

Recovery From Hail Damage - Good Luck or Good Management?

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Australian cotton production areas are prone to significant damage by hail storms. Following a hail strike, a grower is left with trying to make the most out of what remains of his crop. There are few guidelines or criteria available to assist growers in making management decisions in regard to their hail damaged crop. A three year project looking at the management of hail damaged cotton crops, instigated and funded by the Cotton Research and Development Corporation, was begun in the 1993/94 season with the aim of developing some guidelines for managing hail damaged cotton crops.

From a series of field trials and case studies on hail damaged crops, it has become obvious that in managing a hail damaged crop, OBJECTIVE THINKING must be the rule! Keeping several facts in mind, hail damage results in yield loss and the period over which a yield potential can be replaced is reduced compared to a full growing season and management decisions are restricted by an individual grower's financial situation.

Management options differ with the stage of growth and the time of the season at which the hail strike occurred. But generally relate to three periods of crop development in which the hail strike may have occurred, ie. The planting period; Last Replant Date to Last Square Date or thirdly, Last Square Date to Harvest.

Hail Damage During The Planting Period

During the crop planting period through to the last date for replant, decisions revolve around whether to replant or not. Hail damage in these early stages causes a reduction in plant stand and plant vigour. Immediately following a hail strike a grower needs to determine whether a commercially viable stand remains, an assessment of uniformly distributed healthy plants remaining will determine if the stand is still within the commercially acceptable range eg. 6 - 14 plants per metre.

A grower would normally replant if the plant stand is lower than acceptable, but after hail you need to look at the calendar date and the potential yield reduction from the late replant and keep in mind what is a realistic yield potential for late planting. Looking at long term climatic data it is possible to determine the potential yield reduction with delayed planting for the 'average season'. Constable *et al.* (1976) determined the relationship between lint yield and season length (defined in Growing Day Degrees or GDDs) and calculated the expected yield reduction with delayed planting. Using the same method and including the longer term temperature data available today we are able to determine the yield reduction with delayed planting for the Namoi valley and other cotton production areas (Figure 1). Note that this method does not take into account factors other than temperature which in practice act to reduce the available growing season eg. reduced water availability for dryland or late insect control costs in areas such as the Emerald irrigation area.

Yield reductions with delayed replanting should be weighed up against the yield reduction inherent in carrying on with the damaged stand which is already established. Vigorous regrowth is not usually seen for 10-14 days following the damage, the plant then replaces lost plant parts before continuing its development. Crop development is delayed compared to an undamaged stand. The existing stand may still have the advantage of less delayed growth than a replanted stand when delays to replanting caused by wet soil conditions and re-establishment time is taken into account.

Hail Damage When Replanting is Past being an Option?

Once the last economic replant date has passed, if a hail strike is to occur, a grower in all except the most severe damage situations needs to regrow the crop and replace lost yield potential. The ability of a crop to recover and replace lost yield in this period rapidly declines to zero by Last Square Date.

Case studies show that growers are often overly optimistic as to the yield that can be replaced in the reduced season available to them. Yes! in a percentage of cases you will get away with pushing a crop to replace the total lost yield, but on average you won't. Following hail, crop growth is delayed and once growth restarts, it needs to mature within the remaining season if the grower is to avoid all the problems associated with late crops ie. late high cost spraying, late/extra watering, difficult defoliation and low quality cotton.

If we break down the management of the crop into separate areas, insect and water management are whole farm strategies. Hail damaged cotton will be watered later into the season and often require an extra watering if it is to replace lost yield. In limited water situations, a grower will achieve a greater return by allocating water to undamaged cotton. In regard to insect management, you need to protect any fruit which develop and so many growers will reduce spray thresholds accordingly. Note, that with the crop development curve shifted to later in the season, insect sprays will be applied later in the season, and hence 'heavier' and more expensive sprays may be necessary. Hence, both water and insect management involve increased production costs following hail damage.

The aim is to get the crop regrowing and then mature it in the remaining season available, therefore nutrients and growth regulators can play an important part in managing a hail damaged crop. Trials carried on hail damaged crops during the period covered by the project have concentrated on these two areas of management.

In respect to crop nutrient status, case studies show that growers have either left the nutrient status as is and let the crop regrow, or applied small and large amounts of nitrogen and other nutrients to replace? or boost? nutrient levels in the crop. Resulting problems have included lack of regrowth due to less than optimum nutrient levels or excessive vegetative growth adding to the lateness and delayed maturity of hail damaged cotton.

Figure 1: Lint Yield Depletion with Delayed Planting of Cotton

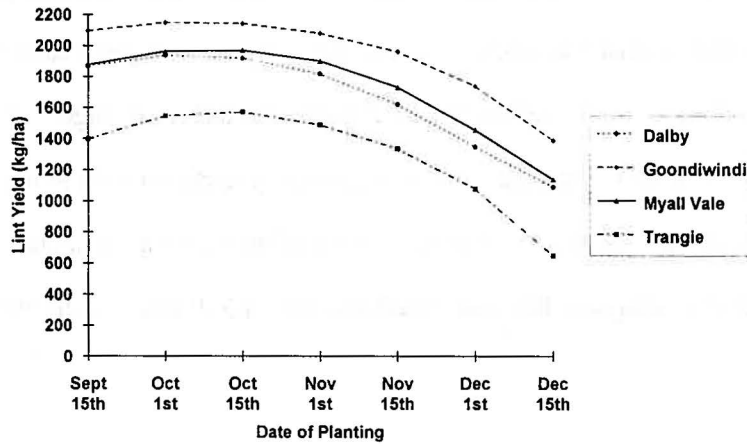


Figure 2: Decline in Petiole Nitrate in Cotton Following Hail Damage

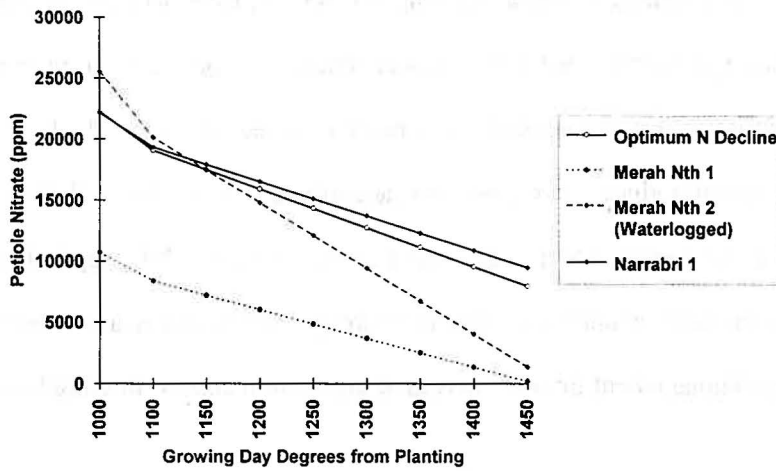
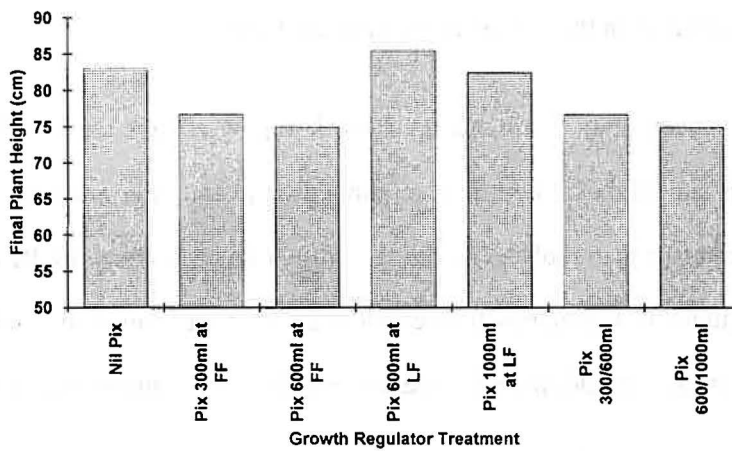


Figure 3: Control of Plant Height in Hail Damaged Cotton Using Pix (Site: Dalby 1994/95)



Constable *et al.* (1991) determined that the rate of decline of petiole nitrate during the early flowering period was the most accurate measure of nitrogen status in a cotton crop. Monitoring of petiole nitrate levels in hail damaged trials cotton showed rates of decline of petiole nitrate near optimum for the soil type (eg. Grey clays $31.8 \text{ ppm/GDD} \pm 1 \text{ ppm/GDD}$) in all cases where full crop nitrogen requirements had been applied prior to the hail damage (Figure 2). High rates of nitrate decline, indicating deficiency, were measured in one trial where prolonged waterlogging occurred following the hail. In a second trial, nitrogen was limiting prior to the hail damage and petiole testing following the hail damage revealed a deficiency of nitrogen. Nitrogen was applied to a trial area to bring nitrogen levels up to normal crop requirements, and in these areas rates of decline in petiole nitrate indicated optimum fertilisation. Application of 150% of normal crop requirements of nitrogen did not increase yields further. Hence, it can be concluded that provided normal crop nitrogen requirements have been applied to a crop prior to damage, no advantage is gained by applying nitrogen in excess to normal crop requirements.

Foliar fertiliser mixes are often applied in hope of alleviating part of that stress imposed by hail damage. In trials of foliar fertilisers carried out on Auscott Narrabri during the 1995/96 season, hail damaged cotton was found to show an initial response to applied zinc. Leaf area at three weeks after the application of foliar zinc was greater in zinc treated plots compared to nil zinc areas. The advantage had disappeared by later sampling dates and no increased yield was measured. The field showed marginal zinc levels in soil tests carried out immediately following the hail strike and adequate levels following the application of foliar zinc. It is suggested that the applied zinc alleviated the deficiency existing in the field contributing to earlier replacement of leaf area in zinc treated areas.

Growth regulator trials on hail damaged crops have shown varying responses related to how conducive climatic conditions have been to regrowth and maturity of regrowth following the hail damage, but the crop growth stage at the time of damage is a primary response determining factor. As the degree of recovery from damage declines rapidly to zero as we move from last replant date through to last square date, the timing and rates of growth regulators used needs to maximise regrowth in the limited time available. In the growth regulator trials, applications of pix as single or split applications, at high and low rates were used. The idea being to look at the crop response to 'pegging back' vegetative growth with early or split applications compared to moderate and heavy late doses which aimed to 'pull up' the crop by last flower date.

Greater overall responses to pix applications were achieved with hail strikes earlier in the period ie. early to mid flowering stage damage. Where crops were close to cut-out, both regrowth and responses to growth regulators was reduced or nil.

Where trials were carried out on crops damaged in early to mid flowering, early pix applications were able to successfully control vegetative growth when applied to act by first flower (FF) on regrowth (eg. Figure 3).

Yield responses to pix were variable. With severe damage, although not statistically significant, there is a trend for higher yields where the crop is allowed to regrow then 'pulled-up' at the end of the season by heavier doses of pix (600 or 100 ml/ha) applied at Last Square (LS) to act by Last Flower Date (LF). With moderate damage at the early to mid-flowering stage, the crop has more time to regrow following the hail strike.

Monitoring regrowth and 'pegging back' excessive vegetative growth with lower rates of early pix (eg. 300 ml/ha) or split applications (300 + 600 ml/ha) tends to produce a better response in terms of increased yield (Not statistically significant). In this situation, maturity measured as date to 60% open bolls, was also advanced by 2-3 days compared

to nil pix treatments and 5-7 days compared to trying to 'pull up' the crop with 600 or 1000 ml/ha pix at last flower date. Although further work needs to be carried out on this strategy to confirm these trends, the opportunity of maturing damaged cotton earlier has a financial advantage in terms of picking costs and lint quality discounts.

Excessive nutrient levels together with luxuriant water supplies and warm conditions following a hail strike may encourage optimistic thoughts in regard to the potential to recover from hail. But these same conditions are producing a late and expensive crop! Using nutrients and growth regulators to assist in replacing lost yield and to mature the regrowth within the available 'average' season length will act to reduce late season problems with insect infestation, defoliation, picking and lint quality problems.

Accepting that the season and yield potential is reduced and containing regrowth of the hail damaged cotton to the shortened crop development window may not produce the top yielding crop but maybe the better return on your dollar.

Late Season Damage

Once the last flower date for a particular cotton production area is reached, in the average season no further flower that are produced contribute to yield. Hail damage during this period results in direct losses with no recovery possible. Management strategies revolve around rescuing what cotton is mature. From the case studies collated to date, it can be concluded that the date of no recovery in terms of regrowth is much earlier than we have believed. Following earlier stage damage, new vegetative material does not appear for approximately 14 days after the hail damage occurs, as the crop is in a state of stress. Likewise following later stage damage, damage repair and maturation of remaining fruit does not begin again for at least 14 days following the strike. With a development time of on average of 21 days from square to flower, the zero recovery date would be better defined as Last Square Date.

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