The nursery value of sorghum intercropped with cotton – the effects on heliothis egg parasitism and predator abundance in cotton.

Brad Scholz and Nathaniel Parker.
Qld. Department of Primary Industries and Fisheries & Aust. Cotton CRC, PO Box 102, Toowoomba 4350.

Key Findings

- Intercropping cotton with sorghum encouraged the establishment and population growth of *Trichogramma* and two species of predatory beetles in the cotton.
- Higher levels of heliothis egg parasitism were found in cotton adjacent to sorghum where *Trichogramma* were released, than in cotton adjacent to control sorghum. These differences were detected ca. one generation after the *Trichogramma* were released, suggesting that inoculative releases of wasps can supplement native populations, and enhance the overall impact of *Trichogramma* on heliothis.
- Predatory beetles were more abundant in sorghum than adjacent cotton. Red and blue beetles and the white collared ladybird were the most abundant predatory species found. Their abundance in cotton was greater downwind of intercropped sorghum than it was in upwind cotton, suggesting that there was some movement from the sorghum into the cotton.

Introduction

Sorghum is extremely attractive to ovipositing heliothis (*Helicoverpa armigera*) moths. Some cotton growers on the Darling Downs are intercropping cotton with sorghum because they believe that sorghum may act as a beneficial nursery, and that the beneficials may move into the adjacent cotton.

Here we report on a trial comparing the levels of heliothis egg parasitism and predator abundance in cotton adjacent to intercropped sorghum. The heliothis egg parasitoid *Trichogramma pretiosum* was released into half of the sorghum, and the levels of egg parasitism in the adjacent cotton were compared between the release and non-release sections of the field.

Methods

The trial was conducted at Evanslea on the Darling Downs at Neil Nass's property on West Prairie Road. Their were 48 row-pairs of single skip cotton (Sicot 80) planted either side of 80 rows of MR43 sorghum, with one metre row spacings. The trial was 880 m long, i.e. two 12.7 ha plantings of cotton either side of 7 ha of sorghum. The trial was planted during the last week of November 2002. The cotton was sprayed twice up until early February, viz. Costar® on 30 December 2002 and Tracer® on 14 January 2003.

Heliothis Egg Parasitism

A pre-release collection of heliothis eggs was completed on the 17th January 2003. Pre-flowering sorghum heads were cut and individually spun into a funnel that emptied into a small 30 mL plastic diet cup. The eggs from a single sorghum head were collected into a diet cup, and 22 heads were selected at random from the sorghum. The cups were returned to the laboratory, and the eggs were isolated individually in the cells of a plastic micro-titre tray. The egg colour was recorded, i.e. white or brown, and all eggs were held in a constant temperature room at ca. 25°C and 60% R.H. until they hatched or showed signs of parasitism (turned jet black). The proportion of brown eggs parasitised, and the mean number of eggs per sorghum head, were determined.

On the 17th January 180 cardboard capsules, each containing ca. 1,000 *T. pretiosum* wasps, were released in the northern half of the sorghum. The *Trichogramma* were released in a grid pattern, viz. 30 capsules per row; 14 m apart; in every 13th row commencing from row 7, i.e. rows 7, 20, 33, 46, 59 and 72.

Heliothis egg cards were used to assess the levels of egg parasitism because there were few natural eggs laid throughout the trial. Adult *H. armigera* moths were placed in oviposition chambers where they laid eggs onto paper towelling. Each card was made by stapling pieces of paper towelling containing approximately 20 *H. armigera* eggs to paper strips measuring 1.5 x 7 cm. The eggs were less than 24 hours old. Each card was stapled to the upper side of a leaf at the top of a plant. The egg cards were stapled on leaves in a grid pattern, viz. 20 cards per row in row-pairs 2, 5, 10, 25, and 45 of the cotton (on each side of the sorghum), and in rows 25 and 50 of the sorghum.

The egg cards were placed in approximately the same location each week, and were used weekly for three weeks - 17 January, 24 January and 31 January 2003. The egg cards were collected after 48 hours exposure in the field, and were allowed to develop in a constant temperature room at approximately 25°C and 60% R.H.. The proportion of viable egg cards containing parasitised eggs were recorded.

Egg cards that contained no eggs after collected, or cards that were comprised entirely of collapsed or shrunken eggs, were discarded when calculating the levels of parasitism.

Predator Abundance

The numbers of predators in the cotton and inter-cropped sorghum were assessed weekly over four weeks from 7-28 January 2003. A yellow beat sheet (Scholz *et al.* 2001) was used to sample the cotton in row-pairs 2, 5, 10, 25 and 45 on either side of the sorghum, and in each half of the inter-cropped sorghum. Six beat samples were taken at each site in the cotton and sorghum. Predatory beetles, bugs, ants, lacewings and spiders were counted on the beat sheets.

Results and Discussion

Heliothis Egg Parasitism

There were 0.6 ± 0.2 eggs/head in the sorghum, and no eggs parasitised on the 17th January, i.e. egg pressure and egg parasitism were very low prior to the release of *Trichogramma*. There were negligible levels of heliothis egg parasitism in the sorghum, and only low levels of parasitism in the cotton on the 17th and 24th January (Figure 1). The greatest levels of heliothis egg parasitism were found in the cotton on the 31st January.

The level of egg parasitism in the cotton adjacent to the release sorghum (21%), was significantly higher than that in the cotton adjacent to the control sorghum (9%) on the 31st January (Table 1). There were no significant differences in the levels of egg parasitism recorded on the other dates. The 31st January was approximately one generation after the wasps were released in the sorghum. This suggests that the *Trichogramma* were able to establish on natural eggs within the field, and that their abundance rose sufficiently over one generation to have a significant impact on parasitism levels in the adjacent cotton. There was low heliothis oviposition activity throughout this study, with egg densities peaking at 0.75 eggs/m (Table 2). No field collections of naturally laid eggs were completed.

The levels of egg card parasitism in the cotton varied across the field, with the highest levels (58%) recorded on the downwind, western side of the sorghum (Figure 1). This suggests that the sorghum may have been a nursery for the *Trichogramma*, and that their dispersal was affected greatly by prevailing winds.

Predator Abundance

Throughout the study there were more predators in the sorghum than in the adjacent cotton (Figure 2). The majority of predators counted were predatory beetles (57% in cotton and 73% in sorghum). Of these, the most frequently counted species were the red and blue beetle (*Dicranolaius bellulus*), and the white collared ladybeetle (*Hippodamia variegata*). These two beetles accounted for 94% of the adult beetles in cotton, and 91% of the adult beetles in sorghum. Ladybird larvae were only found in the sorghum.

There were significantly more predators on the downwind side of the sorghum than on the upwind side on three of the sampling dates (Table 3), suggesting that the sorghum may have had a role in supplementing the abundance of predators in the cotton. There were significant differences in the abundance of the two common beetle species, *D. bellulus* and *H. variegata*, between the downwind and upwind sections of the cotton. The sorghum appeared to be very attractive to these beetles, and there seems to be some flow-on benefits to nearby cotton.

Further research is needed to more fully understand the benefits of intercropping cotton with sorghum to enhance the abundance, and impact, of predators and parasitoids. This study was conducted during low heliothis pressure. Similar work should be completed under higher pest pressure. Ideally separate fields with and without sorghum intercropped should be compared.

Acknowledgements

We thank Neil Nass for cooperating in this research, and the Cotton Research and Development Corporation for funding the research (project DAQ125C). Sue Maclean (DPI Toowoomba) supplied *Helicoverpa armigera* eggs. This assistance is gratefully acknowledged.

References

Scholz, B., Cleary, A. and Lloyd, R. (2001). Sheet unbeatable for sampling predators in cotton. *Australian Cottongrower* 22(5): 14-17.

TABLE 1

The levels of heliothis egg card parasitism in conventional cotton intercropped with sorghum. *Trichogramma pretiosum* were released into half of the sorghum on 17 January 2003, and the levels of egg parasitism in the adjacent cotton were assessed in row-pairs 2, 5, 10, 25 and 45 on either side of the sorghum. The values represent the mean ± standard error of parasitism levels assessed in ten row-pairs of cotton (20 egg cards per row-pair). Means for a given date followed by the same letter are not significantly different (Un-paired t-test, P = 0.05). Control = no *Trichogramma* released into sorghum; Release = *Trichogramma* released into sorghum on 17 January 2003.

Date	Control Cotton	Release Cotton
17 January 2003	2.5 ± 1.4 a	4.5 ± 2.0 a
24 January 2003	1.3 ± 0.9 a	1.3 ± 0.8 a
31 January 2003	8.8 ± 2.6 a	20.7 ± 4.8 b

TABLE 2

Mean heliothis egg densities per metre in cotton intercropped with sorghum at Evanslea.

Date	White Eggs	Brown Eggs	Total Eggs
7 January 2003	0	0.08	0.08
13 January 2003	0.25	0.25	0.50
21 January 2003	0.17	0.08	0.25
28 January 2003	0.25	0.50	0.75

TABLE 3

The total numbers of predators in cotton, downwind and upwind of intercropped sorghum. Values are the mean ± standard error of 30 beat sheet samples. Means for a given date followed by the same letter are not significantly different (Un-paired t-test, P = 0.05).

Date	Downwind (West)	Upwind (East)
7 January 2003	1.00 ± 0.19 a	1.20 ± 0.18 a
13 January 2003	2.43 ± 0.35 a	1.43 ± 0.23 b
21 January 2003	2.17 ± 0.33 a	1.33 ± 0.18 b
28 January 2003	2.87 ± 0.37 a	1.96 ± 0.25 b

TABLE 4

The numbers of white collared ladybeetles (*Hippodamia variegata*) in cotton, downwind and upwind of intercropped sorghum. Values are the mean ± standard error of 30 beat sheet samples. Means for a given date followed by the same letter are not significantly different (Un-paired t-test, P = 0.05).

Date	Downwind (West)	Upwind (East)
7 January 2003	0.10 ± 0.07 a	0 a
13 January 2003	0.93 ± 0.22 a	0.17 ± 0.07 b
21 January 2003	0.33 ± 0.13 a	0.03 ± 0.03 b
28 January 2003	0.50 ± 0.16 a	0.38 ± 0.16 a

TABLE 5

The numbers of red and blue beetles (*Dicranolaius bellulus*) in cotton, downwind and upwind of intercropped sorghum. Values are the mean ± standard error of 30 beat sheet samples. Means for a given date followed by the same letter are not significantly different (Un-paired t-test, P = 0.05).

Date	Downwind (West)	Upwind (East)
7 January 2003	0.37 ± 0.10 a	0.53 ± 0.13 a
13 January 2003	0.63 ± 0.16 a	0.33 ± 0.10 a
21 January 2003	1.00 ± 0.18 a	0.67 ± 0.16 a
28 January 2003	1.17 ± 0.24 a	0.50 ± 0.17 b

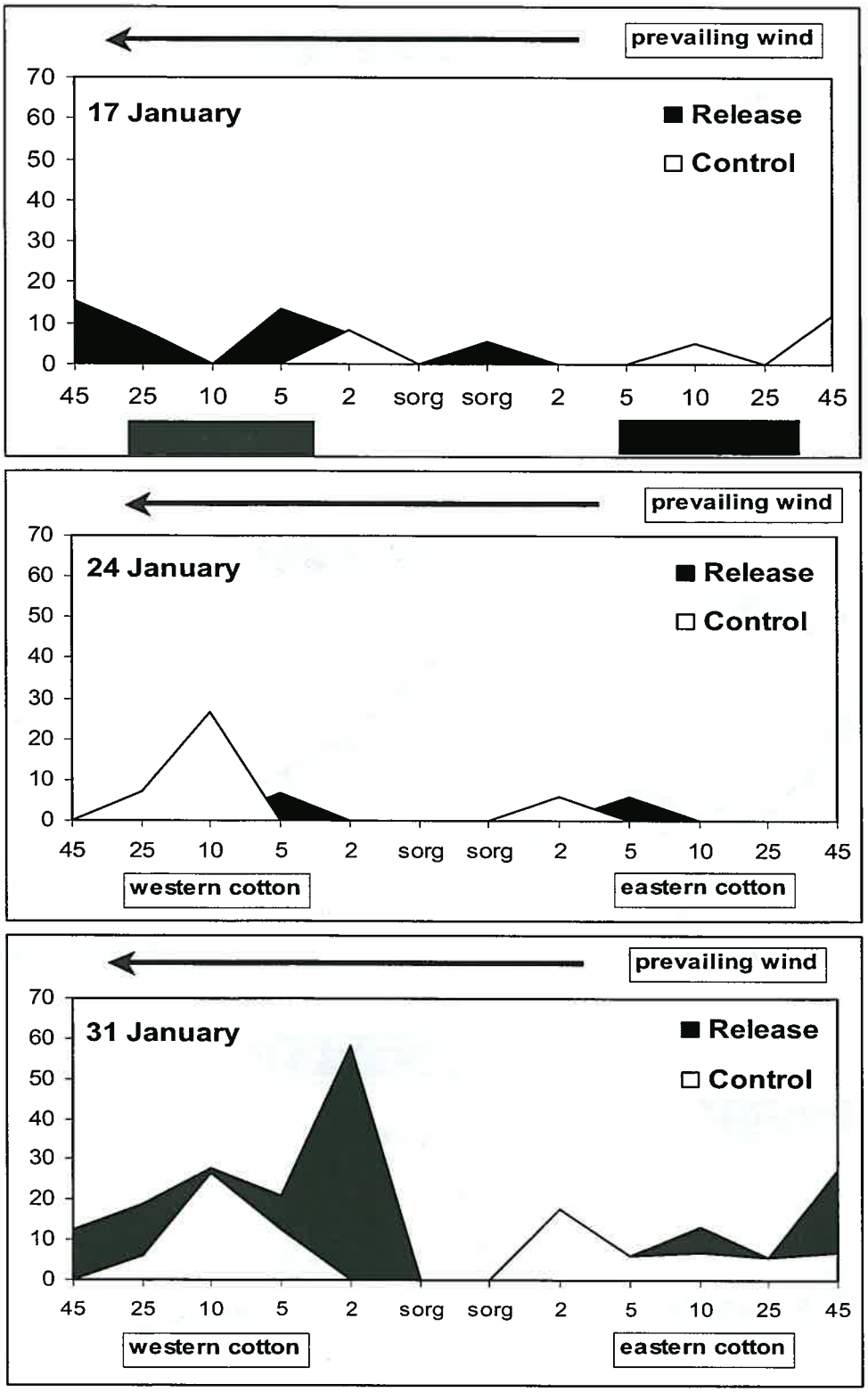

Figure 1: The levels of heliothis egg parasitism in conventional cotton inter-cropped with sorghum. The values are the % of egg cards parasitised at weekly intervals following the release of *T. pretiosum* on 17 January 2003 into half of the sorghum. The egg cards were placed in the cotton at regular intervals on either side of the sorghum (row-pairs 2, 5, 10, 25 and 45), and in sorghum rows 25 and 50. The release rate was 60,000 wasps/ha. The levels of egg parasitism increased approximately one generation after the release (on the 31st January) on the down wind side of the sorghum.

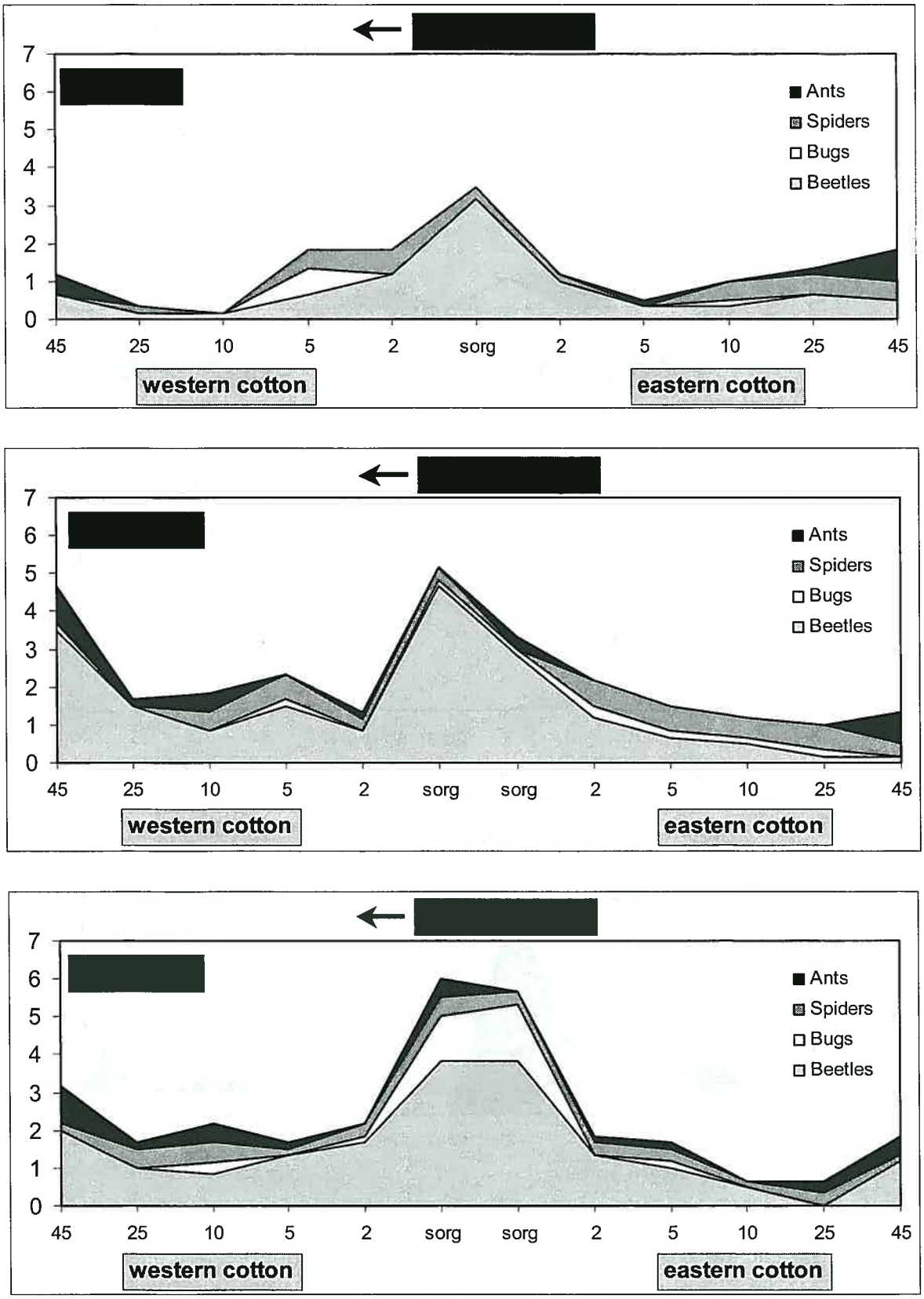

Figure 2: The numbers of predators per metre in conventional cotton inter-cropped with sorghum. The values are the means of six beat sheet samples. The beat samples were taken in the cotton at regular intervals on either side of the sorghum (row-pairs 2, 5, 10, 25 and 45), and at random in each half of the sorghum. Row-pair 45 was approximately 135 m from the edge of the sorghum.

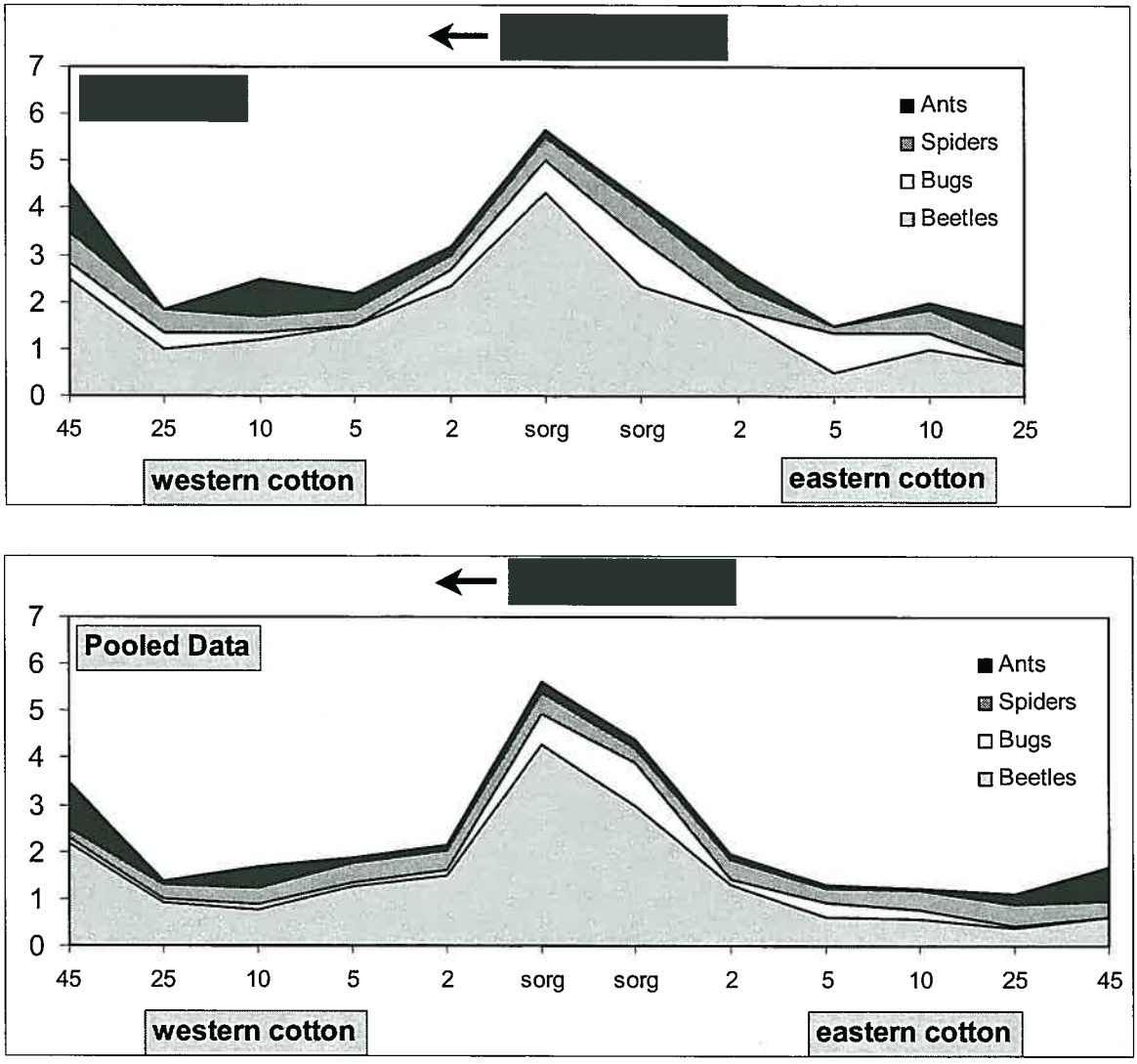

Figure 2 (cont.): The numbers of predators per metre in conventional cotton inter-cropped with sorghum. The values are the means of six beat sheet samples. The beat samples were taken in the cotton at regular intervals on either side of the sorghum (row-pairs 2, 5, 10, 25 and 45), and at random in each half of the sorghum. Row-pair 45 was approximately 135 m from the edge of the sorghum. Pooled data are the overall means for all (4) sampling dates.