

Insecticide Resistance Management Strategy (IRMS) for 2013–14

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The use of pesticides selects for resistance in pest populations. The cotton industry IRMS seeks to manage the risk of resistance in aphids, mites and *Helicoverpa* spp., both in conventional and Bollgard II cotton. Additional resistance management requirements are also in place for managing the risk of *Helicoverpa* spp. developing resistance to Bollgard II (refer to pages 75–79). Below, the key elements of the IRMS are described and questions regarding the design and reasons for the IRMS are answered. In this document, the term ‘insecticide’ refers generally to pesticides used for insect or mite control. The resistance risk management for silverleaf whitefly is built into the Silverleaf Whitefly Threshold Matrix (refer to page 29).

Checklist

- Use recommended thresholds for all pests to minimise insecticide use and reduce resistance selection. Refer to Table 17 pages 39–40.
- Monitor first position fruit retention at flowering and aim to retain at around 60% or alternatively maintain a fruiting factor of between 1.1 and 1.3. Refer to IPM section page 52.
- Avoid repeated applications of products from the same insecticide group, including Bt products, even when targeting different pests. Rotate between groups. Consider seed treatment as a ‘spray’ and do not apply a first foliar spray from the same insecticide group as the seed treatment.
- Do not exceed the maximum recommended use limits indicated on the Insecticide Resistance Management Strategy charts for cotton (see pages 64–67).
- Do not respray an apparent failure with the same product or another product from the same insecticide group. Rotate to a different group.
- For all pest species, aim to use the most selective insecticide options first, delaying the use of broad spectrum insecticides for as long as possible. On the IRMS charts the options are arranged from top to bottom in order of selectivity. Using the most selective option helps conserve beneficial insects, reducing the chance of mite, aphid and silverleaf whitefly outbreaks.
- Monitor mite populations regularly after seedlings emerge. If established mite populations are present (5–10% of plants infested) avoid using broad-spectrum insecticides to control other pests. Instead use selective options or options that also control or suppress mites, either alone or in mixtures as required.
- Avoid early season use of omethoate or dimethoate. When targeting mirids, avoid early season dimethoate / omethoate use as it will select catastrophic pirimicarb resistance in aphids.
- Control weeds and volunteer cotton on farm to minimise alternative hosts for mites, aphids and silverleaf whitefly through winter and particularly in the lead up to cotton planting.

- Cultivate cotton and residues of alternative host crops as soon as possible after harvest to destroy overwintering *H. armigera* pupae, particularly if crops are defoliated after 9 March. In Bollgard II fields, cultivation must be completed before the end of July.
- Comply with any use restrictions placed on insecticides used on other crops. This will reduce the chance of prolonged selection for resistance over a range of crops.

Your questions answered

How was the 2013–14 IRMS decided?

The development of the Insecticide Resistance Management Strategy is driven by the Transgenic and Insect Management Strategies (TIMS) Committee. TIMS is a part of Cotton Australia. The results from the insecticide and miticide resistance monitoring programs, carried out during the season, are used to inform the committee of any field-scale changes in resistance levels. Extensive communication and discussion with cotton growers and consultants is undertaken in all regions of the Australian cotton industry before TIMS finalises their recommendations. Communication is critical for ensuring that the IRMS is practical and can be implemented.

How do insects develop resistance?

Resistance is an outcome of exposing pest populations to a strong selection pressure, such as an insecticide. Genes for resistance naturally occur at very low frequencies in insect populations. They remain rare until they are selected for with a toxin, either from an applied pesticide or from within Bollgard II. Once a selection pressure is applied, resistance genes can increase in frequency as the insects carrying them are more likely to survive and produce offspring. If selection continues, the proportion of resistant insects relative to susceptible insects may continue to increase until reduced effectiveness of the toxin is observed in the field.

On the IRMS chart, what do the colours for the various products represent?

In the IRMS charts, the different colours for the various products correspond to maximum usage restrictions. Abamectin and Emamectin (Affirm) can individually have maximum of two applications however a maximum of three applications is allowed from these two products. In addition to colours please be aware of addition restrictions at side and footnoted. Insecticide groups are listed on page 67. Rotate to an insecticide from a different mode of action group.

What is the scientific basis of the IRMS?

The basis of the IRMS is to minimise selection across consecutive generations of the pest. Pest life cycles therefore determine the length of the ‘windows’ around which the IRMS is built. As the life cycles of *Helicoverpa* spp. and the sucking pests are very different, the strategy for one will not manage resistance for the other.

***Helicoverpa* spp.**

Ideally the length of the 'windows' would be 42 days (average time from egg to moth) to minimise the selection pressure across consecutive generations. Most chemicals are restricted to windows of between one and two generations to account for the practicalities of pest control. To counteract this compromise there are additional restrictions on the maximum number of applications for each chemical group.

Sucking pests – mites and aphids

The resistance strategy for the short life cycle pests depends on rotation of insecticides/miticides between different chemical groups (different modes of action) to avoid selection over successive generations. Non-consecutive uses of chemistries is particularly important for aphids as they reproduce asexually. All offspring from a resistant aphid will be resistant. There are also restrictions on the maximum number of uses for individual products and chemical groups to further encourage rotation of chemistries.

Does the IRMS seek to manage resistance in Silverleaf Whitefly (SLW)?

The IRMS has now been modified to include all commercially available products registered for use in cotton, including SLW. Inclusion is based on the SLW threshold matrix which is designed to minimise the need to intervene with chemical control as well as to delay the development of resistance. Refer to the SLW Threshold Matrix, page 29, for additional industry recommendations on the best way to utilise the available products with the lowest risk of developing resistance.

How do refuges help manage resistance to Bt in Bollgard II, and do they help manage resistance to insecticides in *Helicoverpa*?

Growing refuge crops is a pre-emptive resistance management strategy that is implemented to retard the evolution of field-scale resistance to Bollgard II. The success of the refuge strategy depends on the majority of the general population being susceptible (SS) to the toxins in Bt-cotton. When a susceptible moth mates with a resistant moth (RR), the offspring carry one allele from each parent (RS). These offspring are referred to as heterozygotes. In the cases of Bt resistance that have so far been identified, heterozygotes are still controlled by Bollgard II cotton.

Refuges are able to help manage Bt resistance through the generation of SS moths. If RR moths are emerging from Bollgard II fields, they are more likely to mate with SS moths if a refuge has been grown. The RS offspring is susceptible to Bollgard II and an increase in the frequency of RR individuals can be retarded.

This is not always the case for resistances to other insecticides. For many of the conventional insecticides (to which resistance has already developed), resistance mechanisms are functionally dominant. This means that heterozygotes (RS) survive the application and can make up a large part of the resistant population. In such circumstances the dilution effect created by refuges is far less effective.

While refuges cannot assist when insecticide resistance is already prevalent in the field population, such as with synthetic pyrethroids, there may be some benefit from the unsprayed refuge options for new chemistries. Unsprayed refuges will produce moths that have not been exposed to insecticide selection pressure.

Why is there a Northern, and Southern/Central IRMS?

The IRMS has always accounted for pest movement among different cotton growing regions. For example several field studies have shown that *Helicoverpa* spp. moths can travel large distances. Recently, some genetic work showed that mirids move long distances between regions. Insecticide resistance in one region can therefore spread to other regions by pest migration. The TIMS Committee designs the IRMS to reduce the chance that pests moving between regions would be reselected repeatedly by the same insecticide group. This is done by limiting the time period over which most insecticides are available. The two strategies accommodate the different growing seasons from central Queensland through to southern NSW.

Will the large uptake of Bollgard II reduce the population sizes of *Helicoverpa* spp.?

H. armigera is closely linked with cropping regions and the widespread use of Bollgard II may be affecting the size of natural populations of this pest. In most seasons, the majority of moths are locally generated, so Bollgard II may be acting as a 'sink' and influencing the overall population size. However, this species uses hosts other than cotton, so even with widespread use of Bollgard II, population sizes are likely to also be regulated by the abundance of these alternative hosts.

In contrast, large populations of *H. punctigera* moths can be generated in inland areas and migrate to cotton growing regions. In this case, as moths are generated in other environments, Bollgard II will have little effect on the size of these populations, especially early in the season following the annual spring migration events of this species. However the size of these populations will be strongly influenced by the availability of hosts in inland areas and stop over points along the way, which is largely determined by rainfall and degree of land degradation. Years where inland areas receive little rainfall may produce few migrating moths, and even large populations may be prevented from migrating to cropping regions if suitable habitat along the way is absent.

Why do we need an IRMS in conventional cotton when there are such large areas of Bollgard II?

Whenever insecticides are used there is selection pressure for resistance. In Bollgard II cotton, aphids, mites, mirids and silverleaf whitefly are no longer secondary pests. More often than not, it is this range of pests that require intervention with foliar insecticides to protect cotton yield and quality and as such there is a risk of resistance developing in these populations. The IRMS charts seek to directly manage the risk of resistance in pests as well as reduce risk of inadvertent selection of pests that are not the primary target of the insecticide.

Large areas of Bollgard II will not change the frequencies of resistance genes being carried by *H. armigera* moths. The same proportion of resistant and susceptible moths will continue to lay eggs in cotton – be it conventional or Bollgard II. Hence the likelihood of resistance development to foliar and soil applied insecticides remains the same, even if the overall size of the *H. armigera* population is reduced. Continuing to follow the IRMS will ensure that the industry retains the ability to control *H. armigera* effectively with insecticides on conventional cotton both now and in the future. The IRMS should always be consulted when making a spray decision, even in Bollgard II cotton.

When do stage windows start and stop?

The dates shown on the strategy charts are for the start of each stage. Windows will start at 00:01 h on the date shown as the start (e.g. 15 December for Stage 2 in Central areas) and end at midnight 24:00 h on the day before the start of the next window (e.g. 1 February for Stage 2 in Central areas). For those individual insecticides and miticides that start or end outside window boundaries, the start and end dates are specified and the same principles apply.

What do the terms cross-resistance and multiple resistance mean? How can they be minimised?

Cross-resistance occurs when selection for resistance against one pesticide also confers resistance to another pesticide, either from the same mode of action group or a different group. For example, the mechanism for pirimicarb resistance (Group 1A) in aphids also gives resistance to omethoate/dimethoate (Group 1B). Cross-resistance is important as it means that a pest may be resistant to a chemical to which it has never been exposed (i.e. without selection pressure).

Multiple resistance simply means that an insect is resistant to more than one mode of action group. For instance, *H. armigera* can have metabolic resistance to synthetic pyrethroids (Group 3A) and nerve insensitivity to organophosphates (Group 1B).

The development of both cross-resistance and multiple resistance can be minimised by following the IRMS. The strategy is designed to manage both of these occurrences. For example, in the strategy for aphids, there is a break between the use of pirimicarb and dimethoate/omethoate during which other chemistries should be used. The use of alternative chemistries should minimise the number of pirimicarb resistant aphids being exposed to dimethoate/omethoate.

Is pupae busting in conventional cotton still important for resistance management?

Yes. Pupa busting is an effective, non-chemical method of preventing resistance carryover from one season to the next. The pupae busting guidelines for sprayed conventional cotton are based on the likelihood that larvae will enter diapause before a certain date, allowing for removal of pupae busting operations in field specific situations. The estimated commencement date of diapause is based on the model which drives the *Helicoverpa* Diapause Induction and Emergence Tool on the Cotton CRC website. The model was developed from field research conducted on the Darling Downs by Qld DAFF and has broad application to farming systems in eastern Australia. The web tool predicts the timing of diapause.

Post Harvest Pupa Destruction statement

Sprayed conventional cotton crops defoliated after the 9th March are more likely to harbour insecticide resistant diapausing *Helicoverpa armigera* larvae and should be pupae busted as soon as possible after picking and no later than the end of July.

How does the use of insecticide mixtures fit in the IRMS?

When used repeatedly, mixtures are high-risk and a controversial strategy for managing resistance. They can undermine the IRMS by repeatedly selecting for resistance to the common components in mixtures and by selection for resistance across multiple chemical groups. When mixtures are used frequently, it becomes difficult to determine whether each component is contributing equally to efficacy.

The use of mixtures to overcome the effects of resistance requires very careful consideration. As a general rule, mixtures are unnecessary in situations where individual products provide adequate control.

Several criteria need to be met for mixtures to be effective.

Components of the mixture should:

- Be equally persistent;
- Have different modes of action;
- Not be subject to the same routes of metabolic detoxification; and,
- Be tank-mix compatible.

In addition, the majority of the pest population should not be resistant to any component of a mixture, as this may render it a redundant or 'sleeping partner' in terms of insect control. When very heavy *Helicoverpa* spp. pressure occurs and egg parasitism percentages have been low, include an ovicide (e.g. amitraz and methomyl) in sprays to take the pressure off larvae. When targeting sprays against eggs and very small larvae do not expect 100% control with any insecticide or mixture of insecticides. If larval numbers are reduced below threshold then the treatment should be regarded as effective. Some mix partners provide more than additive kill (synergism), but this is not always the case. The Croplife Australia Insecticide Resistance Management Group, recommend that no two compounds from the same chemical group/mode of action be included in a mixture. The repeated use of any insecticide with different mix partners will also increase selection for resistance. It is illegal to use rates above those recommended on the label of an insecticide alone or in mixtures. Efficacy will not always improve at rates above the highest label rate or if two insecticides of the same chemical group are applied as a mixture.

Can emergency changes be made to the IRMS during the season?

Yes, the TIMS Troubleshooting Committee (TTC) was established by TIMS to act on its behalf to respond quickly to requests to vary the Strategy temporarily for specific regions. The TTC is not able to approve major changes to the Strategy – that is the role of the TIMS Committee.

What is the process for requesting a within-season change to the IRMS?

The TIMS Troubleshooting Committee (TTC) has put in place a clear process for handling requests for within-season changes to the IRMS.

A request to temporarily alter the Strategy for a district or part of a district can be initiated by any grower or consultant, but it will not be considered by the TTC unless it is presented with clear evidence of having been discussed and gained majority support at a local level. This will include:

- Evidence that the local consultants who might be affected by the requested alterations have discussed them and are in agreement.
- A request from the local Cotton Growers Association (CGA) that outlines the problem and the preferred solution.
- Evidence that all reasonable efforts have been made to apply the alternatives available within the strategy.

The request can be faxed or emailed to Lewis Wilson. A return contact name and phone number should be included so that receipt of the request can be acknowledged and further



discussion can be held with a TTC member if required. All members of the TTC will be faxed or emailed the request and asked to respond to an ACRI contact point by 10 a.m. the following morning (or the next working day if the request is lodged on a weekend or public holiday). A decision will then be made and a response issued by 12 noon. All reasonable efforts will be made to meet this level of response, however it should be recognised that complex or poorly communicated requests may take longer to resolve.

The granting of a request by the TTC to temporarily alter the Resistance Strategy applies to a specific district. It does not confer the same temporary changes to other districts unless they have also lodged a request to the TTC in the manner outlined above. TTC changes for a region have a limited duration and do not carry over from one season to the next.

Considerations following a suspected spray failure

In the event of a suspected pest control failure, don't panic as it is important to assess the situation carefully before deciding on a course of action. The presence of live pests following an

insecticide application does not necessarily indicate insecticide failure. What is the insecticide's mode of action? Has it been given enough time to work? Products such as thiodicarb, foliar Bt, NPV and indoxacarb are stomach poisons and may not give maximum control until 5–7 days after application. Similarly, propargite, abamectin, pyriproxifen and diafenthiuron are slow acting and may take 7–10 days or longer to achieve maximum control. In some instances pest infestation levels remain high following a treatment but little if any economic damage to the crop occurs (e.g. if the pests are sick and have ceased feeding). When diagnosing the cause of an insecticide failure, it is important to remember that there are a wide range of variables that influence insecticide efficacy. These include species complex, population density and age, crop canopy structure, application timing, the application method, carrier and solution pH – and their effects on coverage and the insecticide dose delivered to the target, environmental conditions, assessment timing and insecticide resistance expressed in the pest population. For every insecticide application, it is the interaction of all of these factors that determines the outcome. While it will not be possible to optimise all of these variables all of the time, when more compromises are made, there is a greater likelihood that efficacy will be unsatisfactory.

It is also important to maintain realistic expectations of the efficacy that can be achieved. For example, do not expect satisfactory control of medium and large *Helicoverpa* larvae late in the season, regardless of the insecticide treatment used. If a field failure is suspected to be due to insecticide resistance, collect a sample of the surviving pest from the sprayed field using the industry guidelines and send to the relevant researcher.

- For *Helicoverpa*, Lisa Bird (02) 6799 1500.
- For mites and aphids, Grant Herron (02) 4640 6333.
- For whitefly, Richard Lloyd (07) 4688 1315.

Sending samples for testing can confirm or rule out resistance as the cause of the spray failure and is an important part of assessing the presence of resistance across the industry.

After any spray failure, do not follow up with an application of the same insecticide group alone or in mixture (at any rate). Rotate to an insecticide from a different mode of action group.

TIMS TROUBLESHOOTING COMMITTEE CONTACTS 2013-14

Name	Telephone	Fax	Email
Lewis Wilson, CSIRO (chair person)	(02) 6799 1550	(02) 6793 1186	lewis.wilson@csiro.au
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Greg Kauter, Cotton Australia	(02) 9669 5222	(02) 9669 5511	gregk@cotton.org.au
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Cotton IRMS

INSECTICIDE RESISTANCE MANAGEMENT STRATEGY 2013/14

BEST PRACTICE PRODUCT WINDOWS AND USE RESTRICTIONS TO MANAGE INSECTICIDE RESISTANCE IN APHIDS, SILVERLEAF WHITEFLY, MITES AND HELICOVERPA SPECIES.

Central & Southern Regions: Balonne, Bourke, Darling Downs, Gwydir, Lachlan, Lower & Upper Namoi, Macintyre, Macquarie, Murrumbidgee

	STAGE 1	STAGE 2	STAGE 3	STAGE 4	WHICH PRODUCT FOR WHICH PEST? Refer to Tables 2–16, pages 7–38.
		15 Dec 2012	15 Jan 2013	15 Feb 2013	
↑ SELECTIVITY increasing	Foliar <i>Bacillus thuringiensis</i> (Dipel)				Excludes Bollgard II refuges.
	<i>Helicoverpa</i> viruses (Gemstar, Vivus)				Avoid season long use of low rates.
	Pirimicarb				NON CONSECUTIVE APPLICATIONS. ¹
	Paraffinic Oil (Canopy, Biopest)				No restrictions.
	Phorate at planting insecticide				After 1625 DD in a salvage situation, a knockdown is required before use. ³
	Etoxazole (Paramite)				Note ¹
	December 1 Chlorantraniprole (Altacor)				Note ^{4,7}
	Dicofol				Ground only. NSW only.
	Amorphous silica (Abrade)				No restrictions.
	start date = canopy closure Diafenthiuron (Pegasus)				NON CONSECUTIVE APPLICATIONS. ³
↓ SELECTIVITY decreasing	Pymetrozine (Fulfill)				NON CONSECUTIVE APPLICATIONS. ³
	Indoxacarb (Steward) January 31				Note ⁴
	Spirotetramat (Movento)				Note ³
	Abamectin				Note ⁴
	Emamectin (Affirm) } Max. 3				Note ^{4,7}
	start date = squaring Propargite				NON CONSECUTIVE APPLICATIONS. ⁷
	Amitraz				Note ⁴
	Fipronil				Notes ^{4,7}
	Neonicotinoids (Amparo, Cruiser, Gaucho, Actara, Confidor, Intruder, Shield)				NON CONSECUTIVE APPLICATIONS. ^{2,7}
	February 1 { Carbamates (methomyl, thiodicarb) Dimethoate / Omethoate OPs (chlorpyrifos, methidathion) Synthetic Pyrethroids				Note ⁵
<div style="border: 1px solid black; border-radius: 50%; padding: 10px; display: inline-block; text-align: center;"> CHECK IMPACTS ON BENEFICIALS, PAGES 8–9. </div>					
<div style="border: 1px solid black; padding: 5px; display: inline-block;"> NO MORE THAN ONE APPLICATION PER SEASON </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> NO MORE THAN THREE APPLICATIONS PER SEASON </div>					
<div style="border: 1px solid black; padding: 5px; display: inline-block;"> NO MORE THAN TWO APPLICATIONS PER SEASON </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> NO MORE THAN FOUR APPLICATIONS PER SEASON </div>					

STOP OVERWINTERING OF RESISTANT POPULATIONS BY PRACTISING GOOD FARM HYGIENE AND CONTROLLING WINTER HOSTS. PUPAE BUST AFTER HARVEST.⁶

COMMENTS AND NOTES DESCRIBE ALL USE RESTRICTIONS

NO MORE THAN ONE APPLICATION PER SEASON

NO MORE THAN THREE APPLICATIONS PER SEASON

NO MORE THAN TWO APPLICATIONS PER SEASON

NO MORE THAN FOUR APPLICATIONS PER SEASON

Note 1: If a phorate side dressing is used instead of a neonicotinoid seed dressing then do not use pirimicarb or dimethoate/omethoate as first foliar spray as there is cross resistance between them all. Dimethoate/omethoate use will select catastrophic pirimicarb resistance in aphids so do not use pirimicarb and dimethoate/omethoate in the same field.

Note 2: Failures of neonicotinoids against aphids have been confirmed. DO NOT follow a seed treatment with a foliar neonicotinoid when aphids are present.

Note 3: Cross check with the Silverleaf Whitefly Threshold Matrix, page 29.

Note 4: Maximum 2 consecutive sprays, alone or in mixtures.

Note 5: Additional applications can be made if targeting *Helicoverpa* moths using Magnet.

Note 6: Sprayed conventional cotton crops defoliated after March 9 are more likely to harbour resistant diapausing *Helicoverpa armigera* and should be pupae busted as soon as possible after harvest and no later than the end of August.

Note 7: Observe Withholding Periods, page 158. Products in this group have WHP 28 days or longer.

Note 8: High resistance is present in *Helicoverpa armigera* populations. Expect field failures.

Cotton IRMS

INSECTICIDE RESISTANCE MANAGEMENT STRATEGY 2013/14

BEST PRACTICE PRODUCT WINDOWS AND USE RESTRICTIONS TO MANAGE INSECTICIDE RESISTANCE IN APHIDS, SILVERLEAF WHITEFLY, MITES AND HELICOVERPA SPECIES.

Northern Region: Belyando, Callide, Central Highlands, Dawson

STAGE 1	STAGE 2	STAGE 3	STAGE 4	WHICH PRODUCT FOR WHICH PEST? Refer to Tables 2–16, pages 7–38.
	15 Nov 2012	15 Dec 2012	15 Jan 2013	
Foliar <i>Bacillus thuringiensis</i> (Dipel)				Excludes Bollgard II refuges.
<i>Helicoverpa</i> viruses (Gemstar, Vivus)				Avoid season long use of low rates.
Pirimicarb				NON CONSECUTIVE APPLICATIONS. ¹
Paraffinic Oil (Canopy, Biopest)				No restrictions.
Phorate at planting insecticide				After 1625 DD in a salvage situation, a knockdown is required before use. ³
Etoxazole (Paramite)				Note ¹
Chlorantraniprole (Altacor)				Note ^{4,7}
Amorphous silica (Abrade)				No restrictions.
start date = canopy closure				NON CONSECUTIVE APPLICATIONS. ³
Diafenthiuron (Pegasus)				NON CONSECUTIVE APPLICATIONS. ³
Pymetrozine (Fulfill)				Note ⁴
Indoxacarb (Steward)				NON CONSECUTIVE APPLICATIONS. ³
Spirotetramat (Movento)				NON CONSECUTIVE APPLICATIONS. ³
Abamectin				Note ⁴
Emamectin (Affirm)				Note ^{4,7}
start date = squaring				NON CONSECUTIVE. ⁷
Propargite				Note ⁴
Amitraz				Notes ^{4,7}
Fipronil				NON CONSECUTIVE APPLICATIONS. ^{2,7}
Neonicotinoids (Amparo, Cruiser, Gaucho, Actara, Confidor, Intruder, Shield)				Note ⁵
Carbamates: (methomyl, thiodicarb)				Not for use in rotation with pirimicarb. ^{1,7}
Dimethoate / Omethoate				Notes ^{4,7}
OPs: (chlorpyrifos, methidathion)				High resistance, <i>H. armigera</i> ^{3,4,7,8}
Synthetic Pyrethroids				

STOP OVERWINTERING OF RESISTANT POPULATIONS BY PRACTISING GOOD FARM HYGIENE AND CONTROLLING WINTER HOSTS. PUPAE BUST AFTER HARVEST.⁶

COMMENTS AND NOTES DESCRIBE ALL USE RESTRICTIONS

NO MORE THAN ONE APPLICATION PER SEASON

NO MORE THAN THREE APPLICATIONS PER SEASON

NO MORE THAN TWO APPLICATIONS PER SEASON

NO MORE THAN FOUR APPLICATIONS PER SEASON

- Note 1:** If a phorate side dressing is used instead of a neonicotinoid seed dressing then do not use pirimicarb or dimethoate/omethoate as first foliar spray as there is cross resistance between them all. Dimethoate/omethoate use will select catastrophic pirimicarb resistance in aphids so do not use pirimicarb and dimethoate/omethoate in the same field.
- Note 2:** Failures of neonicotinoids against aphids have been confirmed. DO NOT follow a seed treatment with a foliar neonicotinoid when aphids are present.
- Note 3:** Cross check with the Silverleaf Whitefly Threshold Matrix, page 29.
- Note 4:** Maximum 2 consecutive sprays, alone or in mixtures.
- Note 5:** Additional applications can be made if targeting *Helicoverpa* moths using Magnet.
- Note 6:** Sprayed conventional cotton crops defoliated after March 9 are more likely to harbour resistant diapausing *Helicoverpa armigera* and should be pupae busted as soon as possible after harvest and no later than the end of August.
- Note 7:** Observe Withholding Periods, page 158. Products in this group have WHP 28 days or longer.
- Note 8:** High resistance is present in *Helicoverpa armigera* populations. Expect field failures.

Cotton IRMS

INSECTICIDE RESISTANCE MANAGEMENT STRATEGY 2013/14

Explanatory notes for all regions

IRMS Guidelines:

The use of pesticides selects for resistance in pest populations. Many products used in cotton for insect and mite control are efficacious against more than one important pest. In every population of every pest species there will be a small proportion of individuals with the ability to survive an insecticide. The IRMS aims to assist users to:

- Lower the risk of inadvertent selection of resistance in pests that are not the primary target of the insecticide application.
- Delay the evolution of pest resistance to key chemical groups, by minimising the survival of individuals with resistance.
- Manage entrenched resistance problems, such as the now widespread resistance in cotton aphids to neonicotinoids.

For 2013/14, the IRMS includes all actives commercially available for use in cotton at the time of publication. This means the IRMS should be consulted for EVERY insecticide/miticide decision. This change aims to address the risks of resistance in pests that are not the primary target of the insecticide application and improve the relevance of the IRMS to insecticide use on Bollgard II cotton.

Principles underlying the IRMS

1. Monitor pest and beneficial populations.
2. Use recommended thresholds for all pests.
3. Monitor fruit retention.
4. Comply with all directions for use on product labels.
5. Avoid repeated applications of products from the same insecticide group, even when targeting different pests. Rotate between groups.
6. Do not respray an apparent failure with the same product or another product from the same insecticide group. Rotate to a different group.
7. For all pest species, aim to use the most selective insecticide options first, delaying the use of broad spectrum insecticides for as long as possible.
8. Control weeds and cotton volunteers in fields and around the farm all year to minimise pest hosts.
9. Pupae bust cotton as soon as possible after harvest.

In-season Troubleshooting

Ratification of the IRMS prior to the start of each season is the responsibility of Cotton Australia's TIMS Committee. A Troubleshooting sub-committee is empowered to act on TIMS' behalf during the cotton season to respond to emergency requests to vary the IRMS. The Troubleshooting sub-committee has a clear process for handling requests (detailed on page 62). For further information contact Greg Kauter, Cotton Australia (02 9669 5222).

How to use the 2013/14 IRMS

REGION. There are now two IRMS regions. Central and Southern Regions have been combined. The Northern Region covers Central Queensland and stage dates accounts for the early planting and quicker crop development.

STAGE. The dates shown on the strategy charts are for the start of each stage (eg. 15 December 2013 start of Stage 2 for Central & Southern region IRMS). For those individual insecticides and miticides that start or end outside window boundaries, the start and/or end dates are listed.

SELECTIVITY. The products listed in the IRMS are listed in order of decreasing selectivity. For all pest species, aim to use the most selective option in the window first, delaying the use of broad spectrum insecticides for as long as possible.

USE RESTRICTIONS. Colours in the table now represent the maximum number of applications per crop per season for any given product.

COMMENTS AND NOTES DESCRIBE ALL USE RESTRICTIONS

NO MORE THAN **ONE** APPLICATION PER SEASON

NO MORE THAN **TWO** APPLICATIONS PER SEASON

NO MORE THAN **THREE** APPLICATIONS PER SEASON

NO MORE THAN **FOUR** APPLICATIONS PER SEASON

Additional restrictions to product use can be found on the right hand column of the table, with links to specific footnotes. Avoid repeated applications of products from the same insecticide group, even when targeting different pests. Rotate between groups.

Key Changes for the 2013/14 cotton season

In addition to the new layout the following changes to the IRMS include:

- **Restrictions on first foliar spray based on seed treatment.** Neonicotinoid resistance in cotton aphids remains at high levels and there are limited 'soft options' for aphid control. If a phorate side dressing is used instead of a neonicotinoid seed dressing then do not use pirimicarb or dimethoate/omethoate as first foliar spray as there is cross resistance between them all. Dimethoate/omethoate use will select catastrophic pirimicarb resistance in aphids so do not use pirimicarb and dimethoate/omethoate in the same field.

Insecticide Groups :

Active ingredient (proprietary trade names)	Insecticide Group	Chemical Group
Helicoverpa viruses (Gemstar, Vivus)	Not a member of a group	Nuclear polyhedrosis virus
Paraffinic Oil (Canopy, Biopest)	Not a member of a group	Petroleum spray oil
Dicofol	Not a member of a group	UN - Unknown mode of action
Amorphous silica (Abrade)	Not a member of a group	Not a member of a group
Methomyl	GROUP 1A INSECTICIDE	Carbamate
Pirimicarb		
Thiodicarb		
Chlorpyrifos	GROUP 1B INSECTICIDE	Organophosphates
Dimethoate / Omethoate		
Methidathion		
Phorate		
Fipronil	GROUP 2B INSECTICIDE	Phenylpyrazoles (Fiproles)
Alpha-cypermethrin	GROUP 3A INSECTICIDE	Synthetic Pyrethroids
Beta-cyfluthrin		
Bifenthrin		
Cypermethrin		
Deltamethrin		
Gamma-cyhalothrin		
Lambda-cyhalothrin		
Zeta-cypermethrin		
Acetamiprid (Intruder)	GROUP 4A INSECTICIDE	Neonicotinoids
Clothianidin (Shield)		
Imidacloprid (multiple, including seed treatments)		
Thiamethoxam (multiple, including seed treatments)		
Abamectin	GROUP 6 INSECTICIDE	Avermectins
Emamectin (Affirm)		
Pyriproxyfen (Admiral)	GROUP 7C INSECTICIDE	Pyriproxyfen
Pymetrozine (Fulfill)	GROUP 9B INSECTICIDE	Pymetrozine
Etoxazole	GROUP 10B INSECTICIDE	Etoxazole
Foliar Bacillus thuringiensis (Dipel)	GROUP 11 INSECTICIDE	Bt microbials
Diafenthiuron (Pegasus)	GROUP 12A INSECTICIDE	Diafenthiuron
Propargite	GROUP 12C INSECTICIDE	Propargite
Amitraz	GROUP 19 INSECTICIDE	Amitraz
Indoxacarb	GROUP 22A INSECTICIDE	Indoxacarb
Spirotetramat	GROUP 23 INSECTICIDE	Spirotetramat
Chlorantraniliprole (Altacor)	GROUP 28 INSECTICIDE	Diamides

Source: CropLife Australia Insecticide Resistance Management Review Group, 2012 <http://www.croplifeaustralia.org.au/>