Overuse of Synthetic Pesticides: How Can Integrated Pest Management Help?©

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APPROACHING INTEGRATED PEST MANAGEMENT

Many pest management problems arise from the repeated use of simplistic, unilateral management responses for what are often complex and highly variable pest problems. It is inefficient for a motorist to repair an oil leak by replacing the engine; it is equally unwise for a grower to manage a small pest problem by using large amounts of synthetic pesticides. A motorist is more likely to replace or repair small components of the engine, and a grower should also be prepared to use an integrated and more refined approach to dealing with pest problems. Is pest management changing the spark plugs or is it replacing the entire engine?

INTEGRATED PEST MANAGEMENT

There is a growing realisation that growers need to switch from the use of single methods to manage pests, which are usually restricted to the use of pesticides, to the use of a range of means to achieve the same endpoint. These management strategies might incorporate methods that directly attack the pest, that change the host plant, or that manipulate the environment.

A conventional approach to pest management involves the grower directly attacking the pest without utilising other means of managing the problem (Fig. 1A). Integrated pest management (IPM) begins to consider other ways in which to manage the numbers of pest insects, diseases, or weeds in the crop environment. By taking into account, for example, the crop itself or the environment, the pest may be managed to low numbers without the use of pesticides. The grower may consider using a selection that is resistant to the pest problem, whether that is an insect pest or disease. By removing the pest's host, or food source, the population is not able to build up in sufficient numbers to economically impact the grower. Similarly, by improving hygiene in and around the crop, the environment may be made inhospitable to the pest or disease, and numbers may be managed this way. By using these methods in addition to pesticides when it is shown to be needed through monitoring, the pest may be managed effectively (Fig. 1B).

HISTORY OF PEST MANAGEMENT

Routine pesticide applications have been used for managing pest problems for many years and is often referred to as "calendar spraying," where the crop is sprayed on a regular basis as a prophylactic against the mere possibility that a pest will build up in numbers and possibly cause economic losses. In this system, pesticides are often the main, or only, tool used to reduce pest numbers. This system was widely used in Australia during the 1940s into the 1970s and leads to many problems such as increased insecticide resistance and the occurrence of the "pesticide treadmill" (Fig. 2).

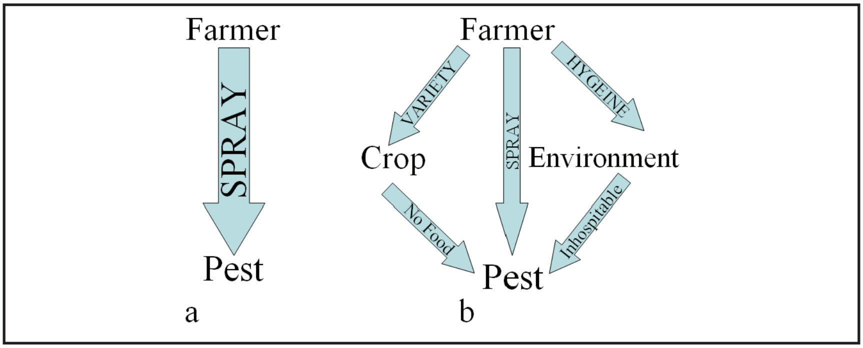

Figure 1. (a) The unilateral approach that has previously been followed with pest management involves the grower directly attacking the pest with pesticides. (b) Integrated pest management directs the grower to consider other means to manage pest populations, such as altering the crop (using resistant varieties for example), modifying the environment, or improving hygiene in and around the crop, in addition to pesticide use to effectively manage pest numbers.

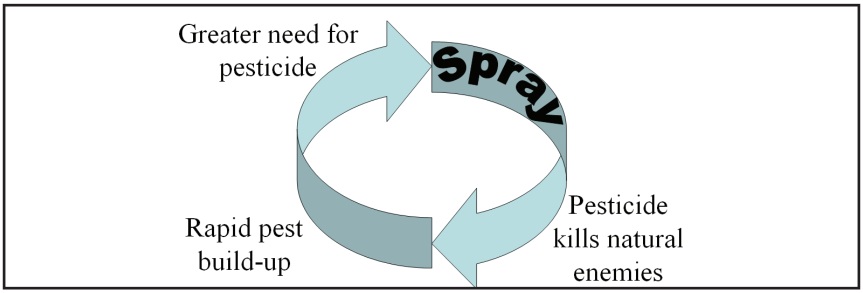

Figure 2. The pesticide treadmill: The overuse of harsh, broad-spectrum pesticides reduces the numbers of pests but also the numbers of natural enemies. Pests often develop faster than beneficial insects, and as a result, rapid pest build-up occurs. This leads to repeated use of pesticides, which in turn destroys populations of natural enemies, which creates a cycle of increasing reliance on chemical applications.

Rational pest management is a system that has been growing in use since the 1970s. This system, like routine pest management, uses pesticides as the main tool. Monitoring for pest numbers is introduced into this system and treatments of pesticides are only applied when pest numbers justify their use. The "cheap insurance" of calendar spraying is avoided.

Integrated pest management is a system that has been around for thousands of years in agricultural production systems, mainly due to the fact that synthetic pesticides are a recent inclusion in the arsenal against agricultural pests. Using an integrated approach, pesticides are not ruled out and are often used when all other actions have failed, but their uses are managed through intensive monitoring and are often preceded by several preventative strategies that are designed to maintain a low population of pests. When pesticides are used in an IPM system, it is common for reduced-chemicals, such as soaps and oils or very target-specific chemicals, to be used and rotated to help manage pesticide resistance. It is possible that in avoiding the “pesticide treadmill” that the grower may be able to exploit the “IPM treadmill” (Fig. 3). By reducing the impact on beneficial insects by reducing the use of harsh, broad-spectrum and often synthetic chemicals, populations of natural enemies may be allowed to build up in numbers and aid in the reduction of pest number build-up.

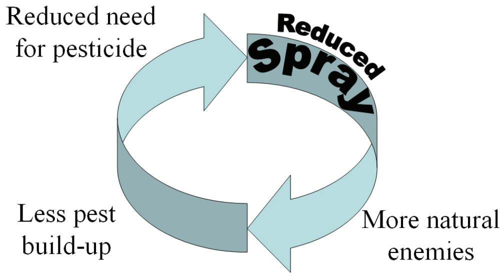

Figure 3. The IPM treadmill: By reducing the use of harsh, broad-spectrum pesticides, natural enemies are able to build up in numbers and aid in the minimisation of pest build-up. This in turn leads to a reduced reliance on pesticide applications and leads to reduced sprays.

IPM

The essence of an IPM program is the integration of appropriate and compatible methods. The use of pesticides is not precluded, though they are used only when necessary and are used in conjunction with a resistance management plan. A resistance management plan is extremely important since there are now over 450 species of insects, over 100 plant pathogens, and over 50 weed species that are now resistant to chemical controls.

Other methods such as resistant selections of plant, increasing hygiene in and around the crop, and using techniques such as biological control agents. Throughout the process, intensive monitoring is undertaken to aid decision making. For these reasons, IPM is a very knowledge intensive system, and there is an emphasis on knowing the crop and the system, knowing what problems you might encounter, and also being aware of what tools are at the grower’s disposal. The emphasis is on “knowing your enemy” and “knowing what’s in the tool box.”

IPM Tip Number 1: Hygiene. There are many parts to an IPM program, the first of which is improving the hygiene in and around the crop. Clearing non-crop plants from within the crop and creating a weed-free growing area at least 5 m from the boundary of the crop is of paramount importance. Leaving plants in, and around, the crop creates refuges for insect pests and diseases and makes it easier for them to move around and migrate into the crop. Clearing these areas and possibly laying weed-mat will assist in keeping the pests out of the crop. Within the crop, diseased and dead plants must be removed so that a reservoir of disease and/or pest insects is not facilitating the spread of disease or pest populations. Removal and appropriate disposal of these wastes must be carried out regularly. Clean clothes, shoes, and tools are vitally important to the health and maintenance of a crop. Locating foot baths and antiseptic wash basins at each entry to the greenhouse will minimise the risk of disease spread if an outbreak occurs in one area. Wearing separate paper lab coats or overalls in each house will also limit the spread of non-flying pests such as mites. Structural changes can also assist in limiting the movement of insect pests, and it follows that disease may also be reduced in the same way by limiting the spread of insects that carry disease. Thrips-grade mesh at all the openings of a greenhouse will help minimise their free movement into the crop. If the pests can't enter the crop, there will be nothing to spray for.

IPM Tip Number 2: Monitoring. The cornerstone to a successful IPM program is knowing exactly what is causing problems in the crop and when to take action against the pest. The use of sticky traps, regular crop inspections, record keeping, and accurate and early diagnosis will allow the grower to make effective management decisions that may or may not involve the use of chemicals. By taking into consideration the crop's economic injury threshold (the point at which management of the pest problem begins to cost less money than the potential losses accrued), a manager may prevent unnecessary, and costly, use of pesticides or other management options by letting the pest run its course. Intensive record keeping is important for the grower to be able to build a knowledge base on when this threshold is likely to be crossed.

IPM Tip Number 3: Cultural Control Options. Healthy plants are more resilient to pest attacks, and maintaining an environment for the crop to thrive in allows for fewer pest outbreaks. The appropriate application of plant nutrition, pH, and EC; providing the correct temperature, humidity, and irrigation requirements for the plant; and making the most appropriate selection for the growing conditions will all maximise the crop's ability to be resistant to insect pests and diseases.

IPM Tip Number 4: Chemical Control. An IPM program does not preclude the use of chemical control options. Rather, the appropriate use of the appropriate chemicals is an extremely important part of any integrated program. Chemical applications are only used when pest numbers exceed the action threshold. There may also be the possibility, as is often the case with pests such as two-spotted mites, to spot-spray areas of the crop that are affected by a pest build-up and leave the rest unsprayed. It is important in any program to implement an insecticide resistance management plan that will involve the rotation of chemical groups, following label directions, and spraying only when needed. In an IPM program where the grower intends to encourage beneficial insects, the restriction of harsh chemicals and using reduced-risk chemistry is very important. Residues left behind by many synthetic chemicals are often evident in media and structural surfaces for years to come unless cleaned thoroughly.

IPM Tip Number 5: Biological Control. If the grower has good nursery hygiene, a monitoring program for pests and diseases, and optimum growing conditions and is using soft chemical options, it is possible that the highest, and often most difficult, point in an IPM program can be used — biological control. Biological control agents are available for use in a number of different crops and for a vast array of different crop pests. Biological control suppliers are able to assist growers in the application and use of biological control agents for most pests found within crops (Table 1).

There are many ways to manage pest problems, and an integrated approach is the best way to maximise a grower's chances at a successful pest management strategy. Experts from commercial companies are available to assist growers in setting up their IPM programs and staff at NSW Department of Primary Industries are also able to offer advice and guidance.

Table 1. Common pests and their biological control agents.

Pest	Biological Control Agent
Heliothis caterpillars	*Trichogramma pretiosum,* damsel bugs (*Nabis kinsbergii*), local *Trichogramma*, predatory bugs, predatory beetles, and Bt spray
Lightbrown apple moth	*Trichogramma carverae,* local *Trichogramma*, predatory bugs and predatory beetles
Mealybugs	Cryptolaemus beetles, predatory beetles
Twospotted mite	Predatory mites (*Phytoseiulus persimilis*), local predatory mites, stethorus beetles, hover fly
Aphids	Green lacewings (*Mallada signata*), brown lacewings (*Micromus tasmaniae*), ladybird *Hippodamia variegata,* damsel bugs (*Nabis kinsbergii*), parasitoid (*Aphidius colemani*), brown and green lacewings, aphid parasitoids, ladybirds, hover fly
White fly	*Encarsia formosa,* green lacewing (*Mallada signata*), lacewings
Fungus gnats	*Hypoaspis* predatory mites, parasitic nematodes
Thrips	*Amblyseius montdorensis* predatory mites, *Amblyseius cucumeris* predatory mites, *Hypoaspis* predatory mites, pirate bugs, *Ceranisus menes, Beauveria*, and *Entomophthora* pathogens