NSW GOVERNMENT Primary Industries

FACTSHEET

Vegetable Integrated Pest Management

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What is IPM?

Many insect pest and disease management problems arise from relying entirely on pesticides for control. Integrated pest management (IPM) is a strategy that draws on a range of management tools with the goal of using the least ecologically disruptive techniques to manage pests within economically acceptable levels. Pests can include insects, mites, diseases, nematodes, weeds and vertebrate pests.

IPM was first defined for managing insects and mites and in practice, most IPM growers begin with applying the strategy to insects and mites and later incorporating other pests such as diseases and nematodes. IPM covers a continuum of practices which ranges from 'intelligent pesticide management' to biointensive IPM strategies.

At the most basic IPM involves routine crop monitoring, to ensure that pesticides are only applied when needed, as well as to ensure appropriate timing of pesticide applications. The most developed *biointensive* IPM relies primarily on beneficial organisms to manage insect pests; when greater pest control is needed, interventions chosen are complementary to the survival of these beneficials. As other pests are incorporated more and more prevention strategies are adopted which reduces the need for direct control practices.

IPM is a model of continual improvement (see Figure 1). Growers adopting IPM typically focus initially on management strategies for a single key insect pest, usually after 'conventional' insecticides fail to control the pest adequately or are deregistered. As strategies are developed for the target pest, focus moves to other key or minor pests. IPM can become part of a fully integrated farm management system, and can potentially involve the whole market chain.

IPM considers the production system in a holistic manner, and looks at all aspects of the farming enterprise as potentially increasing or decreasing pest numbers and, where possible, enhancing the activities that reduce these pest populations.

Although this Factsheet uses insect pests as the main model, the same principles apply for diseases, weeds and vertebrate pests.

In natural systems, insect pest numbers are limited by food supply, climatic conditions and natural enemies, such as predatory and parasitic insects or insect diseases. IPM seeks to enhance, rather than disrupt, this ecological balance. Where direct control is needed, a management strategy is chosen that will reduce the pest population to within economically acceptable limits with minimal adverse impact on the environment.

IPM is knowledge-intensive. An IPM program is built on all compatible control tactics: cultural, biological, chemical, and mechanical; and aims over time to strengthen the preventative practices to reduce the need for control tactics.

IPM cycle

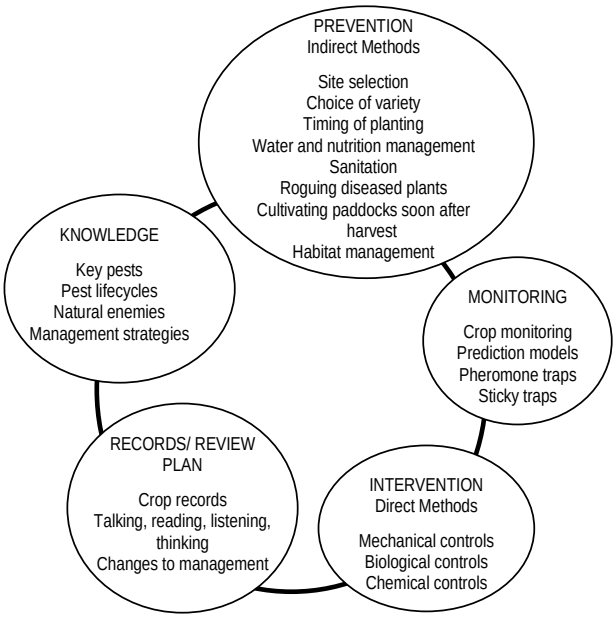


Figure 1. IPM cycle

Table 1. Common insect pests and diseases of vegetables (will vary between crops and regions)

Insect Pests		Diseases	
Major	**Minor**	**Major**	**Minor/sporadic**
Heliothis	Rutherglen bugs	Sclerotinia	Anthracnose
Diamondback moth (brassicas only)	Cutworm, loopers, cluster caterpillars	Tomato spotted wilt virus	Botritis (major in onions in some areas)
Silverleaf whitefly	Wireworm & false wireworm	Powdery mildew	Fusarium (major in cucurbits in some areas)
Western flower thrips (WFT) (when virus present)	Leafhoppers	Downy mildew	Rhizoctonia
Tomato or onion thrips (when virus levels high)	Thrips (when virus absent)	Mosaic viruses	Pythium
Aphids (when virus levels high)	Aphids (when virus levels low)		Alternaria

Knowledge

It is important to develop an understanding of both key and minor (or occasional) pests that are found in crops in your area. Examples of common insect pests and diseases found in vegetable crops are listed in Table 1 and within resources found under Vegetable Resources at the end of the factsheet.

It is equally important to know and understand the management options that are available to you as a grower. As more 'tools' become available, it is important to know when and how they can be used, and what effect they will have on the management of your pests. The knowledge that is developed about both the pest and the management tools available is also largely dependent on the local area and the experience you gain on your own farm. What works on one part of your farm may, for some reason, not work on another, and what works for your neighbour may not be the most appropriate option for you. The ideas behind IPM are based around knowing your 'enemy' and understanding the 'weapons' at your disposal.

Prevention

Where possible, it is preferable to prevent pest problems rather than manage them after they arrive – *prevention is always better than cure*. What measures you use will depend on your particular situation and what are your most serious pests. The following are some prevention strategies that can be important for vegetables:

1. From the available varieties, select ones that have resistance to or tolerance of important diseases or insect pests in your area.
2. Seeds and seedlings can be a source of pests (including: insects, diseases, weeds); use certified seed, know your nursery's management practices and inspect seedlings for pests. If you are using biological control agents, for example, this includes knowing and understanding the effects of chemical residues left from nursery pesticide applications on seedlings.
3. If possible, minimise susceptible crops in the ground during periods of high pest pressure.
4. Irrigating to minimise the period of leaf wetness will reduce foliar diseases.
5. When foliar diseases are present avoid working in the crops while foliage is wet to reduce spread.
6. Optimal nutrition – avoiding excess nitrogen will reduce crop susceptibility to some fungal diseases.
7. Remove weeds from within and around cropping areas particularly if western flower thrips (WFT) and tomato spotted wilt virus (TSWV), are a problem, or the weeds are known hosts of crop diseases or insect pests; e.g. sow thistles are hosts of lettuce necrotic yellows virus and brassica weeds are hosts of a range of brassica diseases and insect pests.
8. Chipping out and removing (roguing) diseased plants will reduce the source of host plants that assist in spreading infection to healthy plants. Once chipped, the plants need to be properly destroyed: buried, bagged or removed from site.
9. Cultivating paddocks immediately after harvest, or if crop is abandoned for some reason, will reduce the harbouring potential for pests, and thus reduce their potential to spread to other plantings on your farm.
10. Use crop records to identify factors or management practices that may be

encouraging or discouraging pests. Because IPM is knowledge-based and relies on local experience, this information will improve your ability to use IPM effectively in subsequent seasons, by allowing you to see what did and didn't work.

Crop monitoring

Routine crop monitoring is the first and most fundamental step in adopting IPM. It is important to keep check on the number of insects (both pest and beneficial) in your crop and to assess crop health. Most beginning IPM growers find it very helpful to contract a professional crop consultant to monitor your crops on a regular basis. If you are monitoring yourself ensure that you can identify the key insect pests, diseases and beneficials that may be present, and send specimens away for identification when there is doubt. All state departments of agriculture offer this service.

Follow a systematic protocol for monitoring, so that direct comparisons can be made of numbers found between monitoring dates and plantings, and keep accurate crop monitoring records so that you can develop a deep understanding of your crop system. Some crops, such as brassicas, lettuce, tomatoes and sweet corn, have suggested monitoring strategies.

A basic strategy involves visual monitoring the same number of plants on a regular basis (e.g. 40 seedlings or 20 mature plants). It is recommended that monitoring sites are widely dispersed throughout the planting, including near crop boundaries. Monitoring should be carried out on at least a weekly basis – at critical points in crop development or pest outbreak situations, crops should be monitored more frequently.

Figure 2. Pheromone trap

Other monitoring tools include vacuum samplers, pheromone traps and sticky traps. Pheromones are available for the two heliothis species, as well as for diamondback moth, and increasingly for thrips species. The heliothis traps selectively trap one species, and having a pheromone trap for each species helps assess the proportion of the heliothis (*Heliocoverpa armigera*) population that is likely to be resistant to the older insecticides. Pheromone traps also indicate flights of the target species; however, be aware that the traps attract male moths, and do not always give a good indication of the populations of female moths that are depositing eggs into the crop.

Figure 3. Sticky traps

Sticky traps are also a useful tool for assessing thrips, whitefly and other small flying species. They are usually yellow, although blue traps can be used for monitoring thrips. In areas where tomato spotted wilt virus is common, sticky traps are regularly used to monitor levels of WFT.

Quality assessments at harvest are a better measure for comparing plantings and years than records of actual marketed product, as market standards vary during the season and between years depending on market supply.

Intervention

Crop monitoring information, past crop records and any pest 'economic threshold' (the point at which the cost of control is equal to yield loss if no control measure is taken) will help with deciding whether the pest numbers warrant active intervention. An 'action threshold' is the point at which you decide to 'act', such as by putting on a pesticide.

In vegetables, economic thresholds are very hard to identify, given the large fluctuations in crop price and quality. Some basic thresholds have been developed for a few pests in a few crops, but these are developed largely from experience, keeping records and evaluating the success of particular decisions.

The factors that will influence your action threshold are the crop stage (e.g. heliothis are more difficult to control once sweet corn cobs have formed, or head lettuce has hearted), crop destination (i.e. export, domestic fresh, or processing), numbers of beneficials known to predate on the target pest, current and expected weather conditions, regional resistance management strategies, previous treatments used and effectiveness of control options.

The factors most likely to affect disease control decisions are varietal susceptibility, diseases

present in the crop, whether the climatic conditions favour spread or development, crop vigour/health/nutritional status, irrigation methods, crop destination, the effectiveness of control options and, if the disease is transmitted by an insect, the population size and source of that insect.

The actual control option selected should be the option least likely to disrupt beneficial organisms, but also one that will control the pest within certain constraints. Constraints can include product registration, withholding periods, market requirements, cost, resistance management strategies and current conditions. If a pesticide is selected, it needs to be applied using best practice spray application techniques.

Evaluation

All insect sprays should be evaluated after application. Synthetic pyrethroids, organophosphate and carbamates insecticides should show immediate effects; however, some of the newer chemistries, such as Success®, Avatar®, Chess®, and biological pesticides such as NPV (a viral pathogen insecticide for Heliothis) and Bts (a bacterial pathogen against caterpillars) can be expected to take many days to kill. Feeding usually ceases shortly after application.

Harvest assessments are recommended for the purpose of comparing crops and seasons. Spending some time each year looking at crop records to see why some plantings were more successful than others can be insightful. Records will reveal pest population trends following control measures. This will help you to learn more about the indirect effects of particular chemical applications; for example, the use of a broad-spectrum insecticide may wipe out the target insect pest as well as the beneficial insects present in the crop, which may result in a minor insect pest becoming a serious problem.

Talking to others about current conditions, crop quality and pack-outs can provide information on how you are performing relative to others, and give you ideas for ways to improve your management. Looking over records over a number of seasons may show patterns or paddock variations that you hadn't noticed previously, which will allow you to address the problem and improve your overall performance.

IPM continues to evolve as new pests arrive, new management options become available and new techniques are adopted. Over time, an IPM strategy will tend to shift effort from intervention strategies to prevention strategies.

Sending samples for identification

Management strategies are most effective when accurate identification of a pest is made.

Insects can be identified either from specimens collected into a vial or container, or from sticky traps. If possible collect at least 10 specimens to send. If it is likely to be some time before you can deliver or send the sample then and the insect is soft bodied (e.g. aphid, caterpillar or thrips) then, if possible, collect specimens into a small quantity of rubbing alcohol (available at the chemist). Sticky traps can be covered in plastic cling wrap before removing from the field or greenhouse. Try to avoid squashing sticky traps as accurate identification is difficult if specimens are damaged.

For diseased plants collect a number of plants showing the range of symptoms. Wrap plant material in damp but not wet paper, place in a plastic bag, keep cool and send or deliver as quickly as possible.

Samples can be left at any NSW DPI office or sent to:

Insect specimens - Delivery or Postal

Attention: Sample Submissions
NSW DPI
OAI, Forest Road, Orange NSW 2800
Ph: (02) 6391 3980

Plant specimens-Delivery

Attention: Sample Submissions
Elizabeth Macarthur Agricultural Institute
Woodbridge Rd MENANGLE NSW 2568

Or Postal

Attention: Sample Submissions
NSW DPI Elizabeth Macarthur Agricultural Institute
PMB 8 CAMDEN NSW 2570
Ph: (02) 4640 6327

[fees are charged for diagnostic services]

NSW DPI Pest & disease diagnostic laboratories information and submission forms:
http://www.dpi.nsw.gov.au/aboutus/services/das/plant-pests-diseases

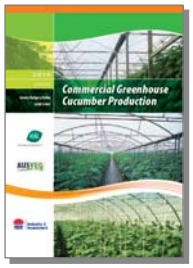
Vegetable Resources

Information manuals/guides

Keep It Clean (2009) NSW I&I Badgery Parker *et al.* Comprehensive guide for greenhouse growers that lists and describes more than 70 management practices that can significantly reduce the costs and losses that can result from pests and diseases.

A series of summary fact sheets and example record sheets are also available to download. Manual can be down loaded or hard copy ordered.

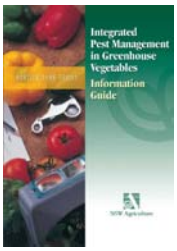
http://www.dpi.nsw.gov.au/agriculture/horticulture/greenhouse/pest-disease/general/preventing



Commercial Greenhouse Cucumber Production (2010) NSW I&I James and Badgery Parker. This 216 page growing guide for greenhouse cucumber growers includes sections on managing crop pests. This manual can be purchased.

Integrated pest management in lettuce: information guide (2002) NSW Agriculture McDougall *et al.* 150pp

http://www.dpi.nsw.gov.au/aboutus/resources/bookshop/ipm-lettuce-infoguide



Integrated pest management in greenhouse vegetables: information guide (2002) NSW Agriculture Goodwin & Steiner 216pp

http://www.dpi.nsw.gov.au/aboutus/resources/bookshop/veg-ipm-info-guide

Both information guides provide information about IPM, what it is, recognizing and monitoring of pests, beneficials, diseases and weeds (lettuce only), spray application and record sheets.

Companion field identification guides are also available:

Pests, beneficials, diseases and disorders in lettuce (2003) NSW Agriculture McDougall & Creek

http://www.dpi.nsw.gov.au/aboutus/resources/bookshop/ipm-lettuce-field-id-guide

Pests, diseases, disorders and beneficials in greenhouse vegetables (2002) NSW DPI Goodwin

http://www.dpi.nsw.gov.au/aboutus/resources/bookshop/veg-ipm-field-id-guide

Pests, Beneficials, Diseases and Disorders in Cucurbits (2009) NSW DPI Napier & Draper

http://www.dpi.nsw.gov.au/aboutus/resources/bookshop/cucurbits-field-id-guide

Lettuce Best Practice: Integrated Pest Management (2010) Vic DPI Dimsey *et al.*

http://www.hin.com.au/Associations/HSPN/Resources/Manual-Lettuce-Ute-Guide

Brassica Best Practice: Integrated Pest Management (2010) Vic DPI Dimsey *et al.*

http://www.hin.com.au/Resources/Manual-Brassica-Ute-Guide.aspx

Chemical use

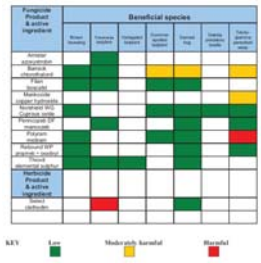
Western flower thrips (WFT) insecticide resistance management plan (2010), NSW DPI, G. Herron et al. This series of web pages gives basic information on WFT resistance management and pages of the permitted insecticides for crops.

http://www.dpi.nsw.gov.au/agriculture/horticulture/pests-diseases-hort/multiple/thrips/wft-resistance

Spray Sense – information for users of chemicals. This booklet is available from the NSW DPI bookshop or as pdf leaflets from the NSW DPI website. Spray Sense covers all aspects of chemical application from reading chemical labels, calibrating sprayers, using different spray applicators to cleaning out tanks.

http://www.dpi.nsw.gov.au/agriculture/farm/chemicals/general/spray-sense-leaflet-series

Chemical impact on beneficials

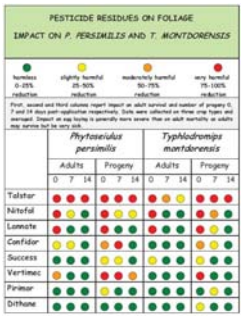


Three one-page tables detailing the effects of pesticides on beneficials

1. Insecticide effects on beneficial insects and mites
2. Insecticide compatibility with non target beneficials
3. Fungicide and herbicide effects on beneficials

www.ipmtechnologies.com.au > IPM tools> Insecticide compatibility

Series of colour coded tables on insecticide impact on Greenhouse biological control agents.



1. Pesticide residues on foliage
2. Pesticide residues in media
3. Pesticide residues on greenhouse plastic
4. Side-effects of pesticides on biological control agents

http://www.dpi.nsw.gov.au/agriculture/horticulture/greenhouse/pest-disease impact of pesticides on greenhouse biological control agents

Beneficial insects, mites and nematodes can be purchased from a number of commercial insectaries that are affiliated with the Australasian Biological Control group. Information on the impact of pesticides on commercially available biological control agents is also available via:
http://www.goodbugs.org.au/

Monitoring tools

Handlens and yellow or blue sticky traps are available from a number of sources and may be available from your local agricultural supplier.

Or can be purchased from:

Australian Entomological Supplies:
Phone : (02) 6684 7650 Fax : (02) 6684 7188
http://www.entosupplies.com.au/

Bugs for Bugs
Phone: (07) 4165 4663 Fax: (07) 4165 4626
http://www.bugsforbugs.com.au/ipm/tools

Biological Services
Phone: (08) 8584 6977 Fax: (08) 8584 5057
http://www.biologicalservices.com.au

Further information

Visit the Vegetable diseases, pests & disorders section of NSW DPI website for more factsheets

http://www.dpi.nsw.gov.au/agriculture/horticulture/vegetables/diseases

or the Pests, diseases & disorders in greenhouses section of NSW DPI website

http://www.dpi.nsw.gov.au/agriculture/horticulture/greenhouse/pest-disease

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