



LEARNER GUIDE

Turf Maintenance (Level 2)

LNS-GNM-2018-1.1

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Course Overview

Code:	LNS-GNM-2018-1.1
Name:	Turf Maintenance (Level 2)
Duration:	18 hours, inclusive of 2 hours of assessment

WSQ Framework

Landscape

Technical Skills and Competencies (TSC)

Turf Maintenance

TSC Proficiency Description

Level 2

LNS-GNM-2018-1.1

Identify routine turf maintenance requirements and perform turf maintenance tasks using mechanisation and technology

Learning Outcomes

On successful completion of this unit, the participant will be able to:

1. Implement control measures for pests, diseases and invasive species on turf
2. Perform mowing to maintain the finish and aesthetic of turf
3. Apply horticultural practices on turf
4. Perform post-maintenance activities
5. Manage hazards and risks associated with turf maintenance

Teaching Methodologies

- Lecture
- Discussion
- Demonstration
- Practical
- Feedback

Assessment Methodologies

- Practical Exam (90 minutes)
- Oral Questioning (30 minutes)

Learning Outcome 1: Implement Control Measures for Pests, Diseases and Invasive Species on Turf

Incorporating Learning Outcome 5: Manage Hazards and Risks associated with Turf Maintenance

Common Types of Turfgrasses

Turfgrasses undergo various stress factors, especially in an urban environment. These environmental stresses cannot be changed and can only be managed by species selection and special management practices.

The following are common types of turfgrasses which can withstand wet soil and flooded conditions, typical in Singapore:

1. Cow Grass (*Axonopus compresses*)
2. St. Augustine / Buffalo Grass (*Stenotaphrum secundatum*)
3. Bermuda Grass (*Cynodon dactylon*)
4. Manila Grass (*Zoysia matrella*)
5. Seashore Paspalum (*Paspalum vaginatum*)



Cow Grass
(*Axonopus compressus*)



St. Augustine Grass / Buffalo Grass
(*Stenotaphrum secundatum*)



BERMUDAGRASS

Bermuda Grass
(*Cynodon dactylon*)



Manila Grass
(*Zoysia matrella*)



Seashore Paspallum
(*Paspalum vaginatum*)

Threats to Turf Health

The health of turf is under regular attack from common threats such as:

1. Weeds,
2. Pests and
3. Diseases

These threats can cause the turf to look unsightly and bare, become unhealthy and even die.

Weeds

- Weeds are fast-growing plants that become invasive if not treated.
- They compete for food and nutrition with other plants.
- They outgrow the grass and often appear before it is time to mow the grass.

Common Weeds in Singapore	
<p>Mimosa (Touch-me-not/Shame Plant) <i>Mimosa pudica</i></p> <ul style="list-style-type: none">• Sensitive to touch, will close or fold its leaves inwards when touched• Grows to 15cm - 50cm in height, but can reach up to 1m or more when supported by other vegetation	 <p>Mimosa</p>
<p>Lalang <i>Imperata cylindrica</i></p> <ul style="list-style-type: none">• Common weed in unmanaged grass and bush• Its long blade can extend up to a person's height• Grows to 0.6m - 1.2m in height	 <p>Lalang</p>

<p>Broadleaf Plantain <i>Plantago major</i></p> <ul style="list-style-type: none"> • Difficult to remove • Grows to 15cm - 45cm in height; oval-shaped leaves are arranged in a rosette which lies close to the ground 	 <p>Broadleaf Plantain</p>
<p>Virginia Buttonweed <i>Diodia virginiana</i></p> <ul style="list-style-type: none"> • Deep-rooted weed with spreading branches • Able to spread fast and cannot be easily removed by mowing • Grows to 10cm – 80cm in height 	 <p>Virginia Buttonweed</p>
<p>Love Grass <i>Chrysopogon aciculatus</i></p> <ul style="list-style-type: none"> • Spreads fast through seed dispersal when it 'hooks' on to surfaces (e.g., clothes, shoes, tools, and equipment) • Cannot be easily removed by mowing • Grows to 15cm - 25cm in height 	 <p>Love Grass</p>

Pests

Pests attack turf in different ways. Some pests eat away the grasses' blades while others chew on the roots. Digging pests can destroy the turf's root system as they move underground.

Common Turf Pests in Singapore	
<p>Sod Webworm <i>Herpetogramma licarsisalis</i></p> <ul style="list-style-type: none">• Larvae of the sod webworm moth; feed in the night and hide during the day in the burrows they created in the soil• Feed on grass blades and entire stems, leaving behind brown patches• Cause damages very quickly and affect a wide turf area	 <p>Fig. 2</p> <p>Sod Webworm</p>  <p>Discoloured lawn caused by Sod Webworms</p>

Armyworm

Spodoptera Mauritia

- Dark coloured, soft bodied caterpillar up to 45mm long
- Often appear in groups when feeding, bundled around stems and foliage of the turf
- Usually most active in the evening or at night
- Attack leaves, stems and seed heads of turf



Armyworm



Discoloured turf caused by Armyworms

African Black Beetle

Heteronychus arator

- Range from 12mm to 15mm in size
- Damage the turf's roots, resulting in their inability to access moisture in the soil
- In severe cases, large patches of the turf lose its root structure and the turf can actually be peeled back, exposing a large number of the feeding larvae
- Turf damage can also occur when birds feed on the larvae by digging up the soil in the turf



African Black Beetle



Larvae of African Black Beetle



Dried irregular patches

Black Cutworm

Agrotis ipsilon

- Found mainly on golf greens
- Usually feed during the night
- Typically cut off young plants at the crown level and pull them into a burrow, resulting in a bald patch of turf surrounding the burrow



Black Cutworm Moth



Black Cutworm



Pock marks caused by
Black Cutworm

Ants

Lasius flavus

- Not generally considered dangerous pest but can pose significant health damages to turf grass
- Tunnel underground, causing soil to dry out fast, resulting in dried and dead patches on turf
- Build ant hills causing root damages and unsightly mounds which may pose a hazard to foot travellers and mower blades



Ant hill on turf



Ants' colony

Diseases

Diseases can cause extensive damage or death to grass as they can spread across a large turf area. Most turf diseases are caused by fungus.

Common Turf Fungus	
<p>Brown Patches <i>Rhizoctonia solani</i></p> <ul style="list-style-type: none">• Rings or patches of blighted turfgrass• Harm only the blade of grass not the roots• Caused by heat, humidity and excessive nitrogen	 <p>Brown patches on turf</p>
<p>Dollar Spot <i>Sclerotinia homoeocarpa</i></p> <ul style="list-style-type: none">• Sunken, circular patches that turn from brown to hay in colour• More severe in dry soil	 <p>Sunken, circular patches on turf</p>

Powdery Mildew

Erysiphe graminis

- Leaves have a greyish-white or powdery appearance
- Severely infected turf turns yellow, then tan and brown in colour
- Severely infected turf, especially in shaded areas, can thin out and eventually die



Greyish-white or Powdery Mildew on turf

Fairy Ring

Marasmius oreades.

- Has outer rings that are either dark-green or brown in colour; the shape and size of the rings vary depending on the species
- Above-ground mushrooms may appear



Above ground mushroom may appear in a ring



Learning Activity 1

In the classroom, share your experiences with pests, diseases or invasive species at your turf sites. How did you or your organisation managed those threats?

Biological and Chemical Control Methods for Pests, Diseases and Invasive Species

Pests, diseases and invasive species can be removed using biological or chemical means.

Biological Control Method

Biological control method is a method of controlling pests and diseases using other organisms, such as bacteria and fungi, or the natural enemies of the pests. For example, parasitic wasps are used to control aphids; the wasps lay eggs in the aphids and as the wasps grow, the aphids will die.

There is an increased interest in using the biological control method as it is more environmentally friendly and safer as compared to the use of chemicals. Pests also do not become resistant to the biological control agents.

However, the biological agents released can feed on other plants or insects that are non-target species. In addition, this process usually takes a longer time to work and pests cannot be completely eliminated, as doing so will mean the predators will also die.

Chemical Control Method

The types of chemicals (pesticides) used in landscape maintenance include:

Contact Chemicals

- Chemicals that kill pest directly upon contact.
- Example of contact chemicals are *fungicides*, which inhibits the growth of fungi and *insecticides*, which treat insect infestations.

Systemic Chemicals

- Chemicals that are absorbed by a plant when applied to the seeds, soil, or leaves.
- The chemical then circulates through the plant's tissue, killing the insects that feed on them.
- Example of a systemic chemical is *herbicides*, which are translocated into the plant system to kill weeds.

Types of Herbicide:

Types of Herbicides for Treating Invasive Species	
Selective Herbicide	Herbicide that targets specific weed species
Non-selective Herbicide	Herbicide that kills all plants when comes into contact

Horticultural Chemicals for Turf Health Management



Fig. 12

Liquid Turf Insecticide



Fig. 13

Granules Turf Insecticide



Controls a wide range of turf pests such as larvae of African Black Beetle, as well as Cutworms, Armyworms and Webworm



Fig. 14

Liquid Turf Fungicide



Fig. 15

Granules Turf Fungicide

Systemic fungicide that provides effective broad spectrum disease control in turf

Safety Data Sheet (SDS)

All chemicals sold or supplied must come with a safety data sheet (SDS). The SDS contains information on the chemical that will allow for proper preventive measures to be developed for the handling, application, storage and disposal of the chemicals.

Use of Pictograms

A pictogram is a symbol which conveys a message without the use of words, with the aim of communicating key safety information to users in different countries, and with varied levels of literacy.

The Globally Harmonised System of Classification and Labelling of Chemicals (GHS) pictograms are the most commonly used on pesticide labels.



Fig. 16

GHS pictogram definition

Chemical Application for Turf Health Management

Prepare for Chemical Spraying

Personal Protective Equipment for Chemical Spraying

Put on the appropriate PPE to prevent the chemical from coming into contact with your eyes and skin.



Face and eye protection – Face Shield

Protect against fumes - Face Mask

Body protection – Raincoat including pants

Hand protection – Rubber Glove

Feet protection – Safety Boots

Set-up a Safe Work Zone

As chemicals pose a certain degree of toxicity, it is advisable to cordon off a larger area around the infested plants to prevent members of the public from going near the worksite.

Safety zone requirements:



Red/White Tape



Safety Cones



Warning Signs

Tools and Equipment for Mixing and Applying Chemicals



Backpack Sprayer



Horticultural Chemicals



Pail



Measuring Jug



Before using any chemicals, please check and follow the manufacturers' labelled instruction and safety precautions.



Read labelled information on chemical bottles before mixing

Off-Target Chemical Spraying

Chemicals may drift during spraying, causing off-target spray drift issues which can cause damages or injuries to plants, the environment and also affect human health.

To minimise the impacts of off-target spraying:

- a. Read and understand the manufacturers' labelled instructions and safety precautions before carrying out any chemical spraying. Product labels provide contact details of the manufacturer who can provide reliable technical advice to assist you if necessary.
- b. Be careful of surrounding areas – check around area where you intended to spray. If possible, maintain a buffer zone between areas of application and areas where there is a risk of damage from spray drift e.g., other flora and fauna
- c. Use the right equipment – select applicators and nozzles that will give you the correct droplet size to minimise drift and maximise efficiency. Make sure the equipment you are using is in working condition. Always use equipment as recommended by the manufactures
- d. Check weather conditions - if there is a change in wind direction during spraying, stop and monitor the situation before continuing.

Steps for Chemical Spraying

Steps for Chemical Spraying	
<p>1. Put on the appropriate PPE.</p> <p>2. Inspect turf and confirm the area to be sprayed.</p>	
<p>3. Check that the sprayer is in working condition:</p> <ul style="list-style-type: none">• Pour some water into the sprayer.• Test that the sprayer is working.• Do not use the sprayer if it is faulty; inform the supervisor of the faulty equipment.	 <p>Fig. 17</p> <p>Check all equipment</p>
<p>4. Prepare (mix) the chemical</p> <ul style="list-style-type: none">• Use a measuring jug/cup to measure out the required amount of chemical as per labelled instructions.• Dilute the chemical with an appropriate amount of water, as per labelled instructions, and pour the mixture into the sprayer.• Always check with your supervisor if you need clarification on the chemical types and dosages.	
<p>5. Pump the sprayer 10 to 15 time before you start spraying. To ensure uniform coverage, pump the handle again every 5 seconds to ensure constant pressure.</p>	
<p>6. Spray evenly from waist height at the affected/designated area. Do not spray off-target.</p>	 <p>Fig. 18</p> <p>Spray from waist height</p>

7. After you have finished spraying, do not walk on the areas that you had sprayed as you will carry the chemical on your shoes to other areas.

8. Rinse the sprayers after each use.

- Do not pour the rinsed water into sinks, drains or hard surfaces.
- Pour the rinsed water and leftover chemical into a designated pail.
- All chemical waste will be sent to NEA (National Environment Agency) designated waste collection centre.



Fig. 19

Pour leftover chemical in designated container

10. Wash hands thoroughly with soap.

Storage of Chemicals

Chemicals, including pesticides, must be stored appropriately as required by WSH regulations, which include:

- Refer to the Safety Data Sheet (SDS) of the chemicals for proper storage and handling
- Store in dry and well-ventilated areas, away from heat and direct sunlight
- Containers should be properly labelled and covered when not in use
- Safety equipment such as fire extinguishers and washing facilities and PPE should be provided in the vicinity of the storage area
- Chemicals should be stored under lock and key, with access given to authorised personnel only



Fig. 20

Storage for horticultural chemicals



Learning Activity 2

Practice chemical spraying, following the steps below:

1. Set up a safe work site using signage and safety barriers as practiced in the industry.
2. Inspect the assigned turf plot for presence of weeds, pests or diseases.
3. Put on the appropriate PPE for chemical spraying.
4. Select the appropriate tools and equipment for chemical spraying.
5. Prepare (mix) the chemical in accordance to the labelled instruction.
6. Perform spraying evenly from waist height at the affected/designated area; do not spray off-target.
7. After the completion of spraying, clean the tools and equipment and dispose of waste properly.
8. Wash hands thoroughly.

Learning Outcome 2: Perform Mowing to Maintain the Finish and Aesthetic of Turf

Incorporating Learning Outcome 5: Manage Hazards and Risks associated with Turf Maintenance

Mowing is important to maintain the look and health of the turf. Mowing stimulates the growth of turf, making it stronger to fight against the pests, diseases and invasive species.

Turf Equipment and Machinery

The common types of turf equipment and machinery to perform mowing include:

Knapsack Brush Cutter

- A brush-cutter (nylon trimmers) is a petrol-powered hand-held machine that uses a flexible thin strand nylon line for cutting grass.
- It is used in areas where mowers cannot reach, such as the edge of footpaths, drains, road kerbs, or bases of trees.
- If used in an unsafe manner, the brush cutter can cause serious injuries to workers and other people in the vicinity.

Walk-behind Rotary Mower (Push-behind Lawn Mower)

- The Walk-behind Rotary Mower allow workers to walk behind and guide the cutting movement.
- It is easy to manoeuvre in compact spaces and suitable for use in small turf areas.

This course will be focused on the use of the Knapsack Brush Cutter and Walk-behind Rotary Mower to perform mowing.

Ride-on Lawn Mower or Tractor Lawn Mower

- The Ride-on Lawn Mower is designed to mow large areas of lawn in the shortest time possible.
- Multi-gang (multi blade) mowers are mounted on tractors for mowing large area of grass such as in golf courses and community parks.



Ride-on Lawn Mower

Robotic Lawn Mower

- The Robotic Lawn Mower, which operates like a robotic vacuum cleaner, is able to cut the grass continuously without a person operating it.
- As the mower cuts the grass, the grass clippings fall on the ground to act as fertiliser; there is no need to manually clear the grass clippings from the machine.
- The mower can be tracked with its in-built GPS (Global Positioning System) and be controlled remotely through the user's smartphone application.



Robotic Lawn Mower

Prepare for Mowing

Personal Protective Equipment for Mowing



Soft Hat



Safety Glasses



Safety Reflective Vest



Earplugs



Safety Boots



Cotton Gloves

Set up a Safe Work Zone for Grass Cutting

1. Set up a safe work site using signage and safety barriers as practiced in the industry before grass cutting.



Barricade the work area

2. Always place the warning sign on the brush cutter or mower to caution other vehicles and persons.

3. Check the work zone for potential hazards e.g., stones, glass, nails or other unwanted items. Remove them to avoid the items flying off and hitting others when cutting.



Fig. 21

Remove any stones, glass or nails.

Safety zone requirements:



Red/White Tape



Safety Cones



Warning Signs

 Carry out grass cutting operations only during specified, allowable times.

Tools and Equipment for Mowing



Fig. 22

Knapsack Brush Cutter



Walk-behind Rotary Mower



Clam-shell Shaped Basket
(Pongkes)



Bunker Rake

Mowing Methods

Using a Knapsack Brush Cutter

Check and Start the Knapsack Brush Cutter	
<ol style="list-style-type: none">1. Check that the brush cutter is in working condition before use.2. Make sure that the safety guard is in place.3. Make sure that all parts of the knapsack brush cutter are secured, e.g.<ul style="list-style-type: none">• No loose parts• Oil tank cover is tightened	 <p>The diagram shows a knapsack brush cutter with a red engine and a black backpack. A red safety guard is attached to the cutting head. A black arrow points to the safety guard, and a green box labeled 'Knapsack Brush Cutter' is positioned below the main body of the tool.</p>
<ol style="list-style-type: none">4. Adjust the harness and handles to suit your height.	 <p>The photograph shows two workers in orange safety gear using knapsack brush cutters in a field. The worker in the foreground is adjusting the harness. A caption below the image reads 'Adjustable harness to suit different heights'. The image is labeled 'Fig. 23' in the bottom right corner.</p>

5. Start the engine for the brush cutter

a. Turn the switch to ON position

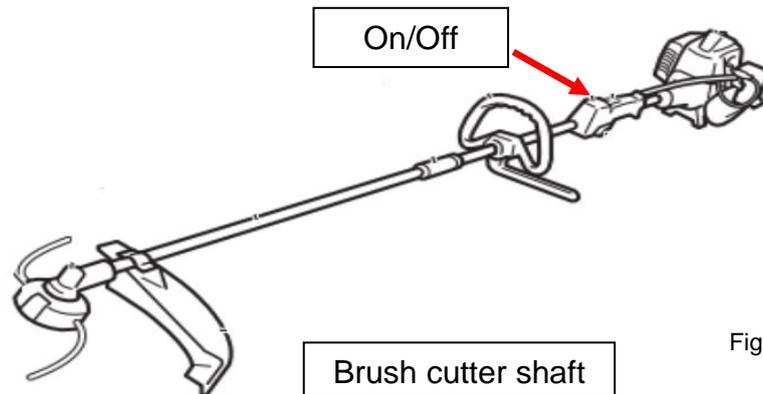


Fig. 24

b. Push the primer bulb a few times for fuel to flow. The location of the primer bulb depends on the model of the brush cutter, but it is usually near the fuel cap and starter handle.

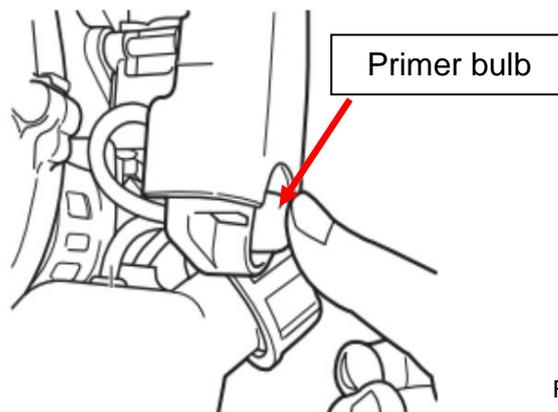
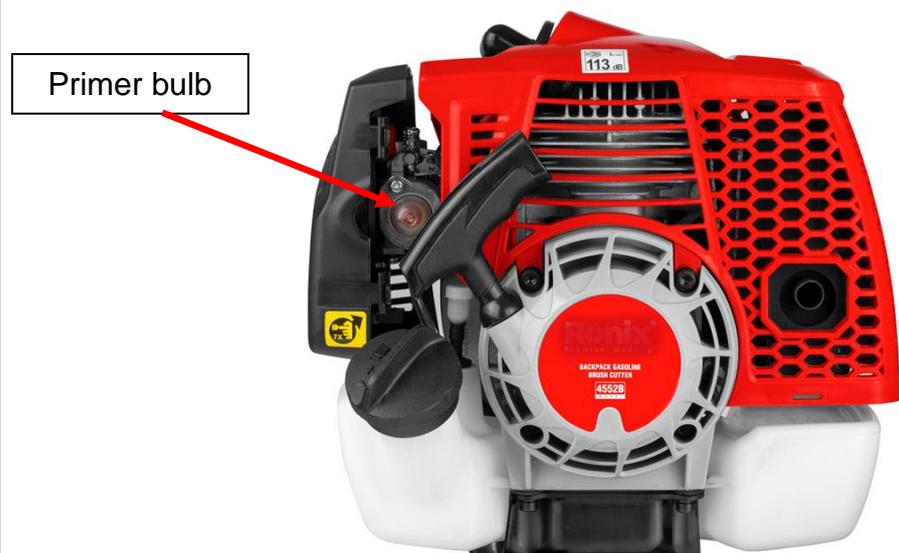
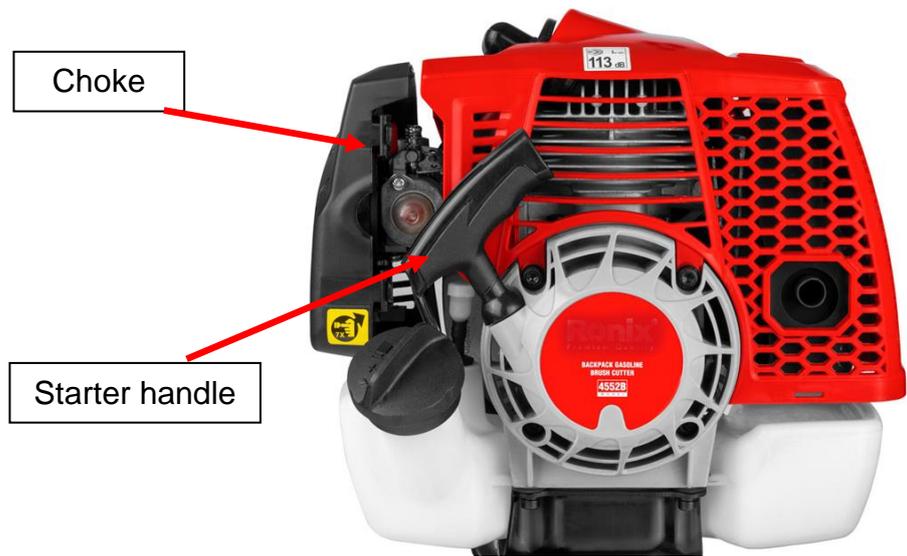


Fig. 25



- c. Set choke to CLOSED position
- d. Pull starter handle
- e. Set choke to RUN position



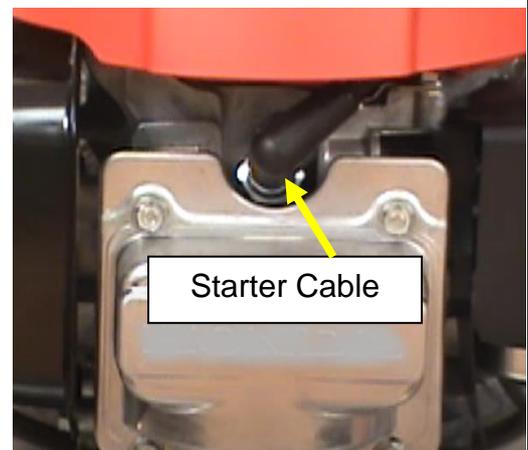
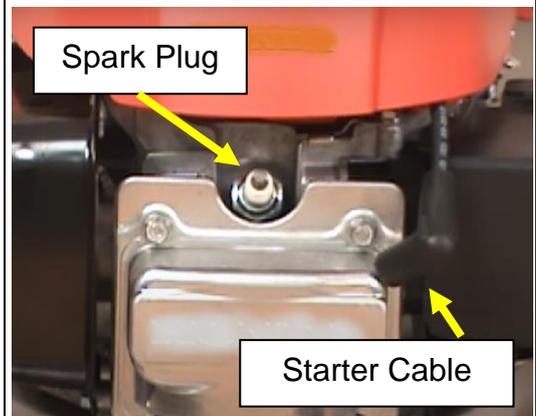
- f. Allow the engine to run for 2 -3 minute before cutting.

Steps to Operate a Knapsack Brush Cutter	
1. Keep a safe distance from other people (15 meters or more) when operating.	
2. Start the knapsack brush cutter in a well-ventilated area e.g., open turfed or lawn space.	
3. Make sure that the safety guard is in place before operation.	
<p>4. Maintain good control of the brush cutter.</p> <ul style="list-style-type: none"> • Always keep both hands on the control handle. • Do not strike its cutting head against any solid objects, e.g., concrete, rocks, woods. • Keep the cutting head below the waist. Do not operate it above head level. • A right-to-left cutting action is recommended because the cutting attachment rotates anti-clockwise. 	 <p style="text-align: right;">Fig. 26</p>
5. Keep hand, feet and other body parts away from the nylon line.	<p>Maintain good control of brush cutter. Keep the cutting head below waist level and the body away from the nylon line.</p>
6. Switch off the engine and let the nylon line come to a stop before lifting the brush cutter to a new position.	
7. After you have completed the cutting, use a rake to distribute the clippings evenly over the mowed turf.	

Using a Walk-behind Rotary Mower

Check and Start the Walk-Behind Rotary Mower

1. Make sure that the starter cable is connected to the spark plug.



Starter cable capped over spark plug

2. Stand behind the mower.

3. Start the engine start/stop lever with your left hand.



4. Perform a sharp, quick pull on the starter handle with your right hand.
5. If the engine does not start, repeat the pull again.



Pull the starter handle using right hand

Steps to Operate a Walk-Behind Rotary Mower

1. Stand with feet slightly apart to maintain proper balance and secure footing.

2. Calibrate the mower to the correct cutting height according to the type of turf grass:

- a. Cow Grass
Axonopus compresses
25 to 30 mm
- b. St. Augustine Grass/ Buffalo Grass
Stenotaphrum secundatum
25 to 75 mm
- c. Bermuda Grass
Cynodon dactylon
12 to 63 mm
- d. Manila Grass
Zoysia Matrella
12 to 76 mm



Calibrate the mower to correct cutting height

3. Mow in a forward direction in straight lines for a nice, clean cut.

- 4. Keep hands and feet away from rotating parts.
- 5. Keep a distance away from the mower in case of slip accident.



Keep hands and feet away from rotating parts

6. If the blade hits an object, turn off the mower immediately and wait for it to stop completely.

- | |
|--|
| 6. After you have completed mowing, turn off the engine and wait for the blade to stop rotating. Do not attempt to manually stop the blade. |
| 7. Remove the grass clippings that have built up and placed them into a clam-shell shaped basket (pongkes) for distribution on the mowed turf. |
| 8. Use a rake to even out the grass clippings. |



Learning Activity 3

Practice cutting/mowing of turf using the Knapsack Brush Cutter and Walk-behind Rotary Mower, following the steps below:

1. Set up a safe work site using signage and safety barriers as practiced in the industry.
2. Inspect the assigned turf plot and remove any hazards such as stone and nails.
3. Put on the appropriate PPE for mowing.
4. Use the Walk-behind Rotary Mower to mow the larger area.
5. Use the Knapsack Brush Cutter for tight spaces or around pavers where the mower is unable to reach.
6. Remove the grass clipping from the Walk-behind Rotary Mower after mowing is completed.
7. Distribute the clippings on the mowed turf; use a rake to spread the clippings evenly.

Learning Outcome 3: Apply Horticultural Practices on Turf

Incorporating Learning Outcome 5: Manage Hazards and Risks associated with Turf Maintenance

Fertilisers are used on turf to help it stay green and grow strong and dense. Strong turf is able to resist the invasion of weeds and diseases.

Types of Fertilisers for Turf

There are two broad types of fertilisers:

Organic Fertilisers

Organic fertilisers are made from decaying plants or animal matter. They release nutrients as they break down, improving the condition of the soil and its ability to hold water and nutrients. Given time, they make soil and plants healthier and hardier. Organic fertilisers are renewable and biodegradable, therefore, sustainable and environmentally friendly.



Compost



Fig. 27

Kelp Seaweed Soluble Powder



Fig. 28

Organic Liquid Fertilisers

Inorganic Fertiliser

Inorganic fertilisers are manufactured artificially from minerals or synthetic chemicals. They provide fast and exact doses of nutrients to meet the specific needs of plants. They are available in three forms:

- Granular form; spread or broadcasted on the grass and levelled evenly with a bunker rake.
- Powdered form; spread or broadcasted on the grass.
- Water-soluble form; mixed with water and sprayed on the leaves of the grass or injected directly into the soil.

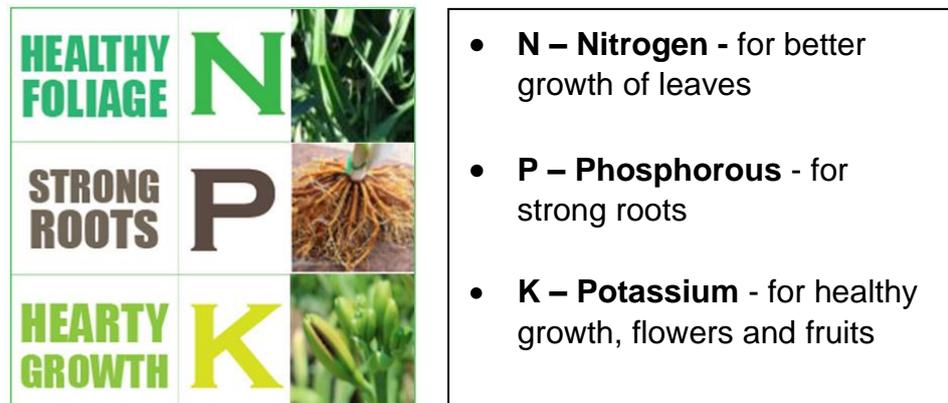


Fig. 29

N.P.K. fertiliser components



15 parts **N** - Nitrogen
15 parts **P** – Phosphorus
15 parts **K** - Potassium

Granule N.P.K.



46 parts **N** – Nitrogen
0 parts **P** – Phosphorus
0 parts - Potassium

Granule Urea
(N.P.K)

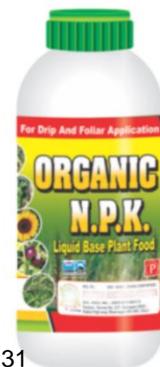


Fig. 31

Liquid N.P.K.



Fig. 32

Powder N.P.K.

Apply Fertilisers and Topdressing for Turf

Prepare to Apply Fertiliser and Topdressing

Personal Protective Equipment for Fertilising and Topdressing



Soft Hat



Safety Glasses



Cotton Gloves



Safety Reflective Vest



Dust Mask



Rubber Safety Boots

Set-up a Safe Work Zone

Safety zone requirements:



Red/White Tape



Safety Cones



Warning Signs

Tools and Equipment for Fertilising Turf



Fertiliser



Topdressing
Material



Watering Can



Bunker Rake



Clam-shell Shaped Basket
(Pongkes)

Steps to Apply Fertiliser and Topdressing

There are various methods to apply fertiliser to turf, such as broadcasting by hand or using a rake, and using an equipment like a fertiliser spreader. Liquid fertiliser can be applied using a hand-held spray or a backpack sprayer for a bigger area.

This course will be focused on the application of fertiliser using the broadcasting method.

Steps to Fertilise Turf by Broadcasting	
1. Put on the appropriate PPE for the work.	
2. Select the fertilisers to be used for feeding the turf.	
3. Check the wind direction. 4. Manually scatter (broadcast) the fertiliser on turf in the direction of the wind, while walking backward in a straight line.	 <p>Scatter fertiliser evenly on turf</p>

Topdressing for Turf

Topdressing is an organic turf care method. It is a process of adding a thin layer of material, normally about 3mm of compost or other soil amendment/conditioner, over the turf. Topdressing has many benefits, one of which is to smooth and level the surface of the lawn. Topdressing also improves drainage and ease the breakdown of the grass clippings.

Topdressing material may include washed sand, sandy loam or compost.

Steps for Topdressing Turf	
1. Scatter up to a 3mm layer of topdressing material evenly over the fertilised area.	 <p>Scatter topdressing evenly</p>
2. Use the bunker rake to level the topdressing material.	 <p>Rake the topdressing evenly</p>
3. Water the fertilised turf area thoroughly so that the roots can absorb the nutrients effectively.	
4. After the completion of fertilising and/or topdressing, avoid walking on the area that you have just fertilised.	

Automated Irrigation System

An automatic irrigation system is a watering system with a timer and sensor to ensure that the turf receives enough water. As turf irrigation usually covers large areas, the system can distribute the right amount of water to the turf area.

Automated irrigation systems also have rain sensors that can turn the sprinklers off during periods of heavy rains and start the sprinklers again when needed.

There are 3 common types of automated irrigation systems used in Singapore:

1. **Traditional Spray System** – ground level and pop-up heads that spray water in a full, half or quarter circle.
2. **Drip System** - water is dripped in slowly into the soil, allowing the soil to absorb the water at its own pace.
3. **Rotor System** –distribute water more evenly especially for off-shaped areas, non-absorbent soils, or sloping lawns. This system is usually used for commercial properties such as golf courses.



Fig. 33

Water outlet for Traditional
Spray System

The maintenance of irrigation systems involves many technical procedures such as:

- Turning on and off the main control for checking of the irrigation system
- Checking of water pressure from the irrigation sprinkler
- Checking for damages on sprinkler head and other damages or leakages
- Adjusting the angle of the irrigation sprinkler heads so that they cover the correct areas to water
- Adjusting the water schedule depending on dry or rainy seasons

The above-mentioned maintenance work should ideally be carried out by irrigation professionals. A landscape maintenance technician can however carry out some basic tasks to support the maintenance of the irrigation system to help it function optimally:

Basic Checks for Automated Irrigation System	
1. Remove plant materials that had grown over or near the sprinkler heads.	 <p style="text-align: right; font-size: small;">Fig. 34</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Remove grass around sprinkler</div>
2. Remove dirt covering the sprinkler valves.	 <p style="text-align: right; font-size: small;">Fig. 35</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Remove grass and dirt covering the valve</div>
3. Report to the supervisor if the sprinkler is clogged, damaged or not working correctly.	



Learning Activity 4

Practice the application of fertiliser and topdressing on the mowed turf from Learning Activity 3.

Learning Outcome 4: Perform Post-Maintenance Activities

It is important to clean and store all tools, equipment and machinery after use. Doing so can prolong the equipment's lifespan and reduce the possibility of a disease or weed contamination when using equipment on different turf areas.

Cleaning and Maintenance of Knapsack Brush Cutter

Post-Operational Maintenance for Knapsack Brush Cutter	
1. Turn the brush cutter off and place it on a flat ground.	
2. Using a cloth, wipe off the dirt on the brush cutter. Be extra careful when you get to the engine as it may still be warm.	 <p>Use a cloth to wipe off dirt</p>
3. Remove the dirt and debris stuck in the ventilation holes with a soft brush. This will prevent the engine from overheating.	 <p>Use a hard brush to clean off bits of grass</p>
4. Using a hard brush, remove the bits of grass, dirt and debris under the protective cover and around the line feed area.	
5. Wipe down the entire brush cutter.	

Cleaning and Maintenance of Walk-behind Rotary Mower

Post-Operation Maintenance for Walk-behind Rotary Mower	
1. Unplug the spark plug to avoid any machinery movement during cleaning that can cause injury (most important!) .	
2. Dispose the grass clippings from the back deck/grass catcher of mower.	 <p>Empty the grass catcher</p>
3. Turn the mower on its side and use a water hose to spray away soil and grass clippings built-up under the mower.	 <p>Fig. 36</p> <p>Spray down the bottom of the mower</p>
4. Use a brush and soapy water to scrub off any balance built-up.	
5. Rinse off the soap and remaining dirt.	
6. Dry the mower before storing it.	

Reporting Faulty Equipment

If you find a faulty equipment, or one with missing or loose parts, use a repair tag to indicate the fault. If the repair tag is not available, tie a red/white tape on the equipment to inform other people not to use the equipment.

Report the faulty equipment to the supervisor as soon as possible.



REPAIR TAG

FOR ALL TOOLS AND EQUIPMENT

EQUIPMENT ID _____
LOCATION _____
PROBLEM _____

REPAIRED BY _____ DATE _____

WORK COMPLETED

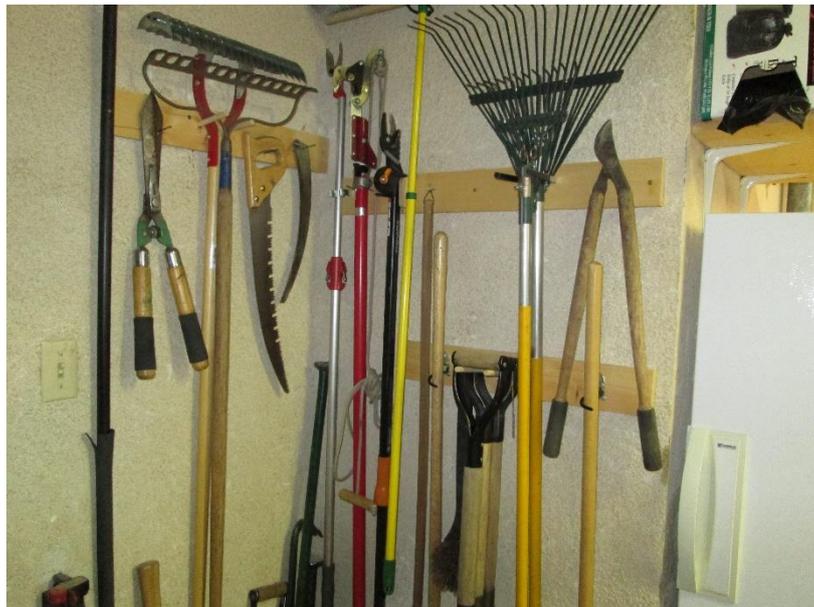
BY _____ DATE _____

REMOVE THIS TAG TO INDICATE THAT
REPAIRS HAVE BEEN COMPLETED

An example of a repair tag
to put on faulty equipment

Storage of Tools and Equipment

- Store in a dry and well-ventilated area away from sunlight.
- Store machines out of reach of others under lock and key.



Store tools and equipment in a storage space
away from sunlight



Learning Activity 5

1. Practice the post-operation maintenance of the Knapsack Brush Cutter and Walk-behind Rotary Mower.
2. Report faulty equipment.
3. Store tools and equipment properly.

Learning Outcome 5: Manage Hazards and Risks associated with Turf Maintenance

Other Hazards and Risks associated with Turf Maintenance

Vibration

The continuous use of vibrating hand-held equipment, including knapsack brush cutter, can result in Hand-Arm Vibration Syndrome (HAVS).

The most commonly observed HAVS is Vibration White Fingers (VWF), which is due to intermittent lack of blood supply to the fingers.



Fig. 37

Fingers turned white due to poor circulation. Resulting in numbness and poor control of machines

To prevent Hand-Arm Vibration Syndrome

- Take frequent short breaks
- Keep machine in proper working order, do not attempt to use damaged machine/equipment
- Do not use machinery continuously; follow the recommended exposure time in the table below:

Vibration for Common Landscape Machine			
Landscape Machine		Vibration (m/s ²)	Maximum Exposure Time (Per Day)
	Chainsaw	6	4 hours
	Lawn Mower	5	5.5 hours
	Brush Cutter	7	4 hours
	Hedge Trimmer	7	4 hours

Table 1: Result from HSE (Health and Safety Executive), UK

Noise

Prolonged exposure to excessive noise can cause noise-induced hearing loss leading to noise-induced deafness (NID).

To prevent noise-induced hearing problems:

- Use hearing protectors (earmuffs or earplugs); the proper use of earplugs can reduce noise level by up to 35dBA
- Keep a sufficient distance from your co-workers when operating the knapsack brush cutter or walk-behind rotary mower
- Minimise the number of noisy machineries running at any one time
- Reduce your noise exposure by limiting the duration of machinery usage; follow the recommended exposure time in the table below:

Activity	Noise Level dB(A)	Maximum Exposure Time Per Day (Minutes)
Tree Pruning	91 – 107	3 – 120
Shrub Trimming	92	120
Leaf / Grass Clippings Blowing	86 - 90	240
Grass Cutting	85 – 90	240
Lawn Mowing	86	240

Table 2: Noise level for common landscape machinery activity
Singapore Standard, SS549:2009
Workplace Safety and Health (Noise) Regulations 2011

N.B. For noise levels that are above 100 dB(A), workers should be provided with both ear plugs and earmuffs, as stipulated in Singapore Standards 549.

The operation of the brush cutter or lawn mower produces a noise level of 85 - 90 dB(A); this will sound like a running kitchen blender or hairdryer. With effective use of earplugs, the noise level can be reduced by up to 35 dB(A); at this level, the noise produced by the landscape machines will be similar to a washing machine in operation. The use of earplugs will allow users to use the machine safely for a longer duration as compared to without the earplugs.

To protect exposed employees from the adverse effects of noise, every workplace with a noise hazard should implement a comprehensive Hearing Conservation Programme (HCP) as part of the company's workplace safety and health (WSH) programme.

Chemical Exposure

The improper handling or application of chemicals can cause irritation, burns and even affect internal organs.

It is important to observe the following when handling chemicals:

- Read the chemical label and follow manufacturers' instruction on usage, quantity, storage and disposal.
- Put on the appropriate PPE, especially when working with liquid chemicals.
- Ensure there is a first aid box available at the worksite.

Working at Roadside

Working at the roadside can be dangerous. Safe work practices in high traffic work area include:

- Rotating and/or flashing lamps need to be placed at regular intervals along work zone on roadside
- Use larger direction sign
- Use Truck Mounted Attenuator (TMA) when working on expressways and roads with a speed limit above 70km/h.



Working on expressway



Truck Mounted Attenuator (TMA) - Mount blinking beacon lights on the top and warning signs rear of vehicles

The following control measures in LTA's Code of Practice must be adhered to while working along the roadside:

- Cordon off the work area
- Re-direct traffic flow
- Install TMA (for expressway) and placement of warning lights and signages
- Workers must wear luminous vests to enhance their visibility
- Establish the work zone and its removal, especially near fast lanes, expressways, and major roads

Heat Stress

It is important to protect yourself from extreme heat and solar radiation by:

- Drinking plenty of water.
- Wearing cooling and protective clothing.
- Wear soft hat and sunglasses to block out direct sunlight contact.
- Monitoring yourself and your co-workers for symptoms of dehydration or heat exhaustion.



Learning Activity 6

Share your personal experience with hazards associated with turf maintenance at the workplace. How did you and your organisation manage those hazards?

Assessment Information

The assessment methodology for this course is Practical Exam and Oral Questioning.

Practical Exam

For the Practical Exam, you will be given **90 minutes** to perform the following tasks to demonstrate your competence for the learning outcomes:

- a. Put on the appropriate PPE, set up a safe worksite and check the turf for potential hazards before commencing work.
- b. Mow turf using the walk-behind rotary mower and knapsack brush cutter.
- c. Apply fertiliser and topdressing on mowed turf.
- d. Inspect turf for turf health problems.
- e. Perform chemical spraying to affected turf area using a backpack sprayer.
- f. Perform post-operation maintenance for the knapsack brush cutter and walk-behind rotary mower.
- g. Report faulty equipment/maintenance issues.

Oral Questioning

For Oral Questioning, you will be given **30 minutes** to answer 10 questions that check your knowledge in accordance to the learning outcomes.

Appendix 1 – Tools, Equipment and Material Checklist

Personal Protective Equipment			
			
Safety Helmet <input type="checkbox"/>	Safety Glasses <input type="checkbox"/>	Face Shield <input type="checkbox"/>	Dust Mask <input type="checkbox"/>
			
Earplugs <input type="checkbox"/>	Safety Vest <input type="checkbox"/>	Raincoat <input type="checkbox"/>	Safety Boots <input type="checkbox"/>
			
Cotton Gloves <input type="checkbox"/>	Rubber Gloves <input type="checkbox"/>		
Work Zone Requirements			
			
Red/White Tape <input type="checkbox"/>	Safety Cones <input type="checkbox"/>	Warning Signs <input type="checkbox"/>	
Tools, Equipment and Machinery			
			
Knapsack Brush Cutter <input type="checkbox"/>	Walk-behind Rotary Mower <input type="checkbox"/>	Backpack Sprayer <input type="checkbox"/>	

			
Pail	Water Scoop	Watering Can	Measuring Jar
			
Clam-shell Shaped Basket (Pongkes)	Bunker Rake		
Horticultural Products			
			
Fertiliser	Topdressing Material	Horticultural Chemical	
Housekeeping Items			
			
Hard Brush	Cloth	Dustpan	Disposal Bag

Reference Material

WSH Council, Workplace Safety and Health Guidelines, Landscape and Horticulture Management, Singapore, Second revision:2018

Health and Safety Executive (UK) - <https://www.hse.gov.uk/index.htm>

Sustainable Landscape. Published for Urban Greenery & Ecology. National Parks Board Headquarters - <https://www.nparks.gov.sg/-/media/cuge/ebook/sustainable-landscape/sustainable-landscape.pdf>

ACGIH (American Conference of Governmental Industrial Hygienists) - <https://www.acgih.org/>

Daily Household Appliances noise <https://www.captel.com/2019/10/noise-levels-of-common-household-sounds-infographic/>

What is the Ideal Height to Cut the Grass?
<https://www.diynetwork.com/how-to/outdoors/gardening/what-is-the-ideal-height-to-cut-the-grass>

Fig. 1: Lalang

https://lh3.ggpht.com/sEDyGErGM0OEsnbgpYZTKWp3SmDKr8Y6NAT-1VnWpHJJj87czXzE8nn1vIDb6kqdf_O5toCQxZdRA4CIHQLj_g=s580 Accessed on 15 Apr 2021

Fig. 2: Sod Webworm <https://www.cardinallawns.com/wp-content/uploads/2016/02/sod-webworm.jpg> Accessed on 02 Mar 2021

Fig. 3: Armyworm

https://www.syngentaturf.sg/sites/g/files/zhg946/f/styles/syngenta_large/public/1024x716px_army_worm.jpg?itok=iJ2D4SF Accessed on 02 Mar 2021

Fig. 4: African Black Beetle

https://www.syngentaturf.sg/sites/g/files/zhg946/f/styles/syngenta_large/public/1024x716px_adult_black_beetle_carousel.jpg?itok=COF6CXBp Accessed on 27 Feb 2021

Fig. 5: Larvae of African Black Beetle

https://www.agric.wa.gov.au/sites/gateway/files/styles/original/public/african%20black%20beetle_VL_3.jpg?itok=j_lqNqCc Accessed on 02 Mar 2021

Fig. 6: Dried irregular patches

https://www.syngentaturf.sg/sites/g/files/zhg946/f/styles/syngenta_large/public/1024x716px_black_beetle_grub_associated_bird_damage_carousel.jpg?itok=M71-aNcc
Accessed on 27 Feb 2021

Fig. 7: Black Cutworm Moth

https://extension.umn.edu/sites/extension.umn.edu/files/styles/caption_medium/public/cutworm1.jpg?itok=0KIYp_Zi Accessed on 02 Mar 2021

Fig. 8: Black Cutworm <http://uspest.org/mint/images/blackcutla.JPG> Accessed on 02 Mar 2021

Fig. 9: Ant hill on turf <https://www.pest-ex.com.au/wp-content/uploads/2019/07/funnel-ants-lawn.jpg> Accessed on 27 Feb 2021

Fig. 10: Ants' colony <https://www.gardeningknowhow.com/wp-content/uploads/2015/05/anthill-lawn.jpg> Accessed on 02 Mar 2021

Fig. 11: Above ground mushroom may appear in a ring - By User: Mrs skippy - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=3352618> Accessed on 18 Feb 2021

Fig. 12: Liquid Turf Insecticide https://fernland.com.au/media/catalog/product/cache/1/thumbnail/600x/8bff7d3c9b924101de3c97edfbc52f27/i/m/image_24340.jpg Accessed on 24 Mar 2021

Fig. 13: Granules Turf Insecticide <https://www.jimboombaturf.com.au/wp-content/uploads/2019/08/insecticide.jpg> and <https://www.gardentech.com/-/media/Images/GardenTech-NA/US/products/Sevin-12-07-17/Sevin-Insect-Killer-Lawn-Granules-10lb.jpg> Accessed on 24 Mar 2021

Fig. 14: Liquid Turf Fungicide https://www.sunspotsupply.com/pub/media/catalog/product/cache/29738d70a38100d8acf8617ac5ce7888/h/e/heritage-tl_2.jpg Accessed on 24 Mar 2021

Fig. 15: Granules Turf Fungicide https://www.siteone.com/medias/sys_master/root/h4d/h9e/8935722450974/554996-1-515Wx515H.jpg Accessed on 24 Mar 2021

Fig 16: GHS pictogram definition https://www.chemsafetypro.com/Topics/GHS/GHS_Pictogram.png Accessed on 09 Mar 2021

Fig. 17: Check all equipment <https://thumbs.dreamstime.com/b/farmer-spray-insecticide-rice-farm-chemical-electric-sprayer-taiwan-farmers-use-sprayers-to-grow-crops-noise-197011900.jpg> Accessed on 14 Apr 2021

Fig. 18: Spray from waist height <https://pmepercourses.cce.cornell.edu/images/Backpack.JPG> Accessed on 27 Feb 2021

Fig. 19: Pour leftover chemical in designated container
<https://i.ytimg.com/vi/cvu9iKv5HQ8/maxresdefault.jpg> Accessed on 15 Apr 2021

Fig. 20: Storage for chemical
https://www.ehs.gatech.edu/sites/default/files/images/offices/chemical/flammable_storage_cabinet.jpg Accessed 08 Feb 2021

Fig. 21: Remove any stones, glass or nails.
Workplace Safety and Health Guidelines, Landscape and Horticulture Management, Second revision: 2018

Fig. 22: Knapsack Brush Cutter https://im01.itaiwantrade.com/82a1c21b-40ef-420b-ba50-5f0515716cb7/knapsack_brush_cutter_FB243N-100x100.jpg Accessed on 18 Feb 2021

Fig.23: Adjustable harness to suit different height
<https://www.theonlinecitizen.com/wp-content/uploads/2018/07/grasscutting-1068x579.jpg> Accessed on 27 Feb 2021

Fig. 24: Brush cutter shaft
Tanaka Knapsack Brush Cutter Operation Manual

Fig. 25: Primer bulb
Tanaka Knapsack Brush Cutter Operation Manual

Fig. 26: Maintain good control of brush cutter, keep cutting head below waist level and keep body away from nylon
Workplace Safety and Health Guidelines, Landscape and Horticulture Management, Second revision: 2018

Fig. 27: Kelp Seaweed Soluble Powder
https://www.huahng.com.sg/wp-content/uploads/2019/01/STARX-Kelp-Soluble-Powder-250g_1500px_wm-300x300.jpg Accessed on 25 Mar 2021

Fig. 28: Organic Liquid Fertilisers
http://www.greencare.com.my/images/com_hikashop/upload/thumbnails/500x500f/primomaxx.jpg Accessed on 25 Mar 2021

Fig. 29: N.P.K. Fertiliser component <https://www.dayliliesinaustralia.com.au/wp-content/uploads/2013/09/NPK-Dose-for-Daylilies-Fertilisers-Nitrogen-Phosphorus-Potassium.jpg> Accessed 08 Feb 2021

Fig. 30: Granule Urea (N.P.K.)
<https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRPa2quZ1oZYafpN8LHGUNwOzwo1ALkwq>

[a51O1wFi5K4pbT4KW2vlhoXF60Fu6w5oIWkMY&usqp=CAU](https://www.gardenandgreenhouse.net/wp-content/uploads/2018/02/xdry-fertilizer.jpg.pagespeed.ic.X_5hXuhirx.webp) Accessed on 25 Mar 2021

Fig. 31 Liquid N.P.K <http://biofertilizer.biz/product/wp-content/uploads/2018/08/042-copy.png> Accessed on 09 Mar 2021

Fig. 32 Powder N.P.K. https://www.gardenandgreenhouse.net/wp-content/uploads/2018/02/xdry-fertilizer.jpg.pagespeed.ic.X_5hXuhirx.webp Accessed on 09 Mar 2021

Fig.33: Water outlet for Traditional Spray System
<https://www.greenvallyirrigation.com/wp-content/uploads/2019/04/3-Different-Types-of-Sprinkler-Irrigation-Systems-for-Your-Lawn2.jpg> Accessed 10 Feb 2021

Fig. 34: Remove grass around sprinkler <https://texaslawnsprinklers.com/wp-content/uploads/2019/02/texas-lawn-sprinklers.jpg> Accessed on 22 Feb 2021

Fig. 35: Remove grass and dirt covering the valve
From Hunter Irrigation Youtube Video: Hunter Spray Adjustment and Maintenance
Accessed on 22 Feb 2021

Fig. 36: Spray down the bottom of the mower <https://ordersodnow.com/blog/wp-content/uploads/2019/10/cleaning-your-mower.jpg> Accessed on 02 Mar 2021

Fig. 37: Fingers turned white due to poor circulation. Resulting in numbness and poor control of machines
Workplace Safety and Health Guidelines
Landscape and Horticulture Management, Second revision: 2018

Fig. 38: Working at expressway
<http://www.pioneertrainingcentre.com/wp-content/uploads/2017/06/BTCC-8.jpg>
Accessed on 17 Feb 2021

Fig. 39: Truck Mounted Attenuator (TMA) - Mount blinking beacon lights on the top and warning signs rear of vehicles
<https://www.singhengahoe.com/assets/Services/3960cf1964/machinery-truck-mounted-attenuator.jpg> Accessed 17 Feb 2021