LEARNER GUIDE

Plant Nutrition & Soil Management

Level 3

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Title:		**Manage Soil Fertility and Plant Nutrition**					
Applied Title:		**Manage Soil Fertility and Plant Nutrition in a Citrus Production Environment**					
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Sub-Field:		Primary Agriculture					
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Table of Contents

Directions **5**

Introduction **6**
1. Purpose 6
2. Learning Assumed to Be in Place 6

Revision of Level 2 .... **7**
1. Preparing and Measuring Soil Nutrient Applications 7
2. Sampling for Nutrient Analysis 7
3. Properties and Composition of Soil 8
4. Basic Symptoms of Nutritional Deficiencies 9

Chapter 1 .... **11**
1. Introduction 11
2. Manual Applications 12
   2.1. Calculation of the Total Requirement 12
   2.2. Collection from Storage 12
   2.3. Measurement 13
   2.4. Application 13
3. Mechanical Applications 13
   3.1. Calculation of the Total Requirement and Collection from Storage 14
   3.2. Measurement 14
   3.3. Calibration 14
   3.4. Application 14
4. Fertigation 14
   4.1. Application 14
   4.2. Measurement and Calibration 14
   4.3. Guidelines and Principles of Fertigation 15
5. Foliar Applications 15

Chapter 2 .... **17**
1. Introduction 17
2. Preparation for Sampling 17
3. Sampling Pitfalls 17
   3.1. Leaf Sampling 17
   3.2. Soil Sampling 18
4. Handling Samples 18
5. Dispatching Samples 18
6. Recording Samples 18

Chapter 3 .... **21**
1. Relationship between Fruit Quality and Tree Nutrient Status 21
   1.1. Nitrogen (N) 21
   1.2. Phosphorus (P) 21
   1.3. Potassium (K) 21
   1.4. Calcium (Ca) 21
2. Basic Recommendations for Improving Nutritional Status 21

Chapter 4 .... **24**
1. The Impact of Soil Properties on Plant Nutrition 24
   1.1. The Impact of Physical Soil Properties on Plant Nutrition 24
      1.1.1. Texture 24
      1.1.2. Structure 24

1.1.3. Soil Depth 24
1.1.4. Soil Strength 24
1.1.5. Layering or Stratification 25
1.1.6. Aeration 25
1.2. The Impact of Chemical Soil Properties on Plant Nutrition 26
1.2.1. pH 26
1.2.2. Resistance 26
1.2.3. Fertility 27
1.2.4. Salinity 27
1.2.5. Organic Material 27
2. The Impact of Soil Properties on Soil Preparation 27
2.1. Soil Survey 27
2.1.1. Positioning Profile Pits 27
2.1.2. Digging Profile Pits 28
2.1.3. Surveying Profile Pits 28
2.1.4. Sampling Profile Pits 29
2.1.5. Comparing Profiles 29
2.1.6. Demarcation of Soil Types 29
2.1.7. Preliminary Recommendations on Soil Preparation 29
2.2. Chemical and Physical Analyses of Profile Pit Soil Samples 29

Chapter 5 31
1. Introduction 31
2. The Purpose of Soil Preparation 31
3. Cultivation Needs of Various Soils 31
3.1. Profile Properties and Soil Preparation 31
3.2. Chemical Properties and Soil Preparation 32
3.2.1. pH 32
3.2.2. Salt Content 32
4. Soil Preparation Methods and Implements 32
4.1. Mixing 33
4.2. Loosening 33

Bibliography 34

Directions

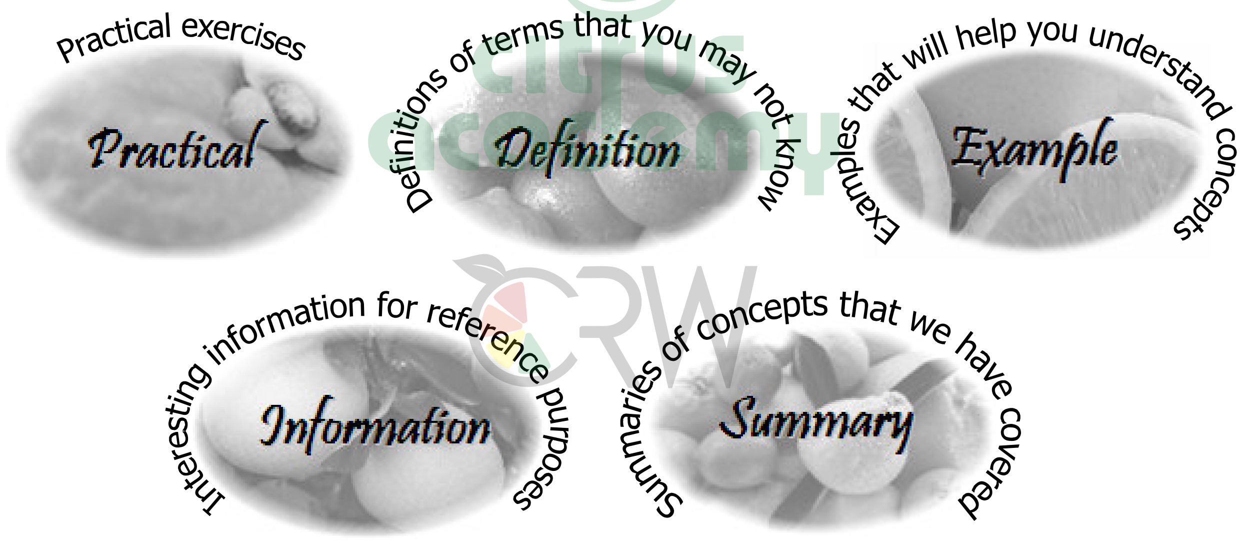
This learning material has been developed to assist the learner wishing to complete this unit standard. The guide contains all necessary learning to ensure that the learner will attain the competencies required by the unit standard.

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

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

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

Information in boxes is indicated by tags that show:



Introduction

1. Purpose

A learner achieving this unit standard will be able to supervise application of soil nutrient preparations in a safe, effective and responsible manner for the benefit of plant/crop growth with consideration to the environment.

Learners will gain specific knowledge and skills in soil and plant nutrition and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.

They will be capacitated to gain access to the mainstream agricultural sector in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

2. Learning Assumed to Be in Place

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

NQF Level	***Unit Standard Number***	***Unit Standard Description***
NQF2	Literacy and Numeracy	
2	116053	Understand basic soil fertility and plant nutrition
3 (F)	116269	Supervise the collection of agricultural data
3	116218	Explain the planning and scheduling of tasks in a production environment
3	116214	Interpret factors influencing agricultural enterprises and plan accordingly

Revision of Level 2

1. Preparing and Measuring Soil Nutrient Applications

- Plants need sunlight, water, air (oxygen and carbon dioxide) and nutrients in varying quantities to grow well and produce food. Nutrients are also called essential nutrient elements.
- To grow citrus successfully, we need to know which nutrients are required, the quantities of nutrients required, the right time to apply them, and the best way to apply them.
- Essential nutrient elements are divided into macro and micro nutrient element groups.
- Essential nutrient elements play various roles in the physiological processes in plants, some of which are still not understood.
- Nutrients, or fertilisers, are applied through soil applications (manual or mechanical), foliar applications, and fertigation.
- Fertilisers can be from organic (natural or synthetic) or inorganic (chemical) sources. In commercial citrus production inorganic, commercial fertilisers are mostly used.
- Compost and manure are forms of organic fertilisers that are produced by allowing organic material to decompose.
- Commercial fertilisers are available in granular, powdered and liquid form.
- A fertilisation program is developed to provide for the application of fertilisers that need to be applied during a specific period, usually a year.
- Soil and leaf analyses are used to guide the development of the fertilisation program and to detect nutrient deficiencies and excesses.
- When the fertilisation program has been developed, preparations are made for the fertiliser applications by calculating the total amount of fertiliser required, collecting the fertiliser from storage and measuring the fertiliser to determine the volume relative to the weight prescribed on the fertilisation program.
- The total amount of fertiliser required is calculated by determining the number of trees in the orchard, and multiplying that with the amount prescribed per tree.
- When fertiliser is collected from the storeroom, the active ingredient and the weight of the bags must be checked.
- The volume of fertiliser that must be applied to each tree is determined by weighing the required amount. Scoops of the exact volume are made to be used during the application.
- Fertilisers are applied manually by irrigating the orchard first to demarcate the area where the feeder roots are concentrated, and then scooping the correct amount of fertiliser and applying it to the wetted area.

2. Sampling for Nutrient Analysis

- A nutrient deficiency means that there is not enough of a specific nutrient for the plant to complete a physiological process.

- Nutrient deficiencies of each nutrient cause very specific symptoms.
- Nutrient deficiencies are confirmed by doing leaf and soil analysis.
- Fertilisation programs cannot be developed in response to a detected nutrient deficiency as the deficiency would already have had a negative influence on the growth and production of the plant.
- Sampling and analyses are used as a diagnostic tool.
- Soil analyses are used to determine the chemical composition and nutrient content of the soil, and certain physical and chemical properties.
- Leaf analyses are used to determine the nutrient status of the plant.
- Fruit sampling is not used to determine the nutrient status of the plant in citrus production, but is only used for maturity indexing.
- Fertiliser samples are taken and analysed if there is uncertainty about the content of the container or the chemical composition.
- A sample must be representative of a unit.
- Sampling equipment must be washed thoroughly with clean water before being used.
- Leaf and soil samples must be taken at the same trees every time.
- Leaf samples are taken in South Africa between February and May before harvesting.
- Between 50 and 100 leaves must be taken for a leaf sample from fruit-bearing twigs.
- Soil samples are taken by combining a number of smaller samples, or sub-samples, and taking a sample from the mixture.
- Sub-samples are also taken from fertilisers and mixed. The final sample is taken from the mixture.
- Sample labels must contain all the necessary information, with at least one label containing all the contact information of the farm or producer.

3. Properties and Composition of Soil

- Plants need soil to stay upright and to get nutrients, water and air (oxygen and carbon dioxide).
- It is important to understand chemical and physical soil properties to understand their influence on the ability of plants to grow.
- Soil with optimal properties is not always available for cultivation, and steps can be taken during soil preparation to correct or at least improve the conditions.
- Physical soil properties include texture, structure, depth, layering (stratification) and aeration.
- Texture is a fixed soil property and ranges from clay to sand.
- Soil with a clay content of between 7% and 30% is optimal for citrus production.
- Soil ranges from having no structure to being granular. Soil structure determines the aeration, water penetration and drainage of the soil.
- Soil with a depth of at least 500mm is required for citrus production.

- Soil layers are formed over many years, and the differences in the properties of soil in various layers determines the ability of water and roots to move from one layer into the next.

- Aeration refers to ability of the soil profile to supply air to the roots. Poorly drained soil becomes water-logged and anaerobic, which can cause roots to die.

- Chemical soil properties include pH, resistance and electrical conductivity, salinity, fertility level, cation exchange capacity, and organic matter.

- pH indicates the acidity of soil. The optimal pH(water) of soil for citrus production is between 6.5 and 7.5.

- Electrical conductivity and resistance indicate the salinity of the soil.

- Soil salinity affects soil fertility and physical soil properties.

- Soil fertility indicates the ability of soil to sustain plant growth.

- The cation exchange capacity of soil determines the ability of soil particles to bind with nutrients and keep them available to plants.

- Organic matter in soil consists of dead plant and animal material, organic and microbial debris, and humus. Humus contributes to the activity in soil.

4. <u>Basic Symptoms of Nutritional Deficiencies</u>

- The plant's ability to complete its physiological process, grow and produce food depends on the concentration of the most limiting element.

- Each nutrient element has a very specific role and function in the metabolism or life of a plant.

- The most limiting element is the nutrient element present at the lowest percentage of its optimum concentration. Even if only one nutrient element is not at optimum concentration, the plant will be limited in its ability to grow.

- Nutrient deficiency symptoms are specific to the nutrient that is not at the optimum level, but can be blurred by a combination of deficiency symptoms or symptoms of other factors.

- The fertilisation program should provide for keeping nutrient elements at optimum levels. Mild deficiencies can be tolerated during certain times of the year.

- The cause of the deficiency has to be identified in order to deal with it effectively.

<u>Nutrient Deficiency</u>

A nutrient deficiency is when there is not a sufficient quantity of a specific nutrient element and the plant cannot complete a certain physiological process as a result.

<u>Soil Penetrometer</u>

A soil penetrometer is an instrument that measures soil strength. Soil strength is the resistance of soil against penetration of roots, or against the probe when using the instrument. Soil strength is expressed in *mega-Pascal per square centimetre*, written as MPa/cm^2 or MPa cm^{-2}.

Field Water Capacity (FWC) Field Water Capacity (FWC) is reached when a soil is allowed to drain freely after it was saturated with water. This is the point where no free water is present in the soil. All the water present is bound to the soil particles.
pH pH indicates the acidity or alkalinity of any substance, in this case soil, on a scale of 1 to 14. pH can range from 1 (extremely acidic) to 14 (extremely alkaline). A pH value of 7 is neutral. Plant sap has a pH of 5.8 and the pH of human blood is almost 7. Soil with a low pH is referred to as ***acidic***. Soil with a high pH is referred to as ***alkaline***.
Electrical Conductivity Electrical conductivity refers to the ability of soil paste to conduct an electrical current and can be expressed in various units. The international standard unit is Siemen.
Resistance Resistance is the opposite of electrical conductivity, and refers to the resistance of a soil paste to conducting an electrical current. Resistance is expressed in ohms.

Chapter 1

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

Prepare for soil and foliar nutrient applications using specialised equipment

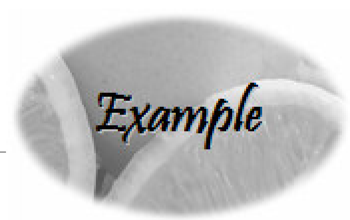
1. Introduction

Fertilisers and other compounds used in soil management, such as potassium sulphate, are applied either to the soil or to the leaves of citrus trees. Lime, for instance, is added to soil that is too acid, and applications can be done as part of soil preparation before the trees are planted, or as part of the fertilisation program after the trees have been planted.

Soil applications can be in the form of manual applications, mechanical applications and fertigation. The following steps are followed in any fertiliser application:

- ***Calculation of the Total Requirement*** – The total amount of fertiliser required is calculated by using the information supplied on the fertilisation program.
- ***Collection from Storage*** – The correct fertiliser must be identified and collected from storage. Controls should be in place to ensure that the correct amount of fertiliser is collected only for prescribed applications.
- ***Measurement*** – The correct amount of fertiliser must be measured carefully. Over-application can be as harmful to the tree as under-application, and over-application also leads to financial losses.
- ***Preparation*** – Most fertilisers used in citrus production do not require any preparation, but there are some application methods that require mixing.
- ***Calibration*** – Certain application methods require the calibration of equipment to ensure that the fertiliser is applied at the correct rate.
- ***Application*** – Fertiliser must be applied to the trees using the predetermined method and at the prescribed rate.

Below is an example of a typical fertilisation program for a citrus farm. We will use this example program to assist with explaining the principles in the following sections.



Fertilisation Program

FERTILISATION PROGRAM – CITRUS			
Orchard:	Orchard 10	**Size:**	3.0ha
Cultivar/Variety:	Delta Valencias	**Trees per ha:**	316
Fertiliser		***Quantity***	***Application Time***
Soil Applications		**g per tree**	
Limestone Ammonium Nitrate (LAN)		500g	July

LAN	250g	August
LAN	250g	September
Potassium Chloride (KCL)	500g	September
Dolomitic Lime	4000g	October
Foliar Sprays	**g per 100l water**	
Low Biuret Urea	1000g	July
Manganese Sulphate	200g	October
Solubor®	150g	October
Remarks:		

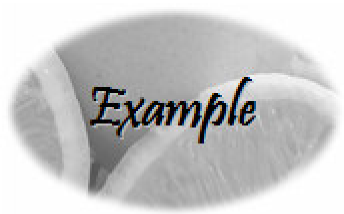
After an application has been completed, one can verify that the correct amount has been applied by comparing the total amount of the fertiliser used with the required amount that was calculated before the application. This will help to ensure that the application is efficient and that the scoops and other application equipment are calibrated correctly.

2. Manual Applications

A manual application is a method of soil application, meaning that the fertilisers are applied directly to the soil. During a manual application, the prescribed amount of granular or powdered fertiliser is applied to each tree by hand.

2.1. Calculation of the Total Requirement

The total fertiliser requirement is calculated by calculating the number of trees in the orchard, and multiplying the recommended amount of fertiliser per tree with the number of trees. Using the example fertilisation program above, the calculations are done as follows:



Calculating the Total Fertiliser Requirement

The total amount of LAN needed for the September application is calculated as follows:

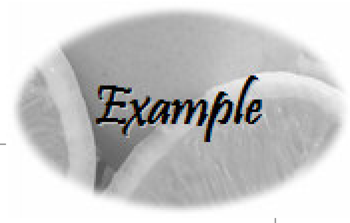
Number of Trees in Orchard = Orchard Size in Hectare (ha) x Number of Trees per Ha
= 3.0ha x 316
= 948 trees in the orchard

Total Amount of Fertiliser Required = Fertiliser per Tree (g) x Number of Trees in Orchard
= 250g x 948 trees
= 237,000g (/1,000 to convert to kg)
= 237kg

We have calculated that 237kg of LAN is required for the September application to orchard 10.

2.2. Collection from Storage

Granular and powdered fertilisers are most commonly supplied in 25kg or 50kg bags. The number of bags that has to be collected from storage is calculated by rounding the total amount required up to the nearest 25 or 50, depending on the size bags available on the farm. This number is then divided by 25 or 50 to give the number of bags required.



Calculating the Number of Bags to be Collected from Storage

We have established that LAN is available in 50kg bags on our farm. Using the example above, the number of bags are calculated as follows:

237kg rounded up to the nearest 50 = 250
250 / 50
= 5 bags of LAN must be collected from storage

Note that there should be 13kg (250-237) of fertiliser left in the last bag if the application is done correctly. This bag should be returned to the storeroom and sealed to be used at a later stage.

When collecting fertiliser from storage, check the following:

- The names and descriptions on the bags. Good agricultural practices (GAP) prescribe that fertiliser of the same type should be stored together, but do not assume that this is the case.
- The concentration of the active ingredient specified on the bag or container, because some fertilisers are supplied in more than one concentration. Zinc nitrate, for instance, is supplied in formulations with an active ingredient (Zn) concentration ranging from 5.5% to 16%.
- The mass of every bag.
- The seals on half-full bags if they are being used.

2.3. Measurement

Even though the fertilisation program usually states the amount of fertiliser to be applied in grams per tree, the fertiliser cannot be weighed in the field for every tree before it is applied, as it would be impractical and unproductive.

The fertiliser is weighed accurately once, and the volume that corresponds with the weight is determined. Scoops are then manufactured by cutting used tin cans to this volume. **Never use empty chemical containers for this purpose.** If the scoop is filled with fertiliser, the scoop will contain the correct, prescribed mass of fertiliser. Each fieldworker is supplied with a scoop of the correct volume, and the fertiliser is scooped out of the bag and applied in the manner described below.

2.4. Application

Fertiliser is applied in the area around the tree trunk where irrigation water is applied, and where the feeder-roots are. The majority of the feeder-roots are concentrated in a strip of 50cm inside to 50cm outside the drip-line of the tree, provided this area is irrigated. Irrigate the orchard for about 30 minutes before applying fertiliser to demarcate the area where the feeder-roots are.

Fieldworkers scoop the fertiliser from a bag and spread it below the canopy of the tree on the wetted zone with as little fertiliser as possible against the trunk.

3. Mechanical Applications

Mechanical application is another soil application method. Lime and other fertilisers are applied by using spreaders that have been adopted from field-crop applicators. Spreaders are adapted to apply fertiliser from one or both of its sides, but not from behind.

In some areas, contractors are engaged to mechanically spread fertilisers. The operators and supervisors of the contractor are in this case responsible for the calibration of equipment, and the correct application of the fertiliser. Fertiliser suppliers also offer an application service. Fertiliser is prepared in the form of suspensions or slurries, and applied to the soil with special equipment. This is a specialised service and the manager only needs to request it from the supplier. Mixing the fertilisers and calibrating the equipment are part of the service.

3.1. Calculation of the Total Requirement and Collection from Storage

The amount of fertiliser required for a mechanical application is calculated in the same way as for manual application, and the same procedures are followed for when fertiliser is collected from storage.

3.2. Measurement

The total amount of fertiliser required for a mechanical application is weighed carefully and loaded into the spreading equipment.

3.3. Calibration

The spreader is calibrated to deliver a certain mass of fertilisers over a specific area at a certain speed. This calibration is done whenever the application rate changes. Tractor speed and settings on the fertiliser spreader are interrelated and must be kept constant for a specific calibration. Mechanical applicators must be calibrated to apply the fertilisers in a strip of about one metre wide. The mechanical spreaders must not apply fertilisers in the orchard roads behind the spreader.

3.4. Application

The mechanical spreader is attached to the tractor and pulled through the orchard, spreading fertiliser from one or both sides.

4. Fertigation

Fertigation is also a method of soil application where the nutrient solution, normally liquid fertiliser, is added to the irrigation water and applied through the irrigation system. Fertigation is the most recent development in the application of nutrient solutions or single-element solutions.

4.1. Application

Fertigation systems can apply any number of the essential nutrient elements at the same time. It is important that workers who work with this type of system and the associated equipment receive very clear instructions and very good training to make sure that they do it correctly. The operating instructions and training are provided by the suppliers of the equipment.

To apply the fertilisers effectively, the irrigation system must operate effectively. If not, the faults with the irrigation system are made worse by applying the fertilisers ineffectively.

4.2. Measurement and Calibration

The fertilisation instruction specifies mass or volume of fertiliser to be added to the fertiliser tank. It is dissolved in the irrigation water and applied via the irrigation system at a rate and ratio determined by the supervisor or manager.

Note that one should be careful if liquid fertilisers are used and the recommendation is specified as a mass. The density of liquids is seldom 1.00, meaning that one litre is not the same as one kilogram. Be careful to make sure that the correct amount of active ingredient is used.

4.3. Guidelines and Principles of Fertigation

- The principle of applying fertiliser only to the wetted area is easy to adhere to with fertigation because the water carries the fertiliser. The fertilisers must be applied in small dosages during 90% to 100% of the length of the irrigation cycle.

- When fertigation is used with drip irrigation, the depth to which the fertilisers are applied is important. The system must be calibrated to fertigate only the top 60% to 70% of the total root-zone.

- Fertigation with phosphate fertilisers by means of micro-jets is not always successful. The success rate depends on the pH and clay content of the soil, with a success rate of below 20% except in sandy, neutral to acid soils. For all other soils where fertigation with micro-jets is practised, the phosphate must be in the form of single or double super-phosphate. It must be applied in a narrow strip of about 10cm wide, below the drip line of the trees. Please note that no other phosphate source can be applied like this.

- Fertigation systems vary enormously in the way fertilisers are measured, prepared, diluted and introduced into the system, and the operating instructions for every unit should be followed very carefully.

5. Foliar Applications

Foliar applications are when nutrients are applied to the leaves of the tree, from where it is absorbed and taken up by the tree.

A variety of mist blowers and spraying machines are used on citrus farms to apply foliar sprays. Spraying equipment is not normally dedicated to nutritional foliar application and is mostly used to apply pesticides. The requirements for foliar application of nutrients and pesticides vary and the same calibration should not be used for both types of sprays.

Leaves can only absorb nutrients that are dissolved in water. The leaves must therefore stay wet with the nutrient solution for as long as possible. The mass of nutrient and therefore the volume of nutrient solution that stays on the leaves are also important. To create an effective period of absorption, the following calibration requirements are important:

- The concentration of the nutrient element in the spray solution must be as high as possible, while avoiding the possibility of scorching the leaves or fruit.

- The droplets applied to the leaves must be larger than 500 micron in diameter. This will prevent excessive runoff and too fast drying of the droplets.

- The leaves must be kept wet for as long as possible, at least for longer than 15 minutes, by not spraying during windy or very hot periods. Spraying during the night is the most effective.

- The nutrient spray solution must be applied to the leaves in the outer 50cm layer of the canopy.

Acidifying the nutrient spray solution is required for some but not all chemicals.

Chapter 1

- ➢ Fertilisers are applied as soil applications (manual application, mechanical application and fertigation) or foliar sprays.
- ➢ In every application, fertiliser must be measured correctly, collected from storage, measured

accurately, prepared according to prescriptions if necessary, and applied as prescribed. In some cases, application equipment must be calibrated.

- The total amount of fertiliser required for any application is calculated by using the fertilisation program.
- Fertiliser must be measured carefully to avoid over- or under-application. Pay attention to liquid fertilisers used in fertigation or foliar applications for which the mass is indicated on the fertilisation program and not the volume.
- When collecting fertiliser from storage, the description, active ingredient and mass of each bag and the seals on half-full bags must be checked.
- In soil applications, fertiliser must only be applied to the zone wetted by irrigation.
- Foliar applications are done with spray machines and the leaves must be wetted thoroughly.
- The instructions for fertigation systems differ and must be followed carefully.

Complete activities 1, 2 and 3 in the **Learner Workbook**.

Chapter 2

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

Supervise the collection of samples, and the storage and dispatch of samples to appropriate service providers

1. Introduction

In the level 2 learner guide for plant nutrition and soil fertilisation the procedures for taking leaf, soil and fruit samples were discussed in detail. In sampling procedures, the steps for taking the actual samples are where errors occur most frequently. Taking samples is hard work, and taking samples according to the prescribed procedures, is even harder. It is tempting to take shortcuts and speed-up the process. The quality of samples can however be jeopardised by what may seem like insignificant deviations from the prescribed procedure. Deviations usually occur when the person taking the sample is not fully aware of the precise procedure or does not appreciate the importance of following the procedure precisely.

Being aware of the pitfalls of sampling is important when one is supervising these activities. There are also certain preparations that are made to ensure that the samples are taken from the correct orchards.

Remember that we do not take fruit samples in citrus farming for nutrient analysis. Fruit samples are only taken in preparation for harvesting to determine whether the fruit are mature and ready to be picked. Fruit sampling is therefore discussed in citrus harvesting learning material.

2. Preparation for Sampling

- Identify and mark the index rows in all orchards where samples will be taken for the first time.
- Ensure that the demarcation of the index rows is still in place and visible in orchards where samples were taken previously.
- Prepare a list of the orchards to be sampled and indicate whether leaf or soil or both samples must be collected.
- Ensure that the containers, being cartons for soil samples and plastic bags for leaf samples, are marked properly. Some laboratories provide sample containers for those orchards registered with them at the beginning of the season. If soil and / or leaf samples are not taken from all the registered orchards, cancel the container(s) and do not take them to the orchard. At the orchard, confirm that the correct containers are used for the orchard.
- Allocate specific sampling tasks to specific people who have been trained and briefed in the correct procedures.
- Give cautionary advice and health and safety instructions to your team.
- Go to the orchard with the team where the sampling is supposed to take place.

3. Sampling Pitfalls

3.1. Leaf Sampling

- The diagnostic leaf, which is the leaf that will be analysed, must be located on a new shoot formed during the spring of the same year. Leaves on older twigs are older than nine months and will have a different nutrient composition than an ideal diagnostic leaf. The sampler must be aware of the difference between a seven to nine month-old leaf and older leaves located on older twigs.

- The diagnostic leaf must be taken from a fruit-bearing twig, meaning that the shoot should carry fruit. Sometimes, especially with lemons, it is difficult to find a fruit-bearing twig with a leaf. The sampler may be tempted to pick a leaf from an older twig.

- Only one or at most two leaves must be picked from a single tree. When there is one tree in the orchard with abundant fruit-bearing twigs with leaves it is tempting to pick more than two leaves from the same tree.

3.2. Soil Sampling

- The major pitfall with soil-sampling is taking the total mass of soil required at one single tree. Taking soil samples requires even more effort than leaf samples, especially in rocky and clayey soils and it is tempting to take fewer sub-samples, which are the number of smaller samples that are mixed and from which the eventual sample for analysis is taken.

- Soil samples must be taken to a depth of 20-30cm. It is tempting to only take the sample from the top layer of soil.

- The sub-samples must be mixed thoroughly before taking a composite sample that will be analysed. If the soil is wet or clayey it is more difficult to mix.

- It may be difficult to reach the wetted and fertilised area below the canopy, but samples must not be taken outside this specific area.

4. Handling Samples

After the samples have been taken, they must be handled in the following manner:

- Mark the sample list to indicate that the sample has been collected.
- Seal the sample containers properly.
- Put the samples in the shade until they can be transported to the office.

5. Dispatching Samples

- At the office, separate the leaf and soil samples, and put them in order according to orchard number, normally from the lowest number to the highest, or according to the sampling list prepared before sampling.

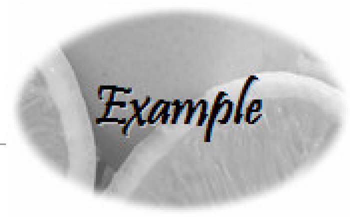
- Check the numbers on the labels of the leaf and soil samples for each orchard and record it on a list that will serve as a consignment note.

- Make a copy of the list and include that with the consignment of samples in the container that is to be dispatched to the laboratory. The list serves as a consignment note. Ensure that all the details that the laboratory may require are included on the list.

6. Recording Samples

Keeping record of the samples is important for the communication between the farm, laboratory and the person formulating the fertilisation program. It is important to streamline this process and to ensure that one keeps track of the samples.

The samples in the consignment are listed on a consignment note, as we have already described, so that the laboratory can crosscheck that they have received all the samples when they arrive. If a sample is missing, it is easy to communicate that immediately with time still available to re-sample the orchard if required. It also helps to keep the relationship between the farm and laboratory professional.



Consignment Note

AA Farming
P O Box 21
Sand River
0111

Telephone: (019) 222-9988
Fax: (019) 222-9989

Contact Person: J Ralepele

To:	CAL
Date:	25/03/05
Carrier:	Sun Couriers
Waybill No:	SC 2118/05
Number of Parcels:	One
Special Instructions:	Please do the standard analyses on leaf and soil samples plus organic matter on all soil samples.

SAMPLES DISPATCHED

Leaf Samples	Soil Samples
1 Deltas	No sample
2 Midknights	2 Midknights
3 Lemons	3 Lemons
27 Deltas	27 Deltas
31 Midknights	31 Midknights
33 Valencias	No sample
34 Lemons	34 Lemons
35 Lemons	35 Lemons
Total of 8 leaf samples	**Total of 6 soil samples**

Some laboratories use codes to identify the orchards and you can also list their code, as follows:.

Leaf Samples		Soil Samples	
1 Deltas	24-A4-1	No sample	
2 Midknights	24-A4-2	2 Midknights	24-A4-2
3 Lemons	24-A4-3	3 Lemons	24-A4-3
27 Deltas	24-A4-5	27 Deltas	24-A4-5
31 Midknights	24-A4-8	31 Midknights	24-A4-8
33 Valencia	24-A4-10	No sample	
34 Lemons	24-A4-11	34 Lemons	24-A4-11
35 Lemons	24-A4-12	35 Lemons	24-A4-12
Total of 8 leaf samples		**Total of 6 soil samples**	

Summary

Chapter 2

- Sampling procedures must be followed carefully to ensure that the results of analyses are accurate and meaningful.
- In preparation for sampling, demarcate the orchards and trees, prepare a list of samples, ensure that the sampling containers are clean and properly marked, allocate specific tasks to specific team members and ensure that they are aware of proper procedure, and health and safety instructions.
- With leaf sampling, ensure that the leaves that are taken is on young shoots, that the leaf is taken from a fruit-bearing shoot, and that not more than two leaves are taken from a tree.
- With soil samples, ensure that the correct number of sub-samples are taken, that samples are taken at a depth of 20-30cm, that the sub-samples are mixed thoroughly, and that samples are taken from the wetted area under the canopy of the tree.
- After samples have been taken, mark it off on the list, seal the containers properly and keep it in the shade.
- Before dispatching samples, separate the leaf and soil samples, check and order the samples, and record them on a consignment note.
- Samples must be recorded to facilitate communication between the farm and laboratory. The most important record is the consignment note.

Practical

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

Chapter 3

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

Identify and interpret symptoms of nutritional deficiencies in various crops and make basic recommendations

1. Relationship between Fruit Quality and Tree Nutrient Status

The nutritional status of the trees at specific periods during the development of the fruit has a definite influence on the quality of the fruit produced, and its exportability. The influence of specific nutrient elements on fruit quality is discussed in detail in this section.

1.1. Nitrogen (N)

A too high nitrogen status of the citrus trees during January to June will delay colour break, increase the thickness of the skins, increase the acid content and reduce carbohydrate reserves. A too low concentration of nitrogen during bud-break and flowering will reduce the number of fruit.

1.2. Phosphorus (P)

Too high concentrations seldom have an influence on the quality of the fruit, but a too low phosphorus status will result in too thick skins, puffy fruit and high acids.

1.3. Potassium (K)

When the potassium status of the trees is too low, the fruit tend to be smaller, the skins smooth and thin, and the acid content low. Excess potassium results in large and coarse skinned fruit with a high acid content.

1.4. Calcium (Ca)

The detrimental effect of excess calcium on fruit quality, apart from lemons, is unknown. Too high concentrations of calcium in lemons are suspected to increase the incidence of Peteca spot. Too low concentrations of calcium in the fruit relates to creasing and poor quality skins.

Combined effects of the status of nutrient elements also occur. A too high status of N and K combined with a too low P status increases the incidence of large puffy fruit with thick, coarse skins.

2. Basic Recommendations for Improving Nutritional Status

Improving the nutritional status of the trees means that the status of all fourteen essential nutrient elements must be brought within the normal range for the specific citrus cultivar and / or selection.

Methods to improve the status of a nutrient element are mostly applications to the soil or through foliar sprays. Both methods have advantages and disadvantages relating to the soil type, condition of the tree and the specific nutrient element.

The most common method to increase the nutritional status of the trees is to apply more of the nutrient to the soil. This decision must be based on soil analyses. Additional application of a fertiliser to the soil must only be done if the concentration of the available form of the nutrient content in the soil is low. A further consideration is whether the applied nutrient will stay in the available form long enough to satisfy the demand. Apart from applying more nutrients to the root-zone, other methods used to improve the nutritional status should be considered. In the table below, possible causes and the corresponding remedies are listed.

Decreasing the nutritional status is not always possible. However, sometimes the effect of too high concentrations of a nutrient element can be counteracted.

Nutrient Element	***Possible Cause***	***Possible Remedy***
N	Too much fertilisers applied at a time	Split the mass / volume of fertilisers applied at any one time
	Excess leaching	Reduce the application of water to wet the root-zone only
	Phytophtora infection of the roots	Test the roots for Phytophtora and act accordingly
	Low efficiency of applied fertilisers	Foliar sprays with low biuret urea or potassium nitrate
P	Too high soil pH	Apply single or double super phosphate in a narrow strip on the soil
	Too low soil pH	Apply lime to increase the pH to 6.50
		Foliar sprays with phosphates are not effective.
K	Too high concentration of magnesium in the soil or water	Use potassium nitrate to apply some of the nitrogen required
	Nematodes	Test the roots for nematodes and act accordingly
	Salinity	Locate the source and act accordingly
	Low efficiency of applied fertilisers	Foliar sprays with low potassium nitrate
	Poor root health	Take remedial actions
	Old trees	Rejuvenate the root system
	Compaction	Corrective actions with mechanical implements may be used, but are not always successful
Ca	Climatic conditions	Ensure that enough available calcium is present in the root zone during the critical period from budding to petal drop
	Low pH	Apply lime
	Salinity	Locate the source and act accordingly
	Low calcium saturation	Apply lime, gypsum or calcium nitrate
		Foliar sprays with calcium have limited success
Mg	Too high concentration of potassium in the soil	Apply magnesium nitrate foliar sprays
	Low pH	Apply dolomitic lime
	Foliar sprays with potassium nitrate	Apply magnesium nitrate foliar sprays
S	Too low concentration of S in the soil	Apply sulphates to the soil. The efficacy of foliar sprays is unknown.

Nutrient Element	***Possible Cause***	***Possible Remedy***
Cu	Too low concentration of Cu in the soil	Apply foliar sprays. The efficacy of soil application depends on many soil factors.
Fe	Too high pH in the soil	Apply Fe-EDDHA in August
	Water logging	Improve scheduling and drainage
		Foliar sprays with iron are not effective
Mn	Too high pH in the soil	Apply foliar sprays
	Recent liming	Apply foliar sprays
Zn	Too high pH in the soil	Apply foliar sprays
	Recent liming	Apply foliar sprays
	High P status	Apply foliar sprays
		Soil applications to mature trees are not effective
B	Too low pH in the soil	Apply foliar sprays
	Recent liming	Apply foliar sprays
		The applications of boron to the soil is quite effective under most soil conditions
Mo	Too low soil pH	Apply lime. Apply foliar sprays.

Table 3.1: Causes and Remedies of Sub-Optimal Nutritional Status

<u>**Chapter 3**</u>

- The status of various nutrients in the tree has a marked effect on fruit quality. Nitrogen, phosphorous, potassium and calcium play the most important role.
- To correct the nutrient status of the tree, the cause of the over- or under-supply must be known. Applying more fertiliser may not be an effective remedy.

Complete activity 6 in the **Learner Workbook**.

Chapter 4

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

Demonstrate an understanding of the properties of soil and how these impact on plant nutrition and soil preparation

Complete activity 7 in the **Learner Workbook**.

1. The Impact of Soil Properties on Plant Nutrition

Both the physical and chemical properties of soil will impact on plant nutrition. The impact of the physical properties is mostly indirect and that of the chemical properties mostly direct.

1.1. The Impact of Physical Soil Properties on Plant Nutrition

1.1.1. Texture

The higher the clay content of the soil, the more water is absorbed and the less air is present at field water capacity (FWC). It is critical to have enough air around the roots at FWC. Under comparable conditions, citrus trees grown in soils containing more than 30% clay often produce too many small fruit. This could be associated with less air, not enough available potassium or too much competition for the cations that are present.

1.1.2. Structure

When the structure of soil is destroyed or degraded, a number of phenomena will reduce production and fruit quality. These include adverse affect on root development and root health, and weaker water penetration, aeration and internal drainage.

1.1.3. Soil Depth

Theoretically, citrus trees can be grown successfully in any depth of soil. However, shallow soils need better management and more inputs to optimise irrigation and fertilisation. A shallow soil depth also poses many problems with internal drainage. Therefore, a minimum of 30cm effective rooting depth in a profile with at least 75cm total depth is required to produce citrus profitably.

A rooting depth of 40cm to 50cm for micro-jets and 60cm to 70cm for drip irrigation can be considered as optimal, provided that no restrictions to drainage are present at a depth of 75cm to 100cm.

1.1.4. Soil Strength

Most natural soils in arid climates have a natural strength exceeding the maximum pressure that a citrus root can apply. Soil strength can be lessened by mechanical actions and biological activity.

For the development of a healthy root zone, a soil strength of less than 1,800 to 2,000 mega Pascal per cm^2 (MPacm^{-2}) is required. Any volume of soil in the root-zone with a soil strength of more than 2,000MPacm^{-2} is inaccessible for roots. The water and nutrients in this volume can be regarded as not available to the tree, and are regarded as "dead volumes" in the rooting zone. Such dead volumes include stones and clods.

1.1.5. Layering or Stratification

Layering is caused by the differences in the clay content of consecutive layers in the soil profile. This can be easily observed in alluvial soils, which are soils deposited by water such as on river banks, where many thin layers of different textures are present in the profile. The layers can also be quite thick and are the result of various soil forming factors.

A well-documented property of roots is that they do not grow easily from one textural type of soil into another if the soil texture differs too much between layers. The guideline for too great a difference is more than 1.5 times the clay content. The factor of 1.5 is influenced by other soil properties, such as the type of clay and the silt content.

Example

Layering

The factor of 1.5 can be explained as follows: If the top layer of soil contains 15% clay and the next layer 25%, the increase in clay content from the top to the next layer is 25/15 = 1.67. The factor in this case is more than 1.5 and the difference between layers is therefore too large too allow for successful cultivation.

Water movement in the soil profile is also restricted by layering. This is the result of the difference in hydraulic forces in a clayey versus a sandy soil. When a sandy soil is overlaying a clay layer, the water will move quickly through the sandy soil until it reaches the clay layer. Water moves slower through clay than sandy soil and, in this example, will accumulate on top of the clayey layer. This accumulated water is called free water and causes anaerobic (containing no oxygen) conditions in the rooting zone.

1.1.6. Aeration

Roots perform respiration during their normal activity. The decomposition of organic material also produces carbon dioxide. The concentration of carbon dioxide in the air in the soil increases because of these two factors. Soil must be aerated to supplement the oxygen and remove the carbon dioxide.

Definition

Respiration

Respiration is an energy-producing oxidation process in cells, the complete chemical and physical process in which oxygen is delivered to plant cells and carbon dioxide and water are given off.

The macro pores in soil form a chain of canals to exchange the air in the soil with that in the atmosphere. If these pores are filled with water or reduced in size by compaction, the exchange rate is reduced and the rooting zone becomes more anaerobic and less suitable for root activity.

At FWC the soil contains the lowest volume of air. For optimal root development and activity, the spaces filled with air at FWC should be about 10% of the total soil volume.

1.2. The Impact of Chemical Soil Properties on Plant Nutrition

1.2.1. pH

The pH of the soil defines the environment in which the roots must absorb water and nutrients, with the availability of the nutrients being affected by the pH. Optimum soil pH(water), where all the nutrients are available, is said to be between 5.5 and 6.5. The solubility of aluminium, which is phytotoxic, however increases rapidly below a soil pH(water) of 5.3. The optimal pH(water) for cultivation of citrus is therefore set at between 6.5 and 7.5.

Soil with a pH value higher than 7.5 is alkaline and the metal ions Fe, Cu, Mn and Zn are less soluble and hence less available. At a pH of less than 5.3, aluminium becomes more soluble and reaches toxic levels. Manganese also reaches toxic levels in acid soils.

1.2.2. Resistance

Resistance to conductance of electrical current measures the concentration of total soluble salts in a soil. The lower the salt concentration is in soil, the higher the resistance, and conversely, the higher the concentration of soluble salts, the lower the resistance.

The soluble salt content includes the plant nutrients. At the same concentration, different salts or fertilisers will contribute differently to the resistance. Sulphates contribute less to the resistance than chlorides. The contribution of fertilisers to the resistance is called the salt index of fertilisers.

In the table below, the salt index of potassium chloride is 114, but that of potassium sulphate is only 46 at the same concentration. The higher the salt index of the solution, the lower the resistance, and the higher the electrical conductivity of the solution. When the resistance is too low, meaning when the salt index is too high, the plants need energy to overcome the osmotic pressure in order to absorb water and nutrients. When the resistance is too low, the mass of nutrients available for absorption might be too low if not supplemented in time.

The Relative Salt Index of Most Common Fertilisers

Fertiliser	*Salt Index*
Potassium chloride	114
Ammonium nitrate	105
Sodium nitrate	100
Limestone ammonium nitrate	98
Urea (after hydrolyses)	75
Ammonium sulphate	69
Potassium sulphate	46
Double super phosphate (20,5%P)	10
Single super phosphate (10,5%P)	8

1.2.3. Fertility

Fertility is the collective name to describe the level of all the nutrients in the soil. The higher the fertility, up to a certain point, the better the yields, provided all other production factors such as irrigation are optimal.

1.2.4. Salinity

Salinity is to some extend related to resistance, but in practise refers more to high concentrations of sodium and chloride than to other nutrient elements. The effect is the same, but is accentuated by individual effects of sodium and chloride, due to their higher salt indexes, on the absorption of other nutrients.

1.2.5. Organic Material

Organic matter in soil consists of various components including plant and animal debris, partly decomposed material of various origin, and humus. Humus is the stable form of organic material in the soil and consists of very large molecules. Organic material adds another dimension to the soil and plant growth. Organic material influences almost all the physical and chemical factors mentioned above. Furthermore, it influences the biological activity of the soil.

2. The Impact of Soil Properties on Soil Preparation

The purpose of soil preparation is to create a homogeneous rooting zone with no physical and chemical barriers that will restrict root development, root health and root activity. An active and healthy root system has a better chance of maintaining profitable production. Both physical and chemical properties have an impact on soil preparation.

Definition

Homogenous

Homogenous means having a uniform composition and structure. In terms of soil, it means creating a consistent rooting zone with no layering or chemical barriers, such as radical changes in soil pH.

Soil preparation must always be preceded by a soil survey and soil analyses, and the manner in which the preparation is done should be guided by the results of these tests.

2.1. Soil Survey

The purpose of a soil survey is the evaluation of the profile(s) of the soil. The soil profile is the visible face on the side of a hole dug into the soil, referred to as a profile pit. This profile pit is evaluated in terms of depth, the condition, type and sequence of the layers, called horizons, soil structure and indicators of aeration and internal drainage.

2.1.1. Positioning Profile Pits

The number of profile pits per hectare depends on the variation in soil type. Typically, profile pits are dug on a grid of 50m or 100m, but the frequency depends on soil conditions and topography. The pit must always be positioned in such a way to ensure that one of the long sides will receive sunlight to make the survey easy.

The position of the profile pit must be recorded geographically. This can be done by using beacons inside or outside the orchard or site. Nowadays Global Positioning System (GPS) coordinates are used. The position of the pit is important when planning the layout, soil preparation and irrigation system for the orchard.

Definition

Global Positioning System (GPS)

GPS uses latitudinal and longitudinal coordinates to pinpoint any position covered by communication satellites.

2.1.2. Digging Profile Pits

A profile pit is usually 60cm to 75cm wide and 100cm to 150cm long. It is dug to a depth of at least 100cm, or to where the parent material or rock is encountered.

2.1.3. Surveying Profile Pits

Before surveying the profile, use a garden fork or geological hammer and loosen a strip of about 20cm wide from the surface down to the bottom on one of the sides. This will help to observe the profile in a natural state. Look for signs that indicate the different horizons, such as changes in colour, structure and / or texture.

Mark the different layers, or horizons, and measure their position in the profile. The position is marked by the depth from the surface to the top and the bottom of the layer, for instance the first layer 0cm to 25cm, the second layer 25cm to 45cm, the third layer 45cm to 90cm, and so on. Note the transition between layers. It can be gradually over more than 20cm, or abruptly in less than 5cm.

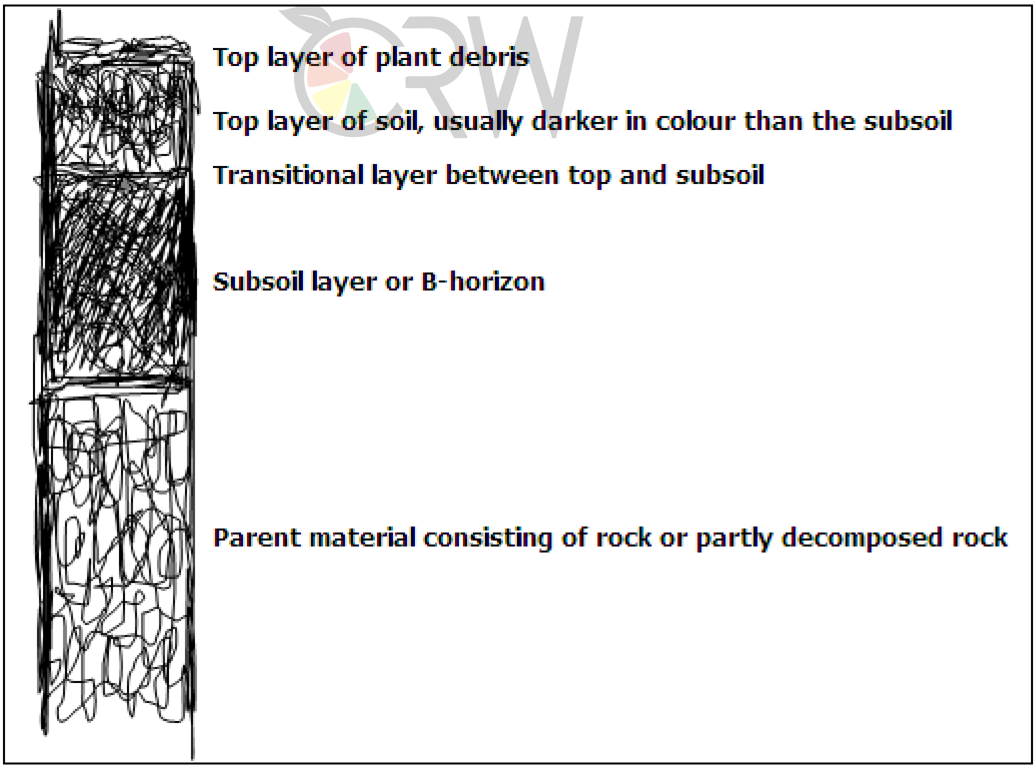


Figure 4.1: Elements of a Typical Profile

2.1.4. Sampling Profile Pits

Mark the position of each layer on all four sides of the profile pit. Take a slice of the layer from its top to its bottom on all four sides of the pit. Mix the soil from the four sides and collect about 500g for analyses. Mark the samples stating the farm, the location or orchard, and the profile number.

2.1.5. Comparing Profiles

The next step in soil survey is to group areas with the same profile properties together. This is the first step to demarcating soil types. Comparison between soil profiles is done on a horizon bases. The same horizons must be present on soils that are grouped together. The horizons that are grouped together must also have the same position, thickness and other properties. Soil samples from the same horizon from different profile pits in the same group can be mixed to give one composite sample. As an alternative, a modal profile pit which represents all similar profiles can be chosen, recorded and sampled to represent the group or area.

2.1.6. Demarcation of Soil Types

Based on the grouped profiles, the area can be demarcated into soil types. The preliminary soil map of the area can, after refinement, be used to design the irrigation and plan the soil preparation action. The refinement of the soil map can be done as soon as the results from the laboratory are available.

2.1.7. Preliminary Recommendations on Soil Preparation

The recommendations should include directions as to the cultivation depth, what type of loosening action is required and whether ridges are needed. All these decisions are based on the profile survey and laboratory analyses.

2.2. Chemical and Physical Analyses of Profile Pit Soil Samples

The purpose of the analyses is to confirm certain observations of the profile survey and to determine the necessity for ameliorants, which are chemicals or fertilisers that will improve the physical and chemical condition of the soil, that are applied during soil preparation, as well as a fertilisation program for the newly planted trees during their non-bearing stage. The minimum analytical requirements on the profile samples are as follows:

- Top soil layer — pH, resistance, P, K, Ca, Mg, Na, texture
- Second layer — pH, resistance, texture
- Third layer — pH, resistance, texture

Chapter 4

- Physical and chemical soil properties play a role in plant nutrition. The impact of the physical properties is mostly indirect and that of the chemical properties mostly direct.
- In as far as **soil texture** is concerned, the higher the clay content of the soil, the less air is available for the roots.
- If the **soil structure** is destroyed, it has an adverse effect on root development and root health, and leads to weaker water penetration, aeration and internal drainage.
- A minimum **soil depth** of 30cm for rooting is required for citrus production, with a rooting depth of 40cm to 50cm for micro-jets and 60cm to 70cm for drip irrigation considered as optimal.

- For the development of a healthy root zone, a **soil strength** of less than 1,800 to 2,000 mega Pascal per cm^2 ($MPacm^{-2}$) is required.
- In terms of **soil stratification**, the guideline for too great a difference is more than 1.5 times the clay content from one layer to the next.
- In terms of **soil aeration**, for optimal root development and activity, the spaces filled with air at FWC should be about 10% of the total soil volume.
- Optimum **soil pH**(water), where all the nutrients are available, is said to be between 5.5 and 6.5.
- When the **soil resistance** is too low, meaning when the salt index is too high, the plants need energy to overcome the osmotic pressure in order to absorb water and nutrients. When the resistance is too low, the mass of nutrients available for absorption might be too low if not supplemented in time.
- The higher the **soil fertility**, up to a certain point, the better the yields, provided all other production factors such as irrigation are optimal.
- **Organic material** influences almost all the physical and chemical factors.
- The purpose of soil preparation is to create a homogeneous rooting zone with no physical and chemical barriers that will restrict root development, root health and root activity.
- The purpose of a soil survey is the evaluation of the profile(s) of the soil, and it is done by evaluating the inside of a profile pit.
- Profile pits are surveyed by marking the positions of the various layers and by taking samples from the layers.
- Profile pits with the same horizons are grouped together. The area is demarcated into soil types based on the grouped profiles and a soil map is developed.

Complete activities 8 and 9 in the **Learner Workbook**.

Chapter 5

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

Supervise and implement soil preparation and remediation

Practical

Complete activity 10 in the **Learner Workbook**.

1. Introduction

Citrus is a permanent crop and citrus trees can be in the soil for more than 50 years. The economic lifespan of citrus trees depends on the cultivar, pests and diseases, climate, and soil preparation. Soil preparation is done before planting and very seldom is corrective cultivation after planting done successfully. Therefore, proper soil preparation must be done to ensure a lengthy economic lifespan for the trees.

Proper soil preparation starts with a soil survey, including profiling and soil analyses, continues with the selection of appropriate implements, and ends with proper execution of the decided actions. Thereafter, the soil must be managed to remain in an optimal physical and chemical condition for as long as possible.

2. The Purpose of Soil Preparation

The main aim of soil preparation for citrus orchards is to create the homogenous layer of soil with no major changes in the physical and chemical properties laterally, but most importantly no major changes with depth. This homogenous layer is the future rooting zone.

The optimum depth of the rooting zone is 50cm to 60cm, but the depth depends on what is available, the soil type and method of irrigation. Thinner rooting zones of 20cm to 30cm require better management of the irrigation, drainage and fertilisation. For drip irrigation the optimum rooting zone has a depth of 60cm to 70cm and with micro-jets the optimum depth is 40 to 50cm.

3. Cultivation Needs of Various Soils

The cultivation needs of a soil are prescribed by the soil profile and the requirement of the roots of citrus trees. Tree roots require a homogeneous volume of soil with no drastic changes in physical and chemical properties.

When evaluating the profile, it is important to record the properties of the different horizons and to sample each horizon separately. Analysing samples of different horizons will identify variation with depth, which is important in deciding on an appropriate cultivation method.

3.1. Profile Properties and Soil Preparation

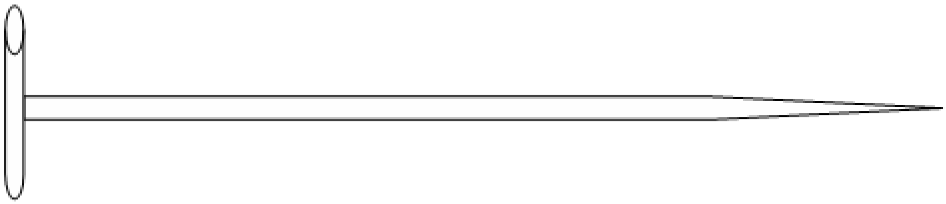
The aim of soil preparation is to create a homogenous, well aerated, well drained rooting zone, with a depth of at least 40cm. The profile properties that are very important in meeting this requirement are texture, layering, strength (compaction), aeration, drainage and depth.

Practical

Soil Probe

One easy way to test these factors is to press a probe into the soil. Use any type of steel rod with a diameter of 8mm to 10mm. This probe will go into wet soil fairly easily, and without effort into soil where no compaction is present. Compaction, cultivation depth, and even wetting depth and spreading can be detected with such a probe.

To construct a soil probe, take a 1.5m length of mild steel with a diameter of 8mm to 10mm. Sharpen the tip and weld a handle to the other end, as indicated in the sketch below.



A soil probe can be used to test the actual depth to which the implement loosened the soil after soil preparation as well. The homogeneity of the loosened profile can also be detected by probing in a fixed pattern.

3.2. Chemical Properties and Soil Preparation

The two most important chemical properties of soil that have an influence on the methods used in soil preparation are pH and salt content. The salt content is measured by the resistance or electrical conductivity. Remember that profile sampling will be done during the evaluation of the profile and that samples need to be taken of the various horizons or at increasing depths.

3.2.1. pH

In neutral to acid soils the pH of the subsoil tends to be lower than that of the topsoil. However, this must be determined in the laboratory. Liming of soils with a pH (water) of less than 6.5 must be done during soil preparation. The depth to where the lime has to be mixed will dictate the method of to be used in preparing the soil.

The opposite can also be true, namely that the pH of the subsoil is higher than that of the topsoil. In this case, the high pH is usually associated with saline or salty conditions and this saline soil must not be brought to the surface.

3.2.2. Salt Content

Under most conditions, the salt content of the soil increases with depth. If the subsoil contains more salts than the topsoil, the subsoil must not be mixed with the topsoil or brought to the surface and put on top of the topsoil. The right implements must be chosen to loosen the profile without turning the subsoil to the top.

4. Soil Preparation Methods and Implements

Based on the discussions above, two major methods of soil preparation are identified. The first method is used where the horizons in the soil profile need to be mixed due to inherent differences exceeding the set limits. This mixing action can also be used to incorporate required chemicals, such as lime or phosphates. The second method is where the profile needs to be loosened only and no mixing is required.

4.1. Mixing

When the soil survey indicates that a mixing action is required to render a homogeneous rooting zone, the selection of the right implement will depend on what needs to be mixed with what. If the second layer has to be mixed with the top layer, the right implement will have the mould board that fit this action. Soil preparation professionals adjust the implement to suit the profile. The plough with the correct mould board to create the correct mixing must be selected very carefully.

The other reason to mix the profile is to incorporate the required chemicals and fertilisers to optimise the chemical composition of the soil. This can be done by any implement with a mixing action, because specific layers in the soil are in this case not being mixed, but the whole profile.

4.2. Loosening

When the properties of the profile indicate that the soil needs only to be loosened, almost any ripper-type plough will be adequate. However, a standard ripper tine will loosen the top half of the penetration depth but compact the lower half. The ripper tine is therefore fitted with wings at its tip to avoid compaction through the lifting action of the wings. The wings must run at an angle of 30° with the horizontal. These wings can extend up to 15cm on each side, depending on the capacity of the tractor.

Loosening is sometimes also referred to as ripping because of the use of a ripping tine.

Chapter 5

- Soil preparation must be done correctly before planting, because corrective cultivation is very seldom successful.
- Proper soil preparation involves a soil survey, the selection of appropriate implements, and the proper execution of the decided actions.
- The objective of soil preparation is to provide tree roots with a homogeneous volume of soil with no drastic changes in physical and chemical properties.
- The profile properties that are important in meeting the objective of soil preparation are texture, layering, strength (compaction), aeration, drainage and depth.
- The two most important chemical properties of soil that have an influence on the methods used in soil preparation are pH and salt content.
- The two methods used during soil preparation are mixing and loosening.
- Mixing is used when soil layers must be mixed to create a homogenous region and where chemicals must be incorporated into the soil during preparation.
- Loosening is used where mixing is not required.

Complete activity 11 in the **Learner Workbook**.

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