7. Nutrition and soil fertility

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As with any crop, it is critical for profitability to closely match canola's nutritional requirements with target yields.

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 7.1). However, on a per hectare basis, canola's nutritional requirements are similar to cereals, as yields are usually about 50 per cent of wheat.

Nutritional requirements will vary depending on soil type, rainfall, rotation and target yield. Canola crops will not achieve potential yields if any of the major nutrients, or trace elements, are deficient. Crops which have a higher yield potential, such as those sown early, will have a higher demand for nutrients.

A good knowledge of a paddock's history and fertility status (preferably determined from soil tests), in conjunction with the crop's expected nutrient removal, will help in determining the type of fertiliser, the rate and when to apply it.

Soil testing

Soil testing for the macro nutrients is the most reliable way to determine the chemical and nutrient status of the soil. Apart from deep soil nitrogen tests, soil tests should be done well before the crop is sown to ensure adequate time for laboratory testing and interpretation of the results.

NITROGEN

Role and deficiency symptoms

Nitrogen is an essential nutrient for plant growth and plays an important role in the formation of many plant compounds, including proteins and chlorophyll. Nitrogen deficiency will

Canola is highly responsive to nitrogen.
PHOTO: P. HOCKING, CSIRO

Table 7.1 Comparison of the average amount of the major nutrients removed per hectare per tonne of grain and stubble for a range of crops, including canola and wheat

	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium (kg/ha)		Sulfur (kg/ha)	
	Grain	Stubble	Grain	Stubble	Grain	Stubble	Grain	Stubble
Canola	40	10	7	2	9	26	10	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

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

reduce plant vigour and yield. Nitrogen is very mobile within the plant and if a deficiency occurs, it is readily moved from the older leaves into the younger growing tissue.

The nitrogen content of a canola plant (expressed as a percentage of dry matter) is highest at the full rosette stage, when deficiency symptoms are often quite visual. Generally, the older leaves become pale green to yellow, and may develop red, pink or purple colours. Plants will be stunted and the crop will not have achieved full ground cover 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.

Unfortunately, some visual symptoms are similar to other nutrient deficiencies (for example, phosphorus and sulfur) which can result in incorrect diagnosis. Tissue tests combined with a good knowledge of the paddock's history (including past fertiliser use and crop yields) will assist in giving a more accurate assessment of the most likely deficiency.

Estimating nitrogen requirements

Canola is ideally grown in soils high in nitrogen fertility; for example, as the first or second crop following several years of legume-dominant pasture. However, paddock fertility is often inadequate so additional nitrogen is required to produce both high yields and good seed quality.

Canola removes 40 kg of nitrogen for each tonne of grain. But the crop requires up to three times this amount of nitrogen to produce this yield (referred to as the efficiency factor). This is because the plants must compete with soil microorganisms for nitrogen, and also some of the nitrogen taken up by the plants is retained in the stubble, senesced leaves and roots. A good canola crop will produce twice the weight of stubble as grain, giving a harvest index (HI) of about 33 per cent. Although the nitrogen content of canola stubble is only about one per cent, a 4 t/ha stubble will remove an additional 40 kg/ha on top of the 80 kg/ha nitrogen removed in the 2 t/ha of grain. So, for a 2 t/ha grain yield, 200 kg/ha of nitrogen is required through a combination of soil nitrogen, in-crop mineralisation and applied fertiliser.

The best technique to determine a crop's potential nitrogen requirement is through a combination of nitrogen removal (total nitrogen in the estimated grain yield x efficiency factor) plus the amount of nitrogen 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 down to 60 cm in the major canola producing areas. They can also be done during the growing season to determine if topdressing is required.

Available soil nitrogen (calculated from deep nitrogen test + estimate of in-crop mineralisation) = 125 kg/ha. As a rough 'rule of thumb' the in-crop mineralisation is calculated as:

Growing season rainfall (GSR–mm) x organic carbon (%) x 0.15
Fertiliser N required for crop = Total N required – Available soil N
= 200–125
= 75 kg N/ha

Nitrogen requirement calculator

Nitrogen removed in grain = Target yield x 40 (kg nitrogen per tonne removed in grain)

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

Example:

Estimated target yield	2 t/ha
N removal in grain	2 t x 40* kg N/t = 80 kg N/ha
	(* from Table 7.1, page 31)
Total N required	= 80 x 2.5
	=200 kg N/ha

Nitrogen fertiliser rates

Fertiliser N required for crop = Total N required – available soil N

Using the above example:
Available soil N (calculated from deep N test + in-crop mineralisation) = 125 kg/ha
Fertiliser N required for crop = 200–125
= 75 kg N/ha (or 163 kg/ha urea).

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

Other formulae are available for calculating nitrogen requirements but these need more detailed inputs which can be provided by consultants or agronomists.

Nitrogen fertiliser application strategies

The total amount of nitrogen applied is more important than the time of application. However, an increasing number of growers apply only a portion of the total estimated amount of nitrogen required prior to or at sowing with the remainder topdressed onto the crop during the growing season. This helps to minimise the risk of crops growing too bulky early in the season, potentially leading to lodging or haying off. Delaying nitrogen application also spreads the financial risk in adverse seasonal conditions. Conversely, if conditions are favourable for higher than targeted yields, then growers are able to adjust their program and apply additional nitrogen to ensure crop needs are met.

Maximum nitrogen rates at sowing

As germinating canola seeds are sensitive to fertiliser burn, take care at sowing to minimise the risk of reduced seedling emergence. Refer to the section on 'Sowing with fertiliser' in Chapter 5 for more detail.

The actual amount of nitrogen that can be applied with the seed will depend on factors such as soil moisture, temperature and row spacing. Wider row spacings will concentrate the amount of fertiliser, so apply lower rates in these situations.

Pre-drilling v broadcasting

When high rates of nitrogen are applied before sowing, the best results are achieved by drilling it in bands (below seeding depth) rather than broadcasting it on the soil surface. Banding results in a slower release of nitrogen during the growing season. It also reduces the risk of leaching and avoids excessive early growth. Broadcasting can result in increased losses by volatilisation, particularly on alkaline clay soils.

Pre-drilling all nitrogen is useful and convenient in areas with low leaching losses (such as the grey clays), ensuring early uptake of nitrogen by the crop, which is critical for canola. However, splitting or delaying nitrogen applications reduces some of the financial risk by allowing growers to make a decision two to three months later when they have more information about potential yield and seasonal conditions.

Where reasonable soil nitrogen levels are present, for example, at least 40–60 kg N/ha, a starter fertiliser containing some nitrogen and all phosphorus needs can be used at sowing and additional nitrogen topdressed during the season. Mono-ammonium phosphate (MAP) is the most popular starter fertiliser.

Topdressing

The aim of nitrogen management is to ensure good healthy vegetative growth prior to bud formation, which occurs in most regions during July (NSW) or August (Victoria). The decision to topdress should be based on seasonal conditions and weather predictions for the remainder of the crop cycle. Remember, weather predictions are only a probability of future rainfall. Splitting or delaying nitrogen applications allows growers to topdress when they have a better idea of potential yield. For highest yields, topdressing is best undertaken before stem elongation. Plant uptake is at its highest during stem elongation so if nitrogen deficiency symptoms occur around this time, topdress immediately. Topdressing at early to mid flowering can be beneficial if the crop is likely to run out of nitrogen during pod fill.

If you are not confident in your ability to assess the need for nitrogen, use test strips. Just after the crop is up, measure a 10 m by 10 m square and apply 1.5 kg of urea. Keep the plot 20 m away from the fence line and compare it to the whole crop. After rain, assess for colour and vigour. The more deficient the crop, the sooner a result is seen. Topdress immediately if colour and vigour improve in the test strip area.

Tissue tests can provide additional information on the nitrogen status of the crop and can help in fine tuning topdressing rates during the season.

An adequate supply of nitrogen during pod fill is important to maximise seed oil content. However, excessive nitrogen can reduce seed oil content as the plant uses it to increase protein at the expense of oil content.

Nitrogen sources

Generally there is no difference in yield response between nitrogen sources — anhydrous ammonia applied to the soil prior to sowing, urea or ammonium sulfate. Check prices by comparing the cost of 1 kg of nitrogen from each source. Ammonium sulfate is usually only used where the crop also requires sulfur.

Urea is normally chosen because it has a high analysis (%) of nitrogen, is cost competitive, and does not affect soil pH. It can be readily incorporated into the soil before sowing or topdressed by ground rig or by air.

Topdressed urea is most successful when it is washed into the soil by at least 6–10 mm of rain soon after application or it dissolves when applied to moist soil. If it dissolves in moist soil and is not washed in by rain there is a higher risk of loss of nitrogen to the atmosphere by volatilisation. Rainfall amount, surface soil pH, texture, wind velocity and ground cover all affect nitrogen losses through volatilisation. Losses are lowest on acidic red soils and highest on alkaline clay soils.

Urea can be readily topdressed onto plants. The fertiliser granules will not damage plants, as they will roll off onto the ground if the leaves are dry. It is important not to overlap or leave gaps during topdressing as crop maturity differences will result. If crops are topdressed with a combine during the vegetative stage, they recover well from wheel tracks without affecting yield potential.

Urea is the preferred source of nitrogen to add to irrigation water but the timing of the first spring irrigation is often too late for the most efficient uptake by the crop. A urea or urea/ammonium nitrate (UAN), solution is also suitable to use as a foliar spray but only at low rates of nitrogen.

Severe phosphorus deficiency showing plant stunting and delayed maturity. PHOTO: R. COLTON, NSW DPI

PHOSPHORUS

Role and deficiency symptoms

Phosphorus (P) plays an important role in the storage and use of energy within the plant. A lack of P restricts root development (resulting in weaker plants) and also delays maturity, both of which affect yield potential and seed oil content, particularly in dry spring conditions. Low P levels also restrict the plant's ability to respond to nitrogen. 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. P is a very mobile nutrient within the plant and if a deficiency occurs, it moves rapidly from older leaves to the young leaves or developing pods.

Fertiliser placement

In the soil, phosphorus is very 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 of P during the early growth stage when phosphorus requirement is at its highest. Many soils (particularly if exchangeable aluminium is present) are able to tie up P, making it unavailable to plants. Therefore, banding the fertiliser can reduce the amount tied up as less fertiliser is in contact with the soil compared with broadcasting. Phosphorus fertiliser banded close to the seed gives better yield responses than phosphorus 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 phosphorus uptake.

Phosphorus requirements

If a wheat crop responds to P, a rate that is at least equivalent should be used when sowing canola. It is important to get the P rate right at sowing as topdressing is ineffective.

Phosphorus deficiency shows as distinct pink-purpling of the tips and margins of older leaves. PHOTO: P. HOCKING CSIRO

A maintenance application of 7–8 kg/ha of phosphorus is needed for every tonne of canola you expect to harvest. If a soil test result indicates a high soil phosphorus level, then lower rates of phosphorus could be applied. In some situations, where soil phosphorus levels are very high it may be uneconomic to apply phosphorus. If more is applied than is removed by the grain, it will be added to the soil phosphorus bank and may be available for following crops or pastures to utilise. However, a significant proportion (up to 50 per cent) of applied fertiliser P can ultimately become 'fixed' into organic and inorganic forms that are largely unavailable for crop uptake.

Most soil phosphorus tests are based on the Colwell P test. If these tests indicate less than 20 mg/kg then phosphorus is considered low (depending on soil type and rainfall) and a response is likely. However, if the soil P level is high (> 40 mg/kg P) a response to phosphorus is less likely, unless the soil is acid (pH_{Ca} less than 4.8) and has a low cation exchange capacity (less than 5cmol (+)/kg), in which cases significant yield responses have been obtained in southern NSW. Soil P tests are less reliable in low rainfall zones or on alkaline soils and so a nutrient budget is better for making phosphorus fertiliser decisions. A Colwell P level of around 40 mg/kg provides opportunity for some seasonal adjustment to fertiliser rates.

SULFUR

Role and deficiency symptoms

Sulfur (S) 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:

- pale, mottled leaves in plants from early rosette to stem elongation; leaves may be cupped, with a purple margin (very deficient crops);
- pale yellow to cream flowers;
- poor pod set and pod abortion, pods that do form are short and bulbous;
- during pod set, stems of affected plants are purple-brown and ripen to a brown rather than a straw colour; and
- 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 sulfur levels will cause yield loss, even if the above symptoms are not obvious.

Soil sulfur

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

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

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

Where higher rates of sulfur are needed, the most economic way is to apply gypsum pre-sowing. Elemental sulfur-amended fertilisers can assist with sulfur requirements but elemental sulfur needs to be converted to sulfate sulfur before plant uptake can occur. This can delay its availability to the growing seedling.

Do not underestimate crop requirements. Sulfur deficiency has occurred in paddocks which 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 nitrogen and phosphorus have been used.

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

Trials around 1990 confirmed paddock observations of the late 1980s of canola's high requirement for sulfur. Flowers are a pale yellow.

PHOTO: A. GOOD, INCITEC

POTASSIUM

An adequate supply of potassium (K) is important to provide plants with increased disease, frost and drought resistance, as well as increased carbohydrate production. Canola crops take up large amounts of potassium during growth but most of it remains in the stubble with only a small proportion removed in the grain. Although deficiency symptoms have been uncommon in the past, they are becoming more frequent on sandy soils in higher rainfall zones where hay has been cut in previous years. In Western Australia, a problem of poorer cereal growth outside the header trails has been linked to the movement of potassium in canola stubbles at harvest. Canola crops subsequently grown in these paddocks also show similar symptoms indicating that the overall potassium level of the paddock is marginal.

Although soil tests, especially the balance of exchangeable cations, can provide a guide to the potassium level, tissue tests are the most reliable method to determine whether a potassium fertiliser is needed.

Avoid sowing potassium fertiliser with the seed as it could affect germination.

OTHER ELEMENTS

BORON

Role and toxicity and deficiency symptoms

Canola requires boron (B) in small amounts but it can cause both deficiency and toxicity problems. In most canola growing areas, boron deficiency is the more likely problem, but in some alkaline and sodic soils, such as the Wimmera and Mallee in Victoria, toxic levels of boron occur at 40 cm or deeper in the soil. Boron toxicity has the two-fold effect of reducing growth as well as reducing the rooting depth of plants. In soils with high subsoil boron, there is little that can be done to ameliorate the problem but boron-tolerant canola types are being investigated.

While adequate boron is essential for plant health it also 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 boron is particularly important under high temperatures as it improves the level of pollen germination.

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

Canola requires 6–10 times more boron than wheat. In southern NSW, canola-wheat rotations over 10 or 11 years continuous cropping have resulted in much boron being removed. As well, many soils, especially the lighter sandy-loam acidic soils which are low in organic matter and are common throughout southern NSW, are low in boron. Under this cropping system a range of crops and pastures, including canola and subclover, frequently have either marginal or deficient levels of boron. In some areas of the South West Slopes region of NSW yield, responses to applied boron have been up to 20 per cent.

Boron deficiency causes seedling plants to bunch, the leaves become long, narrow, with a cupped shape, thicker than normal and brittle, causing them to snap easily. Deficiency is more likely during periods of low moisture availability or where liming has reduced the availability of boron.

Fertiliser requirements

Tissue testing is the best way to confirm a deficiency, 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.

Boron deficiency was confirmed here by tissue testing but symptoms can be confused with manganese toxicity. PHOTO: P. PARKER, NSW DPI

MOLYBDENUM

Role and deficiency symptoms

Molybdenum (Mo) is important to plants to enable them to convert nitrates from the soil into a usable form within the plant. Deficiency is more common when soil acidity falls below pH_{Ca} 5.5 but is difficult to diagnose other than by a tissue test. It can be avoided by applying molybdenum at a rate of 50 g of actual molybdenum per hectare once every five years. The most common method of use is the application of 150 g/ha of the soluble form sodium molybdate (39 per cent Mo) sprayed onto the soil surface. Molybdenum is compatible with pre-emergent herbicides and can be thoroughly incorporated into the soil before sowing.

Fertiliser requirements

While fertilisers containing Mo can be used at sowing, the rate of Mo they contain is less than recommended and they are more expensive than using sodium molybdate. Molybdenum treated single superphosphate (Moly super) applied during the pasture phase is very cost effective and should supply enough Mo for the canola crop.

Zinc deficiency appears as bronzing on the upper leaf surface and may occur in neutral to alkaline soils. PHOTO: B. HOLLOWAY, SARDI

Death of the canola flower head as a result of calcium deficiency. PHOTO: D. McCAFFERY, NSW DPI

ZINC

Deficiency symptoms

Zinc (Zn) deficiency appears in crops as poor plant vigour, with areas of poorer growth alongside healthy, apparently normal plants giving the crop a patchy appearance. Although there are few reports of zinc deficiency in canola, growers should be cautious. Zinc is routinely applied to alkaline soils in the Victorian Wimmera and the clay soils of northern NSW.

Zinc deficiencies can occur in the following situations:

- soils are strongly alkaline, pH_{Ca} greater than pH 7.0, with high phosphorus levels;
- long periods of fallow; and
- 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.

Fertiliser strategies

Where responses to zinc are known to occur, incorporate zinc into the soil before sowing canola. In northern NSW and irrigation areas, broadcast rates of 10–20 kg of zinc per hectare are common where summer crops such as maize and sorghum are also grown. These rates supply enough zinc for five or more years.

On alkaline soils in south-western NSW and Victoria zinc is applied at 2–3 kg/ha every 3–5 years, usually as Zn supplemented fertiliser at sowing.

Zinc oxide is the cheapest and most concentrated form of zinc 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 only a short-term correction and need to be applied before symptoms are obvious soon after crop emergence, or where a Zn deficiency has been identified through tissue analysis.

MAGNESIUM

In recent years, magnesium deficiency has been reported in a number of seedling crops. As the crop grows and develops a deeper root system, the deficiency symptoms disappear because most soils have adequate magnesium deeper in the profile. Low surface magnesium levels are probably due to low levels of sulfonylurea herbicide residues and the harvesting of subclover hay, where large quantities of magnesium 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.

CALCIUM

Calcium (Ca) is important in plants as it assists in strengthening cell walls, thereby giving strength to the 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 calcium deficiency. Calcium deficiency is not common but it can occur in acid soils especially if the level of exchangeable calcium 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.

SALINITY AND SUBSOIL CONSTRAINTS

Canola is moderately tolerant of salinity, with a similar level of tolerance as wheat but slightly lower than barley. Published data suggests that canola can tolerate soil electrical conductivity (EC) levels of 6.5 deci Siemens (dS/m) average throughout the root zone. Subsoil constraints such as hardpans, high alkalinity or acidity, boron toxicity, sodicity and very high levels of salinity can reduce canola yield potential. Subsoil constraints to canola yield have been identified in many areas of north-western Victoria and southern NSW.

SOIL ACIDITY AND LIMING

Canola will grow in a wide range of soils from pH_{Ca} 4.5 (acid) to 8.5 (alkaline). Soil tests for pH should be taken in the winter/spring prior to growing canola especially if soil acidity problems are likely. Collect samples from the surface (0–10 cm) as well as at depth (10–30 cm) to check for subsoil acidity such as an acid ‘throttle’ or band.

On alkaline soils, which are more typical on the northern slopes and plains of NSW (deep cracking grey or brown clays) and in the Wimmera and Mallee regions in Victoria, additional zinc often needs to be applied to the crop.

Acid soils are more typical of the higher rainfall zones in NSW and Victoria. They can contain toxic amounts of aluminium or manganese and may need lime to be applied to the paddock before canola is sown. Most, but not all, acidic soils have high aluminium levels. Canola should not be sown into soils with a pH_{Ca} below 4.5 and not below 4.7 if exchangeable aluminium levels exceed three per cent. Acidity problems may occur in either or both the surface or subsoil layers.

Canola is one of the most sensitive crops to high levels of aluminium which can drastically reduce growth and yield potential. Aluminium (Al) is much more detrimental than manganese (Mn) because it kills the plant’s root tips, resulting in shallow, stunted root systems that are unable to exploit soil moisture or nutrients to depth.

Aluminium toxicity symptoms

Often patches of stunted plants occur within the crop (where aluminium levels are highest), which usually indicates a more serious aluminium toxicity problem.

Note that all nutrient levels shown on a soil test are an average for the paddock and that actual levels will vary as soils are rarely uniform across the whole paddock. For example, if a soil test result indicates that the available aluminium level is three per cent of the cation exchange capacity (CEC), the actual level could vary from 0–6 or seven per cent.

Late sowings and low levels of organic matter may accentuate the problem, particularly when canola is sown after a long cropping history.

Aluminium toxicity appears in the crop as patchy areas of stunted plants and poor growth. PHOTO: R. COLTON, NSW DPI

Manganese toxicity symptoms

Manganese toxicity is a less frequent problem, which shows up as patches within the crop that develop bright yellow margins on the leaves. Symptoms are more common in crops grown in warmer, lighter sandy soils and during periods of moisture stress. Plants usually recover when soil moisture levels improve following rain.

Yellowing of canola leaves from the margins is the main symptom of manganese toxicity. PHOTO: D. McCAFFERY, NSW DPI

Liming

The most effective treatment for Al and Mn toxicity is to apply lime to raise the soil pH_{Ca} above 5.0. Lime rates depend on the pH to depth and the CEC of the soil. A high quality lime is usually applied at 2–4 t/ha. Shallow incorporation is sufficient to ameliorate surface soil acidity but deep ripping is required to incorporate the lime into the subsoil. Deep ripping will also reduce soil strength and improve soil drainage. Where possible, lime should be applied and incorporated to a depth of 10 cm at least two to three months prior to sowing, and preferably six to eight months before.

Lime ready to be spread.
PHOTO: M. LATTIMORE, NSW DPI

Liming to alleviate acid soils not only benefits canola, but the whole farming system. PHOTO: B. RAMSEY, INCITEC PIVOT

FARMER TEST STRIPS

Farmers should conduct their own trials to assess nutrient needs. Visual assessment can be misleading, so make trial evaluations in harvested yield. A simple trial can be done on a measured area along one side of a paddock (wider than the header) that can be harvested and weighed in bulk or checked with the header's yield monitor. Test strips are usually quick to do by adjusting the feeding mechanism to apply different rates of fertiliser in the strips along the paddock. Alternatively, seek help from your agronomist or consultant.

Herbicides are central to any weed management strategy in canola.
PHOTO: G SAUNDERS, ARTISAN DESIGN