Tolerance of cotton to simulated *Helicoverpa* damage

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Abstract

Cotton (*Gossypium hirsutum*) has demonstrated the ability to recover from pest damage over the growing season without yield loss. However, it was unclear to what extent can cotton tolerate repeated damage before and after the onset of fruiting. This 2-year field trial examined the yield recovery and maturity date of cotton subjected to manual damage to shoot tips (twice) and to fruit (twice). Four levels of fruit damage simulating 2, 4, 6, and 8 *Helicoverpa* larvae per metre were imposed. No statistically significant yield loss was found for any damage level but there was a modest delay of 3-8 days in maturity. The process of yield compensation could be associated with changes in the architecture of the cotton canopy following damage which increase light interception and the reproductive capacity of the crop. Understanding the degree of tolerance and the physiological processes of compensation will allow us to manage cotton pests in a more sustainable manner.

Key words

Canopy, fruiting dynamics, Light interception, yield, compensation, pest damage.

Introduction

The process of compensation following pest damage is closely associated with changes to the canopy architecture and fruiting dynamics of cotton plants. Early season damage to plant terminals and young fruit may stimulate branch and leaf development that improves canopy light interception and carbon gain (6). This type of response can result in larger fruit production and, in some cases, a yield gain in damaged over undamaged crops (1). However, since damage causes some delay in the fruiting process, compensation in yield may be associated with later maturity. Both recovery in yield and maturity are critically affected by the degree and the timing of pest damage. While a considerable amount of research has been done on cotton responses to pest damage (e.g., 5), few studies have assessed the recovery process based on repeated damage simulating a specific degree of pest pressure (i.e., feeding by different number of *Helicoverpa* larvae per metre). In this field trial, four damage events to both plant terminal and fruit using 5 levels of pest pressure were imposed. Determination of the limit of compensation will contribute to improving pest management strategies in cotton by minimising pesticide application without yield loss.

Methods AND MATERIALS

This was a two-year study conducted at the Australian Cotton Research Institute, Narrabri, NSW. In both years, a crop of cotton variety Sicala V-2i was established at 10-12 plants per metre and fertilised and irrigated according to standard industry practice. Five treatments with 5 replicate plots each was set up in a randomised block design. Each plot was 3 rows by 4m. The five treatments were an undamaged control and four damage levels simulating fruit removal by 2, 4, 6, and 8 *Helicoverpa* larvae per metre. Prior to squaring, terminals of damage treatment plants were removed (at ca. 35 and 55 days after sowing). This was followed by two square removal events at 85 and 115 DAS. The number of fruit to be removed by hand was derived using the feeding model of Hassan and Wilson (4). The recovery process was monitored through measurements of leaf area, vegetative and fruit dry matter, light interception, and hand-picked lint yield and maturity date (defined as 60% of bolls open).

Results and discussion

While the current threshold for *Helicoverpa* larvae is set at 2 per metre (3), our results indicate that a modern cotton cultivar such as Sicala V-2i can withstand repeated damage equivalent to up to 8 per metre. Despite a substantially different potential yield between years, there were no significant differences in lint yield were evident among the treatments within year (Fig. 1). Yield compensation, however, was associated with a delay in maturity of up to 8 days between control and 8 larvae/m (similar in both years). Given that the last fruit removal occurred about 75 days prior to maturity, this duration could represent the required time for full recovery from lost fruit. Later fruit damage resulted in a significant yield loss (data not shown).

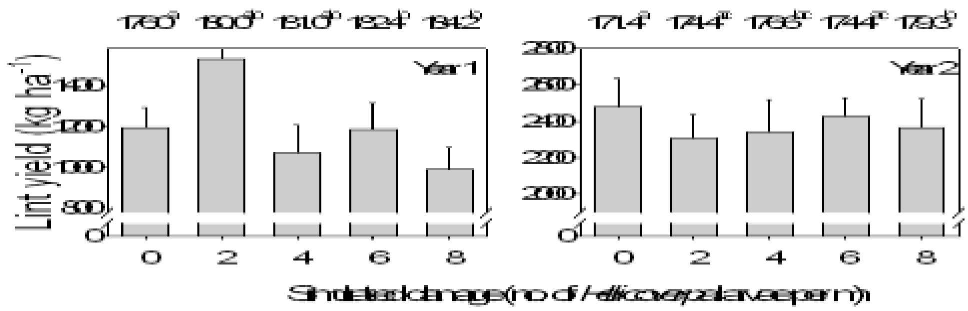

Figure 1. The effect of different levels of simulated *Helicoverpa* fruit damage on cotton lint yield (bar+1 se) and maturity date (numbers above the bars) for the two years. Note the scale on lint yield was different for the two years. Differences (P<0.05) in maturity date are represented by different letters.

For compensation to occur, it is necessary for a damaged crop to maintain a comparable or higher amount of carbon assimilation than an undamaged crop. For tip damaged plants, carbon assimilation is generally enhanced by an increase in lateral branch growth and in light interception. Figure 2 shows that, over most the cotton season, more light was intercepted (i.e., lower % transmitted light) by damaged crops than the control for both the upper half of the canopy and for the entire canopy. Most of the carbon used in boll filling comes from the upper half of the canopy where light levels are higher and leaves are younger (e.g., 2), it is possible that a higher carbon gain and an improved nitrogen metabolism, associated with greater light interception (5), contributed to yield recovery in damaged crops.

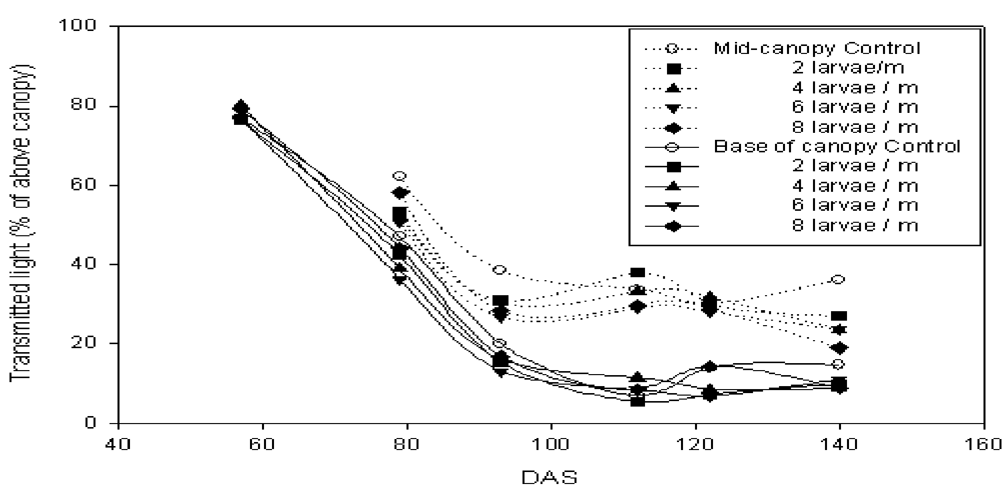

Figure 2. Light penetration through the cotton canopy measured across the growing season at two positions: mid-canopy and ground level. Seasonal patterns for the undamaged control and

the four damage treatments at each position are shown. Measurements were taken around solar noon under clear skies using an 80-cm ceptometer positioned 90^{o} to the plant row.

Another key process of yield compensation involves the re-establishment of the fruiting process in damaged crops following fruit loss. In both years, there was an increase in square production at the time of the second fruit removal (i.e., ca. 115 DAS, Table 1). Boll numbers at this time was variable where low damage treatments exceeded the control while that of higher damage treatments lagged behind the control. Some treatments such as 6 larvae/m in Year 1 recovered the deficit in boll dry mass to the control from 138 DAS (Table 1) to similar final lint yield (Figure 1) during the last 44 days of the season.

Table 1. Fruit development (mean dry mass?1 se) for squares and bolls of an undamaged crop (0 larvae/m) compared with four repeated damage treatments simulating fruit damage by 2,4, 6, and 8 small larvae per metre. Differences (P<0.05) among treatments are represented by different letters. [NS] - no significant treatment effect.

	Year 1				Year 2	
Damage (larvae/m)	110 DAS		138 DAS		113 DAS	
	Square dw (g/m)	Boll dw (g/m)	Square dw (g/m)	Boll dw (g/m)	Square dw (g/m)	Boll dw (g/m)
0	23.6?4.9 [NS]	72.4?17.2 [NS]	3.7?2.3 [NS]	328.5?34.0[a]	14.8?1.5[ab]	124.4?16.6 [NS]
2	22.7?2.0	82.9?34.6	3.4?1.0	344.1?34.7[a]	12.1?1.9[a]	146.0?51.4
4	23.7?3.6	83.4?26.2	3.5?0.9	272.9?22.2[ab]	16.2?3.5[ab]	122.8?25.1
6	27.4?2.9	24.7?7.1	4.7?1.8	262.6?17.3[ab]	14.2?2.7[ab]	95.2?11.4
8	26.9?2.7	25.3?8.0	7.4?2.7	195.2?39.1[b]	22.7?3.5[b]	108.8?27.7

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