LEARNER GUIDE

Pests, Diseases and Weeds

Level 2

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Title:		**Control Pests, Diseases and Weeds on All Crops Effectively and Responsibly**					
Applied Title:		**Control Pests, Diseases and Weeds on Citrus Effectively and Responsibly**					
Field:		Agriculture and Nature Conservation					
Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
Skills Area:		Pests, Diseases and Weeds					
Context:		Citrus Production					
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Unit standard alignment and assessment tool development:
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Directions

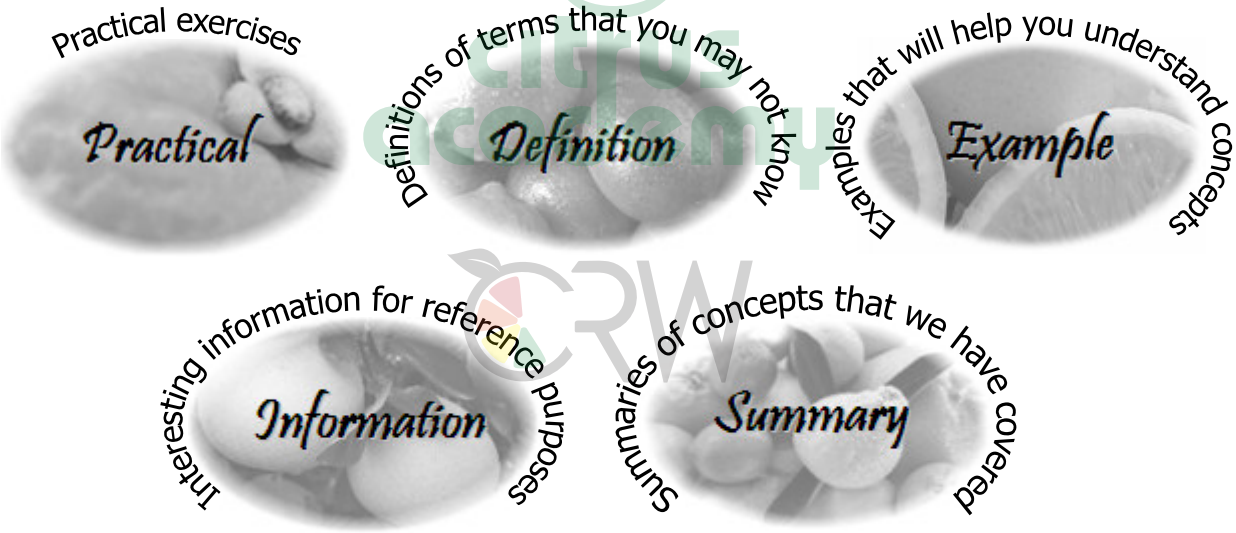
This learning material has been developed to assist the learner wishing to complete this unit standard. The guide contains all necessary learning to ensure that the learner will attain the competencies required by the unit standard.

The learner guide is accompanied by a Learner Assessment Guide. Please ensure that you have access to this guide as well.

The learner guide was designed to be used by a learner during the presentation of a skills program based on the unit standard, and to be kept afterwards by the learner for reference purposes. The learner assessment guide was designed to be completed during and after the presentation of the skills program, and forms part of the assessment process.

Although this learner guide contains all the information required for attaining competency in this unit standard, references to additional resources, both printed and electronic, are provided for further study by the learner.

Information in boxes is indicated by tags that show:



Introduction

1. Purpose

A learner achieving this unit standard will be able to recognise common insects, disease symptoms and weeds and apply basic control measures as per agricultural enterprise.

Learners will gain an understanding of sustainable agricultural practices as applied in the animal-, plant and mixed farming sub-fields. This unit standard focuses on the application of pest control practices in primary agriculture.

They will be able to participate in, undertake and plan farming practices with knowledge of their environment. This unit standard will instil a culture of maintenance and care for both the environment as well as for farming infrastructure and operations.

2. Learning Assumed to Be in Place

It is assumed that the learner has successfully completed the unit standards listed below:

NQF Level	*Unit Standard Number*	*Unit Standard Description*
1 (ABET 4)	Literacy and Numeracy	
1	116204	Recognise pests, diseases and weeds on crops

3. Prescribed Material

The following material is prescribed for this unit standard:

Identification Manual for Citrus Pests and Their Natural Enemies published by Citrus Research International

Contact Details: (013) 759-8000 or bella@cri.co.za.

Introduction to Citrus Production

1. Introduction

This learning material has been developed in the context of citrus production, which means that the skills area is dealt with in terms of and as applied to citrus production. To help the learner place the material in the right context, it is necessary for the learner to understand the background to citrus production, and the manner in which a citrus plant produces fruit.

2. Background

Citrus originates from the subtropical regions of south-east Asia. In the wild, citrus trees in these regions produce fruit all year round, and the fruit are small, poorly coloured and blemished. In the absence of effective production practices, citrus trees do not produce fruit suitable for the market.

Citrus production is largely concerned with management of the practices and processes that manipulate the tree to produce high yields of marketable fruit. Production management, together with the selection of superior varieties and plant improvement, can be seen as an on-going effort to influence the natural tendencies of the tree.

Consumers want the fruit of their choice to be available at all times. Fruit should look good, be unblemished, well-coloured (superior exterior quality), taste good (high interior quality) and be of the right size. At the same time, the citrus producer wants orchards that will provide high yields over an orchard lifespan of 18 to 30 years. On top of all this, the citrus orchard must be managed in such a way that production practices have the least possible impact on the natural environment. Commercial citrus production management is about achieving these objectives efficiently and cost effectively.

3. Citrus Planting

Citrus trees are planted in rows in orchards. The planting distance, also called tree spacing or espacement, between rows and between trees within rows, is determined by numerous factors including climate, variety, and soil type. A typical tree spacing is 6m between rows by 3m between trees, meaning that 555 trees per hectare (ha) are planted (1ha = 10,000 m^2).

Once planted, trees take three or more years before bearing fruit that can be marketed. Thereafter, per tree and per hectare yields steadily increase to 40 to 70 t/ha – depending on cultivar and variety – after a further 4 to 7 years. If the trees are well looked after, this level of production will remain fairly constant until trees start to decline naturally.

Yield

Yield refers to the amount of fruit produced, and can be expressed in terms of:

Tree yield	kg per tree	kg/tree
Orchard yield	tons per hectare	t/ha
Export yield	15kg carton equivalents per hectare (10kg carton equivalents for soft citrus)	cartons/ha

4. Lifespan

The average economic lifespan of a commercial citrus orchard varies between 18 and 30 years, and can be as high as 30 to 60 years in hot, dry areas. Citrus is therefore viewed as a long-term crop. For citrus production to be profitable, the orchard must produce high yields of quality fruit every year, and do this consistently over a long period of time.

In citrus production the challenge is therefore to make production decisions and take actions to ensure high annual production of marketable fruit, while ensuring that these decisions and actions contribute to the long-term sustainability of the orchard.

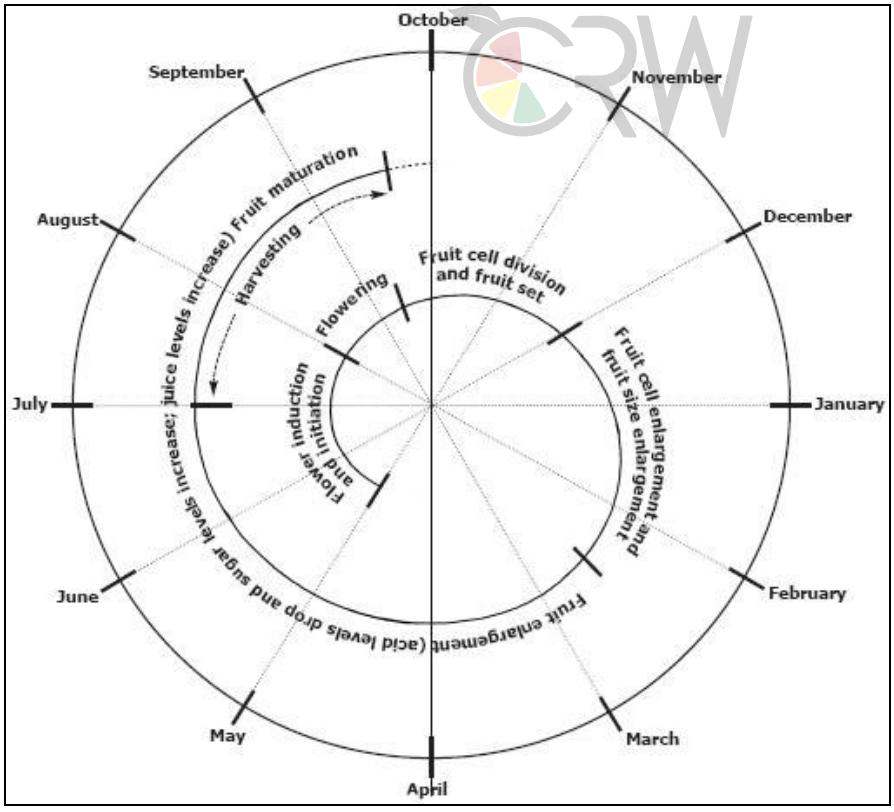
5. Citrus Plant Phenology

Phenology

Phenology refers to regularly recurring biological phenomena and the environmental and climatic factors that influence them. In citrus, phenology specifically refers to the annual cycle of the citrus tree.

Understanding the phenology of the citrus tree is essential to understanding the reasoning behind many of the practices and actions employed in citrus production. For example, the timing of fertiliser applications is linked to the phenology of the tree, with most fertilisers being applied at appropriate times to optimise flowering, fruiting, fruit development and fruit maturation.

The figure and table below set out the annual cycle of the citrus tree with regard to fruit production. Please note that this figure and table reflect the approximate flower and fruit development cycle of a valencia orange tree, and that the phenology of various cultivars differ.



Stage	***Description***	***Time Period***
Flower Induction and Initiation	Flower initiation is the induction and differentiation of vegetative buds into flower buds at a cellular level, and cannot be seen with the naked eye.	May to July
Flowering	Flowering or "bloom" is when blossoms appear on the tree.	August to Mid-September
Cell Division and Fruit Set	Cell division is the period when cells making up the fruit increase in number. Fruit set is the period from flowering or "bloom" until the end of fruitlet drop, after which the final fruit load is determined.	Mid-September to November
Cell Enlargement and Fruit Growth	Cell enlargement is the period during which cells making up the fruit increase in size. Fruit growth is the period during which the fruit grows and develops.	December to Mid-February
Fruit Maturation and further Fruit Growth	During this period fruit enlarges further and matures internally, meaning that the flavour, sugars and acids reach their optimum levels.	Mid-February to September
Harvest		July to September

It is important to note the term **citrus season** refers to the period from when flower initiation begins to the harvest. The season is generally from the beginning of August of one year to the end of July of the next year, although harvesting may extend to September and October for late cultivars.

6. Citrus Learning Material

The following citrus specific learning material is available from the Citrus Academy:

Skills Area	***Description***
Enterprise Selection, Planning and Establishment	Concerns itself with identifying the various components of an agricultural enterprise, and with the selection and planning processes for a new enterprise, and looks at the physical layout of a farm, with specific reference to infrastructure, orchard layout, etc.
Propagation	Concerns the various methods and requirements for the multiplication of plant material of specific varieties that possess desired qualities.
Crop Establishment	Concerns the establishment of a new citrus orchard, in terms of the physical planting of trees and the care for young trees.
Plant Structures and Functions	Considers the structure and function of various plant parts and the manner in which nutrients, water, air and sunlight is taken up and processed.
Plant Nutrition and Soil Management	Concerns itself with plant nutrients, in terms of the requirements of the citrus plant and the supplementation of nutrient elements through fertilisation, with specific reference to the timing and manner of application.
Water Quality	Considers the various factors that influence water quality and manners in which water quality can be measured and controlled. Considers furthermore the effect of water quality on tree and fruit growth and development, in combination with effective irrigation, fertilisation and pest control.

Skills Area	***Description***
Plant Manipulation	Concerns various types of physical and chemical plant manipulation, with specific reference to pruning, girdling and the application of plant growth hormones, and tools and equipment used for this purpose.
Irrigation	Looks at the technical aspects of orchard irrigation, with reference to the types of irrigation systems, the installation of new irrigation systems, and the repair and maintenance of an irrigation system. Also concerns irrigation scheduling, and measures to ensure effective irrigation.
Pests, Diseases and Weeds	**Concerns the identification of pests, diseases and weeds that threaten citrus production. Also considers various methods of effective control, and the planning required for this purpose.**
Crop Protection	Looks at the practical application of crop protection agents through various methods, with specific reference to tools and equipment used, and health and safety requirements.
Food Safety	Concerns the requirements in terms of health and safety, and environmental control for ensuring food safety and hygiene.
Harvesting	Looks at the process of determining fruit maturity through maturity indexing, the harvesting of fruit, and the tools and equipment used for this purpose.
Conservation	Considers the impact of farming practices on the environment, with reference to the measures required to minimise this impact and protect the environment.
Marketing	Concerns the factors influencing citrus marketing, and the development of an effective marketing plan.
Production Management	Concerns the actions and processes involved in effective production management, with specific reference to the coordination of the various production tasks and processes and the creation of a strategic plan for the enterprise.
Industry Overview	An overview of the citrus industry and the various institutions involved.
Packhouse Practices	Concerns the specific principles and practices that are employed in the packhouse environment, and specifically: • Citrus Product Characteristics • Understanding Citrus Fruit Markets • Health and Safety in the Packhouse • Personal Hygiene Requirements for Packhouse Personnel • Understanding and Maintaining the Cold Chain • The Role of Quality Checks in the Packing Process • The Application of Fruit Treatments • The Application of Pre-Sorting Prior to Packing • Receiving Fruit into the Packhouse • Grading Fruit in the Packhouse • Packing and Packaging Materials • Palletisation of Packed Fruit • Storage of Fruit • Dispatch and Transportation of Packed Fruit • Understanding Automated Packing Solutions

Introduction to the Role of Pests, Diseases and Weeds in Commercial Citrus Production

A citrus farm is a business that has to be managed very carefully for it to succeed. One of the most important factors to consider in citrus production is the impact of pests, diseases and weeds on the success and quality of the crop.

Pests refer to insects and other organisms, including larger animals, that invade, eat, scar, or in any other way harm any part of the plant, such as the fruit, leaves, stems and roots. It is important to know and understand the difference between insects that are pests and insects that are beneficial, and apply control methods that maintains a balance.

The control of diseases is very important in terms of commercial citrus production. Many diseases can render the crop unsuitable for sale. It is important to know what diseases to watch out for, and how to monitor the orchard frequently in order to avoid financial disaster.

Weeds are all plants that compete with citrus trees and cause inferior crop production. It is important to know how to control weeds, and consider control methods that will not cause the ecosystem to become unbalanced, causing a rise in other pests and micro-organisms.

The control of pests, diseases and weeds in commercial crop production is a carefully measured and calculated balancing act, which requires constant monitoring, offset by considerations of financial costs and healthy profits.

Chapter 1

After completing this chapter, the learner will be able to:

Recognise and report on common insects associated with the specific agricultural enterprise

1. Introduction

There are numerous insects and organisms that can be found in a citrus orchard. Some are beneficial, while others are considered pests. The majority of citrus pests are insects, but not all insects are pests. An insect becomes a pest for citrus production when it feeds at a vulnerable stage on the bud, blossom, fruit, branch or leaf, leading to loss in marketable crops or damage to the tree.

A few examples of citrus pests are:

- ***Thrips*** blemish fruit and cause deformation of young leaves
- ***Red mite*** cause damage to older leaves and fruit
- ***Bollworm*** feeds on flowers and young fruit
- ***Fruit fly*** lays eggs in the rind of ripening fruit. The eggs hatch and the larvae penetrate the fruit, where they feed and cause decay.

In comparison with many other citrus producing countries, Southern Africa is plagued by a large number of pest species. The citrus farmer also has to contend with a number of diseases which can cause serious economic loss if not controlled.

It is vital that workers in citrus orchards are familiar with the different organisms so that they are able to report pests and keep an eye on the size of the pest populations. Successful pest control requires immediate action against pest populations before they are too high and damage to the fruit or plants too extensive.

2. The Impact of Pests and Diseases on Citrus Production

Pests and diseases play a major role in citrus production, as this is the single biggest threat to the success of growing and exporting citrus. The first important impact that pests and diseases have on production is the damage that certain pests and diseases cause to trees that may result in lower yields or poor quality fruit. It may even lead to damage that trees are unable to recover from, leading to the loss of productive orchards.

The second important factor is the damage that can be caused to the fruit. The South African citrus industry is export oriented, with about 65% of fruit exported to more than sixty countries all over the world. Consumers in these markets require, amongst other things, fruit that have good external quality with very few blemishes.

Wind is the major cause of cosmetic damage on fruit, occurring when the twigs and branches of the tree scrapes against the fruit in windy conditions. Young fruit are particularly vulnerable to wind damage. Wind breaks are planted to control and minimise wind damage, but it can never be controlled fully. The second cause of external blemishes on citrus fruit is pests, such as thrips, which can be controlled much more effectively than wind. Certain pests and diseases, such as fruit fly, also have an effect on the shelf-life of fruit and may cause accelerated decay.

Thirdly, certain export markets have phytosanitary barriers. Phytosanitary pests and diseases have very important implications for commercial citrus production and food safety. Fruit that are found to be infested with phytosanitary pests and diseases cannot be exported to markets that have phytosanitary restrictions, and entire consignments of fruit can be rejected for this reason.

The term "phytosanitary" literally means "plant safe". Phytosanitary measures have to do with keeping the plants in importing countries safe by ensuring that pests and diseases that are harmful to plants are not spread through imported fruit. The most important phytosanitary pests and diseases for South African citrus producers are:

- Citrus black spot
- False codling moth
- Carob moth (only for Asia)
- Mealybug
- Fruit fly

3. Pest and Beneficial Insects

Pest Organisms

In agriculture, pest organisms are organisms that cause damage to livestock, crops, humans, or land fertility, for instance tsetse fly, fruit fly and malaria mosquitoes. Citrus pests are organisms whose feeding and / or reproductive habits lead to a reduction in the quantity and quality of the citrus fruit produced.

Beneficial Organisms

In agriculture, beneficial organisms are organisms that contribute positively by their habits, for example by feeding on pest organisms or by pollinating flowers to enable fruit development.

Not all insects are pests. Bees are for example good insects since they provide honey and pollinate flowers. There are also insects that attack citrus pests. *Aphytis* and *Comperiella* wasps are **parasites** that lay their eggs in the pest red scale, eventually killing it. *Chilocorus nigritus* ladybird beetles are **predators** that feed on red scale and aphids. These are beneficial insects for citrus production.

The use of beneficial insects requires careful consideration in terms of chemical spray actions. Chemical sprays often eliminate all insects in an area and can also destroy beneficial insects. It is for this reason very important that chemical spray actions that are chosen should affect beneficial insect populations as little as possible.

There is a strong move in organic farming towards creating beneficial insect habitats. This may involve planting specific crops, such as wild fennel, along the borders of orchards to attract specific beneficial insects. Beneficial insects can also be introduced into orchards by purchasing insects that have been bred in laboratory conditions and releasing them in orchards.

4. Pest Damage

Insect damage falls in one of the following categories:

- Stinging
- Biting plant parts
- Sucking plant sap
- Laying eggs in plant parts leading to the hatching of larvae that feed on the plant parts
- Causing rubbing marks on fruit with their legs or bodies

- Leaving access points for secondary insects or diseases
- Serving as a vector for other diseases

Vector

A vector is an organism, such as an insect, that transmits disease-causing micro organisms from infected plants to other plants.

5. Common Citrus Pests

The most common citrus pests are described in the ***Identification Manual for Citrus Pests and Their Natural Enemies***, which is prescribed material for this learning program.

The Identification Manual is published by Citrus Research International for the Southern African citrus industry. The manual shows and describes what each pest looks like at various stages during its development and the damage that the pest causes.

6. Controlling Pests in Citrus Orchards

The following main control measures are used for controlling pests in citrus production:

- ***Contact chemical sprays*** that usually affect the insect that comes in contact with the chemical by moving over the area where the chemical has been applied or that chews or sucks on the plant where the chemical has been applied.
- ***Systemic chemicals*** that penetrate the plant parts and poison insects when they chew or suck the plant parts.
- ***Beneficial insects*** that act either as predators or as parasites. Predatory insects prey on the pest insect, while parasites attack pest insects by for example laying their eggs in the pest insect.
- ***Pheromone-based techniques*** that for instance disrupt the mating of insects or work on an attract-and-kill basis.
- ***Traps*** that attract the insects to a device that traps them or contains poison that they ingest.
- ***Cultural control*** that is aimed at minimising the pest pressure in the orchard, and includes practices such as orchard sanitation, tree-banding, skirting, and ground cover trimming.

Chapter 1

- The main impact of pests and diseases on commercial citrus production is damage to trees that may lead to lower yields and poorer quality fruit, damage to fruit that may render it non-exportable and the presence of phytosanitary pests and diseases that may lead to export rejections.
- All insects are not pests.
- Pests are those insects which reduce or damage the crop quality and quantity.
- Beneficial insects assist in pest control through predatory or parasitic behaviour.
- Insects damage plants by sucking, stinging or chewing the plant parts, laying eggs on or in plant parts, damaging the surface of fruit when moving over it, causing access points to other

pests or diseases, or by acting as a vector for other diseases.
- Numerous control measures exist for controlling pests, including chemical sprays, systemic chemicals, beneficial insects, and traps.
- Chemical spays are not the only option for controlling pest populations.

Complete activities 1 and 2 in the **Learner Workbook**.

Chapter 2

After completing this chapter, the learner will be able to:

Recognise common symptoms of diseases

1. Introduction

Healthy Citrus trees produce healthy fruit that can be sold for a healthy profit. Citrus diseases attack specific parts of the tree and might cause damage to the tree itself, or the crop it bears.

A citrus plant is healthy and normal when it can carry out its physiological functions. These physiological functions are:

- The absorption and transportation of water and nutrients
- Photosynthesis and transpiration
- Division and elongation (growth) of cells in order to grow
- Differentiation of specialised organs such as flowers, buds and fruit, for example forming fruit from fertilised flowers and allowing these fruit to ripen

These physiological functions are described in detail in the learning material dealing with Plant Structures and Functions.

2. Disease Classifications

Plant Disease

A plant disease can be described as an impairment of the plant's functions through organisms such as fungi, bacteria or viruses.

Plant diseases are classified as **biotic** or **abiotic**.

2.1. Biotic Diseases

Biotic diseases are caused by micro-organisms such as fungi, bacteria or viruses. Some disease-causing agents are restricted to certain parts of the plant, such as the root, trunk or fruit, while others may affect several or all parts of the plant.

2.1.1. Fungal Diseases

Fungal diseases are caused by organisms called fungi. Fungi attack plants by attaching to the plant surface and feeding on the plant by dissolving the tissue to absorb the nutrients.

Fungal diseases can be mitigated or reduced through canopy management actions that reduce humidity in the orchard and increase airflow. Humidity creates a suitable environment for fungi. Fungal diseases can also be treated through chemical applications.

The most common fungal diseases in citrus are:

- *Phytophthora*
- *Pythium*
- *Fusarium*
- Black spot
- Anthracnose
- Melanose
- Algal disease
- Damping off
- Albinism
- *Alternaria* brown spot
- *Alternaria* core rot
- Sooty mould
- Citrus scab
- Penicillium
- *Diplodia*
- Trichoderma

2.1.2. Viral Diseases

Viral diseases are caused by viruses, which inject their genetic material into the plant (the host) to multiply. Viruses destroy their host's cells because the host cell bursts when it releases the new viruses. Viral diseases often have no cure and trees have to be replaced.

The most common viral diseases in citrus are *Tristeza* and *Exocortis*.

2.1.3. Bacterial Diseases

Bacterial diseases are caused by organisms that reproduce very quickly. The most common bacterial diseases in citrus are Citrus Canker, Pseudomonas leaf spot and greening disease.

2.2. Abiotic Diseases

Abiotic diseases are caused by adverse environmental conditions, nutritional deficiencies or excesses, genetic defects and incorrect cultural practices. Abiotic diseases are best treated through prevention, which implies sound cultural and production management practices.

3. Disease Symptoms

Disease symptoms develop because there is an interference with the plant's functions. Unlike insect pests, which can be detected in the orchard, diseases are often not detected until the plant already shows symptoms of the disease. It is important that orchard workers know what healthy plants look like and that they are on the look-out for disease symptoms and signs that plants are affected by disease.

It is however always important to remember that many disease symptoms are similar to those of nutrient deficiencies or other abiotic conditions. The presence of symptoms does therefore not automatically mean that the disease is present. All diseases must be diagnosed and confirmed by experts. The most common disease symptoms are:

- Wilting
- Discolouration of plant material
- Gum formation (gummosis)
- Dieback
- Postharvest fruit rot

3.1. Wilting

If plants wilt and it is not due to a lack of water, it may be an indication of disease. Wilting may be occurring because nutrients and water cannot move to the different plant parts, because the transportation system of the plant (the xylem and phloem) may be affected.

This may be due to the transportation vessels being blocked by the disease-causing organism or to scarring or cancer formation inside the transportation vessels in response to the disease organism. It can also be due to the disintegration of specific plant parts, such as the roots.

Examples of diseases that may cause wilting are root rot caused by *Phytophthora* or *Pythium* spp., collar rot, caused by *Phytopthora* spp., and seedling damping-off in nurseries, caused by *Fusarium oxysporum*.

3.2. Discolouration

Some diseases can be detected by a change in the colour of plant parts, such as yellowing of leaves or greening of fruit.

For example, necrosis, which is when a part of the tissue is damaged and forms a dry spot, is seen when parts of the plant tissue dies and forms brown or black dried masses on the affected plant parts. This is most often recognised by dry spots on the leaves, and is often caused by fungi such as *Alternaria*.

Chlorosis (yellowing) of foliage is often caused by malnutrition due to a inefficient water and nutrient uptake as the result of damage to root systems by *Phytopthora* spp. This is an early symptom of root rot.

3.3. Gum Formation (Gummosis)

Gummosis is widely encountered throughout the plant kingdom. Gum formation in plants is induced by environmental stress factors such as infection, insect attack, flooding, and mechanical injury.

Gum formation on the trunk or branches is the most commonly observed symptom of gummosis. Gum forms and protrudes from blisters containing gum pockets, usually located on the trunk. The wood beneath the blister shows a pink-orange or brown discolouration.

Several factors such as plant pathogens (*Phytophthora* spp), cold damage, a high water table, and salt accumulation may cause gummosis. It is believed to be a condition of weak and injured trees.

Gummosis is part of the plants defence mechanism and attempts to seal of or to prevent an infection. It is common with *Phytophthora* bark and collar rot and with *Diplodia* infections. Citrus gum is water soluble and disappears after heavy rains.

3.4. Dieback

Twig dieback can be caused by fungi, although non-pathogenic factors may play a more important role. As a result, fungal infection is often secondary, following freeze damage or damage resulting from mechanical or chemical injury. Other factors that can damage twigs are excessive fertilisation, moisture stress, damage to the root system by cultural practices, heavy red scale infestation, or heavy nematode damage.

Affected young branches die back 2.5 cm or more from the tip. Damage to the tree from twig dieback usually is not severe.

4. Common Citrus Diseases

At the end of this manual is an addendum that contains information on the most common diseases in citrus production, with photographs and descriptions of the symptoms of and damage caused by each disease, a summary of the seasonal activity associated with the disease, and details on the commonly used control measures.

Citrus diseases are classified in three main categories, being fruit and foliar diseases, soil-borne diseases, and graft-transmissible diseases. This classification is used in the table.

Chapter 2

- Diseases in citrus are detected through the presence of their symptoms.
- Diseases are caused by micro-organisms, such as bacteria, viruses and fungi.
- Fungi grow on the plant parts and are more likely to occur in humid conditions.
- Viral diseases destroy their host and prevention is the only means of control.
- Bacterial diseases spread very rapidly and are very difficult to control.
- The most common disease symptoms are wilting, discolouration, gum formation and dieback of plant parts.
- Citrus diseases are classified as fruit and foliar diseases, soil-borne diseases, and graft-transmissible diseases.

Complete activities 3, 4 and 5 in the **Learner Workbook**.

Chapter 3

After completing this chapter, the learner will be able to:

Identify by common name the types of weeds present in the field

1. Introduction

Weeds

"Weeds" is the generic word for plants growing in a place where they are not wanted. Weeds become important in commercial farming when they damage crops or poison domestic animals.

Alien Plants

Alien plants are plants that originate from other countries or areas. Alien plants were brought to this country or region for economic or ornamental reasons.

Invasive Plants

Invasive plants are alien plants that have become harmful to the natural ecosystem. Not all alien plants are invasive – in South Africa only 2.5% of plants that are introduced become invasive. Invasive plants do not have natural enemies or other limitation on their growth. They tend to overrun ecosystems that they are introduced into. Invasive plants are a major threat to biodiversity and ecosystem stability.

Weeds impact on successful citrus production because they:

- Compete with citrus trees for water and nutrients
- Increase the risk of fire because they increase the plant density and dry plant material
- Increase the risk of frost because the height of plants brings the frost zone closer to citrus trees
- Provide a host for pests and diseases
- Provide access to the plant for ants, which are disruptive to biological control measures

2. Common Weeds on Citrus Farms

Almost any plant found in a citrus orchard, other than a citrus tree and plants that are used as cover crops, can be considered a weed. There is however some weeds that are also invasive species and they pose a considerably greater threat than other unwanted plants. In terms of commercial farming, invasive plants are the most dangerous weeds, because they are not susceptible to the pests and diseases that the citrus tree may be subjected to, and because they are effective at competing with the citrus tree for water and nutrients.

For the purpose of this guide, we will discuss the list and identification of invasive plants that are most frequently found in citrus-growing areas. Please note that this list does not include all invasive plants and that other invasive species may also be found in your geographical area.

Invasive plants have been categorised by the Botanical Society of South Africa and the Agricultural Research Council (ARC) into three categories, depending on the threat that they hold for indigenous plant and animal species.

2.1. Category 1 Invasive Plants: Declared Weeds

Category 1 invasive plants are specific plants that have been identified as weeds and that are prohibited by the Department of Agriculture. If these plants are found on a farm one is obligated by law to eradicate them.

The plant species have been included in this list for one or more of the following reasons:

- They pose a serious health risk to humans or livestock
- They cause serious financial losses to land users
- They invade undisturbed environments and transform or degrade natural plant communities
- They use more water than plants they replace
- They are particularly difficult to control

Most of the plants in this category produce copious numbers of seeds that are dispersed by wind or birds, or they have highly efficient means of vegetative reproduction.

While some of these plants have no obvious function to fulfil in South Africa and are generally regarded as undesirable, many of them are popular garden or landscaping plants. It is important to look in house gardens on farms for invasive plants that might spread to citrus orchards.

What all these species have in common is that their harmfulness outweighs any useful properties they might have. Care was taken not to include a plant in this category if part of the population of South Africa would suffer if it were eradicated.

Common Name	***Botanical Name***
Triffid Weed (Chromolaena)	*Chromolaena odorata*
Lantana	*Lantana camara*
Barbados Gooseberry (Pereskia)	*Pereskia aculeata*
Bugweed	*Solanum mauritianum*
American Bramble	*Rubus cuneifolius*
Red Sesbania	*Sesbania punicea*
Mauritius Thorn	*Caesalpinia decapetala*
Inkberry	*Cestrum laevigatum*
Balloon Vine	*Cardiospermum grandifl orum*
Field Bindweed	*Convolvulus arvensis*
Perennial Morning Glory	*Ipomoea indica*
Madeira Vine	*Anreda cordifolia*
Water Hyacinth	*Eichhornia crassipes*
Brazilian Pepper Tree	*Schinus terebinthifolius*
Yellow-Flowered Mexican Poppy	*Argemone mexicana*
Montanoa Tree Daisy (spreading in area)	*Montanoa hibiscifolia*
Camphor	*Cinnamomum camphora*
Indian Laurel	*Litsea glutinosa*

Table 3.1: Category 1 Invasive Plants: Declared Weeds

2.2. Category 2 Invasive Plants

Category 2 invasive plants have the potential to become harmful, but have certain beneficial properties that warrant their continued presence under certain circumstances. There are strict control measures for where category 2 plants are grown, including:

- The land user must obtain a water use license
- The plants may not be planted within 30m of the 50-year flood-line
- The plants are only allowed in demarcated areas under controlled conditions
- The plants have to primarily serve a commercial or utility purpose, such as a woodlot, windbreaks, building material, animal fodder, soil stabilisation, medicinal or own consumption
- All reasonable steps must be taken to curtail the spreading of seeds or vegetative reproductive material outside the demarcated area
- All specimens outside the demarcated area have to be controlled
- The conditions under which the plants are cultivated must be controlled
- Plants may only be sold by permit holders

Common Name	***Botanical Name***
Guava and Hybrids	*Psidium guajava*
Johnson Grass	*Sorghum halepense*
Leucaena	*Leucaena leucocephala*
Castor Oil Bush	*Ricinus communis*
Black Wattle	*Acacia mearnsii*
Silver Wattle	*Acacia dealbata*
Blue Gum	*Eucalyptus grandis*
Pine Trees	*Pinus patula/elliottii*
Beefwood	*Casuarina cunninghamiana*

Table 3.2: Category 2 Invasive Plants

In table 3.3 is a list of other species currently recommended for listing as Category 2 invaders.

Common Name	***Botanical Name***
Couch Grass (Kweek)	*Cynodon dactylon*
Perennial Ryegrass	*Lolium perenne*
Kikuyu	*Pennisetum clandestinum*
Napier Grass	*Pennisetum purpureum*

Table 3.3: Category 2 Invasive Plants – Recommended for Listing

2.3. Category 3 Invasive Plants

Category 3 invasive plants have the proven potential of becoming harmful, but most of them are popular ornamentals or shade trees that will take a long time to replace. A few of them were placed into this category instead of into category 1 because they do not cause problems in all situations.

Reproductive material from these plants, such as seeds and cuttings, may no longer be propagated, imported, bought, sold or traded in any way. Category 3 plants may only be planted with special permission and may not be planted within 30m of the 50-year flood-line. It is legal to trade in the wood and other products that do not have the potential to grow or multiply.

Common Name	***Botanical Name***
Syringa	*Melia azedarach*
Peanut Butter Cassia	*Senna didymobotrya*
Annual Morning Glory	*Ipomoea purpurea*
Jacaranda	*Jacaranda mimosifolia*
Orange Cotoneaster	*Cotoneaster franchetii*
Loquat	*Eriobotria japonica*
Australian Silky Oak	*Grevillea robusta*
Common Mulberry	*Morus alba*

Table 3.4: Category 3 Invasive Plants

Invasive Plants Used in Citrus Production

It is interesting to note that there are two invasive plant species that are commonly used as windbreaks on citrus farms, this being *Casuarina cunninghamiana* (category 2) and *Grevillea robusta* (category 3).

Grevillea is no longer recommended for use, but is still found on some farms. *Casuarina* is still widely used, in line with the regulations set out in the section on category 2 plants above, being that they are planted for a specific commercial purpose in controlled, demarcated areas. It is very important to be aware of the status of the plant, so that one can ensure that it is not planted within 30m of the 50-year flood-line and that it is not allowed to spread outside the demarcated area.

3. Weed Control Methods

The following methods are commonly used in commercial crop production to control weeds:

- Chemical control (herbicides)
- Manual control
- Biological control
- Cover crops
- Mulching

3.1. Chemical Control (Herbicides)

Chemical control means spraying agricultural herbicides. Some herbicides react to different types of weeds, while others are very specific and target only a specific category of weed, such as broad-leaved plants. Herbicides are classified according to how they react with the weed in order to eradicate it, being as:

- ***Contact herbicides*** burn the top growth of the weed
- ***Systemic herbicides*** is taken up by the plant and poisons it

Chemical applications of herbicides usually involve application in a liquid form through for instance backpack applications.

It is very important that herbicides are only applied as recommended and instructed. It is also important to take precautionary measures to prevent the herbicide from causing damage to or killing citrus trees. For example, herbicide instructions will often state that the herbicide should be applied at the base of the plant, or that young trees should be shielded during application. Instructions such as these must be followed with great care.

Measures that can be taken to prevent damage to citrus trees include:

- Never spray herbicides in windy conditions, because the spray drift may cause the herbicide to end up on the citrus plants.
- Apply the herbicide with a nozzle that has a cover around it to prevent the chemical from drifting. Keep the cover tightly against the ground or weed surface during application.
- Place screens or covers around the trunks of citrus trees, especially young trees.

Herbicides contain chemicals that may leave residues on citrus fruit, depending on how it was applied. There are very strict guidelines with regards the maximum residue levels (MRLs) of certain chemicals that are allowed on export fruit. MRLs are set internationally to ensure that the fruit we grow are safe for human consumption.

For more information on which types of herbicides are allowed and how much one can apply before exceeding the MRL, visit the website of the Citrus Growers Association at www.cga.co.za. Although the product label also provides information on the withholding period for the chemical, this will generally only apply to South Africa, and not to the export markets for which the fruit is destined. The CGA's publishes and regularly updates a *Recommended Usage Restrictions for Plant Protection Products on Southern African Export Citrus* document that must be consulted.

3.2. Manual Control

Manual control of weeds means take some type of physical action against the weed plant in order to damage or destroy it, such as:

- Flattening the plant
- Removing the above soil parts of the plant (mowing or slashing)
- Removing the entire plant

Manual control often involves physical labour, such as pulling weeds up by hand or chopping the plants off with spades and pangas. Mechanical equipment is also sometimes used, such as slashers, mowers, and chainsaws.

It is important to choose the correct manual eradication method, at the correct time of year in order to have a lasting impact on the weeds. Never try to perform manual methods of weed eradication on weeds or alien species that have gone to seed or are in flower, as the method is likely to spread the seeds and cause a bigger problem in the future. Always try to eradicate weeds before they form seeds. If the weeds have already formed seeds, herbicides might be a preferable method of control.

If the weeds are not listed as invaders, it may be suitable to simply chop them down with a panga, spade or mechanical slasher.

When eradicating invasive species, manual control requires removal of the entire plant, with roots and all. Sometimes this may be a difficult task as the roots of trees such as Wattles grow very deep.

It is important to fell trees safely and correctly. Felling trees is a dangerous action and has to be supervised. It should only be performed by someone who is trained in tree felling. When felling trees near electrical wires it is best to call in the assistance of the local municipality or Eskom. It is also important to follow up felling of invasive trees with secondary control methods, such as the manual application of diesel or herbicides, in order to prevent secondary growth.

3.3. Biological Control

Biological control, or biocontrol, means introducing the alien plant's natural enemies to the habitat in order for these natural enemies to subdue the vigour of the invasive plants. The aim is to remove the plant's competitive advantage until its vigour is reduced to a level comparable to that of the natural vegetation. Natural enemies that are used for biological control are called **biocontrol agents**.

In the control of alien plants, the biocontrol agents used most frequently are insects, mites and pathogens. Biocontrol agents target specific plant organs, such as the vegetative parts of the plant (leaves, stems and roots) or reproductive parts (flowers, fruits and seeds).

The choice of biocontrol agent depends on the aim of the control project. If the aim is to get rid of the invasive plant species, scientists select the biocontrol agent that causes the most damage. In such projects, scientists may use agents that damage the vegetative parts of the plant as well as agents that reduce seed production. Examples of suitable biocontrol agents are:

- Beetles or moths with stem-boring or root-boring larvae
- Moths, beetles or flies with leaf-mining larvae
- Midges, flies, wasps, mites or fungi that cause plant galls
- Beetles, wasps or moths that feed on leaves as larvae and / or adults
- Bugs, cochineal insects or mealybugs that suck plant sap
- Moths, beetles or bugs that damage developing or mature seeds during part of their life cycle
- Fungi that cause plant diseases.

In some cases it may be dangerous to apply biological weed control in an agricultural crop production area. The biocontrol agent might easily become out of control and cause damage to the crop. Biocontrol agents can only be used if the crop plants are not susceptible to damage by the agent, and if the biocontrol agent will not harm the ecosystem to the extent where it might cause other pests and diseases to flare up.

For more information on biocontrol agents, please contact the ARC Plant Protection Research Institute (ARC-PPRI) or the CRI.

3.4. Cover Crops

Cover crops grow in the rows between trees to suppress the germination of weeds. The cover crop either overgrows the weeds, or grows in the rows where weeds usually appear and in this way leaves no space for weeds to germinate. Cover crops also have the advantages of preventing erosion, retaining soil moisture, and possibly serving as secondary income or as livestock feed.

However, in citrus production, due to the shortage of water between citrus rows and the increasing use of drip irrigation within the row, few orchards are suitable for the sowing of cover crops. The use of nematicides on the soil under citrus trees may also render the cover crop poisonous and therefore unusable as livestock feed. Vegetation that naturally springs up in an orchard is very often the best cover crop, as it is what is naturally suited to that environment.

In citrus production, ground cover, whether made up of the naturally occurring vegetation or purposely planted, should have the following advantages:

- Creation of a favourable microclimate for biocontrol (elevated humidity, moderation of temperature).

- Provision of a refuge for natural enemies, such as predacious mites, lacewings, lady beetles, particularly when the environment in the trees becomes unfavourable, such as when pesticides are used.

- Provision of food for natural enemies, for example pollen and insects for predacious mites, and nectar and dew for wasp parasitoids.

- Reduction in ant problems through an increase in species diversity that is enhanced through diversity of vegetation.

The most common cover crop used in citrus is Rhodes grass. Its pollen is reported to be beneficial to predatory mites. Inter-rows can be mown alternately so that some plants are left to flower.

3.5. Mulching

Mulch is a substance that is laid on the soil surface to suppress the germination of weeds. One of the following materials is generally used for mulching:

- Gravel or stones
- Straw or hay
- Shredded carton
- Dried pips or nut shells
- Compost
- Chipped bark and twigs
- Leaves
- Plastic sheets

Mulching has the added benefits of:

- Improving soil moisture conditions by reducing evaporation from the soil

- When organic mulches are used, increasing soil decomposition organism populations which in turn increases the soil fertility by breaking down organic material and improving soil structure

- Reducing soil temperatures

Citrus farmers must be very careful when using mulch. Organic substances in the soil may affect the colour development of citrus crops adversely. It is recommended that the choice of mulch be carefully considered and that experts are consulted before using mulches that may disintegrate and add organic acids to the soil.

Chapter 3

- Weeds are any plants that are not wanted in the area where the citrus crop is produced.
- Invasive plants are plants that come from a different country or area and that have no natural enemies in the specific area.
- Invasive species pose a threat to ecosystems and can cause the decline of natural vegetation and beneficial organisms.
- Invasive plants have been categorised by the Botanical Society of South Africa and the ARC into three categories.
- Category 1 plants have to be removed wherever they are found and category 3 plants are the least threatening.
- Weeds and invasive plants can be controlled through manual or chemical actions or through the introduction of biocontrol agents.

- Weed germination can be suppressed through the use of mulch or cover crops.

Complete activities 6 and 7 in the **Learner Workbook**.

Chapter 4

After completing this chapter, the learner will be able to:

Observe and distinguish between old and new damage and report accordingly
Notice and assist with monitoring of pests (scouting) and explaining if pest levels have not decreased after spraying or other control measures were applied

1. Introduction

Scouting

Scouting means observing orchard and plant conditions in order to gain information about the visible signs and symptoms of pests and diseases. It involves looking at strategic positions in orchards and recording pest numbers, disease symptoms.

The presence of pests and diseases in a citrus orchard is often detected by the damage caused to the citrus tree, the fruit and in the orchard. These symptoms of pests and diseases are important indicators of their presence.

To detect the presence of pests and diseases it is necessary to scout orchards repeatedly in a structured and organised manner. These inspections should be done regularly and could be done in conjunction with inspections for weed densities, and crop nutrient and water status. Scouting is aimed at identifying the pest or disease species that are **present** and the **extent** of infestation. If it is not possible to accurately identify the pest or disease responsible for the damage that has been caused, an expert in the field should be asked for assistance.

2. Pest and Disease Scouts

Successful scouting depends on the scouts used to inspect the orchards. Scouts must have excellent vision and a positive attitude to their job, and they must be well trained to understand the principles of scouting so that results are not biased.

Apart from initial training in basic identification of pests, damage symptoms and natural enemies, scouts must be kept informed of new developments and research findings in the field. If it is for instance determined through research that a specific pest has spread to a new area, the scouts must be informed immediately to be on the lookout for it.

3. Scouting Procedures

Experienced scouts are often able to do what is referred to as an "impression survey". This is a general examination of the orchard and the plant condition, and of the insects that are present. It gives the experienced scout a fairly accurate idea of the pest and disease prevalence in the orchard. This is however not always accurate and very difficult to verify by management.

It is much more effective to have a specific scouting procedure in place that all the scouts are familiar with. A formal scouting strategy that includes all the necessary procedures – including reporting and recordkeeping procedures – is much easier to supervise and monitor.

Scouting procedures normally include the following:

- Selecting permanent data trees
- Unit inspections
- Pest traps
- Cursory examinations
- Recordkeeping and reporting

3.1. Selecting Permanent Data Trees

Permanent data trees are specific, representative trees in each orchard or block from which data is collected during every inspection. The number of trees per orchard or block depends on the size of the orchard or block, with five trees per hectare as the general recommendation.

Assumptions about the pest and disease status of the entire orchard or block are made based on the data collected from the permanent data trees. They must therefore be representative of the general conditions in the orchard.

Trees can be selected diagonally across the block, starting with a tree in one of the corners as shown below.

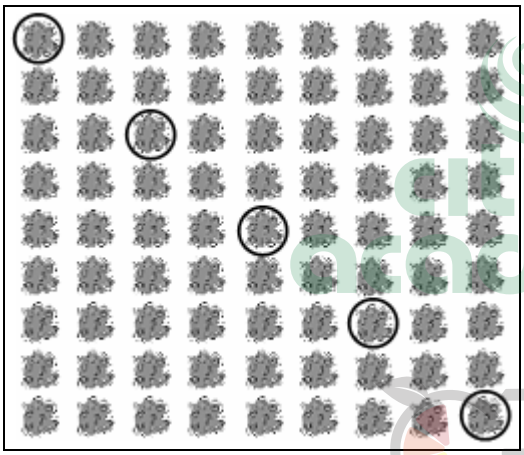


Figure 4.1: Permanent Data Tree Selection

In larger orchards, the trees can be selected along a V- or W-shaped path. Numbered markers should be fixed to the permanent data trees so that they are easily recognisable.

Apart from permanent data trees, scouts should be aware of specific areas of the orchard that are more vulnerable to infestation of specific pests. Thrips and false codling moth is for example more prevalent in areas close to windbreaks, especially if silky oak is used as windbreak trees. Red scale and other sucking insects are often more prevalent in trees close to dusty roads. These areas must be scouted in addition to the permanent data trees.

3.2. Unit Inspections

"Unit" refers here to specific plant parts, such as terminal twigs, leaves, fruit, blossoms, or new growth clusters. "Unit inspection" means when a scout inspects a type of unit on a permanent data tree for pest and disease damage. The unit that will be used depends on the pest or disease that is being scouted for. As a rule, ten units per tree are inspected, and the presence or absence of the pest is recorded on the scouting form.

It is important that scouts are properly equipped for unit inspections. Generally, scouts inspect the selected trees with the naked eye. It is also however necessary to do microscopic evaluations where more information is required. Microscopic evaluations are done with the help of a handheld magnifying glass. They are very useful for determining for example whether scale insects are alive or dead (and in what proportion), and the level of parasitism of scale insects, and to get a more

accurate indication of infestation levels of very small insects, such as mealybug crawlers underneath the calyx and silver mite.

3.3. Pest Traps

Traps that can be used to monitor insect populations have been developed for specific pests. Traps contain substances that attract specific pest insects, where they are then caught and retained. The scout opens the trap on at regular intervals and counts and records the number of insects inside. Traps are placed in the orchard according to the manufacturers instructions.

3.4. Cursory Examinations

The unit inspection is supplemented by a cursory examination of the tree in order to gain a general impression of the populations of beneficial and pest insects. The presence of insects such as ants will for instance be noted during this examination. The impressions gained during the examination are recorded as general remarks on the scouting form.

3.5. Recordkeeping and Reporting

Scouting records must be kept of all observed damage, the cause of the damage, and actions taken to eradicate the pest or diseases causing the damage. During scouting a scouting form is completed, such as in the example below.

Scouting Form

Name:						**Orchard:**					
Pest:						**Date:**					
Fruit / Leaves / Twigs											
		Inspection Unit									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Totals**
TREE NUMBER	**1**											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
General Observations:												

The data from the scouting form is transferred to a permanent record. The current pest and disease activity in this orchard can now be compared to historical information, and to the information from other orchards.

4. Old and New Damage

An important aspect of scouting is distinguishing between old and new damage to the plant. The same person or team of people should be responsible for scouting a specific area on a regular basis, because they will be in a better position to recognise new damage.

Old damage means damage that was caused at some point in the past by a pest, disease or organism that might already have been eradicated. Old damage can be identified through old scars, which may include scar tissue on the branches or trunks of the trees.

New damage is a sign that a new pest, disease or organism is present and causing damage. New damage is for instance injuries that have not yet healed or dried out. If new damage is found it must be reported and dealt with immediately, before the pest, disease or animal causing the damage becomes a major problem.

5. Timing of Symptoms

Certain symptoms occur at specific points in the production cycle or at a specific time of the year. This may be because climatic conditions have become favourable for the emergence of that specific pest or disease, or because the plant has reached a point in its growth cycle where the fruit or flowers are attracting specific types of insects.

Below are guidelines for the appearance of specific types of pests and diseases:

- ***Chewing and sucking insects*** will most likely be found when the plant part which they feed on is still young and tender.
- ***Stinging and egg-laying insects*** are usually found after the fruit has already formed. Their larvae can however occur at any time, normally when the plant part on which they feed appears.
- ***Vector insects*** appear unpredictably.
- ***Fungal infections*** are most likely to occur under humid conditions. Rain and heat increase the humidity in orchards if airflow is hampered.
- ***Phytophthora*** could occur during heavy or prolonged rainy periods, because water-logged soil conditions promote the development of the disease.

Because climatic conditions have an impact on the occurrence of pests and diseases, it is therefore important that these records are also kept and consulted when scouting. Records about the development of the plants, for instance containing information on when flowering commenced, will aid further in predicting the occurrence of pests and diseases.

6. Assessing the Impact of Pest Damage

As discussed previously, the damage caused by pests and diseases has a significant economic impact on the profitability of a citrus farm. It is however necessary to be able to assess when damage may lead to economic losses.

We have already seen that pests and diseases attack various parts of the citrus plants. In terms of short-term economic losses, damage done to the fruit is the most significant factor. Pests and diseases that cause cosmetic damage that may render fruit non-exportable are for instance red scale and thrips, while phytosanitary pests and diseases that may render fruit non-exportable are for instance false codling moth, fruit fly and citrus black spot.

Pests and diseases however also cause damage that may lead to economic losses in the longer term. These are more notably the pests and diseases that attack the tree and negatively impact on its ability to produce fruit. A good example here is greening disease. Greening disease limits the ability of trees to take up nutrients, and will kill tree in the end.

Threshold values, also referred to as action levels, have been established for most pests, and indicate the pest density at which suppression measures should be implemented in order to prevent the pest population from reaching the economic injury level. Threshold values are expressed in different ways, e.g. pest per square cm, insect per trap, etc. Below is an example of threshold values.

Treatment Thresholds - Citrus Thrips

Below are the suggested intervention thresholds for citrus thrips on citrus fruit. To prevent more than 1% cull, treatments should be applied when these numbers are exceeded.

Damage Risk Period	***Mean Infestation Over 1 Week***		***Mean Infestation Over 2 Weeks***	
	Fruit with Larvae (%)	**Fruit with Adults or Larvae (%)**	**Fruit with Larvae (%)**	**Fruit with Adults or Larvae (%)**
Petal Fall - 4 weeks	2	4	1	2
5-6 weeks	3	6	2	4
7-8 weeks	4	8	3	6
9-10 weeks	5	10	4	8
11-12 weeks	6	12	5	10

7. Application of Plant Protection Products

The application of plant protection products is discussed in detail in the learning material for unit standard **116125 – Apply Plant Protection Products Effectively and Responsibly**, which can be obtained from the Citrus Academy.

In this learning material, the various application methods, the equipment that is used for each method, the application procedures, and the health and safety measures that must be applied when handling the products are discussed in detail. Below is a summary of this information:

- The two steps in planning for the protection of citrus crops against pests and diseases are the compilation of a crop protection program and pre-application planning.
- The most important components of pre-application planning are the plant protection products, application methods, application equipment and health and safety requirements.
- Plant protection products are classified as pesticides, fungicides and herbicides.
- Plant protection products must be registered with the Department of Agriculture for specific uses, and may only be used for the purpose for which they are registered.
- The information displayed on the product label is full usage instructions, a physical description, the chemical composition, the toxicity, the pre-harvest interval and the expiry date of the product.

- The crop protection manager must ensure that the required products are available in sufficient quantities.
- Application methods that are mostly used are foliar sprays, trunk applications and soil drenches.
- The four main types of foliar applications are outside cover sprays, medium cover sprays, full cover sprays, and bait sprays.
- The equipment requirements are calculated based on the area of application, the period available for the application and the number of workers available.
- Knapsacks, handguns, mistblowers (spray machines) and crop sprayer aircraft are commonly used for foliar applications, depending on the size of the trees and the spray requirements.
- Calibra applicators or paint brushes are mostly used for trunk applications.
- Measuring cups and jugs are used for soil drenches.
- The health and safety requirements include the use of protective gear and safety equipment and posting emergency contact details in an accessible place.
- The protective gear and safety equipment that are required is indicated on the label of each product with pictograms.
- The pre-application checklist must include all the information required to complete the application.

All chemicals should be considered hazardous until indicated otherwise. Plant protection products can be hazardous to humans, animals and to the environment. When PPPs are being applied, health and safety regulations must be strictly observed.

In terms of planning for PPP applications, the requirements for protective gear and safety equipment for the particular chemical must be known to all who will take part in the application. The contact numbers for emergency services must be displayed prominently and in a place where all workers have access to the information.

All pest, disease and weed control actions also have an impact on the environment and on the ecosystem. The most important principles to remember are:

- The method of pest, disease and weed control should not harm or degrade the natural resources, such as the soil, water or ecosystem.
- The method of pest, disease and weed control should not cause an imbalance in the ecosystem that might cause an increase in the prevalence of other pests, diseases and weeds.

For detailed information on environmental considerations related to citrus production, please refer to the Citrus Academy learning material related to Conservation.

8. Post-Application Monitoring

Once plant protection products have been applied, it is essential that the efficacy of the application is monitored, both in terms of its impact on targeted pests and diseases and on beneficial insects.

Scouting must continue as per usual after treatments have been made. From the recorded data, it is possible to determine whether there has been a decline in pest level and if this level is now below the action threshold. The recorded and plotted monitoring data would speak for itself.

Where it is found that treatments did not have the desired effect, alternative treatments may be considered. It is advisable to consult an expert in this regard, as this may be an indication that the specific pest is resistant to the prescribed treatment.

Chapter 4

- Scouting means observing orchard and plant conditions in order to gain information about the visible signs and symptoms of pests and diseases.
- Scouts must have excellent vision and a positive attitude to their job, and they must be well trained to understand the principles of scouting so that results are not biased.
- A formal scouting strategy is required for each production unit, and should include all the necessary procedures including reporting and recordkeeping procedures.
- Scouting procedures normally include selecting permanent data trees, unit inspections, pest traps, cursory examinations, and recordkeeping and reporting.
- Old damage refers to damage that was caused before by pests and diseases that have probably already been eradicated and new damage refers to new injuries to plants that are caused by a new outbreak of a pest or disease, which should be identified and dealt with.
- Certain symptoms occur at specific points in the production cycle or at a specific time of the year.
- Recordkeeping of pest and disease populations, damage found and actions taken will assist in active pest and disease control.
- Recordkeeping of climatic conditions and the developmental stages of the plant aid in predicting the occurrence of pests and diseases.
- Threshold values indicate the pest density at which suppression measures should be implemented in order to prevent the pest population from reaching the economic injury level.

Complete activities 8, 9, 10 and 11 in the **Learner Workbook**.

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Table of Common Citrus Diseases

Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Fruit and Foliar Diseases				
Alternaria Navel-end rot	  	• Fungal disease • Fungus grows on dead tissue during wet weather, producing airborne spores that infect stylar-end of fruit (opposite to stem-end)	• Premature colouring • Fruit drop • Rot not always evident on outside of fruit • At later stage, frequently not until after harvest, dark slightly sunken spot appears on stylar-end • Rot may cover up to one fourth of the fruit • Internally, tips of segments show dark rot • Juice has unpleasant taste	• Minimise stress on tree through proper irrigation and fertilisation • Remove infected fruit • Chemical applications at balloon and 80% petal drop
Botrytis		• Fungal disease • Appears mainly on lemon fruit, but may infect twigs and small branches of lemon trees • Infects through injuries	• Forms grey, velvety mats of on infected tissue, causing the surface of fruit to be bumpy • Infected twigs may die back several inches	• General preventive measures, such as avoiding mechanical injury, protecting against frost and brown rot, and pruning

Table of Common Citrus Diseases

Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Phaeoramularia	 	• Fungal disease • Infection prevalent with wind-blown rains when susceptible young leaves and fruit are present and temperatures are warm • Not yet a problem in South Africa	• Brown or greyish spots up to 1.3cm in diameter on leaves and fruit, usually surrounded by yellow halos • Lesions, often flat or sunken, which differ from those of citrus canker • Premature defoliation and fruit drop can occur with severe infections • Affected fruit produce poor quality juice not suitable for domestic market or processing	• Phytosanitary precautions when plant material is imported from neighbouring countries (Angola, Zimbabwe and Mozambique)
Diplodia		• Fungal disease • Contamination occurs in orchard, but symptom usually becomes apparent in the packhouse or in transit	• Decay around stem- and stylar-ends, advancing in streaks down side of fruit • No visible fungal growth on surface of fruit	• Decay reduced by dipping fruit in fungicide solutions before de-greening • Losses minimised through prompt handling and shipping, and in transit refrigeration

Table of Common Citrus Diseases

Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Soil Borne Diseases				
Phytophthora (Phytophthora citrophthora)	 	• Fungal disease • Affects plant parts below and above ground (root systems, trunks, branches, leaves, blossoms and fruit) • Especially prevalent during prolonged rainy periods • Trees with bud union below or close to soil and trees in poorly-drained soil that may cause anaerobic conditions are highly susceptible	• Poor growth, smaller trees • Nutrient deficiencies due to damage to feeder roots • Gumming • Lower yield and smaller fruit	• Preventative practices, including use of resistant rootstock and planting in well-drained soil • Recommended control practices include budding seedlings high, avoiding wounds, and keeping soil off lower trunk • Soil fumigation of seedbeds should be practiced in field nurseries • Chemicals with preventative and curative action are registered

Table of Common Citrus Diseases

Disease Name	***Identification***	***Details***	***Symptoms and Damage Caused***	***Prevention/Control***
Phytophthora Brown Rot	 	• Fungal disease • Caused by *Phytophthora* fungi under continued wet conditions • Develops mainly on fruit growing near the ground when *Phytophthora* spores from the soil splash onto the tree skirts during rain storms • Fruit in early stage of disease may go unnoticed at harvest and infect other fruit during storage	• Symptoms primarily on mature or nearly mature fruit • Initially firm, leathery lesions have water-soaked appearance, but soon turn soft and have tan to olive brown colour with pungent odour • Infection progresses over surfaces of fruit, but does not penetrate beyond albedo • Infected fruit eventually drop • Occasionally, twigs, leaves, and blossoms are infected, turning brown and dying	• Brown rot management relies on prevention • Skirting trees to 600mm above the ground significantly reduces risk • Remove all infected fruit from orchard floor • Chemical application 14-21 days prior to harvest should climatic condition warrant action

Table of Common Citrus Diseases

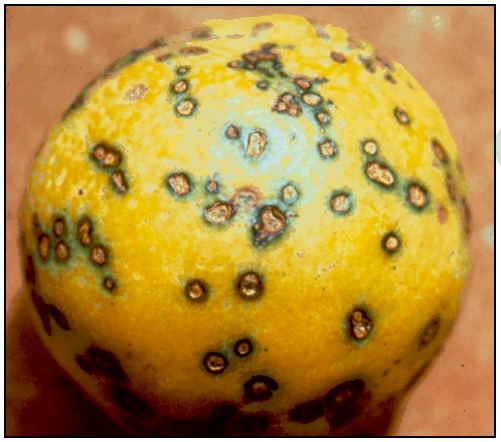
Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Citrus Black Spot	 	• Infection is favoured by warm, wet conditions in summer, presence of susceptible fruit, and presence of abundant inoculum • While conidia (asexual spores) may cause infection, the primary source of infection is ascospores (sexual spores) produced on leaf litter on ground • Ascospores are forcibly ejected during rains or irrigation onto fruit • Fruit are susceptible for 4-5 months after petal fall • Although infection occurs when fruit are young, fungus remains latent for long period and symptoms may not appear until fruit mature	• Necrotic lesions on fruit that make them unacceptable for fresh market • With severe infection extensive premature fruit drop occur that reduces yields of fruit for processing	• Reduce inoculum by removing infected material by means of pruning or removal of sick trees • Apply fungicides in preventative chemical programs • Pick when fruit mature and do not harvest after August in the summer rainfall areas
Nematodes		• Plant parasitic nematodes are very small worms that cannot be seen with naked eye • Especially citrus nematodes are known to attack root system of citrus trees • Burrowing nematode causes disease known as spreading decline	• Trees have nutrient deficiency symptoms • Low production and small fruit • Visible damage to root systems	• Plant disease-free trees • Avoid replanting on old citrus soils • Use trees with nematode tolerant rootstocks • Use nematicides if samples show high levels of infestation

Table of Common Citrus Diseases

Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Citrus (*Fusarium*) Root Rot	 	• Fungal disease • Affects plant parts below and above ground (root systems, trunks, branches, leaves, blossoms and fruit)	• Initially symptoms consist of dark area of decay in bark which will eventually have a dry, cracked appearance • Wood below lesion is dry with brownish-grey stain which could turn slightly purple • Disease may progress in wood for many years with only symptoms being slight wilting under dry conditions • Disease can reach "sudden death" stage, when leaves suddenly wilt and turn yellow and the tree dies rapidly • Phenomenon occurs in conjunction with conditions that cause stress in trees	• Most effective control measure against Fusarium root rot is elimination of conditions that cause stress • Maintain soil conditions favourable for root development • Soil compaction, water logging and salinity are interlinked factors causing stress • Deep ploughing and using organic mulches can successfully neutralise soil compaction, improving soil structure and drainage which improve root health and reduce root rot
Armillaria Root Rot		• Also known as oak root fungus • Can occasionally damage and kill citrus trees • Symptoms may not develop until after the disease is well established	• First symptoms are poor growth or dieback of shoots, small yellowing leaves, and premature leaf drop	• Relies primarily on preventing infection of new trees • Avoid planting in sites likely to be infested • If there are infected trees in orchard, remove completely including roots, let trees dry thoroughly before disposing of them • Remove neighbouring, apparently healthy trees as roots may be infected

Table of Common Citrus Diseases

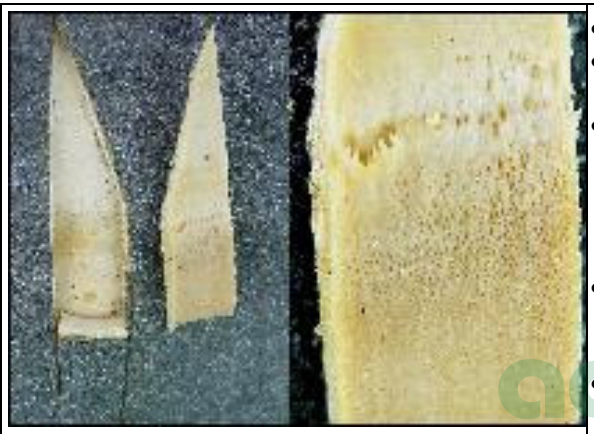
Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Graft Transmissible Diseases				
Tristeza		• Viral disease • Virus transmitted by aphids in semi-persistent manner • Aphid can acquire virus within minutes of feeding on infected plants and transmit it to healthy plants within minutes after acquisition • Aphids lose ability to transmit virus within 24-48 hours after acquisition • Tree decline results from the necrosis and death of the conductive tissue (phloem) at the bud union • Sugars produced in leaves by photosynthesis are blocked from being transported to roots • Without transport of sugars and starches to feeder roots they use up stored starch and begin to decline, leading to death of tree	• Decline / quick decline • Wilting • Dieback • Leaf chlorosis and curling • Heavy fruit set • Honeycombing • Bud union staining • Scion overgrowth • Thickened bark at bud union • Starch depletion in roots • Loss of feeder roots	• Controlling the vector (aphids). • Us nursery trees pre-immunized with mild strain Trizteza virus •

Table of Common Citrus Diseases

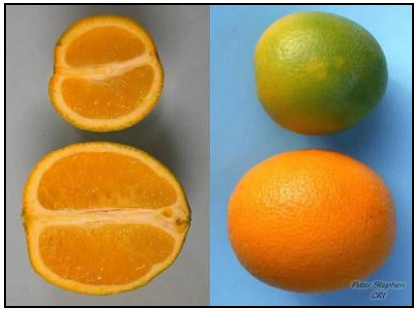
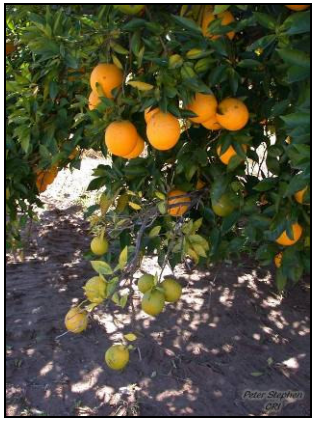
Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Citrus Greening Disease	  	• Bacterial disease • Results in a chronic decline of citrus • Citrus Psylla (Trioza) are vectors of the bacteria	• Leaf veins initially turn yellow • Leaf symptoms may resemble zinc deficiency • Disease begins in one branch or section of larger trees and gradually spreads throughout the tree • Leaves are small, point upright, and show chlorosis • Fruit are small, misshapen, have sour or bitter flavour, and remains green on one side • Seeds in symptomatic fruit are usually aborted • Premature fruit drop occurs	• Control of vector (Psylla) • Removal inoculum source by pruning branches with symptoms and controlling re-growth • Removal of whole tree

Table of Common Citrus Diseases

Disease Name	*Identification*	*Details*	*Symptoms and Damage Caused*	*Prevention/Control*
Exocortis		• Viral disease • Mostly on trees grafted on trifoliate, citrange and Rangpur lime rootstocks • Spread by infected budwood	• Bark scaling and tree stunting viroid • Some cultivars also show stem blotching, and bark splitting • Some show vein necrosis • Some cultivars such as grapefruit, sweet orange and mandarins can have symptomless infections, but if grafted onto sensitive rootstocks, bark scaling and stunting can be expressed	• Use viroid-free budwood obtained by shoot tip grafting • Obtain trees from an accredited nursery • Sterilise pruning equipment