Managing Pesticide Resistance

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What is Pesticide Resistance?

Pesticides have been used as the mainstay of the control of invertebrate insects, weeds and diseases for many years. One of the problems with a pesticide based approach is the development of resistance, where the pest can tolerate the rate of pesticide that is applied.

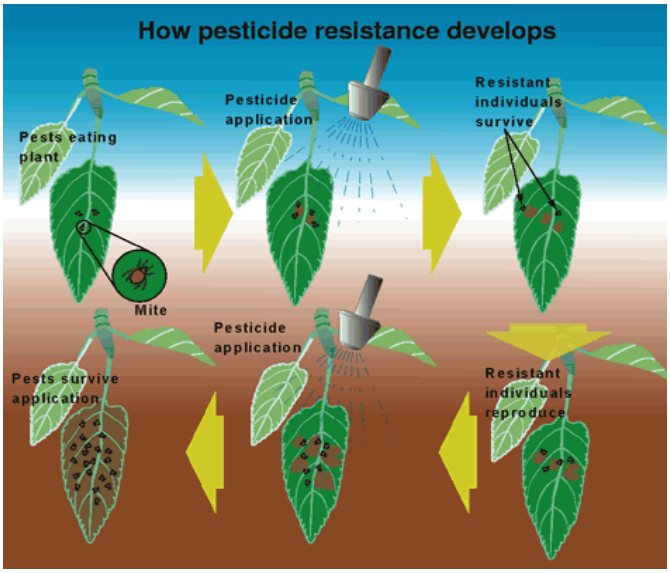
The initial response by many when reaching this scenario is to increase either or both the rate and frequency of pesticide application. This approach will only provide a short term solution because every application will select for resistant individuals.

How Pesticide Resistance Arises

Pesticides are used to combat insects, weeds and diseases of crops, and have been the main method of controlling pests since the 1950's. However when pests are exposed to the same chemical (or chemical group) a small percentage of the population of the insect, disease or weed can tolerate and survive the spray. So although the farmer applying the spray will be very happy with the 99% kill rate, the 1% of the surviving population (because they can tolerate that spray) will be the only individual insects, mites, weeds or fungi that will pass their genes on to the next generation.

Farmers need to think about the population of pests that are present and not the individuals. Although the kill rate can be very high, it is the survival of a very small percentage of the population that is the problem. This part of the population has the genetics to survive the spray that killed the bulk of the initial pest population and so will form the basis of a resistant population.

Basically, every time the same pesticide is used (or the same group of pesticides are used), then the resistance levels to the pesticide will increase and the effectiveness of the insecticide will decrease.



ICP tips for managing pesticide resistance

- Know your pest - are you sure the problem is what you think it is.
- Use all tools available (chemical, biological and cultural) to help you manage your pests.
- Select the most appropriate chemical.
- It is important to look at both the active ingredient and the chemical group when choosing a product.
- Use a resistance management strategy - rotate between chemical groups!
- When using a chemical product:
  - Don't use more than the recommended rate
  - Don't use more often than recommended

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What Happens When the Pesticide Hasn't Been Used For a While?

Depending on the type of resistance, what usually happens is that the target population consists mostly of susceptible individuals. Then, when the pesticide is applied it kills the susceptible portion of the population and all that is left are the individuals with the resistant gene. So the spray may seem to work incredibly well, but then fail totally if it is applied again shortly after.

What is happening here is that a pesticide is being used to select the type of individuals present in a population. When that selection pressure is removed then susceptible individuals will survive. Once that selection pressure is applied again then the genetics of the population shifts to those being able to survive. The more a pesticide is used then the quicker resistant populations will develop.

Control Options

Every grower (and advisor) has a choice in terms of how to control invertebrate and other pest problems. There are only 3 options – **Biological, Cultural and Chemical.** ICP (Integrated Crop Protection) is an approach that uses all three options in a compatible way.

For growers choosing to rely solely on chemicals, using a resistance management strategy is really important. But also, for those growers using an ICP approach it is also really important to make best use of the very few ICP compatible pesticides available.

"A reduction in the use of Group 28 insecticides can be achieved by using an ICP approach. In broccoli and cauliflower crops, a biological approach using the release of the parasitic Diadegma wasp in conjunction with one spray each of Belt, XenTari and DiPel can control Diamondback Moth at a similar level to a conventional spray program which uses six or more foliar sprays.

This combination works as Belt is 'soft' on the naturally-occurring Diadegma wasp, which works alongside other important biological control agents. The other chemicals used allow for the beneficial species to build their numbers early on in the crop cycle".

Lachlan Bird, Bayer Vegetable Product Manager

Cross Resistance

Pesticides are allocated to different groups based on their chemistry and mode of action. This allocation is done by independent assessors within the chemical industry. Regulatory authorities in Australia consider the type of chemical and which group it should be placed in to help with resistance management. An example of insecticide grouping is shown in the table below:

Main Mode of Action Group	Chemical Sub-group	Active Constituent	Trade Name Examples
1 Acetylcholinesterase inhibitors	1A Carbamates	Carbaryl, Methiocarb, Pirimicarb	Carbaryl®, Mesurol®, Pirimor®, Aphidex®
	1B Organophosphates	Chlorpyrifos, Diazinon, Trichlorfon	Lorsban®, Diazinon®, Chlorofos®
2 GABA-gated chloride channel antaganists	2A No registered actives	No registered actives	
	2B Phenylpyrazoles (Fiproles)	Fipronil	Regent®
3 Sodium channel modulators	3A Pyrethroids/Pyrethrins	Bifenthrin, Cypermethrin, Alpha - Cypermethrin	Bifenthrin®, Cypermethrin®, Fastac Duo®
	3B No registered actives	No registered actives	

There may be several closely related pesticides within the same chemical group (eg. Confidor, Actara, Crown, Transform) but they may be within different sub-groups of the chemical grouping. Cross-resistance is a problem when pests develop resistance to one type of chemical group and then can more rapidly and easily develop resistance to chemicals in closely related groups. It is important to look at both the active ingredient and the chemical group and not just the trade name when choosing a product. For example, Vertimec and Gremlin both have abamectin as the active ingredient. Pirimor and Aphidex both have pirimicarb as the active ingredient.

How to Minimise Pesticide Resistance

If growers are using a pesticide-based strategy then they are relying totally on the pesticides. To prolong their efficacy and give growers better results, a Resistance Management Strategy is necessary. This approach relies on shifting from one chemical group to another to delay the development of resistance (i.e. using pesticides from different chemical groups (as listed on the label)). Growers using IPM should be aware that not all chemical groups are compatible with beneficial species or an ICP approach.

Examples of Resistance Management Strategies can be found on the Crop Life Australia website (www.croplifeaustralia.org.au). These strategies provide a guide for the rotation of crop protection products via different product groups. The strategies are designed to manage a specific pest in a specific crop (such as Diamondback Moth in Brassicas). To download a copy of the resistance management strategies for a range of fungicides, herbicides and insecticides go to http://www.croplife.org.au/industry-stewardship/resistance-management

There are many products on the market, and often they are marketed as new (implying that they belong to a new chemical group). Too often the truth is that they do not, and at best may belong to a sub-set of the existing chemical groups.

For growers using IPM, there is still a very real need to not overuse the very few compatible insecticides that are available.

AAA Farms – Werribee

Jason Agosta is responsible for pest management on the crops at AAA Farms in Werribee South. He is careful to not overuse the few insecticides that work on key caterpillar and aphid pests and to minimize insecticide use he uses a combination of biological, cultural and pesticide control measures.

An example of this approach in the field might be:

- Application of only one Group 28 insecticide per crop
- Selecting pesticides with minimal effect on beneficial insect species so that all control measures work together.

A trial on AAA Farms in 2012 demonstrated how the combination of selective pesticides, cultural methods and biological control agents could successfully minimise pesticide use without any loss of quality.

For control of disease he uses a similar approach that does not rely on fungicides alone. He makes sure to use as many different chemical groups as possible within a regular spray program and utilises cultural measures such as rotation, planting density and variety in conjunction with fungicides.

Scouting crops for pest damage

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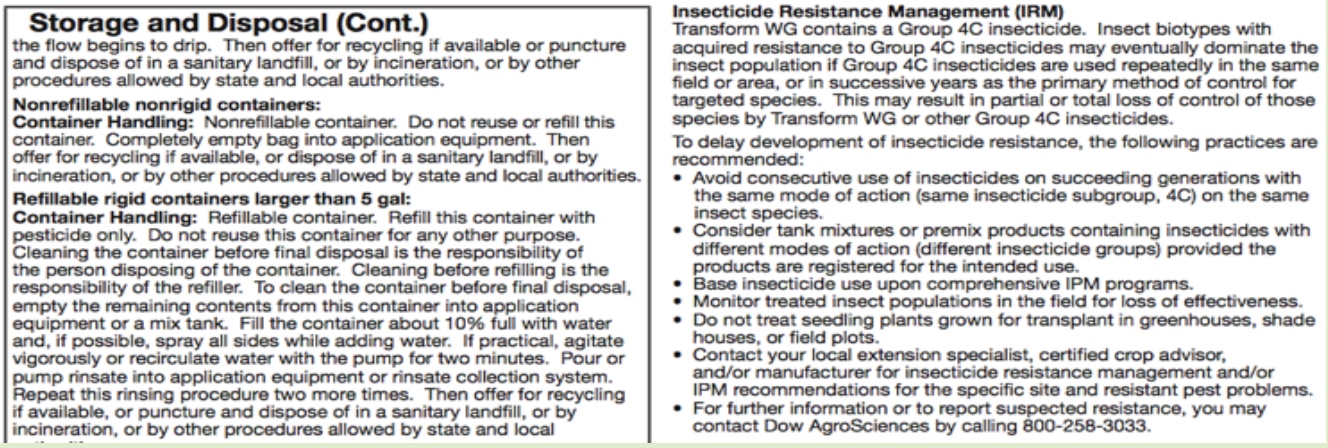
What does the Label tell me?

Information on resistance management is present on herbicide, insecticide and fungicide labels. The information provided can vary from detailed (as shown on this label for Transform Insecticide) through to just a reference to the Crop Life Australia website. It's important to remember the following principles:

- Rate: Don't use higher than recommended
- Frequency: Don't use more often than recommended.



Storage and Disposal (Cont.)

the flow begins to drip. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Nonrefillable nonrigid containers:
Container Handling: Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment. Then offer for recycling if available, or dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Refillable rigid containers larger than 5 gal:
Container Handling: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. If practical, agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local

Insecticide Resistance Management (IRM)
Transform WG contains a Group 4C insecticide. Insect biotypes with acquired resistance to Group 4C insecticides may eventually dominate the insect population if Group 4C insecticides are used repeatedly in the same field or area, or in successive years as the primary method of control for targeted species. This may result in partial or total loss of control of those species by Transform WG or other Group 4C insecticides.

To delay development of insecticide resistance, the following practices are recommended:

- Avoid consecutive use of insecticides on succeeding generations with the same mode of action (same insecticide subgroup, 4C) on the same insect species.
- Consider tank mixtures or premix products containing insecticides with different modes of action (different insecticide groups) provided the products are registered for the intended use.
- Base insecticide use upon comprehensive IPM programs.
- Monitor treated insect populations in the field for loss of effectiveness.
- Do not treat seedling plants grown for transplant in greenhouses, shade houses, or field plots.
- Contact your local extension specialist, certified crop advisor, and/or manufacturer for insecticide resistance management and/or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact Dow AgroSciences by calling 800-258-3033.

Where can I find out more?

Infopest

Infopest is a comprehensive guide on registered agricultural and veterinary chemicals and their permitted uses plus Material Safety Data Sheets (MSDS). You can search Infopest for pesticide products registered to control weeds, insects or diseases in crops and animals. Infopest also includes information on pesticide resistance management. Infopest is regularly updated and available free online. For further information go to www.infopest.com.au

APVMA Gazette

The Australian Pesticides and Veterinary Medicines Authority (APVMA) Gazette is published fortnightly and contains details on the registration of agricultural and veterinary chemical products, notices as required by the Agvet Code and a range of regulatory material issued by the APVMA.

The APVMA Gazette, and information about subscribing to the gazette alert service, is available on the APVMA website at www.apvma.gov.au

Minor Use permits

Some products are not registered for use in particular vegetable crops i.e. the crop is not listed on the product label. The APVMA registration process requires extensive data collection on product efficacy, crop safety (phytotoxicity) and required withholding periods (freedom of residues) which can be very expensive.

If a product is not registered for a crop, it is possible for industry to obtain a minor use permit. For minor use permits it is not required to undertake efficacy and crop safety trials; only withholding periods have to be determined in field trials in major production areas. Generally the permits specify the maximum number of applications per crop or season to manage resistance development.

The APVMA website includes a permit search facility for minor use and emergency use permits issued by the APVMA (www.apvma.gov.au/permits/search.php) - a copy of the permit, including conditions of use, can be downloaded.

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