

An evaluation of unsprayed INGARD cotton strips as nurseries for beneficials in dryland cotton on the Darling Downs.

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Introduction

The DPI has been evaluating unsprayed strip crops planted beside dryland INGARD cotton as nurseries for beneficial arthropods over the past three seasons. This work has included evaluations of lablab, soybean, maize and sorghum in this role (Scholz *et al.* 2000, Scholz *et al.* 2002). All of these crops harboured predatory insects and spiders at various times of the season, but not all of them readily harboured parasitoids. *Trichogramma* egg parasitoids are important beneficials on the Downs, and were most common in sorghum and maize, and less abundant in lablab and soybeans. Ideally an unsprayed nursery that harbours both predators and parasitoids is more desirable than one that primarily harbours predators. Unsprayed cotton offers potential to serve as a nursery for both predators and parasitoids, and was evaluated in this role during the 2001/02 season.

Methods

The trial was carried out at St. John and Edwina Kents' property "Coondarra" near Jimbour on the Darling Downs. Two 30 ha blocks of single skip INGARD cotton (Sicot 289i) were sown on the 31st October 2001. There were 72 row-pairs of cotton in each block ca. 1.4 km long. Half the total length (ca. 700 m) of the first 9 row-pairs on the upwind side of each block were left unsprayed for the season. The remaining 63 row-pairs adjoining the unsprayed strip, and the entire 72 row-pairs in the other half of each block, were treated with insecticides according to conventional pest management practices. Details of the insecticide applications are provided in Table 1. The yield was estimated by hand harvesting 4 x 5 m row-pairs of crop in the unsprayed cotton, and 6 x 5 m row-pairs in the sprayed cotton, in each block.

There was a lot of sorghum planted on, and near, the "Coondarra" study site (250 ha on farm). The levels of heliothis egg density and parasitism in this sorghum were assessed regularly. The closest sorghum to the INGARD was approximately 30 m away.

Insect Assessments

The unsprayed and sprayed cotton were inspected weekly for heliothis eggs and larvae, and detailed counts of key pests in the sprayed cotton were provided by crop consultants. The numbers of beneficials in row-pairs 3, 5, and 7 (unsprayed), and row-pairs 11, 15, 25, 41 and 69 (sprayed) were assessed with a beat sheet (Scholz *et al.* 2001) two times per week.

The levels of heliothis egg parasitism were assessed weekly by collecting naturally laid brown eggs from the same row-pairs in which beneficial counts were completed. Heliothis egg cards (Scholz *et al.* 2000) were also used to assess egg parasitism. The levels of heliothis egg parasitism in sorghum were assessed by collecting pre-flowering heads, spinning the heads into a plastic funnel, and collecting the eggs in 30 ml plastic cups. All eggs were taken to the laboratory and transferred to plastic microtitre trays using a fine paint brush dipped in water. Each tray was sealed with sticky tape, labelled, and held at 25°C until the levels of egg parasitism could be determined. Parasitised eggs typically turn black after four days at 25°C, and adult wasps emerge after another six days. *Trichogramma pretiosum* was released into sorghum on the farm on the 10th January (600,000 wasps) and 14th January (600,000 wasps). The release sites were approximately 250 m away (10th Jan) and 30 m away (14th Jan) from the nearest INGARD cotton.

Results

Heliothis pests were a serious problem throughout the season, with egg densities peaking at almost 90 eggs/m and larval densities exceeding 2 larvae/m for several weeks (Figure 1). Wet weather promoted the growth of dwarf amaranth (*Amarantus macrocarpus*) which supported high numbers of larvae during December. After the weeds were cultivated above threshold numbers of larvae moved on to the cotton. These larvae burrowed into the stems of plants, often killing the top half of infested plants.

The total numbers of predators in sprayed cotton were greater when adjacent to unsprayed strips (Figure 2). However, the overall numbers of predators were much higher in the unsprayed strips than in the adjacent sprayed cotton, and the differences between the sprayed and unsprayed became greater as the season progressed (Figure 3).

The application of chemical insecticides had a disruptive impact on the numbers of predators (Figure 4). The numbers of predators in the unsprayed row-pairs rose throughout the season, while those in the adjacent sprayed cotton were much lower. Steward™ and Tracer® had the lowest impact on the numbers of predators, while organophosphates and synthetic pyrethroids had the greatest impact. The application of Folimat® against green mirids in early January adversely affected the growth of the predator population.

The levels of heliothis egg parasitism were significant from January onwards, with 100% of eggs parasitised on several occasions (Figure 5). Three genera of egg parasitoids were collected, i.e. *Trichogramma* (91%), *Trichogrammatoidea* (8%) and *Telenomus* (1%). Almost all of the *Trichogramma* were *T. pretiosum*. The applications of some insecticides were disruptive to the action of egg parasitoids, notably Tracer®, Bulldock® and Curacron®. However, egg parasitoids were generally more active in sprayed crop than

predators. The genus *Trichogrammatoidea* was more readily found in the unsprayed strips than the sprayed crop, while *Trichogramma* was found in approximately the same frequency throughout the entire crop (Figure 6). The levels of heliothis egg parasitism in the sorghum near to the INGARD cotton rose as the season progressed (Figure 7).

There was no significant difference between the yields of cotton grown with or without an adjacent unsprayed strip (Table 2), however the unsprayed strip yielded only 0.5 b/ha less (4.6 b/ha) than adjacent cotton that had been sprayed 7 times (5.1 b/ha).

Discussion

We found that it is possible to harbour large numbers of predators in unsprayed cotton strips, but there are minimal benefits to adjacent sprayed cotton. There were slightly greater numbers of predators in INGARD cotton that was adjacent to unsprayed strips (Figure 2), but this did not translate to an increase in yield (Table 2).

The impact of insecticides on the numbers of predators was extremely noticeable throughout the study, with a clear demarcation between the sprayed and unsprayed parts of the study fields (Figure 4). There was no evidence suggesting the widespread movement of predators from the unsprayed strips into adjacent sprayed cotton. In fact, the differences between the two treatments grew larger as the season progressed, e.g. there were maxima of 31.0 and 4.5 predators/m in the unsprayed and sprayed row-pairs respectively on the 19th February. Clearly the message for growers interested in utilising predators in IPM is to avoid killing them for as long as possible, as their numbers are not likely to build to their full potential in crops sprayed with conventional insecticides. It is not good enough to go "soft" early because predators are most abundant from January onwards. Every effort should be made to use selective insecticides for as long as possible.

The high levels of heliothis egg parasitism recorded in sprayed cotton from the 22nd January onwards (Figure 5) indicates that egg parasitoids were not as adversely affected by spraying as were predators. These parasitoids had a significant impact on heliothis. At the peak heliothis egg density of 86 eggs/m on the 5th February, 96% of eggs in sprayed cotton were parasitised. At the same time there were only 1.5 predators/m in the sprayed cotton.

The trial site was surrounded by sorghum that supported large numbers of egg parasitoids (Figure 7), and it is possible that the parasitoids may have continually moved from the sorghum into the cotton. The presence of so much sorghum near the trial site probably masked the impact of the unsprayed cotton strips on parasitoid production. Nevertheless, the data show that egg parasitoids can flourish in sprayed cotton, and can cause high

mortality of heliothis. Egg parasitoids are a key beneficial on the Darling Downs and our research emphasis has switched from inundative releases of parasitoids to 'classical' biological control involving the conservation of natural populations of native and introduced wasps.

We have been releasing *Trichogramma pretiosum* at Jimbour since 2000, and at other sites on the Darling Downs since 1995. This species was introduced to Australia from the USA in the 1970's (Grimm and Lawrence 1975, Twine and Lloyd 1982), and appears to thrive in agricultural habitats. Our data suggest that *T. pretiosum* is less susceptible to chemical insecticides than native *Trichogrammatoidea* species (Figure 6), and this may be contributing to its abundance in cotton and other cropping systems in southern Queensland.

The comparable yields of the unsprayed cotton (4.6 b/ha) and adjacent sprayed cotton (5.1 b/ha) highlights the role that beneficials can have in managing heliothis in INGARD cotton. The action of egg parasitoids and predators complements the mortality caused by the *B.t.* toxin early season, and gradually increases as the season progresses.

We would like to continue inoculative releases of *T. pretiosum* throughout cotton growing districts and assess its impact on heliothis over consecutive seasons, as we have done at Jimbour. In addition, we would like to:

- document the benefits, if any, of growing sorghum on cotton farms to act as nurseries for egg parasitoids; and
- determine if other plants and insect hosts can support egg parasitoids in late spring-early summer. This may identify potential sources of wasps that can be used to establish egg parasitoids in cotton earlier in the season, e.g. December.
- Evaluate the usefulness of supplemental releases of egg parasitoids early in the season.

As *T. pretiosum* becomes further established in cotton growing regions, and fewer broad spectrum insecticides are used, its impact on heliothis will become more obvious. *Trichogramma* should be regarded as an integral component of IPM programs on the Downs.

Acknowledgements

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Table 1: Details of insecticides applied to INGARD cotton at Jimbour during 2001/02.

Spray Number	Date	Product	Rate (mL/ha)	Band (%)
1	21 Dec 2001	indoxacarb (Steward™)	650	60
2	9 Jan 2002	omethoate (Folimat®)	280	100
3	17 Jan 2002	spinosad (Tracer®)	200	100
4	23 Jan 2002	indoxacarb (Steward™)	850	100
5	29 Jan 2002	bifenthrin (Talstar®) chlorpyrifos-methyl (Rescue®)	800 2000	100
6	6 Feb 2002	beta-cyfluthrin (Bulldock®) amitraz (Ovasyn®) PBO	800 2000 400	100
7	19 Feb 2002	profenofos (Curacron®) parathion-methyl (Methyl Parathion®)	2000 2000	100

Table 2: Dryland INGARD cotton yields at Jimbour - 2001/02.

Treatment	Yield (b/ha) *	No. of Sprays
Sprayed cotton without an adjacent unsprayed strip	5.4 a	7
Sprayed cotton adjacent to unsprayed strip	5.1 ab	7
Unsprayed cotton	4.6 b	nil

* Data are the means of 8 or 12 hand harvest samples. Yields followed by the same letter are not significantly different (P=0.05, ANOVA, Fisher's LSD).

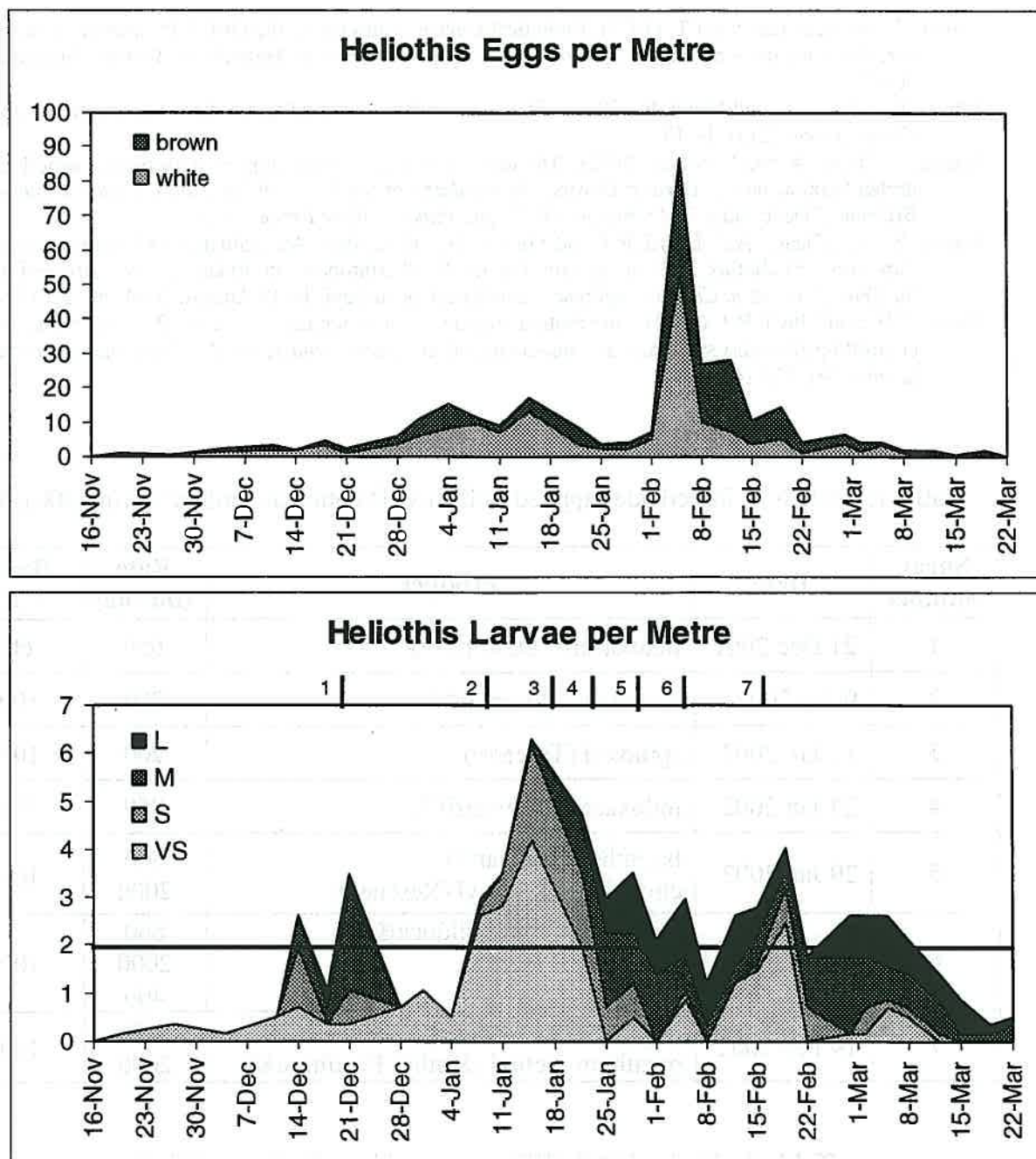


Figure 1: The numbers of heliothis eggs and larvae in sprayed INGARD cotton at Jimbour during 2001/02. The numbered lines refer to ground-rig applications of insecticides (see Table 1). Data are crop scout data courtesy of John and Kylie Fuelling.

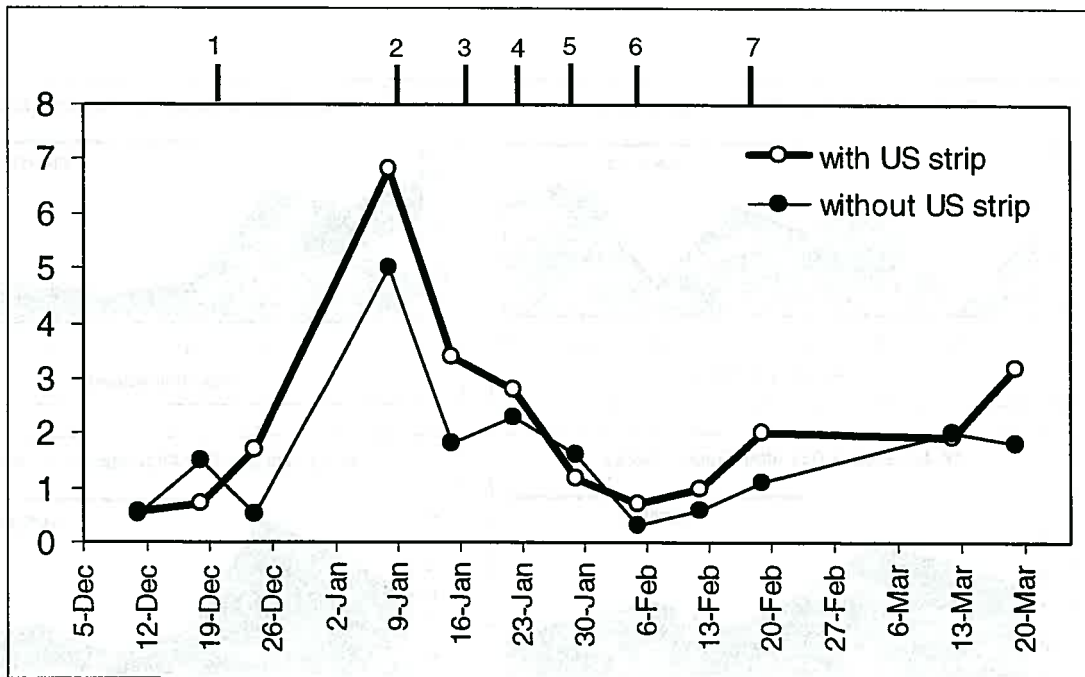


Figure 2: The numbers of predators in sprayed INGARD cotton with and without an adjacent unsprayed cotton nursery strip (US). Data are the mean numbers per metre of 20 beat sheet samples. The numbered lines refer to ground-rig applications of insecticides (see Table 1).

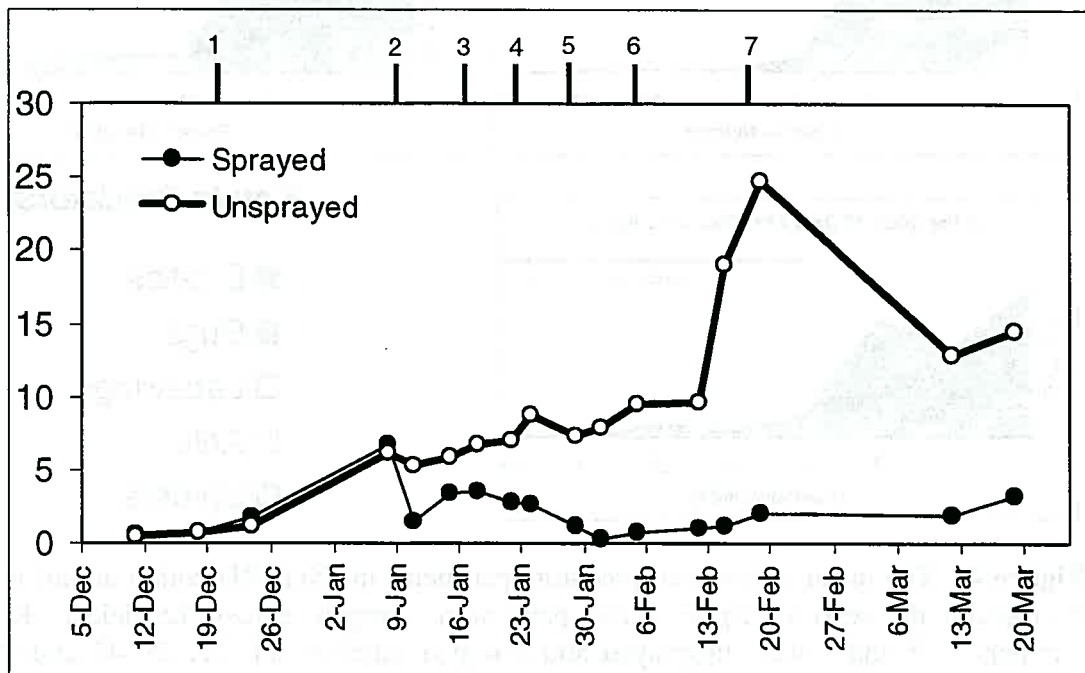


Figure 3: The numbers of predators in sprayed and unsprayed INGARD cotton at Jimbour. Data are the mean numbers per metre of 12 beat sheet samples (unsprayed) or 20 beat sheet samples (sprayed). The numbered lines refer to ground-rig applications of insecticides (see Table 1).

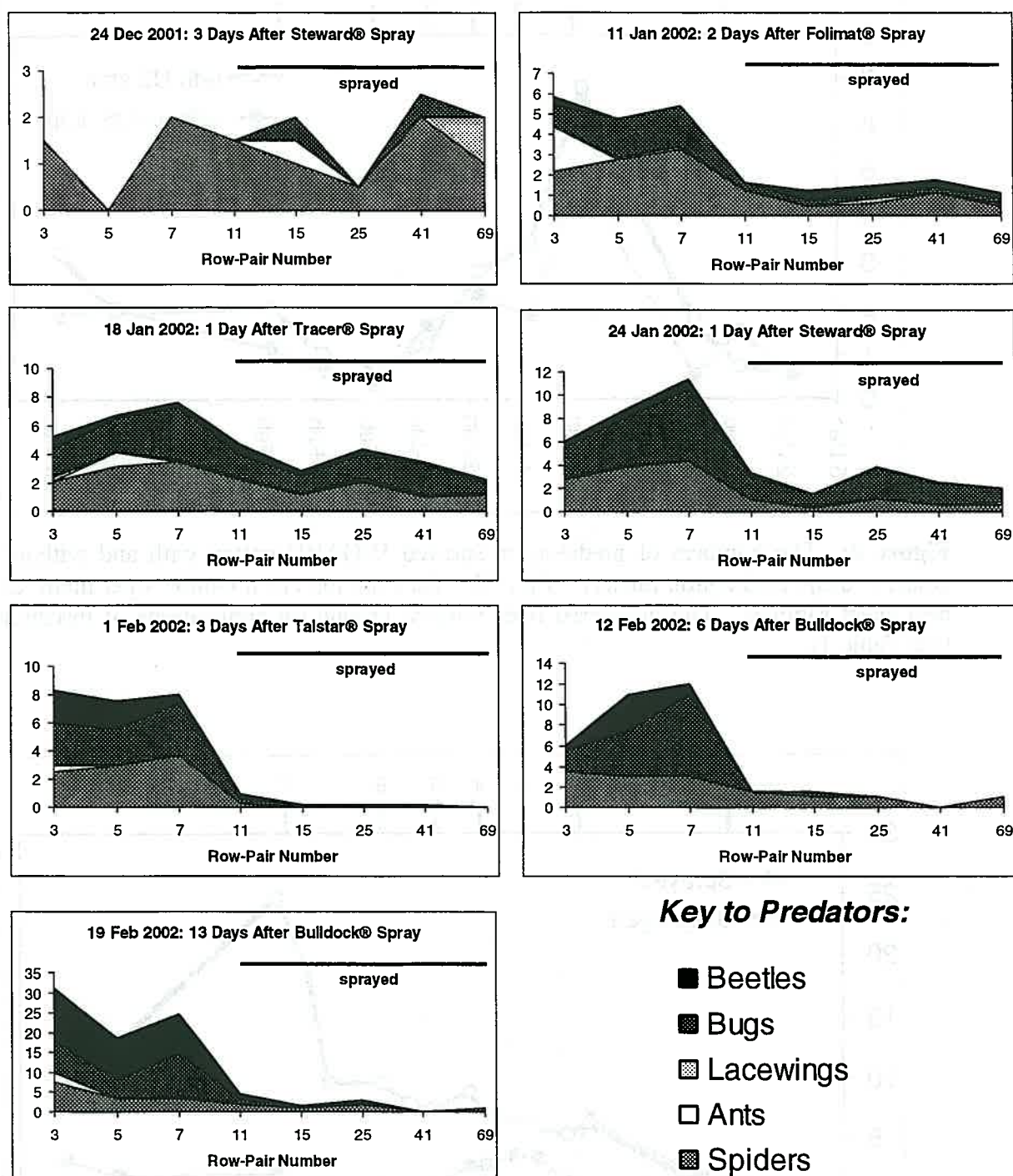


Figure 4: The mean numbers of predators per metre in INGARD cotton at various times throughout the season. Specific row-pairs were sampled across the fields. Row-pair numbers 3, 5 and 7 were unsprayed and row-pair numbers 11, 15, 25, 41 and 69 were sprayed by ground rig (see Table 1 for spray details). Data are the means of 8 beat sheet samples (11 Jan, 18 Jan, 24 Jan and 1 Feb) or 2 beat sheet samples (24 Dec, 12 Feb and 19 Feb). **N.B.** The y-axis in each graph is variable (the maxima range from 3 to 35 predators/m), and the x-axis is not drawn to scale.

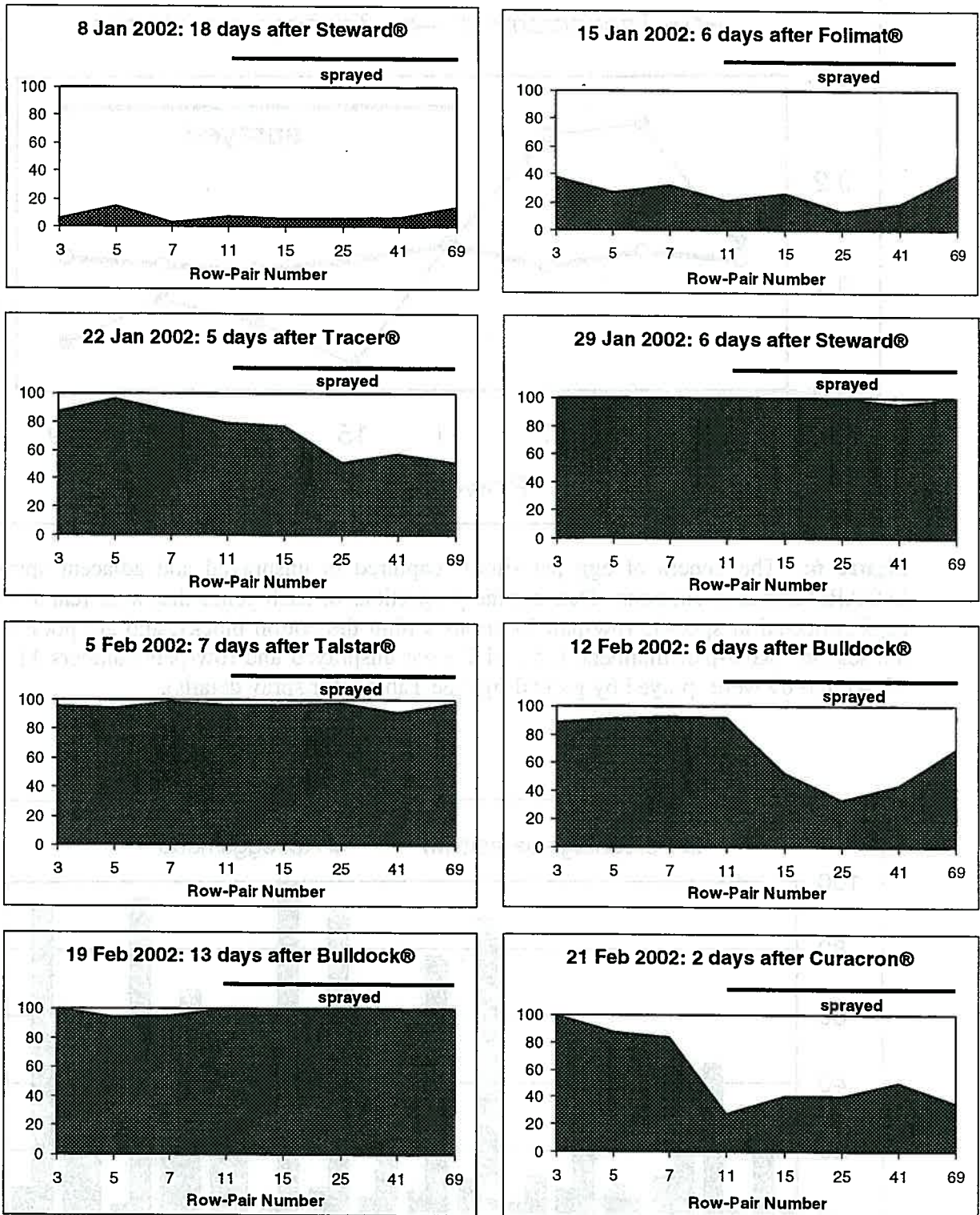


Figure 5: The levels of heliothis egg parasitism (%) in INGARD cotton at various times throughout the season. Specific row-pairs were sampled across the fields. Row-pair numbers 3, 5 and 7 were unsprayed and row-pair numbers 11, 15, 25, 41 and 69 were sprayed by ground rig (see Table 1 for spray details). Data are based on field collections of naturally laid brown eggs for all dates except 21 Feb 2002. Data for 21 Feb represent % egg cards parasitised after 48 hours exposure in the field. **N.B.** The x-axis is not to scale.

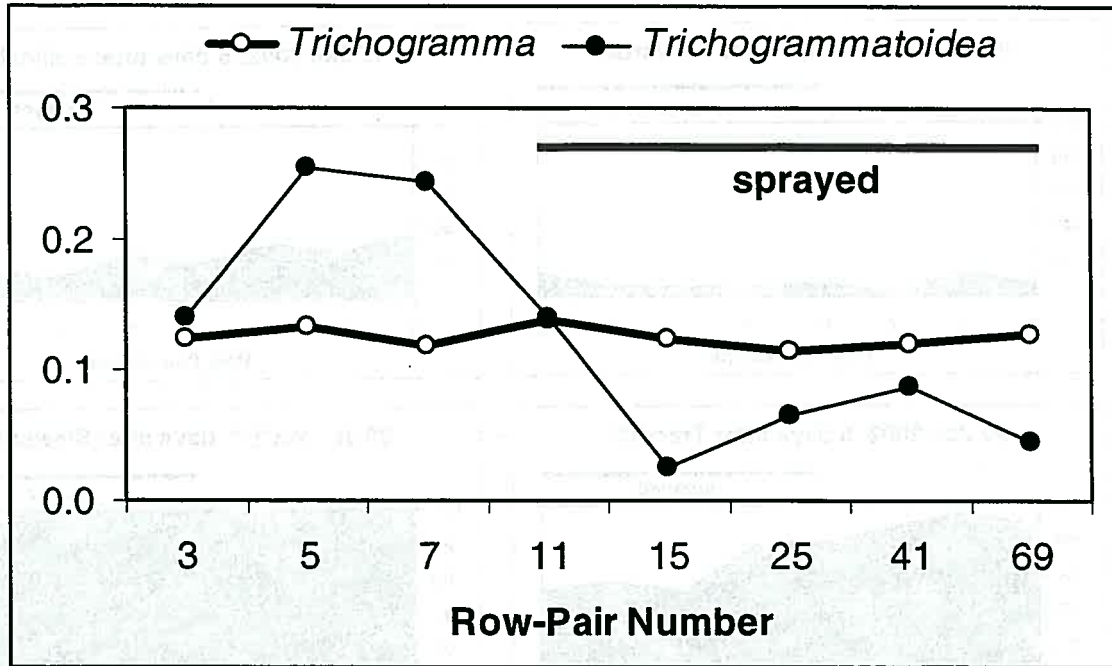


Figure 6: The genera of egg parasitoids captured in unsprayed and adjacent sprayed INGARD cotton at Jimbour. Data are the proportions of each genus that were reared from eggs collected at specific row-pair locations within the cotton blocks, and are pooled for the season. Row-pair numbers 3, 5 and 7 were unsprayed and row-pair numbers 11, 15, 25, 41 and 69 were sprayed by ground rig (see Table 1 for spray details).

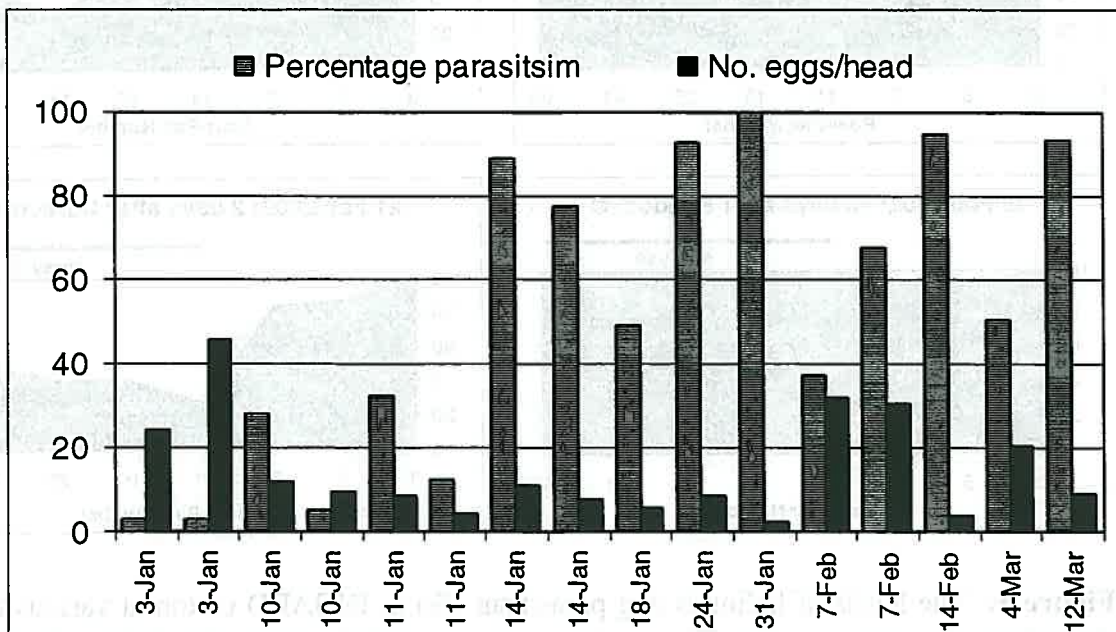


Figure 7: The levels of heliothis (*H. armigera*) egg parasitism (%) and the mean number of eggs per head in sorghum at Jimbour during 2002. All of the sorghum sampled was on, or adjacent to, the "Coondarra" trial site.