Pacific Seeds

Growing possibilities

CORN NUTRITION GUIDE

CORN HYBRIDS

CONTENTS

CORN NUTRITION

Corn is recognised as a high yield crop provided optimum crop management is used. Yield potential of corn is essentially dependent on the amount of intercepted radiation, water and nitrogen available, moderated by factors such as temperature and radiation intensity. The production, retention and function of leaf area is the key to productivity and adequate plant nutrient supply at all stages is vital in this process. High yielding corn crops require nutrient availability in both total quantity and timing. Rates of fertiliser will vary depending on factors such as locality, soil fertility, previous crop, fertiliser history and yield potential. The nutrients that most frequently limit production are nitrogen (N) and phosphorus (P). Sulphur (S), potassium (K) and zinc (Zn) may also be limiting in some soils or under some growing conditions and in some soil types.

Crop Uptake

Corn has a high demand for nutrients. For each tonne of yield, a corn crop requires defined quantities of nutrients. Nitrogen (N) and potassium (K) are nutrients required in the greatest quantities followed by sulphur (S), phosphorus (P), calcium (Ca) and magnesium (Mg). Total uptake for each nutrient can be calculated by multiplying the nutrient uptake in Table 1 by the grain yield (t/ha). The amount calculated also represents the quantity of nutrient likely to be removed if the crop was to be harvested as silage (typically 20- 25 tonnes/ha DM) or hay.

Table 1 Typical nutrient uptake for most commonly applied nutrients in corn

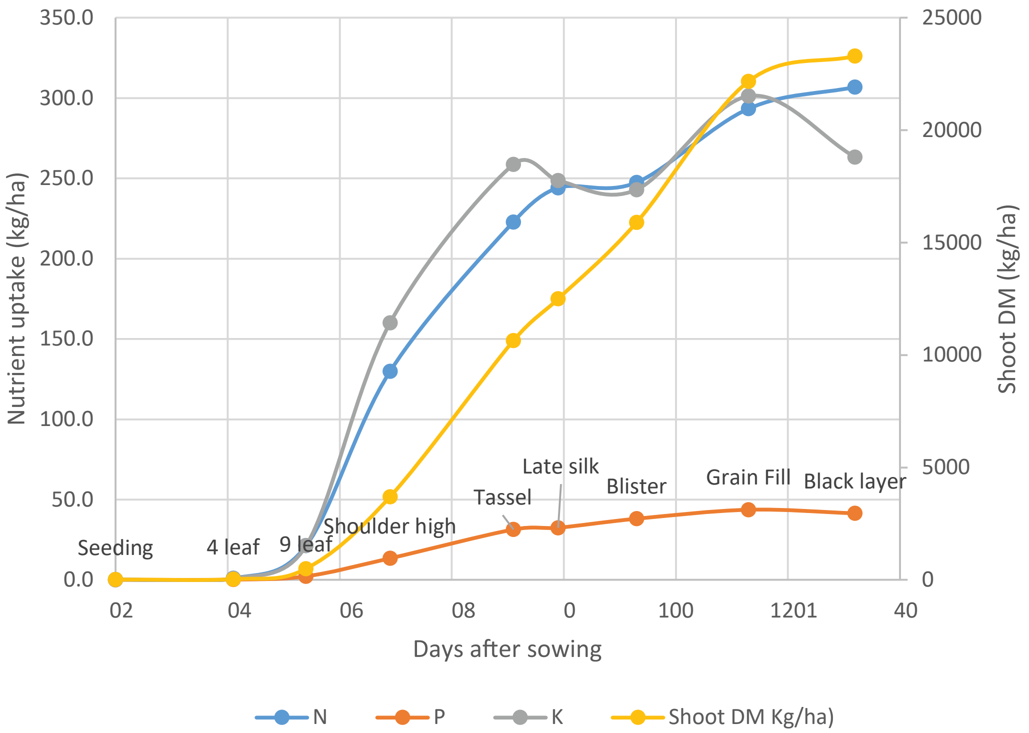
Nutrient	N	P	K	S	Zn
Uptake	22-30 kg/t	4.5 kg/t	16.3 kg/t	5.2 kg/t	24 g/t

The timing of nutrient demand in corn is similar to other cereals with K and N occurring ahead of dry matter accumulation and phosphorus uptake. Corn takes up 75% of its nitrogen requirement in the vegetative period prior to tasselling. A shortage of nitrogen during this period significantly reduces growth in stems and leaves and consequently in the number of grains produced, and so leads to reduced yield. The remaining nitrogen taken up between flowering and maturity is important for maintenance of grain number, achievement of grain size and protein content. Fifty percent of its K requirement is during the vegetative period prior to floral initiation, while the uptake of P peaks at early flowering, with 45% of the total P demand being taken up during booting and flowering (Figure 1).

Minor variations to this pattern may result from differences in the degree of multiple cobbing between varieties. Multiple cobbing generally extends the uptake period for all nutrients.

Double cobbing corn, typical of some hybrids planted at low populations.

Figure 1 Nitrogen, phosphorus and potassium uptake patterns for an 11t/ha grain corn crop (Purdue University 1995)



The demand for N varies more widely than for other nutrients being dependent on the grain yield and grain protein content. Crop N supply is related to the grain protein content (kg N/t) and the N efficiency at which soil and fertiliser N is taken up and transferred to grain. The N supply required to produce a range of yield and protein levels is given in Table 2.

Table 2 Crop N demand required from all sources required for a range of grain yield and protein targets. (Based on the relationship between maximum yield and associated grain N % of Steele et al 1982, Wortmann et al 2011)

	Target grain protein typical economic optimum yield (%)	Target grain protein max yield (%)
Target yield (t/ha)	8	9
1	26	29
2	51	58
3	77	87
4	102	115
5	128	144
10	256	288
12	307	345
15	384	432
18	460	518

NUTRIENT REMOVAL

With soils in many corn growing regions now exhibiting responsiveness to a wider range of nutrients, the starting nutrient rate for crop nutrition strategies is frequently replacement of that removed in the grain. This can be based on published typical nutrient removal rates such as those in Table 3, or can be related to removal measured at a farm or paddock level by measuring grain nutrient content. This can be done by submitting a representative sample of grain for a complete plant tissue analysis. The range in removals displayed in Table 3 were collected from grain samples collected from a range of reference sources both local and international with a large range of growing conditions, varieties, soil and fertiliser regimes.

The range suggests that some investigation of removal at a paddock level is likely to improve calculation of appropriate maintenance rates.

Table 3 Typical nutrient removal (kg/t for NPKS and g/t for Zn) for most commonly applied nutrients in corn

Nutrient	N	P	K	S	Zn
Removal	15	2.9	3.3	1.3	18
Range	9 - 26	1.9 – 4.0	2.6 – 4.1	0.9 – 1.7	13 - 24
% of crop uptake removed	50	65	20	25	75

A maintenance or replacement strategy is generally suitable for nutrients other than N with marginal to adequate soil status. This is typical of situations where crops sometimes show small responses to nutrient addition. The dynamic nature of the nitrogen cycle requires fertiliser N to be managed based more on the seasonal assessment of yield potential and likely soil N supply.

Establishing the need for increased nutrient supply

The need to supplement the native soil nutrient supply to maximise yield can be identified using a number of methods. Most directly via test strips and indirectly through the use of soil and plant tissue analysis. Waiting till the onset of clear foliar symptoms can cost up to 20% yield penalty for a number of years before the clear symptoms emerge. The yield loss that occurs before symptoms occur is commonly referred to as "hidden hunger".

Critical levels of important nutrients for the dominant soil types in corn growing areas are presented in Table 4. The values are general and may vary in response to a range of other soil chemistry and biology variables. Soil sampling depths indicated are important in ensuring the interpretability of laboratory analyses, particularly for soil immobile nutrients such as P, K and Zn.

Table 4 General soil analysis critical values for nutrients most limiting to corn grown in summer dominant rainfall areas

	Sample depth (0-10 cm)		
Nutrient	Low P buffer	Moderate P buffer	High P buffer
Phosphorus (Colwell) mg/kg	20	40	60*
	Low CEC	Moderate CEC	High CEC
Potassium (exchangeable) cmol(+)/kg	0.2	0.4	0.6
	Low pH	Moderate pH	High pH
Zinc (DTPA) mg/kg	0.1	0.5	0.8
	0 – 10 cm		
Sulfur (MCP) mg/kg	8		

The wide critical range for P is related to the range of early season soil temperature and phosphorus buffer indexes (PBI) across corn growing areas.

Plant tissue analysis is generally used as a diagnostic tool where plant growth appears to be affected by nutrient deficiency. Where used correctly it has the advantage of reflecting the root uptake-soil supply relationship of the crop.
The values in Table 5 represent the lowest nutrient concentrations for youngest expanded blade below which yield may be reduced.

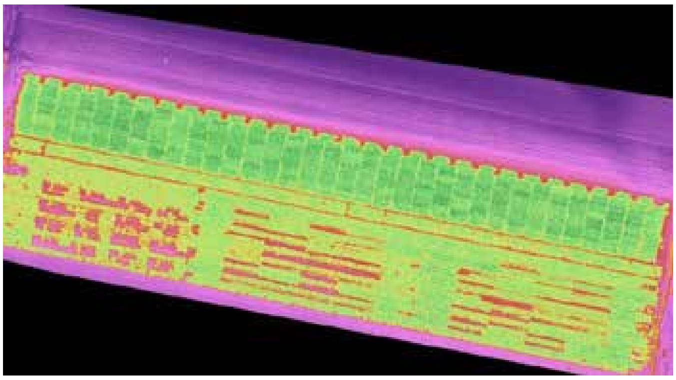
Emerging technologies that use spectral reflectance or transmission also appear to have some application in nutrient management of corn where in-crop nutrient application possible.

This technology is most developed for N but commercial availability of decision support in corn is currently limited. Yara N-Sensor™ and Ag Leaders OptRX® Crop Sensor proximal sensors, SPAD chlorophyll meter, RapidEye® Satellite Sensor and WorldView-3 Satellite Imagery are examples of remote sensing platforms that have been developed to provide crop N status in other crops.

Table 5 Plant tissue analysis lower value of adequate range for corn (Bryson et al. 2014) for whole tops sampled when crop is less than 20 to 30 cm high

N %	P %	K %	S %	Ca %	Mg %	Cu mg/kg	Zn mg/kg	Mn mg/kg	Fe mg/kg	B mg/kg	Mo mg/kg
3.5	0.3	2.5	0.15	0.3	0.15	5	20	20	30	5	0.1


GreenSeeker® in use on corn.


NDVI image of corn captured by drone.

ROLE OF NUTRIENTS IN CORN

NITROGEN

Nitrogen is a key nutrient in a large number of plant functions including being central to production of amino acids and protein, formation of chlorophyll, is a component of vitamins and affects energy relations in the plant.

Nitrogen stress in corn is characterised by:

- Reduced dry matter;
- A light green to yellow general colouration with spindly stalks;
- Yellowing and necrosis of lower leaves beginning at the tip and proceeding in a "V-shaped" pattern;
- Slow growing, small cob size; and
- Low grain protein.

Nitrogen deficiency in corn, late onset, see bottom half of crop with early senescence.

Figure 2 shows the typical N uptake rate (N flux) pattern for a corn plant. It appears that the plant does not use much N during the first 20 days, but by the time the plant is 45 – 55 days it has reached its maximum N uptake rate and by 60 days old, it has used close to 60 percent of the total N. This pattern of uptake, the soils' ability to retain N and growing season rainfall patterns should guide N application strategy.

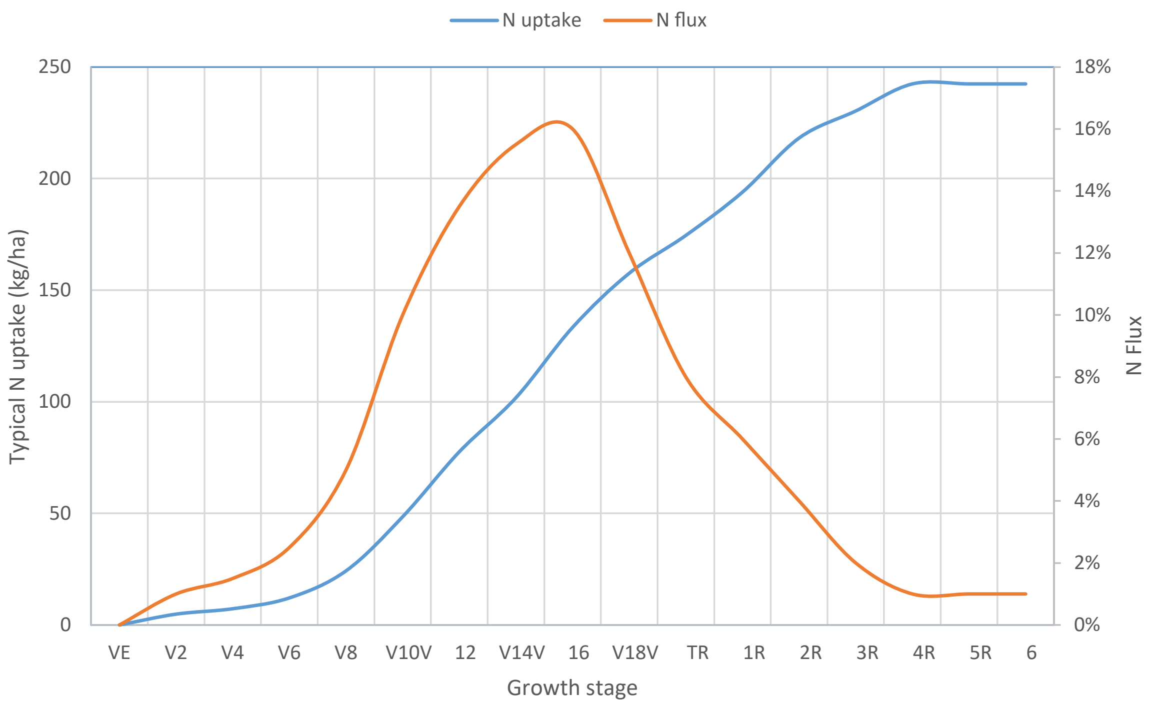


Figure 2 Typical nitrogen flux (% total N requirement for each growth stage) and uptake patterns for corn (12.5 t/ha yield). Maximum daily uptake rate occurs around 50 days.

Nitrogen fertiliser strategies for rain-grown crops should be based on a realistic target yield, based primarily on stored soil moisture with some allowance for summer rainfall and previous paddock history. For irrigated crops, the quantity of water and timing of irrigations are also influential in setting a target yield. The grain protein content of corn and other cereals crops (Table 6) can be used as a reliable indicator of the adequacy of available N to optimise yield for seasonally available water. Grain protein in corn of less than 8% generally indicates that the crop would have likely yield more with increased N availability.

Table 6 Target grain protein for yield optimisation with nitrogen for a range of cereal crop grown in rotation with corn

Crop	Target Grain Protein %*
Corn	9
Sorghum	10
Barley	10.5
Wheat	11.5

* Grain moisture at delivery standard

Nitrogen fertiliser rates are generally determined for corn as part of a partial N budget. The crop N demand is provided for a range of yield and grain proteins in Table 2. This N demand needs to be matched by a combination of residual soil mineral N (as measured by a soil test), N released from the soil organic matter and previous crop residues with any deficit being supplied by fertiliser N.

NITROGEN FERTILISER STRATEGIES

Nutrient Source
Urea, anhydrous ammonia and ammonium sulphate are the most commonly used N fertilisers applied for corn preplant and side-dressed. Topdressing with urea and ammonium sulphate needs to be assessed for the potential for ammonia volatilisation loss. When applied in the same soil banded or broadcast and incorporated there is no evidence of consistent differences between the products' in crop N response.

Efficiency enhanced fertiliser (EEF) products are designed to modify the release pattern of N from the product to either increase synchronisation of N availability with crop demand and/or help lower the risk of losses from denitrification or volatilisation. To date these product have been successful in reducing nitrous oxide emissions but have not reliably demonstrated profitable and predictable dollar returns in raingrown corn crops.

Application Rate
Raingrown generally 0 to 180kg N/ha
Irrigated generally 80 to 300kg N/ha

Application rates for specific yield and soil N availability can be calculated as the difference between a crop's N demand (Table 2) and its soil N supply (Table 7).

Table 7 Estimated N supply from a range of soil mineral N values for sampling 0-90 cm in a cereal based rotation

Soil mineral N mg/kg	Estimated crop available N (kg/ha)
1	15
5	62
10	121
15	179
20	238
25	296

Application Method
Preplant applications are generally best banded into the soil to reduce immobilisation if high stubble loads are still present. Nitrogen bands should generally not be placed at a greater width than plant row spacing. For skip row configurations application bands should be placed to ensure that each row of corn has access to a fertiliser band on at least one side of the plant row. Preplant broadcast application without incorporation should be avoided for urea and sulphate of ammonia on alkaline calcareous soils due to increased losses from volatilisation.

Application of N products in contact with the seed, particularly when sown at wide row spacing, should be minimised or avoided due to the risk of reducing crop establishment (Table 8).

Table 8 Suggested maximum rates to minimise emergence effect of fertiliser for some commonly used fertilisers

Product	Seedbed utilisation (SBU) factor	
	1%	2%
Urea	5	10
MAP	30	50
DAP	20	30

SBU 1% is typical in row fertiliser concentration generated with a furrow width of 1cm on a 100cm row spacing. This data is for clay soil with good soil moisture. For more details see Online Fertilizer Damage Tool http://anz.ipni.net/article/ANZ-3076

When applying N post-emergence using soil disturbing bands, application depth should to sufficient to ensure soil coverage of fertiliser in the application trench and at enough distance from the established crop to avoid root damage. It is advisable to locate the extent of lateral root extension before application.

Application equipment should be configured to minimise dribble banded N contacting the crop. Liquid nitrogen product are generally sufficiently concentrated to cause osmotic burn and localised ammonia toxicity. More extensive burn is create by inappropriate rates of N applied in foliar application

Anecdotal evidence suggests that for broadcast application, rates of urea should be kept below 100kg/ha when crops are between growth stages 2 and 3 are in a single application to lower the risk of fertiliser burn in the centre whorl.

Leaf burn caused by volatilisation of ammonia from unincorporated urea (12 hours).

Application in irrigation water should only be attempted where water application is efficient and even. Where logistically possible, it provides an application option that eliminates soil disturbance. Urea and anhydrous ammonia are the most common products used for this method of application. For flood irrigation, both urea and anhydrous ammonia can be used however there are restrictions related to maximum rate, water temperature and length of run that restrict anhydrous ammonia's effectiveness. Urea and urea-based solutions are suitable for overhead and subsurface irrigation systems. Increased maintenance of metallic components of irrigation equipment should be planned where N products are applied via irrigation.

Application Timing

The total fertiliser N requirement is frequently applied pre or at-planting in raingrown crops due to either unfavourable logistics of in-crop N application or unreliability of rainfall to promote efficient uptake. Given the N uptake pattern in Figure 2, in raingrown crops the highest N efficiency can be achieved by a split application strategy where about one-half to two-thirds of the total N applied preplant or at sowing, the remainder applied side-dressed between the sixth-leaf (V6) to tasselling (VT) stage. Follow-up rainfall to carry the N into the root zone is required to obtain the benefit of N applied in-crop.

For irrigated crops and high yield potential dryland crops, a three-way split, with a portion of the N being applied at the V6 and VT stages provides added flexibility to match N supply to yield potential later in the season. Irrigation method and frequency will have an effect on the root density and distribution in the soil profile. Frequent surface applied irrigation i.e. centre pivot or lateral can encourage a higher density of root growth in the surface layers, compared to limited irrigated or rain grown crops. Placement and timing of N needs to be matched to the available water profile.

Liquid side dress applicator.

Side dressing: Single disc with anhydrous.

PHOSPHORUS

Phosphorus is vital for the early development of young corn. It is involved in photosynthesis, respiration, energy storage and transfer, cell division, and enlargement, promotes early root formation and growth, and increases water-use efficiency.

Symptoms of a lack of phosphorus in corn includes:

- Blue green colouration with reddening of stems and lower leaves;
- Poor vigour;
- Restricted root development; and
- Delayed or uneven flowering.

Phosphorus availability to crops is controlled by the interaction of a range of soil chemical, biological and physical parameters, in combination with weather factors such as temperature and rainfall. Corn grown following paddy rice is especially at risk of P availability problems related to changes in soil P chemistry and biology in soils flooded for an extended period.

Responsiveness to the addition of phosphorus fertiliser is identified by the presence of a number factors that increase the likelihood of corn response (Table 9). Additionally, responsiveness is generally categorised as either a "starter" or "season long" response. Starter responses are generally visible as an increase in growth of a crop early-season that does not always increase harvest yield. Starter responses typically produce grain yield increases of 100 – 500kg/ha. Season long responses are generally visible all season and frequently produce grain yield increases greater than 500kg/ha and hasten flowering.

Table 9 Major contributing factors to the two types of P response

Starter response	Season-long response
Cool soil temperature during crop establishment	Low available P in whole soil profile
Low soil available P in surface soil	Long fallow or following non-VAM crop e.g. canola
Deep sowing	
Short and summer cereal to summer cereal fallows	

Response to P has been more common after long fallows. More recently it has been demonstrate that "season long" summer cereal responsiveness to P in rain grown crops is strongly related to the P in the 10 – 30cm soil layer than 0-10cm alone. Application of P in the 15 – 25cm soil layer has been found to increase the probability of season long responses when soil P test is low in a 10 – 30cm soil layer (Table 4). Seasonal rainfall patterns have also been found to affect response to P. Table 10 contains modelled estimates of the likely effect some common seasonal rainfall patterns on yield reduction from less than optimum fertiliser P supply.

Table 10 Estimates of relative yield losses in summer cereal that could be experienced if a combination of starter P and deep P fertiliser was not applied for different soils and season types (adapted from Zull et al. 2015)

Season	PAWC	Estimate of relative yield loss %
Dry start	120 mm	5
Wet start, dry finish		10
No serious water stress		15
Dry start	240 mm	10
Wet start, dry finish		25
No serious water stress		15

PHOSPHORUS FERTILISER STRATEGIES

Nutrient Source
The majority of both dry and liquid P starter products are based on ammonium phosphates MAP and DAP. Due to the extra ammonium molecule in DAP there is more risk of crop establishment reduction from DAP than MAP when applied in the seed furrow.

If "starter" products contain ammonium forms of nitrogen and/or potassium the rate of application and application method needs to be closely assessed as products will reduce crop establishment if the in-row rate is too high.

Liquid sources of P provide a slightly lower risk of crop emergence damage at equivalent rates of dry granular P, and may have some logistical advantages but have failed to demonstrate superior responses for an equivalent P application in corn growing.

Application Rate
Application rates of P in corn are generally in the range 5 – 15kg/ha, frequently well below the replacement of 2.9 kgP/tonne of grain or 2.5kg P/tonne of dry weight of silage.

To avoid crop establishment reductions, it is suggested that the maximum rate of seed furrow applied MAP and DAP should be 4g/m and 2.5g/m respectively (40kg/ha and 25 kg/ha in 100 cm rows). These rates are for medium clay soils with good planting moisture for a narrow tine opener. For different soils and soil moisture conditions and where other nutrients are contained in the product an appropriate adjustment to rates should be made. Seek detailed direction from your fertiliser supplier for more detail.

For deep applied P, the application rate should be sufficient for 3 – 5 years from a single application.

Application Method
The combination of early P requirement for healthy seedling growth and its immobility in soil, means that fertiliser products need to be applied with, or in close proximity to seed for "starter" response. The target zone for placement is 5cm to the side of, and 5cm deeper than the seed location.

Where surface and deep soil tests indicated potential for enhanced response from deep application of P banding around 20cm depth and at 50cm row spacing early in a fallow is suggested.

Application Timing
The very low soil mobility of P in the majority of corn producing soils requires starter P to be applied either in the seed furrow or adjacent (20 – 50mm) to the seed at sowing.

In soils where response to deep P is likely, timing of the application should allow for reconsolidation of the seedbed by moisture i.e. at the start or a fallow when there is soil moisture to 20 – 30cm depth.

P deficient corn.

POTASSIUM

Potassium is involved in a multitude of functions in the plant ranging from carbohydrate metabolism, break down and translocation of starches, water-regulation, is essential to protein synthesis formation, activates enzymes and controls their reaction rates. Adequate supply also improves temperature hardiness and increases disease resistance.

Corn crops suffering a shortage of K display symptoms such as:

- Interveinal or marginal chlorosis of older leaves;
- Dark green plants with chlorosis along the leaf margins developing to brown striping and necrosis;
- Shortening of internodes and dwarfing plants; and
- Smaller heads and low grain number.

Due to a gradual decline in soil K levels with crop removal, erosion of topsoils, and historically low K fertiliser application rates, there are an increasing number of soils now requiring K fertiliser applications. These include red soils (Ferrosols), open downs soils of the Central Highlands, Queensland, other upland vertosols that developed in situ, and low cation exchange capacity (CEC) acidic coastal soils. Rain grown summer and winter cereals are less likely to respond to K applications than pulses such as soybeans, navy beans and peanuts under conditions of marginal soil K status. Chickpea has recently been identified as sensitive to low soil K. Being more widely grown in rotations with corn, chickpea is now a key indicator of failing soil K supply.

K deficiency in corn.

POTASSIUM FERTILISER STRATEGIES

Nutrient Source

Potassium is generally applied as either muriate of potash (KCl) or potassium sulphate (K^2SO^4). Potassium is also in reasonable concentrations in many manures and composts. Muriate of potash is generally applied in broadcast or preplant banded applications while potassium sulphate is generally preferred in blends with P placed in or near the seed furrow.

For deep application the addition of P to the K band can enhance K uptake. Potassium fertilisers are generally not subject to losses when applied well ahead of crop establishment. Erosion of topsoil and leaching in acidic low CEC are most likely loss process other than removal in harvested produce.

Application Rate

The vast majority of corn growing soils have adequate to good supplies of K both in the surface and subsurface. Where applied, application rates of K in corn should be around replacement rates of 3.3kg K/tonne of grain or 10kg/tonne DM in silage.

Most K fertilisers have a high salt index increasing the risk of fertiliser interfering with crop establishment. As a general precaution K should be avoided in seed furrow placed blends and where unavoidable rates should be less than 0.25g K / linear metre of row (5kg K/ha in 100 cm rows).

Application Method

Potassium is generally not subject to soil reactions that reduce its long term availability, but is of low mobility in moderate to high CEC soils. As with P, responses to K in rain grown crops appear to be more consistent where K is banded in the 15 -25 cm soil layer in combination with and ammonium phosphate product. Unlike P, K does not stimulate root proliferation response in fertiliser bands. High efficiency of K use will result from enrichment of a high volume of soil.

Application Timing

In rain grown crops application of K should be complete at crop establishment. There are prospects of sidedressing response in the 1 – 4 leaf stages in irrigated crops provided it is followed closely by an irrigation.

SULPHUR

Sulphur in the plant is linked to N in a number of biochemical functions. It is an integral part of amino acids, helps develop enzymes and vitamins and is necessary in chlorophyll formation (though it isn't one of the constituents).

Sulphur deficiency in corn is not common in corn growing areas but has been recorded in a range of shallower upland soils without a gypsum (calcium sulfate) layer in the subsoil. In deeper soils following periods of flooding, leaching of S increases the probability of low S availability. The practice of double cropping also increased the chance of S deficiency in above circumstances.

In the initial stages of S deficiency symptoms are often confused with those caused by N deficiency.

Close observation of S deficient plants reveals:

- Commonly occurs as patches in paddock rather than evenly across and area;
- Older leaves are greener than the younger ones; and
- Plants with severe S deficiency. The upper leaves are yellow to white colouration sometimes with pink colouration toward the proximal end.

S deficiency in corn. Source: IPNI crop nutrient deficiency image collection.

SULPHUR FERTILISER STRATEGIES

Nutrient Source
Sulphur is frequently associated with other major nutrients such as N, P, K and Ca in fertiliser products in the plant-available sulphate form. Elemental S with a micro-fine particle size can be a useful source of maintenance S but should not be relied upon to correct responsive soils in the short term.

Application Rate
Products containing sulphate-S should be applied at removal rates (1.3kg S/t). Capital rates of S using gypsum ($CaSO^4$) are frequently at rates 300 – 1000kg/ha (45 -150kg S/ha) being based on attaining even application and cost effectiveness.

Application Method
Sulphate is mobile in soil water thereby providing a wide range of application options. Options are generally limited by the other major nutrient in the fertiliser compound. Water running in irrigated crops is not recommended.

Application Timing
Sulphur requirement in the plant is parallel to N so the range of application timing options are the same as for N.

ZINC

Zinc aids biochemical processes in plant growth hormones and enzyme systems, is necessary for chlorophyll production, carbohydrate formation and starch formation.

Although required in relatively very small amounts, Zn is essential during the development of the young corn plant. Soil tests give some indications as to soil Zn status but requirement is best determine from visual symptoms, test strips and/or leaf analysis. Similar to P, Zn uptake is affected by a range of soil and climatic factors. The effect of fallow length and the crop sequence on VAM being very important. Long clean fallows and corn following canola greatly increase the risk of Zn deficiency. Other factors that increase chances of Zn deficiency include cool soil temperature at planting, alkaline soils and high soil availability of P. Effective early Zn nutrition can require multiple application strategies in a single crop in some soils and seasons.

Symptoms of zinc deficiency include:

- Stunting due to reduction in internode length; and
- White to yellow bands either side of the mid-rib near the base of youngest leaves.

Zinc deficiency in corn. Source: IPNI Crop Nutrient Deficiency Image Collection.

ZINC FERTILISER STRATEGIES

Nutrient Source
Zinc availability from soil applied fertilisers is generally related to water solubility. High water solubility (sulphates and chelates) ensures availability to plant roots early in the season when they are most vulnerable to poor soil supply.

Low solubility products such as oxides with small particle size can be effective in some applications.

Application Rate
Zinc is generally applied at rates 5 to 20 times that of removal. Lower rates are generally associated with foliar applications while higher rates are related to soil application. Many soils show the build-up of Zn that results from regular use of Zn fertiliser at rate greater than removal.

Application Method
There are a wide range of effective application methods for Zn. They include:

- Broadcast and incorporate capital rates (5 – 10kg Zn/ha);
- Water inject into seed furrow (100 - 800g Zn/ha);
- Seed coating (0.5 - 1.5g/kg seed);
- Banded in blended, coated and compounded starter P products (0.2 – 2kg Zn/ha); and
- Foliar spray (50 - 400g Zn/ha).

Application Timing
Zinc is generally applied when the crop is small. This is to ensure adequacy as the crop reaches the critical cob formation around the 6 leaf stage. Correction of deficiencies up to tasselling generally improves yield but yield increase may not match that available from earlier applications (V2 – V4).

COMMENT: EFFECTIVE USE OF RECYCLED BIO-SOLIDS

In many corn growing areas there is increasing use of recycled bio-solids as nutrient sources. Although these products are generally highly variable in nutrient analysis they can be very economical and effective. Availability of nutrients is related to the amount incorporation in organic forms and the degree of composting. Of the major nutrients the availability of P and K is generally give as 70 – 90% of regular products whereas N and S is in the order of 20 – 40% in the year of application. Higher N availability is associated with fresh poultry manure and effluent sludges provided they are incorporated soon after application.

Although P and K availability from bio-solids is high, access by crop to broadcast requires incorporation into the soil making it more popular in irrigated crops.

The application rate of these products should always be with consideration of the total P applied as it is the nutrient with to lowest removal rate with environmental pollution risk where it accumulates in soil.

REFERENCES

Bryson GM, Mills HA, Sasserville DN, Benton Jones Jr. J and Barker AV. 2014. Plant Analysis Handbook III. Micro-Macro Publishing. Athens Georgia, USA.

Colless JM, 1992. Corn growing, Agfact P3.3.3, second edition. NSW Department of Agriculture, Orange.

IPNI Crop Nutrient Deficiency Image Collection 2012 available at http://www.ipni.net/article/IPNI-3231.

Reuter DJ and Robinson JB. 1997. Plant Tissue – an interpretation manual. CSIRO Publishing.

Steele KW, Cooper, DM and Dyson CB. 1982. Estimating nitrogen fertiliser requirements in corn grain production. 2. Estimates based on ear leaf and grain nitrogen concentration. NZ Journal of Agricultural Research, 25, 207-210.

Wortmann CS, Tarkalson DD Shapiro CA, Dobermann AR, Ferguson RB, Hergert GW, and Walters D. 2011. High Yield Corn Production Can Result in High Nitrogen Use Efficiency. Better Crops, Vol. 95, No. 4, p 15.

Zull A, Bell M, Howard H, Gentry J, Klepper K, Dowling C. 2015. A calculator to assess the economics of deep placement P over time. See more at: https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/A-calculator-to-assess-the-economics-of-deep-placement-P-over-time#sthash.jsLO3KMc.dpuf

NOTES

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