Insecticide Resistance Management Strategy (IRMS) for 2010/11

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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 *Helicoverpa spp.*, aphids, mites and whitefly, 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 64–65). 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.

Checklist

1. Cultivate cotton and residues of alternative host crops as soon as possible after harvest to destroy overwintering *H. armigera* pupae. In Bollgard II fields, cultivation must be completed before the end of July.
2. Use recommended pest thresholds to minimise insecticide use and reduce resistance selection. Refer to Table 14 on page 34–35.
3. 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.
4. Delay using broad-spectrum sprays, such as organophosphates or pyrethroids, for as long as possible. These products reduce the abundance of beneficial insects and increase the chance of mite, aphid and silverleaf whitefly outbreaks.
5. Avoid early season use of omethoate or dimethoate. This is to prevent selection for organophosphate-carbamate cross-resistance in aphids. Avoiding early season use of these insecticides also reduces the risk of flaring other pests like silverleaf whitefly.
6. Do not apply a first foliar spray from the same insecticide group as a seed treatment. For sucking pests, consider the seed treatment as a 'spray' and alternate chemistries.
7. 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 compounds or compounds that also control or suppress mites, either alone or in mixtures as required.
8. Avoid continuous sprays of any one mode of action group, including Bt products. (Rotate between chemical groups where possible). Do not exceed the maximum acceptable use limits indicated on the Insecticide Resistance Management Strategy charts for cotton (see pages 52–55).
9. Do not respray an apparent failure with a product of the same group – unless the failure is clearly due to factors not related to resistance, such as poor application, timing, etc.
10. Control weeds on farm to minimise alternative hosts for mites, aphids and silverleaf whitefly through winter and particularly in the lead up to cotton planting.
11. 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 2010/11 IRMS decided?

The development of the Insecticide Resistance Management Strategy is driven by the Transgenic and Insect Management Strategies (TIMS) Committee. TIMS is a sub-committee 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.

What are the key changes in the IRMS this season?

There are not many changes to the IRMS for this season:

1. New insecticide chemical group 23 spirotetramat sold as Movento. Effective against Aphids and SLW. Refer to Silverleaf Whitefly threshold and associated notes.
2. No changes to window dates.
3. No changes to windows for any products.
4. Chemicals that are registered but currently commercially unavailable have been separated from the main body of the strategy and 'greyed' out to give greater clarity to those insecticides that are actually available for use.

Why is it important to follow the IRMS in Bollgard II cotton?

Whenever insecticides are used there is selection pressure for resistance. The IRMS should always be consulted when making a spray decision, even in Bollgard II cotton. This is irrespective of whether the decision has been motivated by above threshold populations of secondary pests, large *Helicoverpa* larvae migrating from refugia or extremely high *Helicoverpa* egg pressure. The IRMS has been designed to fit with IPM principles. Following the IRMS and implementing the Bollgard II RMP is necessary to minimise all resistance risks to insecticides, miticides and the Cry proteins (in Bollgard II).

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.

What do the chemical group numbers on the IRMS charts mean?

The numbers appearing beside chemical names or trade names on the IRMS chart are the international mode of action group numbers. To be consistent with insecticide product labels and international agreements among chemical manufacturers, TIMS also include these numbers when listing chemical groups.

Insecticides with the same mode of action kill pests by the same mechanism eg. by affecting the function of nerves or by paralysing mouthparts. Hence, if insects (or mites) develop resistance to one insecticide in a particular mode of action group, they maybe cross resistant to other insecticides in that 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, aphids and whitefly

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.

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. It is being implemented to prevent field-scale resistance to Bollgard II. This is important as the success of the refuge strategy depends on the majority of the general population being susceptible (SS). 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. Because of the high toxic dose in Bollgard II, it is only RR individuals that can survive. 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 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.

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 prevented.

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.

How does the migration of moths within a season impact on the IRMS?

The IRMS has always accounted for moth movement among different cotton growing regions. Several field studies have shown that moths can travel large distances. Recently, some genetic work showed that *H.armigera* moths move up to 1200 kilometres between regions. Insecticide resistance in one region can therefore spread to other regions by moth migration. The TIMS Committee designs the IRMS to reduce the chance that moths migrating 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 strategies also 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.*?

It is too early to tell whether the widespread use of Bollgard II will affect the size of natural populations of *Helicoverpa*. *H. armigera* is closely linked with cropping regions so it is possible that a reduction in numbers of this pest will occur over time. In most seasons, the majority of moths are locally generated, so Bollgard II may act as a 'sink' and influence the overall population size. However, this species uses hosts other than cotton and, even with widespread use of Bollgard II, population sizes may 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. As these 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 influence by the availability of hosts, which is largely determined by rainfall. Years where inland areas receive little rainfall may produce few migrating moths.

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

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, in case field-resistance to Bollgard II develops.

Self-defence against Heliothis.

There's a new way to defend cotton crops against the threat of Heliothis. New DuPont™ Altacor® quickly acts to stop caterpillars feeding, while remaining friendly to bees and most other beneficial insects. And because of its low toxicity to most non-target organisms the environment has nothing to fear either. With translaminar movement, rainfastness and UV stability, you can be sure of good residual control too. So if it's time to get tough with Heliothis, give your cotton a chance to fight back with the robust, reliable control of Altacor®.

DuPont™ Altacor®
insecticide
powered by
RYNAXYPYR®

Altacor®. Heliothis control without compromise.

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ALWAYS REFER TO THE LABEL BEFORE USE

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 organophoshates (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. Pupae busting is an effective, non-chemical method of preventing resistance carryover from one season to the next.

In 2007/08 the pupae busting guidelines for sprayed conventional cotton were modified according to 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 DEEDI and has broad application to farming systems in eastern Australia. The web tool predicts the timing of diapause.

Post Harvest Pupae Destruction statement since 2007/08

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. Mixtures may provide improved field control of *H. armigera* in situations where a proportion of the pest population is resistant to one insecticide (i.e. pyrethroid) but is susceptible to another chemical group with a different mode of action (i.e. organophosphate). 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 larvicides. When targeting sprays against eggs and very small larvae and 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. Some mixtures may in fact result in reduced effectiveness. For example the synergists, piperonyl butoxide (PBO) and propargite, may increase the efficacy of pyrethroids against *H. armigera*, but may be antagonistic if mixed with organophosphates or chlorfenapyr.

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 (e.g. chlorpyrifos and profenofos). The repeated use of any insecticide with different mix partners will also increase selection for resistance e.g. pyrethroid plus propargite, followed by pyrethroid plus amitraz, followed by pyrethroid plus organophosphate.

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.

TIMS TROUBLESHOOTING COMMITTEE CONTACTS 2010/11

Name	Telephone	Mobile	Fax	Email
Lewis Wilson (Chair person)	(02) 6799 1550	–	(02) 6793 1186	lewis.wilson@csiro.au
CRDC (Tracey Leven)	(02) 6792 4088	–	(02) 6792 4400	tracey.leven@crdc.com.au
Cotton Australia (Greg Kauter)	(02) 9669 5222	0429 700711	(02) 9669 5511	gregk@cotton.org.au

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, spinosad 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*, Sharon Downes (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.

2010–11 Insecticide Resistance Management Strategy for Cotton

Northern Regions:

Central Highlands, Dawson and Callide Valleys

See Cotton Pest Management Guide for suggested thresholds

Helicoverpa

Stage 1	Stage 2 Nov 15	Stage 3 Dec 15	Stage 4 Jan 15	Stage 5 Feb 1

Maximum 2 consecutive sprays of any one insecticide group, alone or in mixtures

- FOLIAR *Bacillus thuringiensis* (BT) -on conventional and Bollgard II cotton but EXCLUDING any refuges
- HELICOVERPA VIRUSES (Gemstar, Vivus) avoid season long use of low rates
- Canopy Oil , Abrade - No restrictions
- AMITRAZ - Max of 4
- ENDOSULFAN see label for restrictions
- Affirm
- ABAMECTIN - for *H. punctigera*, Max of 2, including mite sprays

} Max 3 from 'mectins' group

- Altacor - Max of 3 (Dec 1)
- Steward* - Max of 3 (Feb 15)
- Spinosad* - Max of 3
- PYRETHROIDS & PYRETHROID MIXES
  - PBO, Max of 2
  - Talstar sprays, Max of 2, including mite sprays.
- CHLORPYRIFOS - Max of 3 including mixtures
- Other OPs - Max of 3 including mixtures
- METHOMYL - Max of 4, carbamates Including mixtures
- THIODICARB - Max of 4 carbamates Including mixtures

* September 15th No use of Steward or Spinosad group on chickpeas after this date

- # Prodigy - Max of 3 - #
- # Intrepid - Max of 1 at any rate including mite sprays
- # CHLORPYRIFOS METHYL - Max of 3 including mixtures
- # PROFENOFOS - Max of 3 including mixtures

Post-Harvest

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

Registered but currently commercially unavailable insecticides

See Cotton Pest Management Guide for suggested thresholds

Stage 1	Stage 2 Nov 15	Stage 3 Dec 15	Stage 4 Jan 15	Stage 3 Feb 1

1. Maximum 2 sprays per mode of action group, including mixtures, unless otherwise indicated below.
2. Rotate chemistry. No consecutive use of the same group
3. **Failures** with **neonicotinoids** against aphids **have been confirmed**. Do not follow a seed or planting insecticide with the first foliar spray from the same group. **ALTERNATE**

		Withholding Period
Aphids	Canopy Oil - No restrictions	Nil See label
	Cruiser, Gaucho / Genero, Amparo } Seed dressing — Max of 2 neonicotinoid sprays	Nil See label
	Confidor — Finish date determined by long withholding period	91 days
	Actara, Intruder, Shield	28,10&5days
	Movento - Max of 2 per season	21 days
	PIRIMICARB — Use when beneficial conservation is important	21 days
	Fulfill - Crop must be actively growing — Finish date determined by crop growth (see label)	28 days
	ENDOSULFAN - see label for restrictions	28 days
	DIMETHOATE & OMETHOATE	14 & 21 days
	# CHLORPYRIFOS - METHYL	5 days
Aphids and Mites	ALDICARB — In furrow at sowing	Nil See label
	PHORATE — in furrow at sowing or side dress	70 days
	CHLORPYRIFOS - See Helicoverpa strategy	28 days
	Start date determined by canopy closure (see label) — Pegasus	14 days
	# PROFENOFOS	28 days
Mites	Paramite - Max of 1	21 days
	ABAMECTIN - Max of 2, including *H. punctigera* sprays	20 days
	Don't use pre squaring — PROPARGITE	28 days
	Talstar - Max of 2, including Helicoverpa sprays.	14 days
	# Intrepid - Max of 1 at any rate including Helicoverpa sprays	28 days
SLW	Refer Silverleaf Whitefly Threshold Matrix and associated notes	
Mirids	WARNING Avoid early season omethoate/dimethoate use as it may compromise their efficacy and pirimicarb efficacy against aphids as well as flare other pests including silverleaf whitefly.	

Post-Crop Management

STOP Over wintering resistant populations by practising good farm hygiene (see IPM Guidelines)

2010–11 Insecticide Resistance Management Strategy for Cotton

Central

Darling Downs, Balonne, Macintyre, Gwydir, Lower & Upper Namoi, Bourke

See Cotton Pest Management Guide for suggested thresholds

	Stage 1	Stage 2 Dec 15	Stage 3 Jan 15	Stage 4 Feb 15
	Maximum 2 consecutive sprays of any one insecticide group, alone or in mixtures			
Helicoverpa	FOLIAR *Bacillus thuringiensis* (Bt) - on conventional and Bollgard II cotton but EXCLUDING any refuges			
	HELICOVERPA VIRUSES - (Gemstar, Vivus) avoid season long use of low rates			
	Canopy Oil , Abrade - No restrictions			
	AMITRAZ - Max of 4			
	ENDOSULFAN see label for restrictions			
	Affirm — February 1			
	ABAMECTIN - for *H. punctigera*, Max of 2, including mite sprays } Max 3 from 'mectins' group			
	December 1 Altacor - Max of 3			
	December 1 SPINOSAD* - Max of 3			
		Steward*- Max of 3		
			PYRETHROIDS & PYRETHROID MIXES - PBO, Max of 2 - Talstar sprays, Max of 2, including mite sprays.	
			February 1 { CHLORPYRIFOS - Max of 3 including mixtures; Other OPs - Max of 3 including mixtures; METHOMYL - Max of 4 carbamates Including mixtures; THIODICARB - Max of 4 carbamates Including mixtures	
	* October 15th No use of Steward or Spinosad group on chickpeas after this date			
	# Prodigy - Max of 3			
		# Intrepid - Max of 1 at any rate including mite sprays		
			February 1 { # CHLORPYRIFOS METHYL - Max of 3 including mixtures; # PROFENOFOS - Max of 3 including mixtures	

Post-Harvest

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

Registered but currently commercially unavailable insecticides

See Cotton Pest Management Guide for suggested thresholds

1. Maximum 2 sprays per mode of action group, including mixtures, unless otherwise indicated below.
2. Rotate chemistry. No consecutive use of the same group
3. **Failures** with **neonicotinoids** against aphids **have been confirmed**. Do not follow a seed or planting insecticide with the first foliar spray from the same group. **ALTERNATE**

	Stage 1	Stage 2 Dec 15	Stage 3 Jan 15	Stage 4 Feb 15	With-holding Period
Aphids	Canopy Oil - No restrictions				Nil See label
	Cruiser, Gaucho / Genero, Amparo } Seed dressing	Max of 2 neonicotinoid sprays			Nil See label
	Confidor	Finish date determined by long withholding period			91 days
	Actara, Intruder, Shield				28, 10 & 5 days
	Movento - Max of 2 per season				21 days
	PIRIMICARB		January 1		21 days
	Fulfill - Crop must be actively growing		Finish date determined by crop growth (see label)		28 days
	ENDOSULFAN - see label for restrictions				28 days
				February 1 { DIMETHOATE & OMETHOATE	14 & 21 days
				# CHLORPYRIFOS -METHYL	5 days
Aphids and Mites	ALDICARB In furrow at sowing				Nil See label
	PHORATE in furrow at sowing or side dress				70 days
	Start date determined by canopy closure (see label)	Pegasus			28 days
			February 1	CHLORPYRIFOS - See Helicoverpa strategy	14 days
			February 1	# PROFENOFOS - See Helicoverpa strategy	28 days
Mites	DICOFOL - NSW only + Ground application only				7 days
	Paramite - Max of 1				21 days
	ABAMECTIN - Max of 2, including *H. punctigera* sprays				20 days
	Don't use pre squaring	PROPARGITE			28 days
				Talstar - sprays, Max of 2, including Helicoverpa sprays.	14 days
		# Intrepid - Max of 1 at any rate including Helicoverpa sprays			28 days
SLW	Refer Silverleaf Whitefly Threshold Matrix and associated Notes				
Mirids	WARNING Avoid early season omethoate/dimethoate use as it may compromise their efficacy and pirimicarb efficacy against aphids as well as flare other pests including silverleaf whitefly.				

Post-Crop Management

STOP Over winter-ing resistant populations by practis-ing good farm hygiene (see IPM Guidelines)

2010–11 Insecticide Resistance Management Strategy for Cotton

Southern Regions:
Macquarie, Lachlan, Murrumbidgee

See Cotton Pest Management Guide for suggested thresholds

Stage 1 | **Stage 2** Dec 15 | **Stage 3** Jan 15 | **Stage 4** Feb 15

Maximum 2 consecutive sprays of any one insecticide group, alone or in mixtures

Helicoverpa

- FOLIAR *Bacillus thuringiensis* (Bt) - on conventional and Bollgard II cotton but EXCLUDING any refuges
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- Canopy Oil , Abrade - No restrictions
- AMITRAZ - Max of 4
- ENDOSULFAN see label for restrictions
- Affirm — February 1
- ABAMECTIN - for *H. punctigera*, Max of 2, including mite sprays
  } Max 3 from 'mectins' group
- December 1 — SPINOSAD* - Max of 3
- December 1 — Altacor - Max of 3
- Steward*- Max of 3
- PYRETHROIDS & PYRETHROID MIXES
  - PBO, Max of 2
  - Talstar sprays, Max of 2, including mite sprays.
- February 1 {
  - CHLORPYRIFOS - Max of 3 including mixtures
  - Other OPs - Max of 3 including mixtures
  - METHOMYL - Max of 4 carbamates Including mixtures
  - THIODICARB - Max of 4 carbamates Including mixtures

* October 15th No use of Steward or Spinosad group on chickpeas after this date

- # Prodigy - Max of 3
- # Intrepid - Max of 1 at any rate including mite sprays
- February 1 {
  - # CHLORPYRIFOS METHYL - Max of 3 including mixtures
  - # PROFENOFOS - Max of 3 including mixtures

Post-Harvest

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

Registered but currently commercially unavailable insecticides

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Stage 1 | **Stage 2** Dec 15 | **Stage 3** Jan 15 | **Stage 4** Feb 15

1. Maximum 2 sprays per mode of action group, including mixtures, unless otherwise indicated below.
2. Rotate chemistry. No consecutive use of the same group
3. **Failures** with **neonicotinoids** against aphids **have been confirmed**. Do not follow a seed or planting insecticide with the first foliar spray from the same group. **ALTERNATE**

		With-holding Period
Canopy Oil - No restrictions		Nil See label
Cruiser, Gaucho / Genero, Amparo } Seed dressing	Max of 2 neonicotinoid sprays	Nil See label
Confidor	Finish date determined by long withholding period	91 days
Actara, Intruder, Shield		28, 10 & 5 days
Movento - Max of 2 per season		21 days
PIRIMICARB	January 1 Use when beneficial conservation is important	21 days
Fulfill - Crop must be actively growing	Finish date determined by crop growth (see label)	28 days
ENDOSULFAN - see label for restrictions		28 days
February 1 { DIMETHOATE & OMETHOATE		14 & 21 days
# CHLORPYRIFOS-METHYL		5 days

Aphids and Mites

ALDICARB	In furrow at sowing	Nil See label
PHORATE	In furrow at sowing or side dress	70 days
Start date determined by canopy closure (see label)	Pegasus	28 days
February 1	CHLORPYRIFOS - See Helicoverpa strategy	14 days
February 1	# PROFENOFOS	28 days

Mites

DICOFOL - NSW only + Ground application only		7 days
Paramite - Max of 1		21 days
ABAMECTIN - Max of 2, including *H. punctigera* sprays		20 days
Don't use pre squaring	PROPARGITE	28 days
	Talstar - sprays, Max of 2, including Helicoverpa sprays.	14 days
	# Intrepid - Max of 1 at any rate including Helicoverpa sprays	28 days

SLW Mirids

Refer Silverleaf Whitefly Threshold Matrix and associated Notes

WARNING Avoid early season omethoate/dimethoate use as it may compromise their efficacy and pirimicarb efficacy against aphids as well as flare other pests including silverleaf whitefly.

Post-Crop Management

STOP Over wintering resistant populations by practising good farm hygiene (see IPM Guidelines)

Chemical Groups for Rotation

Effective against

Group. CHEMICAL: Sold as (# registered but not commercially available)	Helicoverpa	Mites	Aphids	SLW
16A. # METHOXYFENOZIDE (IGR): Prodigy				
11C. BT: Dipel, Costar, MVP2, etc				
VIRUS. Helicoverpa virus (NPV's: Gemstar, Vivus)				
OTHERS, Canopy , Abrade			Canopy	
28. RYNAXYPYR: Altacor				
5A. SPINOSAD: Entrust				
3A. PYRETHROID: Bulldock, Decis, Dominex, Fastac, Karate, etc				
3A. PYRETHROID (BIFENTHRIN): Talstar		Suppress only		
19A. AMITRAZ: Amitraz, Ovasyn etc				
2A. ENDOSULFAN: Thiodan etc.				
22A. INDOXACARB: Steward				
6A. AVERMECTIN: emamectin benzoate (Affirm)		Suppress only		
6A. AVERMECTIN: abamectin (Wizard etc)	*H. punctigera* only			
1A. CARBAMATES: methomyl (Nudrin, Lannate etc), thiodicarb (Larvin etc)				
1A. CARBAMATE At planting: aldicarb			No cross resist	
1A. CARBAMATE Foliar: (PIRIMICARB) Pirimor, Aphidex		Cross resistance in Aphids - Treat Pirimicarb and group 1B as one chemical group. Do not use first foliar spray from this group if seed or furrow treatment from this group.		
1B. CHLORPYRIFOS (+ methyl) (OP):Chlorfos, Lorsban, Predator, (Rescue, Diplomat) etc	No cross resistance			
1B. # PROFENOFOS (OP): Curacron, Sabre etc	No cross resistance			
1B. Other OPs: At Planting or side-dress : Thimet, Phorate Foliar: dimethoate, omethoate, parathion methyl.				
13A. # CHLORFENAPYR: Intrepid				
12B. DIAFENTHIURON: Pegasus				
4A. NEONICOTINOIDS (imidacloprid, thiamethoxam acetamiprid & clothianidin): Seed treatments:Gaucho, Genero, Amparo, Cruiser Foliar:Confidor, Actara, Intruder,Shield	Do not use first foliar spray from group 4a if seed /furrow treatment from this group			
9A. PYMETROZINE: Fulfill				
23. SPIROTETRAMAT: Movento				
2B. DICOFOL: Kelthane, Mitifol				
14A. PROPARGITE: Comite, Bullet				
10A. ETOXAZOLE: Paramite				
7C. PYRIPROXYFEN: Admiral				

Key Changes

1. New insecticide chemical group 23 spirotetramat sold as Movento. Effective against Aphids and SLW. Refer to Silverleaf Whitefly threshold and associated notes.
2. No changes to window dates.
3. No changes to windows for any products.
4. Chemicals registered but not commercially available at the time of writing have been identified by grey text and marked with a # .

Key Guidelines

1. Pupae bust cotton and alternative crop residues as soon as possible.
2. Use recommended thresholds for all pests.
3. Monitor 1st position fruit retention at flowering.
4. Avoid using broad spectrum sprays.
5. Monitor pest and beneficial populations.
6. Avoid continuous sprays from same group.
7. Do not respray apparent failure with same group.
8. Control weeds on farm which are hosts for pests.
9. Comply with any insecticide use restrictions according to label.

For more detailed information see web page:
http://www.cottoncrc.org.au/content/Industry/Publications/PestsandBeneficials/Insect_Resistance_Management.aspx

Trouble shooting: A TIMS sub-committee has been established to arbitrate in cases where individuals, groups or regions expect to have difficulties following the strategy guidelines. It includes representation from: CSIRO; Industry and Investment NSW; Department of Employment, Economic Development and Innovation Qld; Cotton Australia.

If problems arise, contact: Tracey Leven Phone 02 6792 4088 Fax: 02 6792 4400 Email: tracey.leven@crdc.com.au

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