SECTION 5

Nutrition and fertiliser

More information

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Virus-in-chickpea-in-northern-NSW-2012

Incorrect levels of nutrients (too little, too much or the wrong proportion) can cause nutritional problems. If the condition is extreme, plants will show visible symptoms that can sometimes be identified. Visual diagnostic symptoms are readily obtained and they provide an immediate evaluation of nutrient status. Visual symptoms do not develop until a major effect on yield, growth or development has occurred; therefore, damage can be done before there is visual evidence of it.

Healthy plants are more able to ward off disease, pests and environmental stresses and so achieve higher yield and better grain quality. [1]

Ensuring adequate nutrition will assist the chickpea crop to generate dense uniform canopies, which deter aphids. [2]

Plant tissue analysis can play an important role in detecting non-visible or subclinical symptoms, and in fine-tuning nutrient requirements. This is particularly helpful where growers are aiming to capitalise on available moisture.

Tissue tests also help to identify the cause of symptoms being expressed by plants but not fitting a visual diagnosis. Technology is enabling quicker analysis and reporting of results to enable foliar or soil-applied remedies to be applied in a timely manner for a quick crop response. [3]

More information

http://www.grdc.com.au/GRDC-FS-NFixation-Chickpeas

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Changing-nutrient-management-strategies-in-response-to-declining-background-fertility

http://www.grdc.com.au/uploads/documents/4%20Nutrition.pdf

5.1 Identifying nutrient deficiencies

Many nutrient deficiencies may look similar. To identify deficiencies:

- Know what a healthy plant looks like in order to recognise symptoms of distress.
- Determine what the affected areas of the crop look like. For example, are they discoloured (yellow, red, brown), dead (necrotic), wilted or stunted?
- Identify the pattern of symptoms in the field (patches, scattered plants, crop perimeters).
- Assess affected areas in relation to soil type (pH, colour, texture) or elevation.
- Look at individual plants for more detailed symptoms such as stunting, wilting and where the symptoms are appearing (whole plant, new leaves, old leaves, edge of leaf, veins etc.).

If more than one problem is present, typical visual symptoms may not occur. For example, water stress, disease or insect damage can mask a nutrient deficiency. If two nutrients are simultaneously deficient, symptoms may differ from the deficiency symptoms of the individual nutrients. Micronutrients are often used by plants to process other nutrients or work together with other nutrients, so a deficiency of one may look

1 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

2 A Verrell (2103) Wirus in chickpea in northern NSW 2012. GRDC Update Papers 26 March 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Virus-in-chickpea-in-northern-NSW-2012

3 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

More information

http://www.grdc.com.au/GRDC-FS-BFDCN

J Paterson (2014). Deep soil tests reveal northern nutrient deficiencies

More information

http://www.grdc.com.au/Research-and-Development/Major-Initiatives/More-Profit-from-Crop-Nutrition

http://www.publish.csiro.au/pid/5352.htm

like deficiency of another. For instance, molybdenum (Mo) is required by pulses to complete the process of nitrogen (N) fixation. [4]

Recent research by Dr Mike Bell, Principal Research Fellow at the University of Queensland's Queensland Alliance for Agriculture and Food Innovation (QAAFI), shows that many farms in central Queensland have phosphorus (P) and potassium (K) concentrated in the topsoil and critically low levels in the subsoil. Plants cannot access these immobile nutrients when the topsoil is dry, and this reduces productivity. [5]

5.1.1 Soil testing

In northern cropping soils, nutrient deficiencies other than N are a relatively recent development. Consequently, limited nutrient research has been conducted in these soils and in the many crop types grown in northern cropping systems. Most research has been done in wheat and barley.

Recent research has highlighted that N applications can be wasted, even on cropping soils that have low N availability, if the levels of other nutrients such as K, P and sulfur (S) are not adequate. The importance of subsoil layers for nutrients such as P and K is not yet reflected in the limited soil test–crop response data available.

Researchers are using rough rules-of-thumb to help interpret P and K soil tests in terms of likely fertiliser responsiveness on northern region Vertosols.

5.1.2 Types of soil test

Appropriate soil tests for measuring soil extractable or plant-available nutrients in the northern cropping region are:

- bicarbonate-extractable P (Colwell-P), to assess easily available soil P
- acid-extractable P (BSES-P), to assess slower release soil P reserves and the build-up of fertiliser residues (not required annually)
- exchangeable K
- KCl-40-extractable S or MCP-S
- 2 m KCl-extractable mineral N, to provide measurement of nitrate-N and ammonium-N

The more attention we pay to all of the activities that contribute to nutrient management (Figure 1), the better the outcome we will get from soil and plant testing. Testing may not provide a useful contribution if one or more of these steps is not done well. [6]

4 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

5 N Baxter (2013) Trials measure chickpea/rotation profit. GRDC Ground Cover Issue 107, Nov.–Dec. 2013, http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-107-NovDec-2013/Trials-measure-chickpea-wheat-rotation-profit

6 GRDC (2013) Better fertiliser decisions for crop nutrition. GRDC Crop Nutrition Fact Sheet November 2013, http://grdc.com.au/Resources/Factsheets/2013/11/Better-fertiliser-decisions-for-crop-nutrition

More information

http://grdc.com.au/Resources/Factsheets/2013/11/Better-fertiliser-decisions-for-crop-nutrition

www.grdc.com.au/GRDC-FS-SoilTestingN

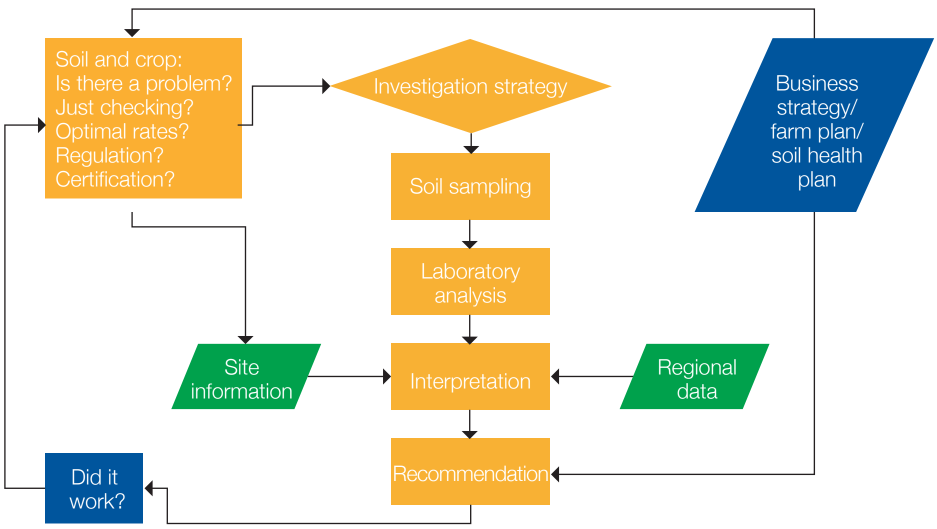

Figure 1: Nutrient management flow chart.

5.2 Nutrient types

Plant nutrients are categorised as either macronutrients or micronutrients (also called trace elements).

Macronutrients are those elements that are needed in relatively large amounts. They include N, P and K, which are the primary macronutrients, with calcium (Ca), magnesium (Mg) and S considered as secondary. Higher expected yields of crops for grain or forage will place greater demand on the availability of major nutrients such as P, K and S. Nitrogen, P and at times S are the main nutrients commonly lacking in Australian soils. Others can be lacking under certain conditions. Keep in mind that each pulse type is different, with different requirements for nutrients and may display different symptoms of deficiency.

A balance sheet approach to fertiliser inputs is often a good starting point when determining the amount and type (analysis) of fertiliser to apply. Other factors such as a soil test, paddock history, soil type and personal experience are useful. Tissue analysis can be helpful in identifying deficiencies once the crop is growing, and can assist in fine-tuning nutrient requirement even when deficiency symptoms are not visible.

Micronutrients are those elements that plants need in small amounts, for example iron (Fe), boron (B), manganese (Mn), zinc (Zn), copper (Cu), chlorine (Cl) and Mo.

Both macro- and micronutrients are taken up by roots and certain soil conditions are required for that to occur.

Soil must be sufficiently moist to allow roots to take up and transport the nutrients. Plants that are moisture-stressed from either too little or too much moisture (saturation) can often exhibit deficiencies even though a soil test may show these nutrients to be adequate.

Soil pH has an effect on the availability of most nutrients and must be within a particular range for nutrients to be released from soil particles. On acid soils, aluminium (Al) and Mn levels can increase and may restrict plant growth, usually by restricting the rhizobia and so the plant's ability to nodulate.

Soil temperature must lie within a certain range for nutrient uptake to occur. Cold conditions can induce deficiencies of nutrients such as Zn or P.

The optimum range of temperature, pH and moisture can vary for different pulse species. Thus, nutrients may be physically present in the soil, but not available to those particular plants. Knowledge of a soil's nutrient status (soil test) pH, texture, history and moisture status can be very useful for predicting which nutrients may become deficient. Tissue tests can help to confirm the plant nutrient status. [7]

5.3 Balancing inputs

If the nutrients (P, N, Zn, etc.) removed as grain from the paddock are not replaced, then crop yields and soil fertility will fall.

This means that fertiliser inputs must be matched to expected yields and soil type. The higher the expected yield, the higher the fertiliser input, particularly for the major nutrients P, K and S.

The nutrient removal per tonne (t) of grain of the various pulses is shown in Table 1. Actual values may vary by 30%, or sometimes more, because of differences in soil fertility, varieties and seasons. For example, P removed by 1 t of faba bean grain can vary from a low 2.8 kg on low-fertility soils to 5.4 kg on high-fertility soils.

From the table, a 2 t/ha crop of chickpeas will on average remove about 6.5 kg/ha of P. This then is the minimum amount of P that needs to be replaced. Higher quantities may be needed to build up soil fertility or overcome soil fixation of P. [8]

More information

http://www.publish.csiro.au/paper/AR9931403

http://bign.com.au/Latest%20News/Perfect%20Pulses

http://www.publish.csiro.au/paper/EA9860353

http://www.publish.csiro.au/?paper=EA98027

http://www.publish.csiro.au/paper/EA97078.htm

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/166329/phosphorous-winter-crops.pdf

http://www.incitecpivotfertilisers.com.au/News/Latest%20News/Perfect%20Pulses

Table 1: Amounts of macro- and micro-nutrients removed per tonne of grain

Note: These values should be used as a guide only

Grain	N	P	K	S	Ca	Mg	Cu	Zn	Mn
			(kg)					(g)	
Pulses									
Chickpea (Desi)	33	3.2	9	2.0	1.6	1.4	7	34	34
Chickpea (Kabuli)	36	3.4	9	2.0	1.0	1.2	8	33	22
Faba bean	41	4.0	10	1.5	1.3	1.2	10	28	30
Lentil	40	3.9	8	1.8	0.7	0.9	7	28	14
Lupin (sweet)	53	3.0	8	2.3	2.2	1.6	5	35	18
Lupin (white)	60	3.6	10	2.4	2.0	1.4	5	30	60
Field pea	38	3.4	9	1.8	0.9	1.3	5	35	14
Cereals									
Wheat	23	3.0	4	1.5	0.4	1.2	5	20	40
Barley	20	2.7	5	1.5	0.3	1.1	3	14	11
Oats	17	3.0	5	1.6	0.5	1.1	3	17	40

Source: Grain Legume Handbook.

Soil types do vary in their nutrient reserves. For example, most black and red soils have sufficient reserves of K to grow many crops. However, the light, white sandy soils, which, on soil test, have <50 μg/g (ppm) (bicarbonate test) of K, will respond to applications of K fertiliser.

Other soils may have substantial nutrient reserves that vary in availability during the growing season or are unavailable due to the soil pH. This can often be the case with micronutrients. Foliar sprays can be used in these cases to correct any micronutrient deficiencies. [9]

7 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

8 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

9 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

5.4 Nutrient budgeting

When grain is harvested from the paddock, nutrients are removed in the grain. If, over time, more nutrients are removed than are replaced (via fertiliser) then the fertility of the paddock will fall.

Nutrient budgeting is a simple way to calculate the balance between nutrient removal (via grain) and nutrient input (via fertiliser).

Table 2 uses standard grain nutrient analyses from Table 1. For a more accurate guide to nutrient removal, use analysis of grain grown on your farm. A more complete picture emerges when several years of a rotation are budgeted.

Table 2: An example of nutrient budgeting

Year	Crop	Yield (t/ha)	Nutrients removed (kg/ha)			
			N	P	K	S
2006	Faba bean	2.2	90	8.8	22	3.3
2007	Wheat	3.8	87	11.4	15	5.7
2008	Barley	4.2	84	11.3	21	6.3
2009	Chickpea	1.8	59	5.8	16	3.6
		Total	320	37.3	74	18.9
Year	**Fertiliser**	**Rate (t/ha)**	**Nutrients applied (kg/ha)**			
			N	P	K	S
2006	0 : 20 : 0 (NPK)	50	0	10	0	1
2007	18 : 20 : 0 (NPK)	70	12.6	14	0	1
2008	18 : 20 : 0 (NPK)	70	12.6	14	0	1
	Urea	60	27.6	0	0	0
2009	0 : 16 : 0 : 20 (NPK)	80	0	12.8	0	16
		Total	52.8	50.8	0	19
Balance			**–267.2**	**+13.5**	**–74**	**0**

As can be seen from Table 2, some interpretation of a nutrient budget is needed:

- Nitrogen: The deficit of 267 kg needs to be countered by any N fixation that occurred. This may have been 50 kg/ha per legume crop. It still shows that the N status of the soil is falling and that it should be increased by using more N in the cereal phase. Estimating N fixation is not easy. One rule to use is 20 kg of N is fixed per tonne of plant dry matter at flowering.
- Phosphorus: The credit of 13 kg will be used by the soil in building P levels, hence increasing soil fertility. No account was made for soil fixation of P.
- Potassium: Some Australian cropping soils (usually white sandy soils) are showing responses to K, and applications should be considered at least to replace the K used by the crop.
- Sulfur: Crop removal of S may exceed inputs in northern NSW.

Other nutrients such as Zn and Cu can also be included in a nutrient-balancing exercise. This is a useful tool for assessing the nutrient balance of a cropping rotation; however, it needs to be considered in conjunction with other nutrient-management tools such as soil and tissue testing, soil type, soil fixation and potential yields.

Because P is the basis of soil fertility and, hence, crop yields, all fertiliser programs are built on the amount of P needed. Table 3 shows the required P rates and the rates of various fertilisers needed to achieve this.

Many fertilisers are available to use on pulses; for the best advice check with your local fertiliser reseller or agronomist.

There is a trend to using 'starter' fertilisers such as mono- and di-ammonium phosphate (MAP and DAP) on pulses. Some growers are concerned that using N on their pulse crop will affect nodulation. This is not the case with the low rates of N supplied by MAP or DAP. A benefit of using the starter N is that early plant vigour is often enhanced, and on low-fertility soils, yield increases have been gained. [10]

Table 3: Fertiliser application rate ready-reckoner (all rates are kg/ha) for some of the fertilisers used on pulses

P	Superphosphate Single 8.6% P		Superphosphate Gold Phos 10 18% P		Superphosphate Triple 20% P		6 : 16 : 0 : 10 Legume Special			10 : 22 : 0 MAP		18 : 20 : 0 DAP		0 : 15 : 0 : 7 Grain Legume Super	
	Fert.	S	Fert.	S	Fert.	S	Fert.	N	S	Fert.	N	Fert.	N	Fert.	S
10	116	13	50	5	45	0.7	62	4	6	46	5	50	9	69	5
12	140	15	67	7	60	0.9	75	4	8	55	6	60	11	83	6
14	163	18	78	8	70	1.1	87	5	9	64	6	70	13	97	7
16	186	20	89	9	80	1.2	99	6	10	73	7	80	14	110	8
18	209	23	100	10	90	1.4	112	6	11	82	8	90	16	124	9
20	223	25	111	11	100	1.5	124	7	12	91	9	100	18	138	10
22	256	28	122	12	110	1.7	137	8	14	100	10	110	20	152	11
24	279	31	133	13	120	1.8	149	8	15	110	11	120	22	166	12

5.4.1 Detecting nutrient deficiencies

It is commonly believed that a soil or plant tissue test will show how much nutrient is required by the plant. This is not so. A soil or plant tissue test will only help to identify what is missing or in excess.

A soil test will only show that at a certain soil concentration, whether the plant is likely or unlikely to respond to that nutrient. These tests are specific for both soil type and plant being grown (Table 4).

Experience suggests that the only worthwhile soil tests will be for P, K, organic matter, soil pH and soil salt levels. An S test has now been developed.

Pulse crops can have different requirements for K, hence different soil test K critical levels.

10 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

Table 4: Adequate levels for various soil test results

Nutrient	Test used		
Phosphorus			
	Colwell	Olsen	
Sand	20–30	10–15	
Loam	25–35	12–17	
Clay	35–45	17–23	
Potassium			
	Bicarb.	Skene	Exchangeable K
Sand	50	50–100	Not applicable
Other soils	100	–	0.25 m.e./100 g
Sandy loam	–	–	–
Faba bean	100–120	–	–
Field pea	70–80	–	–
Lupin	30–40	–	–
Canola	40	–	–
Cereals	30	–	–
Sulfur			
	KCl		
Low	5 µg/g (ppm)		
Adequate	8 µg/g		

Source: Grain Legume Handbook, 2008.

Plant tissue testing can also be used to diagnose a deficiency or monitor the general health of the pulse crop. Plant tissue testing is most useful for monitoring crop health, because by the time noticeable symptoms appear in a crop the yield potential can be markedly reduced.

Several companies perform plant tissue analysis and derive accurate analytical concentrations; however, it can be difficult to interpret the results and determine a course of action. As with soil tests, different plants have different critical concentrations for a nutrient. In some cases, varieties can differ in their critical concentrations.

Table 5 lists the plant analysis criteria for chickpea. These should be used as a guide only. Care should be taken to use plant tissue tests for the intended purpose. Most tests diagnose the nutrient status of the plants only at the time they are sampled; they cannot reliably indicate the effect of a particular deficiency on grain yield. [11]

Another strategy is to tissue-test a number of paddocks and farms. If there is concern over poor-performing areas, the tissue test can be used to diagnose the potential nutrient deficiency.

The critical range (Table 5) can be difficult to use. Wide variations in tissue test results can be due to stress such as frost or waterlogging or even more subtle factors such as solar radiation or time of day of sampling.

Although a valuable tool, tissue testing must be used as only one part of an integrated nutrition program.

11 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

Table 5: Critical nutrient levels for chickpea at flowering

Nutrient	Plant part	Critical range
Nitrogen (%)	Whole shoot	2.3
Phosphorus (%)	Whole shoot	0.24
Potassium (%)	Whole shoot	2.1
Potassium (%)	Youngest mature leaf	1.5
Sulfur (%)	Whole shoot	0.15–0.20
Boron (mg/kg)	Whole shoot	40
Copper (mg/kg)	Whole shoot	3
Zinc (mg/kg)	Whole shoot	12

5.4.2 Nutrient toxicity

Soil pH affects the availability of most nutrients. Occasionally, some nutrients are present in the soil inhibit plant growth. For example on some acid soils, Al and Mn levels may restrict plant growth, usually by restricting the rhizobia and so the plant's ability to nodulate (Table 6).

Boron (B) toxicity occurs on many of the alkaline soils of the southern cropping areas (Figure 2; see also Mn toxicity in Figure 3). The most characteristic symptom of B toxicity in pulses is chlorosis (yellowing), and if severe, some necrosis (death) of leaf tips or margins. Older leaves are usually more affected. There appears to be little difference in reaction between current varieties of chickpeas. [12]

Table 6: Pulse reactions to nutrient toxicities

	Boron	Aluminium	Manganese
Chickpea	Sensitive	Very sensitive	Very sensitive
Faba bean	Tolerant	Sensitive	Sensitive
Lentil[A]	Very sensitive	Very sensitive	Very sensitive
Lupin[A]	Not grown	Tolerant	Tolerant
Field pea	Sensitive	Sensitive	Sensitive

[A]Not usually grown on alkaline–high boron soils.

[12] Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

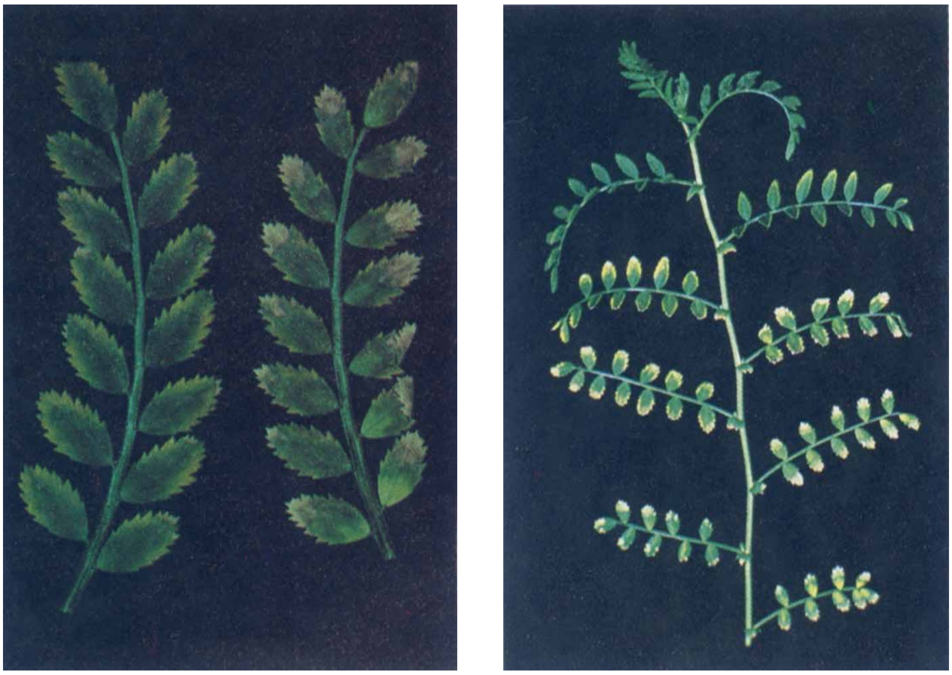

Figure 2: Symptoms of boron toxicity in chickpea leaves. (Source: CSIRO)

Figure 3: Symptoms of manganese toxicity in chickpea leaves. (Source: CSIRO)

5.5 Fertiliser

Fertiliser recommendations for chickpeas, as with most pulses, tend to be generic, with an over-reliance on the recommendation of MAP-based starter fertilisers across nearly all situations. This is often driven by convenience and availability, rather than meeting the specific nutrient requirements of the crop.

Fertiliser recommendations need to be more prescriptive, and should take into account:

- soil type
- rotation (fallow length and impact arbuscular mycorrhizal fungi (AMF) levels)
- yield potential of the crop

- plant configuration (row spacing, type of opener and risk of 'seed burn')
- soil analysis
- effectiveness of inoculation techniques

Molybdenum and cobalt (Co) are required for effective nodulation and should be applied as needed.

Soil P levels influence the rate of nodule growth. The higher the P level, the greater is the nodule growth.

Nitrogen fertilisers in small amounts (5–15 kg N/ha) are not harmful to nodulation and can be beneficial by extending the early root growth to establish a stronger plant. MAP or DAP fertilisers can be used.

However, excessive amounts of N will restrict nodulation and reduce N fixation.

Inoculated seed and acidic fertilisers should not be sown down the same tube. The acidity of some fertilisers will kill large numbers or rhizobia. Neutralized and alkaline fertilisers can be used.

Acid fertilisers include:

- superphosphates (single, double, triple)
- fertilisers with Cu and/or Zn
- MAP, also known as 11 : 23 : 0 and Starter 12

More information

http://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/chickpeas/nutrition

Neutral fertilisers include:

- 'Super lime'

Alkaline fertilisers include:

- DAP also known as 18 : 20 : 0
- starter NP
- lime [13]

5.5.1 Pulses and fertiliser toxicity

All pulses can be affected by fertiliser toxicity. Drilling 10 kg/ha of P with the seed in 18-cm row spacing through 10-cm points rarely caused problems. However, with the changes in sowing techniques to narrow sowing points, minimal soil disturbance, wider row spacing and increased rates of fertiliser (all of which concentrate the fertiliser near the seed in the seeding furrow), the risk of toxicity is higher.

The effects are also increased in highly acidic soils, in sandy soils, and where moisture conditions at sowing are marginal. Drilling concentrated fertilisers to reduce the product rate per hectare does not reduce the risk.

The use of starter N (e.g. DAP) banded with the seed when sowing pulse crops has the potential to reduce establishment and nodulation if higher rates are used. On sands, up to 10 kg/ha of N at 18-cm row spacing can be safely used. On clay soils, do not exceed 20 kg/ha of N at 18-cm row spacing.

Deep banding of fertiliser is preferred for some pulses, otherwise broadcasting and incorporating, drilling pre-seeding or splitting fertiliser applications so that a lower P rate or no P is in contact with the seed. [14]

13 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

14 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

More information

M Bell, G Schwenke, D Lester (2016), Understanding and managing N loss pathways

B O'Mara, C Walker (2015), Lessons learnt about nitrogen and phosphorus from a 30 year study in a sub-tropical continuous cropping system on a vertosol

5.5.2 Nitrogen

If chickpea plants have effectively nodulated, they should not normally need N fertiliser.

Some situations where N fertiliser may warrant consideration include:

- where the grower is unwilling to adopt recommended inoculation procedures
- late or low-fertility planting situations where rapid early growth is critical in achieving adequate height and sufficient biomass to support a reasonable grain yield [15]

Symptoms of N deficiency are depicted in Figure 4, and an N balance for chickpeas is presented in Table 7. Chickpea grain contains 3234 kg N/t. [16]

Figure 4: Nitrogen deficiency in chickpeas. Plants show signs of stunting, yellowing and poor growth. (Source: CSIRO)

More information

http://www.publish.csiro.au/paper/SR9960273.htm

http://www.grdc.com.au/uploads/documents/dnr00004.pdf

Figure 5: Nitrogen balance for chickpeas

Total plant dry matter (t/ha)	Total shoot dry matter yield (t/ha)	Grain yield (t/ha) 40% HI	Total crop N requirement (2.3% N) (kg/ha)	N removal in grain (kg/ha)
1.75	1.25	0.5	40	17
3.50	2.50	1.0	80	33
5.25	3.75	1.5	120	0
7.00	5.00	2.0	160	66
8.75	6.25	2.5	200	83
10.50	7.50	3.0	240	100

Grain harvest index (HI) is the grain yield as a percentage of total shoot dry matter production (average about 40%)

15 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

16 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

More information

D Lester, M Bell, R Graham, D Sands, G Brooke (2016), Phosphorus and potassium nutrition

K Andersson, M Tighe, C Guppy, P Milham, T McLaren (2016), The mobility of P in alkaline clays of the Northern Grains Region

A Verrell, L Jenkins (2016), Nutrition in chickpea 2015 (northern NSW pulse agronomy project)

M Bell, D Sands, D Lester, R Norton (2015), Response to deep placed P, K and S in central Queensland

A Verrell, L Jenkins (2015), Effect of macro and micro nutrients on grain yield in chickpea crops at Trangie and Coonamble

5.5.3 Phosphorus

Chickpeas are adapted to alkaline soils with high levels of unavailable P, and they have evolved methods of extracting P from the soil that would be inaccessible to many other pulse and cereal crops (see Figure 5 for symptoms of P deficiency).

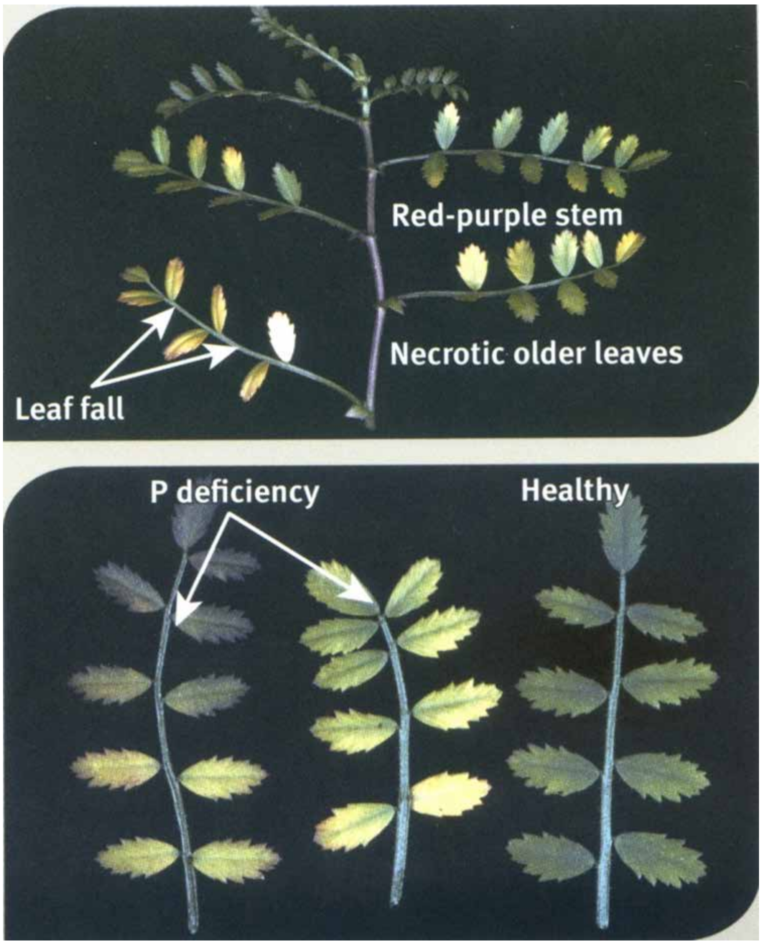

Figure 6: Phosphorus deficiency symptoms in chickpea leaves. (Source: CSIRO)

This ability is largely due to a combination of two factors. First, chickpeas secrete strong organic acids from their roots. These acids dissolve insoluble forms of P in the soil and convert them to water soluble P, which are then available for plant uptake.

Second, AMF colonise and build up to very high levels on the chickpea root system. The fungi produce hyphae that colonise the root and then grow out into the soil (much further than root hairs). Phosphorus and Zn are taken up by the hyphae and transported back for use by the chickpea plant. AMF build up to much greater levels on chickpeas than on wheat root systems (up to five times higher levels).

Although chickpeas are considered to have moderately high crop requirement for P, economic fertiliser responses to P are uncommon.

Most of the research from Australia and overseas indicates that uptake of P is far more efficient in chickpeas than in other winter crops, and responses are usually small and uneconomic.

Possible exceptions are:

- soils with critically low P levels (<6 mg P/kg) and no prior history of P fertiliser; and
- long fallow situations with low AMF levels (≥10 months), where later plantings into cold wet soils can limit or slow the root system development.

Because P is immobile in the soil, these situations can induce P deficiency.

High AMF situations

Where soil AMF levels are moderate–high (double-crop situations or short, 6-month fallows from wheat), consistent responses to applied phosphate fertiliser are only likely where soil bicarbonate-P levels fall <6 mg/kg and are critically low.

Low AMF situations

Levels of AMF become depleted as fallow length is increased (Table 8), or after crops such as canola that do not host AMF growth.

In these conditions of low AMF (long fallows of >8–12 months), chickpeas are very responsive to applied P and Zn. Although chickpeas in this situation will usually show a marked growth response to starter fertilisers (Table 9), this may not always translate into a positive yield response.

Department of Agriculture Fisheries and Forestry Queensland (DAFF) trials at Condamine and Emerald did not show a yield response under conditions of terminal drought stress in spring.

The most cost-effective strategy in a long fallow situation (low AMF) may be to ensure that the paddock is sown relatively early in the recommended sowing window, so that sufficient time is allowed for the crop to recover from the delay in early growth.

These recommendations are based on soil samples taken to a depth of 0–10 cm.

Table 7: An example of effect of fallow length on arbuscular mycorrhizae (AM) spore survival, and crop yield response to fertilisation after the fallow

Fallow duration (months)	AM spores (no./g soil)	Maize yield (kg/ha)	
		Nil (P & Zn)	+ (P & Zn)
21	14	2865	4937
11	26	3625	3632
6	44	5162	4704

Source: J Thompson (1984).

Table 8: Effect of fallow length and fertiliser on chickpea growth

Fallow duration (months)	Dry weight (g/plant) of chickpea at 12 weeks			
	Nil fertiliser	P (50 kg/ha)	Zn (10 kg/ha)	P & Zn
Long (14 months)	1.0	1.2	0.4	1.9
Short (6 months after wheat)	3.1	2.8	2.7	3.3

Results in Table 9 from a Queensland Wheat Research Institute trial at Macalister show that chickpea growth on short-fallow land (6 months after wheat) was much better than growth after long fallow on the same property. The addition of P and Zn fertilisers could not entirely compensate for the lack of AMF in chickpea on the long fallow. [17]

5.5.4 Potassium

Responses to K are unlikely on most black earths and grey clays. Potassium fertilisers may be warranted on red earths (kraznozems) but this should be based on soil analysis.

Fertiliser responses are likely where soil test levels using the ammonium acetate test fall below:

- exchangeable K of 0.25 meq/100 g (or cmol/kg) on black earths and grey clays
- exchangeable K of 0.40 meq/100 g K on red earths and sandy soils

Application of 20–40 kg K/ha banded 5 cm to the side of, and below, the seed line is recommended in situations where soil test levels are critically low (see symptoms of K deficiency in Figure 6).

More information

www.grdc.com.au/GRDC-FS-PhosphorusManagement

http://www.icanrural.com.au/newsletters/NL52.pdf

D Lester, M Bell, R Graham, D Sands, G Brooke (2016), Phosphorus and potassium nutrition

17 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

Alternatively, blends such as Crop King 55 (13 N, 13 P, 13 K) may be considered at rates of 80–120 kg/ha in situations where K levels are marginal. [18]

Figure 7: Potassium deficiency symptoms in chickpea leaves. (Source: CSIRO)

More information

http://anz.ipni.net/article/ANZ-3193

More information

G Blair, W Matamwa, I Yunusa, M Faint (2015), Adding sulfur to finished fertilisers: inside or outside?

5.5.5 Sulfur

Certain soil types are prone to S deficiency, for example, some basaltic, black earths.

On these soils with marginal S levels, deficiency is most likely to occur with double-cropping where levels of available S have become depleted, for example, when double-cropping chickpeas after high-yielding sorghum or cotton crops (see Figure 7 for symptoms of S deficiency).

Application of 5–10 kg S/ha will normally correct S deficiency.

Where soil phosphate levels are adequate, low rates of gypsum are the most cost-effective, long-term method of correcting S deficiency.

Granulated sulfate of ammonia is another effective option where low rates of N are also required.

Marked responses to 25 kg/ha of sulfate of ammonia have been observed when sowing chickpeas in double-crop situations (e.g. after sorghum or cotton due to sulfur removal rates). [19]

18 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

19 Pulse Australia (2013) Northern chickpea best management practices training course manual—2013. Pulse Australia Limited.

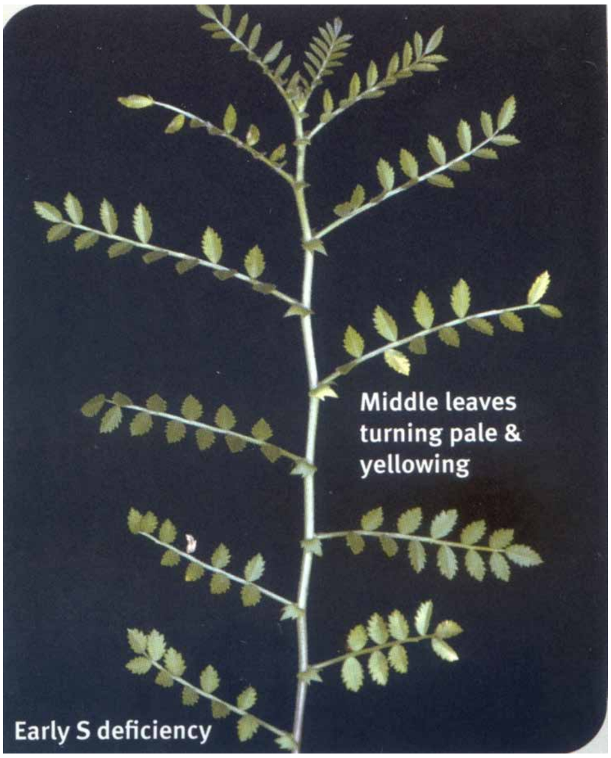

Figure 8: Early sulfur deficiency symptoms in chickpea leaves. (Source: CSIRO)

More information

A Verrell, L Jenkins (2016), Nutrition in chickpea 2015 (northern NSW pulse agronomy project)

5.5.6 Zinc

Chickpeas are considered to have a relatively high demand for Zn, but have evolved highly efficient mechanisms for extracting Zn from the soil (similar to the mechanisms described for P).

There is a lack of Australian and overseas research on Zn responses in chickpeas, and Zn fertiliser recommendations are being conservatively based on a general recommendation used for all crops. Based on DTPA analysis of soil samples at 0–10 cm, critical values of Zn are:

- below 0.8 mg/kg on alkaline soils
- below 0.3 mg/kg on acid soils

AMF are extremely important to Zn nutrition in chickpeas, and large responses can be expected where AMF levels have become depleted due to long fallows (over 8–10 months) (see deficiency symptoms in Figure 8).

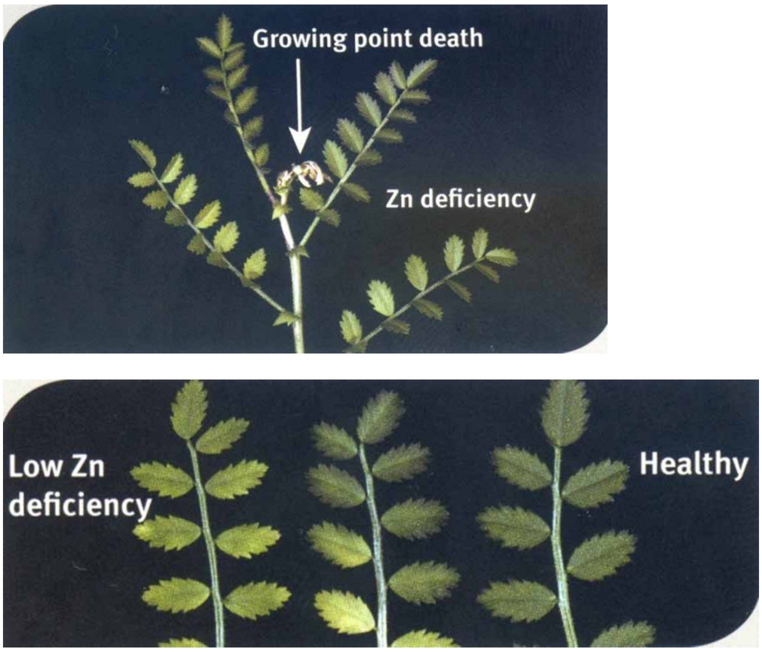

Figure 9: Comparisons of healthy and zinc-deficient chickpea leaves. (Source: CSIRO)

Pre-plant treatments

Severe Zn deficiency can be corrected for a period of 5–8 years with a soil application of 15–20 kg/ha of zinc sulfate monohydrate, worked into the soil 3–4 months before sowing.

Zinc is not mobile in the soil and needs to be evenly distributed over the soil surface, and then thoroughly cultivated into the topsoil.

In the first year after application, the soil-applied Zn may be not fully effective and a foliar Zn spray may be required.

Seed treatments

Zinc seed treatments may be a cost-effective option where soil P levels are adequate but Zn levels are likely to be deficient:

- Broadacre Zinc (Agrichem): contains 650 g/L of Zn and is applied as 4 L product /t seed. Pre-mix with 1 L water prior to application. To minimise damage to the rhizobia, the Broadacre Zinc treatment needs to be applied first and then allowed to dry before applying the inoculum. Broadacre Zinc is compatible with Thiraflo or P-Pickel T® and can be mixed with either product to treat chickpea seed in the one operation.
- Teprosyn Zn (Phosyn): contains 600 g/L of Zn and is applied as 4 L product/t seed. Pre-mix with 2–3 L water to assist coverage. Apply inoculum first and allow to dry before applying the Teprosyn.

Fertilisers applied at sowing

A range of phosphate-based fertilisers either contain, or can be blended with, a Zn additive.

Foliar zinc sprays

A foliar spray per ha of 1.0 kg zinc sulfate heptahydrate + 1.0 kg urea + 1200 mL of non-ionic wetter (1000 g/L) in at least 100 L of water will correct a mild deficiency. One or two sprays will need to be applied within 6–8 weeks of emergence.

Hard water (high in carbonate) will produce an insoluble sediment (zinc carbonate) when the zinc sulfate is dissolved, with the spray mix turning cloudy. Buffer back with L1-700 or Agri Buffa if only hard water is available; zinc oxide products are highly alkaline, with a pH of 9.5–10.5. [20]

5.5.7 Iron

Iron deficiency is observed occasionally on alkaline, high-pH soils. It is usually associated with a waterlogging event following irrigation or heavy rainfall, and is attributed to interference with iron absorption and translocation to the foliage.

Symptoms include a general yellowing of young leaves, which can develop in severe cases to distortion, necrosis and shedding of terminal leaflets (pinnae) (Figure 9).

A mixture of 1 kg/ha of iron sulfate + 2.5 kg/ha of crystalline sulfate of ammonia (not prilled) + 200 mL of non-ionic wetter added to 100 L water has been successfully used to correct Fe deficiency.

The addition of sulfate of ammonia will improve absorption of Fe, with a significantly better overall response.

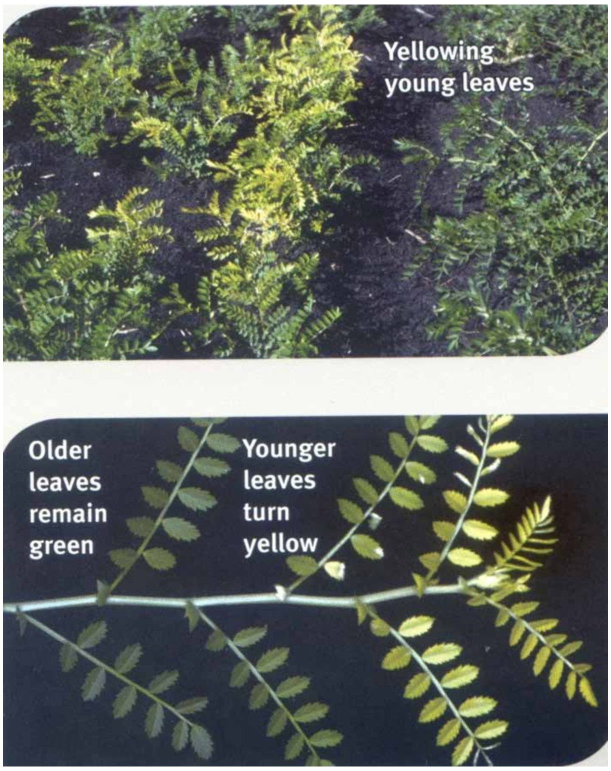

Figure 10: Iron deficiency in chickpeas. (Source: CSIRO)

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Cultivars exhibit marked differences in sensitivity to iron chlorosis, and major problems with Fe deficiency have largely been overcome through plant breeding.

Iron deficiency symptoms tend to be transient, with the crop making a rapid recovery once the soil begins to dry out. [21]

5.6 References and further reading

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