Good cotton crops start with potassium

Bede O'Mara - Technical Agronomist Summer Crop Incitec Pivot Fertilisers

Potassium (K) deficiency caused some issues in cotton crops last season, even limiting yields in some cases. While potassium is considered the poor cousin to nitrogen, it can certainly be a showstopper if availability is restricted.

Cotton is particularly sensitive, but other summer crops like corn or maize can also have a large potassium requirement. To avoid issues in the coming season, it is timely to consider the role of potassium in productive cotton crops and develop appropriate fertiliser strategies.

Potassium assists most growth functions including photosynthesis, protein and carbon synthesis, and in particular, water regulation in plant cells and fruit formation. Adequate potassium also helps to improve and maintain crop yield and quality while improving cold tolerance and disease resistance.

Mature and older leaves are generally the first to show symptoms in classic deficiency situations in cotton. But the onset of potassium deficiency late in the season generally occurs higher in the canopy, with symptoms showing at the younger leaves. The third or fourth leaf from the terminal yellows, then reddens, and the top of the plant drops all its leaves. This is commonly referred to as premature senescence.

Potassium deficiency in cotton crops can be caused by low soil K levels or root restrictions limiting plant uptake. Any restriction to root growth (such as waterlogging, compaction or low soil phosphorus levels) will interfere with potassium uptake.

Cotton has a peak daily requirement of up to 4 kg/ha of potassium, according to the Cotton Research and Development Corporation's NUTRIpak 2018. However, USA data suggests potassium uptake can range from 2.2 and 5 kg/ha of potassium per day at the start of the peak period a few weeks after the start of flowering.[1]

If the crop can't access enough potassium, the penalties include lighter boll weights; and reduced fibre quality, length and strength. This is due to potassium's role in cell water regulation and cell turgor. Fibre maturity may also be affected.

Cotton growers have good reason to monitor soil potassium regularly and ensure potassium replacement in their fertiliser programs. Once soil potassium levels have run down in a cropping system, high rates must be applied regularly for the land to remain productive.

It is much better to monitor removal and maintain soil fertility with maintenance potassium rates than to have to rebuild soil potassium once you're over the cliff.

Know soil potassium levels

Some soils have inherently low background potassium levels, based on their parent material. For example, parts of the Emerald irrigation area, north west slopes of NSW, the grey box soils of the Darling Downs and some basalt clays in southern Queensland.

The availability of potassium in cotton soils can be accurately measured using the ammonium-acetate exchangeable K soil test from the Nutrient Advantage® laboratory. This test is well calibrated for cotton with established response curves. Soil test values are expressed in cmol/kg for the laboratory extraction value, or in mg/kg for the calculated total available potassium. The interpretation charts and threshold values can use either unit of measurement.

For dryland summer crops and cotton, the 0-10 cm depth and the 10-30 cm layer have well established soil test critical values.[2] For irrigated summer crops and cotton, the 0-30 cm depth is the appropriate testing depth and the critical values are reliable through Nutrient Advantage® and other industry decision support tools like NutriLOGIC.

When soil testing for potassium in cotton, also consider stratification in the soil. Stratification problems can only be revealed when deeper soil layers are sampled and tested for potassium.

While there are no established critical values for potassium at the 30-60 cm and 60-90 cm depths, the data can be used to understand the relative concentrations of potassium in the different layers and better understand other hinderances to K uptake like sodicity or salinity.

Consider plant uptake challenges

Potassium is an immobile nutrient and is mainly taken up through the diffusion pathway, where the movement of the nutrient occurs as a result of concentration gradients in the soil solution. Once plant uptake lowers the concentration of the nutrient in the soil solution around the root surface, the nutrient will move in from an area of higher concentration. If there are restrictions to root growth, this system stops working. This is how any cotton crop can suffer from potassium deficiency, even where there are adequate levels of potassium in the soil.

Consider a flood irrigation scenario, where sudden waterlogging can limit aeration of the soil for several days, and root activity recovering slowly in the days following irrigation. The crop's roots will only have a limited period of time to acquire high rates of nutrient before the next flood irrigation. If those few days are cool, rainy or cloudy, the duration of active root growth is reduced further.

Even where soil K levels are adequate, it is no wonder we see intermittent premature senescence. The plant has no choice but to translocate potassium from its leaves into fruit to cater to the demand. These deficiency symptoms usually occur later in the season, when irrigation frequency and potassium demand are both high.

Plant uptake can also be affected by the balance of other nutrients in the soil. High levels of calcium, magnesium or sodium in the soil can compete with potassium and induce potassium deficiencies. Magnesic and sodic soils can also cause soil structural issues which limit vigorous root growth, leading to potassium uptake limitations. A comprehensive soil test segmented over subsoil depths can reveal whether these limitations are likely to be a problem in crop.

Potassium fertiliser strategies

Ensuring a good supply of soil potassium is the first step in providing adequate potassium to cotton crops. Cotton requires more potassium for plant growth than any other nutrient except nitrogen. It is not easily lost from cotton soils, so it can be supplied well before the season gets started in pre-plant applications. Side dress applications can be made early in the season in some situations where soil K is limited or positioned deeper in the profile. Mid to late season foliar applications are the last opportunity to supply potassium in the overall program.

Cotton Sustain® is a blend that has been specially formulated for pre-plant fertiliser applications in cotton. It contains 22.5% potassium as well as 6.1% nitrogen, 12% phosphorus and 0.55% zinc. Approximately 30 kg/ha of this product will cover the typical potassium removal of 1 bale/ha of cotton. See Table 1 for estimated nutrient removal rates in cotton at various yield

Table 1: Nutrient removeal in cotton by yield

The amount of each nutrient removed at various yield levels											
Yield b/ ha	N	P	K	S	Ca	Mg	B	Cu	Zn	Fe	Mn
	kg/ha						g/hha				
4	35	10	15	4	2	5	13	12	53	85	6
5	50	12	18	5	3	7	20	14	63	98	8
6	65	14	22	6	3	8	28	16	72	112	9
7	80	17	26	7	4	10	35	18	82	125	11
8	95	19	29	8	4	11	42	20	91	138	12
9	110	21	33	9	5	13	49	22	100	151	14
10	125	24	37	10	6	14	56	24	110	164	15
11	140	26	41	11	6	16	63	26	119	178	17
12	155	28	44	12	7	17	70	28	129	191	18
13	170	31	48	13	7	19	78	30	138	204	20
14	185	33	52	14	8	20	85	32	148	217	21
15	200	35	55	16	8	22	92	34	157	230	22
16	215	37	59	17	9	23	99	36	166	244	24
17	230	40	63	18	9	25	106	38	176	257	25
18	245	42	67	19	10	26	113	40	185	270	27
19	260	44	70	20	10	28	120	42	195	283	28

Source: Rochester, I & Constable, G, 2006. "Nutrients removed in high yielding cotton crops" Australian Cottongrower, June-July pg 26

levels. Alternatively, Muriate of Potash (50% potassium) can be applied as a straight or in blends with other fertilisers. Sulphate of Potash (41% potassium and 18.5% sulphur) has a lower salt index than Muriate of Potash and is appropriate for use on soils where high chloride levels (>300 mg/kg) are of concern, or where the fertiliser is being placed close to the seed. Another fertiliser which can be used at planting is CK1. This contains 14.7% phosphorus, 14.5% potassium, 0.7% sulphur and 10.7% calcium. Incitec Pivot Fertilisers' custom blending service is also available for tailored solutions taking into account the nutrients required, product suitability and compatibility, environmental considerations and suitable application rates.

Cotton Sustain and Muriate of Potash should never be placed in direct contact with the seed at planting, or too close to intended plant lines during pre-plant applications. When considering placement, remember that potassium is effectively immobile and remains where it is placed. Also consider that a tap-rooted crop like cotton can have a rooting depth of a metre. Broadcasting and incorporating potassium fertiliser through the soil prior to planting is advisable rather than only applying it in highly concentrated bands, because crops like cotton tend to rapidly grow past bands.[3]

Care should be taken when calibrating spreaders and optimising swath width, as the bulk density of the ingredients of fertiliser blends can limit product throw. Repeated applications of sub-optimal K rates on the margins of swaths can result in management-imposed crop deficiencies which are difficult to remediate.

As Bell et al (2016) identify, crop uptake and acquisition of K can be low, so it is important to understand when nutrient application rates need to satisfy both intended crop removal and capital improvement of the overall nutritional status.[4]

In marginal situations, or where potassium uptake problems are likely, foliar applied potassium may also be needed from the start of flowering through to the peak flowering period. Start petiole testing early, especially if soil constraints are known or potassium deficiency has been seen in previous years.

Low rates of nutrients applied in foliar K applications will be unable to replace the entire peak requirements from root uptake, but may be of assistance where soil problems occur, or in times of peak crop uptake demand. Declining absorption rates as the crop ages due to leaf age and epicuticular wax levels must be considered when embarking on a foliar program, so earlier in the crop's life is generally better.

To discuss potassium requirements in more detail or for any other queries, please contact me at bede.omara@incitecpivot.com.au or 0417 896 377.

References

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