

**Agriculture, Horticulture and Conservation and Land
Management Training Package**

CERTIFICATE II IN AGRICULTURE

AHC20122

Unit

AHCPMG202

Treat plant pests, diseases and disorders

SAMPLE

Trainer/Teacher Manual

PASSING

LANE

**Passing Lane Pty Ltd
PO Box 975
COWES VICTORIA 3922**

SAMPLE

Copyright 2024

All rights reserved.

All Passing Lane materials have been provided to an educational or training organisation under an institutional license agreement.

An outline of this agreement can be viewed on the Passing Lane website at www.passinglane.com.au.

The use of these materials without a valid and current licence agreement is strictly prohibited.

Any requests for further information regards the Passing Lane licence agreement can be sought directly from Passing Lane Pty Ltd.

MATERIALS PUBLISHED IN AUSTRALIA

Disclaimer

The information in this document has been developed using information and reference sources considered to be reliable.

Passing Lane Pty Ltd, its employees and contracted content developers accept no responsibility as to any errors or omissions or any loss or damage of any kind caused by using this manual and no warranty is provided as to the reliability of any sources or correctness of the information within this document.

LANE

STUDENT/TRAINEE DETAILS

Student/Trainee Name

Student/Trainee Email

Teacher / Trainer Name

School / Institution / Training Organisation / Employer

TABLE OF CONTENTS

Introduction	Page 5	
Unit of Competency Overview	Page 8	
Section One <i>Prepare to treat plant pests, diseases and disorders</i>	Page 10	<u>(Student/Trainee Manual Page 10)</u>
Section Two <i>Apply treatments to plant pests, diseases and disorders</i>	Page 72	<u>(Student/Trainee Manual Page 70)</u>
Section Three <i>Carry out post treatment operation</i>	Page 100	<u>(Student/Trainee Manual Page 95)</u>
Self Assessment	Page 123	<u>(Student/Trainee Manual Page 114)</u>
PowerPoint Slide Presentation Mapping	Page 124	

SAMPLE

INTRODUCTION

This manual is developed to provide training content that addresses the specific 'Unit of Competency' as outlined on the following pages.

It provides the teacher and/or trainer with a document that includes all that the student and/or trainee manual content plus guidance notes as well as answers to the learning activities in the student/trainee manual.

This manual can be packaged with various manuals addressing other 'Units of Competency' in order to meet the 'Packaging Rules' of a particular Australian Training Package Qualification.

This resource has been designed to be delivered in a form that is conducive to the learning environment including:

- ☆ Online delivery
- ☆ Classroom delivery
- ☆ On the job training

The documents are designed in a 'landscape' format in order to make reading on a computer screen easier as well as reduces the need to scroll down pages. Documents can be easily printed if the learning environment requires the student or trainee to have hard copies of the learning materials.

INTRODUCTION—CONT'D

LEARNING ACTIVITIES

The learning activities in the student and/or trainee manuals are 'Form Enabled' so that if the resources delivered online, the activities can be filled in using the computer keyboard.

Each learning activity is identified with the following icon.

**Learning
Activity**

Learning activities come in the following forms.

- ☆ Questions
- ☆ Research
- ☆ Tasks
- ☆ Interviews

Questions

Questions would relate to the information presented on previous pages.

Research

This type of learning activity would require the student or trainee to locate information by using research methods. The information they would be required to locate would be in line and/or support the information that the manual had outlined in previous pages.

INTRODUCTION—CONT'D

Tasks

This learning activity type would require the student/trainee to actually do or undertake something and would be reinforcing the knowledge they have gained from reading the manual's previous pages.

Interviews

This learning activity type would require the student/trainee to interview person(s) in an actual workplace environment or a person(s) who are experienced in the industry sector which the student/trainee is currently undergoing training.

The student/trainee is made aware of the type of learning activity by noting the learning activity type displayed under the learning activity icon.

**Learning
Activity**

Research

SELF ASSESSMENT

At the end of each manual is a series of questions that the student/trainee should review and answer.

This self assessment is to ensure in the student's or trainee's mind that they have reviewed and understood the information that was presented in their manual.

If they are unsure of their understanding in any of the topics reviewed, they are encouraged to go back and review the information again and/or seek the assistance of their teacher or trainer.

LANE

UNIT OF COMPETENCY OVERVIEW

The following pages are extracts from Training.gov.au website and outlines this specific 'Unit of Competency' including the 'Elements' and the 'Performance Criteria'. The content within this manual has been developed to address this unit.

AHCPMG202 TREAT PLANT PESTS, DISEASES AND DISORDERS

ELEMENT	PERFORMANCE CRITERIA
1. Prepare to treat plant pests, diseases and disorders	<ul style="list-style-type: none">1.1 Identify and record details of pest, disease or disorder and confirm with supervisor according to workplace procedures1.2 Discuss and select appropriate control technique with the supervisor1.3 Perform calculations according to control option and treatment requirements and confirm with supervisor1.4 Select and prepare equipment for use according to workplace procedures, supervisor instructions and manufacturer specifications1.5 Secure treatment area according to health and safety in the workplace procedures and supervisors instructions1.6 Identify health and safety hazards and risks in the workplace and apply appropriate controls according to supervisor instructions
2. Apply treatments to plant pests, diseases and disorders	<ul style="list-style-type: none">2.1 Identify, select, fit and use personal protective equipment according to according to workplace procedures and manufacturer instructions2.2 Prepare treatments according to supervisor's instructions, chemical label instructions, safety data sheets and manufacturer instructions2.3 Apply treatments to minimise damage and exposure to off-target species according to workplace procedures, health and safety in the workplace and environmental legislative and regulatory requirements
3. Carry out post treatment operation	<ul style="list-style-type: none">3.1 Clean and store personal protective equipment and application equipment according to workplace and environmental procedures3.2 Dispose of treatment waste according to environmental procedures3.3 Maintain records according to workplace procedures and legislative and regulatory requirements

Passing Lane acknowledges that the copyright ownership of the above information is the Commonwealth of Australia and this extract has been provided for reference purposes only.

PLEASE NOTE

The training units in this qualification require all student or trainees to demonstrate their ability to perform certain tasks and activities related to this unit of training by successfully completing a number of assessment tasks or activities.

Generally, this unit of training as well as others should be undertaken in a horticultural workplace environment under the supervision and observation of your employer or supervisor.

Your employer or supervisor will be provided instructions and assessment forms which they would follow, fill in, sign and return this paperwork to your teacher or trainer.

If you are not employed or taking work experience in a horticultural workplace at the time of undertaking this unit of training then your teacher or trainer will provide you a 'simulated' environment and they will be your observers as you perform those assessment tasks and activities.

In this training unit the assessment requirements require you on at least one occasion to demonstrate that you have treated plant pests and diseases, including providing evidence as required by this unit's 'Performance Evidence' requirements.

Section One

Prepare to Treat Plant Pests, Diseases and Disorders

TREAT PLANT PESTS, DISEASES AND DISORDERS

SECTION ONE—PREPARE TO TREAT PLANT PESTS, DISEASES AND DISORDERS

INTRODUCTION

This unit of competency describes the skills and knowledge required to treat plant pests, diseases and disorders.

This unit applies to supervised workers in plant or pasture-based industries and is carried out following strict work instructions and under supervision.

Workers in the agricultural industry will encounter a diverse range of plant pests, diseases and disorders in their work activities and it is crucial that they can identify plant pests, diseases and disorders as well as assist in the treatment of them.

SECTION LEARNING OBJECTIVES

At the completion of this section you will learn information relating to:

- ☆ Identifying and recording details of pest, disease or disorder and confirming with supervisor according to workplace procedures
- ☆ Discussing and selecting appropriate control technique with the supervisor
- ☆ Performing calculations according to control option and treatment requirements and confirming with supervisor
- ☆ Selecting and preparing equipment for use according to workplace procedures, supervisor instructions and manufacturer specifications
- ☆ Securing treatment area according to health and safety in the workplace procedures and supervisors instructions
- ☆ Identifying health and safety hazards and risks in the workplace and applying appropriate controls according to supervisor instructions

SAMPLE

PLEASE NOTE

The following pages offer some information on common plant pests and diseases in an agricultural or horticultural setting.

This is only provided as support information and to assist in addressing the assessment requirements of 'Knowledge Evidence'.

It is quite likely that the farm or horticultural operation you work in will have specific plant pests and diseases that they need to deal with and from an assessment point of view you will likely be required to assist in treating those.

IDENTIFY AND RECORD DETAILS OF PEST, DISEASE OR DISORDER AND CONFIRM WITH SUPERVISOR ACCORDING TO WORKPLACE PROCEDURES

Australia's agricultural industry is comprised of grains, grasses, fruit, vegetables, nuts, flowers, turf and nursery products (known as horticulture).

However, like all intensive farming practises agricultural and horticultural farmers face threats to their livelihoods from a range of plant pests, diseases and disorders.

In this section we will look these by common names, what they are as well as how they affect plants.

The Department of Agriculture, Fisheries and Forestry website is a great source of information on this topic.

<http://www.agriculture.gov.au/pests-diseases-weeds/plant>



Australian Government
**Department of Agriculture,
Fisheries and Forestry**

This website lists common pests and diseases that can affect grain and grass crops, fresh fruit and vegetables and over the next few pages we will review those pests and diseases.



COVERED BUNT

Bunt is common throughout wheat growing areas of the world. It is difficult to detect in a crop because infected plants appear similar to healthy ones.

Plants may be slightly shorter, and the heads are usually darker green than normal and remain green for a longer period.

Bunt infections result in the complete replacement of the seed contents with a mass of smut spores.

When crushed, the infected grain releases a fine black-brown powder with an odour like rotten fish.

Bunt is potentially the most devastating smut disease.

Bunt spores are carried on the outside of the seed and can remain viable for up to three years.

When infected seed begins to germinate, the spores also germinate and penetrate the shoot of the seedling just before emergence.

The fungus then grows in between the plant cells just behind the growing point of the plant.

Plants become resistant to bunt infection after emergence and therefore, if an uninfected plant has emerged, it cannot become infected.

The fungus enters the tissues of the head, once formed and black spore masses are produced in the head instead of normal grain.

Bunt infection is spread during harvest and other seed handling operations, when bunt balls (infected grains) are mechanically broken and spread amongst healthy grain.



LOOSE SMUT

Loose smut is probably the most obvious of all wheat diseases.

At flowering, all parts of the head and grain except the rachis (backbone) are replaced by black spore masses.

This disease occurs throughout the world and reduces yields proportionate to the incidence of smutted heads.

The disease does not cause complete yield loss, but losses as high as 27% have been reported, and more commonly, losses of 15% are recorded.

This disease is more prevalent in Western Australia than the rest of Australia and especially in barley.

In contrast to seed borne bunts, loose smut has little effect on seed quality.

The loose smut fungus survives as a dormant fungal thread inside the embryo of wheat seed.

The pathogen is activated when the infected seed germinates and it extends toward the growing point of the plant.

Evident from flowering onwards when the plant begins to form the head, the fungus invades all of the young head tissue except for that of the rachis (backbone).

Production of plant growth hormones by the fungus results in infected plant heads reaching flowering earlier than healthy heads.

The head produced by the infected plant contains black spore masses in place of the grain.

The spores are loosely held and are easily spread by wind onto neighbouring healthy plants.

Because flowering of infected heads occurs earlier than healthy heads, production and release of spores occurs when the rest of the crop is flowering.

Spores are blown by the wind into the flowers of the healthy plants.

The spores enter the ovaries and become part of the developing grain.

In this way, seed for the following year becomes infected.

SAMPLE



TAKE-ALL

Take-all is a wheat disease that infects the plant's roots, blocking the conductive tissue and reducing water uptake.

Early signs of the disease include stunting and yellowing.

Plants mature earlier, may have fewer tillers and can be recognised by the characteristic 'white heads' that appear within a healthy crop.

Large circular patches of premature white heads are often seen.

The roots of diseased plants are black in colour and the base of the stems may also exhibit this symptom.

Affected plants are easy to pull out of the ground due to poor root development.

Take-all is a wheat disease that infects the plant's roots.

Early sown crops are more prone to infection.

Take-all survives in the soil on infected cereal and grass residues.

The fungus on these residues then infects the root tissue of young plants.

Take-all can also form hyphae which spread the disease through the soil between plants, and for this reason the disease is often seen in patches

Disease levels build up where successive cereal crops are grown or if grass weed control is poor.

Grass control in preceding crops should occur early to give root residues an adequate chance of breaking down.

Summer rainfall can enhance decomposition of root matter in the soil provided volunteer weeds are controlled throughout this period.

SAMPLE



SEPTORIA TRITICI BLOTCH

The damage caused by these fungi can range from nil to almost total loss of a crop.

The intensity of the disease depends entirely on the time of onset of infection and the weather.

Generally, areas with more frequent rainfall exhibit increased levels of the disease.

This species of the fungi is found throughout the wheat belt of Australia.

Septoria tritici blotch usually survives on crop residues over summer and autumn.

Rain and wind carry the spores onto the growing crop, hence infections can occur in wheat crops grown on virgin soil.

However, disease is usually spread by rain splash from the soil surface or neighbouring infected plants.

On the leaves, spores germinate and produce a root-like structure that penetrates the leaves.

This root network extracts sugar from plant cells, killing the cells and causing irregularly-shaped dead areas (necrosis) to be created on the leaf surface.

These appear as tan-brown blotches which exhibit small black dots that are actually vase-shaped fruiting bodies.

The black fruiting bodies release more spores that spread to neighbouring plants.

Affected leaves may die prematurely



LEAF SCALD

Leaf scald is a common disease of barley, especially in cool and moist areas.

It is widespread in Europe, North America and Australia.

Historically, scald has caused more severe crop damage in the Mediterranean type climates, such as Australia.

The disease causes dark or pale grey 'water-soaked' lesions that develop into brown irregular shaped areas on the leaves, stems and heads of barley.

The lesions eventually turn a bleached straw colour with brown margins.

Yield losses as high as 35-40 per cent have been reported, however, losses of between 1-10 per cent are more common.

Yield loss is generally a result of reduced grain weight.

Scald is carried from season to season on infected crop residues, volunteer barley or barley grass, or in the tissues of infected seed.

Thus, reduced tillage systems, where grazing, cultivating or burning are not carried out, encourage the propagation of this disease.

If infected seed is planted, the fungus germinates with the seed and infects the coleoptile.

Spores may also be spread onto the seedling by rain-splash from crop residues or neighbouring plants.

After the leaf tissue has become necrotic (developed brown lesions) spores are produced which can be further spread by rain-splash.

Moisture is essential for dispersal of this disease - the disease is not wind-borne.

Scald is more severe in early sown crops.



MANGO SEED WEEVIL

Mango seed weevil is a pest only associated with mangoes.

The seed is the host for the weevil until it is ready to exit the fruit.

Countries that list mango seed weevil as a regulated pest require the fruit to be cut at inspection to identify whether mango seed weevil is present in the seed.

Authorised officers will observe the fruit being cut and then when it is safe to do so, inspect the seed for mango seed weevil.



FRUIT FLY

Fruit fly is a serious agricultural/horticultural pest and importing countries enforce strict rules for the import of fruit fly host material.

The fruit fly lay their eggs in the plant material, or just under the skin of fruit and vegetables.

Characteristic sting marks can be observed where the eggs have been laid.

Cutting the fruit or vegetable to investigate whether eggs or larvae is inside is a common method for identifying if the product has been infested.



CITRUS CANKER

Citrus canker is a serious bacterial disease of citrus trees including grapefruit, lemons, limes and oranges.

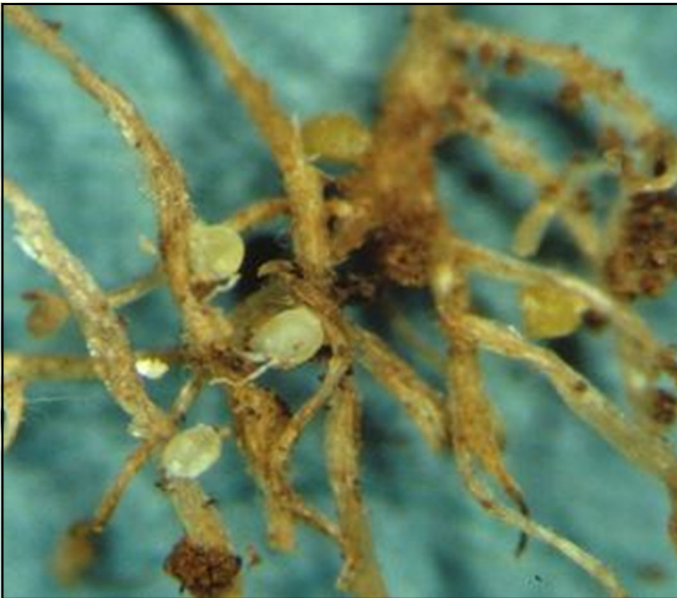
It reduces the growth of new fruit and spoils healthy fruit.

Outbreaks of this disease have been eradicated from Queensland and the Northern Territory at great cost to industry and growers.

The disease attacks the leaves, twigs and fruit of citrus trees.

It causes the leaves to drop and fruit to fall to the ground before it ripens.

People may also contribute to the disease spread by moving infected plants or plant parts.



POTATO CYST NEMATODE

Potato cyst nematodes are roundworms that live on the roots of plants.

They reduce yield and ultimately damage the plant.

The Department of Agriculture lists the following common pests and disease symptoms found on Nursery Stock:

APHIDS

Aphids are one of the most destructive insect pests on plants.

They are soft bodied insects and their colours range from light green to pink.

Aphids can be found on a number of different nursery stock plants.

Ants can also be found where there are aphids due to their symbiotic relationship.



MEALY BUGS

Mealy bugs are an insect that are considered a pest as they feed on plant juices from a variety of different plant species.

They are also a known vector of several different diseases affecting plants.

Mealy bugs appearance is distinctive with a white powdery view from above and a pink coloration viewed from beneath.





POWDERY MILDEW

Powdery Mildew is a fungal disease that affects a wide variety of plants.

The symptoms can be observed on the leaves and the stems of the plants.

It can visually be seen as white powdery spots displaying the affected areas.



RUST

Rust is a fungal disease that affects a variety of different plants.

Symptoms vary from lesions on the leaves, buckling of the leaves and the formation of bright yellow pustules (myrtle rust).

In some cases the movement of plants interstate and to be exported have had restrictions put in place.

An example of this is with plants from the Myrtaceae family being affected from Myrtle rust.

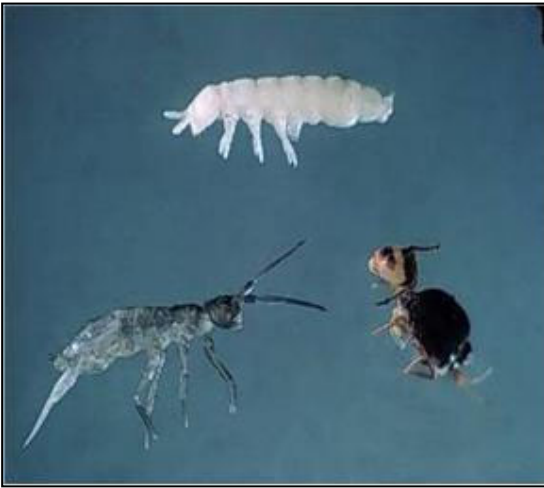
The Department also lists these common pests and diseases on other plant and plant products.

SPRINGTAILS

Springtails are common agricultural and horticultural pests found around the world.

They are known to play a positive role in some agricultural sectors by controlling plant fungal diseases.

At the inspection bench, springtails will more than likely be found on leafy vegetables such as cabbages, lettuce and celery.



ANTS

Ants are commonly found on advanced nursery stock and in pots that still contain soil and other media.

The authorised officer will need to thoroughly inspect the plant and any packaging.

Ants could also be located in the container which the plants will be transported in.





SOOTY MOULD

Sooty mould is a fungi from the excretion of sap sucking insects, such as aphids and mealy bugs.

The fungi mainly blocks sunlight to the plant though is a good indicator that there are other insects affecting the plants health.

(The above and previous information was sourced direct from the Australian Department of Agriculture & Water Resources <http://www.agriculture.gov.au> and this information was reproduced in this Learning Guide under the Departments policy "free to use for educational purposes")



PLANT MOSAIC VIRUSES

Among economically important plants affected by virus are potatoes, tomatoes, sugar cane, corn, wheat, peaches, beans, rice, cucumbers, strawberries, raspberries, apples and many ornamentals.

Virus may kill localised areas, entire plants, or most commonly, reduce plant vigour and thus yield.

Other methods of plant virus transmissions are from dirty machinery, clothing and handling of plants by smokers.

Symptoms vary depending upon the virus and strain, the plant, time of year, and environmental conditions.

The most common symptoms include leaf mottling; puckering or curling; stem and petiole streaking; rough, deformed or spotted fruit; stunted plants; and blossom and fruit drop.

Some viruses cause the leaves of plants to become fernlike or develop a thin 'shoestring' appearance.

Symptoms may be confused with herbicide damage.

Viruses have no active way of penetrating plant parts.

They rely upon mechanical wounds, infected seeds and being carried in the bodies of insects for transmission.

Methods of plant virus transmission are numerous, including direct contact, sap drip and insect carriers (vectors) such as aphids, white fly, mealy bugs and grasshoppers.

The virus can also be present in tobacco and transmitted to plants by the hands of people who smoke.

Once inside the plant cells, the virus replicates.

The virus does not usually kill the plant and takes over the metabolic processes of the leaf, resulting in abnormal cell functioning and growth.

SAMPLE



SAMPLE

BARLEY YELLOW DWARF VIRUS

Barley yellow dwarf virus (BYDV) is an important disease of cereals in high rainfall cropping regions of southern Australia.

This disease is caused by a virus that is spread by aphids feeding on the crop.

BYDV is typically worse in years where there has been a mild wet summer.

Monitoring and spraying for aphids early in the season can control it.

Symptoms usually appear as circles about 1 m in diameter within the crop where infected aphids have landed.

As well as patches through the crop, virus spread is often found along the margins of crops.

Leaf symptoms differ between cereals: barley symptoms are yellowing of the leaves, starting at the tip of the leaf and striping towards the base; wheat show yellowing in young and old leaves similar to barley; oats show reddening of the leaves from the tips down.

When plants are infected early in the season (before tillering) they are often dwarfed.

Infection may occur without visible symptoms.

The disease is not transmitted by any other insects and aphids need to feed on an infected plant for at least 5 minutes followed by a latent period of 12 hours, before the virus will transmit to a healthy plant.

Aphids remain infected for the rest of their life.

The virus is not transmittable through seed, soil or sap.

A large number of grasses both annual and perennial are alternate hosts to BYDV.

Perennial grasses such as couch, paspalum, perennial ryegrass and kikuyu play an important role as alternate hosts allowing the virus to survive over summer.

In autumn and spring, aphids move from these alternate hosts into crops spreading the virus.



RECORDING DETAILS OF THE PLANT PEST, DISEASE AND DISORDER

Recording details of any plant pests, diseases or other disorders you notice in your daily work activities is a crucial task.

Your powers of observation and diligence towards your work environment will make you an important part of your employer's team.

There are a number of steps that will assist you to correctly identify plant pests, diseases and disorders as follows:

- ☆ **Identify the plant itself correctly** - Identification of affected plants is one of the first steps in diagnosing a plant disease.

Both scientific and common names of the plant should be noted.

Common names should not be relied upon, since some distinctly different plant species may have the same common name and the common name used in one area, may be used for a completely different species in another area.

- ☆ **Recognise healthy plant appearance** - It is important to know the normal appearance of the plant species you are investigating.

Each plant species has special growth habits, colours and growth rates.

If you do not know what to expect of the plant, you cannot recognise when something is wrong.

- ☆ **Compare healthy plants with those showing signs of disease, disorder or pest infestation** - Compare characteristics such as overall size, shape, and coloration; leaf shape, size, coloration and distribution; root distribution and coloration and bark, stem or trunk texture and coloration.

It is also important to note normal events, such as leaf drop, that may occur in a healthy plant.

The affected parts of the plants should also be noted:

- ◆ Are there symptoms on the roots, leaves, stems, flowers, or fruit?
- ◆ Is the entire plant involved?
- ◆ Or is only one limb or side of a plant involved?

SAMPLE



☆ **Check for symptoms and signs** - Identify characteristic symptoms.

Describing the characteristic symptoms exhibited by a specimen can be very difficult to do accurately.

However, there are some features of distressed plants that may make this task easier for you.

For example:

- ◆ Underdevelopment of tissues or organs.

Examples include such symptoms as stunting of plants, inadequate development of roots, malformation of leaves, inadequate production of pigments and failure of fruits and flowers to develop

- ◆ Overdevelopment of tissues or organs.

Examples include: galls on roots, stems, or leaves and profuse flowering

- ◆ Death of plant parts.

These may be some of the most noticeable symptoms, especially when they affect the entire plant, such as wilts or diebacks.

Other examples include shoot or leaf blights, leaf spots and fruit rots

- ◆ Alteration of normal appearance.

Examples include mosaic patterns of light and dark green on leaves, as well as altered coloration in leaves and flowers

☆ **Observe patterns** - Check distribution of symptoms.

One of the first things that you should note is how the diseased plants are distributed over the affected area.

Are they distributed uniformly across an area, or are they localised?

SAMPLE



☆ ***How prevalent is the problem*** - Are all plants affected?

Infectious problems generally occur over time and there is a progression of symptoms.

Rarely will all of the plants be affected.

☆ ***Check for host specificity*** - Is the problem occurring in only one plant species, or are different plant species affected?

If different plant species are affected this suggests the possibility of a non-infectious problem which could be related to environmental problems.

☆ ***Ask questions*** - It is vital that you question the activities that have been conducted around the affected plants.

The problem may not be due to anything that the grower has done; the problem could be related to what his/her neighbour has done.

Information pertaining to the growing environment to which the affected plant has been exposed, is a vital piece of the puzzle.

It is especially important to document changes in the environment.

Environmental factors to consider include: extreme temperatures (freezing and heat), rainfall, hail, lightning, prolonged drought, temperature and prevailing winds.

RECORDING DETAILS

Once you have noted all the previous information into a record you can advise your employer who will then ensure correct diagnoses and treatments are scheduled.

As with all agricultural work activities, attention to detail is the key to ensuring the records you give your employer are useful and allow for a quick response to the plant pest, disease or disorder.

The format of the plant pest and diseases records is likely to be one that the organisation has developed internally.

There are templates that are available online, such as these examples below.

The image displays three overlapping sample record templates. The top-left template is titled 'Crop monitoring record' and includes fields for 'Business name', 'Person monitoring', and 'Date'. It features a table with columns for 'Crop', 'Plant number', 'Incident location or growing site', 'Incident date', 'Incident description', 'Incident type', 'Incident status', and 'Incident notes'. The top-right template is titled 'Crop notes: pest seasonality' and includes fields for 'Property', 'Year', and 'Production area / Plot / House number'. It features a table with columns for 'Plant', 'Pest', and months from Jan to Dec, with a 'Comments' column. The bottom template is titled 'Crop notes: disease seasonality' and includes fields for 'Address', 'Year', and 'Production area / Plot / Greenhouse number'. It features a table with columns for 'Plant', 'Disease', and months from Jan to Dec, with a 'Comments' column. All templates include a footer with the text 'Integrated Pest Management in Greenhouse Information Guide' and 'Section 8: page 1'.

In some cases, an organisation will use a digital 'app' on a digital device such as a tablet or laptop.

Details are entered and a picture can be taken as well.

Whatever the record keeping system is, the information recorded must be accurate as well as easily accessible.

Learning Activity

Task

LEARNING ACTIVITY ONE

Each picture below depicts a plant pest or disease. Tell us what the common name is of each.

1



2



1

2

3

4

3



4



TEACHER / TRAINER GUIDANCE NOTES

- 1) Ants
- 2) Citrus Canker
- 3) Rust
- 4) Fruit Fly

Learning Activity

Task

LEARNING ACTIVITY TWO

Each picture below depicts a plant pest or disease. Tell us what the common name is of each.

1



2



1

2

3

4

3



4



TEACHER / TRAINER GUIDANCE NOTES

- 1) Barley yellow dwarf virus
- 2) Loose smut
- 3) Septoria tritici blotch
- 4) Covered bunt

**Learning
Activity****Task****LEARNING ACTIVITY THREE**

As we mentioned in the beginning of this training manual it is ideal to have you undergo this unit of training in a horticultural workplace environment as a person seeking a horticultural qualification.

It is important that you have either your employer, an experienced co-worker, or a supervisor or manager assist you in this unit of training.

They will need to report back to your teacher or trainer using assessment forms which on a number of occasions will need to be filled in, signed and then sent back to your teacher or trainer.

They will also at times observe you doing some assessment activities or tasks required.

In this activity we want you to inform your teacher or trainer who will be assisting you with this unit of training and they will provide this person instructions and the necessary documentation and assessment forms.

From this point on we refer to this person as your 'nominated observer'.

TEACHER / TRAINER GUIDANCE NOTES

You as the teacher or trainer may want to take the time to interview the person(s) nominated to assist the student or trainee with this unit of training.

There will be a number of assessment activities in which they need to be involved with so they would need to be informed that the commitment to assist is important.

PLEASE NOTE

The following pages offer some information on plant pests and disease control and treatment options.

This is only provided as support information and to assist in addressing the assessment requirements of 'Knowledge Evidence'.

It is quite likely that the farm or horticultural operation you work in will have an 'integrated pest management (IPM)' in place that will have control and treatment procedures they use.

Later you will learn more about 'integrated pest management (IPM)' procedures.



SAMPLE

DISCUSS AND SELECT APPROPRIATE CONTROL TECHNIQUE WITH THE SUPERVISOR

For the purposes of this part of the unit revisit the entire list of pests and diseases we reviewed on the previous pages and look at the treatments.

We already know that there are some plant diseases such as citrus canker, plant pests such as fruit fly and plant disorders such as rust.

Each of these will require very different treatment methods:

MANGO SEED WEEVIL

Monitoring for egg-laying on young fruit is the best way to detect adult activity during fruit growth.

If weevil eggs are detected, chemical control can be used to reduce weevil populations to low levels.

A weevil control program should use three strategies to control weevil infestation; quarantine, hygiene and chemical control.

- 1) **Orchard quarantine** - To maintain a young orchard's seed weevil free status, avoid bringing any mango fruit suspected of harbouring weevils within the seeds into the orchard and surrounding areas.

A strict policy of not bringing mango fruit onto the property will greatly reduce the chance of infestation.

It is also advisable to remove all non-commercial mango trees in the immediate vicinity.

- 2) **Orchard hygiene** - The removal of all fruit and seed material from the orchard will aid in minimising the infestation in following seasons.

Infestation levels in orchards where fruit is regularly removed at harvest are far less than in non-commercial trees, where much of the fruit is left to rot underneath the tree.

Farm-house trees located near orchards are generally untreated and pose a constant threat of infestation.

Either remove these trees, or treat them with insecticide to suppress weevils.

- 3) **Chemical control** - Sprays that are registered for mango seed weevil are Carbaryl and Fenthion.

These sprays are targeted at both the free living adults as well as the larvae inside the fruit.



FRUIT FLY

Garden hygiene is essential, because fruit trees with fallen and rotting fruit around them are a major source of uncontrolled fruit fly infestations.

Sanitation may help to prevent fruit fly eggs and maggots from developing in infested fruit.

All fallen and unwanted fruit should be collected and destroyed and ensures that maggots do not survive to pupate in the ground to later emerge as adult flies.

Other treatments include:

- ☆ **Exclusion** - Exclusion is a preventative method that uses physical barriers to stop female fruit flies from reaching your fruit and vegetables.

Typical barriers that can be used are nets, insect gauze, bags and sleeves.

- ☆ **Trapping** - Trapping is used to monitor for fruit fly activity.

Traps use an attractant to draw adult flies into a container and attractants can be pheromones, food scents or visual cues.

Once captured, the trapped flies are unable to escape and are either killed by an insecticide or drowned in a liquid.

- ☆ **Baiting** - Baiting is a control method used to help reduce adult fruit fly numbers by spraying bait onto the foliage and trunks of trees and plants.

Both male and female adult flies are attracted to the baits while foraging over the leaves for food or sheltering near the tree trunk and are poisoned after feeding on the spray droplets.

- ☆ **Chemical cover spraying** - Cover spraying is a control method which kills adult fruit flies on contact and destroys eggs and maggots within fruit.

- ☆ **Pruning** - Pruning fruit trees to a manageable size makes it easier to harvest fruit and implement fruit fly control methods, such as netting and cover spraying.

- ☆ **Host plant removal** - The physical removal of unwanted fruit fly host plants and trees can help prevent the build-up of fruit flies.

SAMPLE



CITRUS CANKER

The disease cannot be controlled by chemicals after it has reached epidemic proportions.

Therefore, the prevention of primary infection on spring shoots is emphasised.

This is achieved by spraying copper compounds 10-14 days after the first shoots emerge.

There is no treatment for Citrus Canker and infected trees are usually destroyed to prevent spread of the disease, however precautions can reduce the chances of citrus canker arriving on the farm:

- ☆ To avoid introducing citrus canker on to the property, establish new plantings with healthy plant material from reputable nurseries.

On receipt of any new plants, check that they are pest and disease free.

If citrus canker is detected, isolate suspect nursery stock from healthy plants until official checks are completed.

- ☆ Keep the farm clean.

Use good sanitation and hygiene practices.

Remember that workers, visitors, vehicles and equipment can spread diseases.

Make sure equipment is clean before it enters the farm.

- ☆ If anyone has been to an overseas country that has citrus canker, they must not wear your travel clothes into the orchard until after they have been washed in hot soapy water.

- ☆ Make sure that all farm workers are familiar with the symptoms of citrus canker.

Regularly check your orchard and report any unusual or unfamiliar symptoms.

SAMPLE



POTATO CYST NEMATODE (PCN)

When a PCN infestation is found, regulatory controls are imposed on potato growers and all businesses which involve the potential movement of soil.

Because PCN cysts are extremely long lived in soil, even in the absence of suitable host plants, eradication of PCN from an infested site is not possible in the short term.

However ongoing management of PCN outbreak sites should aim to progressively reduce PCN populations, eventually to the point where PCN may be considered to be eradicated.

Nematode control in Australia is heavily dependent on general soil fumigants (Metham sodium) and non-fumigant nematicides (Nimitz) which can be effective when applied according to label recommendations and with proper soil preparation.

However nematicide use should be part of an Integrated Pest Management (IPM) program, together with soil testing.

‘Integrated Pest Management’ methods include:

- ☆ Use of certified seed
- ☆ Soil testing for PCN
- ☆ Hygiene protocols for potatoes, equipment, farm workers, soil and water
- ☆ Resistant potato cultivars
- ☆ Control of non resistant self sown potatoes
- ☆ Crop rotations
- ☆ Nematicides (A type of chemical pesticide used to kill plant- parasitic nematodes)
- ☆ Soil solarisation (mulching the soil and covering it with tarp to trap heat)
- ☆ Alternative crops



SAMPLE

APHIDS

If insecticides are needed, insecticidal soaps and oils are the best choices for most situations.

Oils may include petroleum-based agricultural oils, or plant-derived oils such as neem, or canola oil.

These products kill primarily by smothering the aphid, so thorough coverage of infested foliage is required.

Apply these materials with a high volume of water, usually a 1 to 2% oil solution in water and target the underside of leaves as well as the top.

Soaps, neem oil and agricultural oil kill only aphids present on the day they are sprayed, so applications may need to be repeated.

Although these materials can kill some natural enemies that are present on the plant and hit by the spray, they leave no toxic residue so they don't kill natural enemies that migrate in after the spray.

SOOTY MOULD

Sooty Mould is a fungus that feeds on the sweet honeydew left by some sort of sap-sucker (like aphids, scale or mealy bugs) and will follow an infestation of this kind.

While Sooty Mould doesn't actually harm plants, it is a good indicator that there is some other sort of pest issue that needs to be controlled.

- ☆ **Organic treatment** - Remove or treat the honeydew producing insects and the sooty mould will disappear.

Sooty mould can be removed by wiping the affected foliage with a damp cloth.

This is only temporary and re-infestation will occur if the other pest issues are not treated.

Collect fallen leaves affected by sooty mould and place in bin – **do not compost!**

Controlling ant populations who tend the honeydew producing insect, will minimise the opportunity for them and the sooty mould to take residence on your plants.

- ☆ **Chemical** - Neem oil insecticide works as a systemic in many plants when applied as a soil drench.



MEALY BUGS

Monitor at fortnightly intervals from mid-November to near harvest.

Sample five fruit per tree on each of 20 randomly selected trees per 1-5 ha block.

Apply spray if 25 or more fruit are infested with one or more mealybugs.

☆ **Biological control** - The most important predator is the mealybug ladybird.

The ladybird larvae are white and mealy with long waxy appendages and grow to 10 mm.

The adults have black wing covers and other parts are reddish-brown.

The ladybirds are about 4 mm long.

Both adults and larvae feed on the mealybug and, once established, the predator is able to control heavy infestations in 2-3 months.

It is, however, sometimes slow to locate an infestation.

The introduced parasitic wasp is also very effective.

☆ **Chemical** - Due to the significant seasonal variation in mealybug populations and the important role of beneficial species in keeping numbers low, it is recommended that chemical controls only be applied when and where required.



SPRINGTAIL

We look at two treatments for 'Springtail'.

- ☆ **Prevention** - Springtails are commonly found where there are sources of moisture.

Remove excessive mulch, moist leaves, prune shrubbery and ground cover and eliminate low, moist areas to permit proper air circulation.

Remove wet, mouldy wood or other mouldy items.

- ☆ **Chemicals** - Residual sprays of diazinon and/or Dursban formulations can be effective in reducing springtail populations.

ANTS

We look at two treatments for 'Ants'.

- ☆ **Organic treatment** - Use horticultural glues around tree trunks to aid biological control of scales, aphids and mealy bugs, as ants defend these pests from attack by their natural enemies to maintain their supply of honeydew.

Use boric acid based ant products as a least toxic control or wipe over ant trails with pennyroyal or eucalyptus oil.

- ☆ **Chemical treatment** - Products such chemical based ant baits is picked up by foraging ants, taken back to the nest and fed to the queen.

The bait contains an insect growth regulator which stops the queen producing eggs.

Plant Treatment



POWDERY MILDEW

We look at three treatments for 'Powdery Mildew'.

- ☆ **Biological** - Destroying fallen infected leaves in autumn will reduce the amount of infectious spores next spring.

Mulching and watering reduces water stress and helps make plants less prone to infection.

Promptly pruning out infected shoots will reduce subsequent infection.

- ☆ **Organic remedies** - Baking Soda is an effective fungicide against powdery mildew.

Milk has long been popular with home gardeners and small-scale organic growers as a treatment for powdery mildew.

Milk is diluted with water (typically 1:10) and sprayed on susceptible plants at the first sign of infection, or as a preventative measure, with repeated weekly applications often controlling or eliminating the disease.

Studies have shown milk's effectiveness as comparable to some conventional fungicides.

- ☆ **Chemical** - Chemical treatment with a fungicide product acts as a 'systemic' with a residual presence in the plant- treat plant once or twice in its vegetative stage in order to successfully suppress powdery mildew.

Avoid treating plants with it during the latter stages of growth.

Plant Treatment



RUST

We look at two treatments for 'Rust'.

- ☆ **Organic treatments** - Some organic preventative solutions are available and sulphur powder is known to stop germination.

High standards of hygiene along with good soil drainage and careful watering may minimise problems.

Any appearance of rust must be immediately dealt with by removing and burning all affected leaves.

Leaving infected vegetation on the ground will spread the disease.

- ☆ **Chemicals** - Fungicides such as Mancozeb or Triforine may help, but may never eradicate the disease.

COVERED BUNT

Bunt is effectively controlled by most seed treatment fungicides.

LOOSE SMUT

Systemic seed treatment fungicides effectively controls loose smut.

Also, you would not sow seed infested with loose smut and have suspect seed tested.



BARLEY YELLOW DWARF VIRUS

The preferred management option, is to sow resistant varieties but this is not always possible.

It is vital to prevent spread of the virus during the first 8-10 weeks after crop emergence using insecticides.

In high risk areas, crops can be sprayed 3 weeks after crop emergence (or 2-leaf stage if aphids are easily found) with a second spray 4 weeks after first spray.

There are a number of products registered for control of aphids in cereals.

The active ingredient pirimicarb only effects aphids and will not be detrimental to any beneficial insects present at the time of spraying.

PLANT MOSAIC VIRUSES

Virus diseases cannot be controlled once the plant is infected.

Therefore, every effort should be made to prevent introduction of virus diseases into the crop.

Sanitation is the primary means of controlling virus diseases. Infected plants should be removed immediately to prevent spread of the pathogens.

Perennial weeds, which may serve as alternate hosts, should be controlled in and adjacent to the garden.

Avoid planting tomatoes next to cucumbers, spinach, or other vegetables and flowers susceptible to these diseases.

The use of tobacco products during planting or seeding should be avoided to prevent infection of plants with the tobacco mosaic virus.

Those people using tobacco or working with infected plant material should wash their hands thoroughly in soapy water before handling susceptible plants.



INTEGRATED PEST MANAGEMENT PLAN (IPM)

It should be immediately apparent that a **chemical free** treatment plan is nearly always recommended regardless of which plant pest, disease or disorder you may be treating and particularly in the agricultural and horticultural sectors as people become less inclined to consume products that have been treated with chemicals.

There is a challenge to the agricultural and horticultural industries to grow products completely free of any chemicals (organic) while the plant pests, diseases and disorders are simultaneously increasing in both scale and resistance to common treatment methods.

Integrated pest management (IPM) is an environmentally sensitive way of managing pests.

It uses a combination of practices and control methods in order to prevent problems from occurring rather than dealing with them after they have happened.

IPM practices include forward planning, regular monitoring and timely decision-making.

IPM control methods include:

- ☆ Biological control, using predators, parasites or microbial pathogens to suppress pests.
- ☆ Cultural and physical control, using methods such as barriers and traps; adjusting planting location or timing; or crop rotation and cultivation techniques which expose pests to predation or destroy their food, shelter and breeding habitats.
- ☆ Chemical control, selecting the least toxic pesticides and using them only when needed as opposed to regular preventative spraying.
- ☆ Plant choice, choosing plant varieties that are resistant to diseases in an area, and matching species to the site.
- ☆ Genetic control, releasing sterilised male insects to decrease the incidence of successful mating of pest species.
- ☆ Pheromone control, using pheromones to monitor insect populations in a crop or orchard.

**Learning
Activity****Task****LEARNING ACTIVITY FOUR**

As you are aware, to successfully complete this unit of training you are to be observed demonstrating your ability on at least one occasion treat a plant pest and a plant disease.

This will include other tasks and activities which we will go through later.

In this activity you are to organise with your 'nominated observer' a time where you can demonstrate your ability to treat a plant pest and a disease under supervision.

Once this has been done, on the next page tell us the plant pest you will be treating and the plant disease you are treating.

Then tell us what plant pest control (treatment method) you will be using and what plant disease control (treatment method) you will be using.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases.

Type of agricultural or horticultural operation _____

Type of plant pest to be controlled (treated) _____

Control measure to be used.

Type of plant disease to be controlled (treated) _____

Control measure to be used.

Nominated observer's name _____

Nominated observer's contact number _____

This information is required in case your teacher or trainer wishes to confirm your 'nominated observer' has reviewed the above information and he or she has approved this activity.

**Learning
Activity****Question****LEARNING ACTIVITY FIVE**

SAMPLE

In this Section we learned about 'Integrated Pest Management', or IPM. What were the six control measures of an IPM?

TEACHER / TRAINER GUIDANCE NOTES

IPM control methods include:

- 1) Biological control, using predators, parasites or microbial pathogens to suppress pests
- 2) Cultural and physical control, using methods such as barriers and traps; adjusting planting location or timing; or crop rotation and cultivation techniques which expose pests to predation or destroy their food, shelter and breeding habitats
- 3) Chemical control, selecting the least toxic pesticides and using them only when needed, as opposed to regular preventative spraying
- 4) Plant choice, choosing plant varieties that are resistant to diseases in an area and matching species to the site
- 5) Genetic control, releasing sterilised male insects to decrease the incidence of successful mating of pest species
- 6) Pheromone control, using pheromones to monitor insect populations in a crop or orchard



PERFORM CALCULATIONS ACCORDING TO CONTROL OPTION AND TREATMENT REQUIREMENTS AND CONFIRM WITH SUPERVISOR

When treating plant pests and diseases it often involves applying chemicals by spraying.

This means that there would be the need of spray equipment and this could include:

- ☆ Spray bottles
- ☆ Backpack sprayer
- ☆ Quad bike with a tank sprayer
- ☆ Farm ute tank mounted sprayer
- ☆ Tractor mount sprayers

SAMPLE



Whatever the type of sprayer equipment chosen, it involves the mixing of chemicals in the right proportions to ensure suitable application rates.

Chemicals purchased for spraying programs will come in the form of pesticide, herbicide or fungicide concentrate.

This concentrate is very strong and must be diluted before use by mixing a small volume (amount) of the chemical concentrate with a larger volume of water.

It is necessary to work out how much of the concentrate will be needed for the spraying job and how much water it must be mixed with.

Only enough pesticide, herbicide or fungicide solution to fill the sprayer should be mixed at any one time.

To calculate the mixture proportions based on application rates you would check the pesticide label to find the application rate at which the concentrate should be used.

The application rate of a particular pesticide is the amount of mixed chemical solution (chemical plus water) which is needed to treat an area of a particular size.

This means you need to work out the area to be sprayed.

This will be the size (usually in hectares) of the crop or orchard to be sprayed and is critically important to ensure the correct amount of chemical spray is used and no waste is left.

Using the application rate stated in the instructions, you calculate the amount of chemical concentrate needed for the size of the area to be sprayed and then calculate how much water is needed to dilute the concentrate to the correct strength.



OTHER FACTORS RELATING TO APPLICATION RATES

When spraying some plants such as vines and fruit trees, there is a term called 'run-off'.

This term is used to describe the situation that occurs when the majority of the leafy plant, tree or vine is thoroughly covered by spray droplets and the spray on the outside leaves begins to drip or 'run-off'.

The amount of spray solution required to spray to this level of wetness is termed the 'dilute volume' and the spraying program is called 'dilute spray application'.

When calculating or spraying to the point of run-off, the whole canopy coverage needs to be considered, not just the leaves closest to the sprayer.

Many farms will test their sprayers first with clean water to determine the 'dilute volume' to the point of 'run-off'.

They will adjust their spray equipment to the point where the inside leaves and fruit are wet and the outside leaves are showing minor signs of run-off.

Once this has been worked out, the chemical mixture can be prepared and the crop sprayed.

This type of application is often performed using larger equipment or aerial spraying.

It is unlikely that a trainee at this level would be involved in such treatment type applications, however it is good to know about this type of treatment application from a knowledge building point of view.

**Learning
Activity****Question****LEARNING ACTIVITY SIX**

When spraying, what does the term 'run-off' mean?

TEACHER / TRAINER GUIDANCE NOTES

This term is used to describe the situation that occurs when the majority of the leafy plant, tree or vine is thoroughly covered by spray droplets and the spray on the outside leaves begins to drip or 'run-off'.



SELECT AND PREPARE EQUIPMENT FOR USE ACCORDING TO WORKPLACE PROCEDURES, SUPERVISOR INSTRUCTIONS AND MANUFACTURER SPECIFICATIONS

The success of a pesticide application depends on the pesticide and proper application.

Improperly applied pesticides can result in ineffective control, plant injury or excessive pesticide residues.

Maximum coverage of the target area is essential to the control of plant pests, so every effort should be made to insure that applications are correct and safe.

There are several types of chemical sprayers which include:

- ◆ Hand held
- ◆ Motorised backpack types
- ◆ Boom types

☆ **Hand held** portable sprayers come in a variety of sizes.

However, calibrating these types of sprayers can be difficult because pressure and rate of application are difficult to control.

☆ **Backpack mist blower sprayers** use a small motor to generate wind which acts as a carrier for the pesticide solution.

This type of sprayer is excellent for applying fungicides and insecticides to small acreage.

The calibration is difficult due to variations in speed and flow rate.

Some of the newer sprayers also have a small motor to maintain pressure and agitation.



- ☆ **Boom type sprayers** come in numerous sizes for large tractors and as small as those used by an ATV.

Some are attached to the machine and others towed.

These use pumps to develop a constant pressure and a static boom equipped with atomisers that break up and direct the spray solution.

Basic sprayer components consist of tank, pump, pressure gauge, regulator, agitator, hoses, valves, fittings and nozzles.

Nozzles are mounted on the boom which is suspended over the plants.

Some larger operations will use aerial spray equipment such as fixed winged airplanes or small helicopters; many are contractors.





Whatever equipment is used in chemical application, it is essential that it is properly prepared.

- ☆ **Calibration** - The sprayer should be calibrated regularly to ensure chemicals are applied evenly and at the prescribed application rate.

A properly calibrated sprayer will reduce the risk of applying too much chemical, which can lead to unacceptable residues and damage to crops.

Before calibrating, make sure the sprayer is operating correctly.

Never calibrate a sprayer with chemicals in its tank and ensure that the tank is half full with clean water.

The travel speed used in calculating the calibration should match the usual operating methods and conditions.

These include the usual walking pace or the gear in the tractor, engine revs, slope and surface where spraying will occur or the speed of the ATV.

- ☆ **Droplet size** - Droplet size is very important when managing drift.

It is general practice that a nozzle or sprayer setting that produces the largest possible droplet size (coarsest spray quality) is used to reduce the risk of drift without compromising the efficacy of the chemical.

The following factors can affect droplet size:


- ◆ **Nozzle size** and type are increased nozzle size to increase droplet size; low drift nozzles are also available
- ◆ **Spray pressure** - reduce spray pressure to increase droplet size or use a larger nozzle for greater application volume rather than increase spray pressure
- ◆ **Evaporation** - evaporation of droplets reduces their size and droplets evaporate faster in high temperatures and in low humidity
- ◆ **Spray release height** - the longer the spray droplets are suspended in the air, the greater the potential for evaporation
- ◆ **Chemical formulation** - some adjuvants can reduce droplet size. (An adjuvant is any substance added to the spray tank in order to improve pesticide activity or application characteristics)

SAMPLE

- ☆ **Nozzles** - Modern hydraulic nozzles are classified by an ISO system that classifies the output of a nozzle by colour.

Two different types of nozzles (e.g. flat fan and AI) that are the same colour will have the same nozzle capacity - when used at the same pressure, both will produce the same output (L/min), only the droplet size may differ.

You should ensure you consult the nozzle manufacturer's current catalogue to select the nozzle that will produce the required droplet size stated on the label, or as advised by their agronomist, consultant or the product's manufacturer (if no droplet size is specified).

	PSI	DROPS SIZE	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ./MIN.	GPA  30° Field Acres											
					3 MPH	3.5 MPH	4 MPH	4.5 MPH	5 MPH	5.5 MPH	6 MPH	6.5 MPH	7 MPH	7.5 MPH	8 MPH	8.5 MPH
AI9501SEVS (100)	30	XC	0.13	17	8.6	7.4	6.4	5.7	5.1	4.7	4.3	4.0	3.7	3.4	3.2	3.0
	40	XC	0.15	19	9.9	8.5	7.4	6.6	5.9	5.4	5.0	4.6	4.2	4.0	3.7	3.5
	50	XC	0.17	22	11.2	9.6	8.4	7.5	6.7	6.1	5.6	5.2	4.8	4.5	4.2	4.0
	60	VC	0.18	23	11.9	10.2	8.9	7.9	7.1	6.5	5.9	5.5	5.1	4.8	4.5	4.2
	70	VC	0.20	26	13.2	11.3	9.9	8.8	7.9	7.2	6.6	6.1	5.7	5.3	5.0	4.7
	80	VC	0.21	27	13.9	11.9	10.4	9.2	8.3	7.6	6.9	6.4	5.9	5.5	5.2	4.9
AI9502EVS (50)	30	XC	0.23	29	15.2	13.0	11.4	10.1	9.1	8.3	7.6	7.0	6.5	6.1	5.7	5.4
	40	XC	0.24	31	15.8	13.6	11.9	10.6	9.5	8.6	7.9	7.3	6.8	6.3	5.9	5.5
	50	XC	0.26	33	17.2	14.7	12.9	11.4	10.3	9.4	8.6	7.9	7.4	6.9	6.4	6.1
	60	VC	0.28	36	18.5	15.8	13.9	12.3	11.1	10.1	9.2	8.5	7.9	7.4	6.9	6.5
	70	VC	0.30	38	19.8	17.0	14.9	13.2	11.9	10.8	9.9	9.1	8.5	7.9	7.4	7.0
	80	VC	0.32	41	21	18.1	15.8	14.1	12.7	11.5	10.6	9.7	9.1	8.4	7.9	7.5
AI9502SEVS (50)	30	XC	0.22	28	14.5	12.4	10.9	9.7	8.7	7.9	7.3	6.7	6.2	5.8	5.4	5.1
	40	XC	0.25	32	16.5	14.1	12.4	11.0	9.9	9.0	8.3	7.6	7.1	6.6	6.2	5.8
	50	XC	0.28	36	18.5	15.8	13.9	12.3	11.1	10.1	9.2	8.5	7.9	7.4	6.9	6.5
	60	VC	0.31	40	20	17.5	15.3	13.6	12.3	11.2	10.2	9.4	8.8	8.2	7.7	7.2
	70	VC	0.33	42	22	18.7	16.3	14.5	13.1	11.9	10.9	10.1	9.3	8.7	8.2	7.7
	80	VC	0.35	45	23	19.8	17.3	15.4	13.9	12.6	11.6	10.7	9.9	9.2	8.7	8.2
AI9503EVS (50)	30	XC	0.40	51	26	23	19.8	17.6	15.8	14.4	13.2	12.2	11.3	10.6	9.9	9.3
	40	XC	0.42	54	28	24	21	18.5	16.6	15.1	13.9	12.8	11.9	11.1	10.4	9.8
	50	XC	0.44	57	29	25	22	19.8	17.8	16.2	14.9	13.7	12.7	11.9	11.1	10.5
	60	VC	0.47	60	31	27	23	21	18.6	16.9	15.5	14.3	13.3	12.4	11.6	10.9
	70	VC	0.49	63	32	28	24	22	19.4	17.6	16.2	14.9	13.9	12.9	12.1	11.4
	80	VC	0.51	66	33	29	25	23	21	19.1	17.5	16.1	15.0	14.0	13.1	12.3
AI9504EVS (50)	30	XC	0.55	57	26	23	19.8	17.6	15.8	14.4	13.2	12.2	11.3	10.6	9.9	9.3
	40	XC	0.58	60	30	25	22	19.8	17.8	16.2	14.9	13.7	12.7	11.9	11.1	10.5
	50	VC	0.49	63	32	28	24	22	19.4	17.6	16.2	14.9	13.9	12.9	12.1	11.4
	60	VC	0.53	68	35	30	26	23	21	19.1	17.5	16.1	15.0	14.0	13.1	12.3
	70	VC	0.57	73	38	32	28	25	23	21	18.8	17.4	16.1	15.0	14.1	13.3
	80	VC	0.60	77	40	34	30	26	24	22	19.8	18.3	17.0	15.8	14.9	14.0
AI9505EVS (50)	30	XC	0.63	81	42	36	31	28	25	23	21	19.2	17.8	16.6	15.6	14.7
	40	XC	0.43	55	28	24	21	18.9	17.0	15.5	14.2	13.1	12.2	11.4	10.6	10.0
	50	XC	0.50	64	33	28	25	22	19.8	18.0	16.5	15.2	14.1	13.2	12.4	11.7
	60	VC	0.52	72	37	32	28	25	23	21	19.5	18.0	16.5	15.3	14.3	13.5
	70	VC	0.61	78	40	35	30	27	24	22	20	18.6	17.3	16.1	15.1	14.3
	80	VC	0.66	84	44	37	33	29	26	24	22	20	18.7	17.4	16.3	15.3
AI9506EVS (50)	30	XC	0.71	91	47	40	35	31	28	26	23	22	20	18.7	17.6	16.6
	40	XC	0.75	96	50	42	37	33	30	27	25	23	21	19.8	18.6	17.5
	50	VC	0.79	101	52	45	39	35	31	28	26	24	22	21	19.6	18.6
	60	XC	0.52	67	34	29	26	23	21	18.7	17.2	15.8	14.7	13.7	12.9	12.1
	70	VC	0.60	77	40	34	30	26	24	22	19.8	18.3	17.0	15.8	14.9	14.0
	80	VC	0.67	86	44	38	33	29	27	24	22	20	19.0	17.7	16.6	15.6
AI9508EVS (50)	30	XC	0.77	91	47	40	35	31	28	26	23	22	20	18.7	17.6	16.6
	40	VC	0.79	101	52	45	39	35	31	28	26	24	22	21	19.6	18.6
	50	VC	0.85	109	56	48	42	37	34	31	28	26	24	22	21	19.6
	60	VC	0.90	115	59	51	45	40	36	32	30	27	25	24	22	21
	70	VC	0.95	122	63	54	47	42	38	34	31	29	27	25	24	22
	80	VC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
AI9508EVS (50)	30	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	40	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	50	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	60	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	70	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
	80	VC	1.20	154	79	68	59	53	48	43	40	37	34	32	30	28
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136	70	60	52	47	42	38	35	32	30	28	26	25
	80	VC	1.13	145	75	64	56	50	45	41	37	34	32	30	28	26
AI9508EVS (50)	30	XC	0.69	88	46	39	34	30	27	25	23	21	19.5	18.2	17.1	16.1
	40	XC	0.80	102	53	45	40	35	32	29	26	24	23	21	19.8	18.6
	50	XC	0.89	114	59	50	44	39	35	32	29	27	25	23	22	21
	60	VC	0.98	125	65	55	49	43	39	35	32	30	28	26	24	23
	70	VC	1.06	136												



- ☆ **Agitation** - Good tank agitation is essential when mixing chemicals and for continued suspension with wettable powders or water dispersible granules.

Provide an adequate agitation system and ensure it is working properly.

Usually a by-pass return from the pump is used.

- ☆ **Spray drift** - Spray drift is the most common cause of off-target chemical movement.

As an agricultural chemical user, you must take care to prevent spray drift.

A combination of various factors can contribute to spray drift, including wind speed and direction, temperature, boom height, droplet size and the volatility of the chemical.

It is important to check weather conditions when spraying.

If the weather is unstable or unpredictable, don't spray.

- ☆ **Sprayer maintenance** - Systematically inspect the sprayer used in your workplace with guidance from your workplace supervisor.

All components of the sprayer should be inspected for wear or deterioration and replaced if defective.

This includes not only components of the spray equipment, pump, hoses, nozzles, etc., but also the structural elements of the boom, axles, bearings, etc.

- ☆ **Tank and hose maintenance** - Check all hose connections for tightness and inspect hoses for leaks, wear or deterioration.

Fill only through the strainer to ensure that no solids enter to block either the pump or nozzles.

The main filter assembly should be removed and cleaned after each spraying period.

Be careful not to damage or deform the filter mesh while cleaning.

**Learning
Activity**

Question

LEARNING ACTIVITY SEVEN

What seven items would be on a checklist that you would need to review when preparing spray equipment for use?

TEACHER / TRAINER GUIDANCE NOTES

- 1) Calibration
- 2) Droplet size
- 3) Nozzles
- 4) Agitation
- 5) Spray drift
- 6) Sprayer maintenance
- 7) Tank and hose maintenance



SECURE TREATMENT AREA ACCORDING TO HEALTH AND SAFETY IN THE WORKPLACE PROCEDURES AND SUPERVISORS INSTRUCTIONS

State and Territory regulations require farmers and horticulturists to display re-entry signage after there has been crops sprayed with chemicals or an area has been treated with chemicals.

This is for both indoor and outdoor applications.

This is to prevent visitors or other farmers and workers from entering into an area, field or plant hothouse shortly after chemicals have been sprayed.

In many farms or large plant nurseries there will be what is known as a 'Standard Operating Procedure', or 'SOP'.

The definition of a Standard Operating Procedure, or SOP, is a set of step-by-step instructions created by an organisation to help workers carry out routine operations.

Their purpose is to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply to industry and local regulations.

In relation to chemical use, the SOP would not only outline chemical storage, transport and the steps in chemical application, but also refer to the need to erect signage.

Learning Activity

Question

LEARNING ACTIVITY EIGHT

Scenario:

You are applying herbicides in your local park reserve which is adjacent to a walking track frequently used by joggers and others. From the images below tick the appropriate signs you would erect.



1 ☐



2 ☐



3 ☐



4 ☐



5 ☐



6 ☐



7 ☐



8 ☐

TEACHER / TRAINER GUIDANCE NOTES

This is a bit tricky in the sense the student must remember it is herbicide that was sprayed. The signs they should have ticked are:

1
2
7



IDENTIFY HEALTH AND SAFETY HAZARDS AND RISKS IN THE WORKPLACE AND APPLY APPROPRIATE CONTROLS ACCORDING TO SUPERVISOR INSTRUCTIONS

Because the nature of treating plants for pests and diseases range from operating pieces of equipment, to use of chemicals and in some cases risks associated with possible complications arising from contact with some weeds, WHS issues are varied.

Remember that WHS hazards relate to any situation, substance, activity, event or environment that could potentially cause injury or ill health as well as environment or property damage.

Identifying hazards is the first step of the risk control processes.

Methods of identifying hazards include:

- ☆ Site inspections
- ☆ Historical hazard and risk incidents reports
- ☆ Employees recognising hazards
- ☆ Equipment and machinery hazards and risk reviews
- ☆ Materials such as chemicals information (MSDS or SDS)

SAMPLE

WHS laws and regulations requires employees to be trained and be proactive in identifying and controlling hazards before any harm/injury occurs.

Some hazards relating to using chemicals to treat plants for pests and diseases are:

- ☆ Storage problems - leaking containers, damaged shelving, security issues and so on
- ☆ Unavailable or damaged PPE
- ☆ Unmaintained or damaged spray equipment such as damaged guards, leaking hoses and so on
- ☆ Workers using unsafe work practices
- ☆ Manual handling problems
- ☆ Extreme weather conditions
- ☆ Chemical application hazards such as drift, spills
- ☆ Chemical disposal issues

Employees who identify any hazards would need to document the hazard clearly and in detail.

Then this would need to be passed on to the supervisor or business owner for risk assessment and actioning.



DOCUMENTING A HAZARD

How the hazard is documented will depend on the 'risk management system' in place at the workplace.

A properly developed and implemented risk management system would include forms and associated procedures relating to hazard identification and reporting.

You as an employee would need to learn, fully understand and follow those risk management procedures.

If by chance there are no formal procedures in place, then the employer or supervisor would need to be informed (generally in writing) of any hazards or risks you may have identified.

This information should include:

- ☆ Date the hazard was identified
- ☆ Full description of the hazard
- ☆ Where the hazard is
- ☆ Who you believe is at risk
- ☆ Person identifying the hazard
- ☆ Date it was reported
- ☆ To whom it was reported to and their position

SAMPLE

You may have identified a hazard and eliminated, or at the very least minimised the risks through your own actions.

For example, you have noticed the door on the chemical storage shed was not locked so it was unsecured.

You retrieved the chemicals you required and then locked the door.

But you also noticed that the lock was quite corroded with rust, hard to lock and will likely need replacement.

This you would need to report.

Any details you document in whatever form needs to be clear, concise and accurate.

It is important that you keep a copy of the document for your own records.



TAKE STEPS TO CONTROL RISKS AS DIRECTED

All WHS hazards and risks should be risk assessed and then based on the level of risk posed from the chemical use activity, the risks can be managed through a number of potential strategies.

The hierarchy of control measures, shown below (and on the next pages), are in order from the best possible solution on in numerical order.

If the first control measure cannot be implemented, then the second may be possible and so forth down the list.

- ☆ **Elimination** - As the title suggests, this control measure involves eliminating or removing the risk in its entirety.

Risk: High levels of risk in the use of chemicals in agriculture/horticulture operations
Control: Use biological means to control plant pests (if possible) thereby reducing the need to use chemicals at all

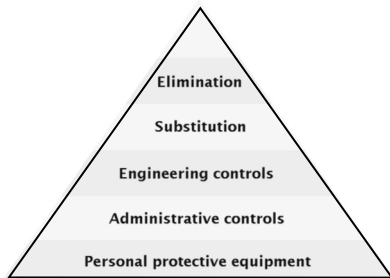
- ☆ **Substitution** - This form of control involves substituting a safer process or material for the hazardous process/material identified.

Risk: Chemicals causing allergic reactions and nausea
Control: Substituting a less toxic or non-allergenic chemical for the task.

- ☆ **Isolation** - This control involves separating the hazard or hazardous work practice from employees in other work areas.

This may involve sectioning off the area by erecting barriers, or by relocating either the hazardous work practice or the other employees and their work practices.

Risk: Risk of other people being affected by chemical spray drift
Control: Erect warning signs or create a barrier around the area where chemicals are being applied, hence creating an isolating barrier between the hazard and other persons



- ☆ **Engineering Controls** - This method of control involves designing and/or adding physical safety features to plant or equipment.

As part of engineering controls are equipment and workplace design which is the provision of new and/or additional equipment or redesign of a workplace can be used to control identified hazards.

Risk: Chemical spills while transporting chemical to work site

Control: Build a secure crate on back of vehicle that ensures chemical containers remain secure

- ☆ **Automation (Engineering Controls)** - Fully or partially automating a process removes the need for, or reduces the risk of, performing a hazardous task.

Risk: Chemical fumes given off during enclosed application like a nursery propagation shed

Control: Construction of an air extraction system to remove the fumes at the source.

- ☆ **Administrative Control** - This type of control is most effective when used in conjunction with measures mentioned above or as an interim control whilst more effective control measures are developed and implemented.

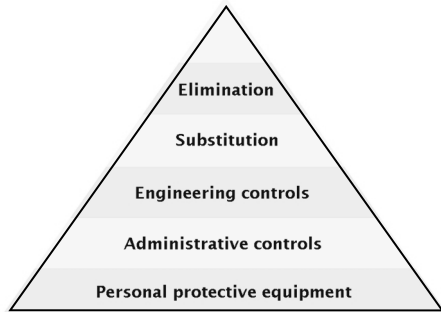
It requires systems to be established or amended in order to control the risk presented.

Most often it requires the assessment and modification of the tasks performed.

It may include measures such as amendment or establishment of new Policy and Procedures or Safe Work Procedures.

For example:

- ◆ Developing documented safe work practices for a hazardous task, or implementing restrictive policy to prevent staff from coming in contact with identified hazards
- ◆ The introduction or review of existing maintenance schedules for plant and equipment, or safe work practices.
This measure is used to ensure that existing plant, equipment and procedures do not deteriorate to the point where they become hazardous.
- ◆ Limiting the exposure of personnel to elements that are only hazardous when they exceed a certain threshold.
These types of hazards can include: noise, radiation, heat, chemicals, etc., and can be controlled by introducing elements as simple as job rotation
- ◆ Providing training and information in safe work practices and other workplace health issues so that personnel can work safely.



☆ **Personal Protective Equipment (PPE)** - PPE is not a particularly effective control method and should only be used:

- ◆ When all other control measures are impractical
- ◆ In conjunction with other more effective, control measures

It is important to select the correct PPE for the hazard identified, and advice should be sought in this regard if you are not sure

The “Hierarchy of Control” provides a basic guide for controlling hazards in the workplace.

You may want to work with your employer or supervisor and attempt to find solutions or controls by working your way down the hierarchy.

Let’s look at some hazards that may have been identified in the use of chemicals and determine appropriate risk controls from those we discussed previously:

<i>Hazard</i>	<i>Risk Control</i>
<p>Health Hazards</p> <p><i>Inhalation</i> (breathing chemical spray drift or fumes)</p> <p><i>Absorption Risk</i> (absorption of chemicals through skin either through spilling while mixing, or spray drift)</p> <p><i>Ingestion</i> (accidental swallowing of chemicals)</p>	<p><i>Elimination</i> - can biological means be used to control pest?</p> <p><i>Substitution</i> - could a less toxic chemical be used?</p> <p><i>Isolation</i> - can the chemical application area be isolated to only chemical users?</p> <p><i>Engineering controls</i> - can the spray equipment be engineered to direct spray drift away from operators?</p> <p><i>Automation</i> - could the chemicals be applied for example by application through the irrigation system?</p> <p><i>Administrative controls</i> - are appropriate policies, procedures and work instructions available to spray users? Are all staff properly trained in the use of chemicals?</p> <p><i>PPE</i> - is the correct PPE available and are chemical users shown how to use it correctly?</p>

SAMPLE

**Learning
Activity****Task**

SAMPLE

LEARNING ACTIVITY NINE

As you are aware, to successfully complete this unit of training you are to be observed demonstrating your ability on at least one occasion treating a plant pest and a plant disease.

One assessment requirement is that you are able to identify hazards and risks related to the treatment of a plant pest and a plant disease where you work.

With the assistance of you supervisor, we want you to list on the next two pages those hazards and/or risks you may encounter when you are treating a plant pest and a plant disease for the purpose of training assessment.

For each hazard or risk include a control measure that will eliminate or minimise the hazard or risk.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ identified health, safety and environmental hazards and risks and applied controls according to workplace procedures

In many cases, the assessment requirements relate to a specific 'Performance Criteria' and in this case it is:

“Identify health and safety hazards and risks in the workplace and apply appropriate controls according to supervisor instructions”

SAMPLE

Plant pest treatment _____

Hazard or risk _____
Control measure _____

Hazard or risk _____
Control measure _____

Hazard or risk _____
Control measure _____

Hazard or risk _____
Control measure _____

Nominated observer's name _____

Nominated observer's contact number _____

This information is required in case your teacher or trainer wishes to confirm your 'nominated observer' has reviewed the above information and summary and he or she has approved this activity.

Plant disease treatment _____

Hazard or risk _____
Control measure

Hazard or risk _____
Control measure

Hazard or risk _____
Control measure

Hazard or risk _____
Control measure

Nominated observer's name _____

Nominated observer's contact number _____

This information is required in case your teacher or trainer wishes to confirm your 'nominated observer' has reviewed the above information and summary and he or she has approved this activity.

SAMPLE

**Learning
Activity****Task****LEARNING ACTIVITY TEN**

We will be focusing on 'plant pest treatment' for the rest of this training manual.

We will address 'plant disease treatment' at the end of this manual.

This is an activity which we call an 'observable' assessment activity.

This means that your 'nominated observer' will be watching you when the time comes around for you to perform 'plant pest treatment'.

He or she will be observing you doing the following:

- ☆ Identifying and recording details of the plant pest to be treated and confirming details with your supervisor
- ☆ Discussing and selecting appropriate plant pest treatment control technique with supervisor
- ☆ Performing required calculations for plant pest treatment and confirming calculations with supervisor
- ☆ Selecting and preparing equipment for use
- ☆ Securing the treatment area using appropriate methods and your supervisor's instructions
- ☆ Showing that you have identified health and safety hazards and risks
- ☆ Applying appropriate hazard and risk controls according to supervisor instructions

Your teacher will report back to your teacher or trainer using the 'third party observation assessment forms' they were provided.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ recognised and recorded target pests, diseases and disorders and confirmed with supervisor
- ☆ discussed and selected control options with supervisor
- ☆ prepared control options and treatments following required procedures
- ☆ identified health and safety in the workplace and environmental hazards and risks and applied controls according to workplace procedures

Knowledge Evidence

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- ☆ common pests, diseases and disorders identification
- ☆ pests, diseases and disorders and dissemination method common to work area
- ☆ pests, diseases and disorders treatment options, including:
 - ◆ cultural
 - ◆ chemical
 - ◆ mechanical
 - ◆ biological
- ☆ regulatory requirements and responsibilities when applying control measures
- ☆ pests, disease and disorders control equipment, capabilities and limitations

Section Two

Apply Treatments to Plant Pests, Diseases and Disorders

TREAT PLANT PESTS, DISEASES AND DISORDERS

SECTION TWO—APPLY TREATMENTS TO PLANT PESTS, DISEASES AND DISORDERS

INTRODUCTION

In this section we focus more on the safety issues and WHS requirements relating to the application of treatments to plants.

SECTION LEARNING OBJECTIVES

At the completion of this section you will learn information relating to:

- ☆ Identifying, selecting, fitting and using personal protective equipment according to workplace procedures and manufacturer instructions
- ☆ Preparing treatments according to supervisor's instructions, chemical label instructions, safety data sheets and manufacturer instructions
- ☆ Applying treatments to minimise damage and exposure to off-target species according to workplace procedures, health and safety in the workplace and environmental legislative and regulatory requirements



IDENTIFY, SELECT, FIT AND USE PERSONAL PROTECTIVE EQUIPMENT ACCORDING TO WORKPLACE PROCEDURES AND MANUFACTURER INSTRUCTIONS

The many types of chemical applications and treatments used in a farm or horticultural operation also leads to the need to use proper personal protection equipment, or PPE.

The use of application equipment as well as the preparation and application of chemicals for weed treatments have a high level of personal injury potential, so proper PPE is essential.

Personal Protection Equipment or PPE in relation to applying chemical treatments for weeds may consist of the following:

- ☆ **Respiratory protection** - for example, disposable, cartridge, air line, half or full face
- ☆ **Eye protection** – for example, spectacles/goggles, shields, visors
- ☆ **Hearing protection** – for example, ear muffs and plugs
- ☆ **Hand protection** – for example, gloves and barrier creams
- ☆ **Foot protection** – for example, shoes/boots
- ☆ **Head protection** – for example, helmets, caps, hoods, hats
- ☆ **Skin protection** – for example, hats, sunburn cream, long sleeved clothes
- ☆ **PPE garments** - such disposable clothing for working with chemicals, coveralls when using chemicals, aprons

Weed treatment chemical manufacturers will also provide information on what PPE should be used when preparing and applying their product.

This information is generally on the product container labels as well as the 'Material Safety Data Sheets' (MSDS) or the 'Safety Data Sheet' (SDS)



Under the WHS Act an organisation's management must ensure that:

- ☆ The needs for PPE are assessed by a person who is competent to judge whether other methods of risk control can offer better protection of safety and health than the provision of PPE
- ☆ Professional advice is obtained, where necessary, to identify the most suitable types of PPE for the tasks to be carried out
- ☆ Training is provided to supervisors and employees in order to enable them to ensure the proper selection, fit, use, cleaning and maintenance of PPE
- ☆ Supervision and enforcement of the PPE policy is undertaken
- ☆ Evaluation of the effectiveness of the PPE program is carried out on a regular basis
- ☆ Suitable PPE is provided for visitors who may be exposed to hazards in the workplace

However the WHS Act imposes obligations upon the worker as follows:

- ☆ The worker must use the protective clothing or equipment in a manner in which he or she has been properly instructed to use it
- ☆ The worker must not misuse or damage the clothing or equipment, and
- ☆ The worker must notify the person providing the clothing or equipment of the damage, malfunction or need to clean or sterilise the clothing or equipment

**Learning
Activity**

Question

LEARNING ACTIVITY ONE

What were the eight types of PPE we reviewed in this Section?

TEACHER / TRAINER GUIDANCE NOTES

- 1) Respiratory protection
- 2) Eye protection
- 3) Hearing protection
- 4) Hand protection
- 5) Foot protection
- 6) Head protection
- 7) Skin protection
- 8) PPE garments

**Learning
Activity****Question****LEARNING ACTIVITY TWO**

WHS legislation requires employees to do three things, in relation to PPE. What are they?

TEACHER / TRAINER GUIDANCE NOTES

- 1) The worker must use the protective clothing or equipment in a manner in which he or she has been properly instructed to use it
- 2) The worker must not misuse or damage the clothing or equipment
- 3) The worker must notify the person providing the clothing or equipment of the damage, malfunction or need to clean or sterilise the clothing or equipment

**Learning
Activity****Question****LEARNING ACTIVITY THREE**

Which of the images shown below indicate 'best practise' in the use of chemical spraying PPE?

1**2**

TEACHER / TRAINER GUIDANCE NOTES

The student/trainee should be aware that they both represent adequate PPE but clearly the PPE chosen must reflect the level of hazard appropriate to the nature of the task. Number 1 image is PPE required to undertake chemical spraying using highly toxic chemicals where there is a risk of ingestion, absorption or inhalation.

The Number 2 image represents appropriate PPE where using low toxicity type chemicals, such as garden applications.

**Learning
Activity****Task****LEARNING ACTIVITY FOUR**

As you are aware, to successfully complete this unit of training you are to be observed demonstrating your ability to treat plant pests and treat plant diseases.

One assessment requirement is that you are able to identify what are the appropriate types of PPE required related to the preparation and use of chemicals for treating plant pests and treat plant diseases.

On the next page we want you to summarise the PPE you will require for the tasks you will be doing when you are treating plant pests and treat plant diseases.

Description of the PPE I will be using when treating plant pests.

Description of the PPE I will be using when treating plant diseases.

Nominated observer's name _____

Nominated observer's contact number _____

This information is required in case your teacher or trainer wishes to confirm your 'nominated observer' has reviewed the above descriptions and he or she has approved this activity.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ identified, selected, fitted and used personal protective equipment

Knowledge Evidence

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- ☆ health and safety in the workplace including personal protective equipment required for treating pests, disease and disorders

In many cases, the assessment requirements relate to a specific 'Performance Criteria' and in this case it is:

"Identify, select, fit and use personal protective equipment according to workplace procedures and manufacturer instructions"

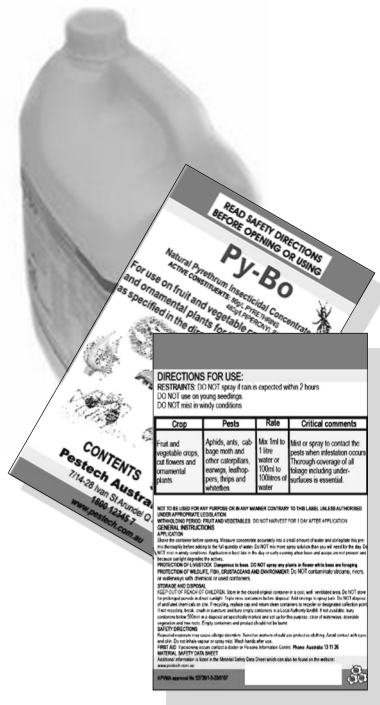
PREPARE TREATMENTS ACCORDING TO SUPERVISOR'S INSTRUCTIONS, CHEMICAL LABEL INSTRUCTIONS, SAFETY DATA SHEETS AND MANUFACTURER INSTRUCTIONS

It is law that all chemicals must have both a manufacturer's label, as well as a Safety Data Sheet (also known as the Material Safety Data Sheet).

It is essential that you refer to both when using chemicals to treat plant pests, diseases or disorders in the workplace.

Information provided on chemical manufacturer's label includes:

- ☆ The product identifier
- ☆ The name, Australian address and business telephone number of either the manufacturer, or importer
- ☆ The identity and proportion disclosed, in accordance with Schedule 8 of the WHS Regulations, for each chemical ingredient
- ☆ Hazard symbol consistent with the correct classification of the chemical hazard statement
- ☆ Signal word and precautionary statement that is consistent with the correct classification of the chemical
- ☆ Information about the hazards, first aid and emergency procedures relevant to the chemical, which are not otherwise included in the hazard statement or precautionary statement
- ☆ The expiry date of the chemical, if applicable
- ☆ The emergency phone number, for specific poisons or treatment advice
- ☆ The overseas name, address and telephone number of the manufacturer or supplier
- ☆ A website or internet address
- ☆ Reference to the safety data sheet, for example a statement on the label that says: "Additional information is listed in the safety data sheet"



Below is an example of a chemical label:

DIRECTIONS FOR USE:
RESTRAINTS: DO NOT spray if rain is expected within 2 hours
 DO NOT use on young seedlings.
 DO NOT mist in windy conditions

Crop	Pests	Rate	Critical comments
Fruit and vegetable crops, cut flowers and ornamental plants	Aphids, ants, cabbage moth and other caterpillars, earwigs, leafhoppers, thrips and whiteflies.	Mix 1ml to 1 litre water or 100ml to 100litres of water	Mist or spray to contact the pests when infestation occurs. Thorough coverage of all foliage including under-surfaces is essential.

NOT TO BE USED FOR ANY PURPOSE OR IN ANY MANNER CONTRARY TO THIS LABEL UNLESS AUTHORISED UNDER APPROPRIATE LEGISLATION.
 WITHHOLDING PERIOD: FRUIT AND VEGETABLES: DO NOT HARVEST FOR 1 DAY AFTER APPLICATION

GENERAL INSTRUCTIONS
APPLICATION
 Shake the container before opening. Measure concentrate accurately into a small amount of water and stir/stirrate this pre-mix thoroughly before adding to the full quantity of water. Do NOT mix more spray solution than you will need for the day. Do NOT mist in windy conditions. Application is best late in the day or early morning when bees and wasps are not present and because sunlight degrades the active.

PROTECTION OF LIVESTOCK: Dangerous to bees. DO NOT spray any plants in flower while bees are foraging.
PROTECTION OF WILDLIFE, FISH, CRUSTACEANS AND ENVIRONMENT: Do NOT contaminate streams, rivers, or waterways with chemical or used containers.


STORAGE AND DISPOSAL
KEEP OUT OF REACH OF CHILDREN. Store in the closed original container in a cool, well-ventilated area. Do NOT store for prolonged periods in direct sunlight. Triple rinse containers before disposal. Add rinsings to spray tank. Do NOT dispose of undiluted chemicals on site. If recycling, replace cap and return clean containers to recycler or designated collection point. If not recycling, break, crush or puncture and bury empty containers in a Local Authority landfill. If not available, bury containers below 500mm in a disposal pit specifically marked and set up for this purpose, clear of waterways, desirable vegetation and tree roots. Empty containers and product should not be burnt.

SAFETY DIRECTIONS
 Repeated exposure may cause allergic disorders. Sensitive workers should use protective clothing. Avoid contact with eyes and skin. Do not inhale vapour or spray mist. Wash hands after use.

FIRST AID: If poisoning occurs contact a doctor or Poisons Information Centre. Phone Australia 13 11 26

MATERIAL SAFETY DATA SHEET
 Additional information is listed in the Material Safety Data Sheet which can also be found on the website:
www.purshch.com.au

APVMA approval No 53738/1-5-20/0107





Not all information about the hazards of a chemical or instructions for safe storage, handling and use may be provided on labels.

The Safety Data Sheet (SDS or MSDS) is a key information resource for workers and persons conducting a business or undertaking in managing the risks of a hazardous chemical in a workplace.

It is important that workers read the SDS carefully and understand its contents before working with a hazardous chemical so that it can be safely stored, handled or used in the workplace.

In most cases, the SDS/MSDS will contain much more information about a hazardous chemical than appears on the label.

The SDS/MSDS can be used to assist in assessing specific risks associated with a chemical and in training workers on how to use a chemical safely.

Information found on the SDS/MSDS includes the following:

- ☆ The identity of the chemical product and its ingredients
- ☆ The hazards of the chemical including health hazards, physical hazards and environmental hazard,
- ☆ Physical properties of the chemical, like boiling point, flash point and incompatibilities with other chemicals
- ☆ Workplace exposure standards for airborne contaminants
- ☆ Safe handling and storage procedures for the chemical
- ☆ What to do in the event of an emergency or spill
- ☆ First aid information
- ☆ Transport information

The following images are an example of a chemical SDS, or in this case it is called a Material Safety Data Sheet or MSDS:

Pyrethrum Insect Dust - Material Safety Data Sheet

Material Safety Data Sheet

Hazardous according to criteria of Worksafe Australia
Pyrethrum Insect Dust

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

COMPANY DETAILS:

Kendon Chemical & MNFG. Co. Pty Ltd
71 McClure Street
Thombury, Vic, 3071
Phone: 03 9497 2822
Fax: 03 9499 7225

PRODUCT DETAILS

Product Name: Pyrethrum Insect Dust
Synonyms: Pyrethrin based insecticide.
Manufacturer's Product Code(s): A130

Use: A powder insecticide especially suited for use on vegetables, ornamentals, in domestic use, in stored potatoes, dust bins and compost heaps for the control of insect pests. The piperonyl butoxide ingredient enhances the activity of the permethrin (synergist).

UN Number: Not applicable
Proper Shipping Name: Not applicable
Dangerous Goods Class: Not applicable
Subsidiary risk: Not applicable
Packing Group: Not applicable
Hazchem Code: Not applicable

2. COMPOSITION / INFORMATION ON INGREDIENTS

SUBSTANCE NAME	Proportion	CAS Number
PYRETHRUM	2.2%	8003-34-7
PIPERONYL BUTOXIDE	12.5%	51-03-6
TALC (magnesium silicate hydrate mineral)	>60%	14807-96-6

3. HAZARD IDENTIFICATION

Hazardous according to the criteria of Worksafe Australia

Pyrethrum Insect Dust - Material Safety Data Sheet

Hazard Category: Irritant

ACUTE HEALTH EFFECTS

Swallowed:
May be harmful if swallowed. May cause irritation to mouth, throat and stomach with effects including mucous build up, irritation to the tongue and lips and pains in the stomach.

Eye:
Will cause irritation to the eyes, with effects including: tearing, pain, stinging and blurred vision. Depending upon duration of exposure, eye damage may occur.

Skin:
Will cause irritation to the skin, with effects including: Redness, itchiness, and possible dermatitis.

Inhaled:
May cause irritation to the nose, throat and respiratory system with effects including: Dizziness, headache and possible confusion.

Chronic:
Prolonged or repeated skin contact may lead to dermatitis.

4. FIRST AID MEASURES

Swallowed:
If swallowed, DO NOT induce vomiting. Give a glass of milk. Seek medical assistance immediately

Eye:
If dust enters the eyes, immediately, flush with plenty of water for 15 minutes, ensuring eye lids are held open. If irritation persists transport to hospital or doctor.

Skin:
If material contacts the skin, remove any contaminated clothing and wash skin thoroughly with water and soap if available. If irritation persists transport to hospital or doctor.

Inhaled:
Move victim to fresh air. Apply resuscitation if victim is not breathing. Open all doors, windows and/or vents.

First Aid Facilities:
Eye wash fountain, safety shower and normal wash room facilities nearby.

Advice to Doctor:
Treat symptomatically. Contact Poisons Information Centre 13 1126.

5. FIRE-FIGHTING MEASURES

Extinguishing Media: Use extinguishing media suitable for surrounding fire situation.
If safe to do so, move undamaged containers from fire area.

Fire/Explosion Hazard: Not an explosion hazard.

Hazardous Decomposition Products: Decomposes on heating emitting soot, smoke, decomposition products and carbon monoxide. Fire Fighting Procedures Fire fighters to wear self-contained breathing apparatus (SCBA) if exposed to products of decomposition. Full protective clothing is also recommended.

6. ACCIDENTAL RELEASE MEASURES

Spillage: Ventilate the area. Remove all unnecessary personnel from spill area. Wear protective equipment. Sweep or shovel up, avoid spreading the dust. Prevent the powder from entering into drains and waterways. Collect and seal in properly labelled containers for disposal.

7. HANDLING AND STORAGE

Store in a cool place and out of direct sunlight. Store away from sources of heat, from oxidizing agents and from food. Keep containers closed, when not using the product. Store in original packages as approved by manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards

PYRETHRUM

(Worksafe Australia) 5 mg/m³ [TWA]

(American Conference of Govt. Industrial Hygienists) 5 mg/m³ [TWA]
A4 - Not classifiable as a human carcinogen.

PIPERONYL BUTOXIDE No Exposure Standard available

POLYETHANOXY-9-NONYL PHENOL: No Exposure Standard available

Engineering Controls

Maintain adequate ventilation at all times. In most circumstances natural ventilation systems are adequate unless the material is heated, reacted or otherwise changed in some type of chemical reaction, then the use of a local exhaust ventilation system is recommended.

Personal Protection Equipment

Avoid skin, eye and inhalation contact.
CLOTHING: PVC or natural rubber apron.
GLOVES: PVC or natural rubber.
EYES: Chemical goggles, faceshield or safety glasses with side shields to protect eyes.
RESPIRATORY PROTECTION: Avoid breathing dusts. If natural or local exhaust ventilation is not adequate, select and use

a dust respirator in accordance with AS/NZS 1715/1716.
If entering spaces where the airborne concentration of a contaminant is unknown then the use of a Self-contained breathing apparatus (SCBA) with positive pressure air supply.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Fine beige powder
Boiling Point Not applicable
Melting Point: Not applicable
Vapour Pressure: Not available
Specific Gravity: 2.7 approx
Flash Point: Not Applicable
Flammability Limits: Not Applicable
Solubility in Water: The active ingredient is soluble in water.
The carrier (talc) is insoluble in water.

10. STABILITY AND REACTIVITY

The active ingredients are stable under normal conditions of use.

CONDITIONS TO AVOID: Heat, flames, and incompatibles.

INCOMPATIBLE MATERIALS: Strong alkalis, acids, oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: The active ingredient will emit smoke and fumes when heated to decomposition. May form carbon monoxide

HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL INFORMATION

Pyrethrum (as 100%):

Acute Oral Toxicity LD₅₀ (rat) = 3500 mg/kg
Acute Skin Toxicity LD₅₀ (rabbit) = >19000 mg/kg

Piperonyl Butoxide (as 100%):

Acute Oral Toxicity LD₅₀ (rat) = 6150 mg/kg
Acute Skin Toxicity LD₅₀ (rabbit) = 1880 mg/kg

Pyrethrum Insect Dust - Material Safety Data Sheet

12. ECOLOGICAL INFORMATION

This substance may be harmful to aquatic organisms. Avoid contaminating waterways.

Pyrethrins degrade quickly on exposure to sunlight and are not persistent in soil or water.

Piperonyl Butoxide is also degradable in soils and water and is basically immobile in most soils.

- Aquatic Toxicity: Fish LC50 (Carassius Auratus) : 4.2 mg/L
LC50 (Rainbow Trout) : 6.1 mg/L
- Aquatic Toxicity: LC50 (Daphnia Magna) : 2.95 mg/L after 24 hrs

13. DISPOSAL CONSIDERATIONS

Disposal: In accordance with the Local, State & Federal EPA waste regulations.

Advise irritant nature. Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to an approved waste facility. Processing, use or contamination of this product may change the waste management options.

The unclean container must also be handled as hazardous waste until cleaned.

14. TRANSPORT INFORMATION

Not classified as a Dangerous Good according to the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code) 6th Edition; or according to the UN, IACO(IATA) [by air] or IMO(IMDG) [by sea].

15. REGULATORY INFORMATION

Workplace Hazardous Substance

HAZARD CATEGORY: IRRITANT

RISK PHRASES

R36/38 Irritating to eyes and skin.

SAFETY PHRASES

S2 Keep out of reach of children.

S13 Keep away from food, drink and animal feeding stuffs.

S24/25 Avoid contact with skin and eyes.

S37/39 Wear gloves and eye/face protection.

S26 After contact with eyes, rinse immediately with water and seek medical advice.

S28 After contact with skin, wash immediately with soap and water.

Not a Dangerous Good.

Not a Scheduled Poison.

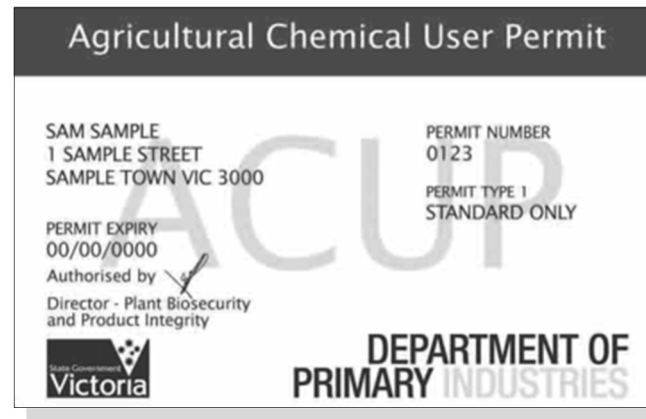
NICNAS - Aust. Inventory of Chemical Substances: All ingredients are on the AICS.

You can see the importance of referring to both the chemical label and the SDS.

These two should be read and understood before use of any chemical or hazardous substance.

It should be noted that an 'Agricultural Chemical User Permit' is required in some jurisdictions before chemicals can be purchased and used.

This license requires the applicants for the licence to prove they have completed a course in safe storage, use and transportation of agricultural chemicals.



**Learning
Activity****Task****LEARNING ACTIVITY FIVE**

In this activity you are to locate and have handy a copy of the 'Safety Data Sheet' (SDS) and/or the 'Material Safety Data Sheet' (MSDS) for each of the chemicals you will be using for the treatment of a plant pest and for the treatment of a plant disease.

You may seek the assistance of your 'nominated observer' for this activity if locating those documents seems difficult.

Once you have those documents, your 'nominated observer' will let your teacher or trainer know you have them.

This will assist you in addressing a 'Knowledge Evidence' assessment requirement.

TEACHER / TRAINER GUIDANCE NOTES***Knowledge Evidence***

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- ☆ purpose and use of chemical labels and safety data sheets (SDS)



APPLY TREATMENTS TO MINIMISE DAMAGE AND EXPOSURE TO OFF-TARGET SPECIES ACCORDING TO WORKPLACE PROCEDURES, HEALTH AND SAFETY IN THE WORKPLACE AND ENVIRONMENTAL LEGISLATIVE AND REGULATORY REQUIREMENTS

An important part of any workplace activities in relation to treating plant pests, diseases and disorders is to ensure non - target plants are not damaged.

In addition there are environmental regulations that are in place to ensure that the natural environment suffers no adverse impact either.

There are some measures that should be implemented to avoid environmental impact or affecting non - target species when treating weeds in the agricultural or horticultural workplace.

☆ **Chemical characteristics** - Assess the following characteristics of chemicals when selecting a herbicide, pesticide or fungicide:

- ◆ **General environmental risk.** Select a product that has few or no environmental risks (e.g. to birds, fish, invertebrates, native vegetation, waterways)
- ◆ **Selectivity.** Can the product control the weeds, but leave other organisms unharmed?
- ◆ **Persistence or half-life.** Does the product remain active in the environment for a long period of time?
- ◆ **Volatility.** Does the product readily evaporate into the atmosphere? Select a product with low volatility to minimise the risk of volatile drift onto non-target areas
- ◆ **Absorption.** Select a product with a high absorption coefficient as it adheres to organic matter in the plant and soil, and is less mobile in the environment.
- ◆ **Solubility.** Select a product with low solubility, as it is less likely to migrate from the application site in surface or soil water

☆ **Map awareness zones** - Draw or sketch a map that highlights any sensitive areas around the field to be sprayed and shows the prevailing wind direction.

This will help to provide you with a risk assessment for the area.

SAMPLE



- ☆ **Create buffer zones** - Buffer zones, or separation distances can be used on the downwind edge of a field to ensure spray drift does not impact on adjoining sensitive areas.

Different types of buffer zones include:

- ♦ **Field splitting.** This involves treating the upwind section of a field, leaving the required buffer distance to neighboring sensitive areas unsprayed (a no-spray zone), until there is a favorable change in wind direction
- ♦ **Vegetative buffers.** Rows of trees, shrubs or tall grasses can be planted on the downwind edge of a property to reduce the impact of spray drift on neighboring sensitive areas.

Vegetative buffers work by filtering spray droplets out of the air as it passes through foliage.

Vegetative buffers should only be considered in addition to other methods of drift control, not as a substitute

- ☆ **Consider waterbodies** - Before applying a herbicide, pesticide or fungicide near a waterbody (e.g. drainage line, creek, stream, farm dam, lake or reservoir) it is important to consider environmental and seasonal conditions which increase the risk of harm to aquatic environments.

Herbicides can enter water either directly through in-stream spraying or spray drift, or they can reach the surface water via surface run-off or leaching and sub-surface drainage.

It is therefore important to understand that herbicides, pesticides or fungicides can move into waterways even as a result of off-stream activities.

When spraying weeds near waterbodies, the choice of herbicide is critical.

This is because many herbicides, pesticides or fungicides are toxic in aquatic ecosystems and may harm animal and plant life.

They may also pollute water supplies intended for human consumption.



- ☆ **Leaks and spills** - Consult the relevant SDS or manufacturer of the herbicide for specific information on handling leaks and spills.

In the event of a chemical spill:

- ◆ Ensure it is safe for you to approach the incident area
- ◆ Move people to a safe distance from the incident area
- ◆ Keep bystanders away from the spill
- ◆ Contain the spilled material if possible, using absorbent material
- ◆ Use absorbent material to soak up spilled liquid, clean up the spill
- ◆ If in doubt, contact the emergency phone number on the herbicide label for specialist advice

- ☆ **Off-target migration** - Spray drift is the airborne movement of agricultural chemicals away from the target area during, or shortly after, its application.

It can be in the form of droplets, particles (fine dust) or vapour and can occur to some degree, even when the chemical is being applied according to label instructions.

It becomes an issue when it has the potential to damage health, neighbouring plants or the environment.

- ☆ **Weather conditions** - Consider weather conditions before spraying, paying particular attention to wind speed.

The wind should be blowing away from sensitive areas.

Also the temperature needs to be considered; mild temperatures (45%) are ideal.

The morning hours often give the best weather conditions for spraying.

Spray operators should monitor and record wind direction, wind speed, temperature and humidity.

- ☆ **Communicate with neighbors and the community** - Keeping other people informed about proposed chemical use can help reduce the likelihood of misunderstanding and future conflict.



- ☆ **Monitor for changing conditions during spraying** - Sometimes conditions change while applying herbicides, pesticides or fungicides.

For example, wind speed or direction can change quickly, or it may start raining.

Spray operators should also be aware of 'temperature inversion' where fine droplets of the chemical can be concentrated in the cool layer near the ground and isolated from the surrounding weather conditions.

This could cause the chemical to be picked up in some way and taken to an area where non-targeted plants are affected.

The herbicide, pesticide or fungicide applicator should constantly monitor environmental conditions while working and may have to adjust their procedures if there are changes, or even stop the application.

- ☆ **Clean up** - To minimise cost and potential harm to the environment, the goal of every spray operation should be to plan the spray job carefully to avoid excess spray solution.

Clean equipment away from sensitive areas such as waterbodies, children's play areas or sensitive vegetation.

- ☆ **Disposal of diluted herbicide** - Any diluted herbicide, pesticide or fungicide solution that is left over from a job should be diluted further with water and applied over a non-sensitive 'sacrifice area'.

Suitable areas include areas of fallow land or pasture, internal tracks or firebreaks.

- ☆ **Disposal of wash water** - Water that has been used to wash spray equipment will contain herbicide, pesticide or fungicide residue and possibly also cleaning agents.

It should be directly disposed of in accordance with organisational procedures.



☆ **Quarantine and bio-security** - You should be aware of quarantine areas for pest plants (weeds), insects or diseases.

Such situations should be identified prior to commencement of spraying.

In addition workers should avoid the transfer of weed seeds, insects and diseases between different areas by inspecting the spray vehicle and cleaning it if necessary before leaving a spray job.

Bio-security may be an issue where the genetic material (e.g. pollen or seeds) of a crop is transferred from the place of origin to other places.

Again, the spray vehicle should be thoroughly inspected before leaving a property and cleaned if necessary.

**Learning
Activity****Question**

SAMPLE

LEARNING ACTIVITY SIX

What were the thirteen measures you would consider implementing in order to reduce the risk of adversely effecting non-target plants when treating plant pests, diseases or disorders in your agricultural workplace?

TEACHER / TRAINER GUIDANCE NOTES

- 1) Select chemicals that provide the lowest risk to the environment
- 2) Map environmentally sensitive areas
- 3) Create buffer zones
- 4) Consider the effect of chemical contamination of waterways
- 5) Control leaks and spills
- 6) Minimise spray drift and off- target chemical migration
- 7) Monitor weather conditions
- 8) Communicate with others
- 9) Monitor for changing conditions
- 10) Properly clean up after spraying
- 11) Ensure diluted chemical cannot infect non target species
- 12) Ensure wash water does not contaminate non- target species
- 13) Consider quarantine and bio-security issues

SAMPLE

**Learning
Activity****Task****LEARNING ACTIVITY SEVEN**

As we mentioned earlier, we will be focusing on 'plant pest treatment' for the rest of this training manual.

We will address 'plant disease treatment' at the end of this manual.

This is another activity which we call an 'observable' assessment activity.

This means that your 'nominated observer' will be watching you when the time comes around for you to treat plant pests.

He or she will be observing you doing the following:

- ☆ Fitting and wearing PPE
- ☆ Accessing and referring to the chemical MSDS or SDS when preparing the chemicals for plant pest treatments
- ☆ Preparing the treatments for treating plant pests
- ☆ Applying treatments
- ☆ Being aware and controlling application to avoid off-target species
- ☆ Using safe work practices

Your teacher will report back to your teacher or trainer using the 'third party observation assessment forms' they were provided.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ identified, selected, fitted and used personal protective equipment
- ☆ applied treatments safely ensuring off-target species were unaffected

Knowledge Evidence

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- ☆ basic environmental considerations when using chemicals for treating pests, diseases and disorders, including:
 - ◆ spray drift and off target damage
 - ◆ inversion
 - ◆ re-entry period
 - ◆ residues
- ☆ chemical handling
- ☆ health and safety in the workplace including personal protective equipment required for treating pests, disease and disorders

Section Three

Carry Out Post Treatment Operation

TREAT PLANT PESTS, DISEASES AND DISORDERS

SECTION THREE—CARRY OUT POST TREATMENT OPERATION

INTRODUCTION

Performing treatments to plants/crops has tasks that go on even after the chemicals have been applied.

Some are physical tasks and others could be defined as 'paperwork'.

In this final section we look at these topics.

SECTION LEARNING OBJECTIVES

At the completion of this section you will learn information relating to:

- ☆ Cleaning and storing personal protective equipment and application equipment according to workplace and environmental procedures
- ☆ Disposing of treatment waste according to environmental procedures
- ☆ Maintaining records according to workplace procedures and legislative and regulatory requirements

CLEAN AND STORE PERSONAL PROTECTIVE EQUIPMENT AND APPLICATION EQUIPMENT ACCORDING TO WORKPLACE AND ENVIRONMENTAL PROCEDURES

In terms of the equipment used to treat plant pests and diseases in the agricultural or horticultural workplace, proper cleaning serves two purposes.

- ☆ To make sure the equipment is ready for the next time it is required
- ☆ To make sure none of the equipment has failed and needs to be replaced

The following steps should be implemented to ensure proper cleaning and storage of PPE, chemical application equipment and chemicals themselves.

- ☆ **PPE when cleaning equipment** - When cleaning herbicide-contaminated equipment, wear the same personal protective equipment (PPE) that the labeling requires for making applications, plus a chemical-resistant apron or other appropriate protective equipment.

Select a location to clean equipment where any spilled rinse will not contaminate water supplies, streams, crops or other plants and where puddles will not be accessible to humans, pets, livestock, or wildlife.

If a facility to catch and/or contain the rinse is not available, spray the rinse water or the cleaning solution on a site and in a manner consistent with the label use of the herbicide.



This person is wearing proper PPE and is cleaning a sprayer over top of a waste water containment slab.



- ☆ **Cleaning chemical sprayer** - These steps can be used for small backpack sprayers to large tank sprayers.

It is called the 'triple rinsing'.

- 1) **First rinse** - Drain and collect any chemical solution that may remain in the tank.

Add one-half tank of fresh water and flush tanks, lines, booms, and nozzles for 10 minutes using a combination of agitation and spraying.

Collect rinse sprayed through the booms in a containment facility or spray on a 'sacrificial site' for which the herbicide is labeled.

- 2) **Second rinse** - Fill the tank with clean water, add recommended cleaner (detergent, ammonia or commercial tank cleaner) and re-circulate for 15 minutes.

Operate the spray booms or wands long enough to ensure that all nozzles and lines are filled with the cleaning solution. Let the solution stand in the system for several hours, preferably overnight.

Agitate and spray the solution onto 'sacrificial sites' for which the herbicide is labeled or collect the solution in a containment facility.

- 3) **Third rinse** - Drain (or spray as described above) the cleaning solution from the tank, rinse with clean water and spray rinse through wand or boom.

Remove all filters, nozzles, nozzle screens and pipe end caps and inspect to be sure they are clean.

If not, soak in a cleaning solution and use a soft brush to scrub away any build up.

Rinse with clean water and reinstall all filters, screens and nozzles and lubricate sealing O-rings with vegetable oil.

☆ **Storing of chemicals and equipment** - Before storing hazardous chemicals, check the label for advice about storage and:

- ◆ Determine the quantity of the substance to be stored
- ◆ Determine how long you need to store the substance for
- ◆ Identify the toxicity and stability of the substance
- ◆ Check the state of the containers (only use original containers - never use food containers)
- ◆ Check the state of the labels (replace labels if they have come off)
- ◆ Store chemicals in a shed with a bund or some other spill containment system
- ◆ Ensure safe design, location and installation of storage and handling systems (e.g. racking systems, tanks)
- ◆ Separate incompatible substances to prevent reactive chemicals interacting
- ◆ Control potential ignition sources around flammable substances
- ◆ Have appropriate safety signage and placards
- ◆ Be prepared for spill containment and have clean up systems
- ◆ Have an emergency plan in place to deal with an incident involving the hazardous chemicals
- ◆ Ensure PPE is stored correctly (e.g. respirators sealed)
- ◆ Have fire-fighting equipment available in proximity to the chemical shed
- ◆ Secure chemicals from unauthorised access by locking the chemical storage shed





CLEAN AND STORE PERSONAL PROTECTIVE EQUIPMENT

Cleaning and maintenance instructions from the PPE manufacturer must be followed for **reusable** PPE.

Never reuse any type of disposable (one-time use) PPE equipment, because you can be exposed to residues remaining on the PPE from the previous use, or to product moving through damaged or deteriorated PPE during reuse.

Note that reusable or limited-use PPE must be discarded if not cleaned and maintained properly, because there is a significant risk of herbicide exposure.

For example, herbicide, pesticide or fungicide exposure can occur from residues remaining from the previous use, damaged seals in the respirator, small holes or tears in gloves or clothing, or degradation of the chemical-resistant PPE.

Remove PPE as soon as you complete the tasks where you were exposed to the herbicide.

Wash disposable OR reusable gloves with soap and water and then remove other PPE while still wearing the gloves.

Then wash the gloves again with soap and water before removing them.

Clean reusable PPE according to the PPE instructions, without causing contamination to yourself.

Wash regular work clothes that have been exposed to herbicides, pesticides or fungicides as soon as possible to ensure maximum herbicide residue removal.

Wash them separately from other laundry using detergent and hot water.

Using an outdoor clothesline rather than a dryer may help break down any remaining herbicides, pesticides or fungicides residues.

Always obtain replacement parts for half and full-face respirators from the original manufacturer and repair PPE in accordance with manufacturer instructions.

Respirator component parts are NOT interchangeable between different manufacturers.



SAMPLE

Storage instructions from the PPE manufacturer must be followed for both reusable and disposable PPE.

Most PPE must be protected from chemicals, sunlight, extreme temperatures, excessive humidity and moisture, or the specified shelf-life will be reduced.

Disposable, reusable, or limited-use PPE must be discarded if not stored properly.

Keep PPE in its sealed package until use and never store PPE with herbicides or personal clothing.

Keep PPE in its sealed package until use, and never store PPE with herbicides or personal clothing.

Disposal is the critical last step in handling PPE.

Ensure that you remove and discard PPE without causing contamination to yourself, garbage collectors, or the environment.

PPE may have an expiration date, while other PPE requires careful inspection – read the PPE manufacturer directions and be diligent about disposal of PPE that will no longer provide protection.

Clean disposable, washable items with soap and water prior to disposal, to remove herbicide, pesticide or fungicide residues.

Properly cleaned PPE can be disposed as regular garbage.

PPE that is contaminated with a herbicide, pesticide or fungicide must be disposed of according to directions on the herbicide, pesticide or fungicide product label and all Commonwealth, state and local regulations.

In the absence of specific label directions or government regulations, dispose of contaminated PPE as household hazardous waste, which can be taken to an appropriate waste collection event or disposal site.

If all PPE instructions for cleaning, maintenance, storage, and disposal are not followed carefully, PPE can become ineffective or even increase exposure to a herbicide, pesticide or fungicide.

If in doubt, dispose of the PPE or PPE component.

**Learning
Activity****Question****LEARNING ACTIVITY ONE**

Answer the following questions regarding PPE as follows:

True or False

1. To determine the toxicity of the herbicide, it is important to read the herbicide label
2. Herbicide-soiled clothing should be removed outdoors
3. All herbicide-soiled clothing can be safely laundered
4. Never pre-rinse herbicide soiled clothing

1 _____ **2** _____

3 _____ **4** _____

Multiple Choice

Place the letter in the space provided

5. Which glove material below would be the best choice to protect against chemicals?

- a) Leather
- b) Cotton
- c) Butyl-rubber

6. When are chemically resistant aprons most useful?

- a) During an application
- b) Equipment clean-up
- c) During mixing and loading

7. If a respirator is not available, which piece of PPE can be used as a substitute?

- a) Dust mask
- b) Goggles
- c) A & B
- d) Neither

8. What is the best material for work boots while applying herbicides?

- a) Leather
- b) Canvas
- c) Chemical-resistant material
- d) none of these

SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

- 1) True
- 2) True
- 3) False
- 4) False
- 5) C
- 6) C
- 7) D
- 8) C

**Learning
Activity****Question****LEARNING ACTIVITY TWO**

Why should you not clean and re-use disposable PPE?

TEACHER / TRAINER GUIDANCE NOTES

You should not clean and re-use disposable PPE because it was designed and manufactured for one time only use- if re-used there is potential for exposure to residues remaining on the PPE from the previous use, or to product moving through damaged or deteriorated PPE during reuse.

**Learning
Activity****Question****LEARNING ACTIVITY THREE**

Below is an image of a storage facility at an agricultural operation. Why is this a good example of a chemical storage facility?



TEACHER / TRAINER GUIDANCE NOTES

It has the proper signage, it has restrictive access, it is away from offices and other building or sheds, it has a wash-up facility.



DISPOSE OF TREATMENT WASTE ACCORDING TO ENVIRONMENTAL PROCEDURES

Earlier, we looked at treatment and disposal methods of chemical waste products.

Let's revisit that in more detail now.

There are regulatory and legislative impositions on environmental and bio-security risks that all farmers, horticulturists and workers need to be aware of.

Pesticides, herbicides and fungicides are toxic chemicals designed to treat a certain pest or disease, however unfortunately a very large percentage of pesticides, herbicides and fungicides reach a destination other than their target.

Instead, they enter the air, water, sediments and even end up in our food.

Pesticides, herbicides and fungicides easily contaminate the air, ground and water when they run off from fields, escape storage tanks, are not discarded properly and especially when they are sprayed aerially.

Environmental considerations and risks can be categorised as follows:

- ☆ **Water** - Pesticides, herbicides and fungicides can also be found in rain, ground water, streams, rivers, lakes and oceans.

There are 4 major ways that pesticides, herbicides and fungicides can reach the water: it can drift outside of the area of where it was sprayed, it may leach through the soil, it could be carried as runoff, or it may be spilled accidentally.

- ☆ **Soil** - The use of pesticides, herbicides and fungicides decreases the general biodiversity in the soil.

If there are no chemicals in the soil there is a higher soil quality and this allows for higher water retention, necessary for plants to grow.

- ☆ **Plants** - Nitrogen which is necessary for the growth of many large plants, is hindered by pesticides, herbicides and fungicides that can be found in soil.

This can lead to a large decline of crop yields.

Application of pesticides, herbicides and fungicides to crops that are in bloom can kill honeybees, which act as pollinators.

This creates a decrease in crop pollination and reproduction.



- ☆ **Animals** - Animals may be poisoned by pesticides, herbicides and fungicides residues that remain on food after spraying.

An application of pesticides, herbicides and fungicides in an area can eliminate food sources that certain types of animals need, causing the animals to relocate, change their diet, or starve.

Poisoning from pesticides, herbicides and fungicides can even make its way up the food chain; for example, birds can be harmed when they eat insects and worms that have consumed pesticides, herbicides or fungicides.

- ☆ **Aquatic life** - Fish and other aquatic animals may be harmed by pesticide, herbicide or fungicide contaminated water.

Application of pesticides, herbicides and fungicides to bodies of water can cause plants to die, diminishing the water's oxygen and suffocating the fish.

Repeated exposure of some pesticides, herbicides and fungicides can cause physiological and behavioural changes in fish that reduce populations, such as abandonment of nests, decreased immunity to disease and increased failure to avoid predators.



Correct disposal of surplus chemicals is therefore critical in order to avoid damage to the natural environment.

When disposing of surplus chemicals, the following steps are best practice.

- ☆ **Chemical containers** - Arrange for collection by an approved waste disposal agency (Drum Muster operates across Australia).

All empty containers must be triple rinsed to remove any traces of the chemical and disposed of, or recycled in the manner noted on the label.

Effluent from this process should be treated as hazardous and handled accordingly.

- ☆ **Chemical waste disposal** - 'Rinsate' is herbicide-containing water (or other liquid) that results from rinsing a chemical container, chemical equipment, or other chemical-containing materials.

Rinse chemical application equipment properly over an impermeable surface that drains to a sump.

Rinse water can then be recovered from the sump and disposed of usually in a land fill site.

Rinse water should be applied to land in an area that will not contaminate the environment or impact people, livestock or produce.

Do not allow any contaminated water or chemicals to drain into ground water, storm drains, sewers or other water supplies.

Many new sprayers are equipped with a small tank that holds clean water to rinse out the spray tank in the field.

Immediately following the application, clean water can be pumped into the large spray tank, and the rinse water can be sprayed over the target field, provided registered rates are not exceeded and application is consistent with label directions.

**Learning
Activity****Question****LEARNING ACTIVITY FOUR**

Define the term 'Rinsate'.

TEACHER / TRAINER GUIDANCE NOTES

Rinsate is the mixture of water that's contaminated with low concentrations of herbicide products that is created during a 'rinsing' process; either the rinsing of chemical containers or spray equipment tanks.

MAINTAIN RECORDS ACCORDING TO WORKPLACE PROCEDURES AND LEGISLATIVE AND REGULATORY REQUIREMENTS

In all States and Territories there is a requirement to keep records of chemical use on farms and larger horticultural operations.

Generally the requirements are:

- ☆ the product trade name
- ☆ the date the product was used
- ☆ the application rate of the product
- ☆ the crop/ that was treated
- ☆ the extent of use, such as land area
- ☆ If applied outdoors the wind speed and direction at the time of application
- ☆ the location where the product was used
- ☆ the name and address of the person doing the application
- ☆ the name and address of the person for whom the application was carried out

SAMPLE

Depending on the jurisdiction, it is a legal requirement to record all agricultural chemicals used within 48 hours of the use and keep these records for a minimum period of two years and in some jurisdictions up to three years.


The form in which these records are made usually depends on what is in place at the operation.

There are also numerous templates online, one example below taken from the ‘Agricultural Victoria’ website’.

Record keeping template
Agricultural chemical use

Agricultural chemical application details						Weather details (if involved in being sprayed outdoors)		Contact details	
Date of application	Product trade name	Application rate	Crop/commodity treated OR situation product was applied	Extent of use (area/volume /weight)	Location where product was used	Wind speed	Wind direction	Name and address of applicator and (if applicable) supervisor	Name and address of person for whom the application was carried out

Agricultural chemical details must be recorded within 48 hours of use.
For pest animal baiting, use the 'Pest Animal Baiting' record keeping template.
For details of your legal requirements when using agricultural chemicals visit: www.dps.vic.gov.au/chemicals



There are also record keeping applications that farmers will install on Smartphones or other types of digital devices such as tablets or laptops.

One example is an 'app' called 'Spray App'.

It can be installed on an iPad or iPhone and has all the required information.



**Learning
Activity****Task****LEARNING ACTIVITY FIVE**

As we mentioned earlier, we will be focusing on 'plant pest treatment' for the rest of this training manual.

We will address 'plant disease treatment' at the end of this manual.

This is the final 'observable' assessment activity for 'plant pest treatment'.

This means that your 'nominated observer' will be watching you when the time comes around for you to treat plant pests

He or she will be observing you doing the following:

- ☆ Cleaning application equipment according to workplace and environmental procedures and then storing
- ☆ Disposing of treatment waste according to environmental procedures
- ☆ Cleaning and storing PPE
- ☆ Following recording and record keeping procedures
- ☆ Using safe work practices

Your teacher will report back to your teacher or trainer using the 'third party observation assessment forms' they were provided.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ shut down, cleaned and stored personal protective equipment and application equipment according to environmental procedures
- ☆ disposed of waste according to workplace procedures and environmental procedures
- ☆ updated records according to workplace procedures and legislative and regulatory requirements

Knowledge Evidence

An individual must be able to demonstrate the knowledge required to perform the tasks outlined in the elements and performance criteria of this unit. This includes knowledge of:

- ☆ environmental considerations when treating pests, diseases and disorders, and disposing of waste materials
- ☆ record keeping methods and requirements

**Learning
Activity****Task****LEARNING ACTIVITY SEVEN**

In previous assessment activities we focussed on treating plant pests assigned to you for assessment purposes.

In this activity you will now perform all those assessment activities you did for treating plant pests, however this time it will be for treating plant pests.

TEACHER/TRAINER GUIDANCE NOTES

The assessment requirements for this unit of competency states:

Performance Evidence

The candidate must be assessed on their ability to integrate and apply the performance requirements of this unit in a workplace setting.

There must be evidence that on at least one occasion the individual has demonstrated that they have treated plant pests and diseases, including:

- ☆ recognised and recorded target pests, diseases and disorders and confirmed with supervisor
- ☆ discussed and selected control options with supervisor
- ☆ prepared control options and treatments following required procedures
- ☆ identified health and safety in the workplace and environmental hazards and risks and applied controls according to workplace procedures
- ☆ identified, selected, fitted and used personal protective equipment
- ☆ applied treatments safely ensuring off-target species were unaffected
- ☆ shut down, cleaned and stored personal protective equipment and application equipment according to environmental procedures
- ☆ disposed of waste according to workplace procedures and environmental procedures
- ☆ updated records according to workplace procedures and legislative and regulatory requirements

SELF ASSESSMENT

Self assessment is where you ask yourself certain questions to ensure you have understood what you have learned while reading this manual and completing the learning activities.

This unit requires you the student or trainee at the completion of your training to have a certain level of 'Required Knowledge' in which you would need to have acquired and in which you will be assessed on. This self assessment section reviews this required knowledge by way of questions and if you are able to say YES to all of them you can be confident your assessment will be satisfactory.

- ☆ This training unit had three sections each with information focussed on the treatment of plant pests, disorders and diseases. After reviewing the information in Section One, are you confident that you understand and could:
 - 1) Identify and record details of pest, disease or disorder and confirm with supervisor according to workplace procedures?
 - 2) Discuss and select appropriate control technique with the supervisor?
 - 3) Perform calculations according to control option and treatment requirements and confirm with supervisor?
 - 4) Select and prepare equipment for use according to workplace procedures, supervisor instructions and manufacturer specifications?
 - 5) Secure treatment area according to health and safety in the workplace procedures and supervisors instructions?
 - 6) Identify health and safety hazards and risks in the workplace and apply appropriate controls according to supervisor instructions?
- ☆ After reviewing the information in Section Two, are you confident that you understand and could:
 - 1) Identify, select, fit and use personal protective equipment according to according to workplace procedures and manufacturer instructions?
 - 2) Prepare treatments according to supervisor's instructions, chemical label instructions, safety data sheets and manufacturer instructions?
 - 3) Apply treatments to minimise damage and exposure to off-target species according to workplace procedures, health and safety in the workplace and environmental legislative and regulatory requirements?
- ☆ After reviewing the information in Section Three, are you confident that you understand and could:
 - 1) Clean and store personal protective equipment and application equipment according to workplace and environmental procedures?
 - 2) Dispose of treatment waste according to environmental procedures?
 - 3) Maintain records according to workplace procedures and legislative and regulatory requirements?

If there were any questions that you were unable to confidently say YES to, we encourage you to review the information again in this manual and if needed seek the assistance of your teacher or trainer.

POWERPOINT SLIDE PRESENTATION MAPPING

This training manual is accompanied with a PowerPoint slide presentation, titled the same as this training manual.

The following listing is a ‘mapping cross-reference’ between the Slide Number and the corresponding page number in the ‘Student Manual’.

<i>Slide Numbers</i>	<i>Student Manual Page Number</i>	<i>Slide Numbers</i>	<i>Student Manual Page Number</i>
Slide Number 4	Page 13-24	Slide Number 17	Page 81-84
Slide Number 5	Page 27-30	Slide Number 18	Page 85
Slide Number 6	Page 35-45	Slide Number 19	Page 87-91
Slide Number 7	Page 49	Slide Number 21	Page 97
Slide Number 8	Page 50	Slide Number 22	Page 98
Slide Number 9	Page 52-53	Slide Number 23	Page 99
Slide Number 10	Page 54-56	Slide Number 24	Page 100
Slide Number 11	Page 58	Slide Number 25	Page 106-108
Slide Number 12	Page 60-61	Slide Number 26	Page 110
Slide Number 13	Page 62-65		
Slide Number 15	Page 72-73		
Slide Number 16	Page 79-80		

SAMPLE