IRAC

Maintaining Effective Control Strategies for Codling Moth, *Cydia pomonella*

Insecticide Resistance Action Committee

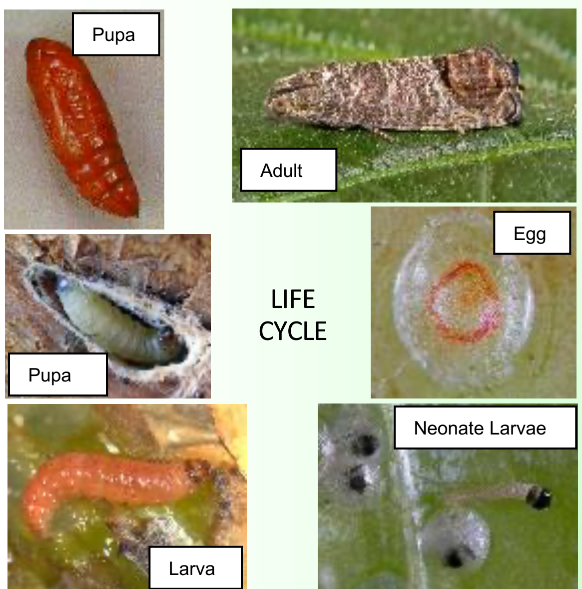
www.irac-online.org

Introduction, life cycle and control

Codling moth, *Cydia pomonella* L. (Lepidoptera: Tortricidae) is one of the most serious insect pest of apple and can also infest pear, crab apple, quince, walnut and other fruits. Codling moth is native to south eastern Europe and is now a pest in areas of Africa, Asia, North America, South America, Australia and New Zealand.

Depending on geographic location, Codling moth has one to three generations per year. It overwinters in the pupal stage in protected areas on the trunk or in leaf litter at the base of trees. Timely, effective control is critical because females emerge with mature eggs and can mate and lay eggs within a two-day period. Codling moth neonate larvae cause direct injury by boring into fruit, inside the fruit, the larvae feed and grow, which can result in significant crop losses.

Integrated Pest Management IPM is widely practised in countries to control Codling Moth. It uses a range of tactics including 1. Agronomic sanitation, e.g. removal of dropped fruit, 2. Scouting or pheromone trapping, or local weather models to evaluate when pest numbers reach intervention thresholds. 3. Mating disruption by sex pheromone to confuse male moths, reduces egg laying. 4. Application of biological or chemical insecticides to target eggs and / or newly hatched larvae.



Typical Larval Infestation and Damage

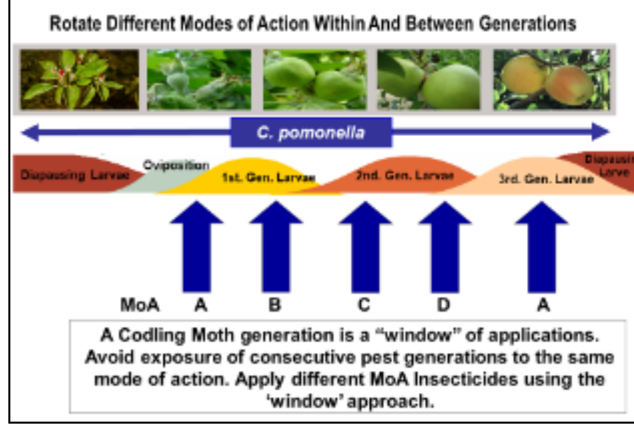
Chemical control of Codling Moth

Modes of Action (MoA)
Many products and MoA are used globally to control Codling Moth (listed below, although fewer effective MoA are generally available locally due to limited product registrations and development of resistance to some chemical classes.
Consult with local experts and authorities to find out MoAs available.

MoA	Primary Target Site	Chemical Class	Example product
1A	Acetylcholinesterase inhibitors	Carbamates	Carbaryl, Methomyl
1B	Acetylcholinesterase inhibitors	Organo-phosphates	Azynphos-methyl, Chlorpyrifos, Diazinon, Malathion, Parathion, Phosmet, Phosalone, etc
3A	Sodium channel modulators	Pyrethroids	*lambda*-Cyhalothrin, *beta*-Cyfluthrin, Cypermethrin, Deltamethrin, Etofenprox etc.
4A	Nicotinic acetylcholine receptor agonists	Neonicotinoids	Acetamiprid, Thiacloprid
5	Nicotinic acetylcholine receptor allosteric modulators	Spinosyns	Spinosad, Spinetoram
6	Chloride channel activators	Avermectins	Emamectin-benzoate
7B	Juvenile hormone mimics	Phenoxyphenoxy-ethylcarbamate	Fenoxycarb
15	Chitin biosynthesis inhibitors, type 0	Benzoylureas	Diflubenzuron, Flufenoxuron, Lufenuron, Novaluron, Teflubenzuron, Triflumuron, etc
18	Ecdysone agonists	Diacylhydrazines	Tebufenozide, Methoxyfenozide
22A	Voltage-dependent sodium channel blockers	Oxadiazines	Indoxacarb
28	Ryanodine receptor modulators	Diamides	Flubendiamide, Chlorantraniliprole, Cyantraniliprole, Tetraniliprole
30	GABA-gated chloride channel modulators	Meta-diamides, Isoxazolines	Broflanilide, Fluxametamide
31	Baculoviruses	Granulovirus	Cydia pomonella GV

Resistance Mechanisms - refer to www.irac-online.org/pests/
Acquired insensitivity to a specific insecticide may result from different types of resistance mechanisms including:
- Metabolic resistance, usually modified enzymatic activities e.g. MFO, GST, EST are the most common types in *C. Pomonella* and can be major concern as may affect many products and MoA, although expression varies between products.
- Target-site resistance, e.g. KDR, MACE
- Adaptation, such as reduced skin penetration and behavioural changes

IRM Strategy for Codling Moth



Codling Moth Resistance Management

To slow down the development of insecticide resistance, use a combination of all available pest management (IPM) and resistance management (IRM) tools to decrease Codling Moth exposure to insecticides.

- Always follow the directions for use on the label of each product.
- Consult product label or the IRAC's website www.irac-online.org to determine the mode of action MoA of each product.
- Do not treat successive generations with products of the same MoA.
- Follow the "treatment windows" approach.
- A "treatment window" is the period of residual activity provided by single or sequential applications of products with the same MoA. The "treatment window" should be approximately 30 days (generally used as the length of an insect pest generation) but can be less. In a 'window' make no more than 2 applications of products from the same MoA.
- Following this treatment period rotate in approximate 30 day "windows" with effective insecticides of different MoA as required*. See IRM example above.
- Generally, the total exposure period of products representing a single MoA applied throughout the cropping cycle should not exceed approximately 50% of the crop cycle or exceed 50% of the total number of insecticide applications targeted at the same pest species.
- Apply insecticides only when needed based on economic thresholds.

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