Premature Senescence on High Potassium Soils

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Summary

If you have more than 150 ppm of available potassium in the top 15 or 30 cm of soil do not apply potassium fertilizer prior to sowing.

Introduction

Symptoms of premature senescence initially appear on the upper leaves (normally the third and fourth leaf from the top) with these leaves turning yellow and then rapidly red or bronze. These symptoms may spread further down the canopy with time and eventually cause defoliation. In the last decade we have seen an increasing incidence of this problem particularly in the Emerald area but also elsewhere. This problem is complex but the underlying cause is associated with potassium nutrition.

For the Emerald region the levels of potassium in the soil can be low enough (less than 150 ppm, or 0.38 meq by ammonium acetate extraction) that straight potassium deficiency is occurring. Grower's should apply potassium prior to sowing under these conditions. Rates will depend on the severity of the deficiency. However, a rough guide is that it requires 40 to 45 kg of potassium per ha to replace the amount of potassium removed by a 7.5 bale per ha crop, suggesting that rates should be at least this high. Graham Harden has more details and recommendations for areas with low potassium status in his article in this booklet.

Premature senescence, however, is also occurring on soils with high levels of potassium. This is often the case in areas other than Emerald. In these areas something more complex than potassium deficiency is taking place as premature senescence occurs in these areas only under certain conditions. These conditions are typically a crop with a high yield potential but small plant size experiencing a stress (cool weather, waterlogging, water stress etc) at a time when the boll load is reaching a peak (eg. January and early February).

Leaf reddening does not automatically mean that the crop is suffering from premature senescence, as leaves turn this colour for many reasons. Both mites and certain members of the organophosphate pesticide group (eg. Curacron) can cause leaf reddening. Further, the syndrome's name is *premature* senescence, leaves turning red in late March probably reflect natural senescence not a potassium problem.

In this article I will chiefly focus on the this problem on soils with adequate levels of soil potassium. First by briefly describing the factors that may cause a crop to develop premature senescence under these conditions and second by summarising some preliminary research on methods of predicting and preventing this problem.

Factors affecting a crops susceptibility

1) Boll load:

Growing a crop with low yield potential is a very effective control measure for premature senescence (but not a very sane one). If you pull up some plants with leaf reddening in an affected field and compare them with plants with no symptoms you will find that the red plants have a higher number of bolls. Boll maturation requires large amounts of potassium and other nutrients, particularly nitrogen. Plants with few bolls can supply this requirement by taking up potassium from the soil. However, plants with a high number of bolls require much more potassium; when they can not get this from the soil they remove potassium from leaves and transfer this to bolls. Unfortunately this causes the leaves to turn red and eventually fall of before they should have. This in turn reduces yield as now the plant has lost some of its food factories and is less able to supply the maturing bolls with energy. In one sense then a crop with premature senescence is a compliment to the grower indicating that the management of the crop has been good enough to ensure a high yield potential. However, the majority of crops with high boll loads do not turn red other events must occur to induce premature senescence.

2) Stress:

For premature senescence to occur something must disrupt the crop's ability to take up potassium from the soil. Waterlogging combined with low temperatures are perhaps the most likely events to push a crop into premature senescence. Roots under these conditions can only supply a small amount of potassium which forces those crops with a high demand (high boll load) to remove potassium from other plant parts. Other stresses that probably influence premature senescence are soil compaction, salinity and poor nitrogen nutrition.

3) Variety:

Some varieties do appear to be more susceptible than others. In California the widely commercially grown variety Acala SJ2 is susceptible while the closely related variety Acala GC510 is not (Cassman *et al.* 1989). In Australia the differences between varieties seem to depend on whether they are long or short season varieties, with the short season varieties being more susceptible. This is because they have a higher daily requirement for potassium during peak boll filling. Amongst the long season varieties Sicala V-1 (and V-2) has a reputation for been the least likely variety to develop premature senescence.

Preliminary results

Experiments run both at Myall Vale (Fig. 1) and at a site near Pilliga (Fig. 2) showed no significant response in lint yields to soil applied potassium even at the very high rates used (200 kg K ha^{-1}). This was despite the fact that visible symptoms were present and differences in the concentration of potassium in petiole sap (Fig 3&4) were evident particularly at the Pilliga site. The Pilliga site had lower levels of potassium near the soil surface. However both sites had available potassium levels well above the critical value (Fig. 5). No differences in fibre quality were apparent at the Myall vale site. However, at the Pilliga site when averaged across varieties the addition of potassium increased fibre maturity with the percentage of mature fibres being increased from 82 to 85%. Fineness increased from 156 to 162 millitex and micronaire from 3.9 to 4.1 micrograms per inch. These effects on fibre quality while desirable would not have returned any more dollars as fibre quality was acceptable in the crops with no added potassium. In these experiments detailed measurements of the level of potassium (and other elements) in various plant parts were made at regular intervals in the season. These measurements, combined with data from the coming two seasons, will allow us to develop methods for predicting when a crop is likely to suffer from premature senescence. We will also be running experiments on the best methods available for correcting the problem.

The preliminary results discussed above agree with results from grower and consultant trials with very few of these showing a response to soil applied potassium. This suggests that if you have a field that in the past has suffered from premature senescence but the soil levels of potassium are greater than 150 ppm in the first 15 (or 30) cm then a response to soil applied preplant potassium is unlikely. Avoiding premature senescence under these conditions requires another approach. The most effective strategy will be to try and eliminate as many factors as possible that are likely to contribute to the crop suffering from premature senescence. Do all that is possible to prevent soil compaction, ensure good nitrogen nutrition, if appropriate to your region grow a long season variety and ensure good irrigation management.

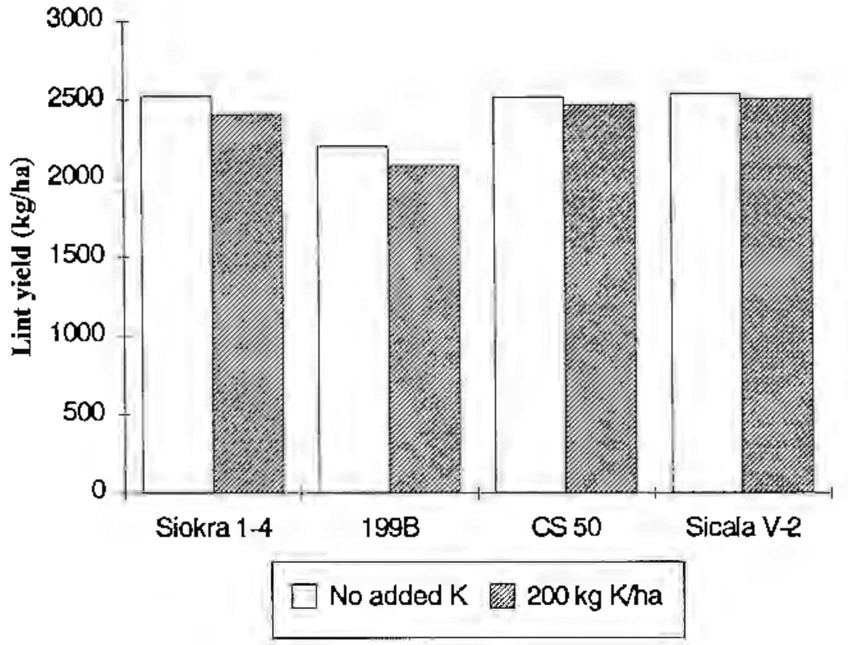

Figure 1. Lint yield at the Myall vale site for different varieties with or without added potassium.

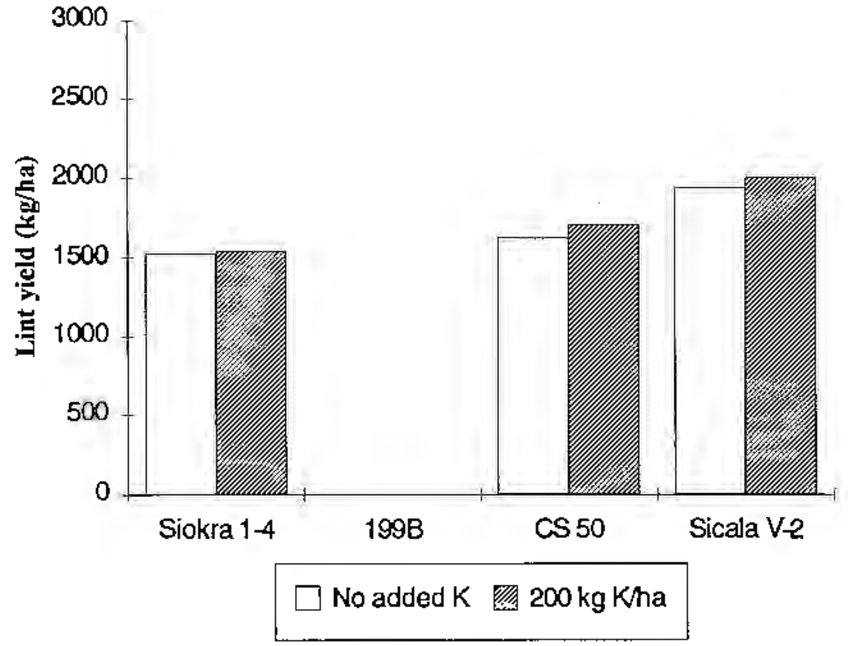

Figure 2. Lint yield at the Pilliga site for different varieties with or without added potassium. The variety 199B was not grown at this site.

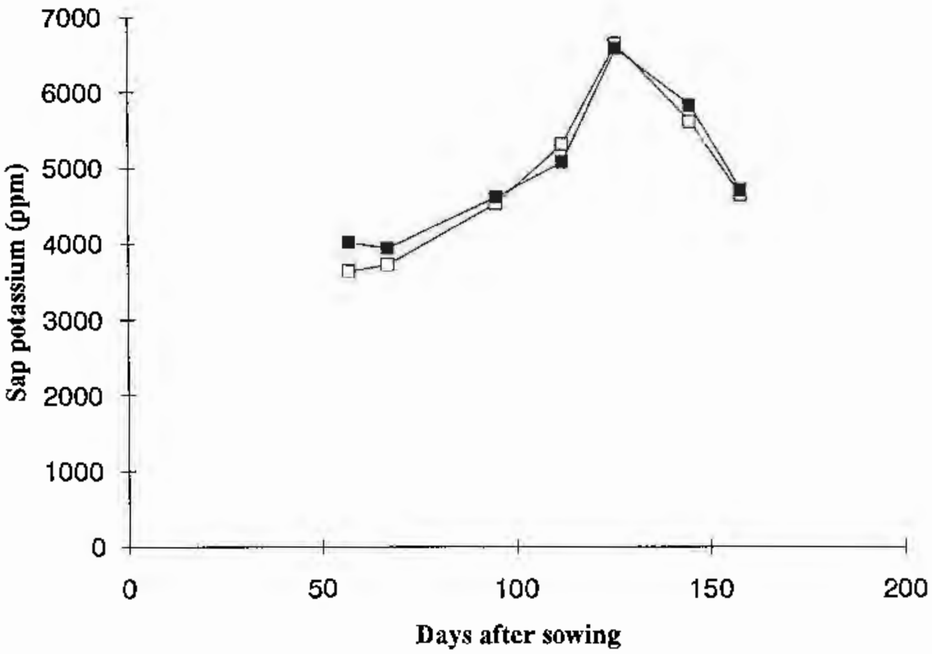

Figure 3. Change in potassium concentration of petiole sap with time at the Myall Vale site, for plants grown with no added potassium (□) or grown with the addition of 200 Kg K/ha (■).

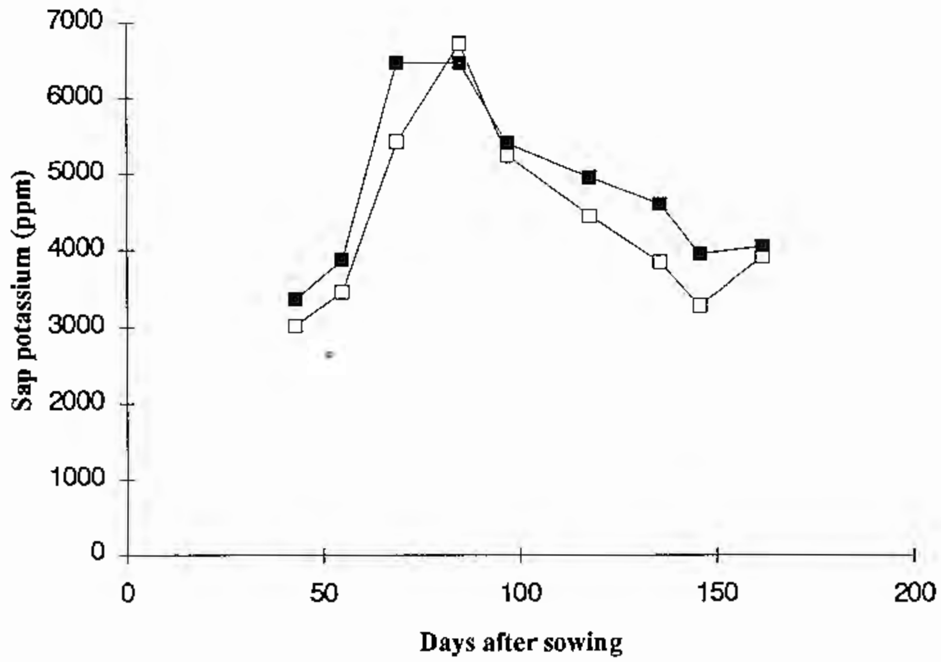

Figure 4. Change in concentration of potassium in petiole sap with time at the Pilliga site, for plants grown with no added potassium (□) or grown with the addition of 200 Kg K/ha (■).

During a season it may be possible to get a response to foliar or water run applications. Little is know about the effectiveness of these treatments under Australian conditions and research is continuing in this area. The difficulty with foliar applications is that only a small amount can be applied at each application (approximately 5 kg K/ha, as KNO_3); as higher rates cause leaf burn (Oosterhuis 1991). Peak demand for potassium during the season can be as high 4 kg ha^{-1} day^{-1}. Hence, one foliar application will only provide 1 to 3 days supply. Given this it will require several applications to improve the potassium status of the crop. Under American conditions the recommendation is for 3 to 4 applications to be applied every 10 days, starting 10 days after first flower. Given the logistics of foliar applications (and the cost) water run potassium fertilizer becomes an attractive proposition. However, a caution is required as theoretically this technique for potassium is supposed to be very inefficient. Before we can provide firm recommendations on the use of either of these alternatives we need to carry out further work.

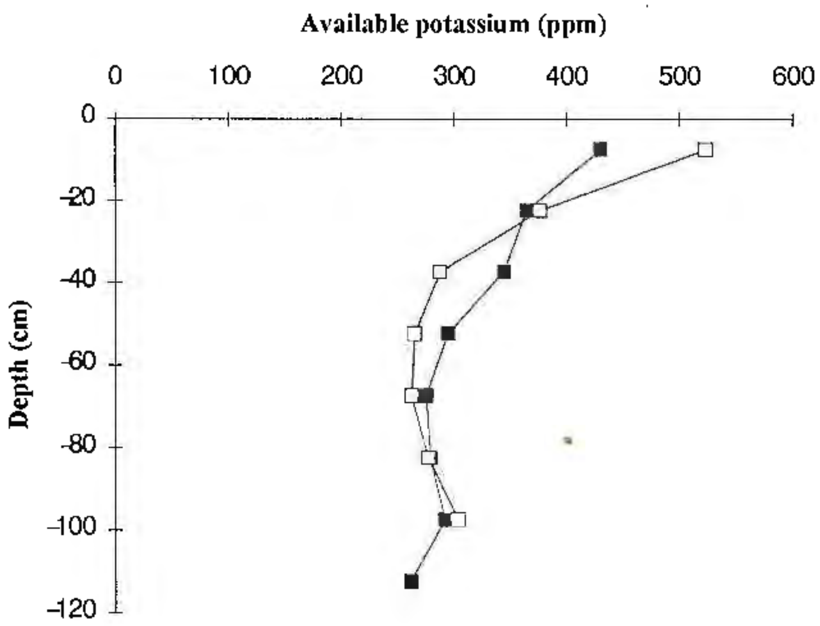

Figure 5. Available potassium with depth for sites at Myall vale (□) and Pilliga (■).

Conclusion

1) If your soil has less than 150 ppm (0.38 meq) of available potassium in the first 15 or 30 cm then you should treat this situation as true potassium deficiency by applying potassium fertilizer prior to sowing.

2) If your soil has more than 150 ppm of available potassium and you have had premature senescence symptoms in the past then you should **not** apply potassium prior to sowing. Try and reduce your risk by

a) Preventing soil compaction
b) Ensuring good nitrogen status
c) Growing a long season variety (**If** appropriate for your region)

For Australian conditions we do not yet have recommendations for the use of foliar or water run potassium. In the interim if you have strong reasons to believe that the crop will suffer from premature senescence then based on the American recommendations at least 2 and preferable 3 or 4 foliar applications of potassium nitrate should be applied every 10 days starting 10 days after first flower.

Acknowledgments

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