Safe Handling of Agrochemicals

Module 1:
General Safety

Learner Guide

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Introduction

In the process of producing and packing citrus fruit, we make use of many chemical products. There are fertilisers, herbicides and pest control chemicals used in the nursery and on the farm, chemical treatments used in the packhouse, and chemicals used to clean and sanitise work areas, to name a few examples. These chemical products are referred to as agrochemicals, meaning chemicals used in agriculture.

There is a wide range of agrochemicals that workers in nurseries, on farms and in packhouses regularly work with. All agrochemicals can be dangerous to humans, animals and plants, and can damage the environment if they are, for instance, allowed to get into waterways or into the soil. Even agrochemicals classified as safe can be harmful to your health – it is all a question of how much you are exposed to and how you are exposed.

Different agrochemicals can pose a danger to you in different ways. Some of them can be poisonous to humans or animals when they are swallowed – what we call "ingested" – while others can cause chemical burns or even poison you when they come into contact with your skin. Another great danger is inhaling certain agrochemicals while they are being sprayed in orchards. Others are very dangerous when, for instance get them in your eyes.

Remember that many agrochemicals, like pest control chemicals and herbicides, are made to kill living things like pest insects and weeds. Agrochemicals must be stored and always used with safety in mind. In this series we look at how we protect ourselves, others and the environment when using agrochemicals, how we store agrochemicals safely, and how we correctly mix and use agrochemicals. In this module we look at general safety procedures.

Occupational Health and Safety

Every workplace in South Africa – in our case every nursery, farm and packhouse – must adhere to the requirements of the Occupational Health and Safety Act. Under this Act there are very specific regulations for how all chemicals that are used in that workplace must be used and stored. Workers must receive regular training on the requirements of the Act and the Act itself must be printed out and put up on a wall in the workplace. Have a look at it, and make sure that you comply with the law.

There are also other requirements and regulations that citrus producers and packhouses must adhere to if they want to export citrus fruit. There is for instance the GlobalGAP accreditation system and the SIZA programme. Both of these require that the workplace must have a health and safety management system. Workers should also be trained about what they are required to do to comply with the system.

Communication is a critical part of a successful health and safety management system. Workers must not only know the hazards that they face in the workplace but also what to do in the event of an accident or emergency. Always remember that these regulations and systems are put in place to protect you. It is important that you play your part in making sure that you stay safe and healthy in the workplace.

Protective Equipment and Clothing

Protective equipment and clothing is the first thing that we need to keep ourselves safe when working with agrochemicals. Protective equipment and clothing is designed to prevent workers from ingesting or inhaling agrochemicals and from getting agrochemicals on their

skin. How much and what kind of protection you need depends on the agrochemical you are working with.

As we discuss in a later module, all agrochemicals are classified according to how dangerous they are. This is shown on the label of the agrochemical, where we can also see what protective equipment and clothing we need to wear when working with that particular agrochemical. Always follow the instructions on the label, even when it is hot or the equipment makes you uncomfortable.

Types of Protective Equipment and Clothing

All workers that come into contact with agrochemicals must have the following protective equipment and clothing available to them:

- **Cotton overalls**
  The best option is a two-piece overall. Overalls are worn just about all the time when working on a farm. Cotton provides better protection and is more durable than those made from lightweight synthetic fabric.
- **Rubber boots**
  Rubber boots are also worn most of the time on a farm, but it is especially important when working with agrochemicals. Rubber boots are water tight and strong.
- **Apron**
  An apron is worn while mixing agrochemicals to protect you in case of spillage.
- **Rain Coat and Hat**
  A rain coat and hat is worn while spraying agrochemicals, to protect from skin contact.
- **Goggles**
  Goggles are used to protect a worker's eyes while they are mixing agrochemicals and sometimes when they are applying them.
- **Rubber gloves**
  Rubber gloves prevent skin contact with agrochemicals while they are being mixed and applied.
- **Face mask**
  A face mask offers protection against inhaling agrochemicals.
- **Respirators**
  Some agrochemicals are even more dangerous when inhaled and a respirator is used in those cases.

Workers must know how to put on and use protective equipment and clothing correctly, and that it must be the right size for them. It is no use wearing a respirator that fits loosely or rubber gloves that are too big and keep falling off.

Maintenance of Protective Equipment and Clothing

Protective equipment and clothing will only protect you if it is clean, whole and working properly. Make sure that your overalls, gloves, boots, apron, raincoat, rain hat and face mask are whole and do not have any rips or tears. A hole or tear can bring the agrochemical into contact with your skin, and it can cause poisoning or a chemical burn.

One of the requirements of a health and safety management system is regular inspection of protective equipment and clothing. Workers are responsible for checking their protective equipment and clothing regularly, but this must be followed up by spot checks by the health and safety officer.

Best practice is to wash clothes and equipment immediately after it is used. This way you can be sure that it is clean when you need to use it again, and it will also stop agrochemicals from being absorbed by the clothing.

Protective equipment and clothing that is badly damaged and no longer effective must be replaced. Rather be safe than sorry – better to replace an item too soon than too late and risk injury.

Preventing Soil and Water Contamination

Farmers have a very particular responsibility to protect the environment and land from which they make their living. Pollution is very damaging to the environment, and a major source of pollution on a farm is agrochemicals that are not handled properly.

Remember that all agrochemicals can cause damage to the environment if they are at a high enough concentration, even if they seem to be harmless. This is why we must prevent accidents that can lead to agrochemicals getting into the soil and water supply, and why we must minimise the amount of runoff agrochemicals when they are being applied.

To limit this, chemical storage and mixing facilities should be constructed at least fifty meters away from natural water sources, even boreholes. To limit soil contamination, chemical mixing areas must also have a separate drainage system where chemicals can be trapped and contained. In a later module we will look at this in more detail.

Emergency Procedures

The workplace should have clear, written procedures for how agrochemicals must be handled to prevent them from getting into the water supply and the soil, and from posing a danger to wild animals, workers and all other humans that are on the farm. All workers that handle agrochemicals must be trained on these procedures.

Firstly, workers must now what to do every day when they work with agrochemicals to stay safe and to prevent emergencies. But no matter how careful we are, it is sometimes impossible to keep emergencies from happening. When it does happen, we must know what to do to minimise the damage caused by the incident.

Poisoning

Poisoning is the first emergency incident that we will look at. Poisoning can happen not only when an agrochemical is swallowed, or ingested, but also with some agrochemicals when they are absorbed through the skin or inhaled.

The first thing to do to is to work closely with the local doctor and other medical facilities. The doctor should have an up-to-date list of the agrochemicals stored and used in the workplace so that he can have the right antidotes available in case of an emergency.

The second important thing is to have a trained first aid officer in the workplace. A first aid officer is trained to recognise different poisoning symptoms and can react immediately if someone gets in trouble. All workers that come into contact with

agrochemicals should know the symptoms of poisoning. There are various posters available that show the symptoms of poisoning and they should be displayed where people work with agrochemicals.

If anyone develops poisoning symptoms, the first aid officer must be called immediately. Also arrange for medical attention as soon as possible or arrange for the worker to be taken to the hospital or clinic. While this is being done, the first aid officer will follow these procedures:

1. Try to find out which agrochemical caused the poisoning.
2. If this can be found out, consult the label for specific first aid procedures.
3. Try to determine how the agrochemical was taken in, being by mouth, through the skin or by inhalation.
4. Make sure that the breathing tract is open.
5. If the patient is unconscious, turn him or her onto their stomach.
6. Start artificial respiration if the person is not breathing.
7. If the patient absorbed the chemical via the skin, remove the patient from the contamination point, remove all contaminated clothing and wash affected areas with soap and water.
8. If the eyes have been affected, wash with clean water for at least fifteen minutes.
9. If the chemicals have been swallowed do not make the person vomit unless it specifically says so on the product label.
10. Keep the patient warm.

Spillage

The second type of emergency incident that we have to prepare for is spillage, or leakage. Even if workers are really careful when handling chemicals, spillages or leakages can still occur. It is important to have the right equipment available so that the damage can be limited. As part of their health and safety training, workers who work with agrochemicals must be trained on how to deal with spillages and leakages.

To do this quickly and effectively, we need the following tools and equipment:

- Extra sets of protective clothing, including respirators and face masks
- Brooms and shovels
- Powdered lime
- Sand or soil
- Open-top drums in which to put spilled chemicals

If a spillage or leakage occur, follow this procedure:

1. Give first aid to anyone that might have been in contact with or poisoned by the agrochemical.
2. Isolate the spill area and keep all unauthorised people away.
3. Every worker involved in the clean-up must wear protective clothing.
4. Try to contain the spillage or leakage as far as possible by constructing an absorbent barrier of sand, soil or lime around the spilt material.
5. Place leaking containers, if any, into open-top drums and label the drums clearly.

6. Collect the spilt agrochemicals and soil, sand or lime with the shovels and brooms, and place it into open-top drums for disposal.
7. If it is indoors, ventilate the building by opening all the doors and windows.
8. If the spillage is on soil or gravel, dig up the area and remove the contaminated soil.
9. If the spillage is on concrete neutralise the agrochemical with lime, sodium carbonate or sodium hydroxide, depending on the chemical that was spilt.
10. Clean all equipment used during the clean-up operation thoroughly, including laundering protective clothing, and store it for future use.
11. Dispose of the open-top drums and its contents in a responsible manner.

Conclusion

Agrochemicals used in citrus production can all be harmful to the people using it. By following procedures and sticking to safety guidelines, we can minimise the risks and ensure a safe working environment.

Safe Handling of Agrochemicals

Module 2:
Agrochemical Storage

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Introduction

All agrochemicals, including plant protection products, fertilisers, herbicides and cleaning products, must be handled with the greatest care. Agrochemicals are not only potentially toxic to humans, but can also harm animals and pollute water sources and soil. Storing agrochemicals properly is essential to making sure that we have a safe working environment, and that we are able to deal with unexpected incidents such as spillage.

Regulations for Storing Agrochemicals Safely

The rules for the storing agrochemicals safely are prescribed by Good Agricultural Practices regulations and by certification organisations like GlobalGAP. The basic principles are:

- Agrochemicals must be stored in a secure, well-ventilated, cool, dry building that cannot be accessed by children, animals or unauthorised persons.
- There must be easy access to washing facilities with running water, soap and towels. An eye-flushing bottle must be available in the event that eyes are contaminated.
- The storeroom must have a smooth, level cement floor.
- Warning signs must be placed on the outside of the storeroom and they must clearly show that this is an agrochemical storeroom.
- The storeroom must have at least two 9kg dry-powder fire extinguishers on hand, placed outside the storeroom.
- No food products, animal feed or seeds may be taken into the storeroom.
- No eating, drinking or smoking is allowed inside the storeroom.
- Pesticides, fungicides, herbicides and growth-regulators must be separated in the storeroom. Each storage area must be demarcated so that products cannot be mixed by accident. Herbicides should preferably be stored completely separately.
- Powders and granular products must be stored apart from liquid products to avoid contamination in the event of spillage.
- Group the agrochemicals in the store according to their hazard potential. For example, store red-band agrochemicals, meaning those in group 1a and 1b, in the same part of the store.
- Products should be used on a first-in-first-out basis. This will help to make sure that agrochemicals are used before reaching their expiry date.
- Bags and containers that are not on shelves should be stacked on pallets to prevent moisture from building up.
- All containers and bags must be marked properly. If a label is destroyed or lost, mark the container with a marking pen, clearly stating its contents. The label should always be visible.
- Containers with agrochemicals that have been opened and partly used should be resealed and returned to the store.
- Bulk tanks that are used for products such as spray oil should be placed in a dam that has a greater volume than that of the tank, so that the spillage can be contained if the tank should leak or rupture.

- A stock movement recordkeeping system that shows the quantities of each agrochemical purchased, issued and returned must be in place. From the recordkeeping system, one should be able to determine the exact type and quantity of agrochemicals on hand at any given time.

Safety Signs

Adequate, easily visible signage that is in line with the requirements of the authorities must be put up where agrochemicals are stored and used. Signs either give you information or they give you clear instructions on what to do or not to do, in a way that is understandable no matter what language you speak. The signs that are most common are:

- Danger
- No entry
- No smoking
- No drinking and eating
- Fire extinguisher
- First aid equipment
- Emergency exit
- Protective clothing required
- Do not drink the water from this tap

Agrochemical Identification

Now that we know what the storeroom should look like, let's find out how we can identify different agrochemicals to ensure that the are stored in the right place. It is against the law to use products that are not officially registered and permitted in the country of use, or to use a product on crops that it is not registered for. It is also good practice to only use products from trustworthy sources. It is important to know how to read the labels of agrochemicals, because this is where we can find all the information we need.

All agrochemicals are approved and registered with the Department of Agriculture, Forestry and Fisheries. The product label is part of the registration of the agrochemical. On this label the following information must be available:

- Full **instructions** on how to use the chemical, together with detailed information on the uses for which the product is registered. Read these instructions carefully and follow them strictly. This will make sure that we get the best results and that people and the environment are not put in danger. It is against the law to use an agrochemical in a manner for which it is not registered.
- A **physical description** of the product, including its colour and whether it is a fluid, powder or granules. The crop protection manager should look at the agrochemical in the container to make sure that it answers to this physical description. If not and the container has never been opened before, the manufacturer or supplier must be contacted immediately. If the container has been opened before, the container and its contents must be discarded, as prescribed.
- The **chemical composition** of the product.
- The **toxicity** of the product, along with instructions for how to handle it safely.

- The **pre-harvest interval (or PHI)** of the product. The PHI, also known as the withholding period, is the period after application of the agrochemical during which the fruit may not be harvested. PHIs vary considerably from agrochemical to agrochemical and must be checked by the crop protection manager when he compiles the crop protection program.
- The product **expiry date**, being the date on or before which the agrochemical should be used. Agrochemicals must be used before the expiry date to make sure that it is still effective.

Hazard Classification

Agrochemicals are classified in terms of their toxicity in five groups, from group one for the most dangerous agrochemicals, to group five for agrochemicals that are unlikely to cause harm to humans if used in the normal way. There is also a colour band for each group, and the first four groups also have hazard statements.

Internationally recognised symbols are used to indicate the toxicity of chemicals in groups one and two.

Advice pictograms indicate what steps to take to protect yourself against contamination. In particular, it shows what protective gear and clothing to use.

Warning pictograms is used if the agrochemical is dangerous or harmful to particular types of animals, or if it shouldn't be applied in a particular way, such as by crop sprayers.

Sanitation

The agrochemical store, the area around it and the protective gear and clothing that is used when agrochemicals are handled or applied must be kept clean and sanitised to limit the chance of contamination.

There must be a wash trough or large basin close to the agrochemical store; so that workers can wash their protective gear and clothing on site and immediately after it is used.

Equipment, such as scoops, buckets and measuring cups, must be washed at the end of the workday.

Disposal of Contaminated Items

Empty chemical containers must under no circumstances be reused for any purpose whatsoever. Even if the container has been washed thoroughly, the risk of contamination is too high.

Rinse the empty container by filling it to about a quarter with clean water, closing it, and shaking it well. Pour the rinse water into the spray tank or down the drain. Repeat this process at least three times. Puncture the container after rinsing it, so that it cannot be reused.

To dispose of used items, burn waste bags, paper and mildly contaminated items. Severely contaminated items and redundant chemicals must be disposed of using a high-temperature incinerator, which can also be used for empty containers. Containers of highly flammable chemicals must however not be burned, even if they have been rinsed. A professional waste disposal company must take care of these containers.

Recordkeeping

Recordkeeping forms an important part of the well run agrochemical store. A system must be in place from which we must always be able to tell what agrochemicals are in storeroom, and how there is of each one. The system must also be used to make sure that we use the oldest agrochemicals in the store first.

There are various ways to keep stock records in a agrochemical store, but whatever system you choose to use, it is important that it must make it possible for you to record the details of new agrochemicals when they are received, record the details when an agrochemicals is taken from the store to be used, and record when any agrochemical are disposed of for whatever reason.

Incident reporting is another important part of recordkeeping. An "incident" refers to an accident or a near accident at the workplace where workers were or could have been injured or killed, safety was compromised, or property was damaged.

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Conclusion

Storing agrochemicals properly is important to make sure that we limit the chance of pollution and contamination, and to make sure that we do not waste money due to sloppy recordkeeping and wasting agrochemicals.

Safe Handling of Agrochemicals

Module 3:
Agrochemical Application Principles

Learner Guide

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Introduction

Agrochemicals in citrus are used for a variety of purposes, including plant protection, plant nutrition, and plant manipulation. Depending on the purpose, agrochemicals can be applied to specific parts of the tree itself, to the soil and to the water. In this module we look at how to apply agrochemicals safely and effectively.

Application Methods

There are three ways in which agrochemicals are applied. These are foliar applications, trunk applications and soil applications.

Foliar Applications

Foliar applications are where agrochemicals are sprayed onto the leaves of trees. This is the most common way for applying agrochemicals. There are four main types of foliar sprays, namely:

- Outside cover sprays
- Medium cover sprays
- Full cover sprays and
- Bait sprays

Outside cover sprays are applied at low volume and with a light covering of the tree canopy. Droplet size is small, and the tree is sprayed with a fine mist of spray material that only covers the outer canopy of the tree. The volume of spray material applied per tree varies depending on tree size and shape, but ranges from a half litre to ten litres per tree.

Medium cover sprays wet the foliage of the tree to the point of run-off, meaning that all leaves of the tree are wet but very little spray material drops off the leaves. The tree canopy is not necessarily penetrated, but some of the branches may be slightly wet, especially the green branches that bear the leaves. The volume of spray material applied per tree during a medium cover spray also varies depending on tree size and shape, but ranges from ten to twenty litres per tree.

Full cover sprays are designed to thoroughly wet the tree canopy and to penetrate the inside of the canopy, drenching the branches and framework of the tree as well. The volume of spray material applied per tree during a full cover spray ranges from twenty to fifty litres per tree, depending on tree size and shape.

Bait sprays are commonly used for the control of fruit fly. These applications require a spray with coarse, large droplet size. Sprays are often applied to only a portion of the orchard, depending on the intensity of the pest threat. The volume of spray material applied per tree varies from a hundred to eight hundred millilitres per tree, depending on tree size.

Trunk Applications

Some agrochemicals are applied directly to the trunk of the citrus tree. These agrochemicals are systemic, meaning that they are absorbed through the bark and translocated within the tree to the area where they are required.

These agrochemicals have clear application instructions on their labels, which you need to follow carefully. In many cases they require very precise measuring, and specialised equipment that can measure the volume very precisely is normally used.

Soil Applications

The type of agrochemical that is most often applied to the soil is granular fertilisers. They are applied to the soil by hand, and scattered a specific volume of the fertiliser around the tree trunk and over the irrigated area under the tree.

Plant protection products can also be applied to the soil, by way of a soil drench. This involves diluting the agrochemical in water and then pouring it onto the soil around the trunk of the tree. From here it is absorbed by the roots and translocated within the tree. These agrochemicals are also systemic.

Certain agrochemicals – mostly fertilisers – are applied to the soil through the irrigation system. Fertigation is the method of applying fertilisers through the irrigation system. These systems are usually automated.

Mixing Agrochemicals

Before you can start applying agrochemicals, you have to mix them to the right concentration. It is mostly for foliar applications that agrochemicals need to be mixed beforehand. Instructions for the concentrations of particular applications can be found on the plant protection plan.

Measuring Equipment

It is important to accurately measure the amount of agrochemicals used in an application.

For liquid agrochemicals, measuring cups that are clearly marked on the sides are used. To avoid unwanted chemical reactions, it is good practice to use separate containers for each agrochemical that you are working with. The measuring cup must also be big enough to contain the total volume that you need to measure.

Scales are used for granular chemicals that are measured by weight. Electronic scales are the best because they are accurate and easy to use, but any scale will do as long as it is accurate. Scales should be calibrated regularly by the agrochemical stores manager, and at least once a year by a professional company. The containers used on the scales must be kept clean and residue free.

Pre-Mixing

Pre-mixing is where an agrochemical has to be mixed with water before being added to the spray tank. For this we need a bucket large enough to contain the volumes of agrochemicals and water we need to mix, and a metal stirrer.

Calculations

The dosage instructions for the concentration to be used for an application are normally in millilitres or grams per 100 litres of clean water. To determine how much chemical is needed per spray cart, you need to know the volume of the spray tank. For this exercise we will work on a volume of 500 litres.

Let's say the dosage instruction is for 100 millilitres per 100 litres of water. Divide the volume of the spray tank – in this case 500 litres – by the volume in the instructions – in this case 100 litres. This gives us five, meaning there is five times more water in the spray tank than what our instruction is for. If we multiply the dosage in our instruction by this factor, we will know how much of the agrochemical we need to the volume of water in the tank. In this case, we will need 500 millilitres of the agrochemical in the 500 litre spray tank to get the correct concentration.

In some cases, you will need to mix more than one agrochemical in the same spray tank. The volume for each agrochemical must be determined on its own with a separate calculation. The same method is used if we need to add spray oils to the mixture.

Mixing

Once you have collected the agrochemicals from the storeroom, inspect and identify the chemicals, check their expiry dates, and ensure that you are aware of the toxicity of agrochemicals and safety instructions for handling them. Put on the necessary protective clothing and gear. Clean water and soap must be available so that you can immediately wash if an agrochemical comes into contact with skin, and so that you can wash after handling the agrochemicals. After you have identified the volumes of the agrochemicals that you need, do as follows:

- Accurately measure the agrochemical, using the appropriate equipment.
- Fill the spray tank halfway with clean water. Run the water into the spray tank through a course filter to make sure there are no particles in the water that can block the spray heads.
- If the product label indicates that premixing is required, add the measured volume of agrochemical to 10 litres of clean water in a bucket and mix thoroughly with the metal stirrer. Add the mixture to a spray tank half full of water.
- If premixing is not required, add the measured volume of agrochemical directly to the half-full spray tank.
- Fill up the spray tank, stirring – also called "agitating" – the mixture all the time.

Calibration of Application Equipment

To ensure that the right amount of spray material is applied to the crop, the spray equipment must be calibrated. Carefully follow the calibration instructions for the equipment that you use. Incorrect calibration can result in the agrochemical application being ineffective if not enough of the product is applied to the crop, and if too much is applied, it can damage the crop. Over-application can also poison people, animals and the environment. It is also a waste of money. Check equipment thoroughly before use. Do not use faulty equipment, but report it as soon as you are aware of it.

For trunk applications and soil drenches, plant protection products are measured and equipment calibration is therefore not normally needed. The exception is for where special applicators are used for trunk applications of when a Calibra applicator is used. In this case the Calibra must be calibrated or set at the correct volume required for the trunk size, according to the formula given on the label. When foliar applications are used, the spray equipment must, however, be calibrated to ensure that the correct volume of spray material is delivered. As there is a wide variety of mist blowers in use, follow the procedures recommended for the mist blowers you use for calibration.

Cleaning Equipment

After mixing the chemicals all equipment must be thoroughly cleaned and dried. Chemical residue left in containers used for mixing can cause unwanted chemical reactions if used without proper cleaning. As discussed in a previous module we must also ensure that all safety clothing and equipment are cleaned and stored away neatly after each day's work. Chemical containers that were used but that are not empty must be taken back to the storeroom and replaced in the correct places.

Recordkeeping

Recordkeeping is an important and often neglected facet of managing agrochemical use, as chemicals are issued from the store and mixed records must be kept of the quantity used and in which orchard and block the chemicals were applied. Recordkeeping can help us keep track of what application was done to certain blocks and let us work out if our measurements were accurate or not. Soil samples should be taken at least annually by an accredited lab to assess chemical load of the soil and the residue levels of all crop protection and crop production products Recordkeeping also forms an important part of all certifications systems such as Global GAP and others.

Conclusion

It is important that we as producers and workers take the responsibility of using agrochemicals safely and effectively. Using agrochemicals as directed can save the production facility money. More than this, using the chemicals safely and storing them as directed can make sure that we get full value out of these products.