

Compensation in cotton: Yield responses to non-uniform tip damage

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Summary

Compensation is the ability of the plant or crop to offset damage caused by pests or other factors such as hail. Compensation can act at the plant or crop levels. **Plant compensation** refers to the ability of individual plants to regrow after damage. **Crop compensation** may arise when damage is not uniform, i.e. crops compensate when insect attack on one individual allows its undamaged neighbour to grow faster. In this paper we present results of an experiment that shows that a plant next to a damaged plant yields more than it would otherwise.

Introduction

Compensation is the ability of the plant or crop to offset damage caused by pests or other factors (*e.g.* hail). We use compensation in our pest management decisions when we assume that there will be no significant yield loss for an infestation below a given threshold. A range of natural regulatory mechanisms are implicit in the threshold: a number of insects will die (*e.g.* washed away by rain, eaten by

predators) while the plant will be able to 'compensate' for the damage caused by the survivors. Sustainable cotton production requires pest management systems that enhance the role of those regulatory mechanisms. This requires, in turn, a better understanding of the mechanisms involved in the interaction between cotton crops and pests.

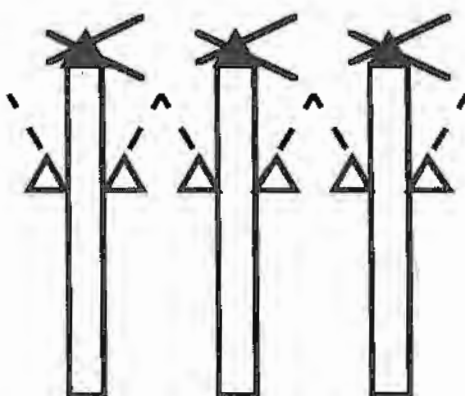
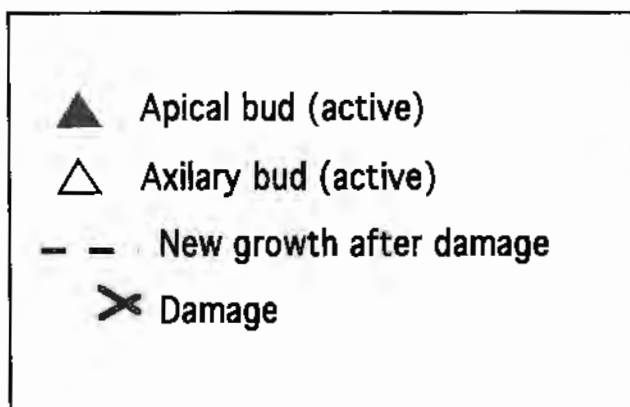
Compensation can act at the **plant** or **crop** levels (Crawley 1983). For instance, a **plant** compensates after tip-damage by producing branches that resume plants' growth (Fig. 1a). Brook and colleagues (1992) extensively investigated yield responses of cotton crops in which tip-damage was simulated by removal of terminal buds. They found that yield of **uniformly** tip-damaged crops was similar or greater than that of undamaged controls. The mechanism involved in this response is described in Fig. 1a.

When damage is not uniform a second type of compensation may occur: at the **crop** level (Fig. 1b). Consider plants in a crop competing for resources such as water, nitrogen, light and space. Competition can be thought of as a 'tension' between individual plants. If one individual is damaged, there may be a 'relaxation' in competition. We could expect, therefore, that undamaged plants growing alongside plants that suffered tip damaged may 'fill gaps' left by neighbours whose growth has been delayed by pest damage. These hypothetical crop responses have been largely neglected in cotton research in the past.

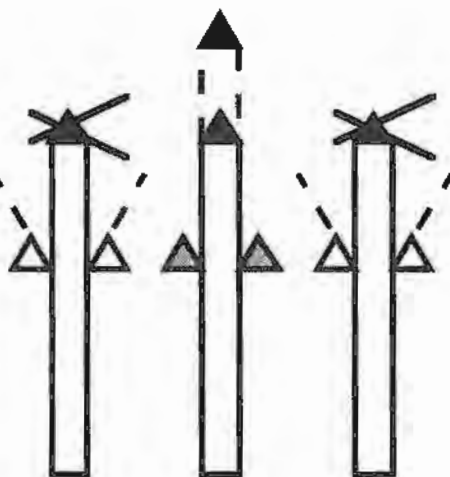
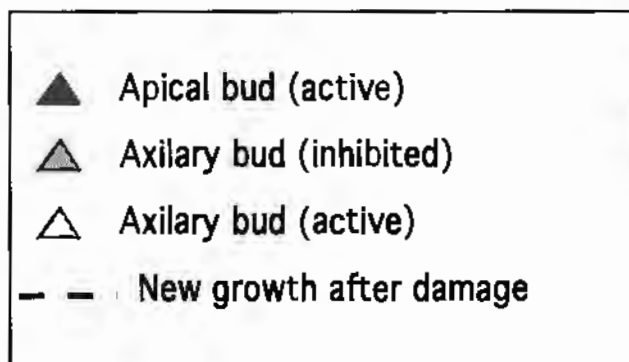
FIGURE 1. Cotton responses to tip damage

Apical buds inhibit the growth of axillary buds in intact plants. This phenomenon is known as "apical dominance". Tip-removal releases apical dominance then axillary buds become active and produce branches.

a) **Uniform damage:** all plants produce branches (compensation at plant level)



b) **Non uniform damage:** undamaged plants growing alongside damaged ones "fill" the gap (compensation at crop level)



In an attempt to understand yield responses under conditions of non uniform damage, we designed an experiment to compare the responses of non uniformly damaged cotton with both undamaged controls and uniformly damaged crops.

Methods

Crops

Crops (Sikala V-1) were sown on October 8, 1993. Water, fertilisation and defoliation were managed according to standard practices. Experimental plots comprised eight rows (20 m long) that were sprayed as necessary to minimise insect damage.

Treatments and measurements

Three treatments were established on December 23:

- A. Undamaged control
- B. Uniform damage: manual removal of mainstem growing tips of all plants.
- C. Non-uniform damage: manual removal of mainstem growing tip of every second plant. Damaged and undamaged plants in this treatment were labelled and harvested separately at maturity.

Four replicates of each treatment (A, B, and C) were established in crops sown at two sowing rates (9 or 18 kg seed/ha). One

subplot (3 rows x 2 m) for each tip treatment was established in each replicate.

Plants from 1 m of each central row were harvested at maturity, on April 18, 1994. Dry weights of stems and yield components were determined.

Results

Lint yield of control crops ranged from 6.8 bales/ha at high plant density to 9.1 bales/ha at low density (Fig. 2). Tip damage had no effect on lint yield at either plant density (Fig. 2). Maturity time was also unaffected.

The mechanisms by which damaged crops compensated were different depending on whether damage was uniform or not. Compensation at the **plant** level (Fig. 1a) was observed in **uniformly damaged crops**: they produced more branches and a similar number of open bolls than undamaged controls. The greater branching in damaged plants is demonstrated by a 35% increase in stem dry mass: undamaged controls had 23 g stem/plant compared with uniformly damaged plants that had 31 g stem/plant. The similar production of bolls is shown in Fig. 3 (compare "undamaged control" and "damaged uniform").

Figure 2. Lint yield of tip-damaged cotton crops (Auscott-Narrabri, 1993/94)

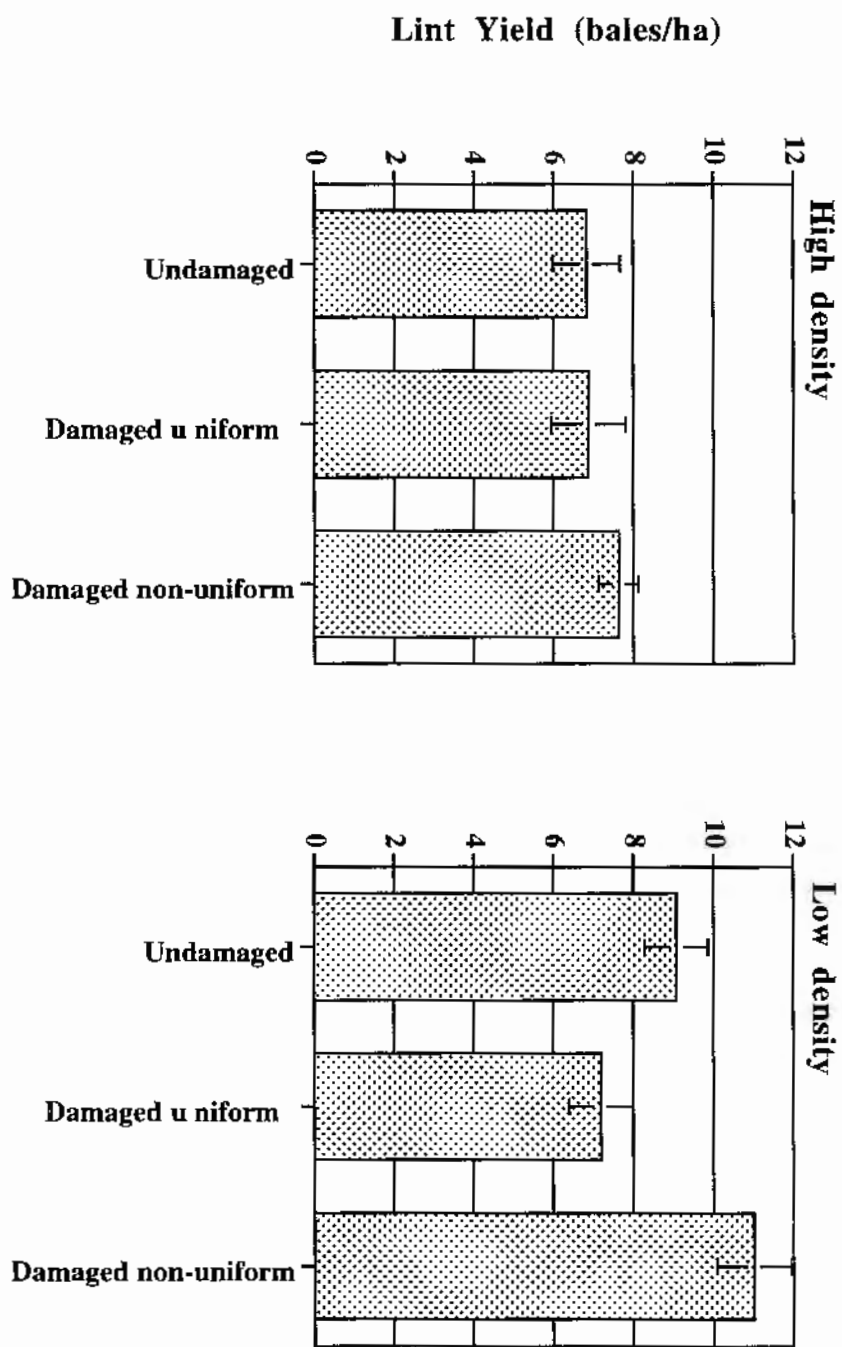
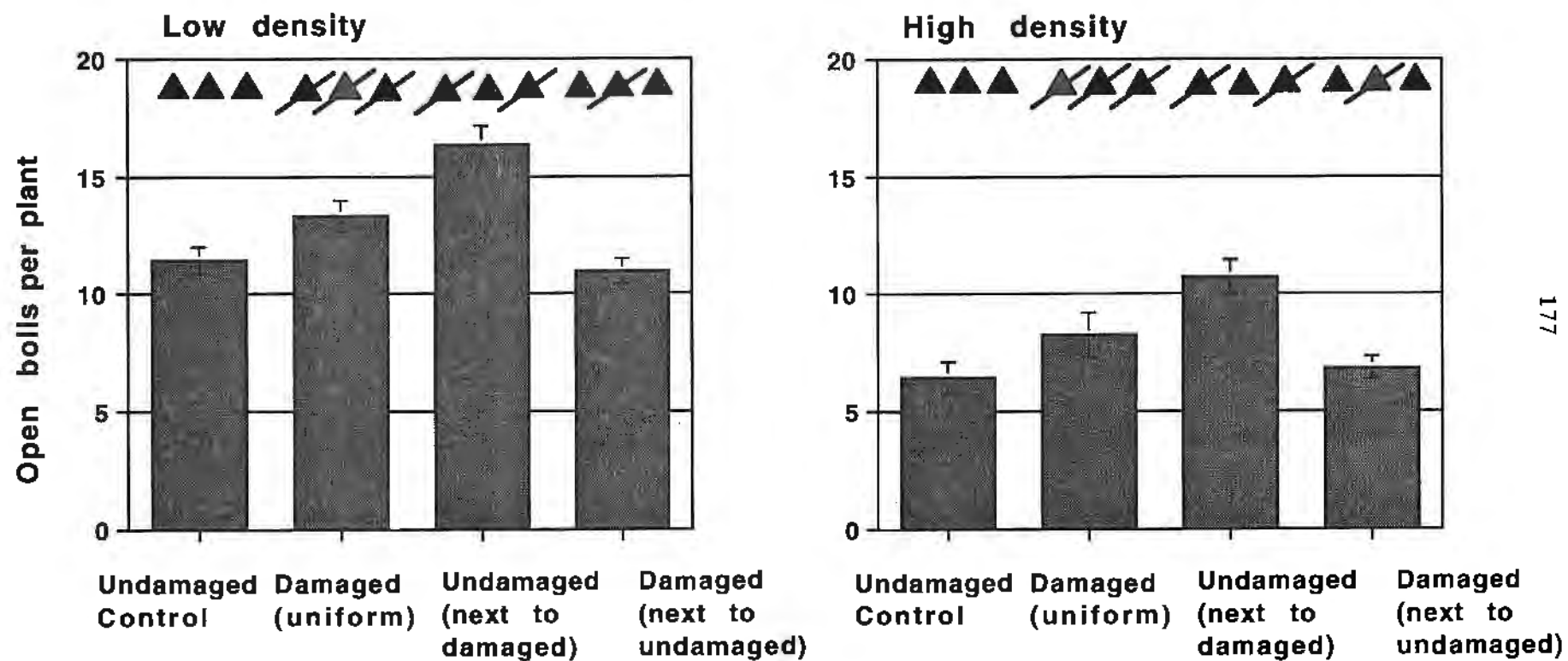


Figure 3. Open bolls in undamaged controls, uniformly and non-uniformly damaged plants



Compensation at the **crop** level (Fig. 1b) was observed in **non uniformly damaged crops**. In contrast with the case of uniform damage, compensation when damage was non uniform was the result of a greater growth of undamaged plants grown next to damaged neighbours: they produced 35% more stem mass and more bolls than undamaged controls. The increase in boll production is shown in Fig. 3 (compare "undamaged control" and "undamaged next to damaged"). On the other hand, damaged plants grown next to undamaged ones were unable to produce more stems or bolls than undamaged controls (Fig. 3, compare "undamaged control" and "damaged next to undamaged").

Conclusion

The cotton crops in the present experiment tolerated tip damage with no yield loss or delay in maturity. Our results indicate that compensation **among** plants may be an important component of cotton responses to tip damage. More work is necessary to evaluate the generality of these responses.

Experiments are also necessary to evaluate crop responses to non-uniform damage caused by pests that feed on squares and bolls (*e.g.* bollworms and mirids). This information will be useful for the design of crop mixtures of transgenic and non-transgenic cottons aimed at the management of *Heliothis* resistance to Bt.

Acknowledgments

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References

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