

PREMATURE SENESCENCE OF COTTON:

CURRENT DEVELOPMENTS

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INTRODUCTION

A widespread problem of premature defoliation and physiological cut out of cotton has occurred in the Emerald Irrigation Area since the early 1980s. The problem was particularly severe in 1988 and 1989. This premature senescence has consistently been associated with a discolouration of the upper leaves towards plant maturity, and also with the leaf spot fungus *Alternaria macrospora*. Premature senescence can occur and lead to leaf loss even in the absence of leaf spot infection, although defoliation is neither as swift or complete. To enable comparison between visual estimates in the field, a standard scale of the symptom severity has been adopted (table 1). This is usually assessed at a time just prior to the first boll splitting.

Table 1 Symptoms of premature senescence and *Alternaria* leaf spot on cotton.

Index	Foliar Discolouration	<i>Alternaria</i> leaf spot	Defoliation
1	No symptoms	No symptoms	No defoliation
2	Yellowing between veins of upper leaves	Few tan-brown spots in upper canopy, each <5mm	Slight defoliation
3	Upper leaves reddened	Many spots in upper canopy, some larger than 5mm	Up to 25% defoliation
4	Middle canopy red, some upper leaves bronze	Spots spread to middle canopy, some sooty with visible spores	Up to 50% defoliation
5	Bronze leaves in middle canopy, some upper leaves lost	Most spots sooty, some leaves necrotic and defoliated	Up to 75% defoliation
6	Most of middle canopy bronze, all upper leaves lost	Most leaves necrotic, extensive defoliation	Near complete defoliation

Historically, the Southern cotton growing areas do not seem to have had the same frequency of appearance or severity of premature senescence. This season however, saw an increase in the Darling Downs region at Dalby and Pittsworth. New South Wales also recorded its first significant occurrence since the 1987-88 season, with some incidence in all areas (S.Allen pers.com.).

CAUSES OF PREMATURE SENESCENCE

A survey of the Emerald region estimated that between twenty and thirty percent of the cotton fields had soil potassium levels lower than the accepted minimum 150ppm for healthy growth (Kirby and Adams 1985), with some soils as low as 60ppm. Tissue analysis of cotton in these areas usually gave results of less than 2% potassium in petioles, and less than 1% in leaf blades, for plants at early flowering. Information from a field trial over the 1990-92 seasons determined that soil addition of potassium to areas prone to premature senescence increased fibre yields of DP90 up to 30%, from 6.6 bales/Ha to 8.7 bales/Ha (see fig.1). Senescence symptoms and leaf spot infection were reduced (fig.2) and grade measurements were increased by potassium addition.

It may be inferred from this, that low levels of available potassium are conducive to premature senescence. Non-senescent plants of "upland cotton" cultivars are not highly susceptible to leaf spot, and low potassium predisposes them to fungal infection.

Application of a systemic fungicide to control *Alternaria* in both senescent and non senescent cotton crops has not yet led to yield improvement. From this it appears that the fungus itself is not a major cause of yield loss, as perhaps fungal attack of senescent plants occurs at a point when low potassium already

Fig.1 The effect of potassium addition on yield of DP90 cotton for "scrub" soil (TbUg-2), Emerald 1990-1991.

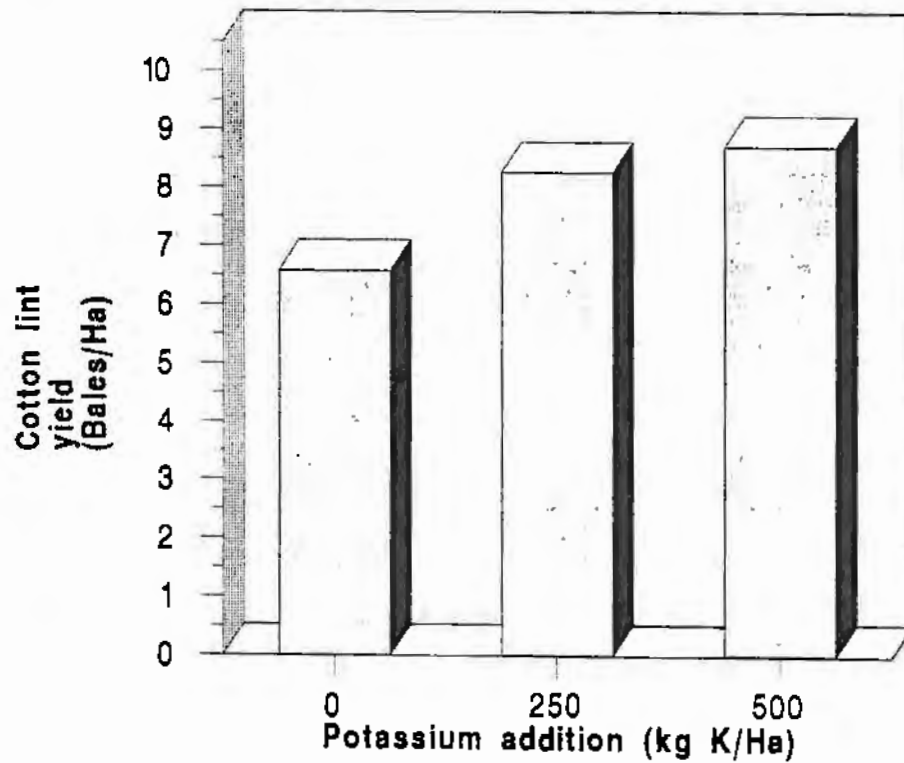
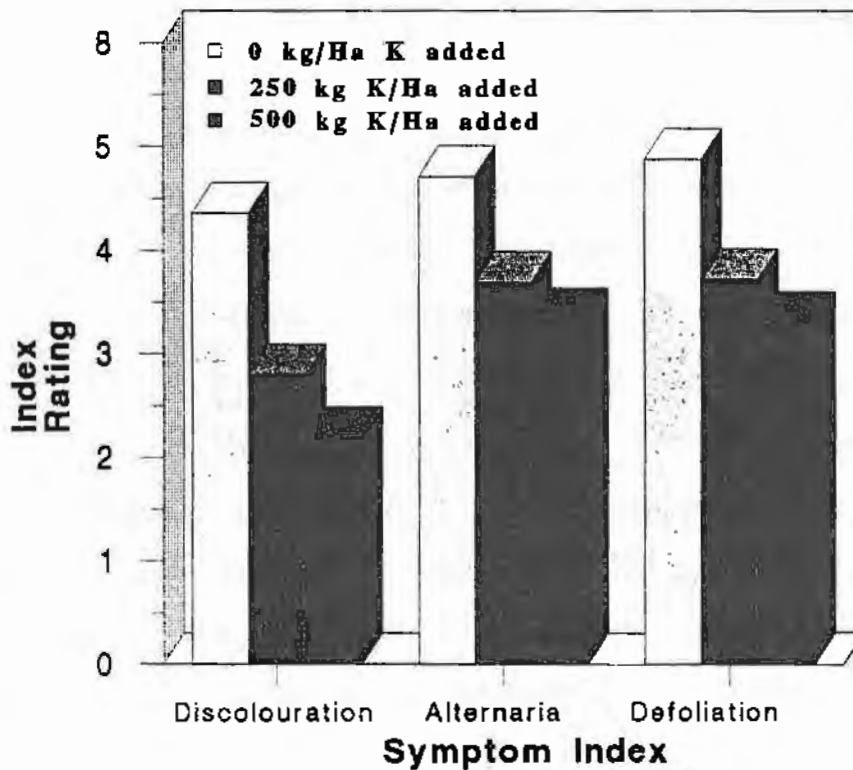


Fig.2 The effect of potassium addition on symptoms of premature senescence for DP90 cotton on "scrub" soil (TbUg-2), Emerald 1990-1991.



inhibits fibre development. It also suggests, (fig.2) that increased potassium availability, in enabling plant defences to function efficiently, is a much more effective leaf spot control than fungicide applications in the trial.

A FEW COMPLICATIONS

While the condition of absolute soil potassium deficiency accounts for many occurrences of premature senescence in Central Queensland and areas around Dalby, some soils on which the problem is noted are quite high in exchangeable K (eg. up to 400ppm near Narrabri, Greg Constable pers.com.). The plant tissue levels of potassium in these plants are often low and the plants suffer deficiency symptoms. An explanation for this may involve the rate of availability and uptake. Cotton is a comparatively poor forager for soil potassium, yet it has a very high requirement for this nutrient, with uptake of up to 4 kg per day in the period between first flowering and peak bloom. This builds a reserve for fruiting, as much of the potassium used during boll growth and fibre development is not taken up by roots at that time but transferred from leaves and stems.

Rate of potassium availability may not be well predicted by a soil test alone, even those which take into account soil "fixing" of potassium and the balance of other ions in the soil. Nutrients used by the crop also rely on the plant's ability to take them up. This depends on both the condition of the plant and the size or surface area of the root system. Cotton root metabolism and therefore potassium uptake can be inhibited by low temperature, poor aeration (waterlogging and compaction), low available water, high salinity or reduced root carbohydrate. The size of the root system is influenced not only by these factors, but also by soil compaction, low individual plant size, and root diseases such as *Rhizoctonia* and *Black Root Rot* during earlier growth stages.

To complicate tissue analysis as an estimator of plant uptake and health, plants with apparently adequate levels of potassium during early growth may still senesce. If a large number of fruit are set relative to the size of the plant and hence its total nutrient reserve, plants can become potassium deficient. This can lead to competition between plant parts and by such time that deficiency symptoms are visible in leaves, some yield potential is already lost by the bolls.

All of these factors have been observed to influence the incidence and severity of premature senescence.

MANAGEMENT STRATEGIES

As soil levels of potassium may not always be the major cause of premature senescence, pre-season fertiliser application may not prove helpful, although thorough soil testing is recommended. Foliar potassium nitrate holds some promise but is complicated by the logistics of dissolving and applying the large volumes and number of treatments required. Research into foliar and water run fertiliser is continuing.

In managing affected areas waterlogging and compaction should be avoided. Water and fertiliser strategy must aim to ensure vigorous root development prior to flowering. Some thought must also go into the choice of variety planted. The varieties with longer fruiting periods are less likely to develop premature senescence due to lower rates of nutrient demand (even if the total uptake requirement is similar).

THE FUTURE

For the early diagnosis of premature senescence, accurate interpretation of

tissue potassium remains a problem and requires much additional information on the influences of plant size and expected fruit load.

In the United States, potassium addition has also been used to improve yields of cotton affected by *Verticillium*, and coincidence or not, the cultivars bred for verticillium tolerance appear also to be less susceptible to senescence. Whether this is due to fruiting pattern, improved ability to uptake potassium, or a lower tissue requirement is yet to be examined.

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REFERENCES

- Harden, G. and Kochman, J.K. 1990. Premature senescence of cotton. **Proceedings of the Fifth Australian Cotton Conference**, Broadbeach, Queensland.
- Kerby, T.A. and Adams, F. 1985. Potassium nutrition in cotton. **Am. Soc. Agronomy** in "Potassium in Agriculture" pp. 843-860
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