

# TOWARDS DYNAMIC THRESHOLDS FOR *HELICOVERPA* ON TRANSGENIC COTTON IN THE KIMBERLEY

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## BACKGROUND

*Helicoverpa spp* are considered the most damaging insect pests of cotton in Australia and consequently have attracted considerable research attention. Problems with insecticide resistance and possible environmental damage associated with excessive insecticide use has led to concerted efforts to reduce spraying in cotton. Integrated Pest Management (IPM) methods and area wide management have emerged as new tactics and are underpinned by decision support systems, including CottonLOGIC. However, despite the myriad of factors to be taken into consideration before spraying, the most important remains the "pest threshold", as measured by crop scouting. In the case on INGARD™ cotton, the established threshold for *Helicoverpa* is a total of 2 larvae/m row in all crop growth phases (Anon. 2002).

Early experiments with INGARD™ at Kununurra raised concerns that the fixed threshold of 2 larvae/m may not be appropriate for the unusual winter growing environment in the Kimberley. The concerns were twofold, firstly because the "reverse" growing season meant that cotton growth was rapid in high temperatures at the beginning and end of the season but slow during boll development in mid-season, and secondly, that extensive periods of "sub-threshold" damage were often observed. To test the validity of established *Helicoverpa* thresholds in the winter system, a series of field trials were conducted between 1998 and 2001 with the aim of developing a more dynamic and responsive threshold to better reflect the growth stage of the crop and the impact of insect damage.

## METHODS

Methodology was similar for each year of the experiments. Plots were large, 21.6 m (12 beds) or 27 m (15 beds) X paddock length (150 - 250 m). The standard variety sown was Siokra L23i in 1998 and 1999, and Siokra V16i was the variety in 2000 and 2001. Cotton seed was sown at 13 seeds per metre to establish 9-12 plants/m. Seed was sown at a depth of 2 cm into moisture using a precision air seeder. Temik® was applied in the planting furrow at 7 kg/ha for sucking pest control. Fertiliser and irrigation schedules were as per standard practice for the area.

The trials were planted as randomised complete block designs with four replications of each treatment. For ease of applying treatments and for machine picking, plots ran the entire length of the

field. The treatments were spray thresholds for *Helicoverpa* larvae. There were three treatments in 1998 and four treatments in each of the other seasons, as summarised in Table 1.

Table 1. *Helicoverpa spp* thresholds evaluated in field experiments at Kununurra, 1998-2001.

1998	1999	2000	2001
0.5 larva/m	0.5 larva/m	Fixed Threshold (2 larvae/m)	Fixed Threshold (2 larvae/m)
1.0 larva/m	1.0 larva/m	Cumulative 5 larvae/m	Cumulative 10 larvae/m
2.0 larvae/m	2.0 larvae/m	Cumulative 10 larvae/m	Cumulative 10 larvae/m + Retention Factor
	Untreated control	Cumulative 15 larvae/m	Untreated control

All larval stages, excluding very small larvae (< 3 mm) were included in the threshold calculations in 2001 but excluded in all the previous seasons. Control action was always taken on the first check rather than the second consecutive check. Control action was taken when the mean number of larvae of four plots in the treatment reached the prescribed threshold. Sprays were applied either with a spray coupe, when soil conditions permitted, or with an aircraft fitted with micronaires.

Scouting of all plots in all years used the presence /absence method as described in CottonLOGIC. Similarly the thresholds from the CottonLOGIC program were used in all cases for fixed thresholds set at either 0.5, 1.0 or 2.0 larvae/m. However, for **cumulative thresholds** a new calculation was used. In essence, the cumulative threshold calculation uses typical scouting data but also sums some past scouting data to give a cumulative output. The developmental stage of the *Helicoverpa* counted is also taken into consideration by applying a **damage rating**. The damage rating ensures that when medium and large larvae are encountered, the cumulative larvae threshold accelerates compared, for example, to when only eggs and small larvae are present.

In 2001 the additional factor of fruit **retention** was included so that high retention crops did not reach threshold as quickly as low retention crops at the same levels of pest pressure.

The trials were harvested using a John Deere cotton picker, which was modified to pick small trials. One of the picking heads was removed so that only one row was picked at a time and the chutes were extended into the cage. Bags were attached to the chutes to collect the seed cotton. Six X 15 m strips were picked from the middle bed of each plot and the cotton collected into hessian bags. The samples were weighed and a small sub-sample (300-600 grams) was taken for ginning. The sub-sample was hand ginned and a turnout and lint yield in bales/ha calculated. Yield measurements were statistically analysed using Genstat for Windows (5<sup>th</sup> Edition).

## RESULTS

### 1998

In the first year of trials, the standard threshold of 2 larvae/m was compared to lower thresholds of 0.5 and 1 larva/m. The results in Table 2 show that the 0.5 larva/m threshold gave a significantly higher yield of almost 1 bale/ha but at a cost of two additional sprays. Pest pressure from *Helicoverpa* was low and the 1 larva/m treatment did not reach threshold and therefore received no additional insecticide applications and yields were equivalent to the standard 2 larvae/m threshold which also did not reach threshold.

Table 2. The influence of *Helicoverpa* thresholds on yield of Siokra L23i grown at Kununurra, 1998.

Treatment	Yield (bales/ha)	% yield of 2 larvae/m	Number of pre-cutout sprays
0.5 larvae/m	10.48±0.21	110%	2
1.0 larvae/m	9.75±0.19	102%	0
2.0 larvae/m	9.52±0.17	100%	0

LSD =0.53, P<0.05

### 1999

In 1999 the threshold trial of the previous season was repeated but included an unsprayed control to better benchmark the yield potential of the crop in that particular season. The data shown in Table 3 show that all the *Helicoverpa* thresholds tested gave a significantly higher yield compared to the unsprayed control. In addition, the 1 larva/m threshold also resulted in a significantly higher yield than the standard threshold of 2 larvae/m. However, as in the previous season, an additional insecticide application was required to achieve a modest yield increase of 8%. In contrast, two additional sprays were used for the lowest threshold of 0.5 larvae/m but no significant yield improvement over the 2 larvae/m treatment was observed.

Table 3. The influence of *Helicoverpa* thresholds on yield of Siokra L23i grown at Kununurra, 1999.

Treatment	Yield (bales/ha)	% yield of 2 larvae/m	Number of pre-cutout sprays
0.5 larvae/m	6.36±0.54	104%	5
1.0 larvae/m	6.60±0.80	108%	4
2.0 larvae/m	6.11±0.68	100%	3
Control	4.76±0.65	78%	0

LSD =0.38, P<0.05

## 2000

The trial in 2000 evaluated three “cumulative” thresholds with the standard fixed threshold of 2 larvae/m. This was the first attempt at developing a more dynamic threshold, which took into calculation the numbers of sub-threshold larvae from previous checks (see “Methods” for details).

The results in Table 4 are inconclusive with the cumulative 10 larvae/m threshold giving a significantly lower yield than each of the other thresholds. However there was no significant yield difference between the fixed 2 larvae/m, cumulative 5 larvae/m and cumulative 15 larvae/m threshold treatments.

In terms of insecticide requirements, the lowest of the cumulative thresholds (5 larvae/m) had four sprays compared to two sprays for the other treatments. There was no yield improvement attributable to the extra sprays in the cumulative 5 larvae/m. The other threshold treatments required two sprays each but the timing of the sprays was different due to the different threshold calculations. Despite different spray timings, no significant yield differences occurred between the fixed 2 larvae/m threshold and the cumulative 5 or 15 larvae/m treatments.

Table 4. The influence of *Helicoverpa* thresholds on yield of Siokra V16i grown at Kununurra, 2000.

Threshold Treatment	Yield (bales/ha)	% yield of 2 larvae/m	Number of pre-cutout sprays
Fixed Threshold (2 larvae/m)	7.17±0.13	100%	2
Cumulative 5 larvae/m	7.23±0.16	101%	4
Cumulative 10 larvae/m	6.68±0.16	93%	2
Cumulative 15 larvae/m	7.31±0.20	102%	2

LSD =0.46, P<0.05

## 2001

The 2001 threshold trial again aimed to refine the cumulative larval threshold concept and include the additional variable of retention in the calculations. Thus the cumulative 10 larvae/m threshold was compared to the standard 2 larvae/m, an untreated control and a cumulative 10 larvae/m + retention factor threshold. A summary of results is shown in Table 5.

Yields in 2001 were very poor but interestingly, the fixed 2 larvae/m threshold did not out-yield the unsprayed control despite two insecticide applications. The highest yield was achieved using the cumulative 10 larvae/m threshold which required only one insecticide application. The addition of a retention factor to the cumulative threshold caused an additional spray but did not increase yield.

Table 5. The influence of *Helicoverpa* thresholds on yield of Siokra V16i grown at Kununurra 2001.

Threshold Treatment	Yield (bales/ha)	% yield of 2 larvae/m	Number of pre-cutout sprays
Fixed Threshold (2 larvae/m)	5.00±0.09	100%	2
Cumulative 10 larvae/m	5.65±0.19	113%	1
Cumulative 10 larvae/m + Retention Factor	5.28±0.08	106%	2
Unsprayed	4.86±0.15	97%	0

LSD =0.38, P<0.05

## DISCUSSION

Field trials in 1998 and 1999 explored the impact of different fixed thresholds for *Helicoverpa* on yield of INGARD™ cotton at Kununurra. The standard threshold of 2 larvae/m was compared to lower thresholds and to unsprayed controls in large experiments. In both years either the 0.5 larva/m or the 1 larva/m threshold gave a significant yield improvement over the standard threshold. These results were important because they demonstrated that significant yield was being lost by adhering to the standard threshold of 2 larvae/m. Moreover the lower thresholds did not lead to excessive insecticide use, one extra spray was used in 1999 and two more sprays in 1998. Nevertheless the imposition of any additional sprays was considered undesirable and counter productive to the goal of sustainable IPM production systems for the Kimberley (Strickland et al 1998).

An observation from the early trials was that the timing of sprays in the lower threshold treatments was noticeably different to the standard treatment. It was perceived that the lower thresholds had the effect of early intervention in prolonged sub-threshold damage common in INGARD™ crops. Thus it was considered important to investigate a new approach to *Helicoverpa* thresholds in a way that responded to sub-threshold damage rather than waiting for a predetermined 2 larvae/m threshold to be reached. Therefore, in 2000 and 2001, **cumulative larval thresholds** were evaluated in field trials at the Frank Wise Institute. The cumulative thresholds utilise normal scouting data but include counts from previous scouting events. In the 2001 trial, a **retention factor** was also built into the formula so that crops with poor retention would have earlier spray intervention than crops with high retention, and visa versa.

The cumulative larval thresholds have given variable results but have included some encouraging yields, especially in an inherently low yielding season as experienced in 2001. In that season the cumulative 10 larvae/m treatment produced a significantly higher yield than the other thresholds and required one fewer spray. This highlights the important fact that cumulative thresholds have the capacity to change the timing of insecticide applications rather than the number of sprays. At least in some cases this results in a significantly higher crop yield with the same or fewer sprays than in crops

utilising the standard fixed threshold of 2 larvae/m. More research is required to fully test and further refine the concept of cumulative larval thresholds.

## REFERENCES

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