ENVIROFEAST IPM IN COTTON:PART 3. INTEGRATION WITH NUCLEAR POLYHEDROSIS VIRUS (NPV)

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Introduction

Australian cotton production relies heavily on insecticides for the control of the major pests, *Helicoverpa* spp., mites and sucking insects (Fitt 1994). An over-reliance on insecticides results in problems of insecticide resistance, disruption of natural enemies and environmental contamination and has cast doubt on the long term viability of reliance on synthetic insecticides. The efforts of the cotton industry is to reduce the dependence on insecticide. This can be achieved by developing control programmes that integrate minimal use of pesticides with other forms of control, especially predation by natural enemies of *Helicoverpa* spp. Despite widespread use of economic thresholds and the so called "soft options" in the current production systems, little emphasis has been placed on beneficial insects, while the reliance on chemicals negates the use of the term integrated pest management (IPM) for such a system. In cotton crops in Australia an average of 8 to 12 insecticide sprays are applied each season to control *Helicoverpa* spp. and other pests. A true IPM system should conserve natural enemies of the pests using appropriate techniques and utilize them as basic components in the management of these pests. An IPM program is usually a package consisting of different components of pest control which are integrated in stages during the development of the program.

Since 1992, we have been developing an IPM program for cotton and have reached a stage where we have produced cotton yields similar to those obtained from crops which has been managed with conventional insecticides. We report here **stage 5** of our IPM program where we integrated Envirofeast® product and lucerne crop refugia with Gemstar virus (NPV), a product developed by Biosys Inc.

How was the trial conducted?

The trial was conducted on a 53-hectare cotton field at Norwood near Moree from 25 October 1995 until 19 March 1996. The cotton field was interplanted with 6 lucerne strips each 8 rows wide and 144 rows apart across the field. The whole cotton farm was managed with Envirofeast® spray from 30 October until 15 December 1995, thereafter three treatments were set up. The treatments were (1) 2.1 L/ha endosulfan spray followed by 2.5 kg/ha Envirofeast® spray (2) Bt/endosulfan (1.0/2.1 L/ha) mixture sprays followed by 2.5 kg/ha Envirofeast® and (3) Envirofeast®/Gemstar virus (2.5kg/0.741 L/ha) mixture sprays. The plots were arranged in a randomized complete block design with 6 replicates within the lucerne cotton interplants. Conventional insecticide treated plots were used as standard control and were selected from other cotton fields located within 200-400 metres of the trial site to avoid insecticide drift.

Sampling of predatory insects, green mirids (*Creontiades dilutus*) and *Helicoverpa* spp. were made once a week on each treated plot until the end of the study. *Helicoverpa* spp. eggs and larvae were counted in 4 randomly selected 1 metre lengths of row of cotton in each treated plot. Data was expressed as numbers per metre. Predatory insects and green mirids were sampled from both cotton and lucerne in each treated plot by taking a 20 metre long vacuum sampling using a small portable suction sampler, D-vac (Homelite Textron Inc. NC, USA) with 120 mm diameter cone and a nozzle speed of approximately 10 metre per second. Data was expressed as numbers per metre.

Cotton in each treated plot and the conventional insecticide treated plots (standard control) were harvested separately with a commercial picker and the average yields were compared.

Results

Rainfall in November, December and January washed off a large proportion of the Envirofeast® sprays applied to the cotton plants in each treated plot. For example, out of 7 Envirofeast® sprays on all the treated plots, 3 were washed off and 2 out of the 5 Envirofeast®/Gemstar virus mixture sprays were washed off. Therefore excluding wash offs, the Endosulfan followed by Envirofeast® treated plot (treatment 1) had 4 Envirofeast sprays and 3 endosulfan sprays; Bt/Endosulfan mixture sprays followed by Envirofeast® had 4 Envirofeast® sprays and 3 Bt/Endosulfan mixture sprays and the conventional insecticide spray had an average of 8 synthetic insecticide sprays.

Despite the product washed off by rain, results achieved were encouraging especially on the Envirofeast®/Gemstar virus treated plots. The incidence of virus disease in *Helicoverpa* spp. larvae in the plots sprayed with Envirofeast®/Gemstar virus mixture was consistently high between 50-60% for each spray application, irrespective of whether the application was by ground rig (high volume) or by air (low volume). This was in contrast to Dave Murray's trial at Dalby where the Gemstar virus was sprayed without Envirofeast® and incidence of the virus disease was inconsistent and had a wide range.

The number of *Helicoverpa* spp. eggs and larvae were not significantly different between Envirofeast® treatments and conventional insecticide plots (Figure 1). Predators of *Helicoverpa* spp. identified from the plots are given in (Table 1). The highest number of predators per plot were recorded on the Envirofeast®/Gemstar virus mixture treated plots followed by Envirofeast® and Bt/Endosulfan mixture sprays and Envirofeast® and Endosulfan alone sprays (Figure 2). The conventional insecticide treated plot had the lowest number of predators which were predominantly spiders (Figure 2). The predators were abundant early season with numbers peaking on 24 November 1995 and thereafter declining. The rapid decline in numbers on the conventional insecticide plot and the Envirofeast® and Endosulfan, Envirofeast® and Bt/endosulfan plots was due to a combination of rainfall and the insecticides used on these plots (Figure 2). Most of the insecticides used in this study were applied by ground rig until 15 January 1996, as a result insecticide drift to neighbouring plots was minimal. The decline in predator population until 15 January on Envirofeast®/Gemstar virus treated plots could be attributed to rainfall. However after 15 January 1996, synthetic pyrethroids were used in farms very close to the study site. These insecticides were applied by air and the insecticide drift from these sprays may caused the predator population to collapse (Figure 2). The collapse of the predator population resulted in high densities of *Helicoverpa* spp. larvae and a talstar/parathion mixture was applied as clean up spray to the whole field on 20 February 1996. That was the only.insecticide used on the Envirofeast®/Gemstar virus plots.

The study also showed that numbers of green mirid adults and nymphs were higher on the lucerne strips than the Envirofeast®/Gemstar virus and the other treated cotton plants (Figure 3). Green mirid numbers on the Envirofeast®/Gemstar virus and the other Envirofeast® treated plots were not significantly different from the conventional insecticide managed plots (Figure 3). This indicated that the presence of the lucerne strips prevented the green mirids from going onto cotton.

Yields harvested from the treated plots and the conventional insecticide plots are given in Table 2.Results showed that cotton yields harvested from the Envirofeast® IPM plots were not significantly different from the conventional insecticide managed plots.

Discussion

The study indicated that the Envirofeast® IPM program can manage cotton pests especially *Helicoverpa* spp. and green mirids to achieve cotton yields similar to conventional insecticides. In 1994-95 season at Auscott (Warren), Envirofeast® IPM managed cotton yielded 3.5 bales per acre which was also similar to conventional insecticide managed crops (Mensah and Harris 1995). Therefore this seasons yield confirms what had been achieved with Envirofeast® IPM for the past two years. However, for growers to use this technology successfully, they should understand the pest management decisions involve in the management of Envirofeast® IPM. The components of Envirofeast® IPM are lucerne strips, viruses, synthetic insecticides and the course Envirofeast® product itself. Each of these components provide a significant contribution to the IPM program and therefore the package should not be broken up and used in pieces but as a whole.

The 50-60% virus incidence achieved consistently in this study when Gemstar virus was mixed with Envirofeast® compared with the inconsistency of the same virus when applied without Envirofeast® (see Dr Dave Murray's report, this proceedings) and suggests that the virus works best in Envirofeast® in IPM programmes. The virus should not be viewed as a substitute for ineffective or inappropriate chemicals (Teakle *et al.* 1996, this proceedings). Envirofeast® is currently being reformulated by Rhone-Poulenc Rural (Aust.) Pty Ltd to improve its rainfastness before it is released for commercial use.

Compatibility with transgenic cotton: Durability of transgenic cotton plants in Australia, will depend on how well the Bt plants are managed to delay resistance. The pre-emptive Bt-resistance management strategies currently being advocated will involve the planting of "normal cotton" as refugia to generate susceptible moths to mate with the Bt resistant ones emerging from the transgenic cotton plants. The normal cotton refugia could either be unsprayed (i.e 10 ha to 100 ha Bt cotton) or sprayed with conventional insecticide (i.e 50 ha to 100 ha Bt cotton) (Fitt personal communication). Envirofeast® IPM can be used on the refugia crops to give growers acceptable cotton yields as well as generating susceptible moths. Envirofeast® sprays can also be applied to transgenic cotton plants to enhance the activity of beneficial insects in these plants. Also since Envirofeast® IPM does not depend solely on insecticides, other pests especially two-spotted mites will not be flared. Green mirids are expected to be a problem on transgenic cotton since the toxin does not affect them, but because green mirids prefer lucerne to cotton (Mensah and Harris 1994, 1995, 1996), lucerne strips, a component of Envirofeast® IPM, could be used to manage these insects in transgenic cotton. The advent of transgenic cotton will not exclude Envirofeast® IPM but they will complement each other. Growers should be aware that transgenic cotton is not the end to all their pest management problems. The Bt plants should be managed against Heliothis resistance in the context of IPM if the plants are to remain durable and this is where Envirofeast® IPM program is needed.

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Table 1. Major predators identified from study plots within cotton under Envirofeast® IPM and conventional insecticide regimes at Norwood, 1995-96.

Order	Family	Species
Coleoptera	Coccinellidae	*Harmonia arcuata* (Fabricius)
		Adalia bipunctata (Linnaeus)
		Coccinella transversalis (Fabricius)
	Melyridae	*Dicranolauis bellulus* (Guerin)
Hemiptera	Nabidae	*Nabis capsiformis* (Germar)
	Lygaeidae	*Geocoris lubra* (Kirkaldy)
	Pentatomidae	*Cermatulus nasalis* (Westwood)
Neuroptera	Chrysopidae	*Chrysopa* spp.
	Hemerobiidae	*Micromus tasmaniae* (Walker)
Araneidae	Lycosidae	*Lycosa* spp.
	Oxyopidae	*Oxyopes* spp
	Salticidae	*Salticidae* spp.
	Araneidae	*Araneus* spp.

Table 2. Yield of cotton under Envirofeast IPM and conventional insecticide regimes, Norwood 1995-96

Treatments	Yield (bales per acre)
4 Envirofeast®, 3 Endosulfan and 1 Talstar/parathion mixture	3.24 ± 0.14
4 Envirofeast®, 3 Bt/endosulfan mixture and 1 Talstar/parathion sprays	3.10 ± 0.14
4 Envirofeast®, 3 Envirofeast®/Gemstar virus and 1 Talstar/parathion sprays	3.19 ± 0.11
8 Conventional insecticides	3.40 ± 0.10

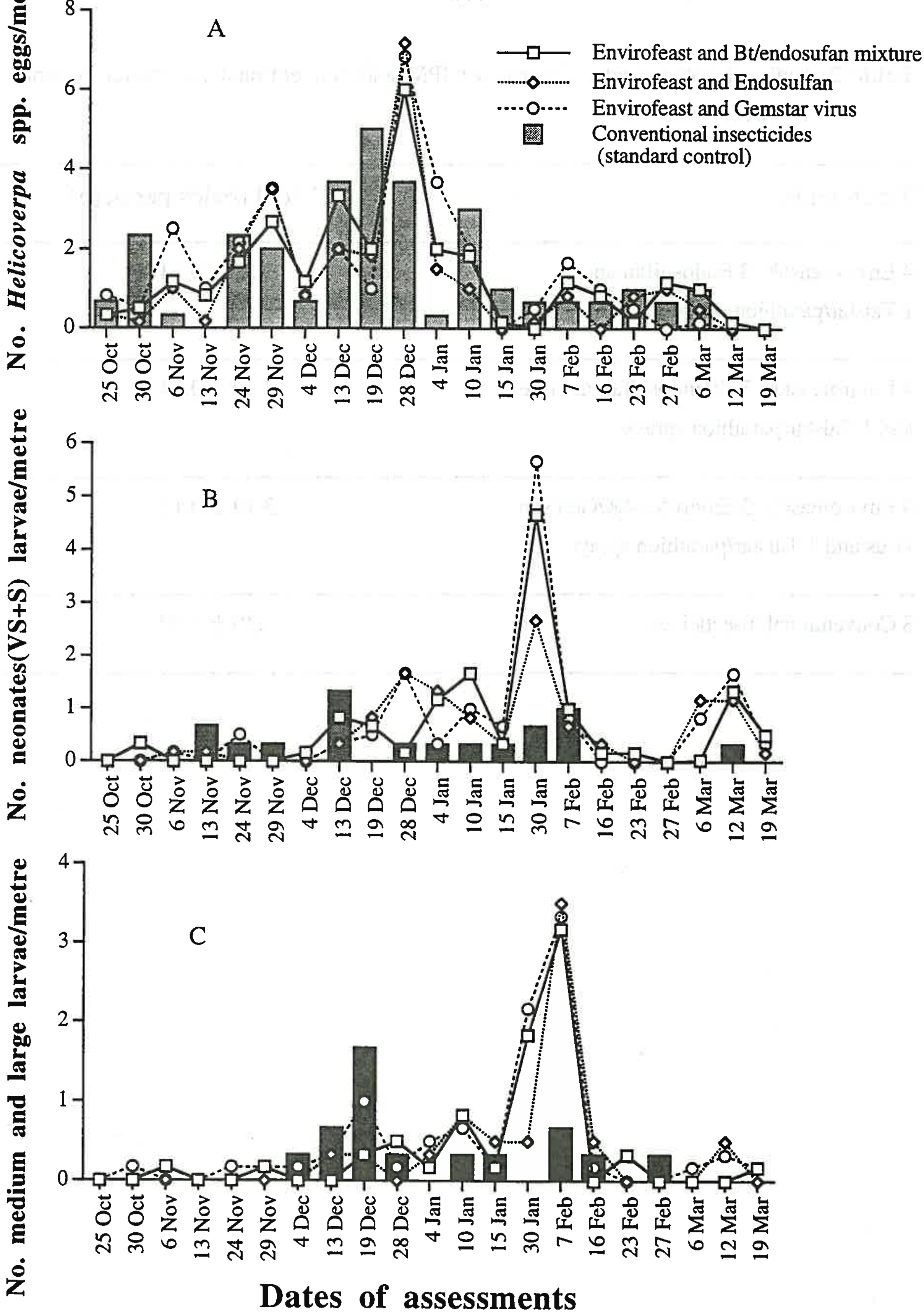
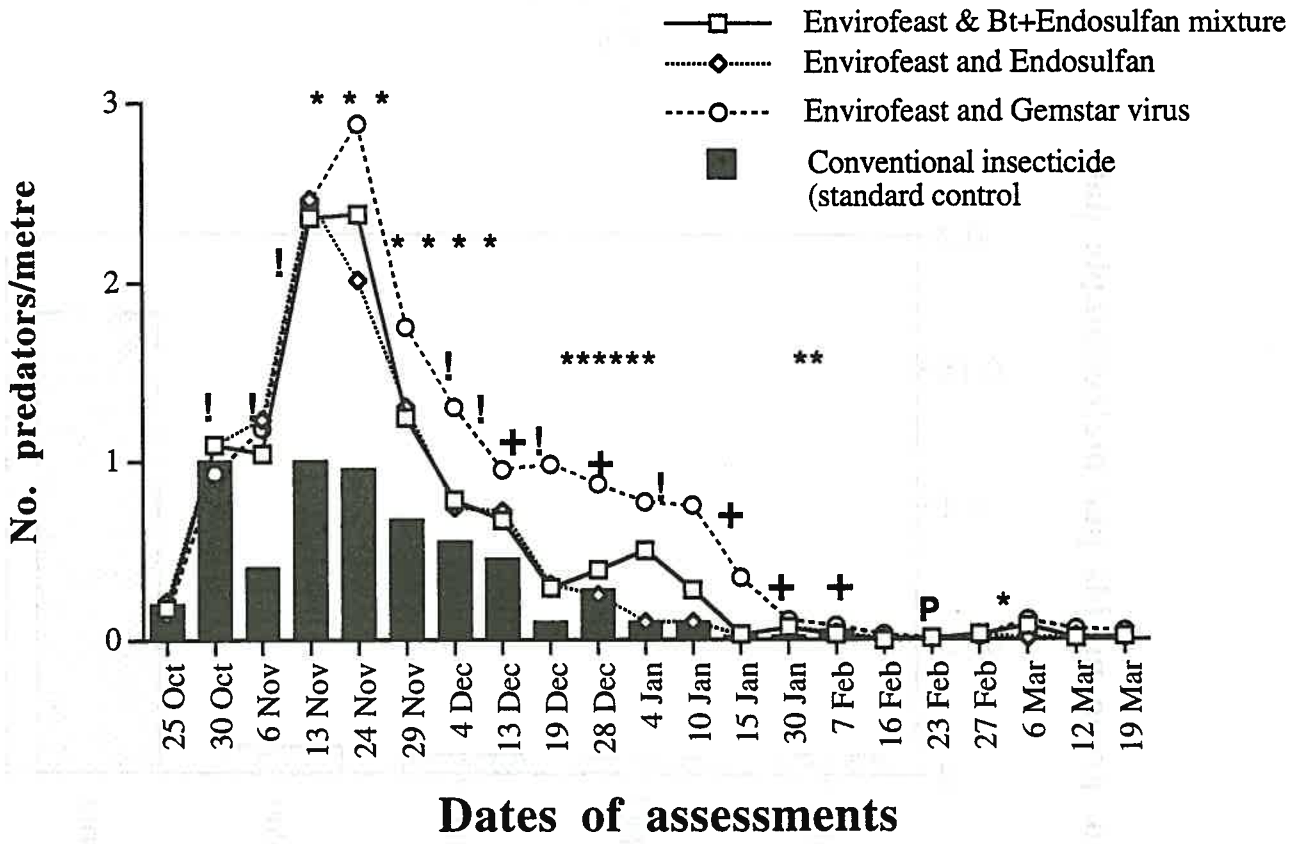


Fig. 1. Numbers of *Helicoverpa* spp. eggs (A), neonates (B) and medium and large larvae (C) in cotton under conventional insecticide and Envirofeast® IPM regimes at Norwood near Moree, 1995-96.



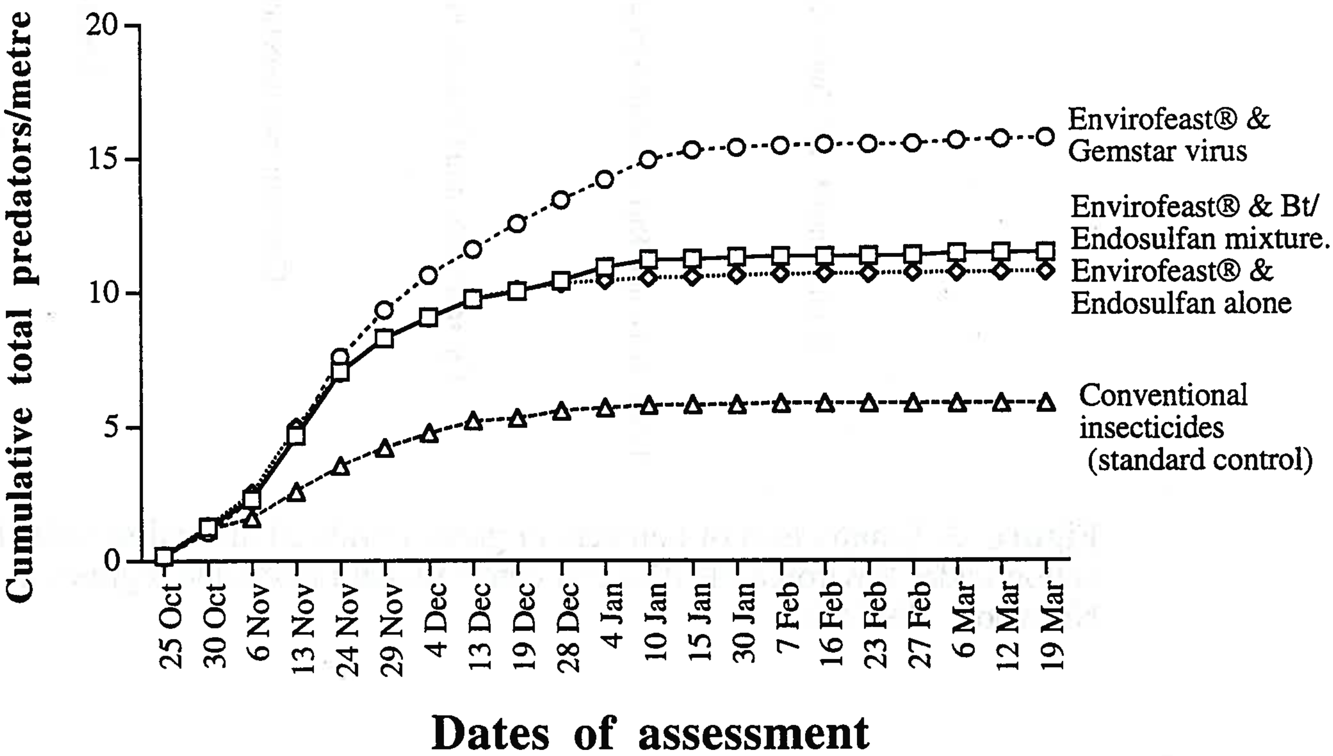


Fig. 2. Number of predators of *Helicoverpa* spp. in cotton under conventional insecticide and Envirofeast® IPM regimes in a commercial cotton farm at Norwood near Moree, 1995-96.
! indicates Envirofeast® applications; + indicates application of either Envirofeast/Virus mixture or Bt/Endosulfan mixture or Endosulfan alone ; **P** indicates application of pyrethroid insecticide on the IPM plots; and * indicates rainfall periods. The conventional insecticide plot had 8 synthetic insecticide applications.

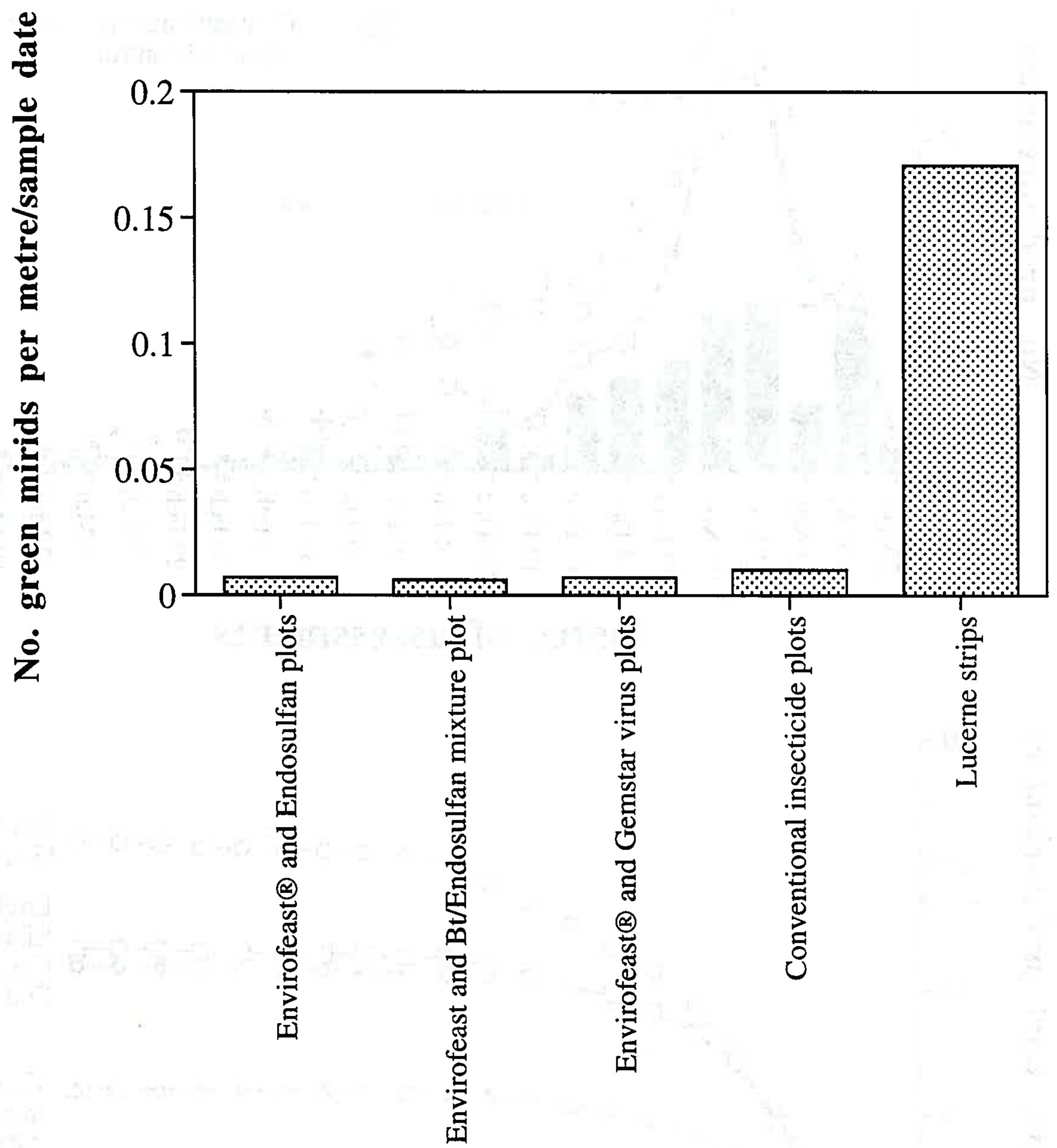


Figure 3. Comparison of numbers of green mirids adults and nymphs in cotton under Envirofeast® IPM and conventional insecticide regimes at Norwood, 1995-96.