IPM ONfarm — Protected Cropping is a training course designed to meet the needs of nursery, cutflower and greenhouse vegetable producers in Australia.

Produced by NSW Agriculture, this training course offers competency-based training that will contribute to the horticultural qualifications of industry workers. The practical training enables industry participants to confidently establish and implement an IPM program for themselves.

IPM ONfarm — Protected Cropping provides IPM training at three levels, as well as an introductory course for those who simply wish to understand more about IPM. Unqualified staff working under supervision, specialist staff with greater responsibilities on the farm, plus management, are all catered for in this new training package.

IPM ONfarm focuses on the practical aspects of IPM:

- undertaking crop inspections for pests and diseases
- knowing what to look for and where to look
- gaining the skills to routinely handle sticky traps and get the most out of them as a monitoring tool
- making informed decisions by developing an understanding of the ability of your crops to tolerate various key pests and diseases
- making use of your own monitoring information to plan an effective control program
- developing the confidence to consider incorporating biocontrol into your management program
- appreciating the need for farm hygiene, and what you can do to improve your own situation.

The NSW Agriculture companion publications Integrated Pest Management Information Guide and Field Identification Guide for both Ornamentals and Greenhouse Vegetables are the resource documents for IPM ONfarm. They ensure course participants receive the right amount of information to go with the practical training in these courses.
IPM ONfarm – Protected Cropping
Competency Training in Integrated Pest Management for the Ornamental and Greenhouse Industries
Course Workbook
Stages 1, 2, 3 and 4

Produced by NSW Agriculture in conjunction with Horticulture Australia
IPM ONfarm – Protected Cropping:
Course Workbook

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Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing (1 September 2002). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Agriculture or the user’s independent adviser.

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On-farm course assessment
This course does not address any national competencies in the National Training Package in Horticulture: it provides an understanding of the aims and practices of IPM and it is also the introduction to Stages 2 and 3 of the IPM ONfarm training program.

Course structure

- What is IPM?
- The seven sectors of plant health
- Pests and diseases
- Benefits of IPM
- Potential barriers to adoption of IPM
- Chemical availability
- Pest and disease resistance
- Commitment to IPM
- Common questions about IPM

Reference material in the Information Guide

- Section 1: What is IPM?
- Section 2: Common Questions
- Section 9: Directory
- Section 11: Glossary
- Handy Guide 4: Registered Chemicals for Common Pests
- Handy Guide 5: Registered Chemicals for Common Diseases

Purpose

You learn about IPM, including the benefits and possible problems with IPM and its role in plant health.
Activities

- Discussing the principles of IPM and some IPM strategies
- Identifying pests and diseases from your own experiences
- Outlining factors that affect plant health
- Listing the benefits of IPM
- Explaining the limitations to the use of registered chemicals and possible chemical resistance in pests
- Outlining how a computer database of registered chemicals is used to obtain information on pest and disease control products and information about chemical resistance in pests
- Discussing some of the potential barriers to the adoption of IPM.

Tasks

Note: All suggested reading associated with page numbers in this Workbook refers to the Information Guide by Section and then page number, for your industry.

What is IPM?

1. What is integrated pest management (IPM)?
   If you think you know what IPM is, write it down.

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DEFINITION OF IPM

a) It’s one o’clock in the afternoon
b) I Pray More
c) A system of pest management that plans ahead, considers all options, and aims to minimise the use of toxic pesticides
2. Read the brief description of IPM on page 1–2 and compare it with yours.

3. What is an IPM program? Tick one in the list below that you think best fits the definition on page 1–2.

**AN IPM PROGRAM:**

a) Uses non-toxic chemicals only

b) Uses only biological control agents

c) Seeks to integrate all compatible options

4. List the elements of an IPM program that you feel you are already practising in your crop(s).

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The seven sectors of plant health

5. Plant health can be affected by a range of factors. Refer to *Plant Health Management* on pages 1–2 and 1–3 and familiarise yourself with all the sectors of plant health. Look at the list below and tick the factors that are harmful to your crops. Make a brief note about why the ones you have selected may be a problem. You could discuss your answer with your mentor or trainer.

a. environment ................................................................................................................. ...
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b. soil/media condition ........................................................................................................
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c. weeds ........................................................................................................................................
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d. pesticides ................................................................................................................................
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e. nutrition .................................................................................................................................
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f. pests ......................................................................................................................................
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g. diseases ............................................................................................................................
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**Pests and diseases**

A pest can be defined as any organism that has the capacity or potential to cause economic harm by reducing quality or yield of crops or other products.

6. You have been provided with specimens of pests and diseases. Write down the names of those that you think you recognise.

   a. ........................................................................................................................................

   b. ........................................................................................................................................

   c. ........................................................................................................................................

   d. ........................................................................................................................................

   e. ........................................................................................................................................

   f. ........................................................................................................................................

   g. ........................................................................................................................................

7. Which pests and diseases have you seen infesting your crops?

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8. Which are the major ones, and what type of damage does each cause?

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9. Describe the action you would take if you came across an unknown pest or disease.

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Benefits of IPM

Refer to pages 1–4 and 1–5 and read about the benefits of IPM.

10. List the benefits in what you see as being the order of importance. Put the most important benefit first in your list.

a. ............................................................................................................................. ...........

b. ............................................................................................................................. ...........

c. ............................................................................................................................. ...........

d. ............................................................................................................................. ...........

e. ............................................................................................................................. ...........

f. ............................................................................................................................. ...........

g. ............................................................................................................................. ...........

h. ............................................................................................................................. ...........
11. Which benefits in Task 10 do you feel best able to achieve?

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Potential barriers to adoption of IPM

Many growers are unsure about starting an IPM program for many reasons. Some of these include cost, uncertainty about the time commitment, uncertainty about using biocontrol agents – or they just don’t know much about it.

12. Read through the list of potential problems on pages 1–6 and 1–7. Would any of these be of concern to you, and why?

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13. Do you have any concerns with using IPM? If so, what are they?

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Chemical availability

In the picture below is one way of looking at pest management.

14. Where can you get information on registered chemicals for your crops? (See pages 9–22 and 9–23 and Handy Guides 4 and 5.)

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15. What problems could there be in using chemicals in the future?

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Pest and disease resistance

Refer to Pest Resistance on page 1–5.

16. Have you ever come across problems with pest or disease resistance? If so, briefly describe the pest or disease and the chemical involved.

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17. Explain why you thought the problem was resistance and not some other factor.

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18. List three other factors that might lead to poor control.

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............................................................................................................................... ...............
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19. Are you aware of what resistance management is?

Yes........................................ No........................................

If you are aware of resistance management, describe some of the key aspects of it.

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IPM ONfarm – Protected Cropping: Course Workbook
Commitment to IPM

Have a look at Challenges on page 1–7.

20. What do you think IPM has to offer you and your farm?

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Common questions about IPM

See Section 2 Common Questions in the Information Guide.

21. What are two questions about IPM that you would like to ask? Can you find them in Section 2?

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National competencies addressed in this training course are from the National Training Package in Horticulture:

- RUHHR202A Treat pests and diseases (element 01 Recognise pests and diseases)

Learners who successfully complete the assessment exercise will receive a Certificate of Attainment for the element of the National Competency listed above.

Course structure

**Topic 1. Introduction to IPM** is dealt with in Stage 1 at the beginning of this Course Workbook

**Topic 2. Basic pest and disease recognition, biocontrol and monitoring equipment**

- Pest recognition
- Disease recognition
- Biocontrol recognition
- Monitoring equipment

Reference material in the Information Guide

**Topic 1** Introduction to IPM: see Stage 1 at the beginning of this Course Workbook

**Topic 2** Basic pest and disease recognition, biocontrol and monitoring equipment:

- Section 4: Designing an IPM Program: Monitoring & Decision-making
- Section 5: Know Your Pests
- Section 6: Know Your Diseases
- Section 7: Know Your Biocontrol Agents
- Section 9: Directory
Purpose

In this stage you will learn how to recognise pests and diseases in your crops and the symptoms of damage. You will also learn about the biocontrol agents that might be useful to you and how to tell them apart from pest species. You learn about the use of chemicals against pests and diseases. Finally, you will learn about the need for monitoring and the equipment and methods used.

Activities

- Recognising pests, diseases and biocontrol agents
- Examining examples of key pests infesting crop and weed plants
- Examining diseased plant material
- Examining samples of commercially produced biocontrol agents and any naturally occurring predators and parasitoids that are available
- Discussing pest and disease diagnosis with reference to Pests, Diseases, Disorders and Beneficials: Field Identification Guide
- Looking for pests and beneficials in plant samples by using a headband or a hand magnifier
- Looked at a sticky trap that has trapped insects in a crop

Tasks

Note that all suggested reading associated with page numbers in this Workbook refers to the Information Guide by Section and then page number, for your industry.

Pest recognition

22. Look at the directory of pests on pages 5–2 and 5–3 and check Pests, Diseases, Disorders and Beneficials: Field Identification Guide. Have a look at the specimens provided. Can you recognise them?

   a. ..................................  b. ..................................  c. ..............................

   d. ..............................  e. ..............................

23. Which of the specimens provided have you seen in your crops? Tick above
24. Choose three of the most common pests you have seen in your crop(s)

   For Pest 1:
   Can you describe how you recognised it and which plants you found it on?
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................
   What sort of damage did you see?
   ........................................................................................................................................
   ........................................................................................................................................

   What were you asked to do about it, if anything?
   ........................................................................................................................................
   ........................................................................................................................................

   For Pest 2:
   Can you describe how you recognised it and which plants you found it on?
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................
   What sort of damage did you see?
   ........................................................................................................................................
   ........................................................................................................................................

   What were you asked to do about it, if anything?
   ........................................................................................................................................
For Pest 3:
Can you describe how you recognised it and which plants you found it on?

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What sort of damage did you see?

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What were you asked to do about it, if anything?

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**Disease recognition**

25. Look at the directory of diseases on page 6–2 and check Pests, Diseases, Disorders and Beneficials: Field Identification Guide. Have a look at the specimens provided. Can you recognise them?

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

26. Describe each as caused by a fungus, bacteria, virus or nematode

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................
27. Describe the symptoms you’ve seen caused by each of the diseases shown in Task 25. Refer to Know your Diseases, Section 6 of the Information Guide, and check diagnostic features.

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

28. Describe what you have been asked to do when you’ve seen these diseases in your crops.

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

Biocontrol recognition

29. From the directory of commercially available biocontrol agents on page 7–2, choose the biocontrol agents you could use against the pests you named earlier in Tasks 23 & 24. Check Pests, Diseases, Disorders, Beneficials: Field Identification Guide for colour pictures and some key information.

30. Which biocontrol agents have been used in your crops?

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

4. ........................................................................................................................................

31. What pests where they used against?

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

4. ........................................................................................................................................
32. How did you tell the biocontrol agent apart from the pest?

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

4. ........................................................................................................................................

**Monitoring equipment**

Look at pages 4–3, 4–4 and 4–9 and answer the following questions.

33. Look at the equipment provided. Use it to magnify a pest or disease from the specimens provided. What can you see now?

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34. Look at the sticky trap provided. Explain how it is used in the crop.

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National competencies addressed in this training course are from the National Training Package in Horticulture:

- RUHHRT317A Control pests and diseases (all elements)
- RUHHRT352A Implement an integrated pest management program (all elements)
- RUHHRT353A Select chemicals and biological agents (element /01, Select appropriate chemical)
- RUHHRT202A Treat pests and diseases (all elements).

Learners who successfully complete the on-farm assessment exercise will receive a Certificate of Attainment for the National Competencies listed above.

Course structure

**Topic 1. Introduction to IPM is dealt with in Stage 1 at the beginning of this Course Workbook.**

**Topic 2. Implement an IPM program:**

- **Section 1:** Preparing for IPM
- **Section 2:** Pest and disease recognition and biocontrol recognition and use
- **Section 3:** Monitoring and decision-making

**Section 1: Preparing for IPM**

Subject areas:

- Staff considerations
- Site considerations
- Physical considerations
- Cultural considerations
- Chemical considerations
- Preparing to implement IPM
Reference material in the Information Guide

- Section 3: Preparing for IPM: Property and Staff
- Section 9: Directory
- Handy Guide 4: Registered Chemicals for Common Pests
- Handy Guide 5: Registered Chemicals for Common Diseases
- Handy Guide 6: Chemical Toxicity to Biocontrol Agents

Purpose

In this section you will learn about the steps that can be taken to minimise the risk of pests and diseases in your crops by preparing your property.

Activities

Drawing up a list of improvements to your work site in preparation for the introduction of IPM

Tasks

Note that all suggested reading associated with page numbers in this Workbook refers to the Information Guide by Section and then page number, for your industry.

Staff considerations

As a person with responsibility for implementing an IPM program, you must be properly prepared for, and be committed to, IPM.

Staff need to:

- understand crop hygiene
- identify, monitor and record pests and diseases.

22. Here is a checklist for staff management:

- Is there a training program in IPM for staff in your workplace? Yes/No/Undecided
- Are you committed to implementing IPM? Yes/No/Undecided
- Do you have appropriate reference material available? Yes/No/Undecided
- Do you know and have you documented your responsibilities in your IPM program? Yes/No/Undecided
- Are appropriate staff hygiene measures in place? Yes/No/Undecided
Site considerations

A poorly managed and badly structured site can attract pests and diseases and hinder any attempts to control them. Part of IPM is the preparation of the production sites so that they prevent pests from occurring.

23. Prepare a mud map of your site on the page provided. Include each of the following
   a. orientation (N/S/E/W)
   b. climate and micro-climate (winds/shelter/aspect)
   c. growing areas
   d. buildings
   e. roads
   f. public access areas
   g. rubbish tips
   h. soil, pot and media storage areas
   i. propagation and production areas.

24. See the site considerations listed on pages 3–4 and 3–5. Do any of these problems relate to your site? If so, list them.

............................................................................................................................... ............
............................................................................................................................... ............

25. Write a list of possible site improvements you could make on your property.

Physical considerations

Greenhouses are important to propagation and production of crops. Growers who have greenhouses need to take special steps to ensure that the environmental conditions in their greenhouses do not favour pests and diseases, but do favour beneficials and healthy crop growth.

Refer to pages 3–6 to 3–10 (Ornamentals), or 3–5 to 3–9 (Greenhouse Vegetables), and then complete the following tasks. You might like to discuss your responses with others in your group.

26. Heat. How do you manage high or low temperatures?

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27. Relative humidity. How do you prevent condensation?
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28. Water. What type of water management do you use?
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Now refer to pages 3–10 to 3–17 and continue with the following tasks:
29. Do you use screening?
Yes ........................................... No .............................................
If not, why not? ...................................................................................................................................
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If yes, what do you use and how effective is it? ..............................................................................
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30. What are the benefits of ventilation in greenhouses and how do you ventilate your greenhouse?
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31. Ignoring costs, are there any site or structural modifications that you would like to make to your greenhouse? List them.
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32. Look at these examples of insect screening.

**TO SCREEN OR NOT TO SCREEN?**

![Insect screening examples]

**Cultural considerations**

Now refer to the paragraphs on nutrient and irrigation management on page 3–18 (Ornamentals), or 3–17 (Greenhouse Vegetables), and continue with the following tasks.

33. What are some of the problems associated with excess nutrients?

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34. What sort of irrigation system do you use, and why? How do you prevent waterlogging or plants drying out?

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35. What sort of pests and diseases are associated with waterlogging and poor drainage?

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Refer to Sanitation Management pages 3–18 to 3–20 (Ornamentals), or 3–17 to 3–19 (Greenhouse Vegetables).

36. Make a list of three things that you do and three things that are new to you.

Things I do ...........................................................................................................................................
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New ideas ............................................................................................................................................... 
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37. The following task relates to the weeds box below. Tick the statements that you think are true.

WEEDS AND YOUR PLACE

WEEDS ARE GOOD FOR:

a) Checking for pests
b) Harbouring TSWV
c) Making the place look neglected
d) Showing you can grow something well
e) Nothing
f) All of the above
Examples of poor weed management

WEED NO-NO’s!

Top left: Crop trash left in greenhouse. Top right: Dumping old crop near your greenhouse is asking for reinvasion by pests and diseases. Bottom left: Weeds and house plants in a greenhouse make a good refuge for pests and diseases. Bottom right: Open greenhouses with broad-leaved weeds growing right up to the edge.

Do you have any of these situations on your property?

Chemical considerations

Chemical use will remain an important tool in an IPM program. Effective results will be determined by which ones you choose and the way they are used.

On pages 3–20 to 3–23 (Ornamentals), or 3–19 to 3–22 (Greenhouse Vegetables), you will find details of what you need to consider before you use chemicals. You’ll also find some of the problems you can have with using chemicals.

38. What happens when you over-use chemicals?

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Now refer to pages 3–28 and 3–29 (Ornamentals), or page 3–27 (Greenhouse Vegetables), for some recommendations about using pesticides.

Check Handy Guides 4 and 5 for details of chemicals registered for pests and diseases in your crops. Note the different activity groups for insecticides and fungicides.

What is an activity group?

Start the Infopest® CD ROM. Click on the information tab at the top of the opening page. Click on the line Pesticide resistance group information from AvCareâ and have a look at the details on activity groups and resistance management strategies.
Now continue with the following tasks.

39. Select two insecticides/miticides and write down the chemical group and activity group for each.

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40. Select two fungicides and write down the chemical group and activity group for each.

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41. What is a common pest or disease on your property?

With reference to your answer to Task 39, see page 3–21 (Ornamentals), or 3–20 (Greenhouse Vegetables), and the paragraph *Rotate between pesticide chemical groups to delay resistance*, and check Handy Guides 4 and 5. Note the different activity groups that are effective against the pest you nominated, and then write a Resistance Management Plan using chemicals from different activity groups.

42. Make a list of things to consider before you use chemicals on your crop and in your greenhouse.

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43. What are two major problems you might face in using chemicals at your site?

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44. On what basis do you decide which chemicals to use in your crops?

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45. What can you do if there isn’t an effective chemical registered in your crop for the pest you wish to spray? See Permits on page 3–29.

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Now refer to What you need to know about sprayers and spraying on pages 3–23 to 3–28 (Ornamentals), or 3–23 to 3–26 (Greenhouse Vegetables).

46. What equipment do you use for applying pesticides?

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47. List the advantages and the disadvantages you have found in using this equipment.

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48. When did you last check nozzle output or change your nozzles?

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49. How could you improve the way you apply chemicals?

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50. Have you completed a Chemical Users’ Course (SMARTtrain, ChemCert, Chemsman, Farm Care or Farm Chemical Users Course)?

Yes ........................................... No ............................................
For more information see pages 3–30 and 3–31 (Ornamentals), or 3–28 and 3–29 (Greenhouse Vegetables), and 9–22 and 9–23.

**Preparing to implement IPM**

Refer to *Maximising the success of IPM* on pages 3–31 and 3–32 (Ornamentals), or page 3–30 (Greenhouse Vegetables).

51. Prepare a list of practices you would like to introduce to your workplace.

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Now refer back to the points listed on pages 3–31 and 3–32 (Ornamentals), or page 3–30 (Greenhouse Vegetables). Did you miss anything? Why? Discuss with your trainer.
Section 2:
Pest and disease recognition and biocontrol recognition and use

Subject areas:
- Pest recognition
- Biocontrol recognition and use
- Use of chemicals with biocontrol agents
- Disease recognition

Reference material in the Information Guide

- Section 5: Know Your Pests
- Section 6: Know Your Diseases
- Section 7: Know Your Biocontrol Agents
- Section 9: Directory
- Section 11: Glossary
- Handy Guide 4: Registered Chemicals for Common Pests
- Handy Guide 5: Registered Chemicals for Common Diseases
- Handy Guide 6: Chemical Toxicity to Biocontrol Agents
- Plus Pests, Diseases, Disorders and Beneficials: Field Identification Guide for your crop

Purpose

In this Section you will learn how to recognise pests and diseases in your crops and the symptoms of damage. You will also learn to recognise and use biocontrol agents and learn about their use with chemicals.

Activities

- Recognising pests, diseases and biocontrol agents
- Examining examples of key pests infesting crop and weed plants (obtained from suppliers for the course and brought in from farms by participants)
- Examining diseased plant material
- Examining samples of commercially produced biocontrol agents (obtained from producers)
- Examining any naturally occurring predators and parasitoids that are available
Tasks

Pest recognition

52. Look at the directory of pests on pages 5–2 and 5–3 (Ornamentals), or page 5–2 (Greenhouse Vegetables).

Have a look at the specimens provided. Can you recognise them?

a. ........................................b. .................................c. ..............................

d. ..........................................e. ..............................

53. Which of the specimens provided have you seen in your crops? Tick above.

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54. Choose three of the most common pests you have seen in your crop(s).

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For Pest 1:
Describe the pest and state the plants where you found it.

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Describe its life cycle. (See Section 5 and go to the appropriate pest group for an example of a life cycle.)

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What sort of damage did you see?

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What did you do to prevent it from occurring or to reduce its presence?

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Refer to the notes related to this pest in Section 5 of the Information Guide.

Would you do something different now?

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For Pest 2:
Describe the pest and state the plants where you found it.

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Describe its life cycle. (See Section 5 and go to the appropriate pest group for an example of a life cycle.)

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What sort of damage did you see?

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..............................................................................................................................................................
..............................................................................................................................................................
..............................................................................................................................................................

What did you do to prevent it from occurring or to reduce its presence?

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..............................................................................................................................................................

See the notes related to this pest in Section 5 of the Information Guide.

Would you do something different now?

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For Pest 3:
Describe the pest and state the plants where you found it.

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Describe its life cycle (see Section 5 and go to the appropriate pest group for an example of a life cycle).

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...........................................................................................................................................
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What sort of damage did you see?

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...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................

What did you do to prevent it from occurring or to reduce its presence?

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...........................................................................................................................................
See the notes related to this pest in Section 5 in the *Information Guide*.

Would you do something different now?

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55. Look at the directory of Pest and Disease Diagnostic Services on pages 9–9 to 9–13 (Ornamentals), or 9–8 to 9–12 (Greenhouse Vegetables).

Which pest diagnostic service is nearest to you? Have you used its services?

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**Biocontrol recognition and use**

For Tasks 56 to 60 have a look at pages 7–3 to 7–7, *Know your Biocontrol Agents*.

Find Handy Guide 6 with the chemical toxicity table.

56. Have a look at the specimens provided. Can you recognise them?

a) ............................................................................................................................. 

b) ............................................................................................................................. 

c) ............................................................................................................................. 

d) ............................................................................................................................. 

e) .............................................................................................................................
57. Name these biocontrol agents (BCAs). The target pest for each is in brackets.

**WHICH BIOCONTROL AGENT IS THIS?**

- a. .................................................................................................................... (spider mite)
- b. ........................................................................................................................... (aphids)
- c. ..................................................................................................................(fungus gnats)
- d. ......................................................................................................................... (whitefly)
- e. ............................................................................................................................ (thrips)
- f. ........................................................................................................................... (aphids)

58. Which biocontrol agents, if any, have you used in your crops?

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What pests where they used against? Name the pests and their biocontrol agents.

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59. When would you choose to use a biocontrol agent?

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60. When would you choose not to use a biocontrol agent?

61. From the directory of commercially available biocontrol agents on page 7–2, and the notes on pages 7–8 to 7–23 (Ornamentals), or 7–8 to 7–20 (Greenhouse Vegetables), choose one agent you could use and answer the following:

- Name the biocontrol agent: .................................................................................................
- Name the key pest you would use it against: ........................................................................
- Name a supplier: ..............................................................................................................
- Describe how you would use it: .........................................................................................

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Use of chemicals with biocontrol agents

WHICH CHEMICALS ARE SAFE TO USE?

- Lannate
- Maldison
- Eco-oil
- Natrasoap
- Pirimor

- Vertimec
- Success
- Benlate
- Sulfur
- Bravo

62. With reference to the biocontrol agent you selected for Task 61, consult Handy Guide 6: Chemical toxicity to biocontrol agents. List three chemicals you could use with your selected biocontrol agent in an IPM program.

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Disease recognition

63. Look at the directory of diseases in Know your Diseases on page 6–2.

Have a look at the specimens provided. Can you recognise them?

a. .................................. b. .......................... c. ...........................

d. ............................. e. ...........................

Which of the specimens provided have you seen in your crops? Tick above.

64. Choose three of the most damaging diseases (in terms of $ loss) you have experienced in your crops.

1. ...................................................................................................................................................

2. ...................................................................................................................................................

3. ...................................................................................................................................................
Is it a fungus, bacterium, virus or nematode?

1. ........................................................................................................................................
2. ........................................................................................................................................
3. ........................................................................................................................................

Describe the symptoms you’ve seen.

1. ........................................................................................................................................
2. ........................................................................................................................................
3. ........................................................................................................................................

How do you think it originally got on to the property?

1. ........................................................................................................................................
   ........................................................................................................................................
2. ........................................................................................................................................
   ........................................................................................................................................
3. ........................................................................................................................................
   ........................................................................................................................................

How do you think it spread through the crop?

1. ........................................................................................................................................
   ........................................................................................................................................
2. ........................................................................................................................................
   ........................................................................................................................................
3. ........................................................................................................................................
   ........................................................................................................................................
Implementation of IPM

How did you (or others) control it or prevent a reoccurrence?

1. ...................................................................................................................................................

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2. ....................................................................................................................................................

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3. ....................................................................................................................................................

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See the notes related to these diseases in Section 6 of the Information Guide.

Would you do something different now?

1. ....................................................................................................................................................

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2. ....................................................................................................................................................

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3. ....................................................................................................................................................

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65. Have a look at the directory of Pest and Disease Diagnostic Services on pages 9–8 to 9–12.

Which disease diagnostic service is nearest to you? Have you used it and if not, why not?

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Practise your skills in the Pest Sense Card Game.
Section 3: Monitoring and decision-making

Subject areas:
- Monitoring equipment
- Monitoring
- Sticky traps
- Record keeping
- Monitoring plan
- Case study exercise
- Action thresholds
- Indicator plants (ornamentals only)
- Final preparation for IPM
- On-farm course assignment

Reference material in the Information Guide

- Section 4: Designing an IPM Program: monitoring and decision-making
- Section 9: Directory
- Section 11: Glossary
- Handy Guide 1: IPM Checklist
- Handy Guide 2: Crop Management
- Handy Guide 3: Sample Monitoring Record Sheets

Purpose

In this Section you will learn how to monitor pests and diseases in your crops and the symptoms of damage. You also learn about the need for thresholds and how to use them in decision-making.

Activities

- Monitoring pests and diseases in crops
- Discussing crop inspection techniques
- Keeping monitoring records
- Using and modifying sample record sheets in Handy Guide 3, and going through a monitoring case study to interpret the information provided.
- Interpreting the information provided in a monitoring case study
Tasks

Monitoring equipment

66. Look at the equipment provided or listed on pages 4–3 and 4–4 and decide what you need to purchase for an IPM program on your property.

Monitoring equipment – what do you have now?

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What would you like to have ($ no barrier!!)

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See Suppliers of monitoring tools on pages 9–6 and 9–7. Where could you purchase the monitoring equipment you would like to have?

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67. Use each of the magnification aids to view one of the pest or disease specimens provided.

What do you notice?

Discuss your diagnosis with the presenter.
Monitoring

Refer to pages 4–2 to 4–8.

68. What does monitoring achieve?

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69. Page 4–2 suggests reasons for monitoring. Select the five that are most important.

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70. See page 4–3 (Ornamentals), or pages 4–2 and 4–3 (Greenhouse Vegetables), and the sections Who does the monitoring? and What level of service do you want? What approach would be suitable for your farm?

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71. Now see pages 4–5 to 4–7. What is a scout, and what is a scout’s responsibility? Look at Handy Guide 3: Record Sheet: Crop Inspection Data, Pest & Disease Control Treatments and Pest & Disease Summary Reports.

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Sticky traps

See pages 4–9 to 4–12 (Ornamentals), or 4–7 to 4–11 (Greenhouse Vegetables), and look at Handy Guide 3: Record Sheet: Sticky Trap Data

STICKY TRAP PLACEMENT
WHICH IS CORRECT?

Top left: hung well above the crop
Bottom left: positioned just above crop height
Top right: lying in the pathway
Bottom right: blue and yellow traps with a numbered station positioned just above crop height

72. Prepare a set of simple steps for installing, monitoring and recording sticky traps in a greenhouse. This should identify:

• where to place the traps (Hint, you may like to draw a map)
• when to place them
• the number of traps to use
• how to display the sticky trap counts.
73. Practising with sticky traps

Count and record the numbers of pests on the sticky trap provided. Test your skill by comparing with the actual number previously counted. If you are having difficulty, get another trap and repeat the exercise. Talk to your presenter about any problems, especially if the insects are hard to identify.

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74. Pick up the sticky trap you brought in after having it hang in your crop for a week. Count and record the numbers of insect pests.

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............................................................................................................................... ............

75. Inspect the Pest Sticky Trap Poster. Ask the presenter to clarify the diagnostic characters of insect pests on the poster or the sticky traps, as you require.

Which insect pests are on these sticky traps?

a. ............................................................................................................................. ...........

b. ............................................................................................................................. ...........

c. ............................................................................................................................. ...........

d. ............................................................................................................................. ...........
e. ...........................................................................................................................................

f. ...........................................................................................................................................

76. Consider any difficulties you may have with using sticky traps.

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Record keeping

77. What points should you keep a weekly note of on your property?

Have a look at pages 4–14 and 4–15 (Ornamentals) or page 4–13 (Greenhouse Vegetables), for some tips.

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Monitoring plan

78. Prepare a simple monitoring plan that includes:

• how you will measure the number and type of pests
• who will do this on a regular basis
• what crops you want to monitor
• when you will monitor (daily, weekly, monthly, morning, afternoon or evening).

You might find it helpful to consult pages 4–5 to 4–7.

Case study exercise

79. Case study exercise

The following tables are monitoring summary sheets for two crops, one chrysanthemum, the other a hydroponically grown cucumber crop. A graph of each table has been prepared.
Select the crop type appropriate to you and complete the tasks.

**Cucumber crop data**

Table of sticky trap counts: cucumber

<table>
<thead>
<tr>
<th>Date Collected</th>
<th>Fungus gnat</th>
<th>Thrips</th>
<th>Whitefly</th>
<th>Shore fly</th>
<th>Aphid</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Nov</td>
<td>8.91</td>
<td>2.36</td>
<td>0.36</td>
<td>0.00</td>
<td>0.27</td>
</tr>
<tr>
<td>18 Nov</td>
<td>10.00</td>
<td>5.82</td>
<td>0.09</td>
<td>0.00</td>
<td>0.09</td>
</tr>
<tr>
<td>25 Nov</td>
<td>15.09</td>
<td>6.45</td>
<td>0.36</td>
<td>0.09</td>
<td>0.27</td>
</tr>
<tr>
<td>2 Dec</td>
<td>23.09</td>
<td>8.45</td>
<td>0.09</td>
<td>0.00</td>
<td>0.27</td>
</tr>
<tr>
<td>9 Dec</td>
<td>33.64</td>
<td>6.05</td>
<td>0.00</td>
<td>0.00</td>
<td>0.73</td>
</tr>
<tr>
<td>16 Dec</td>
<td>33.73</td>
<td>7.45</td>
<td>0.11</td>
<td>0.00</td>
<td>0.36</td>
</tr>
<tr>
<td>23 Dec</td>
<td>23.82</td>
<td>16.09</td>
<td>0.82</td>
<td>0.09</td>
<td>1.09</td>
</tr>
<tr>
<td>30 Dec</td>
<td>9.91</td>
<td>25.08</td>
<td>0.55</td>
<td>0.00</td>
<td>0.55</td>
</tr>
<tr>
<td>6 Jan</td>
<td>16.91</td>
<td>19.36</td>
<td>0.09</td>
<td>0.00</td>
<td>1.64</td>
</tr>
<tr>
<td>13 Jan</td>
<td>18.18</td>
<td>54.64</td>
<td>0.55</td>
<td>0.18</td>
<td>1.05</td>
</tr>
<tr>
<td>20 Jan</td>
<td>18.55</td>
<td>108.91</td>
<td>0.09</td>
<td>0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>27 Jan</td>
<td>17.09</td>
<td>87.00</td>
<td>0.09</td>
<td>0.55</td>
<td>0.36</td>
</tr>
<tr>
<td>3 Feb</td>
<td>12.83</td>
<td>129.11</td>
<td>0.64</td>
<td>3.82</td>
<td>0.36</td>
</tr>
<tr>
<td>10 Feb</td>
<td>16.91</td>
<td>146.09</td>
<td>0.09</td>
<td>0.00</td>
<td>0.18</td>
</tr>
<tr>
<td>17 Feb</td>
<td>18.18</td>
<td>231.09</td>
<td>0.55</td>
<td>0.18</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Graph of sticky trap counts: cucumber
### Table of crop inspection data: cucumber

<table>
<thead>
<tr>
<th>Date inspected</th>
<th>Total number of plants inspected</th>
<th>Percent (%) of plants infested with pest</th>
<th>Two-spotted mite</th>
<th>Greenhouse whitefly (adult)</th>
<th>Greenhouse whitefly (immature)</th>
<th>Thrips</th>
<th>Aphid</th>
<th>No. of weeks crop in ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Nov</td>
<td>60</td>
<td></td>
<td>0.00</td>
<td>3.33</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>18 Nov</td>
<td>66</td>
<td></td>
<td>0.00</td>
<td>7.58</td>
<td>0.00</td>
<td>9.09</td>
<td>0.00</td>
<td>2</td>
</tr>
<tr>
<td>25 Nov</td>
<td>60</td>
<td></td>
<td>1.67</td>
<td>8.33</td>
<td>0.00</td>
<td>15.00</td>
<td>3.33</td>
<td>3</td>
</tr>
<tr>
<td>2 Dec</td>
<td>60</td>
<td></td>
<td>13.33</td>
<td>5.00</td>
<td>0.00</td>
<td>11.67</td>
<td>6.67</td>
<td>4</td>
</tr>
<tr>
<td>9 Dec</td>
<td>60</td>
<td></td>
<td>23.33</td>
<td>5.00</td>
<td>5.00</td>
<td>15.00</td>
<td>10.00</td>
<td>5</td>
</tr>
<tr>
<td>16 Dec</td>
<td>40</td>
<td></td>
<td>27.50</td>
<td>10.00</td>
<td>15.00</td>
<td>20.00</td>
<td>17.50</td>
<td>6</td>
</tr>
<tr>
<td>23 Dec</td>
<td>33</td>
<td></td>
<td>57.58</td>
<td>15.15</td>
<td>15.15</td>
<td>30.30</td>
<td>18.18</td>
<td>7</td>
</tr>
<tr>
<td>30 Dec</td>
<td>44</td>
<td></td>
<td>90.91</td>
<td>9.09</td>
<td>15.91</td>
<td>31.82</td>
<td>13.64</td>
<td>8</td>
</tr>
<tr>
<td>6 Jan</td>
<td>44</td>
<td></td>
<td>79.55</td>
<td>2.27</td>
<td>18.18</td>
<td>43.18</td>
<td>2.27</td>
<td>9</td>
</tr>
<tr>
<td>13 Jan</td>
<td>44</td>
<td></td>
<td>93.18</td>
<td>4.55</td>
<td>11.36</td>
<td>56.82</td>
<td>4.55</td>
<td>10</td>
</tr>
<tr>
<td>20 Jan</td>
<td>32</td>
<td></td>
<td>75.00</td>
<td>0.00</td>
<td>15.63</td>
<td>87.50</td>
<td>0.00</td>
<td>11</td>
</tr>
<tr>
<td>27 Jan</td>
<td>44</td>
<td></td>
<td>86.36</td>
<td>9.09</td>
<td>18.18</td>
<td>63.64</td>
<td>0.00</td>
<td>12</td>
</tr>
<tr>
<td>3 Feb</td>
<td>44</td>
<td></td>
<td>97.73</td>
<td>9.09</td>
<td>4.55</td>
<td>70.45</td>
<td>9.09</td>
<td>13</td>
</tr>
<tr>
<td>10 Feb</td>
<td>44</td>
<td></td>
<td>100.00</td>
<td>6.82</td>
<td>2.27</td>
<td>68.18</td>
<td>0.00</td>
<td>14</td>
</tr>
<tr>
<td>17 Feb</td>
<td>44</td>
<td></td>
<td>100.00</td>
<td>2.27</td>
<td>13.64</td>
<td>77.27</td>
<td>0.00</td>
<td>15</td>
</tr>
</tbody>
</table>

### Graph of crop inspection percentages: cucumber

![Crop Inspection Graph](image_url)
### Table of sticky trap counts: ornamentals

**Average number per trap per 7 days**

<table>
<thead>
<tr>
<th>Date Collected</th>
<th>WFT</th>
<th>Thrips</th>
<th>Whitefly</th>
<th>Aphids</th>
<th>Fungus</th>
<th>Gnat</th>
<th>Shore Fly</th>
</tr>
</thead>
<tbody>
<tr>
<td>17/03/1997</td>
<td>0.0</td>
<td>7.3</td>
<td>2.3</td>
<td>15.2</td>
<td>2.5</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>24/03/1997</td>
<td>0.0</td>
<td>13.5</td>
<td>4.0</td>
<td>22.0</td>
<td>3.0</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>02/04/1997</td>
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### Graph of sticky trap counts: ornamentals

![Sticky Trap Graph](image-url)
### Table of crop inspection data: ornamentals

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What factors influenced your decision?

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**Action thresholds**

Refer to pages 4–12 to 4–14 (Ornamentals), or 4–11 and 4–12 (Greenhouse Vegetables).

80. Describe the difference between an action threshold and an economic damage threshold.

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81. What is an example of an action threshold for a given pest in your crop?

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82. Refer to your response to Task 81. What actions are available to you and which would you implement at this stage?

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83. Refer to your response to Task 81. What could you have done to prevent the pest from reaching this stage?

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**Indicator plants (ornamentals only)**

Indicator plants could play an important role in your IPM plan. See page 4–14 (for ornamentals only).

84. Select a key pest for your crop(s) from the list provided and a plant that might be used to provide an early indication of its presence.

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Where would you locate the indicator plants? (Hint, you may like to use your map.)

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**Final preparation for IPM**

85. Do you feel you are properly prepared to implement an IPM program? If not, what extra information or training do you need?

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On-farm course assignment

86. This exercise is designed to allow you to demonstrate your competency in implementing IPM and will be used to assess you for your Certificate of Attainment in the National Competencies in Horticulture, as outlined in this Course Workbook.

Task: Develop and implement an IPM program for your property

Time allowed to complete the exercise: Two months in winter, or one month at any other time of the year.

You may discuss this exercise with your group and the course presenter.

Here is what you need to do:

- Develop a physical plan of the property with buildings and any other features.
- Identify key pests and diseases in your crops.
- List steps that you could take on your property to minimise the risk of pests and diseases occurring in your crops.
- Compile a list of biocontrol agents available for the pests and diseases you have identified.
- Having in mind your biocontrol agents, compile a list of chemicals registered for use in your crops that would be suitable for your enterprise.
- Develop a management strategy for the pests and diseases that you might anticipate in your crops during this time; use biocontrol agents where possible.
- Prepare a monitoring plan. Follow the guidelines in this course.
- Monitor the crops and count sticky traps weekly, or fortnightly in winter.
- Keep a record of the monitoring data and graph your summary data either on an EXCEL spreadsheet, if you have a computer with Microsoft EXCEL, or by hand on graph paper.
- When you have completed this assignment, notify your course supervisor and arrange for an on-site appointment. Hand your completed assignment to the course supervisor and discuss the details.
National competencies addressed in this training course are from the National Training Package in Horticulture:

- RUHHRT412A Develop an integrated pest management program (all elements)
- RUHHRT431A/01 Promote plant health (point 6 in element/01, Monitor factors that influence plant health; element/02, Diagnose plant health problems; points 1 & 3 in element 03, Remedy plant health problems; element 04/ Evaluate treatment programs)

Learners who successfully complete the on-farm assessment exercise will receive a Certificate of Attainment for the National Competencies listed above.

Course structure

- Designing an IPM Program
- Crop notes
- Access to information and advice
- On-farm course assignment

Reference material in the Information Guide

- Section 3 Preparing for IPM: property and staff
- Section 4 Designing an IPM Program: monitoring and decision making
- Sections 8 Crop Notes
- Sections 9 Directory
- Sections 10 Further Reading
- Section 11 Glossary
- Handy Guide 1 IPM Checklist
- Handy Guide 2 Crop Management
**Purpose**

You learn:
- how to identify the most appropriate approach to IPM for your enterprise
- to identify your staff training needs and where to obtain training in IPM for them
- to make an objective evaluation of the advantages of IPM to your enterprise
- how to use the IPM checklist (Handy Guide 1) before, during and after designing an IPM program
- how to use the Crop Management Guide, Handy Guide 2.
- how to apply your IPM knowledge into real practice on a property
- how you can contribute your knowledge towards an industry database of pests and diseases
- where to find more information on IPM and related issues.

**Activities**

- a visit to a production enterprise, critically evaluating the farm operation with regards to pest and disease management and making recommendations about improvements to pest and disease management
- evaluating your present pest and disease management program
- developing an IPM program for your own property

**Tasks**

Note that all suggested reading associated with page numbers in this Workbook refers to the Information Guide by Section and then page number, for your industry.

**Designing an IPM program**

See Section 4 *Designing an IPM Program* in the Information Guide. Refer to pages 4–15 to 4–18 (Ornamentals), 4–13 to 4–16 (Greenhouse Vegetables) *Putting it all together*.

87. Discuss the relevance of the three-phase approach to your enterprise. Tick off any of the elements in Phases I–III that you feel you have already put in place. Remember that there are no time-lines on adopting any particular phase.

89. How and to whom would you delegate responsibility for ensuring that the property was IPM-ready?

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90. Refer to Handy Guide 2 *Crop Management for Ornamentals*. You might find it useful to refer to this Guide through each crop cycle. Are there any other points you can add? Discuss this Section.

### Crop notes

For tasks 89–90 see Section 8 *Crop notes*.

91. Test your familiarity with pests and diseases that occur on your own property by listing them and noting when you would be on the lookout for them. Name the crops affected.

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92. Describe your management program for dealing with the pests and diseases above.

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Access to information and advice

For tasks 93–95 have a look at Section 9 Directory and Section 10 Further Reading.

93. If a computer with Internet access is available, access one or more of the IPM websites and comment on their relevance to your operation.

94. Where do you currently access information on pest and disease management issues? List your sources and discuss them with the group. Have you come across any other businesses or reading material that you would like to add to the list?

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95. Have you ever contacted a consultant, and did you feel that this was helpful? Discuss where you feel you particularly need outside help, and whether the Directory is appropriate to your needs.

On-farm course assignment

96. Task: Prepare an outline for an IPM program for your workplace

Time allowed to complete the exercise: One month.

Submit documentary evidence for completion of attainment.

Use information in Section 3 Preparing for IPM and Section 4 Designing an IPM Program to outline your present pest and disease management practices.

Assign an estimate of annual costs to this program: separate the costs for time, labour and materials.

Prepare an outline of a new IPM program for your operation, using the phased approach. See page 4–15 to 4–18 (Ornamentals), 4–13 to 4–16 (Greenhouse Vegetables) and use Handy Guide 1 as a reference.

Indicate:

• site considerations
• crop(s)
• known key pests and diseases
• staff involvement and training needs
• equipment required
• external assistance and level of service needed
• recording methods
• monitoring schedules
• timetable for commencement and target dates for key steps
likely costs of the new program (time, labour, materials) and any other pieces of information you feel would be necessary at your workplace or are unique to your workplace.

- your course supervisor and arrange for an on-site appointment. Hand your completed assignment to the course supervisor and discuss the details.
IPM ONfarm — Protected Cropping is a training course designed to meet the needs of nursery, cutflower and greenhouse vegetable producers in Australia.

Produced by NSW Agriculture, this training course offers competency-based training that will contribute to the horticultural qualifications of industry workers. The practical training enables industry participants to confidently establish and implement an IPM program for themselves.

IPM ONfarm — Protected Cropping provides IPM training at three levels, as well as an introductory course for those who simply wish to understand more about IPM. Unqualified staff working under supervision, specialist staff with greater responsibilities on the farm, plus management, are all catered for in this new training package.

IPM ONfarm focuses on the practical aspects of IPM:
- undertaking crop inspections for pests and diseases
- knowing what to look for and where to look
- gaining the skills to routinely handle sticky traps and get the most out of them as a monitoring tool
- making informed decisions by developing an understanding of the ability of your crops to tolerate various key pests and diseases
- making use of your own monitoring information to plan an effective control program
- developing the confidence to consider incorporating biocontrol into your management program
- appreciating the need for farm hygiene, and what you can do to improve your own situation.

The NSW Agriculture companion publications Integrated Pest Management Information Guide and Field Identification Guide for both Ornamentals and Greenhouse Vegetables are the resource documents for IPM ONfarm. They ensure course participants receive the right amount of information to go with the practical training in these courses.