# Good cotton crops start with potassium

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POTASSIUM deficiency has caused some issues in cotton crops over the past few seasons, even limiting yields in some cases. Cotton's requirement for potassium is second only to nitrogen, so 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. Importantly, it regulates water 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 potassium 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. But USA data suggests potassium uptake can range from 2.2 to 5 kg/ha of potassium per day at the start of the peak period a few weeks after the start of flowering. If the crop can't access enough potassium, the penalties may include lighter boll weights; and reduced fibre quality, maturity, length and strength. This is due to potassium's role in cell water regulation and cell turgor.

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 paddocks to remain productive. It is much better to monitor removal and maintain soil fertility with modest maintenance potassium rates than to have to rebuild soil potassium once you're over the cliff when high capital rates are required.

## 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. 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 potassium 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 temporary waterlogging limits aeration of the soil for several days. This also limits root activity in the days following irrigation. During peak potassium uptake periods, the crop's roots only have a limited period to acquire potassium before the next flood irrigation and waterlogging event. If those few days are cool, rainy or cloudy, the duration of active root growth is reduced even further. Even where soil potassium levels are adequate, the plant may not have enough time to meet its potassium demand. The result is intermittent premature senescence. The plant will translocate potassium from its leaves into the fruit to cater for peak demand. These deficiency symptoms usually occur later in the season, when both high irrigation frequency and high potassium demand coincide.

**Potassium fertilisers can be supplied well before the season gets started.**

**TABLE 1: Nutrient removal 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/ha | | | | |
| 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 and Constable, G, 2006. "Nutrients removed in high yielding cotton crops" *Australian Cottongrower*, June-July pg 26.

Plant uptake can also be affected by the balance of other nutrients in the soil. Other cations (calcium, magnesium or sodium) present at high levels 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 further 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 in advance of planting using pre-plant applications. Side dress applications can be made early in the season in some situations where soil potassium 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 per cent potassium as well as 6.1 per cent nitrogen, 12 per cent phosphorus and 0.55 per cent 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 levels.

Alternatively, Muriate of Potash (50 per cent potassium) can be applied as a straight or in blends with other fertilisers. Sulphate of Potash (41 per cent potassium and 18.5 per cent sulphur) has a lower salt index than Muriate of Potash and also no chloride. It 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 per cent phosphorus, 14.5 per cent potassium, 0.7 per cent sulphur and 10.7 per cent 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 straights or blends containing 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. 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.

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 potassium rates on the margins of swaths can result in management-imposed crop deficiencies which are difficult to diagnose and remediate.

As Bell et al (2016) identify, crop uptake and acquisition of potassium 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.

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 potassium 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 bede.omara@incitecpivot.com.au or 0417 896 377.**