Neighbourhood watch: a two-fold effect of fruit loss on yield reduction

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Summary Following square and boll loss, damaged plants may became taller and leafier than undamaged plants. Due to these changes, damaged plants may be better able to compete with their neighbours for light, water and nutrients. This explains why undamaged plants with damaged neighbours yielded about 50% less than undamaged plants with undamaged neighbours in field experiments at Narrabri. Yield reductions due to fruit loss could be greater than expected because of the negative influence of damaged plants on undamaged neighbours.

How fruit loss affects yield

Key cotton pests, including *Helicoverpa* and mirids, have a preference to feed on squares and young bolls which are normally shed after damage. In the case of severe damage, plants could be fruitless or hold only few bolls. In this way, yield is reduced.

There is another way, so far unexplored, in which the loss of squares and bolls could affect yield: by changing the way in which neighbouring plants influence each other. To understand this we have to acknowledge, first, that plants in a crop compete with their neighbours for light, water and nutrients. Lets then think of plants that suffered severe fruit loss: they are taller and leafier than undamaged plants. Thus, it is not hard to imagine that an undamaged "target" plant could be in a disadvantaged competitive situation and yield less when grown alongside damaged neighbours (taller and leafier) than when grown alongside undamaged neighbours.

Experiment

The experiment was laid out in a commercial crop of Siokra V-15 sown on October 12, 1994. To assess to what extent the loss of squares and bolls in a plant may affect the productivity of its neighbours, an experiment was carried out that included three treatments: (i) undamaged controls, (ii) uniformly damaged, in which all plants were damaged, and (iii) non-uniformly damaged, in which every second plant was damaged. Damaged plants had their squares and bolls removed at 85 days after sowing.

Results

Table 1 shows the production of open bolls per unit ground area. Uniform damage reduced the production of open bolls by 80%. The expected yield loss in the non-uniformly damaged treatment, in which 50% of the plants were damaged, should be the average of the damaged (81 g/m^2) and undamaged (378 g/m^2) crops, or 230 g/m^2. The actual yield reduction in the non-uniformly damaged crops, however, was twice as much as expected (114 vs 230 g/m^2).

Table 1. Production of open bolls (lint + seed + boll wall)

Damage treatment	Observed production (g/m^2)	Expected production (g/m^2)
undamaged	378	
uniformly damaged	81	
non-uniformly damaged	114	230

Why was the yield of the non-uniformly damaged crop so low? The answer to this can be found in Table 2, where production per plant is shown.

Table 2. Effect of damage and neighbour status (damaged vs undamaged) on the production of open bolls of target plants

Target plant	Neighbour	Open bolls (g/m^2)
undamaged	undamaged	41
undamaged	damaged	18
damaged	damaged	9
damaged	undamaged	6

The yield of damaged target plants, which had an average of one open boll per plant because they ran out of time for recovery, was unaffected by neighbour status. The yield of undamaged target plants was dramatically affected by the status of their neighbours: if undamaged plants were flanked by undamaged neighbours, they produced 41 g/m^2 but they only produced 18 g/m^2 when flanked by damaged neighbours.

Insects that induce shedding of squares and young bolls may therefore have a two-fold impact in yield. First, yield can obviously be reduced by the drop in the productivity of damaged plants. Second, and no so obviously, crop yield could be reduced because of the drop in productivity of undamaged plants flanked by damaged neighbours.

Conclusion

This study showed that negative influences among damaged and undamaged cotton plants, as predicted by theory, could occur in the field. Such negative influences could be reflected in loss of yield, delay in maturity or both, depending upon the timing, severity and distribution of damage. Current thresholds for pests that cause fruit loss, especially *Helicoverpa*, have largely been derived from field experiments where the pests had their natural distribution and feeding patterns. The impact of competition among neighbouring plants due to non-uniform damage is therefore already built into current thresholds, which probably do not need modification. This study, however, indicates that (i) experimental design, especially for simulated damage experiments, could dramatically influence results, (ii) a deeper understanding of the process of compensation must take into account plant-to-plant effects, and (iii) there may be scope in the future to modify thresholds in the light of the fact that non-uniform fruit damage can result in yield loss or maturity delays greater than expected. Further work is planned to assess the effects of interactions between damaged and undamaged plants on current thresholds for pest management.

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