FINAL REPORT FOR CRC PROJECT UQ9L

PROJECT TITLE : Control of the pink-spotted bollworm (Pectinophora scutigera) by mating disruption with synthetic female pheromone.

Chief Investigator: M.P. Zalucki, P.H. Twine, P.W. Walker

AIM : To determine if the pink-spotted bollworm can be controlled by disrupting mating by permeating the air with synthetic female pheromone.

SUMMARY :

Field work was conducted over the 1988/89 and 1989/90 cotton growing seasons in the Central Highlands of Queensland. Pheromone dispensers, specially formulated for P. scutigera, were obtained from Shin-Etsu Chemical Company Ltd, Japan. In 1989/90 the P. gossypiella pheromone formulation was trialed, and in 1988/89 a microencapsulated formulation produced by Allied Colloids (Australia Pty Ltd) was also trialed. Experiments were generally conducted in large fields (2.7 - 18.3 ha) and dispensers applied at a rate of 1,000/ha (78 mg (AI) (Z,Z)- and (Z,E)- isomers of 7,11 hexadecadienyl acetate mixed in a 9:1 ratio). Effects of treatments were assayed using pheromone traps (both years), regular fruit samples (usually 100 per time, both years), mating table trials (year 2) and dissection of females caught in light traps, (to determine mated status, year 2).

INTRODUCTION :

The pink-spotted bollworm, Pectinophora scutigera, is a serious pest of cotton in Central Queensland and has the potential to spread to other cotton growing districts in Australia. It is a notoriously difficult pest to control as the larvae feed internally on bolls where they are effectively protected from insecticide sprays.

The considerable success in using synthetic pheromones to control P. gossypiella by mating disruption gave the impetus to consider adopting this technique for the control of P. scutigera. The major components of P. scutigera sex pheromone are identical to those of P. gossypiella. In the former species the Z,Z and Z,E isomers of 7,11-hexadecadienyl acetate occur in an approximate 9:1 ratio while in the latter species they occur in a 1:1 ratio.

GENERAL METHODS :

1988/89 Season Trials.

Polyethylene tube dispensers specially formulated for P. scutigera control, containing the Z,Z and Z,E isomers in a ca. 95:5 ratio were obtained from the Shin-Etsu Chemical Company Ltd, Japan.

Experimental trials were conducted at 4 sites in the Callide Valley, Central Queensland, near the township of Biloela in 1988/89. At each site a single cotton field was treated with pheromone dispensers at a rate of 1,000/ha and compared with a similar near-by cotton field under conventional pest management practices. Site 1 was located at the DPI Research Station farm, while Sites 2-4 were all commercial cotton fields. Details of each site are given in the Results Section and Tables 1 and 2.

All pheromone dispensers were tied onto the basal area of cotton plant stems and secured with a double twist. It took approximately 3.5 man hours to treat 1 hectare of cotton.

Initially 5 pheromone traps, baited with a 9:1 mixture of the Z,Z and Z,E isomers, were evenly spaced diagonally across each field, at least 1 week prior to application of the pheromone dispensers. Later, additional pheromone traps were placed in each field containing baits that included the 2 minor components of P. scutigera pheromone (identified by Dr C. Whittle, Division of Entomology, C.S.I.R.O., Canberra). Trap capture was recorded every 1=-4 days. All fields were checked for larval infestation twice weekly. One-hundred squares were randomly sampled from each field until bolls were available. At Site 1, the number of bolls sampled was increased to 200 after the 30 December.

Crop growth was also monitored in each field during boll sampling by recording the number of squares, open flowers, green and dry bolls on 30 plants at fixed sampling points. All fields were sampled until defoliation of the crop.

In 1988/89 a sprayable pheromone formulation produced by Allied Colloids was also trialed.

1989/90 Season Trials

All cotton grown on the DPI Research Station, Biloela, was treated with P. scutigera formulated pheromone dispensers at a rate of 1,000 dispensers/ha. The area of cotton treated totalled 15.9 ha and comprised of six small fields surrounded by other summer crops and pasture land. The nearest untreated cotton field was situated approximately 2 km away. One of the pheromone treated fields (2.7 ha in area) was not sprayed with insecticides throughout the season, while all other fields were sprayed according to the recommendations of local cotton scouts. Dispensers were applied during the early squaring stage of growth on 13 December 1989, or 10 January 1990, depending on the planting date of the cotton. Bolls (N = 100) were sampled from the unsprayed field and one sprayed field at approximately weekly

intervals and inspected for P. scutigera larvae. Pheromone traps were placed in each field before the application of dispensers. The mated status of all P. scutigera females caught in an ultraviolet light trap placed in the unsprayed field, over 12 nights during January, February and March, was determined by dissection. These females were compared with the mated status of those caught in a light trap placed in a commercial cotton field that was not treated with pheromone.

Unmated P. scutigera females, originating from laboratory cultures, were placed within pheromone treated cotton and in adjacent non-cotton crops. Three to five clipped -winged females were placed in containers, with a leaf of the respective crop they were placed in, and tied onto plant stems at sunset. Females were observed during the period of sexual activity, between midnight and dawn. Unmated male and female moths were also placed together inside small containers in pheromone treated and untreated areas. Sweep net samples were taken at approximately half-hour intervals throughout the period of observation to assess the number of P. scutigera within each area.

A commercial cotton field (ca 8 ha) was treated with P. gossypiella pheromone dispensers, at a rate of 1,000/ha, during early squaring of 16 December 1989. The number of moths caught in pheromone traps and rates of larval infestation in bolls was compared with a near-by untreated field.

Results 1988/89 Season

Site 1. The pheromone treated field was a 2.4 ha block of experimental cotton growing on the DPI research station. No insecticides were applied to this field after placement of the pheromone dispensers on 5 December, when plants were in the early squaring stage. The untreated comparison was a 4 ha field of cotton that received 5 aerial applications of

insecticide.

One week prior to applying the pheromone dispensers a total of 52 moths were caught in pheromone traps. After the pheromone dispensers were applied, the trap catch was totally shut down for a period of 62 days, when 1 moth was caught on 5 February. Only 7 more moths were caught up until the crop was defoliated.

Despite the spraying of insecticide 5 times to the pheromone untreated field, of which the last 2 (Lorsban and Alphacord) were applied specifically for the control of P. scutigera, over 5,535 moths were trapped (Fig 1).

Initially differences in larval infestation between the 2 fields looked promising (Fig 2). Levels of boll infestation in the pheromone untreated field started to increase in mid-January and rose steeply in early February, peaking at 45.5% by the middle of the month. Again this was despite the spraying of insecticide 5 times.

Boll infestation in the pheromone treated field remained low throughout January and early February, comparing favourably with the insecticide field. In mid-February infestation levels increased sharply in both fields, and reached very high levels (57%) in the pheromone treated field by the time the crop was defoliated.

Sites 2 and 3 were commercial cotton fields consisting of 9 and 7 ha pheromone treated fields which were compared with nearby 7 and 13.8 ha pheromone untreated fields. The 2 sites were situated ca. 20 km apart. At each site several insecticide sprays were applied to control other cotton pests (mainly Heliothis spp.). Both the pheromone treated and untreated fields received exactly the same number of insecticide applications.

Both sites were treated with pheromone dispensers during the early squaring stage on 17 December. As in Site 1, very good disruption of pheromone trap catch occurred in both pheromone treated fields. Before the pheromone was applied, 2349 and 36 moths were

caught over 7 days, whereas after application only 20 and 5 moths were caught in a ca. 3 month period at Sites 2 and 3, respectively. The first moths were caught 69 and 83 days after application of the pheromone dispensers. In the pheromone untreated fields over 7,778 and 3,269 moths were caught at Sites 2 and 3 respectively.

The difference in boll infestation between the pheromone treated and untreated fields was very marked at Site 2 (Fig 3). Although larvae were found in samples of bolls from the pheromone treated field, the level of infestation remained low at between 0 and 6% until the end of the season. In the pheromone untreated field boll infestation increased sharply towards the end of February and reached 62% when sampling ceased.

A similar, although less marked difference, in boll infestation was seen at Site 3. Because of age differences in the 2 fields bolls were sampled for a longer period of time in the pheromone untreated field. boll infestation in the pheromone treated field was relatively high during late March (13%) but nearly all the larvae found were located along one crop edge that was adjacent to a field containing ratoon cotton plants. These ratoon plants were highly infested with P. scutigera larvae throughout the cotton season and may have been a source of mated females. In the pheromone untreated field the levels of boll infestation increased sharply from 5% on 27 March to 34% on 9 April, surpassing that recorded in the pheromone treated field.

Site 4. This site was chosen as it represented a field of late planted cotton in an area that has consistently suffered from high P. scutigera infestations each cotton season. Generally, late planted cotton is more susceptible to P. scutigera damage than crops planted early in the season.

The pheromone treated field was 18.3 ha in area and directly adjacent to the pheromone untreated field of similar size. Both fields were planted in mid-December and

received a number of insecticide applications to control mainly sap-sucking bugs and Heliothis spp. The same insecticides were applied to both fields except the pheromone untreated field received one extra application (Methyl-parathion) at the very end of the season in an attempt to control P. scutigera (Fig 4).

Pheromone dispensers were not applied until 25 February when cotton plants had reached peak squaring and early bolls were already set. Total "shut down" of pheromone trap catch was achieved at this site. No moths were caught in the pheromone treated field while over 4,306 moths were caught in the adjacent pheromone untreated field.

Larvae were not detected in boll samples until the very end of the cotton season. In the pheromone untreated field boll infestation rose steeply from 2% on 1 May to 27% on 10 May. Larvae were only found in the pheromone treated field on the very last sampling occasion on 10 May (14% of bolls infested) (Fig 4).

1989/90 Season

As in the 1988/89 season, disruption of pheromone trap catch within the pheromone treated cotton fields was spectacular. Only two P. scutigera males were caught in pheromone traps over the entire cotton season, after pheromone dispensers were applied. In comparison, more than 5535 males were caught in one 3.9 ha pheromone untreated cotton field on the DPI Research Station during the 1989/90 season. However, when pheromone traps were placed immediately outside the treated cotton, in non-cotton crops, during late February, large numbers of male P. scutigera were caught. These traps were placed in a bean and sorghum crop less than 3m from treated cotton fields.

Again, as seen in previous trails, despite good disruption of pheromone trap catch, P. scutigera larval infestations still developed in three of the treated fields sampled. In the

unsprayed field, levels of boll infestation were low when compared to previous data collected from unsprayed cotton over three seasons (Walker, unpublished data). However, this may have been partly related to the effects of the very hot and dry weather experienced in Central Queensland which considerably advanced the growth of the cotton plants. Boll infestation in one of the sprayed fields reached 20% and it was necessary to apply an insecticide spray to control P. scutigera larvae.

Capture of males in pheromone traps placed in non-cotton crops suggested that mating can take place in these areas immediately outside the treated cotton. This was verified when clipped-winged virgin female P. scutigera were placed in the field. While all virgin females placed within treated cotton remain unmated, a high proportion of females placed in the adjacent sorghum and bean crops were successfully mated by feral P. scutigera males. Furthermore sweep net samples taken inside the sorghum and bean crops revealed the presence of large numbers of feral male and female P. scutigera, including mating paris.

When unmated male and female P. scutigera were placed inside small containers within pheromone treated cotton, they were able to mate successfully. This suggests that the pheromone treatment is only effective at disrupting long distance sexual communication.

The proportion of unmated females caught in a light trap placed in the unsprayed, pheromone treated cotton was initially high in late January but decreased as the season progressed (Table 3). The number of spermatophores in a female indicates the number of times that female has mated, as males can only pass one spermatophore within 24 hours (Vickers 1982). At the end of January, between 65 and 86% of all females caught in the pheromone treated field were unmated, while nearly all other moths caught had mated only once (Table 3). In the first half of February, the percentage of unmated females caught decreased to between 42 and 62%, and the percentage of females that had mated more than

once increased. Compared to the mated status of females caught in a pheromone untreated field during the same period, the incidence of multiple mating in the pheromone treated field was low (Table 3). In the pheromone untreated field, unmated females were very rare. Most females had mated one to three times although up to six spermatophores were found in some individuals. By the end of March very few unmated females were caught in the pheromone treated field and the incidence of multiple mating increased to levels similar in pheromone untreated cotton.

The P. gossypiella pheromone dispensers gave very good disruption of P. scutigera pheromone trap catch until early March (Fig 5). During January and February only 1 male was caught in the pheromone treated field compared to over 2602 in the untreated field. However, in March trap catch in the pheromone treated field increased sharply. A total of 625 moths were caught in five pheromone traps (Fig 5), and during this period boll infestation in both fields increased to very high levels (Fig 6).

CONCLUSION :

A single application of synthetic pheromone formulated in polyethylene tube dispensers, at a rate of 1000/ha was successful in disrupting long distance sexual communication in P. scutigera over the entire cotton season.

Control was confounded by the ability of P. scutigera to successfully mate in adjacent non-cotton crops. This led to mated P. scutigera females laying fertile eggs in pheromone treated cotton, particularly late in the season. Generally treatment reduced and delayed but did not prevent PSB infestation.

Control of PSB by mating disruption would only occur when all sources of adult moths are eliminated by either treating very large areas of cotton, or areas that are isolated

from other cotton crops.

P. gossypiella formulated dispensers are not suitable for P. scutigera control, unless they are applied more than once over the cotton season. Similarly the microencapsulation formulation would require repeated application (and some improvement)

DISSEMINATION OF RESULTS :

Two papers have been published to date and a further 1 - 2 major publications arising from this work are planned and these will be forwarded to the Council.

Walker, P.W., Zalucki, M.P. and P.H. Twine. 1990. Control of the pink-spotted bollworm by mating disruption. The Aust.Cott.Grower 10: 38-93.

Walker, P.W., Zalucki, M.P. and P.H. Twine. 1990. Disruption of sexual communication in the pink-spotted bollworm, Pectinophora scutigera (Holdaway) with Synthetic pheromone. Fifth Australian Cotton Conference, Aug 8-9, Broadbeach, Qld.

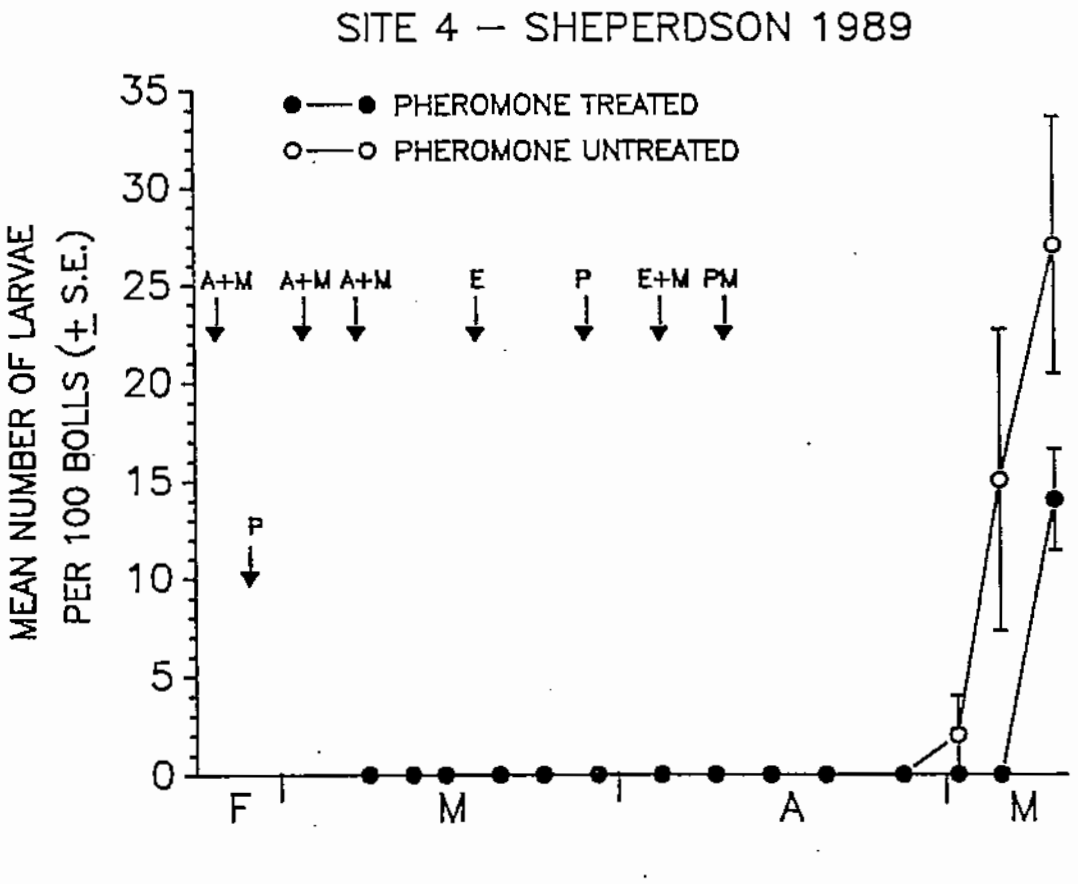

Fig. 8. Mean number of larvae infesting forms (squares or bolls): Site 4 –Sheperdsons' property, Biloela.

Fig.4. Mean number of larvae infesting forms at Site 4, Shepardson Property, Biloela. Upper arrows indicate insecticides sprays applied to both pheromone treated and untreated fields. E=Endosulfan, M=Methomyl, A=Pyrethroid, PM-Methyl-parathion. Lower arrow as in Fig.3.

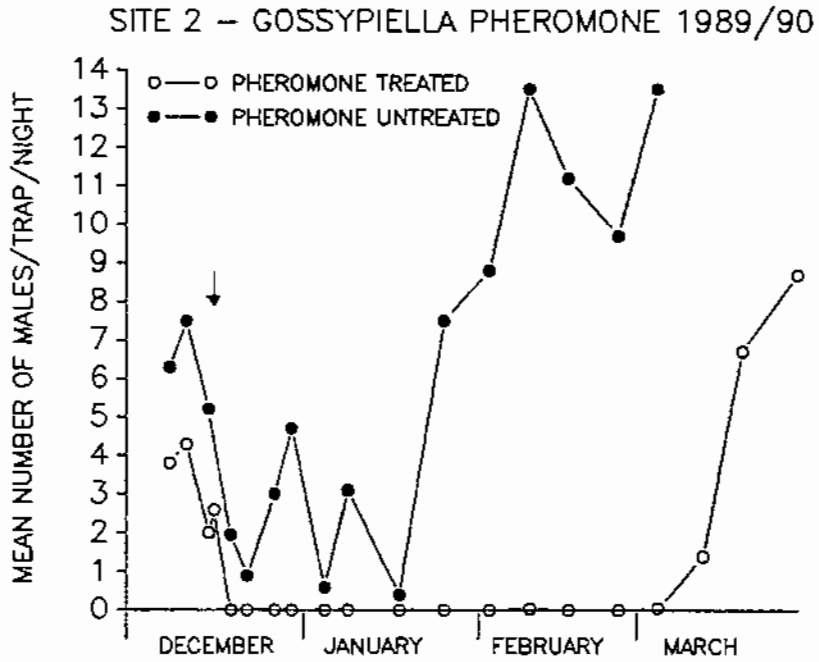

Fig. 6. Mean number of larvae infesting forms in a P. gossypiella pheromone treated and untreated cotton field at Site 2, Biloela.

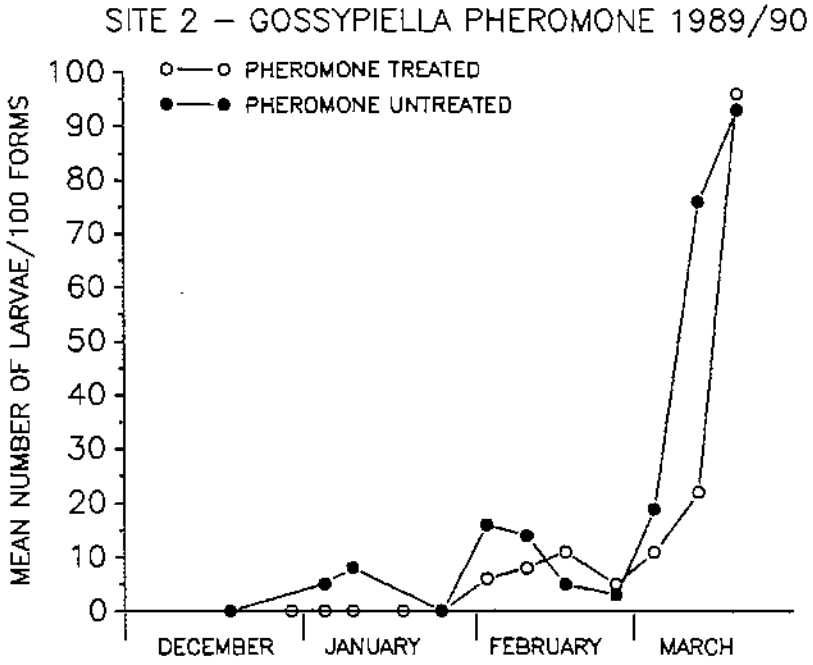

Fig. 5. Mean number of male P. scutigera caught in pheromone traps in a P. gossypiella pheromone treated and untreated cotton fields at Site 2, Biloela. Arrow indicates where treatment applied.

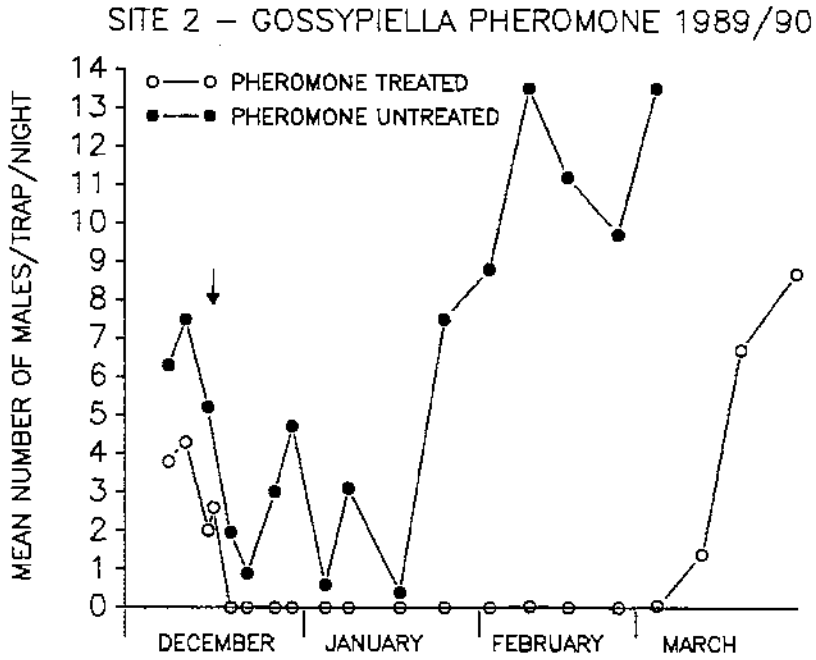

Fig. 6. Mean number of larvae infesting forms in a P. gossypiella pheromone treated and untreated cotton field at Site 2, Biloela.

Table 1. Size of cotton fields treated with pheromone, date treated and the stage of growth of cotton when pheromone was applied. All fields were treated at a rate of ca. 1,000 pheromone dispensers per ha.

Site	Size of field (ha)	Date treated with pheromone	Stage of growth of cotton when treated
1	2.4	5 December	Early squaring
2	9.0	17 December	Early squaring
3	7.3	17 December	Early squaring
4	18.3	25 February	Late squaring/ early flowering

Table 2. Total number of P. scutigera males caught in pheromone traps in fields treated or untreated with pheromone dispensers and the percentage reduction in trap catch.

Site	Total number of males caught: Pheromone treated	Untreated	% reduction in trap catch
1	8	5535	99.86
2	20	7788	99.74
3	5	3269	99.85
4	0	4306	100
Total	33	20898	Mean 99.86

Table 3. The mated status of P. scutigera females caught in an ultraviolet light trap placed in cotton treated or untreated with synthetic pheromone. The number of spermatophores/female indicates the number of times mating has occurred.

Date caught	No. caught	Percentage of females containing spermatophores						
		0	1	2	3	4	5	6
		Pheromone treated cotton						
29/1/90	40	65.0	35.0					
30/1 "	38	76.3	18.4	5.3				
31/1 "	28	85.7	14.3					
6/2 "	44	61.4	36.4	2.3				
7/2 "	19	42.1	47.4	10.5				
14/2 "	38	55.3	34.2	10.5				
15/2 "	32	62.5	28.1	6.3	3.1			
20/2 "	76	36.8	53.9	6.6	1.3	1.3		
21/2 "	83	34.9	56.6	7.2	1.2			
2/3 "	180	16.1	55.5	22.2	4.4	1.7		
12/3 "	144	31.9	45.1	10.4	9.7	2.8		
13/3 "	109	8.3	55.1	22.9	10.1	2.7	0.9	
		Pheromone untreated cotton						
8/2/90	11	0	27.3	27.3	18.2	9.1	9.1	9.1
14/2 "	19	5.3	52.6	21.0	5.3	15.8		
15/2 "	15	0	86.7	6.7	0	6.7		
16/2 "	31	12.9	38.7	32.3	6.4	3.2	3.2	3.2
20/2 "	8	12.5	50.0	25.0	12.5			
21/2 "	12	0	33.3	41.7	0	25.0		
1/3 "	51	9.8	68.6	13.7	5.9	0	2.0	

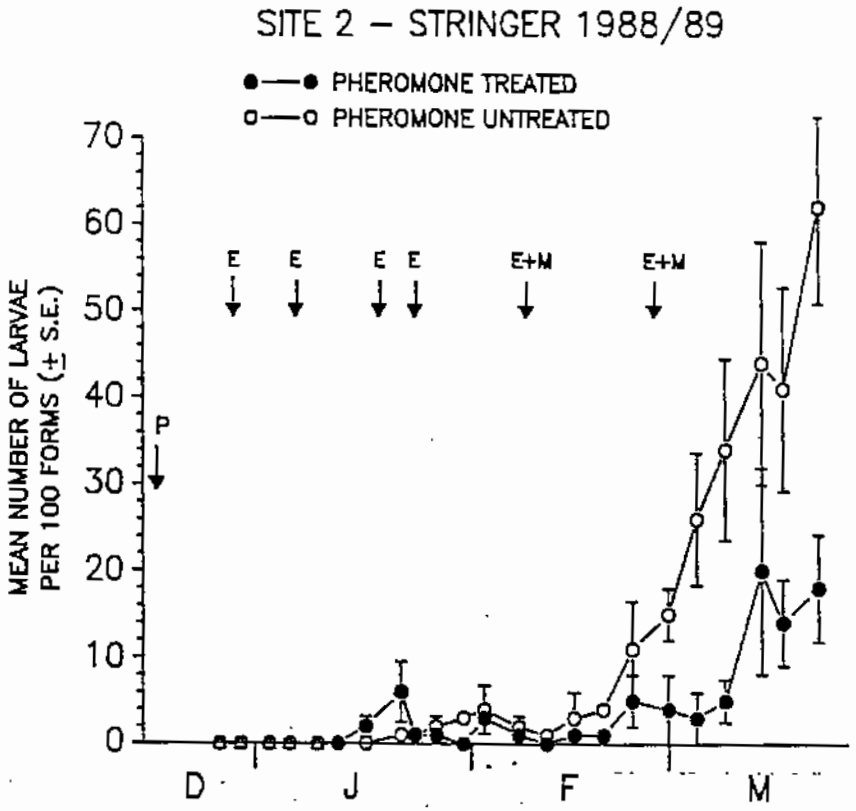

Fig. 3. Mean number of larvae infesting forms at Site 2 Stringers property, Biloela. Upper arrows indicate insecticides sprays applied to both pheromone treated and untreated fields. E=endosulfan, M=methomyl. Lower arrow (P) indicates the date of pheromone application.

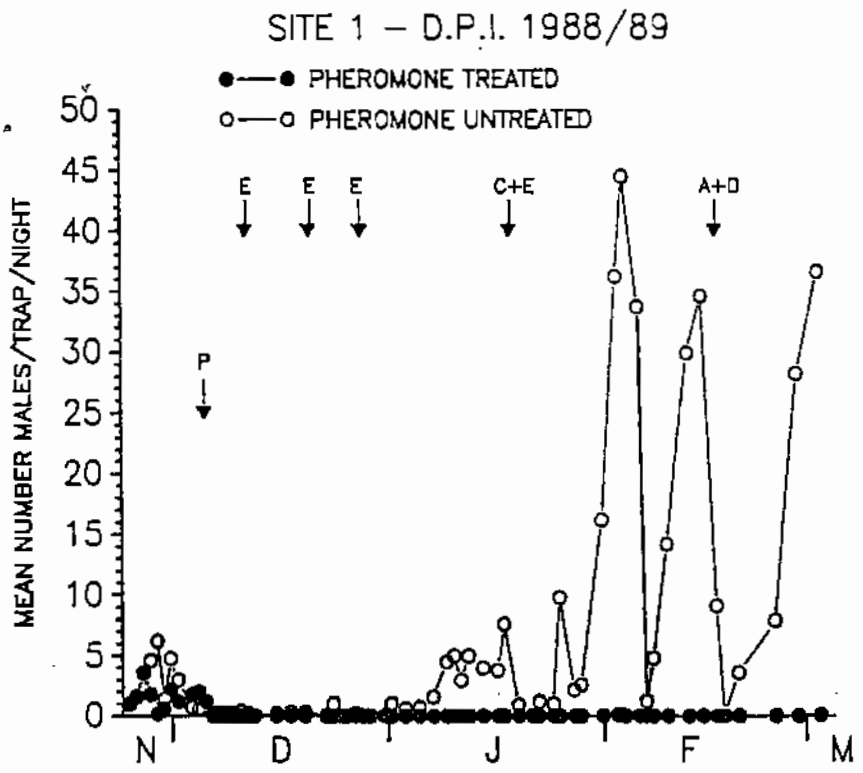

Fig. 1. Mean number of male P. scutigera caught in pheromone traps placed in pheromone treated and untreated fields at Site 1 D.P.I. Research Station, Biloela. Upper arrows indicate insecticide sprays applied in the pheromone untreated field only. E=endosulfan, C=chlorpyrifos, A=pyrethroid. Lower arrow (P) indicates the date of pheromone application.

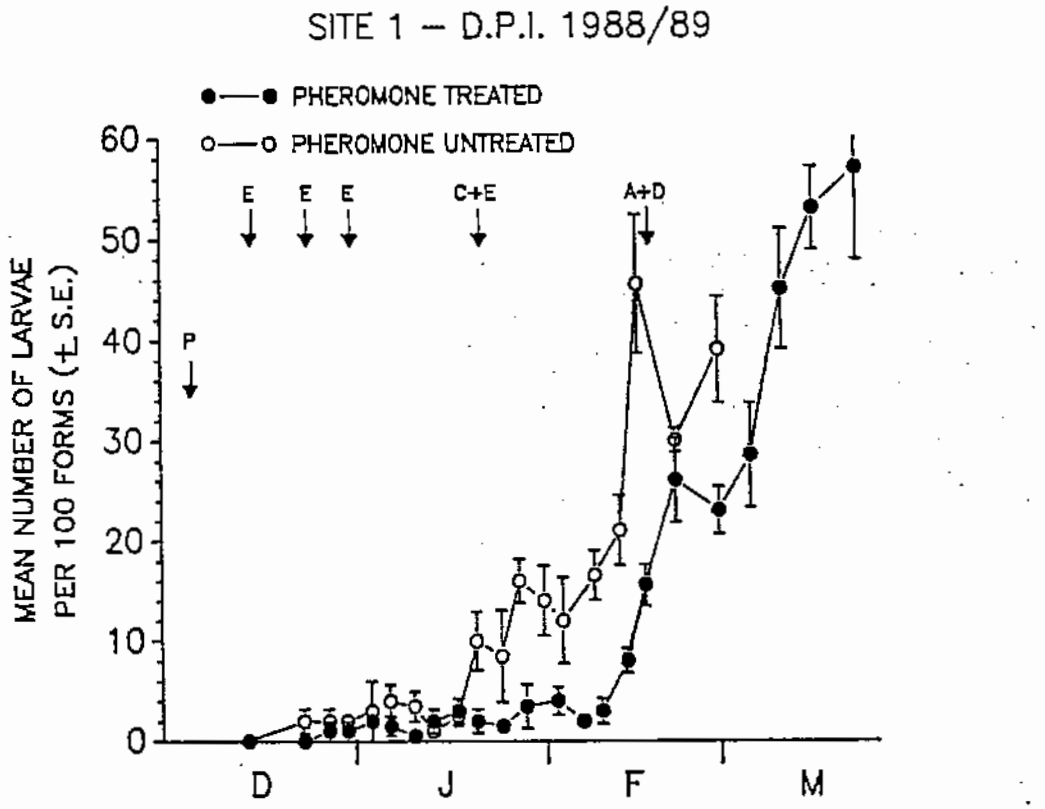

Fig. 2. Mean number of larvae infesting forms (squares and bolls) at Site 1 D.P.I. Research Station, Biloela. Arrows indicate dates of insecticide and pheromone applications (see Fig. 1).