Suppression of *Helicoverpa* spp. (Lepidoptera : Noctuidae) Oviposition by Use of the Natural Enemy Food Supplement Envirofeast®

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Abstract The deterrent activity of a newly developed food product, Envirofeast® and other food sprays viz. sugar, Envirofeast 2 and petroleum oil plus kelgum mixture on *Helicoverpa* spp. oviposition on cotton crops was investigated by mesh house choice and no-choice tests and large scale field trials at the Australian Cotton Research Institute at Narrabri, Norwood near Moree and Alcheringa near Boggabilla in New South Wales from 1992-95. Envirofeast® treated plants received significantly fewer eggs than did any other treatment and control (water-sprayed) plants, both in the mesh house choice and no-choice tests and in field plots sprayed at fortnightly intervals and exposed to natural populations of *Helicoverpa* spp. The deterrent effect on oviposition by Envirofeast® spray in the mesh house was greater on *Helicoverpa punctigera* (Wallengren) than *H. armigera* (Hubner) but this effect was partially offset by increased *H. armigera* infestations in the field. This was evident in the 1992-93 and 1993-94 field trials at Norwood when the number of eggs laid on Envirofeast® treated plots was significantly lower than any other treatments tested to peak in February when the moth populations were dominantly *H. armigera*. Despite the species difference in the response, the study demonstrates oviposition deterrence by the Envirofeast® product towards *Helicoverpa* spp. on cotton which indicates that Envirofeast® may be used in an integrated approach in cotton systems to reduce *Helicoverpa* spp. numbers. This effect would modify the predator to prey ratios so as to enhance levels of biological control.

Introduction

Commercial cotton crops in Australia are attacked by a wide range of insects, the major ones being *Helicoverpa armigera* (Hubner) and *Helicoverpa punctigera* (Wallengren) (Fitt, 1994). Both species are polyphagous and females lay their eggs singly on terminal buds, newly developed leaves and squares, and less frequently on old leaves, stems and bolls. The larvae feed preferentially on young growing tips or reproductive structures resulting in loss of terminal buds, squares and bolls causing considerable yield loss.

The current control strategy for these pests on cotton involves repeated applications of synthetic insecticides. Over-reliance on insecticides with associated problems of insecticide resistance in the major pests, disruption of natural enemies of the pests and environmental consequences have cast doubt on the long term viability of the traditional insecticidal approach. A major focus of the cotton industry therefore is to reduce the dependence on insecticides and maximise the long term sustainability of the industry. This can be achieved only through the development of alternative methods of control which have no significant impact on natural enemies.

Research for alternative methods for controlling insects and especially food attractants, oviposition deterrents and antifeedants has progressed greatly in recent years (Hagen *et al.*, 1971; Renwick *et al.*, 1989; Jermy, 1990; Dimock & Renwick, 1991; Hough-Goldstein & Hahn, 1992; Mensah & Harris, 1995). Such compounds, singly or in mixtures, are safer on non target organisms and can/should be integrated into pest management systems. Extensive studies have shown that food attractants or sprays either attract, conserve, augment or increase oviposition of beneficial insects resulting in the enhancement of their efficacy to control pests (Ewert & Chiang, 1966; Schiefelbein & Chiang, 1966; Hagen *et al.*, 1971; Carlson & Chiang, 1973; Hagen, 1986; Evans & Swallow, 1993; Mensah & Madden, 1994), but no studies so far have looked into the effect of these supplementary food sprays on the oviposition behaviour of the adult insect pest on the host plant. Any compound or mixture that can deter *Helicoverpa* spp. oviposition could have a significant effect on the pest's population because the reduced number of eggs on the plant results in lower pest numbers and thus a shift in the predator to prey ratio to favour natural enemies, and thereby enhances biological control. In this study I examined the effect of a newly developed supplementary food product called Envirofeast® on *Helicoverpa* spp. in choice and no-choice tests in a mesh house and commercial cotton crops.

Materials and methods

Sources of supplementary food products, plant and insect materials. Unless otherwise stated all experiments were conducted in a Sarlon mesh house (4 m x 10 m) at the Australian Cotton Research Institute (ACRI) at Narrabri in New South Wales, Australia. The food products evaluated were Envirofeast® and Envirofeast 2 (NSW Agriculture, ACRI, Narrabri, NSW, Australia). Envirofeast products were developed by the author from mixtures of complex carbohydrates and protein supplements. The protein base of Envirofeast 2 differed from that of Envirofeast®. The other food products evaluated were sugar, and a mixture of petroleum oil (Caltex Lovis, a C_{21} narrow-range oil with a 50% distillation temperature of 361°C at 101.33 kpa) and Kelgum (Kelco & Co., San Diego, CA).

The experimental plants used in all studies were potted cotton plants (Sicala VI), 0.5 m high. The plants were grown from seeds in pots in the same mesh house where the experiments were carried out. *Helicoverpa* spp. moths used in all the mesh house experiments were from colonies established by the ACRI's Insecticide Resistance Management Group. All experimental data were subjected to analysis of variance (Instat 2.03; Graphpad Instat Software Inc., San Diego, California) and Tukey-Kramer Multiple Comparisons tests or the least significant difference (lsd) test were used to separate the means.

Ovipositional responses of *Helicoverpa* spp. to supplementary food sprays

Experiment 1

Free choice preference test. The "free choice" ovipositional preference of *Helicoverpa* spp. among the different food supplements was measured by counting tbe number of eggs laid by the moths on cotton plants sprayed with each of the food products evaluated. The experiment was conducted in the mesh house in November 1992 when plants were 4 weeks old. A randomised complete block design was used with four treatments and a control. There were 5 replicates of each treatment, with each treatment consisting of 8 plants i.e 40 plants per treatment. The treatments evaluated were 0.03 kg Envirofeast® in 1 L of water, 0.03 kg Envirofeast 2 in 1 L of water, 0.03 kg sugar in 1 L of water, a mixture of 0.5% (vol/vol) Lovis oil and 0.01% (wt/vol) Kelgum, and water (control). Separate experiments were conducted for *H. armigera* and *H. punctigera*. The plants in each treatment were sprayed with approximately 1 L of test solution using a knapsack sprayer and 110 pairs of *H. armigera* or 100 pairs of *H. punctigera* were introduced into the mesh house. The numbers of eggs laid on the plants were counted daily and data expressed as number of eggs/plant/treatment. These data were used to calculate an oviposition deterrent index (ODI) for each treatment as follows: $ODI = 100 \times (C - T)/(C + T)$, where C represents the total number of eggs in the control plot and T the total number of eggs in the treated plot. An ODI significantly greater than zero (repeated measures analysis of variance test) indicates that moths preferred to oviposit on control plants, ODI not significantly different from zero indicates no preference between control and treated plants, and ODI significantly less than zero indicates a preference for ovipositing on treated plants relative to the control (Lundgren, 1975; Renwick & Radke, 1985; Renwick *et al.*, 1989; Dimock & Renwick, 1991).

No choice preference tests. The no-choice preference of *Helicoverpa* spp. among the different food supplements was measured in the mesh house by egg production of the moths enclosed in separate cages with plants sprayed with one of the test products.
The experiment commenced in January 1993 using 4 week old cotton plants as previously described. Eight plants from each treatment were enclosed in a square cage (200 x 10 cm high) and 8 pairs of either *H. armigera* or 5 pairs of *H. punctigera* adults were released into each cage. This was replicated 5 times i.e. 40 plants/treatment. Numbers of eggs on each plant were recorded daily

and data expressed as numbers/plant/treatment and an ODI for each treatment was calculated for each treatment.

Experiment 2

Ovipositional response of *Helicoverpa* spp. to sprays of mixtures of Oil/Envirofeast®. Following the results of experiment 1, a trial was conducted in the mesh house with mixtures of Envirofeast® and oil sprays. The treatments include 0.03 kg Envirofeast® in 1 L of water mixed with each of (1) 0.01% Lovis oil, (2) 0.01% Synertrol oil (3) 0.01% D-C tron oil (4) 0.01% Peppermint oil (5) 0.01% Fish oil and water (control). Separate experiments were conducted for *H. armigera* and *H. punctigera.* There were 5 plants in each treatment and this was replicated 5 times. Under free choice conditions the plants were treated with the test solutions with a knapsack sprayer as in experiment 1 and 60 pairs of *H. armigera* or *H. punctigera* were introduced into the mesh house. The number of eggs/plant/treatment were recorded daily.

Under no choice conditions plants from each treatment were enclosed in separate cages within the mesh house as described in experiment 1 and 5 pairs each of the test insect species were released into each cage. Numbers of eggs/plant/treatment were recorded daily. Egg counts were used in both choice and no-choice tests to calculate the ODI for each treatment.

Experiment 3

Field studies on ovipositional response of *Helicoverpa* spp. to supplementary food sprays. Experiments were conducted in a 15-hectare cotton field at Norwood, near Moree in New South Wales. The treatments evaluated were (1) 3 kg Envirofeast® (2) 3 kg Envirofeast 2 (3) 4 kg sugar (4) a mixture of 0.5% (vol/vol) Lovis oil and 0.01% (wt/vol) Kelgum (5) control (untreated) and (6) conventional insecticide treated plot (treated standard). Plots were arranged in a randomized complete block design with 4 replicates with the size of each replicate measuring 0.5 ha. Four conventional insecticide treated plots were selected from other cotton fields located 400m away from the trial site to avoid insecticide drift. Similarly, a 40 m wide buffer separated food spray plots and untreated controls. Pre-treatment counts of insects were made 24 h before treatment application and then approximately every 7 d until the end of the study. Foliar applications of each treatment were applied on November 4, 1992 and thereafter at fortnightly intervals until the end of February 1993. On each occasion treatments were applied using 120 L water/ha. In all, 8 applications of each treatment were made during the season. The untreated control plot was left unsprayed and the conventional insecticide treated standard plot received 8 applications of synthetic insecticide sprays by means of ground rig in early season (2 applications) and by aircraft mid and late season (6 applications).

Visual counts of *Helicoverpa* spp. eggs on plants were made on cotton plants in 4 randomly selected 1 m lengths of row in each treatment replicate i.e. 4 m/treatment. Data were expressed as numbers of eggs/m for each treatment and used to calculate ODI using the formula given above.

Experiment 4

Large scale evaluation of Envirofeast® spray on *Helicoverpa* spp. oviposition. This study was conducted in irrigated cotton at Norwood, near Moree in 1993-94 and Alcheringa near Boggabilla in 1994-95. In the 15 ha study plot at Norwood 3 ha were sprayed with Envirofeast® and 0.5 ha was left unsprayed (control). This was replicated 4 times. Foliar applications of the Envirofeast® spray was similar to experiment 3 and were done on November 30, 1993 and thereafter at 14 d interval until March 15, 1994. Counts of the number of eggs/m of both treated and control plots were made as described above.

At the 170 ha Alcheringa study site, 40 ha were sprayed with Envirofeast® and 1 ha was left unsprayed as a control since grower was not prepared to leave a large area of cotton unsprayed. These were replicated 4 times. Foliar application of Envirofeast® commenced on November 8, 1994 and thereafter at 14 d intervals until the end of February 1995. Counts of the number of eggs/m in both treated and control plots were made and compared to similar data taken from 4 conventional insecticide treated plots each measuring 100 ha located 200 m from the other treatments.

Results

Ovipositional responses of *Helicoverpa* spp. to supplementary food sprays (Mesh house study)

Free-choice conditions. Significant differences ($P<0.01$) in ovipositional response of *Helicoverpa* spp. were found among the various supplementary food products tested (Table 1). Significantly fewer ($P<0.01$) eggs were found on plants treated with Envirofeast sprays, especially Envirofeast®, than on the other treatments and the control. The ODI of Envirofeast® and Envirofeast 2 treated plants were significantly greater than zero and higher than any other treatments indicating that these products strongly deterred *Helicoverpa* spp. oviposition (Table 1). The suppressive effect of Envirofeast treated plants was stronger on *H. punctigera* than on *H. armigera*. The oil and kelgum mixture spray also more greatly deterred oviposition by *H. punctigera* than by *H. armigera* as indicated by its ODI.

No-choice conditions. Significant differences ($P<0.05$) were also found among supplementary food products tested with fewer eggs found on Envirofeast® treated plants than the other treatments and the control (Table 2). The oviposition deterrent effect for Envirofeast® as indicated by the ODI, was also higher than the other treatments (Table 2). In all treatments, deterrence of oviposition of *H. punctigera* was more pronounced than that of *H. armigera*.

Ovipositional response of *Helicoverpa* spp. to sprays of mixtures of Oil/Envirofeast®. Under choice conditions, Oil/Envirofeast® mixtures sprayed on plants significantly ($P<0.05$) suppressed oviposition by *H. punctigera*, but results were not significantly different ($P>0.05$) from those plants that received Envirofeast® spray alone (Table 3). However, in the case of *H. armigera*, plants treated with Envirofeast® alone or mixed with either peppermint or fish oils had significantly ($P<0.05$) fewer eggs laid on them compared with the other oil mix sprays (Table 3). In general maximum numbers of eggs/plant were laid on plants treated with water alone. In all cases, the ODI was significantly greater than zero indicating moths prefered to lay on untreated control plants (Table 3). *H. punctigera* was most affected by the oviposition deterrent effect of all treatments. A similar trend was recorded for all treatments under no-choice conditions for both species (Table 4).

Field studies on ovipositional response of *Helicoverpa* spp. to supplementary food sprays. Under field conditions, oviposition by *Helicoverpa* spp. was significantly ($P<0.05$) different among cotton plants treated with the various food products (Table 5). Significantly ($P<0.05$) fewer eggs were found on Envirofeast® and Envirofeast 2 treated plots compared with the other treatments and the control (Table 5). Highest egg numbers occurred on plots treated with oil/kelgum mixture, sugar and conventional insecticide treated and unsprayed control plots respectively. The peak number of eggs laid on Envirofeast® and Envirofeast 2 treated plots were 5 and 10 eggs/m respectively and these occurred on February 18 (Table 5) when moth populations were dominantly *H. armigera*. At the end of the study, plots treated with Envirofeast® spray had 8 times fewer eggs than the sugar, insecticide treated and unsprayed plots.

Large scale evaluation of Envirofeast® spray on *Helicoverpa* spp. oviposition. At the Norwood study site significantly ($P<0.05$) fewer eggs were found on Envirofeast® treated plots compared with the unsprayed plots (Fig. 1A). Egg numbers ranging from 0-1/m were found on the Envirofeast® treated plots from 17 December until 1 February before reaching a peak of 8 eggs/m on 7 February when moths were dominantly *H. armigera* (Fig. 1A). The unsprayed plots however had higher numbers of eggs ranging from 4 - 8.3/m during the same period before peaking at 10.7/m on 14 February (Fig. 1A). At the end of the study 3.1 times fewer eggs were found on the Envirofeast® treated plots compared with the control (Fig. 1A).

Similar results were obtained at the Alcheringa site, with the Envirofeast® treated plots recording a significantly lower ($P<0.01$) number of eggs compared with the conventional insecticide treated and the unsprayed plots (Fig. 1B). The mean number of eggs/m per sample date recorded on the Envirofeast®, insecticide treated and unsprayed plots were 0.72, 1.46 and 1.98 respectively. In this study 2.03 and 2.76 times more eggs had been recorded in the unsprayed and insecticide treated plots respectively compared with the Envirofeast® plot.

Discussion

The results indicate that the oviposition of *Helicoverpa* spp. and especially *H. punctigera* was significantly influenced by treating cotton plants with Envirofeast sprays. Under both mesh house (choice and no-choice trials) and field conditions, Envirofeast sprays suppressed oviposition by *Helicoverpa* spp. on treated plants more than any other treatment assessed. Deterrence of oviposition calculated as ODI in the mesh house study was evidently strongest for the Envirofeast® product (Tables 1- 5). *H. punctigera* oviposition was more significantly suppressed than *H. armigera* indicating that increased infestations of the latter in the field could partially offset the ovipositional deterrent effect of the Envirofeast® product. This was confirmed in the field study during the 1992/93 and 1993/94 seasons at Norwood when the number of eggs laid on Envirofeast® treated plots, though significantly fewer than on any other treatments, peaked in February to coincide with the period when the moth populations were dominantly *H. armigera* (Table 5 and Fig. 1A). The lower number of eggs recorded in the field trials on all treated plots and especially Envirofeast® treatments could be the result of a combination of predation and the ovipositional deterrent effect of the product since Envirofeast® is also known to attract and conserve predatory insects of *Helicoverpa* spp.(Mensah and Harris unpublished data). However the fact that significantly higher numbers of eggs were recorded on the unsprayed plots and the plots treated with sugar which is known to arrest and concentrate predatory insects of these moths (Hagen *et al.*, 1971; Ewert and Chiang, 1966; Ben Saad and Bishop, 1976; Mensah and Madden, 1994) would suggest that the effect of predation in this study was minimal and the ovipositional deterrent effect of the product was mostly responsible for the lower egg numbers on the Envirofeast® treated plots.

The study also indicated that the mixture of oil and kelgum deterred *Helicoverpa* spp. oviposition in the field but this effect was not as pronounced as observed in the mesh house (Table 1 and 5). The deterrent effect of Envirofeast® was reduced when oils were added to increase adherence and persistence on leaves.

In the context of managing *Helicoverpa* spp. in cotton farms, the deterrence of oviposition by Envirofeast® is important as the pest, being highly migratory, can rapidly infest crops from other sources before natural enemies have time to establish and respond to their numbers. This usually results in a low predator to prey ratio in cotton systems and control is achieved, not by biological, but by chemical means. Any product that deters oviposition and modifies the predator to prey ratio in favour of natural enemies of *Helicoverpa* spp. must enhance the effect of biological control. The Envirofeast® product acts in this instance to deter oviposition on the crop by reducing the numbers of eggs deposited on the crop thus shifting the predator to prey ratio to increase the effectiveness of natural enemies.

Several studies have been conducted in the use of supplementary food sprays in crop systems to attract, arrest and conserve predatory insects to manage pests (Hagen *et al.,* 1971; Ewert and Chiang, 1966; Ben Saad and Bishop, 1976; Mensah and Madden, 1994), but no studies have been conducted on the effect of these food products on the oviposition behaviour of the pest species. The use of behaviour-modifying compounds such as oviposition deterrents to reduce oviposition of many insect pests on crops has been progressed recently (Renwick, 1988; Jermy, 1990; Dimock & Renwick, 1991; Hough-Goldstein & Hahn, 1992) and plants have been the major source of these deterrent compounds (Harbourne, 1982; Klocke, 1987; Renwick *et al.*, 1989; Dimock & Renwick, 1991; Hough-Goldstein & Hahn 1992).

These studies have shown that the suppression effect of Envirofeast® on *Helicoverpa* spp. oviposition could be an important supplement to the beneficial effects of Envirofeast® to attract and sustain natural enemies. In conclusion this product has the potential to be integrated into programmes to assist in the control of major cotton pests.

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Table 1. Ovipositional preferences of *Helicoverpa armigera* (n = 110 pairs) and *H. punctigera* (n = 100 pairs) on cotton plants sprayed with various food supplements in the mesh house at the Australian Cotton Research Institute in Narrabri, November, 1992. (Results of free choice tests)(n= 40 plants per treatment).

Treatments	No. of eggs per plant		Mean Ovipositional Deterrent Index (ODI)	
	H. armigera	*H. punctigera*	*H. armigera*	*H. punctigera*
Envirofeast ®	11.78 a	2.10 a	41.5	83.8
Sugar	17.10 b	19.40 b	25.0	8.9
Envirofeast 2	10.78 a	3.73 a	45.1	72.3
Oil and Kelgum mixture	25.20 c	3.13 a	6.1	76.2
Water (Control)	28.50 c	23.17 b	0	0

Means within a column followed by same letter are not significantly different (P>0.05) (Least significant difference).

Table 2. No choice test for oviposition of *Helicoverpa armigera* (n= 8 pairs) and *H. punctigera* (n = 5 pairs) on cotton plants in the mesh house at the Australian Cotton Research Institute in Narrabri, January 1993.

Treatments	No. of eggs per plant		Mean Ovipositional Deterrent Index (ODI)	
	H. armigera	*H. punctigera*	*H. armigera*	*H. punctigera*
Envirofeast ®	1.11 a	0.37 a	74.5	91.7
Sugar	3.82 ab	1.91 bc	33.2	52.7
Envirofeast 2	3.61 ab	0.83 ab	35.7	68.6
Oil and Kelgum mixture	5.33 b	1.99 c	17.6	38.2
Water (Control)	7.61 b	4.45 d	0	0

Means within a column followed by same letter are not significantly different (P>0.05) (Least significant difference).

Table 3. Ovipositional response of *H. armigera* and *H. punctigera* (n = 60 pairs each) to Envirofeast/Oil mixtures sprayed on cotton plants in the mesh house at the Australian Cotton Research Institute in Narrabri, May 1993. (Results of free choice tests)(n = 25 plants per treatment).

Treatments	No. of eggs per plant		Mean Ovipositional Deterrent Index (ODI)	
	H. armigera	*H. punctigera*	*H. armigera*	*H. punctigera*
Envirofeast ®	6.85 ± 0.67 a	4.00 ± 0.62 a	53.6	61.1
Envirofeast® + 0.01% Lovis oil	11.70 ± 1.09 b	3.00 ± 0.58 a	31.9	69.3
Envirofeast® + 0.01% Synertrol oil	8.09 ± 0.81 c	3.67 ± 1.67 a	47.4	63.7
Envirofeast® + 0.01% D-C tron oil	12.45 ± 0.70 b	2.67 ± 0.76 a	29.1	72.2
Envirofeast® + 0.01% Peppermint oil	5.82 ± 1.18 a	8.00 ± 4.58 a	59.1	34.8
Envirofeast® + 0.01% Fish oil	6.00 ± 0.82 a	2.33 ± 0.33 a	58.1	75.3
Water (Control)	22.65 ± 1.00 d	16.54 ± 1.68 b	0	0

Means within a column followed by the same letter are not significantly different (P>0.05) (Least significant difference).

Table 4. Ovipositional response of *H. armigera* and *H. punctigera* (n = 5 pairs each) to Envirofeast/Oil mixtures sprayed on cotton plants in the mesh house at the Australian Cotton Research Institute in Narrabri, May 1993. (Results of No choice tests)(n = 25 plants per treatment).

Treatments	No. of eggs per plant		Mean Ovipositional Deterrent Index (ODI)	
	H. armigera	*H. punctigera*	*H. armigera*	*H. punctigera*
Envirofeast ®	9.00 ± 2.05 ab	1.98 ± 0.32 a	43.3	81.0
Envirofeast® + 0.01% Lovis oil	12.25 ± 1.89 b	1.30 ± 0.28 a	30.0	87.1
Envirofeast® + 0.01% Synertrol oil	14.50 ± 1.55 b	1.05 ± 0.60 a	22.2	89.4
Envirofeast® + 0.01% D-C tron oil	11.00 ± 0.91 b	0.63 ± 0.23 a	34.8	93.5
Envirofeast® + 0.01% Peppermint oil	9.25 ± 1.03 ab	0.43 ± 0.22 a	42.2	95.5
Envirofeast® + 0.01% Fish oil	5.00 ± 1.78 a	1.12 ± 0.62 a	64.0	88.8
Water (Control)	22.75 ± 3.52 c	18.84 ± 1.94 b	0	0

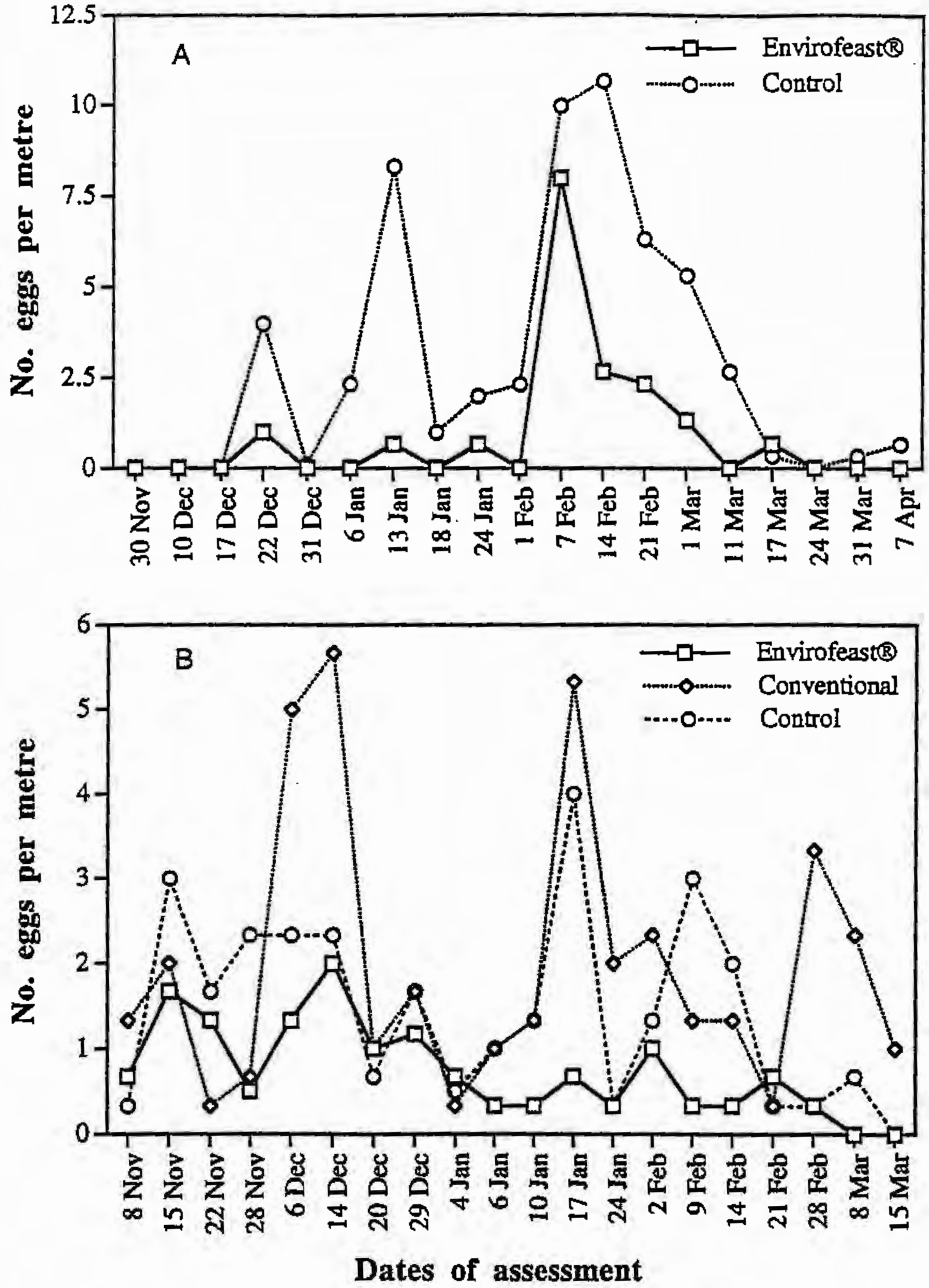
Means within a column followed by the same letter are not significantly different (P>0.05) (Least significant difference).

Table 5. Responses of field populations of *Helicoverpa* spp. to supplementary food sprays in commercial irrigated cotton at Norwood near Moree in NSW, 1992-93.

	No. of eggs per metre					
Dates of assessment	Envirofeast®	Sugar	Envirofeast 2	Lovis Oil + Kelgum	Control (unsprayed)	Conventional
27 November 1992	0	0	0	0	0	0
4 December	0 a	0.25 ± 0.18 ab	0.25 ± 0.10 ab	0.75 ± 0.27 ab	2.50 ± 0.97 b	2.50 ± 0.67 b
11 December	0.75 ± 0.18 a	5.75 ± 1.20 b	0.75 ± 0.27 a	2.60 ± 0.85 ab	5.25 ± 0.71 b	2.50 ± 0.45 b
21 December	1.00 ± 0.10 a	8.75 ± 2.65 b	1.75 ± 0.18 ac	5.00 ± 1.22 abc	6.50 ± 1.24 bc	8.75 ± 0.91 b
30 December	1.00 ± 0.10 a	12.25 ± 1.97 b	1.75 ± 0.35 a	10.75 ± 1.41 b	13.25 ± 2.76 b	11.95 ± 2.32 b
11 January	1.75 ± 0.18 a	7.75 ± 3.15 bc	3.50 ± 1.23 ab	8.50 ± 2.45 bc	9.75 ± 3.82 c	10.25 ± 3.02 c
21 January	2.25 ± 0.36 a	6.00 ± 0.99 ab	2.00 ± 0.96 a	4.50 ± 1.02 ab	8.25 ± 1.05 b	8.25 ± 1.73 b
28 January	1.75 ± 0.25 a	8.00 ± 1.19 b	4.25 ± 1.09 ab	3.50 ± 0.55 a	6.50 ± 0.65 b	7.00 ± 1.18 b
5 February	1.00 ± 0.14 a	23.75 ± 3.06 b	6.08 ± 1.08 a	5.25 ± 0.90 a	17.50 ± 2.60 b	20.77 ± 3.53 b
12 February	2.75 ± 0.92 a	16.75 ± 2.59 bc	6.50 ± 0.98 a	12.50 ± 2.52 ab	28.50 ± 3.35 c	22.25 ± 3.56 c
18 February	5.00 ± 1.34 a	38.25 ± 3.65 b	10.00 ± 2.40 a	25.00 ± 3.77 c	32.00 ± 3.34 b	32.95 ± 3.99 b
25 February	1.50 ± 0.72 a	18.00 ± 1.57 b	2.75 ± 0.75 a	5.50 ± 1.42 a	19.25 ± 5.06 b	17.50 ± 4.43 b
4 March	0 a	7.75 ± 1.26 b	0 a	2.25 ± 0.55 ab	5.25 ± 0.80 b	4.75 ± 0.75 b
10 March	0	0 a	0.15 ± 0.07 b	0 a	0 a	0 a
Mean	1.44 ± 0.38 a	11.79 ± 2.89 b	3.05 ± 0.82 a	6.62 ± 1.84 c	11.85 ± 2.73 b	11.74 ± 2.57 b

Means between treatments within rows followed by the same letter are not significantly different (P>0.05) Tukey - Kramer Multiple Comparisons Test.

Fig. 1. Effect of supplementary food (Envirofeast® spray on *Helicoverpa* spp. oviposition on commercial cotton at (A) Norwood near Moree, 1993-94 and (B) Alcheringa near Boggabilla, 1994-95.


A
Envirofeast®
Control
No. eggs per metre
0
2.5
5
7.5
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12.5
30 Nov
10 Dec
17 Dec
22 Dec
31 Dec
6 Jan
13 Jan
18 Jan
24 Jan
1 Feb
7 Feb
14 Feb
21 Feb
1 Mar
11 Mar
17 Mar
24 Mar
31 Mar
7 Apr
B
Envirofeast®
Conventional
Control
No. eggs per metre
0
1
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15 Mar
Dates of assessment

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