Appendix

Appendix 5.1

Ranking of Predator Abundance

The ranking of the abundance of predators at each treatment. There are 10 treatment sites.
The predators were divided into adults and juveniles before ranking on the overall total at each site.
The abundance was based on the 10 metre sampling with the Bigvac suction sampler.

Midkin 1992/3: Soft-Options, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Campylomma spp.	652	14.38
2	Dicranolaius bellulus	612	7.81
3	Nabis kinbergii	495	8.00
4	Orius spp.	172	2.00
5	Geocoris spp.	158	1.94
6	Creontiades dilutus	141	4.06
7	Formicidae	111	1.63
8	Oxyopes spp.	98	3.75
9	Salticidae	43	0.88
10	Chiracanthium diversum	41	1.00
11	Other Spiders	28	0.38
12	Diomus notescens	24	0.69
13	Coccinella tranversalis	22	0.50
14	Harmonia conformis	12	0.75
15	Germalus spp.	7	0.19
16	Oechalia schellenbergii	7	0.19
17	Micraspis frenata	3	0.06
18	Mictolestodes macleayi	3	0.06

The ranking of adult predators caught over the 1992/3 cotton growing season at Midkin from the area treated with soft-option insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 16 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1992/3: Soft-Options, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	1048	9.56
2	Creontiades dilutus	544	8.00
3	Other Spiders	498	5.50
4	Salticidae	136	3.06
5	Campylomma spp.	91	2.63
6	Malada signata	30	0.81
7	Nabis kinbergii	24	0.88
8	Geocoris spp.	12	0.38
9	Oechalia schellenbergii	9	1.25
10	Chiracanthium diversum	9	0.19

The ranking of juvenile predators caught over the 1992/3 cotton growing season at Midkin from the area treated with soft-option insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 16 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Midkin 1992/3: Conventional Insecticides, Adult predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Dicranolaius bellulus	448	4.69
2	Campylomma spp.	233	4.13
3	Nabis kinbergii	117	2.38
4	Formicidae	109	1.25
5	Creontiades dilutus	81	2.25
6	Coccinella transversalis	70	1.50
7	Oxyopes spp.	66	1.31
8	Orius spp.	64	1.13
9	Chiracanthium diversum	29	0.63
10	Diomus notescens	28	0.63
11	Geocoris spp.	28	0.50
12	Salticidae	27	0.50
13	Other Spiders	14	0.31
14	Germalus spp.	11	0.63
15	Harmonia conformis	4	0.13
16	Mictolestodes macleayi	4	0.19
17	Oechalia schellenbergii	4	0.19
18	Micraspis frenata	0	0.00

The ranking of adult predators caught over the 1992/3 cotton growing season at Midkin from the area treated with conventional insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 16 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1992/3: Conventional Insecticides, Juvenile predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	573	5.38
2	Other Spiders	459	6.19
3	Creontiades dilutus	370	4.81
4	Salticidae	102	1.81
5	Malada signata	48	0.75
6	Campylomma spp.	44	1.13
7	Nabis kinbergii	10	0.38
8	Geocoris spp.	9	0.19
9	Chiracanthium diversum	8	0.19
10	Oechalia schellenbergii	0	0.00

The ranking of juvenile predators caught over the 1992/3 cotton growing season at Midkin from the area treated with conventional insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 16 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Midkin 1993/4: Soft-options, Plot 2, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	237	19.75
2	Campylomma spp.	115	6.00
3	Formicidae	73	4.50
4	Diomus notescens	60	6.00
5	Coccinella transversalis	54	4.50
6	Nabis kinbergii	39	2.75
7	Salticidae	22	2.00
8	Other Spiders	19	1.50
9	Dicranolaius bellulus	18	1.00
10	Chiracanthium diversum	18	1.25
11	Creontiades dilutus	14	1.00
12	Geocoris spp.	12	0.75
13	Orius spp.	9	1.00
14	Germalus spp.	1	0.25
15	Oechalia schellenbergii	1	0.25
16	Mictolestodes macleayi	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Midkin from the area treated with soft-option insecticides (plot 2). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1993/4: Soft-options, Plot 2, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	1496	93.00
2	Other Spiders	360	13.25
3	Chiracanthium diversum	27	1.75
4	Salticidae	24	2.00
5	Creontiades dilutus	18	1.25
6	Geocoris spp.	16	1.75
7	Oechalia schellenbergii	11	2.75
8	Malada signata	8	0.75
9	Campylomma spp.	5	0.50
10	Coccinella transversalis	2	0.50
11	Nabis kinbergii	1	0.25
12	Orius spp.	1	0.25

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Midkin from the area treated with soft-option insecticides (plot 2). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Midkin 1993/4: Conventional Insecticides, Plot 1, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Formicidae	134	6.50
2	Campylomma spp.	95	8.50
3	Diomus notescens	74	8.00
4	Oxyopes spp.	66	4.25
5	Coccinella transversalis	57	4.50
6	Nabis kinbergii	50	5.25
7	Dicranolaius bellulus	38	3.75
8	Creontiades dilutus	33	2.75
9	Other Spiders	15	1.75
10	Salticidae	8	0.50
11	Chiracanthium diversum	8	1.00
12	Geocoris spp.	5	0.75
13	Germalus spp.	2	0.25
14	Orius spp.	1	0.25
15	Mictolestodes macleayi	0	0.00
16	Oechalia schellenbergii	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Midkin from the area treated with conventional insecticides (Plot 1). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1993/4: Conventional Insecticides, Plot 1, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	827	55.00
2	Other Spiders	416	20.00
3	Creontiades dilutus	54	5.25
4	Salticidae	24	2.25
5	Chiracanthium diversum	15	1.75
6	Malada signata	7	0.75
7	Campylomma spp.	3	0.50
8	Geocoris spp.	2	0.25
9	Coccinella transversalis	0	0.00
10	Nabis kinbergii	0	0.00
11	Oechalia schellenbergii	0	0.00
12	Orius spp.	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Midkin from the area treated with conventional insecticides (Plot 1). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Midkin 1993/4: Soft-options, Plot 4, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	253	18.75
2	Campylomma spp.	176	7.50
3	Diomus notescens	82	7.50
4	Coccinella transversalis	77	5.25
5	Nabis kinbergii	46	4.00
6	Formicidae	43	2.75
7	Dicranolaius bellulus	34	2.00
8	Creontiades dilutus	29	2.25
9	Geocoris spp.	22	2.00
10	Chiracanthium diversum	16	1.00
11	Other Spiders	14	0.50
12	Salticidae	5	0.75
13	Orius spp.	4	0.50
14	Germalus spp.	2	0.25
15	Oechalia schellenbergii	2	0.25
16	Mictolestodes macleayi	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Midkin from the area treated with soft-option insecticides (Plot 4). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1993/4: Soft-options, Plot 4, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	1398	80.75
2	Other Spiders	388	11.50
3	Creontiades dilutus	36	3.50
4	Chiracanthium diversum	31	1.50
5	Geocoris spp.	28	3.00
6	Salticidae	10	0.50
7	Coccinella transversalis	8	2.00
8	Nabis kinbergii	8	1.25
9	Malada signata	8	1.00
10	Campylomma spp.	7	0.50
11	Oechalia schellenbergii	0	0.00
12	Orius spp.	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Midkin from the area treated with soft-option insecticides (Plot 4). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Midkin 1993/4: Conventional Insecticides, Plot 3, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Campylomma spp.	150	8.75
2	Oxyopes spp.	69	5.25
3	Diomus notescens	54	6.50
4	Coccinella transversalis	52	4.00
5	Nabis kinbergii	50	6.00
6	Dicranolaius bellulus	30	2.75
7	Creontiades dilutus	25	2.50
8	Formicidae	24	1.25
9	Chiracanthium diversum	14	1.50
10	Other Spiders	11	0.75
11	Geocoris spp.	10	1.00
12	Salticidae	7	0.50
13	Germalus spp.	2	0.25
14	Orius spp.	2	0.25
15	Mictolestodes macleayi	0	0.00
16	Oechalia schellenbergii	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Midkin from the area treated with conventional insecticides (Plot 3). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Midkin 1993/4: Conventional Insecticides, Plot 3, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	652	40.75
2	Other Spiders	499	14.75
3	Creontiades dilutus	39	3.75
4	Chiracanthium diversum	17	1.00
5	Malada signata	15	1.50
6	Campylomma spp.	12	1.25
7	Salticidae	12	0.75
8	Geocoris spp.	7	0.50
9	Coccinella transversalis	0	0.00
10	Nabis kinbergii	0	0.00
11	Oechalia schellenbergii	0	0.00
12	Orius spp.	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Midkin from the area treated with conventional insecticides (Plot 3). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Wilby 1993/4: Control Plot, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Formicidae	423	30.25
2	Campylomma spp.	182	14.00
3	Diomus notescens	181	23.75
4	Oxyopes spp.	139	7.50
5	Coccinella transversalis	104	7.75
6	Dicranolaius bellulus	89	7.75
7	Creontiades dilutus	45	5.50
8	Chiracanthium diversum	32	5.50
9	Nabis kinbergii	30	5.25
10	Other Spiders	24	2.75
11	Geocoris spp.	4	0.75
12	Germalus spp.	4	0.50
13	Salticidae	4	0.50
14	Oechalia schellenbergii	3	0.50
15	Mictolestodes macleayi	2	0.50
16	Orius spp.	2	0.50

The ranking of adult predators caught over the 1993/4 cotton growing season at Wilby from the area treated with no insecticides (Control Plot). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Wilby 1993/4: Control Plot, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	359	37.50
2	Other Spiders	189	12.25
3	Creontiades dilutus	81	12.25
4	Chiracanthium diversum	33	5.50
5	Campylomma spp.	21	1.75
6	Salticidae	13	2.25
7	Geocoris spp.	4	0.75
8	Malada signata	3	0.50
9	Orius spp.	2	0.25
10	Nabis kinbergii	1	0.25
11	Coccinella transversalis	0	0.00
12	Oechalia schellenbergii	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Wilby from the area treated with no insecticides (Control Plot). The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Wilby 1993/4: Organic Treatments, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	114	12.00
2	Coccinella transversalis	93	9.00
3	Formicidae	43	8.50
4	Campylomma spp.	36	4.50
5	Dicranolaius bellulus	25	3.00
6	Diomus notescens	20	3.00
7	Chiracanthium diversum	18	2.50
8	Other Spiders	12	2.00
9	Oechalia schellenbergii	1	0.25
10	Mictolestodes macleayi	0	0.00
11	Geocoris spp.	0	0.00
12	Germalus spp.	0	0.00
13	Nabis kinbergii	0	0.00
14	Orius spp.	0	0.00
15	Creontiades dilutus	0	0.00
16	Salticidae	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Wilby from the area treated with organic treatments. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Wilby 1993/4: Organic Treatments, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	334	43.25
2	Other Spiders	131	14.50
3	Chiracanthium diversum	17	2.50
4	Salticidae	14	2.50
5	Campylomma spp.	7	1.50
6	Creontiades dilutus	4	1.00
7	Malada signata	3	0.50
8	Geocoris spp.	2	0.50
9	Coccinella transversalis	0	0.00
10	Nabis kinbergii	0	0.00
11	Oechalia schellenbergii	0	0.00
12	Orius spp.	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Wilby from the area treated with organic treatments. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Alcheringa 1993/4: Control Plot, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Campylomma spp.	470	41.83
2	Dicranolaius bellulus	260	28.50
3	Formicidae	187	32.75
4	Coccinella transversalis	114	7.25
5	Creontiades dilutus	107	13.67
6	Nabis kinbergii	84	9.33
7	Oxyopes spp.	83	14.50
8	Diomus notescens	49	7.25
9	Orius spp.	30	4.25
10	Other Spiders	19	2.50
11	Geocoris spp.	9	1.17
12	Oechalia schellenbergii	7	0.83
13	Chiracanthium diversum	7	1.00
14	Salticidae	4	0.50
15	Mictolestodes macleayi	0	0.00
16	Germalus spp.	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Alcheringa from the area treated with no insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Alcheringa 1993/4: Control Plot, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	527	51.33
2	Campylomma spp.	177	20.00
3	Other Spiders	152	9.25
4	Creontiades dilutus	125	16.17
5	Coccinella transversalis	37	4.33
6	Malada signata	26	2.50
7	Salticidae	21	1.83
8	Oechalia schellenbergii	13	2.17
9	Orius spp.	12	2.50
10	Nabis kinbergii	7	0.67
11	Geocoris spp.	1	0.25
12	Chiracanthium diversum	1	0.25

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Alcheringa from the area treated with no insecticides. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

Appendix 5.1 continued

Alcheringa 1993/4: Organic Treatments, Adult Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Campylomma spp.	125	24.50
2	Coccinella transversalis	34	6.25
3	Nabis kinbergii	33	6.00
4	Dicranolaius bellulus	31	7.00
5	Creontiades dilutus	18	3.00
6	Oxyopes spp.	18	3.25
7	Formicidae	16	3.50
8	Orius spp.	10	1.75
9	Chiracanthium diversum	7	1.25
10	Other Spiders	6	1.25
11	Geocoris spp.	4	1.50
12	Diomus notescens	3	0.75
13	Oechalia schellenbergii	2	0.50
14	Salticidae	1	0.50
15	Mictolestodes macleayi	0	0.00
16	Germalus spp.	0	0.00

The ranking of adult predators caught over the 1993/4 cotton growing season at Alcheringa from the area treated with organic treatments. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

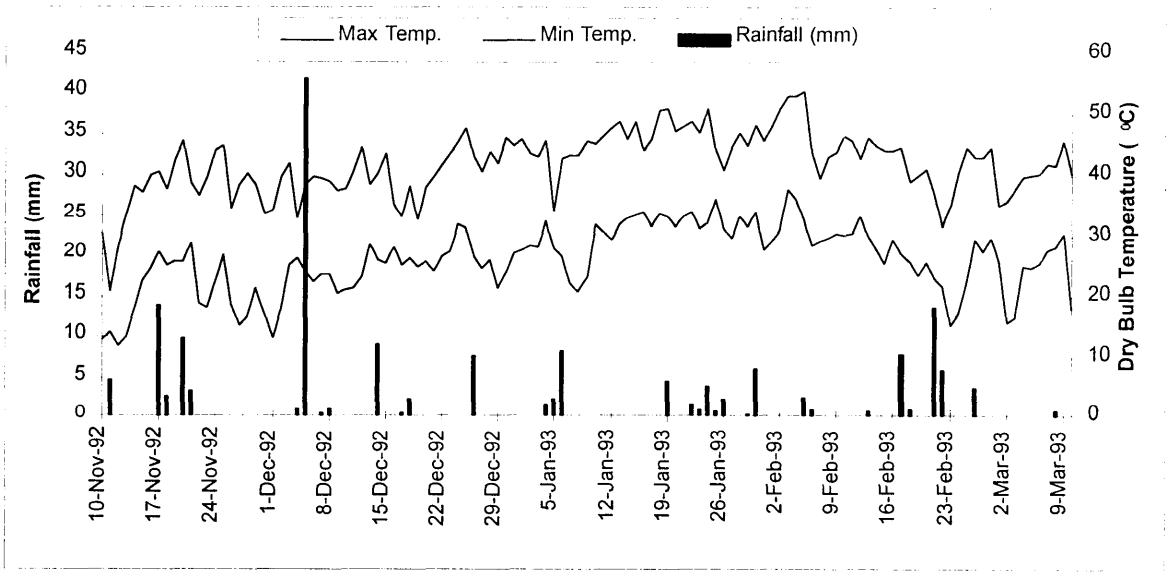
Alcheringa 1993/4: Organic Treatments, Juvenile Predators			
Ranking	**Predator**	**Total**	**Max Daily Average**
1	Oxyopes spp.	309	66.50
2	Other Spiders	88	13.75
3	Creontiades dilutus	25	6.00
4	Malada signata	11	1.75
5	Salticidae	10	3.00
6	Chiracanthium diversum	5	0.75
7	Oechalia schellenbergii	4	2.00
8	Campylomma spp.	4	0.75
9	Geocoris spp.	1	0.25
10	Nabis kinbergii	1	0.50
11	Coccinella transversalis	0	0.00
12	Orius spp.	0	0.00

The ranking of juvenile predators caught over the 1993/4 cotton growing season at Alcheringa from the area treated with organic treatments. The ranking is based on the total number of arthropods collected in 10 metre Bigvac suction samples. The maximum daily average is based on the 4 Bigvac samples which were collected from this site on the dates sampling occured.

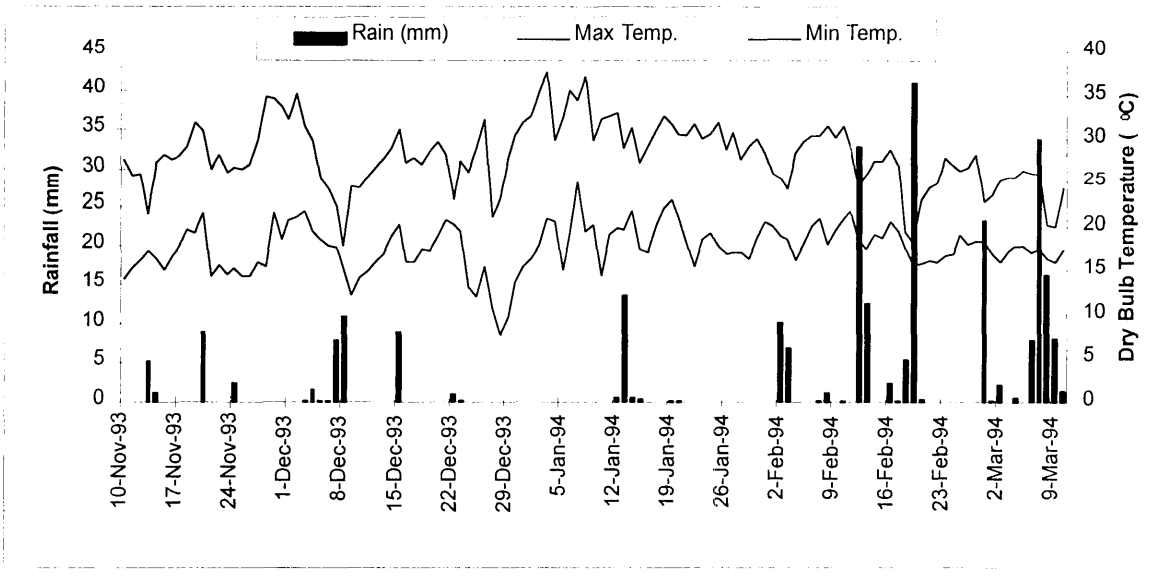
Appendix 5.5

Meteorological Data

Meteorological data from the meteorological stations closest to the sampling sites.
(Data was supplied by the Queensland and NSW Bureaus of Meteorology, Stationed at Moree and Goondawindi)

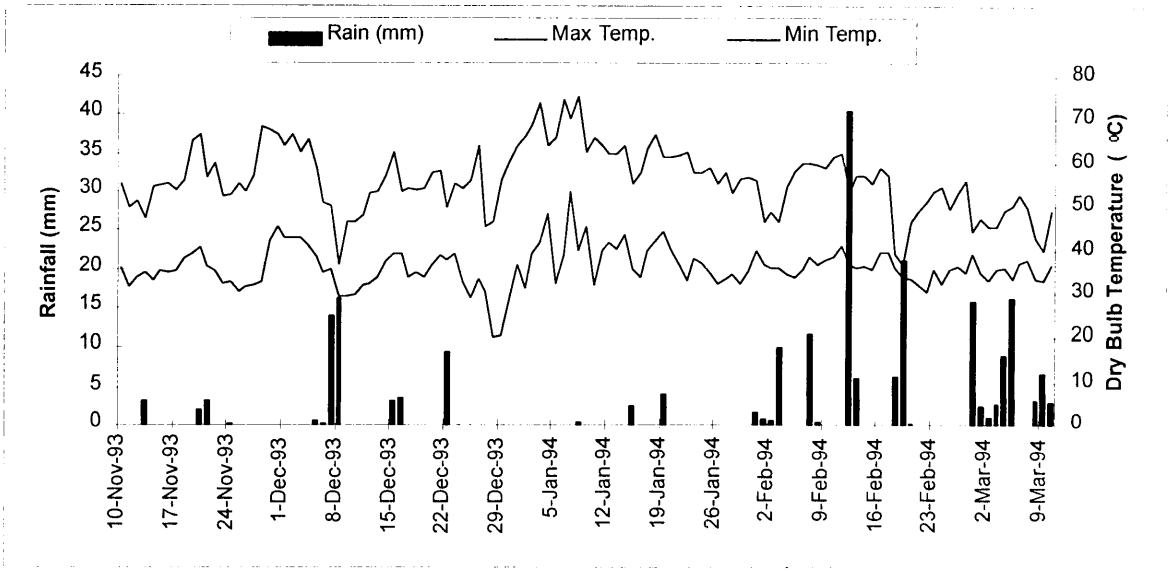


Maximum and minimum daily temperature and daily rainfall for **Moree, NSW** (29^0 28'S 149^0 51' E) over the period of arthropod sampling at Midkin during the 1992/3 cotton growing season. This represents the closest meteorological station to Midkin (ca. 20km South of Midkin).
(Data was supplied by the NSW Bureau of Meteorology, Stationed at Moree)



Maximum and minimum daily temperature and daily rainfall for **Moree, NSW** (29^0 28'S 149^0 51' E) over the period of arthropod sampling at Midkin during the 1993/4 cotton growing season. This represents the closest meteorological station to Midkin (ca. 20km South of Midkin).
(Data was supplied by the NSW Bureau of Meteorology, Stationed at Moree)

Appendix 5.5 *continued*



Maximum and minimum daily temperature and daily rainfall for **Goondawindii, NSW** (28^0 33'S 150^0 18' E) over the period of arthropod sampling at Alcheringa during the 1993/4 cotton growing season. This represents the closest meteorological station to Alcheringa (cv. 4km north west of Alcheringa). Data was not available from North Star, the closest township to the Wilby site.
(Data was supplied by the Queensland. Bureau of Meteorology, Stationed at Goondawindi)

Appendix 5.6

Sources of Insecticides

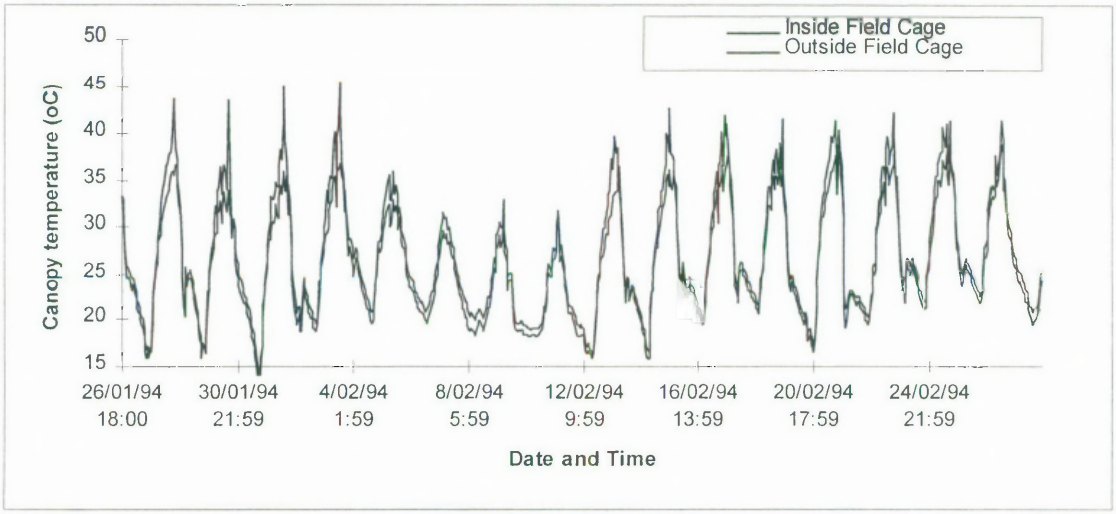
Sources of the insecticides used in the conventional and soft-option treatments at 'Midkin', in 1992/3 and 1993/4.

Trade Name	Active Ingredient	Manufacturer	Manufactorer's Address
Soft-Options			
Larvin®	Thiodicarb	Rhone-Poulenc	3-5 Railway St. Baulkham Hills, Sydney. 2153
Dipel®	Bacillus thuringiensis	Abbot Australasia	47 Epping Rd. North Ryde, Sydney. 2113
Helix®	Chlorfluazuron	ICI Crop Care	1 Nicholson St. Melbourne, Vic. 3000
Pirimor®	Pirimicarb	ICI Crop Care	1 Nicholson St. Melbourne, Vic. 3000
Commercial Options			
Thiodan®	Endosulfan	Hoechst Schering Agrevo Pty Ltd	1731-1733 Malvern Rd. Glen Iris, Vic. 3146
Decis®	Deltamethrin (Synthetic Pyrethroid)	Hoechst Schering Agrevo Pty Ltd	1731-1733 Malvern Rd. Glen Iris, Vic. 3146
Dimethoate®	Dimethoate	Hoechst Schering Agrevo Pty Ltd	1731-1733 Malvern Rd. Glen Iris, Vic. 3146

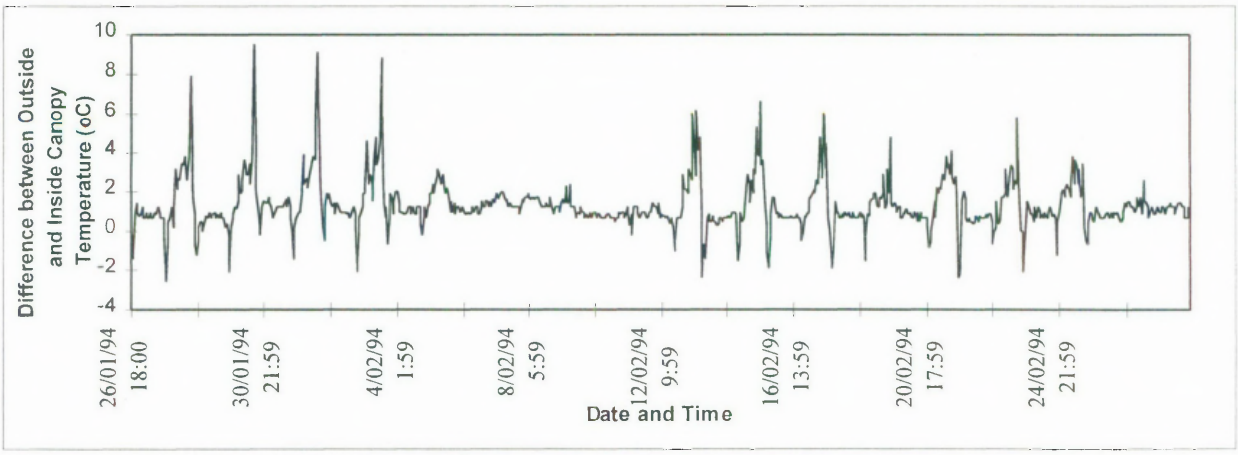
Appendix 7.1

Comparison of Canopy Temperature Inside and Outside the Field Cages

Data loggers were set up to record the canopy temperatures inside and outside field cages during the field cage trials. Two cages were monitored at each trial and the period of measurement continued beyond the insect treatment periods on most occasions. A short section has been extracted to illustrate the trends



A typical trace of canopy temperature recording from the inside and outside of field cages during the field cage trials in January at 'Midkin' 1994. This shows that the temperature of the canopy inside the field cages was generally cooler than that outside and that the greatest difference occurred over the extremes of midday and midnight

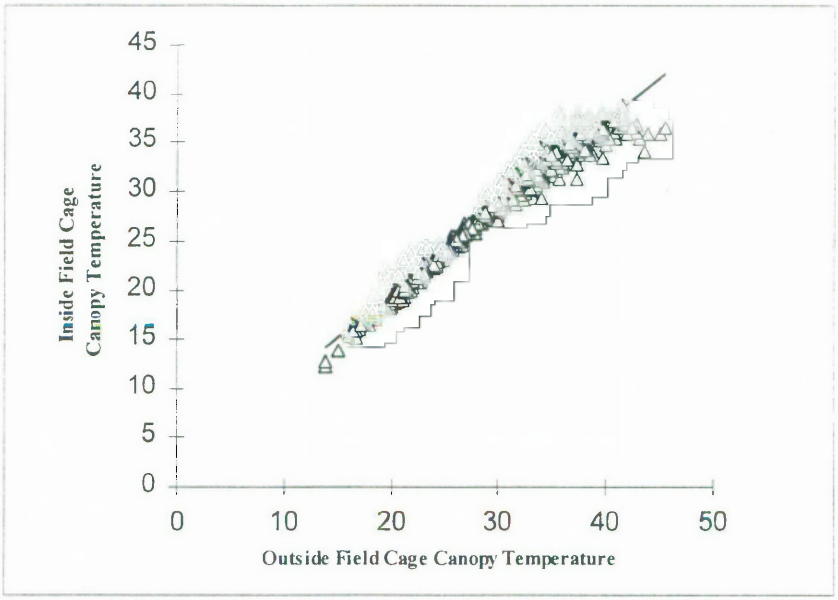


The difference between the canopy temperature inside and outside the field cages for the same date as in the chart above. This shows that the outside temperature was usually between 1 and 4 degrees higher that the inside canopy temperature however this could increase to around 8 degrees or drop to minus 3 (i.e. inside temperature is greater than the outside temperature). The large differences may be explained by the sensor becoming exposed to direct sunlight because the sensors relied on the canopy for shading. The period of no peaks (around the 8/2/94) probably represents a series of overcast days.

Appendix 7.1 continued

Regression Analysis of Inside-Cage and Outside-Cage Canopy Temperatures.

Regression analysis of this data showed a strong correlation between the inside and outside canopy temperatures. The cluster of points corresponding to outside temperatures of about 45^0C imply a limit to inside temperatures but may have been due to rare occasions when the outside temperature sensors were illuminated directly by the sun. These sensors relied on the dense cotton canopy for shading whereas the inside temperature sensors would always have been shaded to some extent by the cage material regardless of the position of the sun.



The regression of canopy temperature inside the field cages verses outside.
$R^2 = 0.97$ (n = 797) and the line formula:

Inside temperature = Outside temperature x 0.88 + 1.1 °C

Appendix 7.2

The Statistical Analysis of the Effect of Three Species of Predator on the Abundance of Alternative Prey (*Aphis gossypii* Glover) in the Third Cage Trial.

(Reported in Chapter 7.6)

Treatments

Twenty four field cages were set up over cotton plants.
The aphids in each cage were scored (percentage infested terminals) and assigned a ranking of low, medium or high abundance. The treatments were randomly assigned to the cages so that two of each treatment fell in each aphid abundance category.
This produced;

6 control cages (no predators present),
6 cages with 30 adult *Coccinella transversalis* (transverse ladybirds)
6 cages with 30 adult *Dicranolaius bellulus* (red and blue beetles)
6 cages with 15 adult *Nabis kinbergii* (pacific damsel bugs).

Helicoverpa punctigera larvae were also present in the cages but this had no significant effect on the aphid density.

One Way Analysis of Variance

Source	df	Sum of Squares	Mean Square	F-ratio
Total	23	8454.24	367.57	
Predators	3	3243.11	1081.03	4.15
Error	20	5211.12	260.55	

Estimates and Standard Errors of the change in aphid abundance from the beginning to the end of the six day predation trial.

Predator Treatment & (Number per cage)	% Change in Aphid Abundance*
Control (no predators)	8.93 a
***Coccinella transversalis* (30)**	-15.85 b
***Dicranolaius bellulus* (30)**	-10.65 b
***Nabis kinbergii* (15)**	10.44 a

Standard Error = 6.59
Standard Error of the Difference = 9.32
Treatments followed by the same letter were not significantly different at the 5% level (LSD).

* Aphid abundance was measured as the proportion (%) of infested cotton plant terminals in each cage.

Appendix 7.3

The Life Cycle and Rearing Methods for *Dicranolaius bellulus*

Introduction

D. bellulus was one of the most abundant species of predator collected in the mid western cotton areas of N.S.W. It exhibited high predation rates in laboratory consumption trials on *Helicoverpa* eggs and is also tolerant of endosulfan. Dispite this, its life cycle has not been described. It is believed that eggs are laid in the soil and that all larval stages and pupae also develop there (Room 1979b). The large number of beetle eggs produced during the laboratory consumption trials (Chapter 7) presented an opportunity to observe the development of all immature stages of this insect.

Methods

Egg Collection: The paper oviposition concertinas which contained beetle eggs were collected from the laboratory consumption trial (Section 7.1.1). These were placed into petri dishes with a dampened cotton roll for humidity. The floors of the petri dishes were roughened with a fine grade of sandpaper to provide traction for the newly emerging larvae. Newly emerging larvae readily fed on a preparation of freeze dried *Helicoverpa* spp. larvae (see below). Bee pollen was also tried but young larvae became stuck to the waxy granules if it became wet by condensation.

Larval Diet: Larvae were raised on a diet of freeze dried *H. armigera* larvae from emergence to pupation. Thirty, fifth instar *H. armigera* larvae from laboratory cultures were blended at high speed in beaker. This was immersed in a larger beaker of ice water during blending to avoid overheating the mixture which may have destroyed nutrients. The complete homogenate was then freeze dried. This was offered to the 1st instar beetle larvae as a dry powder, sprinkled onto the floor of their petri dish. Beetle larvae were reared in groups of 10, but separated at pupation.

Mating: As with many members of this family (Melyridae) *D. bellulus* exhibited a mating ritual (Matthes 1970). The male pursues the female until she turns toward him. He brings both antennae so that they point forward on the ground towards her and allows her to approach and palp around his frons or basal antenna region. After this she will stand still for mating. It has been demonstrated for other Melyridae that glandular secretion are involved (Matthes 1970). It is possible that a gland exists in the enlarged antennal segments of the male, however scanning electron microscopy did not locate any obvious glandular pores.

Appendix 7.3 *continued*

Life Stages of *Dicranolaius bellulus*

The duration of each life stage was recorded and a series of photographs produced to describe the life cycle of this predator (plates 1 to 5 on the following pages).

Eggs

These were laid in clusters of 3 to 30 and hatch in 6 to 8 days at 25^{0}C.

They were 0.3 mm long, oval and yellow. Fertile eggs had a clear chorion at one end.

Larvae

Newly hatched larvae were yellow with a white head.

Two day old larvae were 0.4 mm long.

Late and final instar larvae were red/brown (including the head) and 6.5 mm long.

Duration of the larval stage was 2.5 months under these rearing conditions.

Pupae

Pupae required two weeks to develop.

Shortly before emergence (ca. 2 days) they looked much darker.

Pupal length was 4.5 mm.

The Life Stages of the Red and Blue beetle (Dicranolaius bellulus).

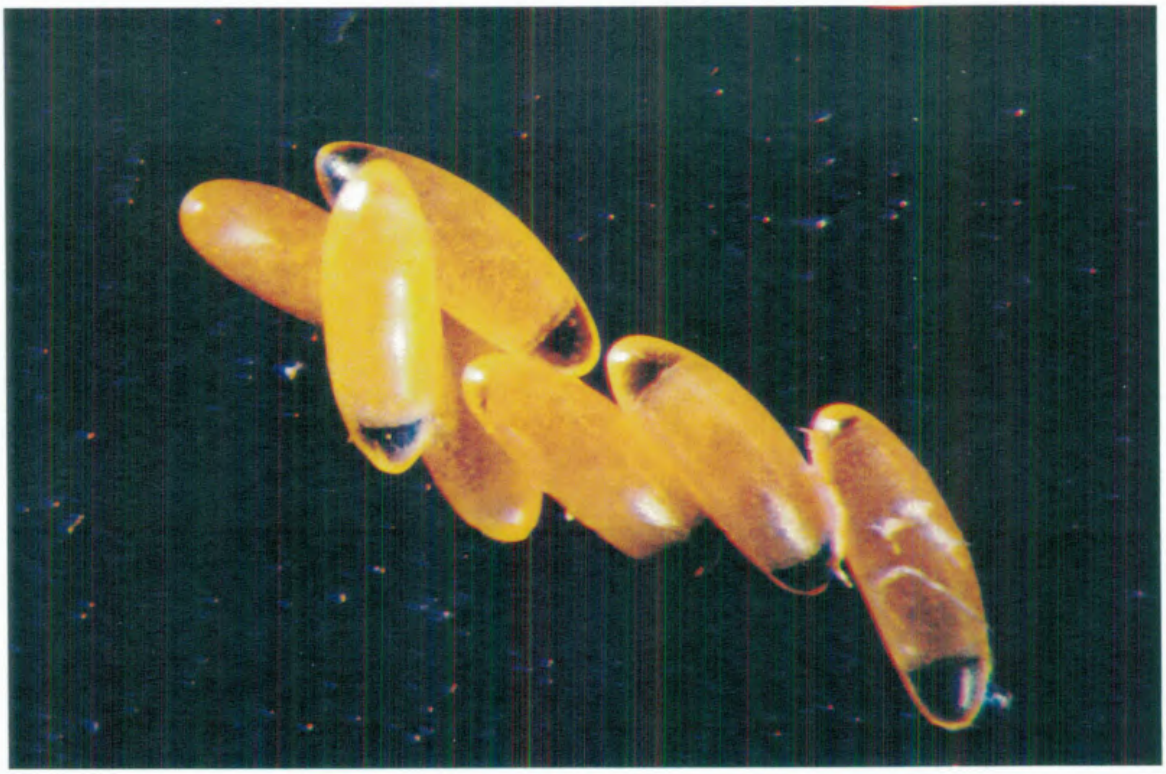


Plate 1. *D. bellulus* eggs , typically laid in clusters of 3 to 30 in the laboratory filter paper fans. These specimens were 0.3 mm long (140 x magnification).

Plate 2. Newly hatched *D. bellulus* larva. These were initially fed freeze dried 5th instar *Helicoverpa* spp. This specimen was 0.4 mm long (150 x magnification)

Plate 3. Late Instar *D. bellulus* larvae.
Specimen length was 6.5 mm.
(20 x magnification)

Plate 4 *D. bellulus* pupa.
Remained as pupae for 2 weeks.
Specimen length 4.5 mm
(30 x magnification)
←

Plate 5 *D. bellulus* Adult
This is the predatory stage which can be found in the cotton canopy
Specimen length 4 mm.
(25 x magnification)
↓

Appendix 7.4

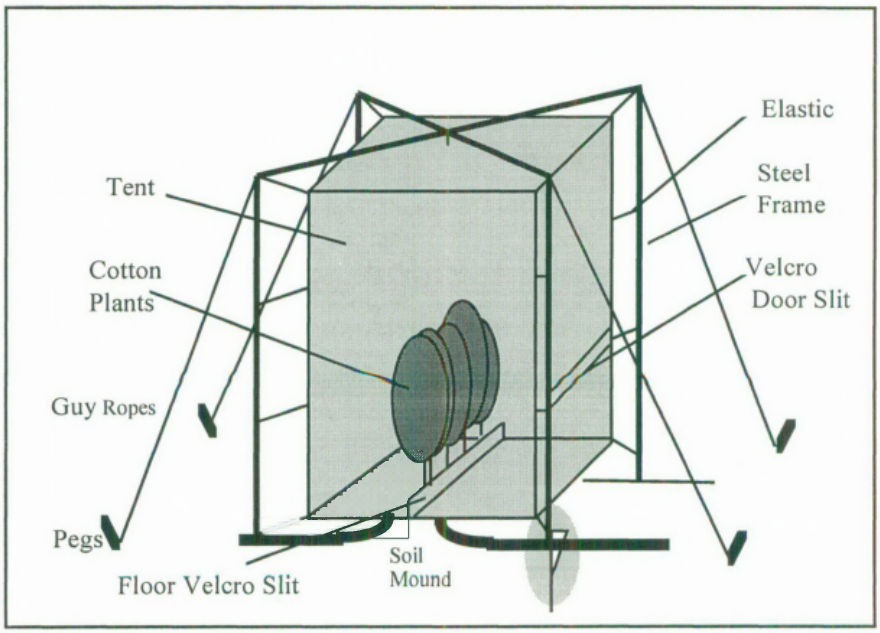
Field Cages for Predation Studies on Cotton

A field cage was designed for the study of predecious arthropods in cotton canopies (plate 6 to 8). Each had a steel frame of 6 mm dia. mild steel rod, from which a rectangular shaped screen tent (1m long x 1m wide x 2m high) was suspended on elastic straps. The design had velcro lined slots which could seal around the waist of an observer to prevent the escape of active insects during searches of the plant canopy. A suspended fabric floor was joined around the stems of the cotton plants with velcro and then sealed with a non-acetate, silicone sealant. This prevented access or escape of arthropods via soil fissures which would be possible if the tent walls were sealed onto the cracking-clay soils of the fields used in this study. Suspending the screen tent on elastic straps helped to protect the tent from tearing by the wind and removed awkward to search crevices that form between internal frames and the cage material of other designs. This also allowed the attachment of additional guy ropes.

The top of the steel frame formed a cross, hinged in the centre by a bolt and joined to the legs by vertical tubular sections of steel pipe. Each leg was pushed about 30 cm into the ground allowing alignment of the tent floor with the stems of the cotton plants. The many hooks required (21 per tent) for joining the elastics to the frames can be cheaply made by prising opening the links of an 'S' link chain. These elastic straps were tied to the tent by strong cloth loops sewn into the tent seams during manufacture. A loop was also sewn at the centre of the roof panel to lift the fabric which helped shed rain water. The frames and screen tents could be disassembled for transportation.

A commonly available polyester curtain material called 'woven voile' (terylene- 772 holes per cm^2 with 0.20 mm^2 holes) was used for the walls, floor and ceiling of the screen tents. The panels of the tent were sown together with polyester thread and the openings; the slit in the floor and the side door slits were lined with 25 mm wide velcro. The wires from data logging sensors entered through the velcro door slits and were also held and sealed in place by a non-acetate sealant. The size of the screening material could be chosen to suit the required insect size range for particular experiments.

Appendix 7.4 *continued*



Field Cage A diagram of a field cage used in the field cage trials reported in Chapter 7. Dimensions are given in the text. The frame had five pieces; four legs and a top 'cross frame' hinged in the center by a bolt. The top of the legs fitted into 10 cm long down-pipes welded at each corner. A triangular shaped piece of steel rod was welded to the base of each leg to help push it into the soil (see oval shaded inset at nearest righthand corner).

Plate 6. Field cages set up over cotton at Midkin in the first cage experiment. Twenty such cages were used in each field cage experiment. Each cage covered one row/metre of cotton plants (ie. approximately 10 plants).

Plate 7. A close up of the floor seal in the field cages to exclude arthropods from the soil. The slit in the suspended floor, through which the plants protruded, were fastened between the plant stems using a 25 mm band of velcro. The top of the velcro join was sealed using a white, non-silicone sealant.

Plate 8. A photograph demonstrating the use of the velcro doors which seal around the researchers waist to prevent the escape of test insects during data collection.