Use of Food sprays in cotton systems: What do we know?

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Introduction

The Australian cotton growers for the past 5 years have come to realise the important role beneficial insects play in managing pests in their cotton farms. With a strong push by the cotton industry to adopt a true integrated pest management (IPM) programs, beneficial insects are increasingly assuming a major role in the cotton system. As a result, techniques required to maximise both the abundance and activity of this beneficial insects will continue to be a priority in the cotton industry. The use of beneficial insect refuges and most importantly the use of food supplements (food sprays) will become major tools in the Australian cotton industry as growers acquire more knowledge about a true IPM and the role of beneficial insects. The development of food sprays and the advent of the predator to pest ratio in particular has already educated growers about the need to conserve beneficial insects in the cotton system, and how to utilise them in cotton pest management programs.

Application of supplementary food on commercial cotton crops can mediate changes in the predator to pest ratio by aggregating predatory insects to the area (Mensah, 2002; Mensah, 1997; Neuenschwander and Hagen, 1980; Hagen, 1986; Evans and Swallow, 1993; Mensah *et al.* 2000); arrestment of predatory insects in the area (Carlson and Chiang, 1973; Ewert and Chiang, 1966), increased consumption rate of predators (Mensah and Singleton, 1998), and decreased oviposition activity of *Helicoverpa* spp. due to the physical presence of the food attractant (Mensah, 1996; Mensah *et al.*, 2000).

For growers to use food sprays to manage cotton pests effectively, they need to understand fully the types of food sprays commercially available, the performance of each of the food sprays for a particular pest situation, how and when to use these food sprays. This paper is intended to educate growers on

- the proper use of food sprays,
- what the different food sprays can and cannot do,
- the differences there are between the different types of food sprays,
- when and how to apply food sprays and
- the impact of these food sprays on pests and predatory insects in cotton.

Types of food sprays

There are four commercially available food sprays in Australia. They are Envirofeast®, PredFeed®, AminoFeed® and Mobait®. These food sprays can basically be grouped into two different types namely (1) yeast-based and (2) sugar-based food sprays. The yeast-based food sprays are Envirofeast® and PredFeed® and the sugar-based ones are AminoFeed® and Mobait®. Because the basic components of the two groups of food sprays are different, they perform different functions and should be used differently to achieve the required objectives. One cannot substitute one group of food spray for the other when it comes to predatory insects conservation and establishment in cotton farms.

Yeast-based food sprays

The yeast-based food sprays can be used mostly as attractants (i.e to attract predators into cotton farms) particularly early in the season. The movement and buildup of these predatory insect populations in cotton farms after an application of a yeast-based food spray is not instant but cumulative. The arrival of some predators after food spray application may attract more predators to move into the farm depending on food availability, mating partners, shelter etc. This means that about 2-3 consecutive applications of a yeast-based food spray at an interval of 10-14 days may be required to bring in reasonable numbers of predators. The yeast-based food sprays do not arrest predators but only attract them into the farm. This means that if the insects are attracted into the field, the yeast-based food sprays cannot make them stay on in the farm unless there are plenty of food (pests) available at that point in time. In addition, the yeast-based food sprays are less used as feeding stimulants in conventional Bt and NPV to make Helicoverpa larvae ingest more of these products. They are less attractive to pests such as *Helicoverpa* spp and sucking pests.

Sugar-based food sprays

This type of food sprays can be used to arrest or make predators already in the cotton crop stay on for a while. This means that in a field which already has predators but less of prey (food), it is necessary to apply sugar-based food sprays to allow the predators to stay on for a while. Thus, sugar-based food sprays perform better as arrestants rather than attractants. Since the basic component of this type of food spray is sugar, if the the sugar-based food sprays are mixed with biological pesticides, it can make Helicoverpa larvae feed more to ingest the toxin. As a result, they are mostly used as feeding stimulants. Sugar based food sprays can be more attractive to pests such as *Helicoverpa* spp. adults and other sucking pests.

When to use food sprays

Application of food sprays is determined by the predator to *Helicoverpa* spp (pest) ratio (see IPM Guidelines for more information).

- When the predator to pest ratio is 0.5 or higher and *Helicoverpa* numbers are below threshold of 2 larvae per metre, there is no need to apply any food spray (The system is working fine).
- When the predator to pest ratio falls below 0.5 but is higher than 0.4 and *Helicoverpa* numbers are below threshold and the population is mostly eggs, a food spray should be applied. The choice of a particular food spray will depend on whether one needs to attract predators from outside (yeast-based food spray) or arrest the predators in the farm (sugar-based food sprays). The type of food spray used should increase your predator numbers which in turn will feed on the *Helicoverpa* eggs to reduce pest numbers and subsequently bring the ratio back to 0.5 or higher
- If the predator to pest ratio falls below 0.5 but it is higher than 0.4, and *Helicoverpa* numbers are below threshold and the population is predominantly larvae (rather than eggs) then a sugar - based food sprays or UV-protected petroleum spray oil should be mixed with biopesticides and applied to the crops to restore the predator to pest ratio to 0.5 or higher. The sugar-based food spray will increase feeding of larvae to ingest a toxic dose of either Bt or NPV; whereas UV protected petroleum spray oil will prolong the persistence of Bt or NPV on the crop giving the larvae enough time to eat and ingest a toxic dose of the biopesticides. All these strategies will assist to bring the predator to pest ratio back to 0.5 or higher.
- If *Helicoverpa* larvae levels are above threshold in your next check following the food spray/biopesticide or UV-protected petroleum oil/biopesticide mixture sprays and the predator to pest ratio is 0.4 or lower, do not use the food sprays but use one of the soft option insecticides to correct the insect pressure situation and then return to the use of predatory insect attractant sprays (yeast-based food sprays) to build up beneficial insect numbers and continue with IPM (see IPM guidelines for more details).

How to use food sprays

Successful establishment of predatory insects in cotton crops may vary in the degree of attraction, the type of food product used and the stage of the growth of the crop when the application of the food spray began. Studies with food sprays (eg Envirofeast®) has shown that the number of predatory beetles, bugs and lacewings per metre in cotton crops treated with Envirofeast® at 4 true-leaf stage were significantly higher than when the product was applied to cotton crops at 2, 6 or 8 true-leaf stages or unsprayed control plot (Figure 1). Thus, the optimum time to commence the application of Envirofeast® spray in cotton fields to achieve maximum conservation and abundance of predatory insects is when the cotton crops are at 4-true leaf stage (Figure 1).

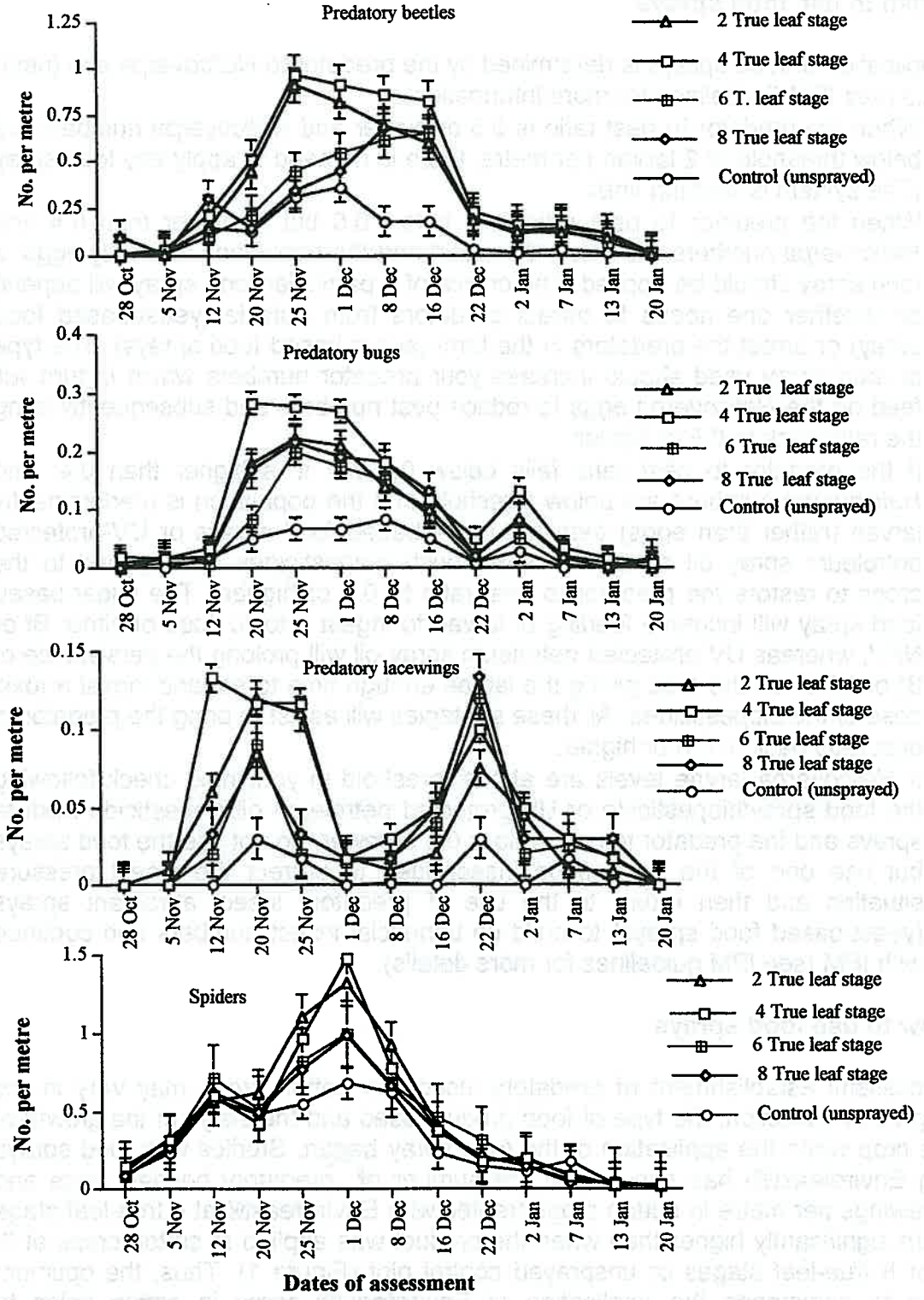

Figure 1. Effect of application of food sprays (Envirofeast®) at different growth states of cotton crops and populations of predators at Yarral near Narrabri, 1998-99.

To reduce the cost of food spray products, apply the products as a band spray (33-50 per cent band) or skip row spray (i.e. to every second row) using a ground rig during the early cotton season. Applying food sprays as band or skip row spray can increase predatory insects population similar to when they are applied over the entire field (solid or no skip row spray) (see Figure 2). This method of food spray application can reduce the cost of the product by 50-67 per cent without affecting efficacy (Figure 2). When the cotton crop is at a 4-true leaf stage, a food spray can be applied at a 33 per cent band to cotton plants using a ground rig or boom sprayer. As the cotton grows, the band width can be increased to 50 per cent. Similarly, food sprays can be applied to every second row of cotton plants in the field rather than the entire cotton rows (no skip) to achieve similar results, thus reducing the total treated area by 50 per cent resulting in a 50 percent saving in spray costs.

Food sprays and pests

The major use of food sprays has been the attraction, conservation and build up of natural enemies of agricultural pests. However, the use of food sprays above the optimum rate required for a particular food product may have adverse effect by encouraging some pests particularly *Helicoverpa* spp. into the crop to lay. Growers should therefore use food sprays only at the rate that will attract beneficial insects but not encourage pests. It is known that insects in general like sugar. They use sugar to generate energy to lay all their eggs.

During the past two seasons (2000-2002), the impact of all the commercially available food sprays on pests was studied. It was found that some of the food spray products particularly the sugar-based ones may increase *Helicoverpa* spp. egg lay depending on the rate of application used.

Experiment 1 (2000-2001): Oviposition responses of *Helicoverpa* spp. to food sprays in commercial normal cotton crops:

Trials were conducted in commercial irrigated normal cotton crops at Auscott in Narrabri during 2000-2001 season. The study evaluated the effect of food sprays on densities of *Helicoverpa* spp. in cotton. The food spray products used for the study were Envirofeast® (2.5 kg/ha), PredFeed® (2.5kg/ha), AminoFeed® (3Litres/ha) (beneficial attractant rate). This was compared with a conventional (biopesticides (Bt, NPV) treated cotton crops. Trials were conducted only in the early season. Each food spray was applied 4 times at aproximately 7-10 days interval. The food sprays were also mixed with either NPV or Bt when a decision was made to control *Helicoverpa* larvae.

The results of the study are given in Figure 3 Significantly higher numbers of eggs per metre ($P<0.05$) were recorded on crops treated with AminoFeed® compared with the other food sprayed and control treatments (Figure 3). The

number of very small and small larvae and also medium and large larvae per metre were not significantly different (P>0.05) among food sprayed plots, but were significantly lower (P<0.05) than numbers per metre recorded on the conventional NPV and Bt plots (Figure 3).

Experiment 2 (2000-2001): Oviposition response of *Helicoverpa armigera* to food sprays in the mesh house.

Following the results of experiment 1, a "free choice" study was conducted in the mesh house at ACRI in December 2000. A 100 mated *Helicoverpa armigera* females were introduced in the mesh house to lay on potted cotton plants treated with Aminofeed® (3L/ha), Aminofeed UV (3L/ha), Mobait® (0.5L/ha, Predfeed® (2.5kg/ha), Envirofeast® (2.5kg/ha) and Sugar solution (2kg/ha). The number of eggs per plant was assessed for each treatment and compared to unsprayed cotton plants.

The results of these experiments are given in Figure 4. Plants treated with sugar solution had the highest number of eggs per plant (Figure 4). This was followed by plants treated with Aminofeed®, Aminofeed UV and Mobait® (Figure 4). The unsprayed plants and plants treated with Predfeed® and Envirofeast® had the lowest number of eggs per plant (Figure 4).

Experiment 3 (2000-2001): Oviposition response of *Helicoverpa armigera* to sugar based food sprays in the mesh house:

Following the results of the mesh house study, the sugar-based food sprays (Aminofeed® and Mobait®) were selected for a "free choice" trial. In this study potted cotton plants were treated with Aminofeed® (3L/ha), Mobait® (0.5L/ha) and Molasses (3L/ha). 100 mated *H. armigera* females were released in the mesh house and the number of eggs per plant were recorded and compared to the control (water-treated plants).

The results of this study are given in Figure 5. The results showed that a higher number of eggs per plant were found on plants treated with Aminofeed®, Mobait® and Molasses compared to plants treated with water (Figure 5).

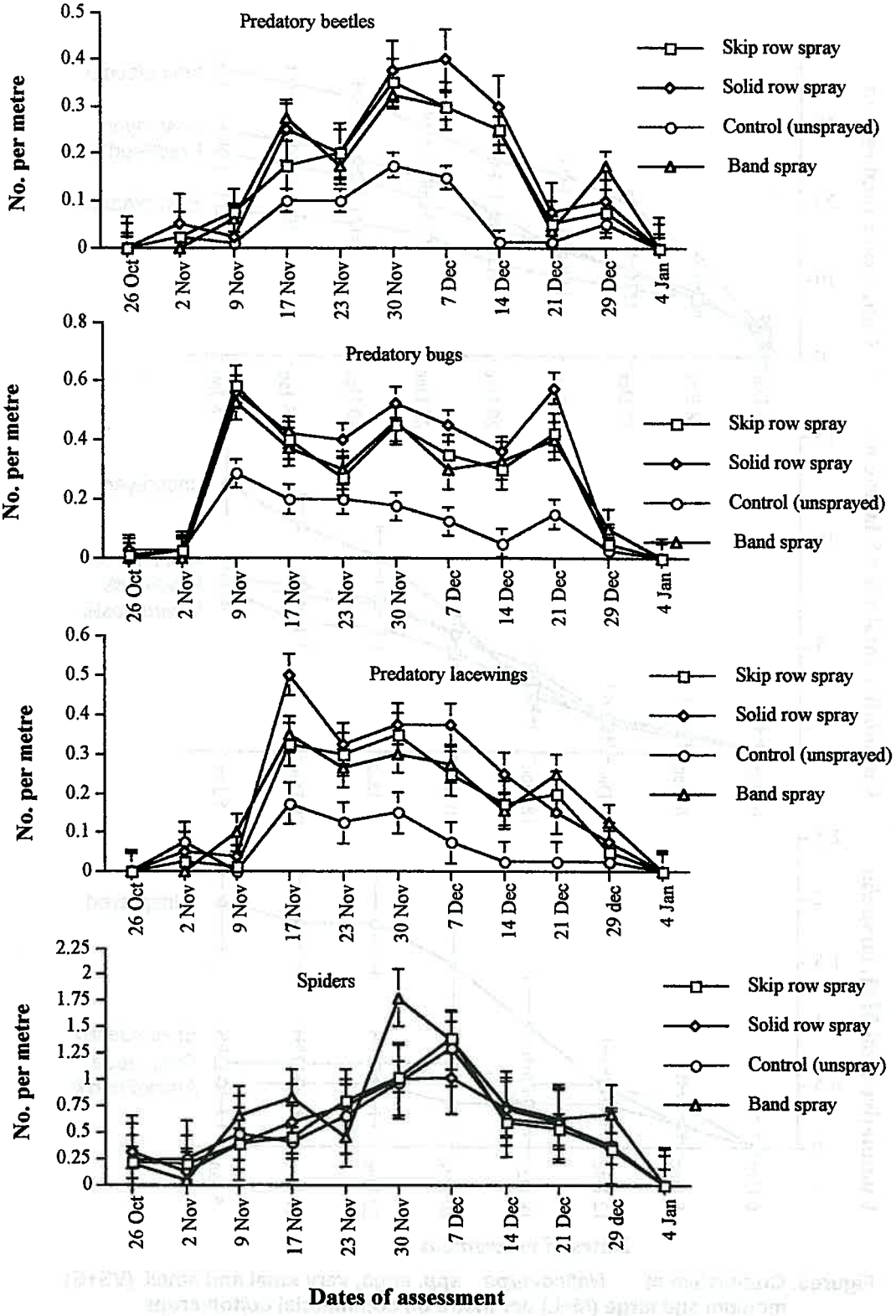

Figure 2. Effect of application of food spray (Envirofeast®) as a "band" or "skip" row spray on populations of predators in commercial cotton crops at Yarral in Narrabri, 1998-99.

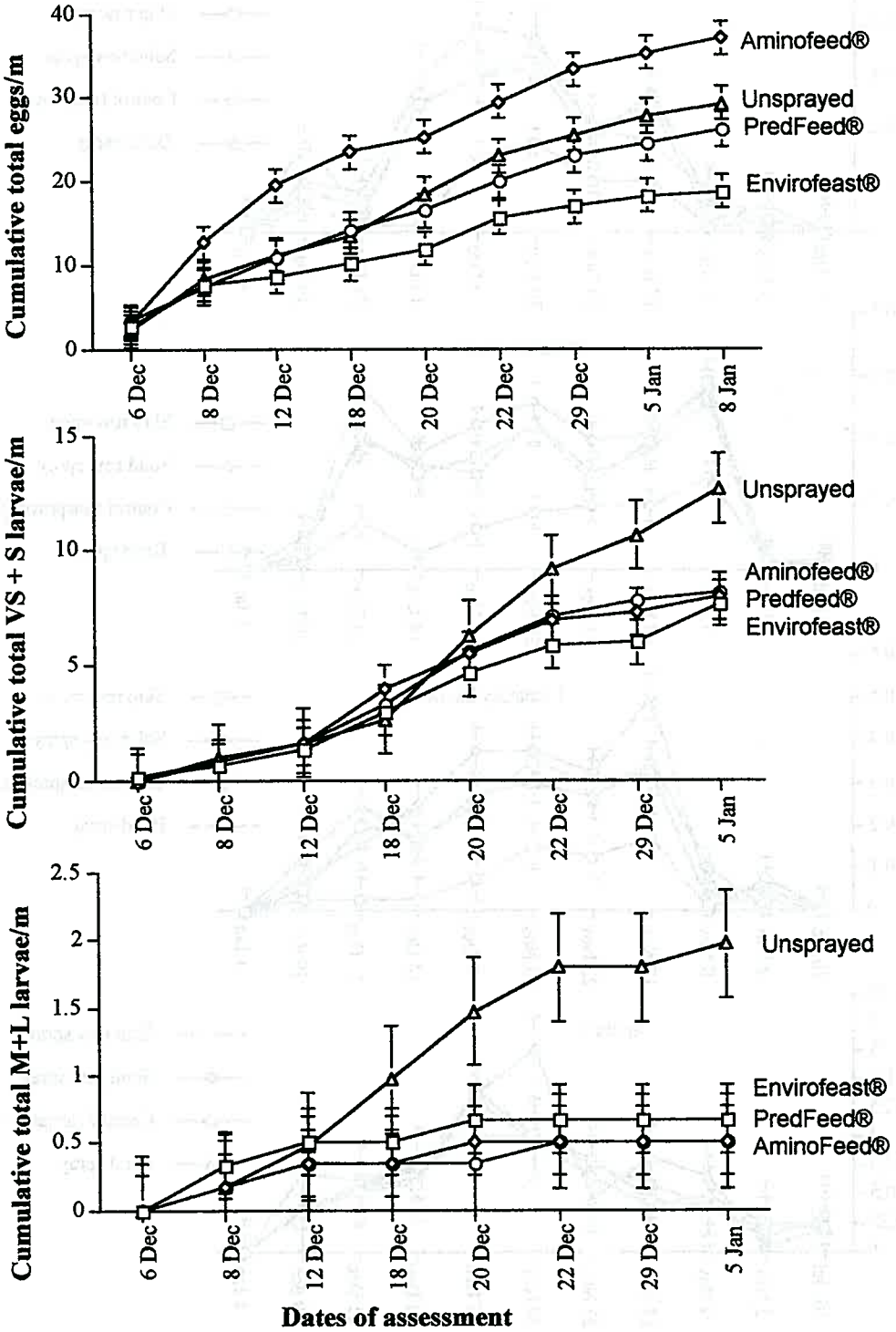

Figure3. Cumulative of *Helicoverpa* spp. eggs, very smal and small (VS+S) medium and large (M+L) per metre on commercial cotton crops treated with food sprays at Auscott in Narrabri, 2000-2001.

Experiment 4 (2000-2001): Oviposition response of *Helicoverpa armigera* to different application rates of Aminofeed.

Following the results of experiment 3, a new study was conducted to determine the optimum rate required to spray Aminofeed® so that *Helicoverpa* egg lay on the plant will be the same as unsprayed cotton plants. In this study, Aminofeed® was applied at 3L/ha, 2L/ha and 1L/ha to potted cotton plants in the mesh house. 100 mated *H. armigera* females were released in the mesh house to lay on the treated plants. The number of eggs per plant recorded on the Aminofeed treated plants were compared to the control (water-treated) plants.

The results of this study are given in Figure 6. The results showed that plants treated with Aminofeed® at 2 and 3 L/ha had significantly ($P<0.01$) higher eggs per plant than plants treated with Aminofeed® at 1L/ha (Figure 6). Additionally, the number of eggs per plant recorded on plants treated with 1L/ha Aminofeed® was not significantly different ($P>0.05$) from plants treated with water. Thus the optimum rate of application of Aminofeed® to increase *Helicoverpa* egg lay was 1L/ha (Figure 6).

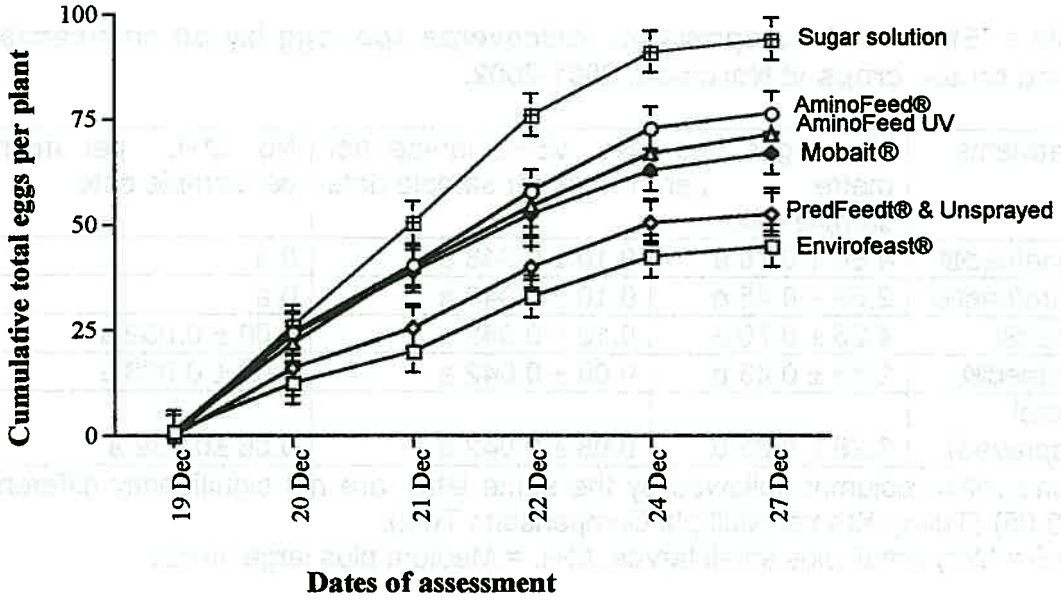

Figure 4. Cumulative total number of *Helicoverpa* spp. eggs per metre recorded on cotton crops treated with food sprays in the mesh house at ACRI in December 2000.

Experiment 5 (2001-2002): Oviposition responses of *Helicoverpa* spp. to food sprays in commercial Ingard cotton crops.

This study was conducted to confirm results of the field experiment (Experiment 1) conducted on normal cotton crops at Auscott in Narrabri during 2000-2001 season. The experiment was conducted at Norwood on Ingard cotton crops from 13 November 2001 until 8 January 2002. This was the period the Ingard crops were fully expressing the Bt toxin. The food spray products evaluated were Aminofeed® (3L/ha), Predfeed® (2.5 kg/ha), Envirofeast® (2.5 kg/ha), Mobait® (0.5L/ha) and unsprayed (control). The number of eggs per metre was recorded on each treatment and control plots every 7 days.

The results of the study are given in Table 1. The result showed that the number of *Helicoverpa* spp. eggs per metre per sample date was significantly lower ($P<0.05$) on Predfeed® and Envirofeast® treated plots than Aminofeed®, Mobait® and unsprayed plots (Table 1). The number of eggs per metre recorded on the Aminofeed® and Mobait® treated plots were significantly higher (50% higher) ($P<0.01$) than the control (unsprayed) plots (Table 1) indicating that the products may be increasing egg lay on the crops.

Table 1. Effect of food sprays on *Helicoverpa* spp. egg lay on commercial Ingard cotton crops at Norwood, 2001-2002.

Treatments	No. eggs per metre per sample date	No. VS+S larvae per metre per sample date	No. M+L per metre per sample date
Aminofeed®	4.66 ± 0.78 a	0.10 ± 0.048 a	0 a
Envirofeast®	2.69 ± 0.45 b	0.10 ± 0.048 a	0 a
Mobait®	4.25 ± 0.70 a	0.10 ± 0.048 a	0.06 ± 0.039 a
Predfeed®	2.43 ± 0.43 b	0.08 ± 0.042 a	0.03 ± 0.028 a
Control (unsprayed)	3.28 ± 0.65 b	0.08 ± 0.042 a	0.06 ±0.039 a

Means within columns followed by the same letter are not significantly different ($P>0.05$) (Tukey-Kramer Multiple Comparisons Test).
VS+S = Very small plus small larvae; M+L = Medium plus large larvae

Food sprays and abundance of predatory insects in cotton.

The major reason that growers use food sprays is to build up their beneficial insects population in order to utilise them in IPM programs. A lot of scientific and published information are available on the product performance of Envirofeast® against beneficial insects in refereed journals. In contrast, the other food products had no information about product performance in refereed scientific journals. It is crucial to document product performance of these commercial food sprays against beneficial insects in order to educate growers.

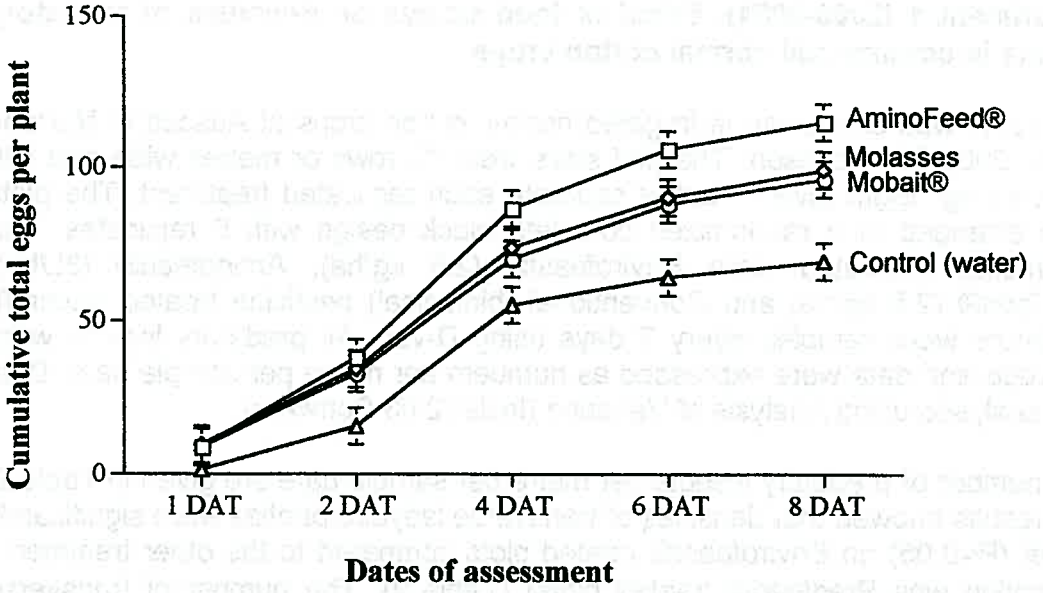

Figure 5. Effect of sugar-based food sprays on *Helicoverpa armigera* oviposition in the mesh house at ACRI, 2001.

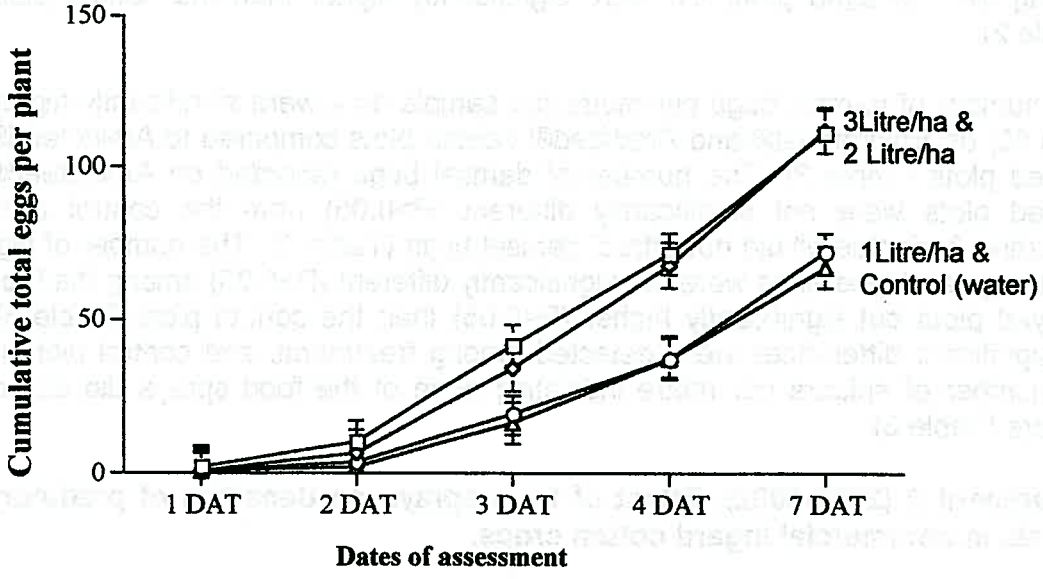

Figure 6. Cumulative total number of *Helicoverpa armigera* eggs per plants treated with different rates of Aminofeed in the mesh house at ACRI, 2002.

Experiment 1 (2000-2001). Effect of food sprays on densities of predatory insects in commercial normal cotton crops.

The study was conducted in irrigated normal cotton crops at Auscott in Narrabri during 2000-2001 season. The plot sizes were 32 rows or metres wide and 400 metres long. Eight rows of buffer separate each replicated treatment. The plots were arranged in a randomized complete block design with 6 replicates. The treatments evaluated were Envirofeast® (2.5 kg/ha), Aminofeed® (3L/ha), Predfeed® (2.5 kg/ha) and Conventional (biological) pesticide treated (control). Predators were sampled every 7 days using D-vac. All predatory insects were recorded and data were expressed as numbers per metre per sample date. Data was analysed using Analysis of Variance (Instat 2.03 Software).

The number of predatory insects per metre per sample date are given in Table 2. The results showed that densities of transverse ladybird beetles were significantly higher ($P<0.05$) on Envirofeast® treated plots compared to the other treatments (exception was Predfeed® treated plots) (Table 2). The number of transverse ladybirds found on Aminofeed® treated plots were similar to the control plots (Table 2). Similar results were achieved for striped and two spotted ladybirds (Table 2). The number of red and blue beetles per metre were not different among food sprayed plots but were significantly higher than the control plots (Table 2).

The number of damsel bugs per metre per sample date were significantly higher ($P<0.05$) on Envirofeast® and Predfeed® treated plots compared to Aminofeed® treated plots (Table 3). The number of damsel bugs recorded on Aminofeed® treated plots were not significantly different ($P>0.05$) from the control plots indicating Aminofeed® did not attract damsel bugs (Table 3). The number of big-eyed bugs and lacewings were not significantly different ($P>0.05$) among the food sprayed plots but significantly higher ($P<0.05$) than the control plots (Table 3). No significant differences were detected among treatments and control plots in the number of spiders per metre indicating none of the food sprays did attract spiders (Table 3).

Experiment 2 (2001-2002). Effect of food sprays on densities of predatory insects in commercial Ingard cotton crops.

The study was conducted in irrigated Ingard cotton crops at Norwood near Moree during 2001-2002 season . The plot sizes were 24 rows or metres wide and about 70metres long. Eight rows of buffer separate each replicated treatment. The plots were arranged in a randomized complete block design with 6 replicates. The treatments evaluated were Envirofeast® (2.5 kg/ha), Aminofeed® (3L/ha), Predfeed® (2.5 kg/ha), Mobait® (0.5L/ha) and Unsprayed(control). Predators were sampled every 7 days using D-vac. All predatory insects were recorded and numbers were expressed as numbers per metre for each sample date. Data was analysed using Analysis of Variance (Instat 2.03 Software).

The results given in this paper are for early season data as space will not allow all data to be included in the proceedings. Detail information will be published in a refereed journal and extracted for the Australian Cotton Grower Magazine.

The number of transverse ladybirds were significantly higher ($P<0.05$) in Envirofeast® and Predfeed® treated plots than the Aminofeed® and Mobait® treated plots (Table 4). Numbers in the Aminofeed® and Mobait® plots were not different ($P>0.05$) but were significantly higher ($P<0.05$) than the control (unsprayed) plots (Table 4). The same results were recorded for two-spotted ladybirds for all treatments (Table 4). There were no significant difference in the numbers of red and blue beetles found in the food sprayed plots (Table 4). However, numbers of red and blue beetles were significantly higher in the food sprayed plots than the unsprayed plots (Table 4).

Table 2. Effect of food sprays on densities of predatory beetles in commercial normal cotton crops at Auscott in Narrabri, 2000-2001.

Treatments	Transverse ladybirds: No No. per metre per sample date	Striped ladybirds: No. per metre per sample date	Two - spotted ladybirds: No. per metre per sample date	Red and blue beetles: No. per metre per sample date
Aminofeed®	0.52 ±0.01 a	0.52 ± 0.01 ac	0.53 ± 0.04 a	0.51 ± 0.01 a
Envirofeast®	0.66 ± 0.04 b	0.57 ± 0.02 b	0.65 ± 0.01 b	0.53 ± 0.01 a
Predfeed®	0.57±0.01 ab	0.56 ± 0.01 ab	0.59 ± 0.02 ab	0.52 ± 0.01 a
Control (NPV, Bt)	0.51 ± 0.01 a	0.49 ± 0.01 c	0.52 ± 0.01 a	0.45 ± 0.01 b

Means within columns followed by the same letter are not significantly different

Table 3. Effect of food sprays on densities of predatory bugs, lacewings and spiders in commercial normal cotton crops at Auscott in Narrabri, 2000-2001.

Treatments	Damsel bugs No. per metre per sample date	Big-eyed bugs No. per metre per sample date	Lacewings No. per metre per sample date	Spiders No. per metre per sample date
Aminofeed®	0.53 ± 0.01a	0.52 ± 0.01 ac	0.51 ± 0.01 a	0.62 ± 0.01 a
Envirofeast®	0.58 ± 0.01 b	0.53 ± 0.02 a	0.55 ± 0.01 a	0.64 ± 0.01 a
Predfeed®	0.56 ± 0.01 b	0.52 ± 0.01 a	0.51 ± 0.01 a	0.64 ± 0.01 a
Control (NPV, Bt)	0.43 ± 0.01 a	0.42 ± 0.01 b	0.41 ± 0.01 b	0.59 ± 0.01 a

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

Table 4. Effect of food sprays on densities of predatory beetles in commercial Ingard cotton crops at Norwood near Moree, 2001-2002.

Treatments	Transverse ladybirds No. per metre per sample date	Two - spotted ladybirds No. per metre per sample date	Red and blue beetles No. per metre per sample date
Aminofeed®	1.03 ± 0.23 a	1.63 ± 0.32 a	0.56 ± 0.15 a
Envirofeast®	1.84 ± 0.28 b	2.03 ± 0.45 b	0.66 ± 0.15 a
Mobait®	0.97 ± 0.24 a	1.31 ± 0.26 a	0.41 ± 0.12 ab
Predfeed®	1.25±0.24 ab	2.06 ± 0.43 b	0.53 ± 0.09 a
Control (Unsprayed)	0.59 ± 0.16 c	0.68 ± 0.17 c	0.25 ± 0.11 b

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

The number of damsel bugs per metre in the Aminofeed® treated plots were the same as the unsprayed plots indicating Aminofeed® did not attract damsel bugs (Table 5). The number of damsel bugs recorded on Aminofeed® and the unsprayed plots were significantly lower (P<0.05) than those on Predfeed®, Envirofeast® and Mobait® treated plots (Table 5).

The number of big-eyed bugs per metre found on the Envirofeast® and Predfeed® treated plots were significantly higher (P<0.05) than those on the Mobait® and Aminofeed® treated plots. The numbers of big-eyed bugs found on Aminofeed® and Mobait® treated plots were not different from the unsprayed plots (Table 5).

The number of green lacewings per metre were not significantly different (P>0.05) among plots treated with food sprays but were significantly higher (P<0.05) than the unsprayed plots exception was the Mobait® treated plots (Table 6). Similar results were achieved with brown lacewings (Table 6). The numbers of brown lacewings in Aminofeed® and Mobait® treated plots were not different (P>0.05) from the unsprayed plots (Table 6).

No significant differences were detected among treatments in the number of spiders per metre per sample date (Table 6).

Table 5. Effect of food sprays on densities of damsel and big-eyed bugs (predatory bugs) in commercial Ingard cotton crops at Norwood near Moree, 2001-2002.

Treatments	Damsel bugs No. per metre per sample date	Big-eyed bugs No. per metre per sample date
Aminofeed®	0.021 ± 0.006 a	0.009 ± 0.003 a
Envirofeast®	0.049 ± 0.012 b	0.029 ± 0.007 b
Mobait®	0.025 ± 0.008 ab	0.008 ± 0.006 a
Predfeed®	0.042 ± 0.009 ab	0.032 ± 0.009 b
Control (Unsprayed)	0.015 ± 0.005 a	0.006 ± 0.003 a

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

Table 6. Effect of food sprays on densities of predatory lacewings and spiders in commercial Ingard cotton crops at Norwood near Moree, 2001-2002.

Treatments	Green lacewings No. per metre per sample date	Brown lacewings No. per metre per sample date	Spiders No. per metre per sample date
Aminofeed®	0.66 ± 0.159 b	0.143 ± 0.067 ab	3.021 ± 0.466 a
Envirofeast®	0.84 ± 0.262 b	0.286 ± 0.087 b	2.625 ± 0.341 a
Mobait®	0.50 ± 0.162 ab	0.179 ± 0.074 ab	2.688 ± 0.418 a
Predfeed®	0.85 ± 0.180 b	0.357 ± 0.117 b	3.438 ± 0.456 a
Control (Unsprayed)	0.24 ± 0.106 a	0.071 ± 0.049 a	3.563 ± 0.494 a

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

General Discussion

Generally, food sprays have an indirect but positive role in cotton pest management. They do not by themselves kill pests but manage the pests indirectly by attracting and conserving natural enemies which in turn control the pests. Thus commencing application of food spray early in the season especially at 4 true leaf stage is crucial in enhancing the establishment of predatory insects prior to *Helicoverpa* spp. infestation.

The cost of food spray products can be reduced if they are applied as a band spray (33-50 per cent band) or skip row spray (i.e. to every second row) using a ground rig. As the cotton crop grows the band width can be varied similar to synthetic insecticide applications.

The results of the studies showed better performance of the yeast-based food sprays (Envirofeast® and Predfeed®) than the sugar based food sprays (Aminofeed® and Mobait®) in attracting most of the predatory insects needed in our cotton fields. The Yeast based food sprays are to be used if the objective of the spray is to attract rather than arrest beneficial insects. Sugar based food sprays should be used if the farm already have enough beneficial insects and the objective is to keep them there. Sugar based food sprays can be used as feeding stimulants to encourage larvae to eat more. However, in using sugar based food sprays caution should be taken to apply the optimum rate that will not encourage pests such as *Helicoverpa* moths to lay more on the crop. Aminofeed in particular can increase Helicoverpa egg lay if applied at the recommended beneficial attractant rate of 3L/ha. The optimum rate of application of Aminofeed is 1L/ha. This rate is not the recommended beneficial attractant rate on the product label.

Tailoring food sprays in this way in addition to applying the product based on the ratio of predators to *Helicoverpa* spp. in individual grower cotton fields will ultimately reduce the cost of food spray products thus encouraging more growers to use the product to support natural enemy- based IPM programs.
Now growers know how food sprays can and cannot do. There is the need to use food sprays in IPM programs since they can assist the adoption of IPM.

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