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Citrus Orchard Foreman Occupational Learning

Study Guide

KM-06:
Crop Protection

Qualification:	110667 – Occupational Certificate: Orchard and Vineyard Foreman		
Module No.:	611202001-KM-06		
Module Title:	Crop protection		
NQF Level:	3	**Credits:**	3

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Content originator:
Citrus Academy

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Ukudla Namanzi (Pty) Ltd

Contents

Qualification Information

The content of this study guide is aligned to the following occupational qualification:

SAQA QUAL ID	**Qualification Title**			
110667	Occupational Certificate: Orchard and Vineyard Foreman			
Originator				
Development Quality Partner – AgriSETA				
Primary Or Delegated Quality Assurance Functionary			**NQF Sub-Framework**	
-			OQSF - Occupational Qualifications Sub-Framework	
QUALIFICATION TYPE		**FIELD**		**SUBFIELD**
Occupational Certificate		Field 01 - Agriculture and Nature Conservation		Primary Agriculture
Abet Band	**Minimum Credits**	**Pre-2009 NQF Level**	**NQF Level**	**Qual Class**
Undefined	147	Not Applicable	NQF Level 04	Regular-ELOAC

Knowledge Module

The content of this learner guide is aligned to the following module of the occupational qualification above.

Module Code	Module Title	Level	Credits
Knowledge Modules			
611202-001-00-KM-01	Plant Structure and Physiology	4	5
611202-001-00-KM-02	Vineyard or Orchard Establishment	3	2
611202-001-00-KM-03	Vineyard or Orchard Manipulation Processes	3	8
611202-001-00-KM-04	Harvesting	3	4
611202-001-00-KM-05	Basic Principles of Plant Nutrition	4	4
611202-001-00-KM-06	Crop Protection	3	3
611202-001-00-KM-07	Assets in Horticultural Production	3	2
611202-001-00-KM-08	Farm Business Management and Farming Process Management	4	8
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611202-001-00-KM-10	Overseeing Farming Resource Utilisation	4	8
Practical Skill Modules			
611202-001-00-PM-01	Organise, Allocate and Monitor Availability and Productive Use of Resources	4	5
611202-001-00-PM-2a	Set Team and Individual Performance Goals to Enhancing Team Performance	4	10
611202-001-00-PM-2b	Control Vineyard or Orchard Practices	4	10
611202-001-00-PM-03	Supply Accurate Daily Orchard or Vineyard and Production Information	4	10

Knowledge Topics, Topic Elements, and IACs

The content of this study guide is aligned to the following knowledge topics, topic elements, and internal assessment criteria of the module above.

Knowledge Topics, Topic Elements, and IACs	
Code	**Title**
KM-06-KT01	**Principles of integrated pest and disease management (50%, 1.5 credits)**
KT0101	Principles of integrated pest and disease management
KT0102	Control methods for common pests and diseases (e.g. chemical, cultivation, biological etc.)
KT0103	Weed control
KT0104	Principles for monitoring of pests and diseases
IAC0101	The principles of integrated pest management (IPM) is explained
IAC0102	Principles of usage restrictions for commonly used plant protection products (PPPs) are outlined and explained in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM
IAC0103	The need for safety and compliance with regulations is motivated
IAC0104	Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given
IAC0105	Commonly used PPPs (application, target pest / disease, mechanism) are outlined
IAC0106	Principles of usage restrictions for commonly used PPPs are outlined in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM
IAC0107	Commonly used biological control agents are described in terms of application, target pest / disease and mechanism
IAC0108	Explain cultivation control methods for pest and disease control with reference to rootstock selection, sound soil management practices, orchard or vineyard sanitation, sterilisation of equipment and the use of wound sealers
IAC0109	Weed control methods (mechanical or chemical) are described
IAC0110	Methods of monitoring efficacy of weed control methods are outlined
IAC0111	Resistance to weed control measures are explained and methods for avoiding resistance are discussed
IAC0112	The different monitoring methods for pests and diseases are described
IAC0113	The monitoring measures are described in terms of the time during the season and location in the block or on the plant
IAC0114	The importance and procedure for post-application monitoring is explained
IAC0115	Role of the monitor is outlined
IAC0116	The impact on the environment and contamination of resources is discussed
KM-06-KT02	**Identification of pests, diseases and weed (50%, 1.5 credits)**
KT0201	Identification of common plant diseases, pests and weeds
KT0202	Life cycle of pests, diseases and weeds and the implications for prevention and treatment
KT0203	Calibration and mechanical integrity of the equipment
IAC0201	The main symptoms or characteristics of diseases, pests and weeds are identified
IAC0202	Confusing symptoms of nutritional deficiencies and toxicity with pests and diseases are discussed
IAC0203	Consequences of the presence of pests, diseases and weeds are explained
IAC0204	The phase of the pest life cycle which causes the damage is described

IAC0205	The reasons why prevention and control measures are recommended to be applied at specific stages of the life cycle of the pest and seasonal cycle of the plant are explained
IAC0206	The favourable environmental factors promoting the occurrence of pests, diseases and weeds are described
IAC0207	The reasons for regular inspection of equipment are listed
IAC0208	The reasons for accurate calibration of equipment are motivated
IAC0209	Fault-finding principles are explained
IAC0210	The reasons for good working condition of all equipment are motivated
IAC0211	The implications of faulty and poorly calibrated equipment on the production process and the product are evaluated

KM-06-KT01: Principles of Integrated Pest and Disease Management (50%, 1.5 credits)

Topic Elements

The content of this chapter covers the following topic elements:

- KT0101: Principles of integrated pest and disease management
- KT0102: Control methods for common pests and diseases (e.g. chemical, cultivation, biological etc.)
- KT0103: Weed control
- KT0104: Principles for monitoring of pests and diseases

1. KT0101: Principles of Integrated Pest and Disease Management

IAC0101: The principles of integrated pest management (IPM) is explained

- Southern African citrus growers must deal with a range of pests that are threats to fruit quality and/or yield.
- Pests can physically damage fruit, spread diseases, and cause increased fruit decay.
- Certain pests are considered phytosanitary threats by some countries.
- Phytosanitary pests are pests that pose a risk to plants and are regulated to prevent their introduction or spread across borders.
- There are many pests in South Africa that pose a risk to citrus, and dealing with them is a vital aspect of farm and production management.
- Integrated pest management (IPM) is a method of pest management that combines various pest control measures into a single system.
- IPM aims to manage pests and the environment effectively to balance costs, benefits, public health, and environmental quality.
- IPM is often used as an umbrella term for managing diseases and weeds as well as pests.
- Pest control involves considering multiple factors beyond the pest itself, including:
    - Labour and equipment costs.
    - The viability of the control method in relation to the pest population.
    - The legality of applying a specific control method.
    - The effects on the environment and natural resources.

- Pest or disease resistance.
- The need for follow up procedures.

- IPM systems rely on technical information on pests and their interactions with the environment.
- IPM programmes use a combination of multiple pest control options, including, but not limited to, chemical control.
- Producing consistent yields of export quality citrus is impossible without chemical pest control.
- IPM focuses on avoiding chemical controls where possible in exchange for other control options, especially biological control.
- Sometimes it may make financial sense to tolerate some economic damage from a particular pest rather than resorting to chemical control that may disrupt biological control methods by killing the biological control agents.
- Killing these biological control agents will require further chemical control as a substitute, increasing costs and risks.
- IPM has been found to improve the cost efficiency of production when calculated over several years.
- IPM incorporates both resistance management and the minimisation of environmental impact to create long-term sustainability.
- IPM systems are also a basic requirement for exporting citrus.
- An IPM system is designed around six basic components, namely:
    - Acceptable pest levels.
    - Monitoring.
    - Cultural control.
    - Biological control.
    - Chemical control.
    - Mechanical control.
- IPM focuses on control, not eradication of pests.
- Wiping out an entire pest population is often impossible, and attempting to do so can be more costly than it is worth and often harmful to the environment.
- Instead, pest control managers should determine acceptable pest levels and apply controls until those levels are reached.
- Regular monitoring is the most important part of IPM.
- Monitoring includes visual inspections, traps, and other monitoring methods to accurately track pest population levels.
- Recordkeeping of all monitoring and control actions is essential.
- Scouts and managers require a detailed knowledge of the life stages, behaviour and reproductive cycles of target pests.
- Cultural control involves farming practices such as selecting healthy varieties well suited to the area of the farm and maintaining healthy crops.

- Biological control involves releasing or accommodating organisms which naturally prey on target pests.
- Biological control can provide effective control with minimal environmental impact, and often at low cost.
- Chemical control involves applying pesticides that target specific citrus pests while attempting to minimise harm to beneficial insects and the environment.
- Chemical control should be considered a last resort and saved for when other controls fail or are deemed unlikely to prove effective.
- Biological insecticides, derived from plants or naturally occurring micro-organisms, also fall into this chemical control.
- Mechanical control involves physically removing pests using tools like traps, barriers, or hand-picking to reduce pest populations.
- Mechanical control is sometimes also grouped into cultural control.
- Should a pest reach an unacceptable level, mechanical methods should be the first options to consider, as they are often relatively cheap, easy to implement and safe for the environment.

IAC0102: Principles of usage restrictions for commonly used plant protection products (PPPs) are outlined and explained in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM

- Agrochemicals serve numerous functions in citrus production, but they must be used carefully, and there are numerous regulations that deal with them.
- All agrochemicals used must be approved by the government, and all are subject to strict national and international standards regulating their use, set by numerous groups and governments.
- One of the most important aspects of these regulations is that of withholding periods.
- A withholding period is the minimum length of time that must pass between the last application of a particular agrochemical and the harvest date of the crop that the agrochemical was applied to.
- This withholding period must be strictly adhered to at all times, even in unforeseen circumstances, such as a sudden pest outbreak.
- Withholding periods are determined through scientific research to ensure that any agrochemical residues left on fruit are at a level considered safe for human consumption.
- Choosing to ignore or failing to meet these requirements can put consumers at risk and have serious legal and financial ramifications for farmers.
- Withholding periods are generally found on the product label, and they are determined to ensure that fruit, particularly export fruit, complies with international standards regarding MRLs.
- Maximum residue levels (MRLs) refer to the highest amount of agrochemical residue that is legally tolerated on fruit.
- These levels are based on research and aim to ensure that any chemical residue remaining on fruit does not harm consumers' health.
- MRLs are prescribed by the food safety legislation and regulations and must be strictly adhered to.

- The prescriptions are contained in a document called Default Maximum Residue Levels for Fungicides and Pesticides for Export Citrus, which is a legally enforceable document that is available from DoA.
- MRLs are set individually for each pesticide and each crop, and different counties have different MRL requirements based on the product being used and the crop it was used on.
- Growers must research the specific MRL requirements of target markets, as they may differ significantly from other markets.
- MRL prescriptions determine how long before harvesting PPPs can be applied to plants, referred to as the pre-harvest interval.
- The best way to avoid food contamination is to adhere to the pre-harvest intervals.
- Residues are monitored by the PPECB and fruit with residues that exceed MRLs will be rejected for export, with serious legal consequences for the grower.
- In South Africa, The Citrus Growers' Association (CGA) and Citrus Research International (CRI) jointly publishes a Recommended Usage Restrictions (RUR) document regularly.
- The RUR indicates the farming practices that will ensure that MRLs are not exceeded and if growers apply the RUR, the resultant residues on fruit will be below the MRLs.

IAC0103: The need for safety and compliance with regulations is motivated

- Agrochemicals are a broad categorisation encompassing a variety of chemicals used in farming, include fertilisers, pesticides, herbicides, fungicides, and growth regulators.
- There are numerous laws and regulations that govern the use of agrochemicals, and it is every grower's responsibility to be aware of and comply with these laws and regulations.
- Non-compliance with these laws and regulations can lead to serious legal and financial consequences for the farm.
- There are four main pieces of legislation that relate to agrochemicals, namely:
  - Health Act of 1977.
  - Registrar of Fertilisers Act No. 36 of 1947.
  - Farm Feeds, Agricultural Remedies and Stock Remedies Act of 1947.
  - Occupational Health and Safety Act No. 85 of 1993 and the Amendment Act No. 181 of 1993.
- All agrochemicals must be approved and registered with the Department of Agriculture (DoA) in terms of Act 36 of 1947.
- The product label is part of the registration of the agrochemical, and agrochemical labels should include:
  - Full instructions on using the chemical and detailed information on the registered uses of the product.
  - The chemical composition of the product.
  - The toxicity of the product, along with instructions on how to handle it safely.
  - A physical description of the product, including its colour and whether it is a fluid, powder, or granules.
  - The pre-harvest interval (or PHI) of the product.
  - The product expiry date.

- Pictograms on the product label are used to give further information about the product.
- Pictograms can be classified as activity, advice, warning, and storage pictograms.
- These pictograms describe the type of product, storage requirements, PPE requirements, and the danger that the product holds for animals.
- The following sections of the Occupational Health and Safety Act, 1993, are relevant to handling agrochemicals on a farm:
  - Section 10 – General Duties of Manufacturers and Others Regarding Articles and Substances for Use at Work
  - Section 17 – Health and Safety Representatives
  - Section 21 – General Prohibitions
- The farm will get a quotation from the supplier so that they know what the cost of the stock will be, but they will not usually enter into a contract with the supplier.
- In some cases, however, it is advisable to have a contract in place with a supplier, such as for agrochemical stock that is supplied regularly at a fixed price by the same supplier.
- These contracts protect the supplier and the farmer because they make it clear who is supposed to do what, and when, and at what price.
- Being in breach of a written contract can lead to serious consequences for the farm or the supplier, and they are useful for protecting the farm in situations where the supplier provides the wrong or low quality agrochemicals.
- All workers must be fully trained in workplace safety rules and regulations, and these regulations should be enforced at all times.
- The safety rules and regulations, specifically for agrochemical use, include:
  - No smoking, drinking, or eating is allowed in the vicinity of where chemicals are mixed, applied or stored.
  - No person that is under the influence of alcohol or other drugs is allowed to handle chemicals for whatever purpose under any circumstances.
  - Safety regulations regarding the use of chemical application equipment.
  - Regulations regarding proper utilisation of PPE.
  - Prescriptive regulations on how chemical spills, leakages and other emergencies should be handled.
  - Instructions concerning the chemical to be applied.
- During applications, all people in or around the orchard must be informed of the activity, even if they are not directly involved.
- This ensures that they will not wander into the area and be contaminated by accident.
- Chemicals should only be mixed in areas designated for the purpose, such as at filling points.
- These areas should be clearly marked, and unauthorised personnel should not be allowed into these areas while chemicals are being handled.
- Regulations also require signage that is approved by the authorities and is easily observable in all locations designated for a specific purpose.
- These signs must give a bold, concise message such as:
  - Danger.

- No Entry.
- No Smoking.
- No Drinking and Eating.
- Fire Extinguisher.
- First Aid Equipment.
- Emergency Exit.
- Protective Clothing Required.

self-assessment

KT0101: Principles of Integrated Pest and Disease Management

Can I?	Y/N
Can I describe the risks and harm caused by pests to citrus production?	
Can I define what phytosanitary pests are and why they are regulated?	
Can I define and explain the purpose of Integrated Pest Management (IPM)?	
Can I list and explain the factors that must be considered when planning pest control?	
Can I describe the various pest control methods that form part of IPM programmes?	
Can I describe the risks of chemical control and why IPM tries to avoid it where possible?	
Can I determine when pest damage should be tolerated?	
Can I explain how IPM improves production cost efficiency over several years?	
Can I outline the basic components of an IPM system?	
Can I determine acceptable pest levels?	
Can I explain the importance of monitoring in IPM?	
Can I describe the various monitoring methods used for IPM?	
Can I keep accurate, current records of monitoring and control actions?	
Can I ensure that scouts and managers have sufficient knowledge of pests?	
Can I define and describe cultural control practices?	
Can I define and describe biological control practices?	
Can I define and describe chemical control practices?	
Can I define and describe mechanical control practices?	
Can I select the appropriate pest control method depending on the pest and situation?	
Can I apply appropriate pest control treatments where needed?	
Can I explain withholding periods and why they are important?	
Can I explain maximum residue levels and their purpose?	
Can I explain the relationship between MRLs and food safety regulations?	
Can I explain pre-harvest intervals?	
Can I explain how failing to comply with MRL or withholding period regulations affects exports?	

Can I describe the role of PPECB, CGA, and CRI in monitoring residues and setting restrictions?	
Can I explain the purpose of the Recommended Usage Restrictions (RUR) document?	
Can I define agrochemicals?	
Can I explain the responsibility of growers regarding agrochemical laws and regulations?	
Can I describe the potential consequences of non-compliance with agrochemical legislation?	
Can I identify the main pieces of legislation that relate to agrochemicals?	
Can I explain the registration requirements for agrochemicals with DoA?	
Can I describe the information that must be included on an agrochemical product label?	
Can I explain the purpose and meanings of pictograms on agrochemical labels?	
Can I describe the purpose of Occupational Health and Safety Act, 1993?	
Can I determine when and why a contract with a supplier is needed?	
Can I train all workers in workplace safety rules and regulations?	
Can I explain safety requirements for chemical application equipment and PPE use?	
Can I prescribe the procedures for handling chemical spills, leakages, or emergencies?	
Can I design safe areas for mixing chemicals?	
Can I design signage for chemical handling areas?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0101	The principles of integrated pest management (IPM) is explained	D2, F1, F2, J1, L1
IAC0102	Principles of usage restrictions for commonly used plant protection products (PPPs) are outlined and explained in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM	A2, A6, F1, F2, J1
IAC0103	The need for safety and compliance with regulations is motivated	A4, A6, J1, J2, L1

2. KT0102: Control Methods for Common Pests and Diseases (e.g. Chemical, Cultivation, Biological etc.)

IAC0104: Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given

- Historically, the first and often only control measure that producers used for pest control was chemical control.
- Exclusively using chemical control has proven over time to have a negative effect on the environment in general and the production unit specifically.
- The three categories of control methods that form part of IPM are:
    - Cultural control.
    - Biological control.
    - Chemical control.
- A fourth category, mechanical control, is sometimes grouped separately, but is often considered part of cultural control.
- Cultural and biological control are preventative and may have more impact on long-term production.
- Chemical control provides short-term relief or prevention from pest pressure and should be considered a last resort.
- Biological control consists of three major components:
    - Classical biological control (CBC).
    - Conservation of biological control agents.
    - Augmentation.
- Classical biological control (CBC) relies on exploiting the relationships that have evolved between the host plant, pests, and their natural enemies over extended periods.
- Many citrus pests originate from outside of Southern Africa, and their co-evolved natural predators often do not accompany the pests when first introduced into Southern Africa.
- Many indigenous biological control agents adopt new pests as their host or prey, but they often do not provide adequate control because they have not evolved alongside the pests.
- CBC attempts to restore the natural balance between plants, pests, and their natural enemies by also introducing the relevant biological control agents from areas where the pest originated.
- The aim of CBC is to permanently establish these introduced biological control agents to reduce the pest population to acceptable levels.
- These introductions must be carefully controlled to ensure that they are ecologically safe.
- Natural enemies may not always be able to prevent the development of commercially significant host populations and damage during a season.
- The relationships between pests and their natural enemies and their populations must be monitored frequently by growers and workers.
- CBC does not provide a solution to all pests since it may be difficult or impossible to find an appropriate biological control agent for a particular pest.

- The pest may be better adapted to the new environment than its biological control agents, limiting the ability of the biological control agents to establish a population.
- The pest may be an indigenous organism which has adopted citrus as a new and favourable host, meaning there may be no biological control agents available.
- If chemical control must be resorted to, this may disrupt the biological control programme and limit its effectiveness by killing biological control agents.
- Conservation of biological control agents relies on cultural control practices and minimising the effects of chemical control on biological control agents.
- Augmentation refers to releasing biological control agents to increase their natural population and effectiveness in controlling pests.
- These biological control agents are generally bred in insectaries and can be bought from specialised companies.
- Augmentation is only available for certain pests in Southern Africa, but can be highly effective, sustainable, and environmentally safe.
- Augmentation only works if the biological control agents are released into an orchard environment that is suitable for their survival.
- Augmentation of parasitoids is a preventative approach, and therefore releases should be initiated as early as possible in the season.
- Releases of parasitoids should be conducted approximately once per month and should continue for a few months until the parasitoids have reached the target population levels.
- Augmentation of predators can be performed correctively in response to elevated levels of pest population.
- Pest control achieved through augmentation is gradual, meaning that it does not work overnight.
- This means that regular monitoring of the target pest and, if possible, natural enemies must be continued until the pest population is sufficiently decreased.
- Sterile insect technique (SIT) is a method of biological control method not widely practiced in agriculture.
- SIT involves releasing sterile pests that cannot reproduce into the orchard.
- These sterile insects are bred and sterilised with low doses of radiation, and mate with pests of the same species, but do not produce viable offspring.
- This lack of reproduction leads to pest population decline as sterile males compete with wild males for female pests.
- Repeated release of sterile insects can eventually wipe out a population, though it is often more useful to consider controlling the population rather than eradicating it.
- Cultural control involves farming practices to maintain healthy trees that are better able to resist pest and diseases.
- Cultural control can contribute both directly and indirectly towards the control of citrus pests.
- Cultural control focuses on managing general production practices and increasing plant diversity.
- Cultural control practices include:
    - Implementing ground cover.

- Selecting appropriate windbreak trees.
- Managing plants outside the orchard.
- Selecting suitable cultivars.
- Managing irrigation.
- Managing fertilisation.
- Orchard sanitation.
- Pruning.
- Skirting.
- Removing dead branches.

- Some cultural control practices used in other crops (such as seasonal crop rotation and interplanting) cannot be implemented in citrus.
- Research into cultural control is ongoing, but it is recommended that growers adopt as many different techniques as possible because there are few disadvantages.
- Increased plant diversity can be achieved using natural ground cover, windbreak trees, other natural vegetation and possibly the use of catch crops.
- Increased diversity can reduce the susceptibility of the main crop and increase biological control agent populations by providing food and breeding grounds for them.
- Using ground covers or cover crops is another important cultural control practice and involves allowing natural growth or planting flowering plants (weeds) between rows of citrus.
- These plants create pollen and/or nectar that natural predators of pests use as a food source, encouraging their establishment in the orchard.
- Ground cover can also play a key role in hosting alternative prey which are not citrus pests for generalist predators such as lacewings, ladybird beetles and predatory mites.
- Allowing natural plant growth between rows of citrus trees also aids in preventing soil erosion and stabilise orchard temperatures and humidity.
- Ground cover should not be mowed excessively, and leaving an unmown strip down the middle of the inter-row area benefits the flowering plants while maintaining easy access to the citrus trees for workers.
- Climate plays a significant role in the survival of these plants, and thus natural growth is encouraged, as these plants will be able to survive without much intervention from growers.
- Continuous ground cover over a whole orchard is not necessary to promote natural enemies.
- There are some disadvantages to using ground covers, namely increased fertiliser requirements due to competition with trees, and possible harbouring of pests.
- Windbreak trees are planted to break the force of wind in the orchard and prevent damage to the fruit and citrus trees.
- Some windbreak trees can provide breeding grounds for pests, so windbreak trees should be carefully selected to avoid increasing pest populations.
- Little is known about other relationships between windbreak trees and citrus pests, although the following observations have been made:

- Other vegetation outside of the citrus orchards themselves should be monitored and managed, as they can support pest insects and natural enemies.
- It may be necessary to remove this vegetation if they provide breeding grounds for pests and significantly increase pest populations.
- Selecting the appropriate citrus cultivar is important, as different cultivars have varying levels of susceptibility to pests and diseases.
- Irrigation and fertilisation are important for keeping trees healthy generally.
- Physiologically healthy trees can resist damage by pests better and recover faster than trees subject to water or nutritional stress.
- Orchard sanitation, especially the collection and destruction of dropped fruit is an important and integral part of pest and disease control in a citrus orchard.
- These dropped fruit and other plant matter provide breeding grounds for pests and allowing them to remain in the orchard can significantly increase pest populations, particularly false coddling moth.
- Orchard sanitation also involves removing diseased or damaged fruit from trees, as some pests can breed and live inside these fruit.
- Orchard sanitation also contributes to reducing the spore load of particularly green and blue mould in the orchard, which can reduce post-harvest waste significantly.
- Pruning for pest control generally involves internal pruning.
- Internal pruning involves shaping the inner branches of the tree through selective pruning to enhance light penetration and stimulate fruiting.
- Internal pruning does not directly influence pest populations but allows for better spray coverage of pesticides and healthier trees.
- Internal pruning can have the disadvantage of increasing temperature in the tree due to enhanced light intensity, which can lead to higher pest populations.
- Skirting involves cutting low-hanging branches so that tree access to crawling pests is confined to the trunk.
- Weeds under the skirt of the tree must also be controlled to eliminate alternative access routes.
- Access via the trunk should be limited by insecticide treatment, or one of several types of trunk barriers.
- Skirting and limiting trunk access aims to keep ants out of the trees where they can interfere with the activity of biological control agents and reduce the effectiveness of biological control of scale insects.
- Ants should not be eliminated from the orchard entirely as they can act as predators of pests in the soil.
- Dead branches must be removed to avoid fruit damage, improve spray coverage, and hosting of pests and diseases.
- Chemical control includes:
  - Traditional pesticide use.
  - Mating disruption (MD).
- Chemical control is only effective when agrochemicals are carefully selected and used.

- Chemicals should be a last resort, only used when it is absolutely essential to avoid serious financial losses due to pest damage.
- Some pesticides are specific in the range of pests they target, while some are non-specific.
- To select the appropriate chemical, managers must be familiar with product labels and the effects of specific chemicals.
- Ideally, managers should consult with other managers in the area, industry experts, or research bodies and publications for assistance selecting chemicals.
- Factors to consider in selecting chemicals include:
  - Product efficacy.
  - Cost effectiveness.
  - Potential hazard to beneficial and other non-target organisms.
  - Potential hazard to workers, the environment, orchard, and fruit.
  - Limitations or restrictions on applications.
  - Impact on resistance development.
  - Maximum Residue Levels.
- Product efficacy refers to how well the particular chemical controls the target pest and is a relative measure compared to performance of other products available for similar usage.
- Product efficacy is arguably the most important factor in agrochemical selection.
- Product efficacy is influenced by the time required for the product to work, the amount of residual control and the variety of pests controlled.
- Residual action may or may not be a desirable quality depending on circumstances, as long-residual pesticides also may reduce the effectiveness of beneficial organisms.
- The cost effectiveness of different pesticides is influenced by the efficacy, length of control and cost of the product per hectare.
- The pest range also influences cost effectiveness, as a single broad-spectrum chemical may be cheaper than two or more specific ones.
- Some pesticides may have adverse effects on beneficial organisms and end up costing more through requiring increased usage to compensate for diminished biological control.
- New chemicals are constantly being researched and registered, and producers should be careful when choosing to use new chemicals.
- New chemicals are often sold as 'breakthroughs', but the long term effects are often difficult to determine right away.
- If a new chemical is being considered by a grower, they should first trial it for a single season by applying it only to single orchards or cultivars to compare it to currently used chemicals.
- This trial is performed to avoid possible issues caused by new chemicals, such as unintended effects on beneficial organisms, ineffective control, or other hazards.
- Mating disruption (MD) involves the use of pheromones, the chemicals produced by insects which evoke a specific response in the other individuals of the same species.
- MD works by releasing a specific pheromone into the orchard to confuse males of pest species, making them unable to locate females, preventing reproduction.

- Mating disruption works in one of three ways:
  - Peripheral and central nervous system effects.
  - False trails.
  - Masking.
- The pheromone receptors in some insects can become overwhelmed when exposed to constant stimulus from the mating disruption.
- Continuous exposure to high concentrations of pheromone may make it difficult for these insects to locate mates by weakening their senses.
- Using false trails involves placing multiple sources of pheromones in the orchard to attract male pests to these false sources, wasting time and energy and preventing reproduction.
- Masking involves releasing a high enough level of pheromones to 'block out' the pheromones of female pests, preventing reproduction.
- Mating disruption has the following advantages:
  - Decreased pesticide usage.
  - Increased effectiveness of biological control.
  - Decreased pest resurgence.
  - Decreased resistance development.
  - Decreased hazard to farm workers since pheromones are non-toxic.
  - No residues.
- Mating disruption has the following disadvantages:
  - MD may not always work for all pests and at all locations.
  - MD may not be effective when pest populations are exceedingly high.
  - MD is highly specific to individual pests.
  - The initial cost of MD can be very high compared with chemical control.

IAC0105: Commonly used PPPs (application, target pest / disease, mechanism) are outlined

- The list of commonly used PPPs in South Africa constantly changes, and growers should contact manufacturers, industry experts and research publications for the latest information and recommendations.

IAC0106: Principles of usage restrictions for commonly used PPPs are outlined in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM

- Agrochemicals serve numerous functions in citrus production, but they must be used carefully, and there are numerous regulations that deal with them.
- All agrochemicals used must be approved by the government, and all are subject to strict national and international standards regulating their use, set by numerous groups and governments.
- One of the most important aspects of these regulations is that of withholding periods.

- A withholding period is the minimum length of time that must pass between the last application of a particular agrochemical and the harvest date of the crop that the agrochemical was applied to.
- This withholding period must be strictly adhered to at all times, even in unforeseen circumstances, such as a sudden pest outbreak.
- Withholding periods are determined through scientific research to ensure that any agrochemical residues left on fruit are at a level considered safe for human consumption.
- Choosing to ignore or failing to meet these requirements can put consumers at risk and have serious legal and financial ramifications for farmers.
- Withholding periods are generally found on the product label, and they are determined to ensure that fruit, particularly export fruit, complies with international standards regarding MRLs.
- Maximum residue levels (MRLs) refer to the highest amount of agrochemical residue that is legally tolerated on fruit.
- These levels are based on research and aim to ensure that any chemical residue remaining on fruit does not harm consumers' health.
- MRLs are prescribed by the food safety legislation and regulations and must be strictly adhered to.
- The prescriptions are contained in a document called Default Maximum Residue Levels for Fungicides and Pesticides for Export Citrus, which is a legally enforceable document that is available from DoA.
- MRLs are set individually for each pesticide and each crop, and different counties have different MRL requirements based on the product being used and the crop it was used on.
- Growers must research the specific MRL requirements of target markets, as they may differ significantly from other markets.
- MRL prescriptions determine how long before harvesting PPPs can be applied to plants, referred to as the pre-harvest interval.
- The best way to avoid food contamination is to adhere to the pre-harvest intervals.
- Residues are monitored by the PPECB and fruit with residues that exceed MRLs will be rejected for export, with serious legal consequences for the grower.
- In South Africa, The Citrus Growers' Association (CGA) and Citrus Research International (CRI) jointly publishes a Recommended Usage Restrictions (RUR) document regularly.
- The RUR indicates the farming practices that will ensure that MRLs are not exceeded and if growers apply the RUR, the resultant residues on fruit will be below the MRLs.

IAC0107: Commonly used biological control agents are described in terms of application, target pest / disease and mechanism

Refer to IAC0104: Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given.

IAC0108: Explain cultivation control methods for pest and disease control with reference to rootstock selection, sound soil management practices, orchard or vineyard sanitation, sterilisation of equipment and the use of wound sealers

Refer to IAC0104: Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given.

self-assessment

KT0102: Control Methods for Common Pests and Diseases (e.g. Chemical, Cultivation, Biological etc.)

Can I?	Y/N
Can I describe and list mechanical control methods?	
Can I employ mechanical control methods?	
Can I describe and list cultural control methods?	
Can I employ cultural control methods?	
Can I explain the importance of orchard sanitation for IPM?	
Can I describe and list biological control methods?	
Can I employ biological control methods?	
Can I describe the three main components of biological control?	
Can I explain how biological control agents are used in IPM?	
Can I select appropriate biological control agents?	
Can I describe and implement augmentation?	
Can I describe and list chemical control methods?	
Can I employ chemical control methods?	
Can I explain the risks of relying only on chemical control?	
Can I describe how chemical control can disrupt biological control programmes?	
Can I describe and implement mating disruption?	
Can I research and select appropriate agrochemicals for chemical control?	
Can I monitor all IPM activities?	
Can I monitor pest populations?	
Can I monitor weed populations?	
Can I monitor disease incidence?	
Can I describe how other production practices affect IPM?	
Can I apply appropriate pest control treatments where needed?	
Can I explain withholding periods and why they are important?	
Can I explain maximum residue levels and their purpose?	
Can I explain the relationship between MRLs and food safety regulations?	
Can I explain pre-harvest intervals?	
Can I explain how failing to comply with MRL or withholding period regulations affects exports?	
Can I describe the role of PPECB, CGA, and CRI in monitoring residues and setting restrictions?	
Can I explain the purpose of the Recommended Usage Restrictions (RUR) document?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0104	Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given	D2, F1, F2, H1, H2
IAC0105	Commonly used PPPs (application, target pest / disease, mechanism) are outlined	F1, F2, H2, J1, L1
IAC0106	Principles of usage restrictions for commonly used PPPs are outlined in terms of maximum residue levels (MRLs) and pre-harvest intervals (PHI)) according to IPM	A2, A6, F1, F2, J1
IAC0107	Commonly used biological control agents are described in terms of application, target pest / disease and mechanism	D2, D3, F1, H2, L1
IAC0108	Explain cultivation control methods for pest and disease control with reference to rootstock selection, sound soil management practices, orchard or vineyard sanitation, sterilisation of equipment and the use of wound sealers	D2, D3, F1, H1, L1

3. KT0103: Weed Control

IAC0109: Weed control methods (mechanical or chemical) are described

- A weed is defined as any plant growing out of its proper place, in an area where it is not wanted or desired.
- In orchards there will often be a variety of different plants growing due to birds spreading the seeds from other plants through defecation.
- These unwanted plants can become a major problem in the orchards, as their roots and shoots get intermingled with the fruit trees'.
- Not all weeds in the orchard have a negative impact on production, and there are advantages and disadvantages to some weeds in the orchard.
- Completely eradicating weeds is difficult and costly, so growers should aim to control weeds to a level which does not adversely affect the health of fruit trees.
- Generally, this is best achieved through a combination of weed control methods.
- Weeds can be classified in different ways but are most often classified into three groups based on their life cycle, namely:
    - Annual weeds.
    - Biennial weeds.
    - Perennial weeds.
- Annual weeds complete their life cycle in one season and reproduce mainly through seeds.
- Biennial weeds take two seasons to complete their life cycle.
- Biennial weeds complete vegetative growth and store food in the first season and begin flowering and seeding in the second season.
- Perennial weeds grow for two or more seasons and propagate through a variety of methods.
- Weed control methods can be classified as:
    - Preventive methods.
    - Mechanical methods.
    - Biological methods.
    - Chemical methods.
- Preventative methods involve preventing the entry of new weeds and weed seeds into the orchard area in the first place.
- Preventative methods can be highly effective if well implemented.
- The first preventative method is ensuring that nursery plants and the soil in their containers are free from weeds and seeds.
- If there are weeds already growing in the orchard, they should be prevented from flowering or seeding.
- Animal manure should not be used as fertiliser as it may also contain weed seeds.
- All equipment and vehicles should be regularly cleaned while operating in the orchard so that weed seeds do not travel from orchard to orchard in them.

- Areas outside and around the orchard, such as water channels, paths, roads, and orchard boundaries must be cleared of weeds before flowering takes place.
- Historically, weeds were controlled by ploughing the orchard with tractor implements, which is easy to implement and can be effective, but easily damages trees, so is no longer recommended.
- Mechanical methods involve physically removing weeds and are highly effective but can be costly in terms of capital and labour.
- Mechanical weed control methods include:
  - Hand pulling.
  - Hoeing.
  - Tillage.
  - Mowing.
  - Smothering.
- Hand pulling involves uprooting weeds manually, and hoeing involves uprooting them with a hoe or spade.
- After hand pulling or hoeing, the inter-row areas can then be covered with black polythene (plastic film) to prevent photosynthesis in the sprouting weeds and prevent further growth and reproduction.
- Biological weed control methods involve using insects, pathogens, parasitic plants, and livestock, to kill or eat the weeds.
- When selecting a biological weed control agent, the following criteria should be met:
  - The agent should be host specific.
  - The agent should be easy to introduce and spread easily.
  - The agent should be from a climatically similar area.
  - If multiple agents are used, they should target different parts of the weed to avoid competition.
- Chemical weed control methods involve using herbicides to kill or inhibit weed growth.
- Herbicides are classified into three groups depending upon their effect on the plant system, namely:
  - Growth regulators.
  - Soil sterilants.
  - Contact herbicides.
- Growth regulators are called growth modifiers, growth substances, translocated herbicides, or systemic herbicides.
- Growth regulators are absorbed by roots or above ground plant parts and transported through the plant system.
- Growth regulators are species specific, as is the concentration at which they are effective.
- This species specificity makes it possible to use growth regulators selectively, killing only certain plants without significantly injuring the others.
- However, care must be taken to avoid excess application of growth regulators as they can be harmful to soil and other plants and animals.

- Soil sterilants are herbicides which prevent the growth of plants when they are present in the soil.
- Soil sterilants resist chemical decomposition and leaching, and this is influenced by climate, soil type and rate of use.
- Contact herbicides kill any plants they come in contact with, and do not translocate through the eco-system.
- Contact herbicides are highly effective against annual weeds and may be selective or non-selective.
- Selective contact herbicides kill or suppress only specific weeds without significantly injuring other plants.
- Non-selective contact herbicides will kill or suppress all vegetation they come into contact with, and as such can kill citrus trees.
- Contact herbicides are only effective if sprayed at appropriate concentrations, and the volume of water used also determines the degree of weed control in an orchard.

IAC0110: Methods of monitoring efficacy of weed control methods are outlined

- After performing weed control methods, follow-up monitoring is performed to determine the efficacy of the control methods and the need for repeated control actions.
- This monitoring consists of regular visual inspections in the orchard, both in the area where the control actions were performed and elsewhere in the orchard.
- Scouts record the number and types of weeds they see in various areas, providing information which can then be used to judge the efficacy of the weed control.
- If the count is significantly lower in the areas that were controlled, the control action can be judged to have been a success.
- This information can also be used to determine trends in weed density, regrowth patterns, and keep track of all problematic weed species in and around the orchards.
- These systematic counts should be performed by block, and the information recorded for each section of the orchard.
- If scouts encounter new species of weed that they cannot identify, they should collect these weeds and take them to their supervisors for identification and recording.
- The qualities of the weeds should also be recorded, including their height or size and their growth stage.
- This information assists in determining the age of the weeds and, over time, their growth rate.
- Weeds that are stunted or weakened can indicate partial success of the control action, and the appearance and fast growth of new young weeds indicates failure.
- Citrus trees should also be monitored in the treated areas, as signs of improved health may indicate increased access to water and nutrients, indicating successful weed control.
- Comparing the success in various treated orchard area can help identify application issues, which, along with application records, can identify faulty equipment or untrained workers.

IAC0111: Resistance to weed control measures are explained and methods for avoiding resistance are discussed

- Herbicide resistance occurs when weed populations gradually develop the ability to survive chemical control methods that previously controlled them.
- This resistance usually develops due to repeated use of pesticides with the same active ingredient or mode of action.
- Resistant weeds will not be affected as intended by the treatment, even when the applications are properly performed.
- Resistance can spread in a weed population as surviving weeds produce seeds or reproduce vegetatively, creating an increasing proportion of resistant weeds on the farm.
- As with pest resistance management, growers should not rely on a single herbicide or single active ingredient, as doing so accelerates resistance development.
- Some weed species naturally develop resistance faster due to factors such as rapid seed production and reproduction or high genetic variability.
- It is recommended that growers rotate herbicides with different modes of action across the season to slow resistance development.
- Using mixtures of multiple herbicides or sequential applications can limit resistance development by limiting even resistant weeds' ability to survive.
- Integrating non-chemical weed control methods (mechanical, biological and preventative) reduces reliance on herbicides and slowing resistance development.
- Properly managing applications in terms of dosage, timing, and coverage can reduce development resistance.
- Monitoring weed populations regularly forms part of resistance management by allowing for detection of potential resistance development and adjusting the weed management programme.
- Maintaining healthy citrus trees indirectly supports resistance management, as healthy trees compete more effectively with weeds, reducing reliance on herbicides.

self-assessment

KT0103: Weed Control

Can I?	Y/N
Can I define weeds?	
Can I describe how weeds enter the orchard?	
Can I describe the damage that weeds cause?	
Can I determine when weeds are harmful?	
Can I determine tolerable weed levels?	
Can I select and implement weed control methods?	
Can I categorise weeds?	
Can I explain how different types of weeds grow and reproduce?	
Can I describe the categories of weed control methods?	
Can I perform preventative weed control?	
Can I perform mechanical weed control?	

Can I perform biological weed control?	
Can I perform chemical weed control?	
Can I categorise herbicides?	
Can I perform follow-up monitoring after weed control?	
Can I train scouts to monitor weeds and citrus trees?	
Can I explain how herbicide resistance develops?	
Can I manage and mitigate herbicide resistance development?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0109	Weed control methods (mechanical or chemical) are described	F1, F2, H1, H2, J1
IAC0110	Methods of monitoring efficacy of weed control methods are outlined	D2, F1, F2, H1, H2
IAC0111	Resistance to weed control measures are explained and methods for avoiding resistance are discussed	F1, F2, H1, H2, J1

4. KT0104: Principles for Monitoring of Pests and Diseases

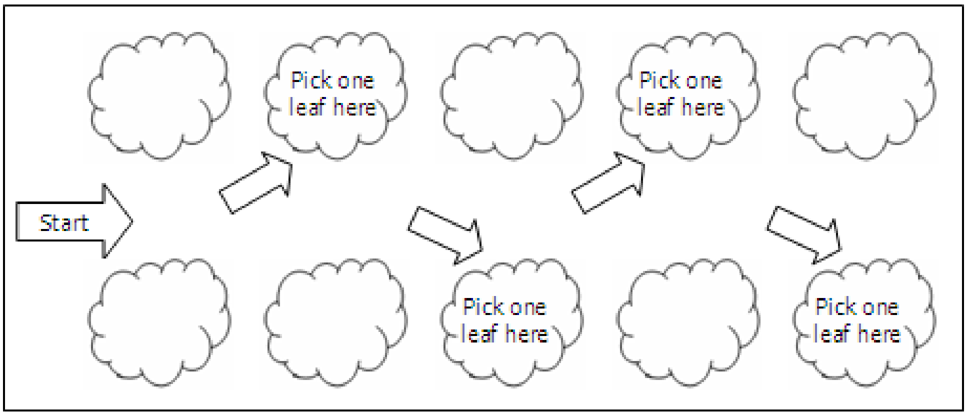
IAC0112: The different monitoring methods for pests and diseases are described

IAC0113: The monitoring measures are described in terms of the time during the season and location in the block or on the plant

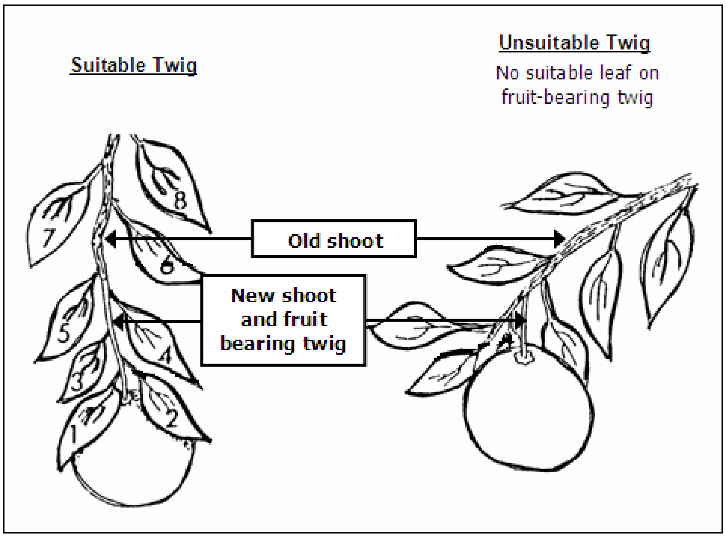
- Monitoring is the most important aspect of IPM.
- Systemic monitoring provides information on pest and weed populations and disease incidence.
- This information allows managers to evaluate IPM performance and maintain accurate records to facilitate managerial decisions.
- This information also allows managers to predict future trends in pest behaviour and populations, allowing them to prepare for control actions before they are needed.
- Monitoring systems vary in complexity and detail, depending on the farm they are designed for.
- Monitoring methods vary depending on individual preferences and specific need, but should provide consistent, reliable information.
- Monitoring generally includes:
  - Checking on the efficacy of control actions.
  - Monitoring pest and weed populations.
  - Monitoring pest damage.
  - Monitoring disease incidence.
  - Monitoring environmental damage.
- The efficacy of a control action can only be determined through follow-up monitoring of the pest population which the control action was aimed at.
- If the control action was successful, a significant decrease in the pest population should be observed.
- If there is no significant decrease in the pest population, or the desired effect is not achieved, an investigation should be performed to determine what went wrong.
- Sample size, location and selection are important to any sample programme, and the first consideration of monitoring is determining the needed number of samples.
- Sampling is only effective when samples represent the whole orchard rather than representing only a piece or section of it.
- A sample is defined as a smaller, manageable volume that reflects the characteristics of the bulk material being analysed.
- In citrus production, a sample is a small, representative portion of fruit, leaves, soil, or other material collected for the purpose of analysis.
- To ensure that samples are representative and provide reliable information, soil and leaf samples should be taken from the same set of trees or orchard area throughout the year.
- Two to four rows of trees should be selected to represent the orchard for sampling, and these are referred to as the index rows.

- Index rows should be marked, and all future samples for that orchard should be taken consistently from these trees.
- Leaf sampling in South Africa is typically performed between February and May, and it should be done at the same time each year for consistency.
- Sampling must be done before harvesting, particularly for early varieties like Satsuma.
- For leaf sampling, the following procedure is followed:

1. Enter the path between two of the rows in the index block.
2. Using clean hands or gloves, pick leaves from every second tree on the left and right, as shown below:



3. Pick 50 to 100 leaves per sample.
4. Pick only healthy, undamaged leaves.
5. Pick leaves that are between 1 and 2 metre from the orchard floor, between about the waist and head of a person of average height.
6. Pick leaves from fruit bearing twigs, as shown below:



7. Put the leaves in a new, clean plastic bag.
8. Squeeze the air out of the bag and close it tightly.
9. Label the sample as prescribed below.
10. Keep the samples until they are dispatched to the laboratory in the shade or in a cool place, but do not freeze the samples.

- For soil sampling, the following procedure is followed:
  1. Enter the same index block where leaf samples are taken.
  2. Identify areas under every second to fourth tree for collecting small samples, or sub-samples, which will be used to make up the eventual sample.
  3. Remove any visible plant debris from the surface of the soil but take care not to remove the topsoil.
  4. Take the sub-sample from the surface down to a depth of 30cm depth using a sterilised spade or soil auger.
  5. Take a total of between 15 and 20 sub-samples per index row.
  6. Collect the sub-samples in a plastic bucket.
  7. Mix the soil in the bucket and place about 500g in a plastic bag to form the sample that will be sent for analysis.
  8. Seal the bag tightly.
  9. Label the sample as prescribed below.
  10. Keep the samples until they are dispatched to the laboratory in the shade or in a cool place, but do not freeze the samples.
- When labelling samples, the following procedure is followed:
  1. Attach a label to the container, by either sticking it on or tying it on securely with string.
  2. Do not write the information directly onto the container, because even permanent marker ink rubs off during transport.
  3. Never place a label inside the bag with the sample.
  4. If the laboratory handles samples from multiple producers, the labels should contain all the details of the sender, including:
     - Name of producer.
     - Address.
     - Telephone number.
     - Details of analysis required in case of special instructions.
     - Order number, if used.
     - Sample reference (such as the orchard number).
     - Type of sample.
     - Date of sampling.
  5. If the laboratory is on farm or only handles the grower's samples, the labels only need to include:
     - Details of analysis required.
     - Sample reference (such as orchard number or location on farm).
     - Type of sample.
     - Date of sampling.
- The sample references, whether they are the orchard name, number, or on-farm location, must be standardised for recordkeeping practices.

- The laboratory report will contain this reference, and the sender must be able to connect the results with the relevant orchard or location.
- References should not be overly detailed and should be as simple as possible while still being standardised and informative.
- Workers, especially those involved in sampling, must be aware of the reference system used on the farm and instructed to follow it.
- Samples must be kept separate from potential sources of contamination, as contamination could alter the analysis results.
- Before packing samples for transport to the laboratory, ensure that all samples are correctly labelled and that the labels are legible.
- Check each sample against the Samples Dispatched list as you pack them to confirm accuracy.
- When packing, place the samples in a sturdy box and use packing materials such as bubble wrap or newspaper to secure and protect them during transport.
- All equipment used during sampling, including cups, spatulas, buckets, and mixing tools, must be thoroughly cleaned and sterilised before use to prevent contamination.
- Sampling equipment should be washed after use, then properly stored, inventoried, and maintained like any other farm equipment.

IAC0114: The importance and procedure for post-application monitoring is explained

- Post-application monitoring allows managers to judge the efficacy of chemical control actions and whether reapplications are needed.
- This monitoring involves monitoring pest and weed populations and disease incidence to determine whether they have decreased to acceptable thresholds.
- If the appropriate decrease is seen, the control action can be judged a success, and if the decrease is insufficient or there is no decrease, the control action can be determined to have failed.
- Post-application monitoring can also identify other issues with the application such as harm to the trees, the environment, or beneficial organisms.
- These issues can occur due to improper application, improper agrochemical handling or preparation, or issues with the agrochemicals themselves, among other reasons.
- Post-application monitoring is essential for early detection of further pest, weed or disease issues and timely control actions.
- Post-application monitoring also forms part of compliance with environmental and safety regulations, by allowing workers to ensure that runoff, spray drift, and residue levels are within acceptable limits.
- All of this information provides guidance for planning future control actions, including better product selection, improved spray practices, or further worker training.
- Post-application monitoring confirms whether application equipment was functioning properly, determining the possible need for maintenance, repairs, or adjustments.
- Post-application monitoring should occur after an appropriate interval after the application, depending on the product and type of control action performed.

- Post-application monitoring is performed in the same manner as standard monitoring for pests, weeds and diseases, including traps, visual inspections, and sampling.
- Environmental and weather conditions should be monitored after application, as some of these factors (such as heavy wind or rain) may affect the effectiveness of control actions.
- All monitoring results should be carefully recorded in a standardised database.
- Once follow-up monitoring has been performed, management can determine the need for follow-up control actions, such as re-application or application of a different control method.
- The frequency of post-application monitoring depends on the pests' reproductive capacities and the time needed for pest populations to reach economic damage thresholds.
- Some pests with a high reproductive potential may require monitoring as often as twice a week, though most pests generally require less frequent monitoring.
- For recommendations on monitoring frequency for specific pests, growers should contact industry experts, chemical manufacturers, research bodies and publications, or other producers in the area.

IAC0115: Role of the monitor is outlined

Refer to IAC0112: The different monitoring methods for pests and diseases are described.

IAC0116: The impact on the environment and contamination of resources is discussed

- Unnecessary chemical application can harm the environment, as when agrochemicals end up in the soil, they can contaminate water sources and harm beneficial soil microorganisms.
- This leads to decreased soil quality and a disruption of the natural ecosystem, including natural biological control mechanisms present in the orchard.
- Killing these beneficial insects and microorganisms that usually naturally control pest populations can increase pest populations.
- Excessive and unnecessary chemical applications can also have serious consequences for the health of people on and off the farm.
- Increased agrochemical exposure increases the risk of serious health issues to workers.
- Runoff from over-sprayed areas can also pollute nearby water sources, affecting aquatic life and public safety.
- Unnecessary and excessive applications run the risk of exceeding MRLs, which can cost growers a lot of money and may harm the farm’s reputation, while putting consumers at risk.
- Pests and diseases develop resistance to agrochemicals at an increased rate the more they are exposed to it.
- Resistance refers to the ability of certain members of a pathogen or pest population to survive or to be immune to agrochemicals.
- After resistant organisms have survived the applications, they alone are left to repopulate, leading to the entire population on that farm being resistant.

- This newly resistant population will make future applications less effective if not totally ineffectual.
- As the agrochemicals become less effective, growers will have to either use more of them, or switch to other, possibly more expensive or harmful chemicals.
- Both of these options not only increase costs for the producer but also place further pressure on the environment.
- Excessive agrochemical usage also wastes chemicals, wasting the money of the farm as a whole.
- Chemicals can be very expensive, and it is unwise to increase these already-high costs without any additional benefit.

self-assessment

KT0104: Principles for Monitoring of Pests and Diseases

Can I?	Y/N
Can I explain the importance and role of monitoring in IPM?	
Can I perform systemic pest, weed, and disease monitoring?	
Can I design and implement IPM monitoring systems?	
Can I determine the success of a control action through follow-up monitoring?	
Can I react appropriately to a failed control action?	
Can I explain the purpose of soil sampling?	
Can I perform soil sampling?	
Can I describe the purpose of leaf sampling?	
Can I perform leaf sampling?	
Can I use sampling results to create and modify fertilisation programmes?	
Can I explain why fruit sampling cannot be used for nutrient analysis?	
Can I visually monitor fruit for nutrient deficiency signs?	
Can I select representative samples of trees, soil, leaves, and fruit?	
Can I properly label samples?	
Can I safely pack, store, and transport samples before analysis?	
Can I clean and sterilise sampling equipment before use?	
Can I clean, store, inventory, and maintain sampling equipment after use?	
Can I create leaf and soil analysis reports?	
Can I properly instruct workers involved in sampling on all of the above?	
Can I judge the efficacy of a control action?	
Can I monitor pest and weed populations?	
Can I monitor disease incidence?	
Can I determine acceptable pest, weed, and disease thresholds?	
Can I identify the nature and cause of issues after applications?	
Can I use post-application results to plan future applications?	

Can I identify issues with application equipment after applications?	
Can I plan and manage post-application monitoring at the appropriate frequency?	
Can I train workers in post-application monitoring methods?	
Can I create accurate and current records of post-application monitoring?	
Can I determine the need for follow-up actions?	
Can I explain the environmental and health risks of unnecessary chemical applications?	
Can I explain the concept and risks of pest and disease resistance?	
Can I describe how excessive chemical use contributes to pest and disease resistance?	
Can I describe the risks of wasting agrochemicals?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0112	The different monitoring methods for pests and diseases are described	A3, D1, D2, D3, D4
IAC0113	The monitoring measures are described in terms of the time during the season and location in the block or on the plant	A3, D1, D2, D3, D4
IAC0114	The importance and procedure for post-application monitoring is explained	A4, F1, F2, H2, L1
IAC0115	Role of the monitor is outlined	A3, D1, D2, D3, D4
IAC0116	The impact on the environment and contamination of resources is discussed	A6, D2, F1, F2, L1

KM-06-KT02:
Identification of Pests, Diseases and Weed
(50%, 1.5 credits)

Topic Elements

The content of this chapter covers the following topic elements:

- KT0201: Identification of common plant diseases, pests and weeds
- KT0202: Life cycle of pests, diseases and weeds and the implications for prevention and treatment
- KT0203: Calibration and mechanical integrity of the equipment

1. KT0201: Identification of Common Plant Diseases, Pests and Weeds

IAC0201: The main symptoms or characteristics of diseases, pests and weeds are identified

- Diseases are caused by microscopic organisms, so they can usually only be identified through the symptoms that develop when diseases interfere with the plant's functions.
- Diseases are often not detectable until the trees are already infected and showing symptoms of the disease.
- All orchard workers, not just scouts, need to know the basic symptoms of diseases to look for, and know how to properly alert their supervisors to any symptoms they notice.
- Many disease symptoms are similar to those of nutrient deficiencies or other issues, so the presence of symptoms does not automatically mean that the disease is present.
- Once supervisors are aware of possible symptoms, they can perform closer inspections or perform sampling and laboratory testing to determine the presence of diseases.
- The most common disease symptoms are:
  - Wilting.
  - Discolouration.
  - Gum formation (gummosis).
  - Dieback.
  - Postharvest fruit rot.
- Wilting can be caused by disease, nutrient deficiencies and water stress.
- Wilting, when caused by disease, occurs when the transportation system of the plant (the xylem and phloem) no longer functions due to pathogens or disease damage.

- Wilting can also occur due to the degeneration of specific plant parts such as the roots, limiting their ability to absorb nutrients and water.
- Diseases that may cause wilting include root rot, collar rot, and seedling damping-off in nurseries, among others.
- Discolouration refers to a change of colour in various plant parts, such as yellowing of leaves or greening of fruit.
- Necrosis, which when 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.
- Chlorosis (yellowing) of foliage is often caused by malnutrition due to an inefficient water and nutrient uptake as the result of damage to root systems by root rot.
- Gummosis 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, as gum forms and protrudes from blisters, usually on the trunk.
- The wood beneath the blister containing gum pockets shows a pink-orange or brown discolouration.
- Gummosis can be caused by many factors, including disease, cold damage, a high water table, and salt accumulation.
- Gummosis occurs as a defence mechanism as plants attempt to seal off or to prevent an infection.
- Citrus gum is water soluble and disappears after heavy rains, so gummosis may appear to improve after rain, but testing is still recommended.
- Twig dieback can be caused by fungi, although these fungal infections are often secondary, following freeze damage or damage resulting from injury.
- Twigs can also be damaged by excessive fertilisation, moisture stress, damage to the root system by cultural practices, heavy red scale infestation, or heavy nematode damage.
- In twig die back, affected young branches die back 2.5 cm or more from the tip, and damage to the tree from twig dieback is usually not severe.
- Weeds also present symptoms on trees when they are negatively affecting them.
- Weeds often compete with citrus trees for light, water, and nutrients, which results in noticeably slower tree growth and reduced canopy development in the trees.
- If there are dense or tall weed patches shading the base of citrus trees, these weeds may interfere with proper sunlight exposure and root-zone access.
- If citrus trees are showing decreased vigour, including paler foliage or reduced flush growth, this may be a symptom of aggressive weeds dominating the root zone.
- Trees may also show symptoms of water stress due to weeds, as weed roots may directly compete for water or prevent water from filtering through the soil to the citrus roots.
- Areas with high weed presence may also have increased pest activity and disease incidence, since some weeds serve as hosts for pests or diseases.
- Increased fruit drop or reduced fruit size may also be symptomatic of weed issues, as unmanaged weed growth competes with the citrus trees for nutrients and water.

IAC0202: Confusing symptoms of nutritional deficiencies and toxicity with pests and diseases are discussed

- Some symptoms of nutritional deficiencies and other health issues may be confused with symptoms of pests and diseases.
- Nutritional deficiencies often cause discoloration that strongly resemble symptoms of disease infections or pest damage, making accurate diagnosis challenging without closer inspection.
- Toxicities from over-applied fertilisers or foliar sprays can lead to leaf burn, tip dieback, or necrotic spotting, which can be mistaken for fungal diseases or chemical injury.
- Irregular leaf deformation or distorted new flush caused by nutrient imbalances, particularly from zinc or copper issues, may appear similar to feeding injury from pests.
- Premature leaf drop can be caused by severe deficiencies, for nitrogen or magnesium, and can be confused with defoliation caused by some diseases.
- Chronic nutrient shortage may be mistaken for long-term pest pressure, since both conditions produce undersized canopies and reduced vigour.
- Fruit symptoms such as small size, poor colour development, or misshapen fruit arising from nutrient disorders can resemble damage from certain pests or fungal infections.
- Toxic salt buildup in the soil may cause leaf damage or wilting that mimics disease-related wilting.

self-assessment

KT0201: Identification of Common Plant Diseases, Pests and Weeds

Can I?	Y/N
Can I list common disease symptoms in citrus?	
Can I train orchard workers to recognise and report basic disease symptoms?	
Can I determine when symptoms stem from non-disease causes?	
Can I identify and determine the cause of wilting in citrus trees?	
Can I identify and determine the cause of discolouration in citrus trees?	
Can I identify and determine the cause of necrosis in citrus trees?	
Can I identify and determine the cause of chlorosis in citrus trees?	
Can I identify and determine the cause of gummosis in citrus trees?	
Can I identify and determine the cause of dieback in citrus trees?	
Can I identify symptoms of weed pressure in citrus?	
Can I differentiate between nutritional deficiencies and pest or disease symptoms?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0201	The main symptoms or characteristics of diseases, pests and weeds are identified	A5, D2, D3, D4, F1
IAC0202	Confusing symptoms of nutritional deficiencies and toxicity with pests and diseases are discussed	A5, D1, D3, D4, F1

2. KT0202: Life Cycle of Pests, Diseases and Weeds and the Implications for Prevention and Treatment

IAC0203: Consequences of the presence of pests, diseases and weeds are explained

- Pests, diseases and weeds play a major role in citrus production, as they are the single biggest threat to the success of growing and exporting citrus.
- Pests are defined as any organisms that cause damage to livestock, crops, humans, or land fertility.
- Citrus pests are organisms whose feeding and / or reproductive habits lead to a reduction in the quantity and quality of the citrus fruit produced.
- Not all insects are pests, as some are considered beneficial organisms, such as bees which pollinate flowers or some wasps that kill pests.
- The main consequences of pests, diseases and weeds are:
  - Damage to trees.
  - Damage to fruit.
  - Spreading disease.
  - Breaking phytosanitary barriers to markets.
- Damage to trees may result in lower yields, poor-quality fruit, and in severe cases, tree death and the loss of entire orchards.
- Damage to fruit lowers external and internal fruit quality, rendering fruit unexportable, if not totally unsellable.
- Pest damage to both trees and fruit can take the form of:
  - Stinging.
  - Biting.
  - Sucking plant sap.
  - Laying eggs and resultant larval damage.
  - Abrasions.
  - Injuries that act as access points for secondary insects or diseases.
- Some pests act as 'vectors', meaning that they carry and spread disease to plants.
- Other factors (such as weather or worker error) can also cause damage to trees and fruit, and any damage should be investigated to determine the exact cause.
- Young fruit and trees are particularly vulnerable to damage from all sources.
- Certain export markets have phytosanitary barriers, meaning that there are certain pests and diseases that are considered serious threats to those markets.
- Fruit that is found to be infested with these phytosanitary pests and diseases cannot be exported to markets that have phytosanitary restrictions.
- Entire consignments of fruit can be rejected for failing to meet phytosanitary regulations, and in the worst cases, farmers can be blacklisted and prevented from further export.

- The most important phytosanitary pests and diseases for South African citrus producers are:
  - Citrus black spot.
  - False codling moth.
  - Carob moth.
  - Mealybug.
  - Fruit fly.
- Some diseases, such as citrus greening (HLB), can wipe out entire citrus orchards, while other diseases negatively affect yield and fruit quality.
- Weeds mainly cause damage by competing with trees for essential resources such as water, nutrients, and sunlight, which can limit tree growth and productivity.
- Weeds can also host pests and pathogens, indirectly increasing the risk of pest and disease outbreaks within citrus orchards.
- Weed growth can also interfere with orchard operations such as irrigation, fertilisation, and harvesting, resulting in reduced efficiency and higher labour costs.

IAC0204: The phase of the pest life cycle which causes the damage is described

- The larval or immature stage of many citrus pests is often the most damaging, because these young stages actively feed on trees while requiring high nutrient intake for development.
- Sap-sucking pests cause damage primarily during their nymphal and adult stages, as both life stages damage trees through feeding and transmitting pathogens.
- The crawler stage of scale insects is often responsible for initial damage, as this is when they are mobile and settle on leaves or twigs to begin feeding before developing into a more stationary form.
- The adult stage of chewing insects produces noticeable damage, because adults consume plant parts in large quantities as they feed and reproduce.
- Root-feeding pests cause damage during their immature phases, as these stages actively penetrate and feed on roots, disrupting nutrient and water uptake.
- Some pests, such as mites, cause injury throughout most of their active life cycle, because both immature and adult mites feed continuously on plant parts.
- Pests that feed on fruit mainly cause damage during the larval stage, when larvae burrow into fruit tissue.
- Certain pests inflict indirect damage during their adult stage by transmitting diseases where the damage results mainly from the disease rather than the pest.

IAC0205: The reasons why prevention and control measures are recommended to be applied at specific stages of the life cycle of the pest and seasonal cycle of the plant are explained

Refer to IAC0104: Control methods for common pests and diseases (e.g. chemical, cultural, biological etc.) are described and relevant examples are given.

IAC0206: The favourable environmental factors promoting the occurrence of pests, diseases and weeds are described

- Many pests thrive in warm temperatures, reproducing rapidly in these conditions.
- Diseases, especially fungal diseases, develop quickly in warm, humid conditions, as this moisture is necessary for spore germination.
- Frequent rainfall or excessive irrigation can create waterlogged soil conditions that favour root rot and other soil-borne diseases, as well as promoting weed germination.
- Prolonged periods of drought can cause water stress in citrus trees, making them more susceptible to pests and diseases due to weakened natural defences.
- Windless, sheltered conditions can provide suitable breeding grounds for pests, as natural dispersal and predation by beneficial organisms are reduced in these environments.
- Sunlight can influence pest behaviour and disease development, as many diseases and pests require shaded, humid areas to reproduce.
- Prolonged warm seasons extend the breeding and feeding periods of insects, allowing multiple generations to occur within a single year, which increases pest pressure.
- Extreme weather events, such as storms or flooding, can physically damage citrus trees and create entry points for pests and pathogens, as well as disperse weed seeds over large areas.
- Nutrient-rich soils provide favourable conditions for the growth of weeds, which can compete with citrus trees for available nutrients when left unmanaged.
- Poor quality soils (such as compacted or poorly draining soils) are detrimental to tree health, reducing their resistance to pests and increasing the likelihood of root-related diseases.
- Soil pH and composition affect the prevalence of certain pests and diseases which may be better suited to certain soil conditions.
- Inconsistent water supply or irregular irrigation schedules can weaken citrus trees, reducing their natural defences against pests and diseases.
- High organic matter content in soil can provide a habitat for pests such as nematodes or soil-borne insects, indirectly affecting tree health and productivity.
- Water contamination or stagnation around the orchard can create breeding grounds for disease vectors that may carry plant pathogens.
- Soil disturbances, such through physical soil preparation, can expose weed seeds to sunlight and moisture, accelerating germination and growth in the orchard.
- Improper orchard planning, such as dense planting and poor tree spacing reduce air circulation, creating humid microclimates that favour disease development.
- Overgrown or poorly pruned trees provide shaded, humid shelters and breeding sites for pests.
- The presence of alternative host plants (weeds) can increase pest populations.
- Fallen fruit, dead branches, and other plant matter can host pests and pathogens, which may reinfect healthy trees if the orchard is not sanitised regularly.
- Limited biodiversity within orchards tends to lead to higher pest and disease pressure, as natural predator populations are decreased.
- The absence of beneficial insects and natural predators, due to pesticide overuse or habitat destruction, can lead to pest population increases and disease outbreaks.

- Improper disposal of infected plant material, including pruned branches and diseased fruit, contributes to the spread of pathogens.

self-assessment

KT0202: Life Cycle of Pests, Diseases and Weeds and the Implications for Prevention and Treatment

Can I?	Y/N
Can I explain how pests damage citrus trees?	
Can I explain how weeds damage citrus trees?	
Can I explain how diseases damage citrus trees?	
Can I define pests in citrus production?	
Can I differentiate between pests and beneficial organisms?	
Can I describe the negative consequences of tree damage?	
Can I describe different types and causes of tree damage?	
Can I describe the negative consequences of fruit damage?	
Can I describe different types and causes of fruit damage?	
Can I investigate the cause of damage?	
Can I define phytosanitary in the context of export regulations?	
Can I list phytosanitary pests and diseases?	
Can I describe the consequences of not adhering to phytosanitary regulations?	
Can I describe which phases of the pest life cycle are most harmful to citrus?	
Can I explain how environmental conditions affect pest populations?	
Can I explain how production practices affect pest populations?	
Can I explain how environmental conditions affect weed populations?	
Can I explain how production practices affect weed populations?	
Can I explain how environmental conditions affect disease incidence?	
Can I explain how production practices affect disease incidence?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0203	Consequences of the presence of pests, diseases and weeds are explained	A5, D1, D2, D3, F1
IAC0204	The phase of the pest life cycle which causes the damage is described	A5, D1, D2, D3, F1
IAC0205	The reasons why prevention and control measures are recommended to be applied at specific stages of the life cycle of the pest and seasonal cycle of the plant are explained	A5, D1, D2, D3, F1
IAC0206	The favourable environmental factors promoting the occurrence of pests, diseases and weeds are described	D1, D2, D3, F1, L1

3. KT0203: Calibration and Mechanical Integrity of the Equipment

IAC0207: The reasons for regular inspection of equipment are listed

- Regular inspection of citrus crop protection equipment ensures that all components, including pumps, hoses, nozzles, and control systems, are functioning properly and ready for use.
- Frequent checks help to identify wear, corrosion, or damage early, preventing minor issues from escalating into major breakdowns that could disrupt spraying schedules.
- Inspections allow operators to verify that calibration settings are correct, ensuring accurate and uniform application of pesticides, fertilisers, and protective sprays.
- Regular inspections reduce the risk of chemical leaks or spills, which protects both workers and the environment from unnecessary exposure to hazardous substances.
- Checking equipment on a routine basis minimizes downtime during critical periods of pest or disease outbreaks, ensuring timely and effective crop protection.
- Inspections contribute to the longevity of machinery by highlighting maintenance needs, such as lubrication, filter replacement, or tightening of connections, before severe damage occurs.
- Regular assessment of electrical and control systems helps prevent failures that could compromise the effectiveness of automated spraying or monitoring operations.
- Routine inspections provide operators with confidence in the reliability of the equipment, allowing them to focus on efficient and precise crop protection activities.
- Identifying and addressing faults early reduces operational costs by preventing costly repairs, wasted chemicals, or lost labour due to equipment failure.
- Inspections support compliance with safety regulations and industry standards, ensuring that all equipment meets required performance and environmental guidelines.
- Regular checks enable record-keeping of equipment condition, maintenance, and repairs, which helps in planning preventive maintenance schedules and budgeting for future replacements.
- By maintaining equipment in optimal condition through regular inspections, farmers can maximize yield, protect fruit quality, and safeguard the overall profitability of citrus production.

IAC0208: The reasons for accurate calibration of equipment are motivated

- Most agrochemicals are applied by some form of machinery or equipment which needs to be calibrated prior to application.
- This calibration ensures that the correct amount of chemical is applied to the crop, avoiding underapplication or overapplication.
- Underapplication will render the application ineffective, requiring repeated applications and wasting labour.
- Overapplication will render the application harmful to the environment or the trees, while wasting money in chemical costs.
- Overapplication may also harm workers or other people, as well as beneficial organisms in and around the orchard.

- For trunk applications and soil drenches, equipment calibration is not required, with the exception of some specialised trunk applicators.
- These applicators may require calibration and volume setting and should be done according to manufacturer's instructions.
- For all other trunk applications and soil drenches, the focus should be on accurately measuring the agrochemicals to be applied.
- Foliar applications that use spray equipment will always require calibration to ensure that the correct volume of spray material is delivered.
- The control action will only be successful if the spray material is uniformly applied in sufficient quantity to adequately cover the tree.
- Spray equipment must be calibrated correctly before it is used to apply spray material, as the calibration of the equipment will determine the amount of spray material applied.
- Spray machines vary in design and complexity but generally they consist of:
  - A pump that pumps liquid from the spray tank through nozzles.
  - Nozzles that consist of whirlers and discs.
- Whirlers determines droplet size, the angle of the spray, and a hollow or full cone.
- Discs have different sized holes which determine the amount of spray material delivered per unit of time.
- The amount of spray material delivered also depends on the pressure of the pump, expressed in kPa (kilo Pascal).
- The following information is required to complete the calibration:
  - Litres required per tree.
  - Tree spacing in row.
  - Tractor speed (for larger spray machines).
  - Number of nozzles.
  - Pump pressure.
- Calibration is based around calculating how many litres per minute each nozzle on the spray equipment must deliver to the trees.
- To calculate this, the following procedure is followed:
  1. For vehicles, calculate how many trees are passed per minute at driving speed.
  2. Look up the delivery in litres per minute per nozzle of the various combinations for whirlers and discs at various pump pressures from reference tables.
  3. Select and attach the appropriate combination of whirlers and discs.
  4. If using a tractor, the PTO speed needs to be set to the correct value.
  5. Test the coverage before application begins and recalibrate if needed.
- Knapsacks and herbicide sprayers may also have to be calibrated, depending on the type of application that required.
- The calibration of this equipment varies and must be done according to manufacturer instructions.

IAC0209: Fault-finding principles are explained

- Fault-finding refers to the process of identifying and diagnosing problems in machinery and equipment.
- Fault-finding requires a clear understanding of the equipment's design, components, and method of operation.
- Fault-finding should incorporate a process of elimination, isolating individual components to determine what the specific issue is.
- The fault-finding should not stop when the first fault is found, as there may be more than one fault in the equipment.
- Regular inspections of equipment and machinery is essential as part of general maintenance and equipment management.
- Many faults develop gradually and worsen over time, due to wear, corrosion, or blockage, and these faults can reduce the effectiveness of pest and disease control actions using this equipment.
- Equipment should be checked regularly and systematically according to manufacturer instructions.
- If any workers notice any issues while using the equipment, such as weak coverage, work must be immediately stopped, and the issue reported to a supervisor.
- The supervisor should issue the worker another piece of the same equipment so that work can continue, if possible.
- After issuing replacements, the equipment should be returned to the storeroom, workshop or equipment manager for further checks and repairs if needed.
- These further checks can include testing operational parameters, such as pressure, flow rate, and spray pattern, to allow for clearer identification of the specific fault.
- Visual inspections should also be performed (for physical damage, wear, blockage, etc.) of each component of the equipment in turn.
- Electrical and control systems on larger equipment should be checked systematically by qualified electricians.
- When performing any fault finding, safety considerations must be a main concern.
- All equipment and machinery undergoing fault-finding must be turned off, depressurised, and isolated in a safe area to prevent accidents during inspection and repair.
- All of these checks, the original issue, the effects on work, possible negative results of the fault, maintenance actions, replacement issuing, costs, and workers involved, should be recorded.
- These records of maintenance and prior faults are used to predict and identify recurring issues, as repeated malfunctions often indicate underlying problems in the maintenance system or with suppliers.

IAC0210: The reasons for good working condition of all equipment are motivated

- Maintenance is a core part of using equipment safely and effectively and ensuring that control actions are successful.
- Equipment being in good condition minimises the risk of mechanical failures during operation, which can cause delays and possibly harm trees or the environment.
- Importantly, well-maintained equipment minimises the risk of accidents and injuries to workers and other people in the field.

- Well-maintained equipment also prevents wastage of chemicals and water, saving money for the farm as a business.
- Control actions such as agrochemical applications are more effective when equipment is in good condition, as spray patterns, coverage and flow rates will be more consistent.
- Regular maintenance extends the service life of equipment, saving replacement and repair costs.

IAC0211: The implications of faulty and poorly calibrated equipment on the production process and the product are evaluated

- Faulty or poorly calibrated equipment can result in over- or underapplication of spray material, both of which are costly to the farm.
- Underapplication will render the application ineffective, requiring repeated applications and wasting labour.
- Overapplication will render the application harmful to the environment or the trees, while wasting money in chemical costs.
- Overapplication may also harm workers or other people, as well as beneficial organisms in and around the orchard.
- Faulty or poorly calibrated equipment will also have more frequent malfunctions, which can delay production and harm workers, the environment, or the trees.
- Faulty or poorly calibrated equipment may also contaminate sprays with rust, dirt, or excess residues, which can affect both tree health and final product safety.
- Faulty or poorly calibrated equipment can lead to legal and regulatory issues, as improper application of pesticides or chemicals may violate safety standards and environmental regulations.
- Faulty or poorly calibrated equipment performance can increase long-term operational costs due to frequent repairs, replacements, and loss of inputs, ultimately reducing profitability.

self-assessment

KT0203: Calibration and Mechanical Integrity of the Equipment

Can I?	Y/N
Can I explain the importance of regular inspections?	
Can I describe the risks of not inspecting equipment?	
Can I inspect equipment?	
Can I train workers in regular inspection?	
Can I describe the role of inspections in regulatory compliance?	
Can I keep records of equipment condition?	
Can I describe the risks of underapplication of agrochemicals?	
Can I describe the risks of overapplication of agrochemicals?	
Can I explain the necessity of accurate equipment calibration?	
Can I calibrate application equipment?	

Can I train worker in equipment calibration?	
Can I describe the main components of spray equipment and their functions?	
Can I perform fault-finding checks on equipment?	
Can I keep maintenance and inspection records?	
Can I describe the value of well-maintained equipment?	
Can I explain the consequences of faulty or poorly calibrated equipment?	

work scenario reference

To learn about how the above information is applied in practice, please look at the following workplace scenarios:

IAC Code	IAC Title	Relevant Work Scenario(s)
IAC0207	The reasons for regular inspection of equipment are listed	I1, I2, I3, I5, I6
IAC0208	The reasons for accurate calibration of equipment are motivated	D2, F1, F2, L1
IAC0209	Fault-finding principles are explained	I1, I2, I3, I5, I6
IAC0210	The reasons for good working condition of all equipment are motivated	I1, I2, I3, I5, I6
IAC0211	The implications of faulty and poorly calibrated equipment on the production process and the product are evaluated	I1, I2, I3, I5, I6