

OPERATIONAL MANUAL FOR WOODY WEED CONTROL IN SINGAPORE



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National Parks Board and
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CONTENTS

1. <u>Acknowledgements</u>	2
2. <u>Introduction</u>	3
3. <u>Mechanical and Manual Methods</u>	4
3.1 <u>Hand Pulling</u>	5
3.2 <u>Uprooting with Tools</u>	7
3.3 <u>Cutting of Small Plants</u>	10
3.4 <u>Girdling</u>	13
4. <u>Chemical Methods</u>	16
4.1 <u>Foliar Spray</u>	17
4.2 <u>Cut-Stump</u>	19
4.3 <u>Drill-Inject</u>	21
5. <u>Field Notes</u>	23
6. <u>Conclusions</u>	24
7. <u>Literature Cited</u>	25
8. <u>Appendix</u>	26

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2 INTRODUCTION

This manual serves as a quick guide to the methods used to remove unwanted invasive plants in Singapore and should be read in conjunction with the Final Report on Controlling the Woody Weeds in the Nature Reserves of Singapore (Koh et al., 2012). Both mechanical and chemical methods will be covered as well as the tools and techniques for each method and effectiveness on common invasive trees in Singapore.

Portions of this manual have been adapted from “Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas” by The Nature Conservancy (Tu et al., 2001).

Note that weed control is not a substitute for weed prevention and eliminating the causes of weed infestations (e.g., canopy damage, soil disturbance, and failure to remove seed sources) should always be given priority. Where weed problems cannot be avoided completely, early detection and immediate action can make a huge difference to the effort required and the eventual outcome.

Seed sources of invasive woody weeds should be eliminated from at least a 1-km buffer zone outside the Nature Reserves for the best chances of preventing their entry to these areas of conservation concern.

3 MECHANICAL AND MANUAL METHODS

Mechanical and manual methods refer to methods used to remove or kill plants through the use of manual force and tools but not through the use of chemicals.

While not using chemicals is ideal when working in ecologically sensitive areas, mechanical and manual methods are often labour-intensive and time-consuming and are best used for plants that are either small in size or few in number. These methods are simple to perform and can also be very specific. However, short of complete physical removal of the plant, not all plants respond well to all mechanical and manual methods, hence limiting their overall effectiveness. Also, in some circumstances, mechanical methods can cause more ecological damage than chemical alternatives.

Manual methods may be combined with chemical methods to treat invasive plants.

3.1 HAND PULLING

Applies to

1. Small plants or small saplings <1 m tall

Item required

1. Cotton or leather gloves

Technique

1. Grasp plant at the base.
2. Pull the plant out cleanly including its roots.
3. Replace the soil to minimise soil disturbance.
4. Properly dispose of plants so that they have no opportunity to regrow at the site.

Advantages

1. This method is cheap to perform.
2. No special tools are required.
3. There is minimal impact to the environment.
4. It is applicable to most plants.
5. It is relatively safe for the operator as no dangerous chemicals are used.

Disadvantages

1. This method is only applicable for small plants and saplings.
2. It is labour-intensive.
3. It is slow if a large area needs to be cleared.



Fig. 3.1.1. Hand pulling saplings and seedlings of woody weeds. Firstly, grab the plant at its base. Secondly, pull the plant out cleanly and completely, including its roots. Lastly, replace the soil when the plant has been removed.

3.2 UPROOTING USING TOOLS

Applies to

1. Plants with ≤ 6 cm basal stem diameter

Item required

1. Pullerbear® Pulls-All (or other similar tools)

Technique

1. Clamp the jaws of the Pulls-All tool around the base of the plant.
2. Use leverage to pull the plant out of the ground. Several attempts may be required.
3. Replace the soil to minimise soil disturbance.
4. Properly dispose of the uprooted plants to prevent re-sprouting.

Advantages

1. This method allows the manual removal of larger plants.
2. There is minimal ecological impact.
3. It is easy to perform.
4. It is applicable to most woody plants.

Disadvantages

1. A special tool is required to be purchased.
2. The tool may be heavy and cumbersome to carry in the field.

Notes

1. Various tools from different manufacturers are available, e.g., Pullerbear®, Weed Wrench Company®. Select in accordance to the field requirements.
2. Some models can be quite heavy.



Fig. 3.2.1. Position the jaw of the Pulls-All tool around the base of the plant's stem using one's foot.



Fig. 3.2.2. When the handle is pulled, the jaws of the tool will bite into the stem's base.



Fig. 3.2.3. Grab the handle of the tool with both arms and pull down to pull out the plant.



Fig. 3.2.4. The plant pulls out cleanly with the roots mostly intact. Replace the soil when done.

3.3 CUTTING OF SMALL PLANTS

Applies to

1. Small plants (1–5 m tall and 6–15 cm DBH)

Items required

1. Chainsaw
2. Pruning saw
3. Loppers

Technique

1. Ensure area is safe, e.g., no one is standing in the path of the tree and tree is free from wasp or hornet nests.
2. Make the first cut higher up to remove the crown of the tree and take weight off the trunk.
3. Make the second cut at the base of the tree to minimise the size of the stump and complete the cut.

Advantage

1. The tree is completely removed.

Disadvantages

1. This method is labour-intensive.
2. The understorey plants and weeds will quickly colonise the gap.
3. Many plants re-sprout from the stump if no further treatment is provided.

Notes

1. Cutting a tree in two stages is necessary to prevent the tree from snapping and splintering.
2. No special training is required for cutting small trees.
3. Cutting of large trees is best assigned to trained contractors.



Fig. 3.3.1. Make the first cut with a saw at approximately 1.5 m above ground to remove the top part of the tree.



Fig. 3.3.2. The top of the tree is removed, thus reducing weight of trunk and decreasing the chance of it snapping.



Fig. 3.3.3. Make the second and final cut close to the ground level.



Fig. 3.3.4. The resultant flat and level stump.

3.4 GIRDLING

Applies to

1. Any tree with uniformly circular trunk with DBH >10cm

Items required

1. Pruning saw
2. Sharp trowel

Technique

1. Cut parallel lines 10–15 cm apart in the bark around the circumference of the tree's trunk using the pruning saw.
2. The cuts should be deep enough to cut through the vascular cambium, i.e., reaching the sapwood.
3. Use the trowel to peel away the bark between the cuts.

Advantages

1. This method is cheap to perform.
2. There is no need to remove the tree.
3. There is no need for large equipment.

Disadvantages

1. Only single-stemmed trees can be girdled.
2. Not all trees can be girdled effectively.
3. This method is labour-intensive.

Notes

1. Girdling too deeply may weaken the tree and cause it to break at the kerf (site of girdling) in strong winds.



Fig. 3.4.1. Make first cut all around circumference of trunk.



Fig. 3.4.2. Make the second similar cut 10–15cm below the first.



Fig. 3.4.3. Insert the trowel into the incision and use leverage to pry the bark away from the sap wood.



Fig. 3.4.4. Gently peel the bark away from the sap wood. The bark must be completely removed to sever vascular cambium connections between the upper and lower cuts.



Fig. 3.4.5. The completed girdle showing the kerf (area between the cuts).

4 CHEMICAL METHODS

Chemical methods refer to the use of herbicides or other chemicals to kill unwanted plants. Many different formulations and types of herbicides are available on the market each with their own unique properties.

Herbicides provide a way to quickly and permanently kill unwanted plants but if not used carefully, they have the potential to damage the environment. Utmost care has to be taken when applying herbicides in the field.

Before using herbicides, it is essential to have knowledge of their properties which include their method of action, effectiveness, mechanism of decomposition, environmental behaviour, toxicity to other living organisms, safety, and human toxicology.

It is also important to be equipped with the correct personal protective equipment when applying herbicides to minimise contact between the chemicals and the user.

In this manual, only the use of 41% glyphosate as the herbicide is described.

4.1 FOLIAR SPRAY

Items required

1. Glyphosate
2. Spray bottle or paint brush
3. Nitrile gloves
4. Splash-proof goggles

Technique

1. Mix the herbicide formulation as required (41% glyphosate).
2. Pour the herbicide formulation into a spray bottle.
3. Spray the plant, ensuring that all parts of the leaves are covered.
4. Alternatively, paint the herbicide formulation onto the leaves using a paint brush.

Advantages

1. Many plants can be treated quickly.
2. This method is effective on many plants.
3. It is easy to perform.

Disadvantages

1. This method requires extensive safety procedures.
2. The chemical is potentially dangerous to non-target plants.
3. The chemical has potential to contaminate the ground.
4. It is not recommended for ecologically-sensitive areas.
5. There is the need to properly dispose of used equipment.

Notes

1. Preparation of the herbicide formulation can be done either off or on site.
2. This method is only recommended for small plants or shoots to minimise spread of herbicide onto non-target plants.



Fig. 4.1.1. Typical waterproof bag and pump-type sprayer available at most hardware shops and florists.

4.2 CUT-STUMP

Items required

1. Glyphosate
2. Chainsaw
3. Pruning saw
4. Spray bottle
5. Dropper bottle
6. Nitrile gloves

Technique

1. Mix the herbicide formulation as required (41% glyphosate).
2. Pour the herbicide solution into a dropper bottle.
3. Cut tree to obtain a flat stump (see 3.3 Cutting).
4. Apply the herbicide formulation using dropper bottle or spray bottle immediately to the circumference of the stump to cover the cambium and the sapwood (from the junction of the bark and wood to the outer part of the wood). The bark and heartwood do not need to be treated.
5. Avoid using too much herbicide.

Advantages

1. Only a small quantity of herbicide is required.
2. This method is effective on most plants.
3. There is a low probability of the herbicide affecting non-target plants.
4. There is a low probability of contamination of the environment.

Disadvantages

1. The tree needs to be cut.
2. Plants may be destroyed when the tree falls.



Fig. 4.2.1. The cut-stump method. Firstly clear the sawdust from the stump. Secondly, apply the herbicide solution from the dropper bottle to the vascular cambium tissue of the stump (at the junction of the bark and the sap wood of the trunk) and the sapwood (outer part of the wood). The herbicide must be applied immediately after cutting the stump to be effective.

4.3 DRILL-INJECT

Items required

1. Glyphosate
2. Cordless drill, spare battery(ies), and drill bits
3. Dropper bottle
4. Nitrile gloves

Technique

1. Mix the herbicide formulation as required (41% glyphosate).
2. Pour the herbicide solution into a dropper bottle.
3. Drill holes at 30–45° angles to the horizontal at 3–5 cm intervals to a depth of 4–5 cm around the circumference of the trunk at a convenient height (around waist level).
4. Clear the sawdust from the holes.
5. Place ~1 ml of herbicide solution into each hole using the dropper bottle or pipette.

Advantages

1. Only a small quantity of herbicide is required.
2. This method is effective on most trees.
3. There is a low probability of the herbicide affecting non-target plants.
4. There is a low probability of contamination of the environment.
5. It is a quick method.

Disadvantages

1. The number of trees that can be treated is limited to the amount of battery power available to the operator so spare batteries are essential if there are many trees to treat.



Fig. 4.3.1. Drill holes at 30–45° angles to the horizontal at 3–5 cm intervals to a depth of 4–5 cm around the circumference of the trunk at a convenient height (around waist level).



Fig. 4.3.2. Clear the sawdust from the holes then place ~1 ml of the herbicide formulation into each hole using the dropper bottle.

5 FIELD NOTES

It is always useful to carry a lightweight pruning saw when clearing plants as the saw can be used for a myriad of purposes other than cutting trees, such as removing branches, clearing shrubs, and reducing the size of plants.

Gloves are also very useful for protecting the hands when handling plants with prickles, spines or thorns or grasses with sharp edges, as well as when handling sharp tools.

In addition, safety goggles are recommended to prevent branches from snapping back into the face of the operator or to prevent sawdust and other debris from entering the eyes.

Always bring sufficient water and isotonic drinks as manual clearing of plants can require a lot of effort, and sufficient hydration is required in hot weather to prevent heat exhaustion. Also, plan for sufficient breaks and do not over-exert.

When transporting herbicides, it is good to prepare a portable spill kit for use in emergencies when the herbicide is accidentally spilt.

For more instructions on how to prepare and transport herbicides safely, please refer to the *Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas* by The Nature Conservancy (Tu et al., 2001).

6 CONCLUSIONS

Prevention is much better than cure, and it is especially so in the eradication of invasive plant species. It is hoped that this manual will serve as a useful guide to some of the techniques available to remove invasive trees. From the numerous methods available, users will have to determine which method is best suited for the intended task by checking Appendix on page 26.

7 LITERATURE CITED

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8 APPENDIX

Appendix 1. Summary of the effectiveness of woody weed control methods on the common invasive plants in Singapore.

S/No.	Species	Manual Methods				41% Glyphosate Methods		
		Hand pulling	Uprooting	Cutting	Girdling	Foliar Spray	Cut-stump	Drill-injection
1.	<i>Acacia auriculiformis</i>	✓	✓	✓*	✓	✓	✓	✓
2.	<i>Cecropia pachystachya</i>	✓	✓	✗	✗	±	±	✓
3.	<i>Hevea brasiliensis</i>	✓	✓	✓*	✗	✓	✓	✓
4.	<i>Falcataria moluccana</i>	✓	✓	✗	✗	✓	✓ _f	✓ _{ff}
5.	<i>Muntingia calabura</i>	✓	✓	✗	✗	✓	✓	✓
6.	<i>Piper aduncum</i>	✓	✓	✗	NA	✓	✓ _f	✓
7.	<i>Spathodea campanulata</i>	✓	✓	✗	✗	✓	✓	✓

Key:

✗ = Ineffective

± = Fair

✓ = Effective

✓* = Effective if DBH >20 cm

✓_f = Effective only with follow up

✓_{ff} = Effective but may require several rounds of follow up

NA = Not feasible because of multiple trunks