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**GENERAL CERTIFICATE IN ORNAMENTAL
HORTICULTURE LEVEL 1**

Workbook :

**Demonstrate an understanding of the
Role and Requirements of Water in Plants**

**Demonstrate an understanding of the
Role and Requirements of Water in Plants
Learner Workbook**

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A c k n o w l e d g e m e n t s

Developed by

Lifestyle College

With special thanks to:

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Study Session Overview

Purpose

The purpose of this study session is to equip you with the knowledge necessary to understand the role and requirements of water in plants.

This study session forms part of the General Certificate in Horticulture, NQF level 1 and is aligned with the Unit Standard: Demonstrate an understanding of the role and requirements of water in plants, which carries 3 credits.

Who is it for?

This study session and unit standard form the knowledge base for people working with plants within the ornamental horticulture or landscaping industry and gives the learner an understanding of:

- The role that water plays in the growth and development of plants.
- The water requirements of the major plant types.
- The importance of watering seedlings and newly planted (transplanted) plants.
- The factors that influence evapotranspiration.

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What's in it for you?

The skills acquired in this study session will equip you with the knowledge needed to be able to understand the role and requirements of water in plants. This knowledge will form the basis of your horticultural studies and help you to:

- Explain the influence that the amount of water received by a plant has on its growth.
- Describe the effect that the frequency of watering has on a plant's growth.
- Describe the transporting of water and nutrients in a plant.
- Explain the factors that effect the water requirements of plants.
- Describe the water needs of the major plant types.
- Explain the importance of frequently watering to ensure that water is available in the root zone of newly planted seedlings and transplanted plants.
- Give reasons why more frequent watering must be conducted when root loss or disturbance in transplanting occurs.
- Explain the effects of various climatic conditions on evaporation.
- Describe the conditions that effect transpiration in a plant.
- Explain the combined effects of evaporation and transpiration, in the calculation of the evapotranspiration.

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What about assessment?

If you can correctly identify the water requirements of the major plant types and answer all the knowledge questions in the summative assessment, you will receive credits for a competent rating on your assessments.

These credits contribute 1 unit standard and 3 credits towards the General Certificate in Ornamental Horticulture, at NQF Level 1.

The laid down policies and procedures with regard to assessment, moderation, RPL and appeals govern this assessment.

You will be rated "Competent" or "Not Yet Competent" against the assessment criteria.

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Unit Standard

Title	Demonstrate an understanding of the Role and Requirements of Water in Plants
Number	119714
Level	1
Credits	3
Field	Agriculture and Nature Conservation
Sub field	Horticulture
Issue date	2006-02-09
Learning assumed to be in place	The candidate should have been found competent against the unit standard : Demonstrate an understanding of the basic structure or ornamental plants.

Specific Outcomes	Assessment Criteria
1. Describe the role that water plays in the growth and development of plants.	1.1 Explain the influence that the amount of water received by a plant has on its growth. 1.2 Describe the effect that the frequency of watering has on a plant's growth. 1.3. Describe the transporting of water and nutrients in a plant.
2. Identify the water requirements of the major plant types.	2.1. Explain the factors that influence the water requirements of plants. 2.2. Describe the water needs of the major plant types.
3. Show an understanding of the importance of watering seedlings and newly planted (transplanted) plants.	3.1. Explain the importance of frequent watering to ensure that water is available in the root zone of newly planted seedlings and transplanted plants. 3.2. Explain the reasons why an

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Specific Outcomes	Assessment Criteria
	additional frequency of watering must be conducted when root loss or disturbance in transplanting occurs.
4. Recognise the factors that influence evapotranspiration.	<p>4.1. Explain the effects of various climatic conditions on evaporation.</p> <p>4.2. Describe the effect transpiration in a plant.</p> <p>4.3. Explain the combined effects of evaporation and transpiration, in the calculation of the E.T. are explained.</p>

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Embedded Knowledge

Embedded knowledge is reflected within the assessment criteria of each specific outcome and must be assessed in its own right, through oral and written evidence. Observation cannot be the only assessment.

Critical Cross Field Outcomes

- Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made – specific outcome 4.
- Work effectively with others as a member of a team, group, organisation or community. Specific outcome embedded in the learning for this level of learner.
- Organise and manage oneself and one's activities responsibly and effectively.
- Collect, analyse, organise and critically evaluate information. Specific outcome 2 and 4.
- Communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation. Specific outcome embedded in the learning for this level of learner.
- Use science and technology effectively and critically, showing responsibility toward the environment and health of others. Specific outcome 3.
- Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation. Specific outcome 2 and 3.

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**Unit Standard Accreditation and Moderation
Options**

1. Internal moderation.
2. External moderation.
3. Moderation of assessment will be overseen by the relevant ETQA, according to the moderation guidelines in the relevant qualification the agreed ETQA procedures.
4. Internal assessment.
5. External assessment with the relevant registered/accredited industry body/ETQA.
6. An Assessor accredited by the relevant ETQA, will assess the Learner's competency.
7. Formative and summative assessment of qualifying Learners against this unit standard should be in alignment with the requirements of the NSB.
8. Practical assessment activities will be used that are appropriate to the contents in which the qualifying Learners are working.
9. Assessment will include self and peer assessment, practical and oral assessment, observations, questions and answers, etc.
10. Direct observation is required in simulated or actual work conditions.
11. Reporting skills are demonstrated by effective communication, using verbal and/or writing skills.
12. Assessment is to be structured to include formative and summative component, as well as the submission of a Portfolio of Evidence.
13. The assessment should ensure that all the specific outcomes, critical cross field outcomes and embedded knowledge are assessed.

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14. Specific outcomes must be assessed in their own right, through oral and practical evidence and cannot be assessed by observation only.
Essential embedded knowledge must be assessed in their own right, through oral and practical evidence and cannot be assessed by observation only.
15. Special outcomes and essential embedded knowledge must be assessed in relation to each other.
16. If qualifying Learners are able to explain the essential embedded knowledge, but are unable to perform the specific outcomes, then they should not be assessed as competent.
17. If qualifying Learners are able to perform specific outcomes, but are unable to explain the essential embedded knowledge, they should not be assessed as competent.
18. Evidence of the specified critical cross-field outcomes should be found, both in performance and in essential embedded knowledge.
19. Assessment activities must be fair, so that all Learners have equal opportunities. Activities must be free of gender, ethnic or other bias.
20. This unit standard can be assessed together with any other relevant registered unit standard.

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Who does what?

You are expected to actively take part in the lessons by:

- Asking questions.
- Planning and preparing for your training and assessment.
- Completing the assessment tasks that you are given.
- Telling your trainer when you need help or don't understand.

Your learning will be supported in the following ways:

- Your trainer will provide you with all the necessary training material.
- Your trainer will manage the learning process during the training.
- The assessor will plan and prepare you for assessment, assess your competence and provide feedback to you and any follow up assessments that may be necessary.

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Introduction

Plants, animals and people all need water to survive, but just like animals and people, if plants get:

- Too little water they can die
- Too much water they can drown.

Unlike animals and people, plants can't move to an area with more water or move away from an area that has too much water. But plants can tell us what they need.

Have your plants ever spoken to you?

Although plants can't talk they can tell us when they are stressed or sick or need a drink of water. Plants talk to us by showing us:

- Wilted or discoloured leaves.
- Dying branches.
- Early leaf dropping.

When plants need water they will start to wilt, change their leaf colour and start to drop leaves, and what do you think the plant is saying?

"Please give me a drink of water".

Let's begin our learning today but taking a look at how plants use water.

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Lesson 1: Plants & Water

Specific outcomes of this lesson :

Describe the role that water plays in the growth and development of plants.

After you have worked through Lesson 1, you should be able to:

- Explain the influence that the amount of water received by a plant has on its growth.
- Describe the effect that the frequency of watering has on a plant's growth.
- Describe the transporting of water and nutrients in a plant.

Introduction

Did you know that 95% of a plant is made up of water?

Plants use water to help them to grow and develop by:

- Taking up nutrients found in the soil that are dissolved into the water.
- Making food through a process called photosynthesis.

Let's take a look at how water and nutrients are transported in a plant!

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**Transporting of water and nutrients through
the Root**

The root hairs of a plant take up from the soil - water and nutrients. This taking up of water happens through a process called **osmosis**.

During the process of osmosis the water and nutrients in the soil which are in low concentration pass into the walls of the root hairs, which is an area of high concentration and are then taken up by the root system.

Let's conduct an experiment, so that you can see for yourself how this works!

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Your Turn...

ACTIVITY 1

Osmosis Experiment

- Peel a large potato and cut off a bit at one end.
- Now shape the potato into a cup by hollowing out the inside of the potato. The walls of the potato should be about half a centimeter thick.
- Insert sositie sticks or “blou draad” into the side walls of the potato cup. Be careful not to split open the sides of the potato.
- Rest your potato onto the sides of a transparent glass.
- Dissolve 5 heaped teaspoons of sugar into $\frac{1}{4}$ cup of hot water.
- Allow the sugar water to cool down and then fill the hollowed out section of the potato $\frac{3}{4}$ full with the sugar water solution.
- Fill the glass container with water, to the same height as the liquid in the potato.
- Mark the level of liquid in both the potato and the glass container using a marker.
- Now wait and watch the liquid in the potato cup and the water. Depending on how thick your potato walls are it can take between 2 to 6 hours to see a big change.

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**Transporting of water and nutrients through
the Stem**

Once the water and nutrients have been taken up by the root hairs, the water and nutrients are then carried to the stem of the plant.

The plant's stem then carries the water and nutrients to other parts of the plant.

Let's try another experiment, so that you can see how water and nutrients are carried by the stem of the plant to the leaves and other parts of the plant.

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Your Turn...

ACTIVITY 2
Experiment:
<ul style="list-style-type: none">▪ Find a clear container.▪ Add about 5mm of food colouring into your container. Green or red food colouring works best.▪ Choose a plant with a flower, which has a light colour like white or yellow. White roses work best.▪ Cut the bottom of the stem.▪ Place your cut flower into the food colouring.▪ Now sit back and watch what happens.
<ul style="list-style-type: none">▪ Did your flower change colour?▪ If so, how did the food colouring get to the flower?

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So how does the stem take up water and nutrients from the root?

To understand how the plants stem takes up water and minerals from the root, we need to take a look at the internal structure of a stem.

Internal Structure of the Stem	
Vascular Bundles	Inside the stem there are tube-like structures called the vascular bundles, these are long and tough and run from the roots through the stem to the leaves and flowers.
Xylem	Inside the vascular bundles are tubes through which the water and nutrients are taken up by the roots and transported. These are called Xylem.
Phloem	Inside the vascular bundles there are also tubes called phloem. These tubes transport the sugars and other foods manufactured by the leaves to all other parts of the plant, including the roots.

An easy way to remember this is:

- the **xylem tubes** transport **water**
- the **phloem tubes** transport **food**.

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Your Turn...

ACTIVITY 3

**Draw a picture to show how water and nutrients are transported
(taken up) in a plant and then in your own words describe how water
and nutrients are transported in a plant.**

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Now that you know how water and nutrients are transported in a plant, let's take a look at how plants use this water to make food for the plant?

Photosynthesis

Plants make their own food through a process called photosynthesis. This word means to "make from light". For photosynthesis to happen, a source of energy (sunlight), chlorophyll (the green colour in leaves), carbon dioxide and water are needed.

During photosynthesis tiny holes in the leaves of plants take up carbon dioxide from the air and water which has been carried from the roots of the plant. Inside the cells of the plants leaves is a chemical called chlorophyll (this gives the leaves their green colour). Chlorophyll takes up the sunlight and uses the energy from the sun to turn the ingredients of carbon dioxide, water and nutrients into energy rich plant food.

So the factors that influence photosynthesis are:

- Sunlight.
- Chlorophyll.
- Carbon dioxide.
- Water and nutrients.

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The reason that photosynthesis is so important is that the foods produced by photosynthesis are used in other parts of the plant. This allows the plant to stay healthy and grow.

So can you see that photosynthesis:

- Produces food for the plant.
- Stores energy.
- Releases oxygen.
- Uses water.
- Uses carbon dioxide.
- Occurs in sunlight.

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**So how does water influence the plant's
growth?**

As you have seen water and nutrients are both needed for the process of photosynthesis to take place (and remember that nutrients need to be dissolved in water to be absorbed by the plant's roots).

So if the plant gets no water, it can't make food.

What happens if a child gets no food?

Yes, it won't grow and it can die.

If a plant gets too little water, it will only be able to make a little food. And just like a child with too little food, the plant will get weak and wilt. If the plant keeps getting too little water, the tips of the plant will start dying back from the newest growth backwards, until the plant eventually dies.

If a plant gets too much water, the roots of the plant will not be able to get the air that they need to breathe. Since the roots of the plant need air to survive, if the plant remains waterlogged the roots will start to die off and the plant can drown and die. If the root dies, then the plant dies.

So you can say if a plant cannot absorb enough water from the soil, it will suffer stress and show signs of wilting. Prolonged wilting leads to the death of the plant.

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It is very important to water plants regularly because if the plant gets enough water this week and then too little water for the next few weeks, the plant will become stressed and this will slow down the growth of the plant.

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Your Turn...

ACTIVITY 4
Explain how the amount of water a plant gets affects its growth.

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Your Turn...

ACTIVITY 5
Describe how the frequency of watering affects the growth of a plant?

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Lesson Checkpoint

Now that you have worked through this lesson, please check that you are able to do all the specific outcomes and meet the assessment criteria:

- I can explain the influence that the amount of water received by a plant has on its growth.
- I can describe the effect that the frequency of watering has on a plants growth.
- I can describe the transporting of water and nutrient in a plant.

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Lesson 2 : Plant Water Needs

Specific outcomes of this lesson :

Identify the water requirements of the major plant types.

Show an understanding of the importance of watering seedlings and new planted (transplanted) plants.

After you have worked through Lesson 2, you should be able to:

- Explain the factors that influence the water requirements of plants.
- Describe the water needs of the major plant types.
- Explain the importance of frequent watering to ensure that water is available in the root zone of newly planted seedlings and transplanted plants.
- Give reasons why an additional frequency of watering must be conducted when root loss or disturbance in transplanting occurs.

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How much water do plants need?

Before you can know how much water to give a plant, you first have to ask yourself these questions?

- **What type of soil is the plant is growing in?**

A clay soil will hold water for a longer time than a sandy soil because clay soils drain slowly and sandy soils drain quickly. So plants that are growing in a sandy soil will need more frequent watering than plants growing in a sandy soil.

- **What is the age of the plant?**

Young established plants will need more frequent watering than older established plants that have established root system. In the same way, large trees can sometimes penetrate deep underground and reach the underground water and so need less watering.

- **What is the size of the plant?**

The bigger the plant the more water it will need.

- **What type of plant is it?**

Some plants like succulents that have fleshy leaves and stems will need less watering than plants with soft leaves. Trees with tap roots need less watering than shallow rooted trees whose roots can't reach the underground water sources. Annuals will need frequent watering and shallow rooted plants like azaleas will also need more frequent watering, so that their roots do not dry out.

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- **Where the plant is growing?**

Plants growing in a hot, exposed north or west facing position will need more watering than plants growing in cooler, shady east or south facing positions because the soil in shade stays wetter for a longer period of time.

Areas sheltered from the wind will tend to dry out more slowly than an area that is windy, so plants growing in windy positions need more frequent watering.

- **What is the time of year?**

In South Africa we have three rainfall pattern areas – summer rainfall areas, winter rainfall areas and in a small area around George where the summer and winter rainfall areas overlap, they have rainfall all year round. In the dry season plants will need more water and in the rainy season they will need less watering.

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Your Turn...

ACTIVITY 6
Explain the factors that influence the water requirements of plants.

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Before you can learn about the watering needs of different plants, you first need to be able to identify the major plant types.

Your Turn...

ACTIVITY 7
Go outside and see if you can identify:
<ul style="list-style-type: none">• Trees• Shrubs• Succulents• Ornamental plants

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Your Turn...

ACTIVITY 8
Now that you have identified the major plant types, write a description for each plant type:
What is a tree?
What is a shrub?
What is a succulent?
What are ornamental plants?

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Major Plant Types Water Needs	
Plant Type	Water needs
Trees	<p>Most trees have roots that go down deep into the soil and generally a tree has roots that extend from the trunk to a distance of 1 to 3 times the height of the tree.</p> <p>Ideally trees need about 2.5 cm of water per week.</p> <p>Trees growing in a sandy soil that drains quickly need up to 5 cm of water per week or watering of 2.5 cm every 4 days or so.</p>
Shrubs	<p>Ideally shrubs will require about 1 to 1,5 cm of water every 3 to 4 days in clay soils.</p> <p>Shrubs growing in a sandy soil will need watering every 2 to 3 days.</p>
Succulents	<p>Succulents will require almost no watering at all in the rainy season and only need to be watered when there has been no rain for three months or more.</p>
Ornamental plants/seedlings	<p>Ornamental plants like annuals need a lot of water and dry out quickly because they have shallow roots and the top few centimeters of soil dries out more quickly than the deeper soil, because of this, ornamental plants need to be watered frequently.</p> <p>As a general rule 20 liters of water per square metre of bed area will water most soils to a depth of 30 cm.</p>

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Major Plant Types Water Needs	
Plant Type	Water needs
Newly planted (transplanted) plants	<p>When a plant is being transplanted it will often wilt if it is too stressed since there is often root loss or disturbance of roots when transplanting occurs.</p> <p>Transplanted plants must be watered immediately after transplanting to help them to recover from the trauma of the move.</p> <p>By giving the plant more than the usual amount of water, you will give back to the plant the water lost and make sure that the damaged roots have plenty of moisture in the root zone during their recovery.</p> <p>Transplanted plants need frequent water to the root zone for proper root development to occur and should ideally be watered every day for the first 5 days, until they are over the shock of being transplanted.</p> <p>Be sure to keep these plants moist but be careful not to drown them.</p>

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The best way to water all plants is to give the plants a deep watering and not a shallow watering because:

- Deep watering encourages the plant to produce deep, strong roots.
- Shallow watering encourages the plant to produce shallow roots which can dry out easily.

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Your Turn...

ACTIVITY 9

Describe the water needs for the following plants:

- **Succulents.**
- **Trees.**
- **Shrubs.**
- **Ornamental plants.**

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Your Turn...

ACTIVITY 10
Explain why it is important to frequently water the root zone of newly planted seedlings and transplanted plants?

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Your Turn...

ACTIVITY 11
Explain why must you give an additional frequency of watering when root loss or disturbance in transplanting occurs?

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Lesson Checkpoint

Now that you have worked through this lesson, please check that you are able to do all the specific outcomes and meet the assessment criteria:

- I can explain the factors that influence the water requirements of plants.
- I can describe the water needs of the major plant types.
- I can explain the importance of frequent watering to ensure that water is available in the root zone of newly planted seedlings and transplanted plants.
- I can give reasons why an additional frequency of watering must be conducted when root loss or disturbance in transplanting occurs.

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Lesson 3: Evapotranspiration

Specific outcomes of this lesson :

Recognise the factors that influence evapotranspiration.

After you have worked through Lesson 1, you should be able to:

- Explain the effects of various climatic conditions on evaporation.
- Describe the conditions that effect transpiration.
- Explain the combined effects of evaporation and transpiration, in the calculation of the E.T.

Introduction

As you have already learnt, a plant needs to keep absorbing water to grow and survive, but what you have not yet learnt is that plants lose large amounts of water every day and unless this water is replaced immediately the plant will die from dehydration.

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How much water is taken up by a plant depends on two processes:

- Water absorption, which is the process by which plants take up water.
- Transpiration, which is the process by which plants lose water in the form of vapour.

You have already learnt how plants take up water, so let's now learn about transpiration.

Transpiration

Transpiration is necessary so that the plant can keep a continual flow of water going through the plant. Water passes through the plant in a continual process. The water passes through the root hairs, travels up the root system, through the stem structure of the plant, into the leaves and then out of the stomata of the leaves into the air. This helps the plant to:

- Cool its leaves and stem tissue through evaporation.
- Move sugars and plant nutrients and food through the plant.

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Evaporation takes place when moisture is sucked out of the leaves of the plant by:

- **The heat of the day.**

The hotter it is the higher the rate of transpiration. On a hot day the rate of transpiration can increase so much that even with enough water in the soil, the plant can develop a water shortage.

- **Humidity (moisture/water content in the air).**

When humidity is low and the air is dry the more transpiration takes place. When humidity is high and the air is more moist, the lower the rate of transpiration.

- **Wind or air movement.**

Breezes and light air movement also draw water from the stomata causing increased transpiration.

When the leaves of a plant are vigorously shaken by strong winds the stomata close up and transpiration stops.

Let's conduct another experiment to see transpiration for ourselves.

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Your Turn...

ACTIVITY 12

Place a plant into a container of dye.

Now bend the stem of the plant below the surface of the container.

Make a cut into the stem.

- If the plant is transpiring, dye will rush in and stain the xylem above and below the cut.
- If the plant has been in moist soil and is only transpiring very slowly, the dye will not enter and so you will see no dye but only sap coming out of the cut.

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Your Turn...

ACTIVITY 13
Explain the effects of various climatic conditions on evaporation.

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Factors that affect the rate of transpiration:

- **The plant's leaf area size**

The larger the leaf surface of the plant the more stomata there are and the more the plant transpire. Adaptations in plants are smaller leaves with fewer stomata.

- **The type of cuticle on the plant**

A waxy cuticle covering the leaves forms a relatively waterproof layer that helps to reduce the loss of water in plants of this nature.

- **The type of epidermal hairs on the plant**

These hairs help to reduce transpiration by reflecting light, decreasing the leaf temperature and increasing the resistance to water transfer.

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Your Turn...

ACTIVITY 14
Describe the conditions that effect transpiration in a plant.

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Measuring evapotranspiration

To calculate or measure the rate of evapotranspiration, we use a tool, which measures:

- the humidity above the plants
- the temperature above the plants
- the air movement above the plants.

All three of these measurements are then used to calculate or measure the amount of water that is leaving the plant and going into the air i.e. its water usage and stress levels. This is called the vapour flow.

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Your Turn...

ACTIVITY 15
Explain the combined effects of evaporation and transpiration, in the calculation of the E.T.

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Lesson Checkpoint

Now that you have worked through this lesson, please check that you are able to do all the specific outcomes and meet the assessment criteria:

- I can explain the effects of various climatic conditions on evaporation.
- I can describe the conditions that effect transpiration.
- I can explain the combined effects of evaporation and transpiration, in the calculation of the E.T.

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