

RESISTANCE MANAGEMENT STRATEGY FOR DIAMONDBACK MOTH IN AUSTRALIAN CANOLA

PHOTO: DAFWA

When DBM larvae are disturbed they will wriggle, and may drop from the plant by a silken thread.



PHOTO: DAFWA

DBM pupae visible through the gauze-like cocoon on the underside of a damaged canola leaf. Pupae start out green in colour, then turn brown before hatching out as adult moths.



KEY POINTS

- DBM is a major pest of canola and mustard crops, particularly at flowering and podding, and of brassica vegetable crops and forage brassicas.
- Five chemical sub-groups are registered to control DBM in Australian canola crops: synthetic pyrethroids (Group 3A); organophosphates (Group 1B); spinosyns (Group 5); avermectins (Group 6); and *Bacillus thuringiensis* (Group 11A). Carbamates (Group 1A) are also registered for use in canola in WA.
- Resistance to pyrethroids and organophosphates is widespread in Australia. Low to moderate levels of resistance to avermectins are also common across Australian canola and vegetable production regions.
- Growers are encouraged to reduce selection pressure on remaining products by using integrated pest management tactics and rotating efficacious products.

Diamondback moth and insecticide resistance

The diamondback moth (*Plutella xylostella*, DBM) is a pest of canola, brassica vegetable and forage crops. DBM larvae feed on plant foliage, stems, flower heads and pods. The larvae can be found at any stage of canola development, with their numbers often increasing in the lead-up to flowering. Canola can tolerate considerable leaf damage before causing yield loss, however severe infestations can cause complete defoliation and yield losses of up to 80 per cent in canola.

The use of chemicals in canola and vegetable crops continues to grow in Australia, placing strong selection pressure on the development of resistance. DBM has a high propensity to develop resistance and there are more than 82 insecticide compounds recorded globally to which DBM has developed resistance. Because of the high dispersal capacity of DBM moths, resistant individuals can soon dominate a landscape if there is widespread use of the same insecticide group. With resistance to

three key insecticide groups (pyrethroids, organophosphates and avermectins) already established, canola growers need to understand how to minimise the further development of resistance.

Resistance management and minimisation strategy

The aim of this strategy is to minimise the selection pressure for resistance to the same chemical groups across consecutive generations of DBM. The strategy includes three insecticides – avermectins (Group 6, Affirm®), spinosyns (Group 5, Success Neo®) and the biopesticide *Bacillus thuringiensis* var. *kurstaki* (Btk) (Group 11A) – each of which provide efficacious field control. It excludes the pyrethroid (Group 3A) and organophosphate (Group 1B) products because resistance to these products is ubiquitous in Australian DBM populations at levels that render them ineffective. Synthetic pyrethroids and organophosphates are not recommended for DBM control.

Based on current knowledge and the field resistance status of Australian DBM populations, the risk of resistance to Btk and Success Neo® is considered low.

However, there has been a detectable shift in field susceptibility to Affirm®, and hence it is the Group 6 insecticides that are considered at greatest risk from resistance development.

The carbamate methomyl is registered for DBM control in Western Australian canola. There is no carbamate resistance data available for Australian DBM, however, organophosphate-carbamate cross-resistance has been reported in overseas populations of DBM.

Integrated pest management is a central feature of this resistance management strategy

The use of integrated pest management (IPM) tactics for DBM management in canola is integral to underpinning a reduction in DBM insecticide use and thereby helping to minimise resistance selection pressures in canola crops. Utilising the suite of common DBM natural enemies that occur in canola crops by better targeting of softer insecticides is encouraged.

Monitoring is key to better targeted spraying and effective DBM management. Sweep-netting at the first sign of damage and at intervals throughout the growing season from mid-July through to late spring is recommended. DBM can increase quickly when they infest canola early and during prolonged warm and/or dry weather.

The following management information should guide growers' selection of control options, and potentially allow for a wider selection and rotation of chemicals in some seasons (see Table 1).

Other general recommendations

- Where possible, avoid the use of pyrethroids and organophosphates for control of spring pests, and instead use target-specific 'soft chemicals' such as pirimicarb for aphids and Bt for caterpillars.
- Ensure the target pest is identified correctly to ensure the most effective insecticide and rate is used. Mis-identification and incorrect insecticide selection results in poor control and contributes to selection for resistance.
- Assess DBM and beneficial populations by sweep-net monitoring to determine

if chemical control is warranted. Use economic thresholds (see Table 2) to ensure spray decisions are warranted.

- Do not re-spray a crop in the same season where:
 - 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. Arrange for a DBM sample to be tested for resistance to the product used.
- If respraying is necessary, avoid using a chemical in the same group, in the same season.
- Comply with all directions for use on insecticide product labels.
- Ensure spray rigs are calibrated properly and sprays achieve good coverage, particularly in crops with a bulky canopy.
- If growing forage brassicas, manage DBM by grazing or use of Btk.

Diamondback moths are so named for the distinctive diamond-shaped pattern on their back.



Canola can tolerate considerable leaf damage from DBM larvae before crop yield is affected. However, severe infestations of DBM larvae can cause complete defoliation and substantial yield losses.



TABLE 1 Growers' selection of control options.

SEASON	RISK FACTORS	MANAGEMENT RECOMMENDATIONS
Summer–autumn – pre-season	Summer rainfall can generate brassica green-bridge growth, which supports DBM (e.g. volunteer canola, lincoln weed, etc.). Abundant green bridge extending through March–April is a high risk for DBM colonisation of canola crops.	Control brassica green-bridge to provide autumn DBM host break prior to canola sowing.
Pre-flowering crop	Greater DBM risk in years with substantial green-bridge over summer and when dry conditions and/or above-average temperatures occur during autumn and winter.	Monitor at 3–4 week intervals from crop establishment using either visual inspection (up to the rosette stage) or a sweep net (stem extension onwards). Monitor more frequently in years of greater DBM risk. Grazing/grain: where possible manage DBM foliar feeding by strategic grazing. If unable to introduce stock to manage DBM, apply a Btk spray ^{ab} if the economic threshold (ET) is reached (refer to Table 2 below). (The same recommendations apply for forage brassicas.) Grain only: if the ET is reached apply a Btk spray ^{ab} .
Flowering/podding (grain only and grazing/grain crops)	Greater DBM risk when weather is dry and/or temperatures are above average.	Monitor crops using a sweep-net at fortnightly intervals throughout flowering to windrowing/harvest (more frequently when high risk). Sweep-net monitoring instructions Take a minimum of 5 sets of 10 sweeps in several representative parts of the crop and calculate the average number of larvae (caterpillars) per 10 sweeps. Record the number of DBM larvae, the numbers of larvae of other moth pests (e.g., <i>Helicoverpa</i>) and the numbers of DBM natural enemies. Trends in these regular counts can be a good predictor of the effectiveness of natural enemies and/or the imminent need to spray. If the DBM ET is reached (refer to Table 2 below) an insecticide treatment is recommended. Insecticide choice: i) if controlling DBM alone, apply a Btk ^c , Affirm ^{®d} or Success Neo ^{®d} spray; ii) if controlling DBM and <i>Helicoverpa</i> larvae that are less than 8mm length, apply a Btk ^{ce} , Btk plus VivusMax ^{®e} , Affirm ^{®d} or Success Neo ^{®d} spray; iii) if controlling DBM and <i>Helicoverpa</i> larvae* greater than 8mm length, apply either an Affirm ^{®e} or Success Neo ^{®e} spray. (* <i>Helicoverpa</i> ET: 4–5 larvae per 10 sweeps.). Good spray coverage is essential for achieving effective control of DBM. Note that dense canola canopies in spring require appropriate nozzle type, pressure and water volumes ^f . Continue to monitor the DBM population and natural enemy activity post spraying. In the unlikely situation that the DBM population again increases to the ET density, avoid consecutive use of the same product e.g. Use Success Neo [®] if Affirm [®] was applied earlier, or vice versa.
Consecutive years	DBM infestations warrant spray treatment in consecutive years.	In the second year avoid using the same product used in the previous year.

Insecticide Product Explanatory Comments

a Btk products conserve beneficials and are suited to the low UV conditions and lesser canopy area during pre-flowering.

b Sometimes pre-flowering crops are infested heavily by DBM and higher control may result from a chemical insecticide rather than a Btk product. In these instances, in fodder brassica crops Success Neo[®] is the only registered chemical product; in graze/grain canola crops Success Neo[®] may be preferred because it has shorter grazing withholding period (7 days) than Affirm[®] (14 days); and in grain crops either Affirm[®] or Success Neo[®] is available.

c Btk products conserve beneficials, but are less suitable if the DBM density is rapidly increasing above the ET.

d Affirm[®] or Success Neo[®] are considered more suitable for rapidly increasing DBM populations, as they have greater persistence compared with Btk products.

e Btk sprays aimed at *Helicoverpa* require optimal conditions and small-sized larvae (no greater than 8mm). A mixture of Btk and VivusMax[®] is a biological insecticide option for *Helicoverpa* control.

f To achieve the necessary canopy penetration and coverage for late season DBM control use water volumes of no less than 100 litres/ha (ground applied). Air-induction nozzles or flat-fan nozzles greater than 110-03, spaced at 50cm, producing a medium spray quality have provided good control of DBM in canola crops and reduce drift when effective products at label rates are used.

TABLE 2 Economic thresholds for DBM in canola.

CROP STAGE	MOISTURE STRESS	DBM THRESHOLD
Rosette*	No	50% leaf area damaged
Pre-flowering stem extension	Yes	30 larvae per 10 sweeps
Pre-flowering stem extension	No	50 larvae per 10 sweeps
Early to mid-flowering*	No	>50 larvae per 10 sweeps
Mid to late-flowering*	No	>100 larvae per 10 sweeps
Pod maturation*	No	200 larvae per 10 sweeps

*Moisture stress is not listed for these growth stages, but note that moisture-stressed crops are more susceptible to insect damage.

A lower threshold may be used if extended dry periods are expected.

FREQUENTLY ASKED QUESTIONS

Is DBM likely to be a pest every season?

Fortunately not. In most canola-growing regions DBM is only a periodic pest, requiring attention perhaps once in every three to five years.

What natural enemies should I be looking out for, and can they control DBM?

There are numerous natural enemies of DBM commonly found in canola crops across Australia. Key groups include parasitoid wasps, lacewings, ladybirds, spiders, damsel bugs and fungal diseases. These play a key role in helping to keep populations in check, and contribute to DBM population crashes, particularly in spring/early summer. Hence it is important to consider the presence (and numbers) of natural enemies when making management decisions for DBM, and to hold off on a decision to spray until DBM numbers reach the economic threshold density.

What is the likelihood I will have a spray failure?

If the spray treatment is timed when the DBM infestation first reaches the threshold level, with water volume, nozzle and spray pressure settings that achieve the necessary canopy penetration and coverage, Bt products, Affirm® and Success Neo® should provide effective DBM control. However, DBM is resistant to synthetic pyrethroid and organophosphate products, and their use will likely result in spray failure and the death of natural enemies. Btk products conserve natural enemies.

How do I prevent spray failures into the future?

The recommendations in this resistance management strategy are designed to reduce the risk of resistance developing to the currently effective DBM products (Bt products, Affirm® and Success Neo®). Following these recommendations will maintain effective insecticidal control of DBM into the future. Spray failures may continue to occur when using pyrethroids and organophosphates.

MORE INFORMATION

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USEFUL RESOURCES

Science behind the RMS for diamondback moth (*Plutella xylostella*) in Australian canola crops, NIRM,

www.ipmguidelinesforgrains.com.au/ipm-information/resistance-management-strategies

Diamondback moth factsheet. GRDC,

www.grdc.com.au/GRDC-FS-DBM