARD



Row spacing and seeding system set-up, crop and fertiliser type and season conditions all interplay to influence the potential for fertiliser to damage emerging crops.

Soil testing, including deep nitrogen testing, is especially important following wet summers as the loss of nutrients by water-logging, leaching and summer weeds, may or may not be balanced by higher release of mineralised nutrients from the warm, moist soils. Where soil nutrient status is low, and soil moisture is high, there is the opportunity to use higher rates of fertiliser at seeding to meet the needs of the crop.

While placing fertiliser in the seed row is an effective practice, germinating seeds are susceptible to damage by fertiliser. Care must be taken to create space between seed and fertiliser, especially with high fertiliser rates and under wide row spacing. If row spacing is increased but the fertiliser rate per hectare remains constant, then the amount of fertiliser in each row increases.

The narrow seed spread typically created by disc seeders can also increase the potential for seedling damage by fertiliser.

The separation of seed from fertiliser is three-dimensional – along, across and down the furrow. The concept of seed bed utilisation (SBU) has been used to address this issue.

Factors to consider when selecting fertilisers and rates

There are several factors that contribute to the safe amount of fertiliser that can be placed with the seed.

Crop type

Canola seedlings are particularly sensitive to damage due to close proximity to fertiliser, while wheat is relatively tolerant. Larger seeds have less damage potential. Any legumes that have been inoculated should also be lime coated to protect the nitrogen fixing bacteria from fertiliser damage.

Across a number of trials, the order of sensitivity among major grain crops from most to least was found to be:

canola > lentil > wheat > peas > barley > oats

Fertiliser type

All fertilisers are relatively concentrated chemical compounds that can affect delicate germinating seeds in a couple of ways.

Osmotic effect

In chemical terms fertilisers are salts and can affect the ability of the seedling to absorb water by osmosis. Too much fertiliser (salt) near the seed and desiccation or 'burn' can occur.

However, fertilisers vary in salt index or burn potential depending on composition. As a general rule, most common nitrogen and potassium fertilisers have a higher salt index than phosphorus fertilisers.

Details of the salt index for different fertiliser products and how it can be calculated is found on the International Plant Nutrition Institute website (<http://anz.ipni.net/articles/ANZ0042-EN>).

Potential to release ammonia

Fertilisers that have the potential to release free ammonia can cause ammonia toxicity in seed. Consequently, in-furrow placement of ammonium phosphate and urea-containing fertilisers is usually not advisable. A solution of urea and ammonium nitrate (UAN) can be applied successfully in-furrow but there is a risk of ammonia damage where high rates are used, especially in situations when germinating seedlings are stressed.

Efficiency enhancers

Some strategies to enhance fertiliser efficiency, such as the use of polymer coatings or urease inhibitors will slow the rate of ammonia production and make these products less likely to cause crop damage.

Soil type and environment

Soil conditions that tend to concentrate salts or stress the germinating seed increase the potential for damage. So, the safe limit for in-furrow fertilisation is reduced with lighter soil texture (sands) and in drier soil conditions. It is also reduced when environmental conditions such as cool temperatures induce stress and/or slow germination. These can result in prolonged fertiliser-seed contact, increasing the likelihood of damage.

Good rain immediately after sowing can reduce the potential for damage as salts are diluted and ammonia is dissolved, which reduces the concentrations around the seed.

Machinery configuration

The type of sowing point and seed banding boot used and the spacing between the drill rows both affect the concentration of fertiliser near seed and the likelihood of damage.

Increasing seed bed utilisation (SBU) using seeding systems

Trials by Dr Jack Desbiolles and colleagues at the University of South Australia established that seeding systems that result in high SBU (up to 100 per cent) at sowing can optimise crop grain yield potential, as well as minimising fertiliser toxicity risk. Trials were carried out on a clay-loam soil with an annual rainfall of 430mm. The yield of Kukri wheat increased from 3.46t/ha (seed rate 88kg/ha, SBU 15 per cent) to 3.89t/ha (seed rate 122kg/ha, SBU 100 per cent).

SBU can be used in canola to determine safe N and P rates as in cereal crops. In practise, it is best to band all urea N when sown with canola due to its sensitivity to ammonia N.

Table 1 Differences in seed bed utilisation for a range of seeding points and boot combinations.

Seeding point	Common seed spread (mm)	% seed bed utilisation (SBU)		
		Row spacing (mm)		
		150	225	300
125mm share	65	43	29	22
65mm share	46	31	20	15
Single side band opener	36	24	16	12
Spear point	25	17	11	8
Inverted T	25	17	11	8

SOURCE: GRDC

Table 2 Approximate safe rates¹ of N as urea, mono-ammonium phosphate (MAP) or di-ammonium phosphate (DAP) with the seed of cereal grains if seedbed has good soil moisture (at or near field capacity).

Soil Texture	25mm (1") seed spread ²			50mm (2") seed spread ²		
	Row spacing			Row spacing		
	180mm (7")	229mm (9")	305mm (12")	180mm (7")	229mm (9")	305mm (12")
	SBU ³			SBU ³		
	14%	11%	8%	29%	22%	17%
Light (sandy loam)	20	15	11	40	30	22
Medium-Heavy (loam to clay)	25	20	15	50	40	30

Table 3 Approximate safe rates of P with canola seed if seedbed has good soil moisture (at or near field capacity).

Fertiliser Type	25mm (1") seed spread ²			50mm (2") seed spread ²		
	Row spacing			Row spacing		
	180mm (7")	229mm (9")	305mm (12")	180mm (7")	229mm (9")	305mm (12")
	SBU ³			SBU ³		
	14%	11%	8%	29%	22%	17%
DAP (18:20:0)	8	6	5	17	13	10
MAP (10:22:0)	10	8	6	21	16	12
Triple Super (0:20:0)	27	21	15	55	42	33
Single Super (0:9:0)	15	12	9	31	24	18

¹ Based on Australia and Canadian tolerance models.

² Width of seed spread must be checked under field condition. Width of spread varies with air flow, soil type, moisture level, amount of stubble and other soil conditions.

³ SBU is the amount of the seedbed over which the seed/fertiliser has been spread.

■ These models are yet to be confirmed and are a guide only – use half these rates in dry soil.

SOURCE: Rainbow RW and Slee DV (2004), *The Essential Guide to No-till Farming* (South Australian No-Till Farmers Association).

These high SBU systems also had an impact on weed control, achieving a significant reduction on early weed vigour, weed seed-set and crop yield loss due to weeds. Other research suggests that the increased soil disturbance and mixing can result in greater germination of weed seeds at sowing, and more crop damage from pre-emergence herbicides.

The UniSA trials found that when high SBU seeding systems were combined with high seed rate, the grain yield and crop/weed competition were both maximised.

Practical options to achieve a high SBU include fitting paired row seeding boots to existing tillage systems, using greater soil disturbance ribbon sowing systems, or reducing row spacing.

When tyne-based systems are used to achieve high SBU, stubble clumping is typically increased and uniformity of seeding depth decreased.

Row spacing

If the same fertiliser rate is used with different row spacings, then the amount distributed along each seeding row will increase as row spacing becomes wider. For example, the rate of fertiliser applied in a 30cm row is basically double that of a 15cm row. To avoid this increased fertiliser concentration in wide-row systems the safe rate of in-furrow fertiliser decreases as row spacing increases (see tables 2 and 3, page 2).

Seed bed utilisation

The concept of SBU has been used to help quantify this issue. SBU is simply the seed/fertiliser row width divided by the seed row spacing, that is, the proportion of row space occupied by the seeds. The wider the lateral seed

PHOTO: ROB NORTON



A seeding system fitted with the ability to band granular and fluid fertiliser at depth. Separating the fertiliser band from the seeds helps minimise the risk of seedling damage.

spread, for a specific row spacing, the greater the SBU (Tables 1, 2 and 3). As SBU increases, so does the safe rate of in-furrow fertilisation.

The greater the lateral scatter of seed and fertiliser in the seed band or row (along, across and to depth) the more fertiliser that can be safely applied with the seed.

The type of planting equipment and seed opener influences the closeness of seed-fertiliser contact (Table 1). For example, minimal lateral spread is achieved by many disc openers, with lateral spread generally increasing with share width. Double shoot/ribbon seeding openers, where seed is spread across a wider furrow, achieve the greatest lateral spread. When the lateral seed spread = share width = row spacing, a 100 per cent SBU is achievable.

Openers with split banding systems can separate the seed and fertiliser

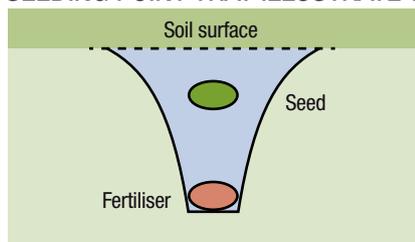
laterally and vertically (Figures 1A, B and C). The greater the angle of the fertiliser boot to the seed boot the greater the vertical separation potential between the seed and fertiliser.

The width of spread must be checked under field conditions. It may vary with air velocity, ground speed, seeding depth and soil conditions.

Along with seeding system crop type, fertiliser and environmental conditions must still be considered. Table 2 shows the safe rates of fertiliser urea for wheat and Table 3 for canola sown in ideal seeding conditions. Seed bed moisture content is also an important factor, and damage is more likely with dry soils rather than moist soils. If the soils are dry or borderline, then rates should be at least halved from those in Tables 2 and 3.

Tables for a range of fertilisers and crops can be found at the website of the International Plant Nutrition Institute.

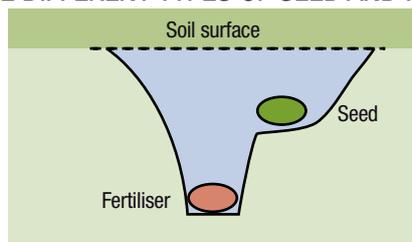
FIGURE 1 THREE ARRANGEMENTS OF SPLIT SEED AND FERTILISER BANDING WITH TILLAGE BELOW THE SEEDING POINT THAT ILLUSTRATE THE DIFFERENT TYPES OF SEED AND FERTILISER SEPARATION ACHIEVED



A. Single outlet with centre banding

Pros: Sub-seed soil disturbance, fertiliser separation banded at depth.

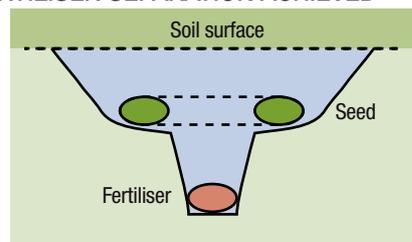
Cons: High draft and breakout force required compared with tillage at seeding depth, seed placement quality variable.



B. Single outlet with side banding

Pros: Sub-seed soil disturbance, fertiliser separation banded at depth, improved seed placement, good moisture transfer to seed.

Cons: High draft and breakout force required, potentially higher soil and residue disturbance.



C. Dual outlet paired row and ribbon sowing systems

Pros: Sub-seed soil disturbance, fertiliser separation, good seed placement except over centre section, higher seed-bed utilisation.

Cons: High draft and breakout force required, higher soil and residue disturbance influencing seeding depth uniformity.



With tyne seeding systems, increasing seed bed utilisation not only reduces the potential for seed damage by in-furrow nitrogen fertiliser but has resulted in less weed competition and improved yield. The top row shows wheat at early crop establishment (2005), and the bottom shows wheat post-full head emergence (2004).

Frequently asked questions

Do all fertilisers cause damage?

Practically all fertilisers are capable of causing damage to germinating seeds if they are in close proximity to each other and in a concentrated band. Urea is most likely to cause damage, unless twin shoot boots are used. Diammonium phosphate (DAP) is also a potential problem with wide rows on light soils.

How bad can it be?

A trTrials in WA and SA have shown substantial yield reductions, especially in light textured soils. A 48 per cent reduction in wheat yield was recorded when 40kg N/ha was drilled in the row compared with banding beneath

the seed rows. In dry conditions in a Mallee sand, canola yield was reduced from 1.6t/ha to 0.8t/ha when 34kg N/ha were sown with a narrow spread compared to ribbon seeding.

What about fluid fertilisers?

There are few guidelines for in-furrow application of fluid fertilisers. As a general rule for fluid fertilisers apply the same rules regarding the maximum nitrogen and phosphorus rates as for granulated (solid) products, based on a nutrient concentration. So, urea/ ammonium nitrate (UAN) can be treated the same as urea, and ammoniated phosphoric acid the same as mono-

ammonium phosphate (MAP).

Are some crops more likely to be damaged than others?

Canola is more susceptible than cereals and is probably the crop to watch most carefully as it is likely to have a high fertiliser requirement.

Is banding an option?

If urea N fertiliser needs to be banded at sowing due to high SBU% concentration, then an absolute separation of 3.5cm below the seed row is required. If urea N is side banded, an absolute separation of a minimum 2.5cm below and 2.5cm to the side is required.

Useful resources:

- **Dr Robert Norton, International Plant Nutrition Institute** **03 5381 2673 Email rnorton@ipni.net**
- **Dr Jack Desbiolles, Institute for Sustainable Systems and Technologies, University of South Australia** **Email jack.desbiolles@unisa.edu.au**
- **International Plant Nutrition Institute** **<http://anz.ipni.net>**
- **GRDC Fact Sheets and update papers** **www.grdc.com.au/director/events/**

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