

# Impact of aphids on photosynthesis and yield of Bollgard II<sup>®</sup> cotton in the Kimberley

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## Introduction

In the Ord River Irrigation Area (ORIA) INGARD<sup>®</sup> cotton varieties have been grown utilising novel integrated pest management systems (Strickland et al 2003). A winter production window, use of specific chemistry and biological control has demonstrated that acceptable yields (7-8 bales/Ha) can be consistently produced with fewer than five pesticide sprays. *Aphis gossypii* (cotton aphid) has been regarded as a tool in this system. During June/July when *Heliothis* and beneficial insect populations are low in cotton, *A. gossypii* populations increase. This encourages beneficial insects into the cotton from the surrounding area. The beneficial insects feed on the aphids and in August, when *Heliothis* populations increase again there is a resident population of beneficial insects in the cotton. In some years in Kununurra, a pesticide spray for *Heliothis* can be avoided using this method of natural control.

Data from eastern Australia suggests that cotton will recover from aphid damage provided infestations do not persist at high levels (>90% plants infested) for too long (<10 days) (Wilson & Spora 2001). These thresholds have not been validated for winter grown cotton in northern Australia. When cotton is grown in the winter, peak flowering and fruit production occur when day length is short, radiation is low and temperature is low. Growing conditions are far from ideal. Aphids may have a larger impact on growth and yield than previously suspected. This paper describes some of the results from a preliminary trial carried out in Kununurra in 2003 examining the impact of aphids on photosynthesis and yield of winter grown cotton.

## Methods

The trial was planted on 28 March 2003 as two rows (80 cm apart) on 1.8 m beds, which is standard practice for all crops in the ORIA. The target population was 8 plants per metre row and this was achieved. Two Bollgard II<sup>®</sup> varieties, Siokra V16B and Sicot 13B and two levels of aphid infestations (with and without aphids) were compared. The “without aphid” plots were maintained free of aphids by regular spraying with insecticide. The plots of the trial “with aphids” were seeded with potted cotton plants of aphids, which had been reared in the greenhouse.

Plot size was 10.8 m wide x 30 m long. The trial was planted as a split-plot design with five replications of each treatment. The main treatment effect was “with aphids” versus “without aphids” and the sub-plot effect was variety.

Measurements of photosynthetic parameters were taken on a weekly basis between 16 May and 7 August. An ADC Gas Analyser was used according to the manufacturer’s specifications. All photosynthesis measurements were taken between 0830-1330 hours when photosynthesis in the plants had equilibrated. Radiation, evapo-transpiration, stomatal diffusive resistance and rate of photosynthesis were measured.

Aphid density was estimated by scoring the number of live aphids present on the third position leaf for 20 leaves in each plot. Samples were taken weekly on the same days as photosynthetic measurements. A rating system was used where 0=no aphids present; 1= 1-10 aphids present; 2= 11-20 aphids present; 3= 21-50 aphids present; 4= 51-100 aphids present; 5= 100+ aphids present.

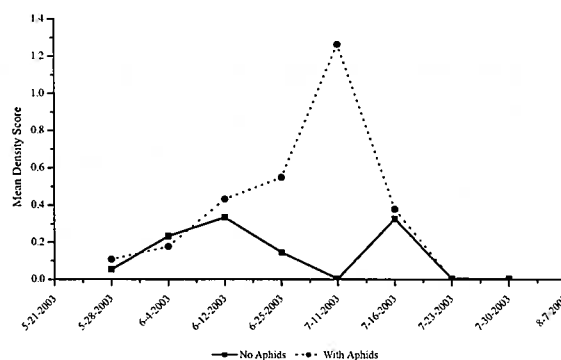
The cotton was harvested using a John Deere cotton picker which had been modified to pick small trials. Two, 20 metre transects were picked from the middle rows of each plot. The samples were weighed and yield in bales/Ha was calculated assuming a 39% gin turnout.

## Results

### Aphid Density

Shadehouse reared *Aphis gossypii* were released into the trial on 17 May 2003 at first flower and allowed to multiply unchecked on the with-aphid plots. We found it very difficult to maintain the aphid population due to the high level of predators, which kept re-infesting the trial area despite our efforts to keep them out. The highest mean aphid density score was 1.2 achieved in July (Figure 1). This was a very low level of aphid infestation which was also reflected in scouting data collected from an adjoining field of cotton. In this field a peak of 60% infested plants was reached in mid-July.

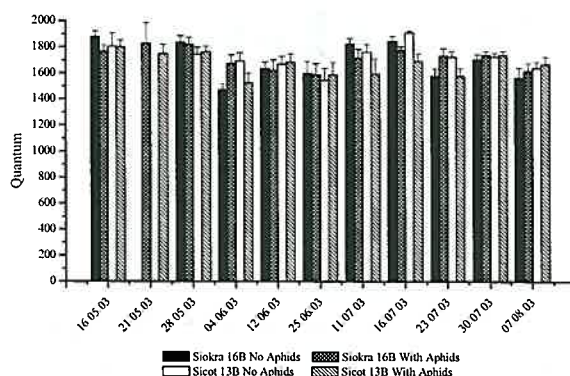
**Figure 1.** Mean aphid density score from cotton grown with and without aphids in 2003 in the ORIA.



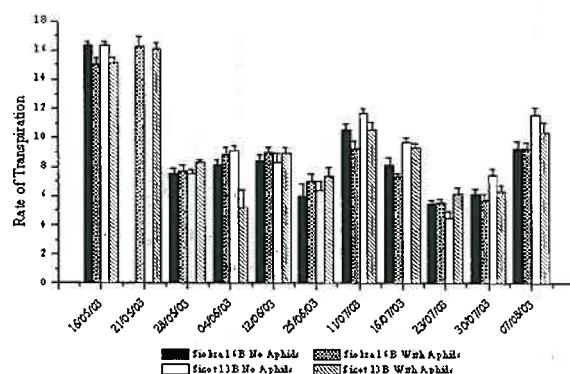
## Photosynthesis

The level of radiation intercepted by cotton leaves was measured with the ADC Gas Analyser (Figure 2). There was no significant difference in the level of radiation between the treatments (with or without aphids), varieties of the treatment by variety interaction within each sampling date. There was also no significant difference in the level of evapo-transpiration between the treatments, varieties or treatment by variety interaction within all the sampling dates except for 7 July. On 7 July there was a significant difference in the level of evapo-transpiration between varieties ( $F=2.787$ ,  $P>0.05$ ). Siokra V16B had a lower rate of evapo-transpiration than Sicot 13B. This is probably a reflection of the shorter growing season required for Siokra V16B. By 7 July, Siokra V16B had reached cut-out while Sicot 13B was still within the flowering period and did not cut-out for another 10 days. After 11 July, when the highest mean aphid density occurred, there was a trend for cotton without aphids to have a higher rate of evapo-transpiration than cotton with aphids (Figure 3).

**Figure 2.** Mean Radiation of cotton measured with an ADC Gas Analyser in 2003 in Kununurra.



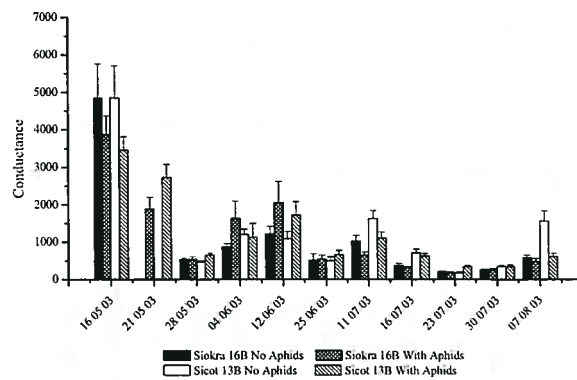
**Figure 3.** Mean rate of evapo-transpiration of cotton measured with an ADC Gas Analyser in 2003 in Kununurra.



Stomatal diffusive resistance was also measured by the ADC Gas Analyser. There was no significant difference in the level of stomatal diffusive resistance between the treatments (with or without aphids),

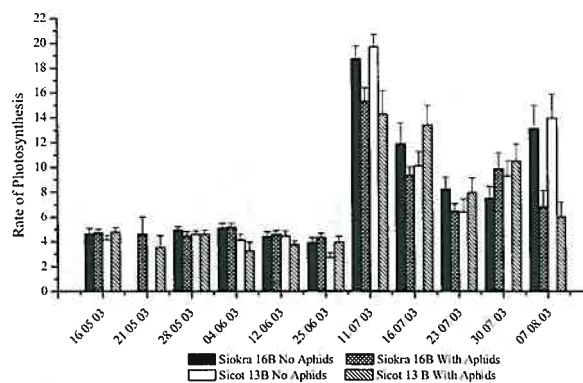
varieties or the treatment by variety interaction within most of the sampling dates. The two exceptions were 11 July ( $F=50.23$ ,  $P>0.05$ ) and 7 August ( $F=2.929$ ,  $P>0.05$ ) when there was a significant difference between varieties. On these dates, Sicot 13B had a higher stomatal diffusive resistance than Siokra V16B. After 11 July, when the highest mean aphid density occurred, there was a trend for cotton without aphids to have a higher conductance than cotton with aphids (Figure 4).

**Figure 4.** Mean rate of stomatal diffusive resistance of cotton measured with an ADC Gas Analyser in 2003 in Kununurra.



There was no significant difference in the rate of photosynthesis between the varieties of the treatment by variety interaction within any of the sampling dates. There was a significant difference between the treatments, with or without aphids, on 11 July ( $F=20.316$ ,  $P>0.05$ ) and 7 August ( $F=39.86$ ,  $P>0.05$ ). Cotton without aphids had a higher rate of photosynthesis than cotton with aphids (Figure 5).

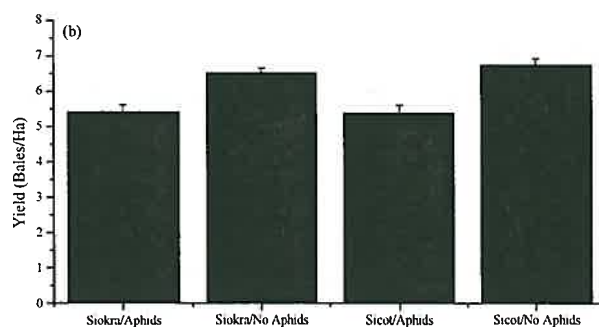
**Figure 5.** Mean rate of photosynthesis of cotton measured with an ADC Gas Analyser in 2003 in Kununurra.



## Yield

There was a significant difference in the yield between the treatments, with and without aphids ( $F=13.694$ ,  $P>0.05$ ). Cotton grown with aphids had a lower yield than cotton grown without aphids (Figure 6). There was no significant difference in the yield between varieties, or the treatment by variety interaction.

**Figure 6.** Mean yield (bales/Ha) of cotton of two varieties, Siokra V16B and Sicot 13B grown with and without aphids in Kununurra in 2003.



## Discussion

Between 2000-2002 cotton growers in the ORIA began to experience yield decline in cotton. During the same period aphid pressure on the cotton had increased. Although thresholds recommended by CottonLOGIC were applied, yield losses still occurred and could only be attributed to aphid damage. The integrated pest management package proposed for cotton in northern Australia recommends dry season production to avoid some of the more serious cotton pests (Yeates et al 2002). However, dry season cotton production in northern Australia places plants under additional physiological stresses. Total radiation reaches its lowest point in June, temperature reaches its lowest point in July and the potential rate of photosynthesis reaches its lowest point in July, for cotton planted between March to May (Stern 1965). Cotton planted between March to May does not reach the same growth potential as cotton planted between January to February (Stern 1965). Any stress placed on the crop during critical growth stages in June and July probably impacts on the final crop yield to a higher level.

The ADC Gas Analyser was an easy way to measure photosynthesis in the field and although it gave variable results they included some encouraging trends. These trends included lower rates of evapotranspiration, stomatal diffusive resistance, and photosynthesis on cotton infested with aphids. Although aphid populations were not high and reached a score of 1.2 out of 5, significant yield reductions of up to 1.4 bales/Ha occurred especially in the normal leaf cotton. More research is required to determine the level at which aphid populations become damaging to cotton and then further refining the aphid thresholds for cotton grown during the winter in northern Australia.

## References

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