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GRDC™ GROWNOTES™



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GRAINS RESEARCH
& DEVELOPMENT
CORPORATION

CANOLA

SECTION 5

NUTRITION AND FERTILISER

CROP REMOVAL RATES | SOIL TESTING | NITROGEN | PHOSPHORUS | SULFUR
| POTASSIUM | BORON | MICRONUTRIENTS | TOXICITY | NUTRITION EFFECTS
ON THE FOLLOWING CROP

SECTION 5

FAQ Nutrition and fertiliser

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[GRDC Update Papers: Economics and management of P nutrition and multiple nutrient decline](#)

[IPNI: Nitrogen and sulfur for wheat and canola—protein and oil](#)

[GRDC Update Papers: CropPro.com.au—diagnostic agronomy for the southern region](#)

5.1 Crop removal rates

Canola requires high inputs per tonne of grain for the major (macro-) nutrients nitrogen (N), phosphorus (P) and sulfur (S) compared with other crops (Table 1). However, on a per-hectare basis, the nutritional requirements of canola are similar to cereals, because yields are usually about half those of wheat.¹

Table 1: Comparison of the average quantity of major nutrients removed (kg/ha) per tonne of grain and stubble for a range of crops, including canola and wheat.

	Nitrogen		Phosphorus		Potassium		Sulfur	
	Grain	Stubble	Grain	Stubble	Grain	Stubble	Grain	Stubble
Canola	40	10	7	2	9	26	3.5-5	3.2
Wheat	21	8	3	0.7	5	21	1.5	1.5
Barley	20	7	2.5	0.7	4.5	18	1.5	1.5
Oats	20	7	2.5	0.6	4.5	18	2	1
Lupins	51	10	4.5	0.4	9	16	3	2.5

5.2 Soil testing

In Australia, canola is not recommended for sowing on soils of pH_{Ca} (measured in CaCl₂ solution) <4.5, and preferably not <4.7 if exchangeable aluminium (Al) levels exceed 3%. Many soils where canola is grown have a pH <5.0; some have pH as low as 4.0. Although most of these soils were naturally acidic, their acidity has been increased by agricultural activities. The acidity may occur in the surface soil or subsoil, or in both. Soil tests for pH are recommended before growing canola. Samples are taken from the surface (0–10 cm), as well as at depth (10–30 cm) to check for subsoil acidity.

Where the soil pH is ≤5, Al and manganese (Mn) toxicities can be a problem for canola. Aluminium is much more detrimental than Mn because it kills root tips, the sites of root growth. Plants with Al toxicity have a shallow, stunted root system that is unable to exploit soil moisture at depth. The crop does not respond to available nutrients, and seed yield is drastically reduced. Severe Mn toxicity reduces yield because entire leaves become chlorotic and distorted. Mild to severe Mn toxicity is often seen sporadically or in patches and often associated with waterlogged parts of fields.²

5.3 Nitrogen

Canola has a high demand for N, twice that of wheat per tonne. A canola crop of 1 t/ha will remove ~40 kg N/ha; however, the crop will require at least twice this amount of N supplied (Figure 1). A crop with a targeted yield of ~2 t/ha crop will require ~160 kg N/ha. This can be supplied through soil reserves, but additional N fertiliser will be needed in many cases. Depending on the amount of soil N available to the crop, ~80–100 kg/ha

¹ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

² P Hocking, R Norton, A Good (1999) Crop nutrition. In 10th International Rapeseed Congress, GCIRC, <http://www.regional.org.au/au/gcirc/canola/p-05.htm>

 **More information**

[NSW DPI: Soil testing](#)

[Canola Yield Decline in South Eastern Australia](#)

i More information

[GRDC Update Papers: Nitrogen and water-use efficiency of canola and mustard in South Australia](#)

[GRDC Update Papers: Nitrogen decision— Guidelines and rules of thumb](#)

[GRDC Update Papers: Residual impact of last year's 'unused' nitrogen fertiliser](#)

[GRDC Update Papers: Modelling gross margins and potential nitrogen exports from cropland in south eastern Australia](#)

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of fertiliser N could be needed. In general, a canola crop requires an amount of N similar to a high-protein wheat crop.

Deep soil testing for N and S is recommended for all growers, particularly first-time growers. This will allow N budgeting.

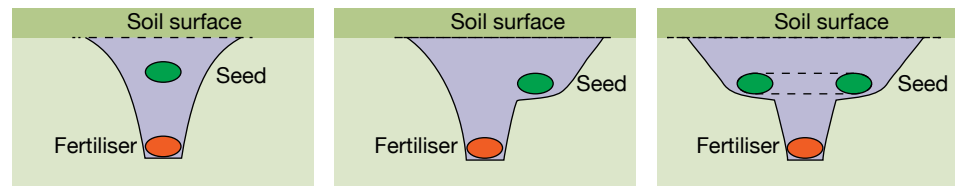


Figure 1: Canola is highly responsive to nitrogen. (Photo: P. Hocking, CSIRO)

Canola seed is very sensitive to fertiliser burn. No more than 10 kg/ha of N should be in direct contact with the seed at sowing in narrow (18-cm) rows, and proportionally less at wider row spacings. Most of the N should be either drilled in before sowing or banded 2–3 cm below and beside the seed at sowing (Figure 2). An alternative is to apply N to the growing crop. Application timing should aim to minimise losses from volatilisation; that is, time the topdressing for when the crop has good groundcover and before a rain event. Losses can be high on dry, alkaline soils.³



³ L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf



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.

Figure 2: Three arrangements of split seed and fertiliser banding with tillage below the seeding point, illustrating the different types of seed and fertiliser separation achieved.

The N content of a canola plant (expressed as a percentage of dry matter) is highest at the full rosette stage, and this is when deficiency symptoms are often visible. Generally, the older leaves become pale green to yellow, and may develop red, pink or purple colours (Figure 3). Plants will be stunted and the crop will not achieve full groundcover by 8–10 weeks after sowing. Once stem elongation commences, a deficiency is then characterised by a thin main stem and restricted branching. This results in a thin and open crop. Flowering will occur over a shorter period, reducing the number of pods per unit area.



Figure 3: Nitrogen deficiency symptoms show as smaller leaves, which are more erect, and leaf colours from pale green to yellow on older leaves and pinkish red on others. (Photo: S. Marcroft, MGP)

Some visual symptoms are similar to other nutrient deficiencies (e.g. P and S), and this can result in incorrect diagnosis.⁴ Nitrogen deficiency affects older leaves first, whereas S deficiency affects younger leaves first.⁵

5.3.1 Estimating nitrogen requirements

Canola is ideally grown in soils of high N fertility, for example, as the first or second crop following several years of legume-dominant pasture. However, paddock fertility is

⁴ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

⁵ DAFWA (2015) Diagnosing nitrogen deficiency in canola. Department of Agriculture and Food, Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-nitrogen-deficiency-canola>

More information

[DAFWA: Diagnosing nitrogen efficiency in canola](#)

often inadequate, so additional N is required to produce both high yields and good seed quality.

Although canola removes 40 kg N/t grain, the crop can require up to three times this amount of N to produce the yield (referred to as the efficiency factor). This is because the plants must compete for N with soil microorganisms, and some of the N taken up by the plants is retained in the stubble and senesced leaves and roots. A good canola crop will produce twice as much stubble as grain (by weight), giving a harvest index of ~33%.

The best way to determine a crop's potential N requirement is through a combination of N removal (total N in the estimated grain yield x efficiency factor) and the amount of N estimated to be available in the soil. Deep soil tests (to a depth of 60 or 90 cm) can be taken prior to sowing. Most deep soil tests are taken to 60 cm in the major canola-producing areas. They can also be done during the growing season to determine whether topdressing is required.

Example

Available soil N (calculated from deep N test + estimate of in-crop mineralisation) = 125 kg/ha

Nitrogen requirement calculator

Nitrogen removed in grain = target yield x 40 (kg N/t grain)

Total N required = N removed in grain x 2.5 (efficiency factor of 40%)

In the example:

Estimated target yield = 2 t/ha

N removal in grain 2 x 40 kg N/t = 80 kg N/ha

Total N required = 80 x 2.5 kg N/ha

= 200 kg N/ha ⁶

Nitrogen fertiliser rates

Fertiliser N required for crop = total N required – available soil N (kg N/ha)

Using the example:

Available soil N (calculated from deep N test + in-crop mineralisation) = 125 kg/ha

Fertiliser N required for crop = 200 – 125 kg N/ha

= 75 kg N/ha (or 163 kg/ha of urea)

As the above calculations indicate, ~75 kg/ha of additional N is required as fertiliser to achieve the anticipated yield. The N can be applied in several combinations pre-sowing, at sowing or as topdressing(s) before stem elongation during the season.

Other formulae are available for calculating N requirements; however, these need more detailed inputs, which can be provided by consultants or agronomists.⁷

5.3.2 Diagnosing nitrogen deficiency in canola

Nitrogen deficiency is the most common nutrient deficiency in canola, especially during cold, wet conditions and in sandy soils in high-rainfall areas. Some hybrid varieties can display leaf purpling with adequate nutrient levels (Figure 4).

⁶ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

⁷ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

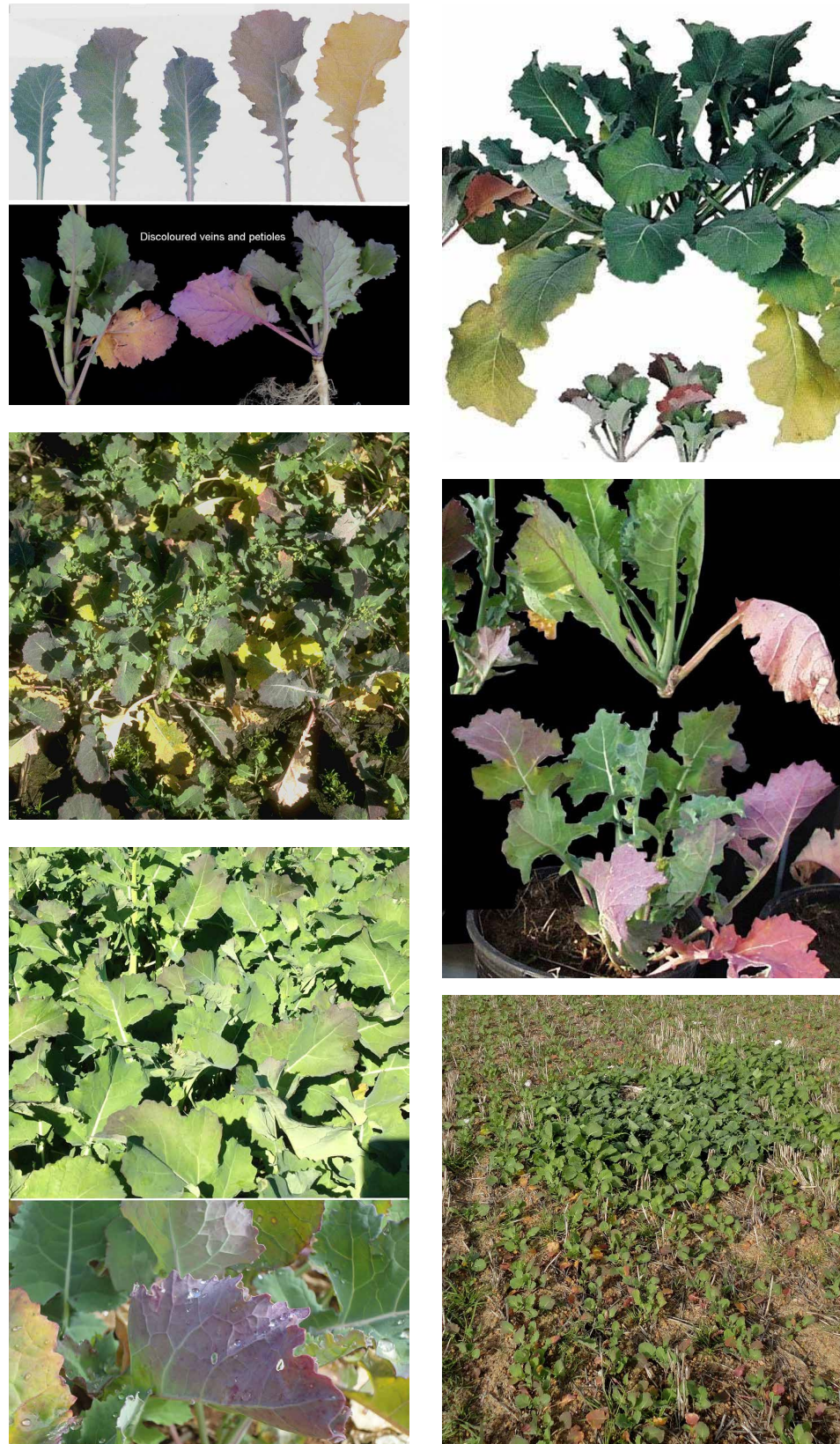


Figure 4: Images of nitrogen deficiency in canola. (Photos: DAFWA)

What to look for

Paddock

- Plants are smaller and less branched with red to purple or yellow leaves.
- Symptoms are worse in wetter seasons, on lighter soil areas and sometimes on non-legume header rows.

Plant

- Mildly deficient plants are smaller with paler green and more erect leaves. Deficient seedlings have reddened cotyledons.
- Oldest leaves develop whitish purple veins and mild purple pigmentation, which starts at the end of the leaf and progresses to the base on both sides of the leaf. (See Table 2 for conditions with similar leaf symptoms.)
- The whole leaf then turns yellow or pinkish purple. Developing leaves are narrow and more erect.
- Established plants that become N-deficient develop yellowing on leaf margins that spreads in toward the midrib between the veins. The midrib becomes discoloured then the leaf dies.
- From stem elongation, the main stem is thinner and branching is restricted. Flowering time and pod numbers are reduced.

What else could it be?

Table 2: Conditions that result in symptoms in canola similar to nitrogen deficiency

Condition	Similarities	Differences
Beet western yellow virus in canola	Purple-red colours spreading from end of oldest leaves	Affected plants are stunted rather than smaller and thinner as in N deficiency
Damping off in canola	Reddened cotyledons and older leaves of seedlings	Damping off causes stunted plants with pinched roots or hypocotyls. Often plant death occurs
Sulfur deficiency in canola	Purple leaves	Sulfur deficiency affects younger leaves the most
Phosphorus deficiency in canola	Purplish older leaves	Phosphorus-deficient plants have purpling on leaf margin, then the leaf turns bronze

Where does it occur?

Nitrogen deficiency can occur on most soils but is most common in the following situations:

- cold, wet conditions that slow N mineralisation and uptake of N
- soils with very low organic matter
- after high rainfall on sandy soils, which can result in N leaching

Management strategies

- Nitrogen fertiliser or foliar spray can be applied. However, only some N can be absorbed through the leaf, so you will still be reliant on rainfall to move the N into the root-zone. The economics of liquid v. solid fertilisers should be taken into account.
- There is a risk of volatilisation loss from urea or nitrate sources of N. Loss is greatest from dry alkaline soils with dewy conditions, but recent GRDC-funded research shows this may not be as high as traditionally thought.⁸

⁸ G Schwenke (2014) Nitrogen volatilisation: Factors affecting how much N is lost and how much is left over time. GRDC Update Papers, 25 July 2014, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/07/Factors-affecting-how-much-N-is-lost-and-how-much-is-left-over-time>

- The yield potential for canola is established during stem elongation and the budding stage, so all N should be applied before this stage of growth (8–10 weeks).

Tissue test

- Use a whole top-of-plant test to diagnose suspected deficiency. Critical N levels vary with plant age and size, but as a rough guide, 2.7% (seedling) to 3.2% (rosette) indicates deficiency.
- Models that combine nitrate, ammonium, soil organic carbon, soil type and legume history are valuable for N fertiliser calculation.
- Leaf-colour symptoms are not a reliable guide for hybrid varieties.⁹

5.4 Phosphorus

5.4.1 Role and deficiency symptoms

Phosphorus plays an important role in the storage and use of energy within the plant. Lack of P restricts root development (resulting in weaker plants) and delays maturity (Figure 5), both of which affect yield potential and seed oil content, particularly in dry spring conditions. Low levels of P also restrict the plant's ability to respond to N. Even a mild deficiency can significantly reduce plant growth without any symptoms. In cases of severe deficiency, the older leaves will often appear dull blue or purple (Figure 6). Phosphorus is a very mobile nutrient within the plant, and if a deficiency occurs, P moves rapidly from older leaves to the young leaves or developing pods.¹⁰



Figure 5: Severe phosphorus deficiency showing plant stunting and delayed maturity. (Photo: R. Colton, NSW DPI)

⁹ DAFWA (2015) Diagnosing nitrogen deficiency in canola. Department of Agriculture and Food, Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-nitrogen-deficiency-canola>

¹⁰ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf



Figure 6: Phosphorus deficiency shows as distinct pink-purple of the tips and margins of older leaves. (Photo: P. Hocking, CSIRO)

Fertiliser placement

In the soil, P is immobile, so fertiliser should be banded close to the seed at sowing. This ensures that the developing seedling is able to take up a good supply during the early growth stage when requirement for P is at its highest. Many soils (particularly if exchangeable Al is present) are able to tie up P, making it unavailable to plants. Banding the fertiliser can reduce the amount of P tied up because less fertiliser is in contact with the soil than occurs with broadcasting.

Phosphorus fertiliser banded above and below the seed gives better yield responses than P broadcast before sowing. In sandy soils, which are prone to drying in the surface layer, banding some of the fertiliser below the seed at sowing may improve the efficiency of P uptake.¹¹

Phosphorus requirements

If a wheat crop responds to P application, then a rate at least equivalent should be used when sowing canola at that site. Topdressing is ineffective, so it is important to achieve the correct P rate at sowing. A maintenance application of 7–8 kg P/ha is needed for every tonne of canola you expect to harvest.

If a soil test indicates a high soil P level, then lower rates of P could be applied. In some situations, where soil P levels are very high, it may be uneconomic to apply P. If more is applied than is removed by the grain, it will be added to the soil P bank and may be available for following crops or pastures to utilise. However, a significant proportion (up to 50%) of applied fertiliser P can ultimately become 'fixed' into organic and inorganic forms that are largely unavailable for crop uptake in the short–medium term but can add to the P pool in the longer term, with a proportion of the P becoming available over time.

Depending on your location, several laboratory analyses are available for P. The Olsen P test (bicarbonate) is often recommended for acid soils, whereas the Colwell P test is more useful on alkaline clay soils. However, each of these tests measures only a proportion of the P status of a soil. The phosphorus buffering index (PBI) is also important because it can indicate how available the P in the soil is to plants. Acid-extractable P (BSES-P) is recommended as a baseline of the pool P status. A qualified soil-nutrition advisor will help you to decide which tests are applicable on your soil type.

If tests indicate <20 mg/kg, then P is considered low (depending on soil type and rainfall) and a response is likely. If the soil P level is high (>40 mg P/kg) a response to P is less likely, unless the soil is acidic (pHCa <4.8) and has a low cation exchange

¹¹ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

i More information

[GRDC Update Papers: Economics and management of P nutrition and multiple nutrient decline](#)

capacity (<5 cmol(+)/kg); in such cases, significant yield responses have been obtained in southern New South Wales. Soil P tests are less reliable in low-rainfall zones or on alkaline soils, where a nutrient budget is better for making P fertiliser decisions. A Colwell P level of ~40 mg/kg provides opportunity for some seasonal adjustment to fertiliser rates.¹²

5.5 Sulfur

5.5.1 Role and deficiency symptoms

Sulfur is crucial for canola in the synthesis of oil and protein as well as for the plant's vegetative development. Sulfur is needed in the formation of chlorophyll in leaves, and therefore for growth. Canola has a much higher requirement for S than wheat or legume crops.

Sulfur deficiency symptoms include the following:

- Leaves are pale and mottled in plants from early rosette to stem elongation; leaves may be cupped, with a purple margin (very deficient crops) (Figure 7).
- Flowers are pale yellow to cream (Figure 8).
- Podset is poor and there is pod abortion; pods that do form are short and bulbous.
- During podset, stems of affected plants are purple–brown and ripen to a brown rather than a straw colour.
- Affected plants are slow to ripen, continuing to flower until moisture runs out, after the rest of the crop has dried off sufficiently for windrowing.

Low levels of S will cause yield loss, even if the above symptoms are not obvious.¹³



Figure 7: Sulfur-deficiency symptoms appear in the rosette stage as pale mottled leaves, which may be cupped and have purple margins. (Photo: H. Burns, NSW DPI)

¹² P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

¹³ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf



Figure 8: Trials ca. 1990 confirmed paddock observations of the late 1980s of canola's high requirement for sulfur. Flowers are a pale yellow. (Photo: A. Good, Incitec)

5.5.2 Soil sulfur

Most sulfur is held in soil organic matter. Cropped soils tend to have low levels of organic matter, so their reserves of S are also often low. The most popular high-analysis fertilisers such as mono- and di-ammonium phosphate (MAP and DAP) contain very little S. The release of organic S by bacteria occurs through a process similar to mineralisation of N, and in some years, seasonal conditions can cause low mineralisation rates. Dry conditions in summer and autumn can reduce mineralisation of S, and wet conditions during winter can cause leaching of S below plant roots. No-till farming systems result in reduced levels of S mineralisation.

All paddocks sown to canola should receive 20 kg S/ha in the form of available sulfate. On lighter soils with a history of deficiency symptoms, increase rates to 30 kg/ha.

We're finding that paddocks with a history of canola now have high residual S levels in the subsoil and rates can be reduced to 5-10kg/ha.

Agronomist's view

Sulfur can be applied before sowing (as gypsum or sulfate of ammonia where N is also required), at sowing (as single superphosphate or a high-analysis fertiliser containing sulfate-S) or topdressed during the vegetative stages (sulfate of ammonia).

Where higher rates of S are required, it is most cost-effective to apply gypsum pre-sowing. Fertilisers amended with elemental S can assist with S requirements, but elemental S needs to be converted to sulfate-S before plant uptake can occur. This can delay availability to the growing seedling.

Do not underestimate crop requirements. Sulfur deficiency has occurred in paddocks that have been topdressed in the pasture phase with single superphosphate. Sulfur deficiency can also be induced in paddocks with high yield potential where high rates of N and P have been used.¹⁴

5.6 Potassium

An adequate supply of potassium (K) is important to provide plants with increased resistance to disease, frost and drought, as well as for promoting increased

¹⁴ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

carbohydrate production. Canola crops take up large amounts of K during growth, but most of it remains in the stubble, with only a small proportion removed in the grain.

Although soil tests, especially the balance of exchangeable cations, can provide a guide to the level of K, tissue tests are the most reliable method to determine whether K fertiliser is needed. Avoid sowing K fertiliser with the seed; it could affect germination.¹⁵

Recent research shows:

- Potassium deficiency has been confirmed in South Australia in grain cropping regions.
- As K reserves are drawn down with higher yields, K replacement may need to be more widely addressed, as it has been in Western Australia.
- The first evidence could be seen as good growth in windrows.
- Soil tests are reliable on sandy soils but less so on heavy soils.
- Potassium at 50–100 kg/ha banded below the seed at seeding where soil tests are below critical concentrations should give economic responses.¹⁶

i More information

[GRDC Update Papers: Do we need to revisit potassium?](#)

[GRDC Update Papers: Economics and management of P nutrition and multiple nutrient decline](#)

5.7 Boron

5.7.1 Role and toxicity and deficiency symptoms

Canola requires boron (B) in small amounts; however, it can cause both deficiency and toxicity problems. In most canola-growing areas, B deficiency is the more likely problem, but in some alkaline and sodic soils, such as in the Wimmera and Mallee in Victoria, toxic levels of B occur at 40 cm or deeper in the soil.

Boron toxicity has the two-fold effect of reducing growth and reducing the rooting depth of plants. In soils with high subsoil B, little can be done to ameliorate the problem, but B-tolerant canola types are being investigated.

Adequate B is essential for plant health, and it has an important role during flowering, specifically in the fertilisation process, where it is involved in the growth of the pollen tube. An adequate level of B is particularly important under high temperatures because it improves the level of pollen germination.

Over several seasons, growers and agronomists have observed crops with a reduced number of seeds set within pods. These symptoms are consistent with low levels of B. Unlike seeds killed by frost, where the residue of the dead seed is visible, with B deficiency, the individual seeds fail to develop, resulting in a missing seed, or seeds, in the pod.

Canola requires 6–10 times more B than wheat. In southern New South Wales, canola-wheat rotations over 10 or 11 years of continuous cropping have resulted in removal of much B. As well, many soils are low in B, especially the lighter, sandy loam acidic soils that are low in organic matter and common throughout southern New South Wales.

Under this cropping system, a range of crops and pastures, including canola and subterranean clover, frequently have either marginal or deficient levels of B. In some areas of the South West Slopes of New South Wales, yield responses to applied B have been up to 20%.

Boron deficiency causes seedling plants to bunch. The leaves become long and narrow, with a cupped shape, thicker than normal and brittle, causing them to snap easily.

¹⁵ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

¹⁶ R Norton (2014) Do we need to revisit potassium? GRDC Update Papers, 25 February 2014, <https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Do-we-need-to-revisit-potassium>

Deficiency is more likely during periods of low moisture availability or where liming has reduced the availability of B.¹⁷

5.7.2 Fertiliser requirements

Tissue testing is the best way to confirm a deficiency (Figure 9), especially as the symptoms of sulfonylurea herbicide damage are similar. If there is a deficiency, apply 1–2 kg/ha of boron.

High rates of boron are used in herbicides to sterilise soil, so it is critical that only recommended rates are applied where a deficiency has been identified.¹⁸



Figure 9: Boron deficiency was confirmed here by tissue testing, but symptoms can be confused with manganese toxicity and are similar to sulfonylurea herbicide damage. (Photo: P. Parker, NSW DPI)

5.8 Micronutrients

5.8.1 Zinc

Although canola is a non-mycorrhizal crop, it requires zinc (Zn) on alkaline soils. Zinc is best applied to the soil and thoroughly incorporated, but if this is not possible, apply it with starter fertiliser and place 2.5 cm to the side of and below the seed at planting. Zinc competes with the seed for soil moisture and so it should not be added in the seed line.

Foliar spraying of zinc sulfate heptahydrate at 1 kg/ha plus wetting agent is an alternative application method if sprayed twice to deficient crops at 3 and 5 weeks after emergence. There are also zinc oxide formulations and zinc chelate formulations. Zinc sulfate is incompatible with some herbicides and insecticides. Zinc seed treatments

¹⁷ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

¹⁸ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

are not normally applied to canola, because insufficient Zn will be applied with the low seeding rate used.¹⁹

Deficiency symptoms

Zinc deficiency appears in crops as poor plant vigour, with areas of poorer growth alongside healthy, apparently normal plants, giving the crop a patchy appearance (Figure 10). Although there are few reports of Zn deficiency in canola, growers should be cautious.

Zinc deficiencies can occur in the following situations:

- in strongly alkaline soils, pH_{Ca} >7.0
- with high P levels
- after long periods of fallow
- following land-forming where alkaline subsoil is exposed

Other major and trace elements apart from Zn may also need special consideration in land-formed paddocks.²⁰

Fertiliser strategies

Where responses to Zn are known to occur, incorporate Zn into the soil before sowing canola.

Zinc oxide is the cheapest and most concentrated form of Zn and it is usually broadcast with fertiliser to ensure an even application. However, it is not water-soluble and is not an effective means of adding Zn if a quick response is required. When coated onto fertiliser, zinc oxide can flake off, resulting in problems with distribution. Foliar sprays are a short-term correction only and need to be applied before symptoms are obvious, soon after crop emergence or if Zn deficiency has been identified through tissue analysis.²¹



Figure 10: Zinc deficiency appears as bronzing on the upper leaf surface and may occur in neutral to alkaline soils. (Photo: B. Holloway, SARDI)

¹⁹ L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf

²⁰ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

²¹ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

5.8.2 Molybdenum

Role and deficiency symptoms

Molybdenum (Mo) is important in enabling plants to convert nitrates from the soil into a usable form within the plant. Deficiency is more common in acid soil (pH_{Ca} <5.5) but is difficult to diagnose other than by a tissue test. Deficiency can be avoided by applying Mo at a rate of 50 g/ha every 5 years. The most common practice is the application of 150 g/ha of the soluble form sodium molybdate (39% Mo) sprayed onto the soil surface.²²

Fertiliser requirements

Although fertilisers containing Mo can be used at sowing, the concentration of Mo they contain is less than recommended and they are more expensive than using sodium molybdate.

Molybdenum-treated single superphosphate applied during the pasture phase is cost-effective and it should supply enough Mo for the canola crop.²³

5.8.3 Magnesium

In recent years, magnesium (Mg) deficiency has been reported in several seedling crops. As the crop grows and develops a deeper root system, the deficiency symptoms disappear because most soils have adequate Mg deeper in the profile. Low surface levels of Mg are probably due to low levels of sulfonyleurea herbicide residues and the harvesting of subterranean clover hay, where large quantities of Mg are exported from the paddock.

Lime–dolomite blends can be used when liming acid soils if there is a history of deficiency symptoms, and other dry and foliar applied fertilisers are available.²⁴

5.8.4 Calcium

Calcium (Ca) is important in plants because it assists in strengthening cell walls, thereby giving strength to plant tissues. Calcium is not readily transferred from older to younger tissue within a plant, so if a deficiency occurs it is first seen in the youngest stems, which wither and die, giving rise to the term 'withertop' to describe Ca deficiency (Figure 11).

Calcium deficiency is not common but it can occur in acid soils, especially if the level of exchangeable Ca is low. The use of lime (calcium carbonate) on acid soils and gypsum on sodic soils has meant only an intermittent occurrence of 'withertop' in canola.²⁵

²² P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

²³ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

²⁴ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

²⁵ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf



Figure 11: Death of the canola flower head from calcium deficiency. (Photo: D. McCaffery, NSW DPI)

5.9 Toxicity

The most effective treatment for Al and Mn toxicity (Figure 12) is liming to increase the soil pH to >5.0 Calcium chloride. Lime rates used will depend on the pH to depth and the cation exchange capacity of the soil. Microfine lime is usually applied at 2.5–4.0 t/ha. Shallow incorporation of lime is sufficient to ameliorate surface soil acidity, but deep ripping is required to incorporate the lime, reduce soil strength and improve drainage where there is the more serious problem of subsoil acidity.

Research has shown that deep ripping for lime incorporation is not beneficial and can have negative impact on yield due to moisture loss.

“Provided the surface soil is not acid, canola appears to be relatively tolerant of subsurface acidity, except where exchangeable aluminium exceeds 20%, manganese is toxic, or where the acid ‘throttle’ is greater than 20 cm deep. Typical subsurface acidity can be managed by liming the surface to pHca5.5.”

Canola Yield Decline in south-eastern Australia, results from GRDC funded project at <http://www.grassrootsag.com.au/CiD%20low%20res.pdf>

More information

https://www.csu.edu.au/data/assets/pdf_file/0003/922764/Canola_and_subsoil_constraints.pdf

Agronomist's view

The sensitivity of canola to soil acidity has had beneficial spin-offs, in that it has forced Australian growers to implement liming programs before their soils become too acidic for less sensitive crop and pasture species.

There are breeding programs to improve the Al and Mn tolerance of Australian canola, by using both conventional technology and genetic engineering. The rationale for increasing the tolerance of canola to soil acidity is to broaden management options for growers while they implement liming programs.²⁶

²⁶ P Hocking, R Norton, A Good (1999) Crop nutrition. In 10th International Rapeseed Congress. GCIRC, <http://www.regional.org.au/au/gcirc/canola/p-05.htm>



Figure 12: Symptoms of severe manganese toxicity in young canola on an acid soil.

5.10 Nutrition effects on the following crop

Canola has provided the opportunity for more reliable responses to N in subsequent cereals by reducing cereal root diseases. However, low yields and poor growth have been reported in crops following canola.²⁷

This is due to the depletion of soil microorganisms called arbuscular mycorrhizal fungi (AMF). They are beneficial soil fungi, assisting the uptake of P and Zn that would otherwise be unavailable to the crop. Canola does not need these fungi to help it take up P and Zn, so under canola, the AMF population declines to a low level. To avoid this problem, follow canola with a short-fallow crop that depends on AMF such as wheat or another cereal crop rather than pulses.²⁸

²⁷ R Norton, J Kirkegaard, J Angus, T Potter. Canola in rotations. Australian Oilseed Federation, http://www.australianoilseeds.com/_data/assets/pdf_file/0014/2705/Chapter_5_-_Canola_in_Rotations.pdf

²⁸ P Parker (2009) Nutrition and soil fertility. Ch. 7. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf