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Vegetables NEW ZEALAND Inc

Using an IPM strategy to manage resistance in Diamondback moth

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The resistance problem

Diamondback moth (*Plutella xylostella*) or DBM, is a destructive pest of cruciferous crops like cabbage, broccoli, cauliflower, and kale. Historically control of DBM relied on regular applications of insecticides from planting through to harvest.

This led to the development of insecticide resistance in DBM in New Zealand. The first documented reports of insecticide resistance for DBM in New Zealand appeared in the late 1980s, with definitive proof of control failures reported in the 1990s where DBM resistance to a synthetic pyrethroid (IRAC Group 3A), lambda-cyhalothrin (Karate® Zeon), was measured at levels equivalent to those associated with control failures in North America (Walker *et al.* 2012). The levels of resistance recorded for the standard organophosphate, methamidophos (IRAC Group 1B), were also likely to cause control failures (Cameron *et al.* 1997).

Key factors that caused DBM resistance included:

- **Heavy reliance on single insecticide mode-of-action (MOA) groups**
- **Frequent calendar spraying rather than threshold-based decisions**
- **Limited integration of non-chemical control methods**

What is Diamondback moth?

Adult moths have a wingspan of 15 to 20 mm and display a distinct diamond-shaped pattern on its wings. The moth's life cycle begins with pale yellow eggs, about 0.5 mm in length, which are laid individually or in small clusters along the veins or uneven leaf surfaces. After approximately 4 to 6 days, the eggs hatch, and during her 16-day lifespan, a female moth can produce an average of 150 eggs. The larvae of the diamondback moth can be identified by their pale green colouration and cylindrical body shape with tapered ends. When disturbed, these larvae demonstrate a unique defence mechanism, vigorously wiggling and dropping from the plant using a silken thread.



Diamondback moth adult. (Credit: CABI)



DBM larvae. (Credit: Cesar Australia)

The solution: an IPM strategy for vegetable brassicas

The levels of resistance in NZ DBM populations prompted the vegetable industry and researchers to develop and implement an integrated pest management (IPM) programme for vegetable brassicas in New Zealand with resistance management as a central pillar.

The original vegetable brassica IPM strategy was released in 2000, this represented nearly 25 years of collective research.

An update was published in 2009 and a revised pest identification pocket guide in 2016.

Resistance management is the central pillar of the IPM programme for vegetable brassicas.



Vegetable brassica IPM pest identification pocket guide.

Key elements of the vegetable brassica IPM strategy include:

- Regular crop monitoring and action thresholds.
- Conservation of natural enemies (e.g. *Diadegma semiclausum*).
- Reduced prophylactic spraying.
- Strategic use of selective insecticides.

DBM insecticide resistance management strategy

Central to the IPM approach was an innovative resistance management strategy. It promoted a “two window” approach whereby the growing season was split into two periods, each covering approximately six DBM generations.

Insecticide products were positioned for use either in an early or a late-window period, with growers changing to an insecticide from a different group (with a different mode of action) at the end of each window period (NZPPS, 2024).

The Diamondback moth resistance management strategy uses an innovative ‘two window’ approach.

It is believed this practice is the reason resistance in DBM has not developed to spinosad (IRAC Group 5) and indoxacarb (IRAC Group 22) in New Zealand. This strategy has subsequently been modified with the advent of new insecticide products, particularly to accommodate the use of pre-transplant drenches.

The most recent strategy is presented in Table 1. It is designed to prevent continuous selection pressure from any single mode of action and allows susceptible individuals to re-enter populations.



DBM is a key pest in brassica crops, such as cauliflower.

Table 1. DBM insecticide resistance management rotation strategy for vegetable brassicas.

<table>
<tr><th colspan="7">Insecticide use windows</th></tr>
<tr><th>Sep - Nov</th><th>Dec - Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun - Aug</th></tr>
<tr><td colspan="7">Diamide/Neonicotinoid insecticides</td></tr>
<tr><td>Transplant drench

OR:</td><td colspan="3">chlorantraniliprole[1] + thiamethoxam (Durivo®) (Grp 4A + 28)

imidacloprid (Cyrus®, Nuprid®) (Grp 4A)</td><td></td><td colspan="2"></td></tr>
<tr><td>Foliar spray</td><td colspan="4">chlorantraniliprole (Coragen®)[1] (Grp 28)
cyantraniliprole (Grp 28)</td><td colspan="2"></td></tr>
<tr><td colspan="7">Other insecticide groups[2]</td></tr>
<tr><td colspan="7">Apply insecticides in response to scouting thresholds or risk assessments</td></tr>
<tr><td colspan="7">Bacillus thuringiensis (Bt)[3]</td></tr>
<tr><td colspan="2">indoxacarb (Steward® eVo) (Grp 22)</td><td colspan="5">spinosad (EntrustTM SC NaturalyteTM) (Grp 5)
spinetoram (Sparta®) (Grp 5)
fipronil (Recoil®) (Grp 2B)</td></tr>
<tr><td colspan="7">organophoshates[5,6] (Grp 1)</td></tr>
<tr><td colspan="7">synthetic pyrethroids[4,6] (Grp 3)</td></tr>
<tr><td colspan="7">For aphids only</td></tr>
<tr><td colspan="2">pymetrozine (Chess®) (Grp 9)</td><td colspan="5">pirimicarb (Pirimor®) (Grp 1A)</td></tr>
</table>

Notes: Trade name examples and IRAC Groups are noted. (Source: NZPPS 2024)

[1] Coragen® and Durivo® have an active ingredient (chlorantraniliprole) in common. If chlorantraniliprole is used as a transplant drench, it should not be followed with a foliar application on that crop.
[2] From any one insecticide group, use a maximum of two consecutive applications (less than 15 days apart) in the life of a single crop.
[3] Apply Bt to small larvae on plants.
[4]There is resistance to synthetic pyrethroids in some populations of diamondback moth (DBM). The use of this group should be avoided in areas where resistance is known to exist. Consult your local pest control advisor before use.
[5] Organophosphates are best used sparingly either against high infestations of early season seedling pests or as an end 'clean-up' application.
[6] Green peach aphid *(Myzus persicae)* and onion thrips *(Thrips tabaci)* are known to be resistant to broad-spectrum insecticides in New Zealand. Unnecessary application of these groups should be avoided as much as possible.

The country-wide adoption of the insecticide resistance management rotation strategy has meant that resistance in DBM has been well managed.

Scouting thresholds for DBM

Scouting thresholds for DBM were developed for the IPM strategy following research carried out in the early 2000s and published in the vegetable brassica IPM manual (Walker *et al.* 2009).

The DBM action threshold varies depending on the vegetable brassica crop type and its growth stage:

- **Seedling Stage** (6-8 true leaf): Action is suggested if 30% of plants are infested with larvae.
- **Leafy Stage** (pre-floret/curd): Action is suggested if 20% of plants are infested.
- **Floret/Curd Formation**: Thresholds drop to 10% for florets and 5% for curds (broccoli/cauliflower) to ensure quality.

Scouting procedure: Randomly select 50 to 100 plants across the field, inspecting for larvae and damage. Broccoli/cauliflower plants are sampled by whole plant examination until the 6-8 true leaf stage. From the 6-8 true leaf stage until floret/curd initiation only the growing tip ("heart leaves") is sampled. This presumes that only the heads of these plants require protection and heavy pest pressure on growing tips may delay plant development. From floret/curd initiation until harvest the floret/curd and surrounding inner leaves are sampled. Plants within 3% of the threshold, recheck in 3-4 days.





Key learnings

The DBM resistance management programme is regarded as a benchmark for resistance management in New Zealand demonstrating that insecticide resistance can be effectively managed - but only through coordinated, science-based, industry-wide action.

By moving early from reactive control failures to a structured IPM and resistance management strategy, the vegetable brassica sector preserved key insecticide tools, reduced long-term risk, and built resilience against one of the world's most resistance-prone pests.

Looking to the future

While DBM in New Zealand is well managed and largely under control, it remains resistant to several older insecticide groups. The vegetable sector has an ongoing initiative to seek new mode of action chemistry to control DBM.

Ongoing vigilance within the sector is needed to ensure that there is no change in resistance status of DBM and no erosion of new modes of action to control DBM.

Recent IPM workshops held on the Pukekohe Research and Demonstration Farm have raised the issue of DBM control and highlighted possible resistance issues with some chemistry in the programme.

The vegetable brassica sector must collectively ensure that the vegetable brassica IPM strategy remains at the forefront of best practice for growers.

The last refresh of the IPM strategy was in 2009, and it is timely for the sector to refresh both the IPM strategy and resistance management advice to ensure both remain fit-for-purpose.

Reports and resources

BCANZ (Biological Control Agents introduced to New Zealand) *Diadegma semiclausum*. Website: https://b3.net.nz/bcanz/view.php?tb=Intro&id=219, accessed May 2026.

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