REVISED JUNE 2018

RESISTANCE MANAGEMENT STRATEGY FOR THE REDLEGGED EARTH MITE IN AUSTRALIAN GRAINS AND PASTURES

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

KEY POINTS

- The redlegged earth mite (RLEM) is an important pest of germinating crops and pastures across Western Australia, South Australia, Victoria, Tasmania and southern New South Wales.
- Four chemical sub-groups are registered to control RLEM in grain crops: organophosphates (Group 1B); synthetic pyrethroids (Group 3A); phenylpyrazoles (Group 2B); and neonicotinoids (Group 4A). The latter two are registered only for use as seed treatments.
- Resistance to pyrethroids and organophosphates in RLEM is widespread in WA. These resistances are also present in parts of SA, and will spread to other regions under current pest management practices.
- Strategies to address insecticide resistance in RLEM are available to growers and their advisers. These provide a selection of management options, while also emphasising the importance of rotating chemical groups between mite generations and using a wider selection of chemicals.

PHOTO: A. WEEKS (cesar)

Redlegged earth mites in grain crops and pastures are being exposed to increasing applications of chemicals, placing strong selection pressure for the development of resistance.

Redlegged earth mites and insecticide resistance

The redlegged earth mite (RLEM), *Halotydeus destructor*, is a major threat to a variety of Australian crops and pastures, with canola, lupins and other legume seedlings the most susceptible to attack. RLEM are also a pest of several vegetable crops, while weeds (particularly capeweed) can be important hosts. Mite feeding can lead to distortion or shrivelling of leaves and, affected seedlings may die at emergence when mite populations are high.

The use of chemicals to target RLEM in grain crops and pastures continues to grow in Australia. This places strong selection pressure for the development of resistance in RLEM populations. High levels of resistance to synthetic pyrethroids (SPs), including bifenthrin and alpha-cypermethrin, are becoming common. Localised resistance to organophosphates (OPs), including omethoate, dimethoate and chlorpyrifos, has recently been discovered on multiple WA and SA properties. This Resistance Management Strategy should guide growers' selection of control options and provides best practice recommendations to manage resistance in RLEM.

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Resistance management and minimisation strategy

Chemicals within a specific chemical group usually share a common target site within the pest, and thus share a common mode of action (MoA) (see Table 3). The basis of this strategy is to minimise the selection pressure for resistance to the same chemical group across consecutive generations of RLEM.

As the dispersal ability of mites is limited, resistance tends to remain relatively localised and spread slowly, although it is important to recognise that spread over larger distances does occasionally occur. Long-range dispersal is achieved via diapause eggs, which are likely to move large distances by intense summer winds (especially on overgrazed, erosion-prone soils) and by adhering to livestock, farm machinery and plant material (such as fodder shipments). It is therefore critical that strategies are implemented in all regions of Australia where RLEM is found.

Due to local differences in resistance levels, there is a need to implement a resistance management strategy that is locally relevant.

Key recommendations for control

Tables 1 and 2 (A,B,C,D) will help guide growers' selection of control options and allow for a wider selection and rotation of chemicals in some seasons. The key recommendations are:

Assess RLEM populations over successive checks to determine if chemical control is warranted. Use economic spray thresholds where available and do not spray if pest pressure is low (for example, in situations of continuous cereal rotations or following a pulse crop that has been kept free of weeds).

Do not use the same chemical group across successive spray windows (on multiple generations of mites) as this will select for resistance to that chemical group. Bare-earth, pre-emergent and seed treatments are likely to target the early season or first generation of RLEM in most situations. Post-emergent sprays will target the first or second generations of RLEM depending on the crop type, occurrence of mite hatchings, sowing dates and post-emergent spraying dates.

PHOTO: GRDC

Redlegged earth mites attacking a young canola plant.

Co-formulations or chemical mixtures are best reserved for situations where damaging levels of RLEM and other pest species are present, and a single active ingredient is unlikely to provide adequate control.

TABLE 1 IPM strategies for the redlegged earth mite.

Season	Management option	Comment
Previous year (winter/spring)	Keep pastures short in early spring	Ideally graze to <1.4t/ha food on offer 3-4 weeks prior to the Timerite® date[1]. Heavily grazed spring paddocks will not require an insecticide spray.
	Keep fencelines clean	Spray out broadleaf weeds (especially in capeweed) along fencelines of paddocks that contain RLEM.
	Use selective chemicals	Where possible avoid using organophosphates (OPs) or synthetic pyrethroids (SPs) for control of spring pests other than RLEM. For example, use pirimicarb for control of aphids and *Bt*, NPV, spinetoram or emamectin benzoate for control of caterpillars.
	Use mite-tolerant pasture species	For continuing pastures, consider selecting varieties with known mite tolerance. The pasture legume *Trifolium glanduliferum* (cv Prima gland clover) is less susceptible to RLEM feeding. Subterranean clovers – Narrikup$^{\phi}$, Bindoon$^{\phi}$ and Rosabrook$^{\phi}$ – may suffer less damage from RLEM than other varieties.
	Use mite-tolerant crops	In situations where significant resistance issues exist, consider selecting crop types that are less susceptible to RLEM. Cereals are more tolerant than canola, and are typically better at compensating for early RLEM feeding damage. Some pulse crops, such as lentils and chickpeas, are not favoured by RLEM.
Pre-sowing	Control weeds 2 weeks before sowing	Control all weeds (especially capeweed and Paterson's curse) using herbicides or cultivation within paddocks and along fencelines at least 2 weeks in advance of intended sowing date. This is especially important in 'late break' years where mites have hatched and are feeding on pre-sowing weeds.
	Avoid bare-earth sprays prior to mite hatch	Do not apply preventative insecticides against RLEM in seasons where crops are sown in advance of known mite-hatching events.
	Use higher seed rates	Consider higher seeding rates to allow for some mite feeding damage and plant loss (especially in canola).
Emergence and crop establishment	Monitor and use spray thresholds	Monitor susceptible crops through to establishment using direct visual searches, and use thresholds to inform spray decisions. Avoid preventative or prophylactic insurance sprays.
	Use barrier sprays if mites invade from edges	Be aware of edge effects; mites move in from weeds around paddock edges. Where RLEM are colonising crop margins and fencelines in the early stages of population development, consider a barrier spray with an insecticide to prevent/delay the build-up of RLEM and to retain beneficial species.

1 Timerite® is a carefully timed chemical application in spring. This approach can drastically reduce the number of 'over-summering' diapause eggs produced by RLEM. If applied correctly, Timerite® will decrease the density of mites that emerge the following autumn. Further information is available at: www.wool.com/timerite

If applying a mixture or co-formulation, ensure a full dose rate of each chemical is applied (i.e. sufficient to control RLEM if applied as a stand-alone product).

Other general recommendations include:

- Consider the impact on target and non-target pests and beneficial invertebrates when applying insecticide sprays. Where possible, use target-specific 'soft' chemicals, especially in paddocks with resistant RLEM. For aphids, this includes pirimicarb (canola, lucerne, medic pastures, cereals and some pulses) and sulfoxaflor (canola and cereals). For caterpillars, use *Bt* (cereals, canola and pulses), Nucleopolyhedrosis virus (NPV) (canola, cereals and some pulses), emamectin benzoate (canola and pulses), spinetoram (canola and forage brassicas), indoxacarb (some pulses) and chlorantraniliprole (some pulses).
- Identify mite species correctly to ensure the most effective insecticide and rate is used. Misidentification and incorrect insecticide selection results in poor control and contributes to selection for resistance.
- If spraying autumn pastures, aim to control the first generation of mites before adults lay eggs (within 3 weeks of mite appearance). This works well in years where there is a mass hatching over a short period (that is, a combination of good autumn rains and a drop in temperatures to 20°C or lower). Chemical sprays do not kill mite eggs – apply sprays when most mites have emerged.
- Do not re-spray a paddock in the same season when a known spray failure has occurred using the same product or another product from the same insecticide group, or if a spray failure has occurred where the cause has not been identified.
- Where resistance is known to be present, implement steps to limit the movement of resistant mites (and mite eggs) through the transport of hay/silage, farm machinery and livestock into paddocks/farms without resistance.
- Comply with all directions for use on product labels.
- Ensure spray rigs are properly calibrated and sprays achieve good coverage, particularly in crops with a bulky canopy.

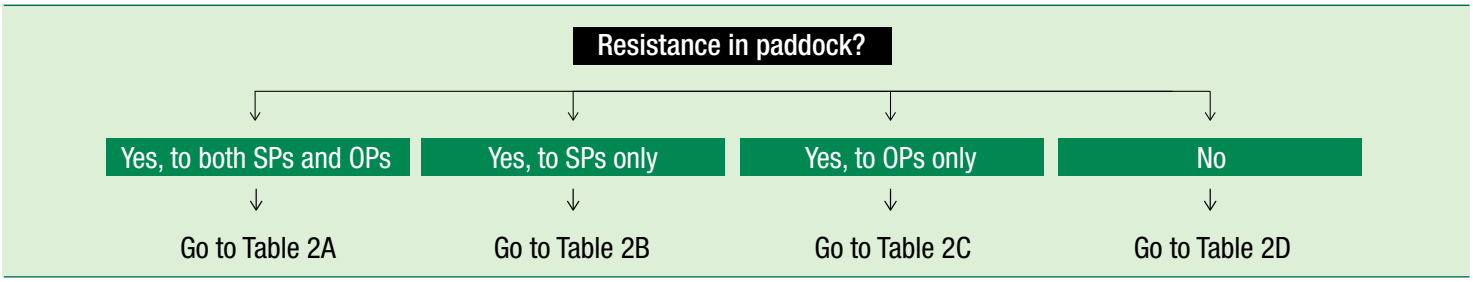

TABLE 2A Chemical control strategies for situations where redlegged earth mites have resistance to SPs and OPs.

SP = synthetic pyrethroid (chemical Group 3A), OP = organophosphate (chemical Group 1B); Refer to Table 3 for more detailed information on relevant insecticide groups.

Spray windows (rotate chemical groups through windows)			Rationale
1	2	3	
Pre-emergence (bare earth) and insecticide seed treatment [1,2,3]	**Early post-emergence** [1,2] (Oilseeds – up to 6-leaf) (Cereals – up to tillering) (Pulses – up to 2nd true leaf)	**Later crop stages** (Incidental RLEM control when targeting other pests)	
Seed treatment: Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). **Pre-emergence/bare earth:** Do not apply.[5]	Avoid wherever possible.[5] Use chlorpyrifos (1B) only if no resistance is detected to this chemical.	Avoid the use of SPs and OPs. Instead use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole.	Use of SPs (3A) for RLEM control not recommended in any spray window as resistance to this group is present. Applications of SPs will rapidly select for further resistance and will not provide adequate control of RLEM. Rotating within the OP group (1B) is an option as resistance is not always ubiquitous across all OPs.[4] Growers should test the response of RLEM in a small area first. Avoid bare-earth applications so there is an option of using chlorpyrifos post-emergence, should mite numbers warrant it.[4] SPs (3A) and OPs (1B) can be used when control of pests other than RLEM is required, although this will select for further resistance in RLEM.

1 Where co-formulations or mixtures are used, they should be considered as two independent applications (one for each chemical group), and therefore this needs to be reconciled by reducing applications from the same insecticide groups at another stage.

2 This includes applications targeted at pests other than RLEM (for example, weevils, aphids, caterpillars and other mites).

3 Bare-earth applications should be avoided, particularly in cases where Timerite® has been used the previous spring and insecticide seed treatments have been applied.

4 Some RLEM populations resistant to omethoate and dimethoate have not demonstrated cross-resistance to chlorpyrifos, so chlorpyrifos may remain effective as a foliar chemical in some situations. There are other Group 1B chemicals registered against RLEM (see Table 3), but these have not been tested against mites with resistance to organophosphates. Thus, their effectiveness and likely resistance risk remain uncertain.

5 There is an urgent need for new chemistries.

TABLE 2B Chemical control strategies for situations where redlegged earth mites have resistance to SPs only.

SP = synthetic pyrethroid (chemical Group 3A), OP = organophosphate (chemical Group 1B); Refer to Table 3 for more detailed information on relevant insecticide groups.

Spray windows (rotate chemical groups through windows)				Rationale
1	2	3	4	
Timerite® used in previous spring?	**Pre-emergence (bare earth) and insecticide seed treatment** [1,2,3]	**Early post-emergence** [1,2] (Oilseeds – up to 6-leaf) (Cereals – up to tillering) (Pulses – up to 2nd true leaf)	**Later crop stages** (Incidental RLEM control when targeting other pests)	
Yes, used dimethoate (1B)	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). **Pre-emergence/bare earth:** Avoid wherever possible, especially for early sowing opportunities. If unavoidable, select chlorpyrifos (1B).	Chlorpyrifos (1B), if not used at pre-emergence (Window 2). Otherwise select dimethoate (1B), or omethoate (1B) as a barrier spray.	Use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole. Only use OPs if not already used at post-emergence (Window 3).	Use of SPs (3A) for RLEM control not recommended in any spray window as resistance to this group is present. Applications of SPs will rapidly select for further resistance and will not provide adequate control of RLEM. Use chlorpyrifos at pre-emergence because dimethoate has been used in Timerite® spray. Rotating within OPs (1B) is an option given resistance is not always ubiquitous across all OPs.[4] SPs (3A) can be used when control of pests other than RLEM is required, although this will select for further resistance in RLEM.
No	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). **Pre-emergence/bare earth:** Avoid wherever possible, especially for early sowing opportunities. If unavoidable, select any registered OP (1B).	Any registered OP (1B). If chlorpyrifos (1B) used in Window 1, select omethoate (1B) or dimethoate (1B). OR If dimethoate used in Window 1, select chlorpyrifos (1B).	Use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole. Only use OPs if not already used at post-emergence (Window 3).	Use of SPs (3A) for RLEM control not recommended in any spray window as resistance to this group is present. Applications of SPs will rapidly select for further resistance and will not provide adequate control of RLEM. No Timerite® spray therefore use any OP (1B) at pre-emergence. Rotating within the OP group (1B) is an option as resistance is not always ubiquitous across all OPs.[4] SPs (3A) can be used when control of pests other than RLEM is required, although this will select for further resistance in RLEM.

See Table 2A for footnotes.

TABLE 2C Chemical control strategies for situations where redlegged earth mites have resistance to OPs only.

SP = synthetic pyrethroid (chemical Group 3A), OP = organophosphate (chemical Group 1B); Refer to Table 3 for more detailed information on relevant insecticide groups.

Spray windows (rotate chemical groups through windows)				Rationale
1	2	3	4	
Timerite® used in previous spring?	**Pre-emergence (bare earth) and insecticide seed treatment** [1,2,3]	**Early post-emergence** [1,2] (Oilseeds – up to 6-leaf) (Cereals – up to tillering) (Pulses – up to 2nd true leaf)	**Later crop stages** (Incidental RLEM control when targeting other pests)	
Yes, but use an SP (3A), not an OP (1B)	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). **Pre-emergence/bare earth:** Do not apply[5].	Any registered SP (3A) if not already used at pre-emergence (Window 2).	Avoid the use of SPs if already used in Windows 2 or 3. Instead use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole.	Use of OPs (1B) for RLEM control not recommended in any spray window as resistance to this group is present. Applications of OPs will select for further resistance in RLEM. OPs (1B) can be used when control of pests other than RLEM is required, although this will select for further resistance in RLEM.
No	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). OR Cruiser Opti (4A+3A) if SPs (3A) will not be used at post-emergence (Window 3). **Pre-emergence/bare earth:** Avoid wherever possible, especially for early sowing opportunities. If unavoidable, select any registered SP (3A).	Any registered SP (3A) if not already used at pre-emergence (Window 2).	Avoid the use of SPs if already used in Windows 2 or 3. Instead use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole.	Use of OPs (1B) for RLEM control not recommended in any spray window as resistance to this group is present. Applications of OPs will select for further resistance in RLEM. OPs (1B) can be used when control of pests other than RLEM is required, although this will select for further resistance in RLEM.

See Table 2A for footnotes.

TABLE 2D Chemical control strategies for situations where redlegged earth mites have no resistance.

SP = synthetic pyrethroid (chemical Group 3A), OP = organophosphate (chemical Group 1B); Refer to Table 3 for more detailed information on relevant insecticide groups.

Spray windows (rotate chemical groups through windows)				Rationale
1	2	3	4	
Timerite® used in previous spring?	**Pre-emergence (bare earth) and insecticide seed treatment** [1,2,3]	**Early post-emergence** [1,2] (Oilseeds – up to 6-leaf) (Cereals – up to tillering) (Pulses – up to 2nd true leaf)	**Later crop stages** (Incidental RLEM control when targeting other pests)	
Yes, used dimethoate (1B).	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). OR Cruiser Opti (4A+3A) if SPs (3A) will not be used at post-emergence (Window 3). **Pre-emergence/bare earth:** Avoid wherever possible. If unavoidable, select any registered SP (3A).	Any registered OP (1B). OR Any registered SP (3A) only if SPs not used in Window 2.	Avoid the use of SPs and OPs if already used in Windows 2 and 3. Instead use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole. If unavoidable, use OPs if SPs used at post-emergence (Window 3). OR Use SPs if OPs used at post-emergence (Window 3).	Avoid OPs (1B) at pre-emergence as dimethoate used in Timerite® spray.
No	**Seed treatment:** Imidacloprid (4A) or Poncho Plus (2x4A) or fipronil (2B). OR Cruiser Opti (4A+3A) if SPs (3A) will not be used at post-emergence (Window 3). **Pre-emergence/bare earth:** Avoid wherever possible. If unavoidable, select any registered SP (3A) or OP (1B), or a mixture of SP/OP (1B+3A). If applying a mixture or co-formulation, do not apply a mixture or co-formulation at post-emergence (Window 3).	Any registered OP (1B) or SP (3A). OR A single application of a mixture or co-formulation if not already used in Window 2. If one chemical group was applied in Window 2, select a different chemical group.	Avoid the use of SPs and OPs if already used in Windows 2 & 3. Instead use pirimicarb, sulfoxaflor, *Bt*, NPV, emamectin benzoate, spinetoram, indoxacarb or chlorantraniliprole. If unavoidable, use OPs if SPs used at post-emergence (Window 3). OR Use SPs if OPs used at post-emergence (Window 3).	Co-formulations or mixtures of chemicals from two groups should only be applied once per season.

See Table 2A for footnotes.

TABLE 3 Insecticide Resistance Action Committee (IRAC) mode of action (MoA) classification of insecticides and acaricides, including active ingredients registered against redlegged earth mites in Australian grain crops, and example trade names of chemical products.

IRAC MoA group	Insecticide category	Active ingredient(s)	Example trade names
GROUP 1B INSECTICIDE	Organophosphates (OPs)	Chlorpyrifos, dimethoate, methidathion, omethoate[3], phosmet	Strike-Out®, Danadim®, Suprathion®, Le-Mat®, Imidan®, Pyrinex Super®[1], Cobalt Advanced®[1]
GROUP 2B INSECTICIDE	Phenylpyrazoles	Fipronil	Cosmos®, Legion®
GROUP 3A INSECTICIDE	Synthetic Pyrethroids (SPs)	Alpha-cypermethrin, cypermethrin, bifenthrin, gamma-cyhalothrin, lambda-cyhalothrin, esfenvalerate.	Fastac®, Scud Elite®, Talstar®, Venom®, Trojan®, Karate Zeon®, Sumi-alpha Flex®, Pyrinex Super®[1], Cobalt Advanced®[1], Cruiser® Opti[2]
GROUP 4A INSECTICIDE	Neonicotinoids	Imidacloprid, clothianidin, thiamethoxam	Gaucho®, Emerge®, Poncho® Plus, Cruiser® Opti[2]

1 Co-formulation containing Group 1B and 3A insecticides.

2 Co-formulation containing Group 3A and 4A insecticides.

3 Omethoate is restricted to barrier sprays.

FREQUENTLY ASKED QUESTIONS

What is the likelihood I will have a spray failure?

This will depend on previous pest management practices and whether insecticide resistance is present in the target pest population. If you suspect resistance, consult your local entomologist.

How do I prevent spray failures into the future?

Avoid the practice of 'insurance' sprays at all costs. Using the broadest range of integrated pest management (IPM) strategies (Table 1) is the best way to avoid future spray failures and prevent or delay the development of insecticide resistance. Make use of thresholds and spray only when absolutely necessary. Follow the guidelines outlined in Tables 1 and 2 (A, B, C, D), ensuring insecticides across different chemical groups are rotated within a cropping season.

Is resistance in RLEM a concern for all growers?

Yes, absolutely. Resistance could spread to, or evolve independently in, regions where resistance is not currently found. Occasional long-range dispersal is known to occur in RLEM and is likely to happen during summer via the airborne movement of diapause eggs in summer dust storms. Eggs may also be dispersed on soil adhering to livestock and farm machinery and through transportation of plant material, particularly fodder/hay during periods of drought. Recent genetic analysis of mite populations has revealed insecticide resistance to SPs has evolved on more than one occasion, demonstrating the potential for resistance in all areas where RLEM are found.

This strategy was developed by the National Insecticide Resistance Management (NIRM) working group of the Grains Pest Advisory Committee (GPAC), and endorsed by CropLife Australia. GPAC is a GRDC-funded project which provides strategic advice to GRDC on pest issues. NIRM, chaired by Dr Paul Umina, is responsible for developing insecticide resistance management strategies for a number of grains pests. The group's representative membership ensures engagement of agro-chemical industries, researchers, advisers and CropLife Australia.

MORE INFORMATION

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USEFUL RESOURCES

Science behind the Resistance Management Strategy for the redlegged earth mite (*Halotydeus destructor*) in Australian grains and pastures
www.ipmguidelinesforgrains.com.au/ipm-information/resistance-management-strategies
Redlegged earth mite – PestNote
www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

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