



Department of
Primary Industries

Noxious and environmental weed control handbook

a guide to weed control in non-crop,
aquatic and bushland situations

NSW DPI MANAGEMENT GUIDE, FIFTH EDITION



Invasive Species Unit

www.dpi.nsw.gov.au/weeds



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Noxious and environmental weed control handbook – A guide to weed control in non-crop, aquatic and bushland situations
5th Edition

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (October 2011). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up-to-date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the user's independent adviser.

Important: ALWAYS READ THE LABEL

Users of agricultural (or veterinary) chemical products must always read the label and any Permit, before using the product and strictly comply with the directions on the label and conditions of any Permit. Users are not absolved from compliance with the directions on the label or conditions of the Permit by reason of any statement made or omitted to be made in this publication.

Note

This handbook has been compiled as a guide for noxious and environmental weed control in non-crop, aquatic and bushland situations. For crop or pasture situations, see the following NSW DPI publications:

Weed control in winter crops
Weed control in summer crops
Weed control in lucerne and pastures

or consult your nearest NSW DPI
District Agronomist.

Inclusion of an advertisement or sponsor's symbol in this publication does not necessarily imply endorsement of the product or sponsor by NSW DPI.

Cover photographs

Front cover

- Tropical soda apple (*Solanum viarum*) infestation. Photo: Greg Egan.

Inside front cover

- Horsetail (*Equisetum* species). Photo: Bob Trounce.
- Lagarosiphon (*Lagarosiphon major*) Photo: Sainty and Associates.
- Water caltrop (*Trapa natans*). Photo: Sainty and Associates.
- Hymenachne (*Hymenachne amplexicaulis*). Photo: Department of Natural Resources, Mines and Water, Queensland (QNRM&W).
- Senegal tea plant (*Gymnocoronis spilanthoides*).
- Yellow burrhead (*Limnocharis flava*). Photo: K. Galway, QNRM&W.
- Eurasian water milfoil (*Myriophyllum spicatum*). Photo: Alison Fox. www.forestryimages.org
- Hygrophila (*Hygrophila costata*). Photo: P. Gorham.
- Anchored water hyacinth (*Eichhornia azurea*). Photo: Kurt Stuber, Max-Planck Institute for Plant Breeding Research
- Kidney-leaf mud plantain (*Heteranthera reniformis*). Photo: Sue Hayward.
- Water pennywort (*Hydrocotyl ranunculoides*). Photo: Jessica Grantley.
- Long-leaf willow primrose (*Ludwigia longifolia*). Photo: Peter Gorham.
- Water soldier (*Statiotes aloides*). Photo: Malcolm Storey, www.bioimages.org.uk
- Other images: NSW DPI, R. Ensbey and B. Trounce.

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Integrated weed management

by Rod Ensbey

Integrated weed management: the key

Integrated weed management is the coordinated use of a range of suitable chemical and non-chemical control methods. The aim is to incorporate a variety of control methods and reduce reliance on herbicides. Successful integrated weed management programs require long-term planning, knowledge of the weed's biology and ecology as well as appropriate weed control methods. In many situations, weed control is more cost-effective and practical when herbicide and non-herbicide control methods are integrated. Many weed infestations can be controlled or eradicated using integrated methods.

Integrated management is required when herbicide control is not economically feasible, for example, in large infestations of lantana where a combination of fire, herbicides, mechanical controls, pasture and grazing management can achieve successful control. An integrated control program for lantana could be: remove stock for several months, burn at the appropriate time, sow an improved pasture in early summer, continue to exclude stock until pasture establishes and follow up with herbicide spot spraying on regrowth. This regime may need repeating for 2 or 3 years. Depending on the terrain and access, burning could be substituted with bulldozing or slashing to reduce the bulk of the mature plants and then followed up with spot spraying. A similar integrated program could also be used for blackberry control.

Bitou bush, another invasive environmental weed, infests up to 75% of the New South Wales coastline. A long-term integrated control program is being implemented to combat this weed threat, involving a combination of manual, biological and chemical controls.

Biological control

Biological control of weeds involves the use of a plant's natural enemies such as

insects, mites and diseases to control weed populations. It is an economical, effective and environmentally sound method of weed control, but is a long-term technique with extensive development and establishment phases. Biocontrol does not eradicate a weed, but if successful, reduces it to an acceptable level where it can be controlled by other means.

There are two main types of weed biological control: inundative and classical.

Inundative control

Inundative biological control is the use of mycoherbicides to control single weed species that escape mechanical or chemical control.

Mycoherbicides are plant pathogens such as rusts and fungi that are applied to control a specific weed. They can be likened to a species-specific natural herbicide, but are not self-sustaining and have a short active period.

In Australia, researchers are investigating the potential of mycoherbicides for controlling alligator weed, Noogoora burr and bitou bush.

Classical control

Classical biological control is the release of control agents such as insects, rusts and mites into a region to permanently suppress selected target weeds. The aim is to establish a natural balance between the weed and its control agent – similar to the balance found in the native range of the weed.

If an agent successfully establishes itself, control becomes self-perpetuating and self-regulating as the control agent becomes a permanent part of the region's ecology, however, monitoring an agent's population dynamics can be an important part of a weed management strategy that is reliant on biocontrol.

Biological control can be an attractive option when the control agent has established in other areas and has shown good results. However, successful programs may take more than 10 years to be effective, and results may vary from area to area.

Biological control is practical and effective for:

- inaccessible areas such as timbered, rocky and steep locations
- areas of low-priority for control
- situations where biocontrol is the only option, for example sensitive aquatic areas
- situations where chemical control may be too expensive or not effective.

Many weeds in Australia have been targeted for biological control. Some programs have been extremely successful; other programs have varied from partly successful to completely unsuccessful.

The most spectacular success involved the control of the common pest prickly pear during the late 1920s. The *Cactoblastis* moth was introduced in 1926, but it wasn't until 6 years later that the moth made its full impact. The result was that millions of hectares of land were freed from prickly pear and again became viable for agriculture. The *Cactoblastis* moth hasn't totally eradicated prickly pear: isolated areas remain, normally in particularly cold and wet locations.

Other successful agents include the *Cyrtobagous salviniae* weevil introduced for the control of the aquatic weed salvinia. This agent is particularly successful in Queensland and northern NSW, becoming less reliable as the climate becomes cooler.

There have been numerous examples of insects that have been released and have either failed to establish, or have established but have had little impact on the weed. Lantana has had 25 agents trialled and released for its control. Some have been partly successful, with the majority having little impact.

In a worldwide review of biological control of weeds, it was calculated that 63% of agents released became established, but only 24% of releases were considered effective in controlling their weed host.

Many programs now underway in NSW are in the early stages of implementation. Most of today's biological control programs will benefit the next generation of land managers.

Flame cultivation

Flame cultivation, flame weeding or flaming as it is also known, has been recognised for a number of years but has never developed into a legitimate weed control method in Australia. Currently there are a number of trials underway assessing this form of weed control in crop and non-crop situations.

In Sweden, flame weeding has been used for many decades, particularly in organic farming situations for pre-emergent weed control in carrots and other slow-germinating row crops. Flaming has also been used in Sweden for selective post-emergent control in heat-tolerant crops and for general weed control on hard surfaces in urban areas.

Liquefied petroleum gas or propane is the fuel most commonly used in flame weeders. The efficacy of flame weeding is attributed to a direct effect of the flame on the plant's cell membranes and an indirect effect during subsequent desiccation.

The flaming process does not require the weed to be burnt, but raises moisture temperatures to above 100°C, at which point the moisture turns to steam and ruptures the plant cells.

Small seedlings are generally more susceptible to flaming than large ones. Species with upright habit and thin leaves are also more sensitive than species with a low stature and protected growth points. Theoretically, then, upright-growing species such as Parramatta grass and setaria should be more susceptible than lower, prostrate-growing species such as couch and kikuyu.

Until flame weeding is fully evaluated, trial work completed, and suitable equipment developed, this control method is generally not a viable option. However, within the next few years flame weeding may become a viable weed control option, particularly for organic farming and other environmentally sensitive areas.

Hot water application

Hot water application or steaming is a relatively new weed control method. Applying hot water to a weed results in the loss of the plant's waxy coating, a reduction in moisture, and dehydration.

The system operates by plumbing water under pressure through a heated chamber onto the weeds. The combination of heat and water pressure breaks down the cellular structure, causing discolouration and death within hours or over a few days. One treatment can kill most annuals and some young perennials. The top growth of older perennials is scorched off, but the impact on the roots is minimal unless treatment is repeated frequently.

This form of weed control is still in the developmental stage. A number of large city councils have trialled the equipment, reporting mixed results on its effectiveness. Trial work and assessments in various situations are still being conducted.

Field trials carried out in New Zealand have shown that hot water application has similar results to glyphosate, except in controlling perennial weeds. Preliminary observations indicate that hot water treatment kills annual weeds in 24 hours. The foliage from some perennials also dies within 24 hours, but regrowth recurs from the roots within a week or two.

Goats

The ability of goats to control weeds in Australia has been well documented. Goats have been used for sustainable pasture management and weed control in a range of weed situations. They can be integrated with sheep, cattle and cropping enterprises to provide weed control and pasture improvement. In most situations, goats should be seen as only one aspect of an integrated weed control program, which can also include burning, mechanical removal, spraying and pasture improvement.

Goats control weeds by preferentially grazing them, thereby placing the weeds at a disadvantage by preventing them from flowering and by ring-barking and structurally-weakening some shrub species. Goats eat a variety of undesirable plants and shrubs that sheep and cattle avoid, and often the nutritional value of these species is quite high. They are efficient browsers and grazers of weeds in steep, rocky areas, around trees, and in other inaccessible areas where conventional control methods are not applicable.

The use of goats for weed control is a medium-to-long-term proposition and, therefore, expectations should be realistic. In some situations, goats can give effective control of a weed. In other cases, they may only limit the spread or have very little effect on the weed at all.

For goats to be effective, stocking rates, timing, weed palatability and farm management strategies need to be considered. In most cases, it is also important to have a competitive pasture to overcome the weed and colonise bare areas.

There are many weed species that are eaten by goats; the degree of control depends on the palatability of the weed.

Highly palatable weeds include: blackberry, sweet briar and scotch broom.

Palatable weeds include: scotch thistles, variegated and nodding thistles, Paterson's curse and horehound.

Other species that are moderately palatable and eaten occasionally include fireweed, groundsel bush, St John's wort, serrated tussock and spear grass.

Herbicide control

Herbicides are widely used for control of weeds in both agricultural and non-agricultural situations. The early herbicides such as arsenic trioxide and iron sulfate were mostly by-products of the chemical industry. Specifically manufactured materials are now used.

These newer materials generally act on specific enzyme systems in plants. In comparison to past use patterns, herbicides are now generally used at significantly lower rates and concentrations of active ingredients.

With the increasing array of products and the continuing refinement of application equipment, herbicides are effective and practical in a wide variety of weed control situations. In many situations, herbicides used alone or integrated with other control methods can prove to be the most economical means of control, requiring less labour, fuel and equipment than other methods.

Herbicides kill weeds by interfering with the growth processes of the plant, replacing hormones in the plant, or blocking chemical reactions in other ways. Some herbicides do this where they

make contact with the plant; others need to be translocated by the plant to the site of action. Herbicides are therefore grouped as either translocated or contact.

Contact herbicides

Contact herbicides kill the parts of the plants they touch, which is usually limited to leaves and stems of the plant. They work more effectively on annual weeds or on seedlings of perennial weeds and kill relatively quickly. Contact herbicides can be either selective or non-selective, depending on weed types and the crops involved. Plants need to be actively growing and stress-free when contact herbicides are applied. Good coverage is required to achieve effective results. Contact herbicides include paraquat and diquat.

Translocated herbicides

Translocated herbicides move within the plant to a site of action. They disrupt growth processes and interfere with biochemical reactions. This usually occurs where cells are actively dividing in growth tissue, such as at the bases of stems in grasses, and in growing tips or buds in broadleaf weeds. Translocated herbicides include glyphosate and metsulfuron-methyl.

Herbicides are also available in a range of forms, including selective, non-selective, residual and pre-emergent products.

Regulation of herbicides

The *Pesticides Act 1999* provides for registration of herbicides, labels and containers. Only a registered herbicide should be used for the control of weeds. Herbicides are to be used only according to the directions on the label, which give an outline of the product's use, mixing, application, restraints and directions. Labels are designed to prevent misuse of a product. Users have a legal obligation to read and follow the instructions on the label.

Handling and applying pesticides

Pesticides, including herbicides, should be handled and applied with consideration of their toxic nature and potentially harmful effects on human health, livestock, and the environment. Trained users can avoid off-target damage and adverse effects by following label instructions and applying herbicides correctly.

There are numerous forms of application techniques and equipment available to apply herbicides. Equipment includes boom sprayers, hand guns, knapsacks, wick-wipers, granular applicators, aerial sprayers and gas guns. Application methods include foliar spraying, basal bark and cut stump applications, stem injection, and wick-wiping.

The type of equipment and application method chosen for weed control depends on the size of the infestation, type of weed, topography, access, potential environmental and health hazards, and susceptibility or suitability of a certain weed to a particular application method.

For application equipment to operate effectively, the weather, soil conditions and time available for spraying must be considered. Suitable weather conditions are essential if herbicides are to be applied safely and effectively. Weather conditions should be assessed and monitored throughout the application period to reduce the risk of drift and subsequent off-target damage.

Heavy rains following herbicide application can reduce the effectiveness of a treatment and may cause contamination through run-off.

Cultivation

Cultivation is a proven way of controlling weeds. Implements range from large tractors and ploughs to hand tools such as chipping hoes. This method results in direct control of weeds.

Cultivation is an option that must be used wisely. Smaller weeds can be rapidly, efficiently and cheaply destroyed by cultivation. Shoots can be buried deeply to prevent regrowth, roots can be exposed to dry out, shoots can be separated from the roots, or a combination of all three.

Cultivation aims to prevent seeding and destroy the existing plants. Cultivation can be used to halt weed problems before they get out of control. However, eradication of perennial weeds by cultivation can be difficult and depends on the root system. Some types of weeds can be controlled by repeated passes, where the roots are dragged to the surface to dry out and die. However this is seldom entirely effective.

Cultivation should be used strategically, choosing the most appropriate equipment for the varying stages of crop and pasture production. For effective control by cultivation, weeds should be attacked before flowering and under reasonably dry conditions.

Manual cultivation using chipping hoes, mattocks and other suitable hand tools is another viable means of weed control in small-scale situations or for follow-up control.

Slashing

Slashing can be used to prevent tall growing weeds from flowering and setting seed. This method can be undertaken with a tractor and slashing implement or by using a hand-held brush-cutting machine.

Slashing can also be used to remove unpalatable or inedible weeds left after stock have selectively grazed a paddock and to prevent these weeds taking over, however slashing may also encourage the growth of less desirable prostrate species.

Slashing is not effective for eradicating a weed, but is useful for temporarily controlling weeds until they re-shoot. Continual slashing may provide control if a desirable prostrate-growing species is present and is encouraged to replace the weed. Slashing can be used for the control of vegetation and weeds along roadsides, but is not suitable for the control of weeds in crops.

Slashing is cheaper than cultivation and preserves the ground cover, thus reducing soil erosion and improving access in wet weather.

Mulching

Mulching involves the use of physical barriers such as black plastic sheeting, woven paper products or woven cloth to exclude sunlight and prevent weed establishment. Mulching has been used in various situations, particularly in row crop production where machinery is available to lay black plastic. Woven black plastic is also useful along roadsides, steep banks and cuttings where areas need to be revegetated. This option is viable for small areas and can assist in weed control, bank stabilisation and erosion.

Natural mulches include sawdust, timber chips, straw, manures and grass clippings. Natural mulches have other beneficial effects by adding organic matter and nutrients to the soil. However, they can be awkward and time-consuming to apply and there can be a risk of introducing weed seeds in the mulch material. Most perennial weeds can penetrate mulches such as sawdust and wood chips.

Mulching for weed control can be effective and is particularly suitable for row-cropping production such as strawberries, isolated areas along roadsides, organic farming and general backyard garden usage.

Fire

Fire has been used for many years as a form of vegetation and weed control. Its success depends on the amount of fuel, the speed and intensity of the fire, and the time of year that burning takes place. Fire can play a major role in the management of woody weeds in western regions of NSW and can also be a useful option for the control of lantana and blackberry in certain situations.

The best fire strategy for woody weeds is a controlled managed burn. The aim is to burn only the desired area, using firebreaks and back-burning techniques. Unlike a wildfire, a managed burn is controlled and minimises damage to the environment without damage occurring to property and livestock.

Controlled burning for managing woody weeds can help restore land to an open condition more suitable for pasture growth or providing access for further weed control. The direct costs of managed burning are far lower than those of alternative techniques such as chemical treatment and mechanical clearing.

An integrated management program may be required when using fire for weed control. For example, lantana can be controlled with a combination of fire, improved pastures, and follow-up spot spraying. Large, dense woody weed infestations are most suitable for fire control, as larger areas burn more effectively.

Reafforestation

Reafforestation is a long-term method of weed control. The aim of reafforestation is to form a dense tree canopy that restricts sunlight penetration to weeds on the forest floor. Reafforestation can be in the form of revegetation with mixed native vegetation species or through establishment of a single species in a plantation.

Mature trees compete for moisture, nutrients and sunlight and restrict potential weed establishment and growth. It can take 5 to 10 years before trees form a dense canopy and, during this establishment phase, weed control can be critical to the success of the plantation. It may therefore be necessary to use other forms of weed control, such as herbicides and mechanical means, to assist in this establishment phase. A competitive, desirable, shade-tolerant grass or legume can also assist with forest management and weed control.

Large areas of land are more suitable for reafforestation, as other forms of weed control can become uneconomic or impractical.

NSW DPI can help with tree selection, site preparation, planting and general forest management. A weed control program can also involve agro-forestry principles, which include tree growing in conjunction with other agricultural enterprises such as cropping or domestic animals.

The effectiveness of reafforestation for weed control depends on the tolerance of various weeds to shading, the added competition, and forest management.

Reafforestation to control groundsel bush has been tried in a number of situations but is not satisfactory unless good forest management methods are adopted. Trials are also being carried out to assess the effectiveness of reafforestation to control serrated tussock and giant Parramatta grass.

Land management

Good land management can play a major role in reducing the incidence and impact of weeds on a property. The initial increase in cost of better management will be compensated for by the reduced amount of weed control

required. Management strategies such as maintenance of pastures or desirable ground covers, reduced disturbances and tillage, management of nutrient run-offs, grazing management, early weed identification and good weed hygiene can all reduce weed problems.

Grazing management

Competitive, desirable pasture species can be an effective weed control method. Stocking rates should be set at appropriate levels so as not to cause overgrazing which will allow weeds to establish.

Pasture management

A vigorous pasture competes more effectively with weeds and has the added benefits of increased production. Weeds can be controlled in a pasture situation by either improving the existing pasture or removing it and replacing it with a more suitable or competitive species. Pastures can be improved by adding fertilisers and lime according to soil test results, and the use of a selective herbicide may be required to further suppress weed competition.

Crop management

Sound crop rotations can also minimise weed problems. Crop rotations help control diseases and insects and help build up soil fertility and structure to produce increasing yields. Increased fertility reduces the impact of weeds, and rotating crops can break the seeding and germinating cycle of the weeds.

Weed hygiene

All weed control methods are of little use if good weed hygiene is not practised. This includes sowing only weed-free seed, cleaning machinery, and removing sources of reinfestation around a control site.

New livestock being introduced to a property should be quarantined for several days so any potential weed seeds can pass through their systems in a known area and be treated later.

Weed identification

Early identification and awareness of potential new weed problems will reduce the impact of weeds and save the property manager time and money. If a potential weed is identified in the early stages of infestation, it will be a lot easier and more economical to eradicate.

Managing your legal responsibilities when applying pesticides

by Mark Scott

The *Pesticides Act 1999* is the primary legislative instrument controlling the use of pesticides in NSW and is administered by the Office of Environment and Heritage (OEH). The underlying principle of the *Pesticides Act* is that pesticides must be used only for the purpose described on the product label and all the instructions on the label must be followed. Consequently, all label directions must be read by, or explained to, the user before each use of the pesticide.

All pesticide users should take reasonable care to protect their own health and the health of others when using a pesticide. They should also make every reasonable attempt to prevent damage occurring from the use of a pesticide, such as off-target drift on to sensitive areas or harm to endangered and protected species.

Record keeping

The Pesticides Regulation 2009 requires all commercial pesticide users (that is, all farmers and spray contractors) to keep records of their pesticide application.

While no set form has to be used, records must include the following:

- full product name
- description of the crop or situation
- rate of application and quantity applied
- description of the equipment used
- address of the property, identification of the area treated and order of paddocks treated
- date and time of the application (including start and finish)
- name, address, and contact details of the applicator and of the employer or owner if an employee or contractor is the applicator
- estimated wind speed and direction (including any significant changes during application)
- other weather conditions specified on the label as being relevant (temperature, rainfall, relative humidity).

A form that captures all the information required by the Pesticides Regulation, together with notes on how to fill it in, is included on the next page. The form and notes can also be downloaded from the NSW DPI website www.dpi.nsw.gov.au/agriculture/farm/chemicals/general/records

A self-carboning record book is available from the SMARTtrain National Support Centre, Yanco. Phone 1800 138 351.

Records must be made within 24 hours of application in legible English, and kept for 3 years.

How to fill out your pesticide application record

Property/holding:

Attach a detailed property map (for instance, line drawing), showing adjoining sensitive areas, with paddocks and other features clearly identified.

Fill in the residential address.

Applicator details:

The applicator, or person applying the pesticide, must fill in their contact details. If the applicator is not the owner (for instance, a contractor or employee), then the landowner's details also have to be filled in. In the case of a contractor, one copy of the record should be kept by the applicator and another given to the owner.

Sensitive area identification:

If there are sensitive areas, either on the property or on land adjoining, these should be identified in advance and marked on the sensitive areas diagram, together with any precautions or special instructions. When using a contractor or giving the job to an employee, this section should be filled in and given to the person doing the application **before** the job starts. The property map with sensitive areas marked should be shown to them, and the job fully discussed.

Paddock identification:

Identify the paddocks/blocks and order of treatments (if there is more than one) in the 'paddock' row of the form. This should be filled in before the start of application, along with the residential address. If using a contractor or employee, this information should also be given to them **before** they start the job. Applicators using global positioning systems (GPS) could include a GPS reading in addition to the paddock number/name.

Crop/animal identification:

The left-hand side of the table is for crops, pastures and plants (non-crop, bushland and fallow); the right-hand side for animals. As a minimum, identify the host (crop/situation) and the weed. It would be helpful to provide as much detail about the weed as possible, for instance, '4-leaf'. Addition of details such as crop variety and growth stage are often important for quality assurance schemes, but may also be necessary to positively identify the area treated, as required by the regulation.

Product details:

The product name and rate/dose should be transcribed from the label. For tank mixes, include all products in the mixture.

If the use pattern is on-permit, include the permit number and expiry date as well as the label details. The permit rate may vary from that on the label. Don't forget to include the label product name.

The water rate may come from the label or from your standard practice or as a result of your calibration. If additives or wetters are included in the mixture, it is helpful to note these.

The total L/kg can be calculated when the application is finished.

If the label has a withholding period (WHP), for example 7 days, note this down.

Example record keeping sheet

Property holding (residential address):					Date:	
Applicator's full name:				Owner (if not applicant):		
Address:				Address		
Phone: Mobile:	Fax:	Email:		Phone: Mobile:	Fax:	Email:
Sensitive areas (incl distances and buffers): N W E S				Comments (incl risk controls for sensitive areas):		
Paddock no/name:		Paddock area:		Order paddocks sprayed:		
Crop/situation:				Type of animals:		
Crop/pasture/variety:				Age/growth stage:		
Growth stage:				Mob/paddock/shed:		
Pest/weed/disease:				No animals treated:		
Pest density/incidence: Heavy <input type="checkbox"/> Medium <input type="checkbox"/> Light <input type="checkbox"/>						
Full product name:				Rate/dose:		Water rate (L/ha):
Permit no:		Expiry date:		Adjuvants:		Total ha:
Total L or kg:		WHP:		ESI:		Date suitable sale:
Equipment type:		Release height:		Speed:	Nozzle type*:	Pressure:
Date last calibrated:			Water quality (pH and/or description):			
Showers <input type="checkbox"/>		Overcast <input type="checkbox"/>		Light cloud <input type="checkbox"/>		Clear sky <input type="checkbox"/>
Rainfall (24 hours before and after)						
Before		mm		During		mm
Time		Temperature		RH %		Wind speed
Direction		Variability				
Start:						
Finish:						
Comments:						

* Include brand and capacity, e.g. TeeJet AI 11002.

Equipment details:

As a minimum record what equipment was used. Specify the settings used for the application: for instance, nozzle type and angle, and pressure. The nozzle type will usually include the angle. Pressure readings should be as close to the nozzle as possible. Other details are useful as a reminder for future use or for checking the set-up should there be a treatment failure: for instance, date of calibration and water quality.

Water quality is important for herbicide efficacy, and water quality can be described in terms of its source: for instance, rainwater, dam water, bore water.

Weather:

As a minimum, record wind speed and direction. This is better measured with instruments than estimated. Record any changes during application. Also record the time of day that chemical application started and finished. Weather records have to be made when using any equipment that distributes pesticide through the air. Rainfall should be recorded for the 24 hours before and the 24 hours after application, unless a different requirement is made in the restraints or critical comments sections of the label. Rainfall before or after application can affect efficacy.

Temperature and relative humidity should also be recorded, particularly if either or both are referred to in the restraints or critical comments sections of the label. Temperature and relative humidity can affect efficacy and increase the risk of off-target drift or may damage the host (phytotoxicity), or a combination of all three.

Pesticide User Training

The Pesticides Regulation 2009 requires all commercial pesticide users to be trained in pesticide application. The training of aerial applicators, pest control operators and fumigators is recognised as satisfying the requirements of the Regulation. Apart from these groups, all commercial users must have a prescribed qualification. Only domestic use, such as home gardens, is excluded, provided the pesticide is a specific domestic/home garden product. Covered by

the regulation and therefore requiring training is pest control by/on:

- public authorities, e.g. State Rail
- golf courses, sporting fields and bowling greens
- agricultural, horticultural, aquacultural and forestry operations
- businesses, educational institutions and hospitals.

The minimum prescribed training qualification is the AQF2 unit of competency, 'Apply chemicals under supervision'. Pesticide users are encouraged to train and be assessed in the two higher AQF3 competencies, 'Prepare and apply chemicals' and 'Transport, handle and store chemicals'. The SMARTtrain course Chemical Application and the standard ChemCert course both cover the AQF3 competencies. For pesticide users with literacy or numeracy problems the AQF2 competency provides the minimum qualification that satisfies the Regulation.

Notification plan

The Pesticides Regulation 2009 includes a requirement to notify the public about pesticide application. This requirement affects public authorities controlling weeds in public places.

The Regulation requires the development of a notification plan for public places where pesticides are applied and to which the public has access. Public places requiring a notification plan include aquatic areas, gardens, picnic areas, playgrounds, parks, sporting fields, road verges, electricity or rail easements legally accessible by the public, national parks, state forest, crown lands, public schools and TAFEs. Public authorities include government departments, statutory bodies and staff or persons who exercise functions on behalf of a public authority such as weed contractors for a local council.

The plan has to define the means by which the community will be notified of pesticide application to public places, such as on-site signs, letters to affected community members, and news items in the local paper or on the local radio.

The notification plan should set out what information about the proposed

pesticide application will be provided to the community. This should include (as a minimum) the product name of pesticide applied, the purpose for which the pesticide was applied (e.g. weed control), the place applied, the date applied, applicator contact details (phone number and/or internet address) and re-entry period (if relevant).

Once the plan is drafted, it is necessary to develop arrangements for public input. The finalised plan has to be accessible to the public and the OEHL has to be notified in writing that the plan has been prepared and finalised in compliance with the Regulation.

Occupational Health and Safety

Hazardous substances legislation

Many registered pesticides are classified as hazardous substances, and most of those that are not pose some risk to the health of those who use them or are exposed to them.

The *Occupational Health and Safety Act 2000* and the Hazardous Substances section of the Occupational Health and Safety Regulation 2001 give details of the legal requirements of suppliers, employers and employees in the workplace for hazardous substances management. The Act and accompanying Regulation are intended to protect workers from both the short- and long-term health effects of exposure to hazardous substances and to improve current health and safety practices by:

- provision of health and safety information to workers (including a list or register of all hazardous substances and an MSDS for each hazardous substance)
- consultation with workers
- training of workers
- assessment of the risks arising from hazardous substances exposure
- control of the risks
- recording of the risk assessment and control measures implemented, training of those applying and exposed to hazardous substances, and health surveillance (if warranted by the risk assessment in respect of organophosphates).

Both storage and use are covered by the *Occupational Health and Safety Act 2000*. Records of training and risk assessments have to be kept for 5 years.

Dangerous Goods Regulation

The Dangerous Goods legislation has been revised to align with hazardous substances legislation. The main requirements include:

- provision of MSDSs
- carrying out and documenting risk assessments
- keeping a register of Dangerous Goods.

All these requirements already apply to hazardous substances. In practice, they require the addition of any Dangerous Goods that are not also hazardous substances to existing management and record systems.

Premises storing large quantities are now required to placard both the storage shed and the entrances to the premises. If very large quantities are stored – which would be rare on-farm, a manifest, site plan and written emergency plan are required. Consult your local WorkCover office for advice.

WorkCover NSW's *Code of Practice for the Safe Use and Storage of Chemicals (Including Pesticides and Herbicides) in Agriculture* is an approved industry code of practice and provides practical guidance to help farm chemical users to comply with the legislation. This has been recently revised to reflect the new Dangerous Goods requirements.

Copies can be obtained from your local WorkCover office, by download from the WorkCover website – www.workcover.nsw.gov.au – or by ringing 1300 799 003.

Pesticides and worker safety

Pesticides can have both immediate (acute) effects and long-term (chronic) effects on the health of people who are exposed to them.

Acute toxicity

The acute or immediate toxicity of a farm chemical is reflected in the Poisons Schedule or poison warnings,

which appear on the label of a pesticide product. The acute toxicity is assessed in terms of the potential of the active ingredient of the chemical to poison an individual by the route of exposure that is most lethal, for example, by ingestion (swallowing).

Poison schedules

Pesticides are classified into four categories in the Poisons Schedule on the basis of their acute health hazard to the user of the pesticide. Each schedule has a corresponding signal heading, which appears in large contrasting lettering on the label of the pesticide product.

Signal heading	Toxicity	Label heading
Unscheduled	Very low toxicity	No heading required
Schedule 5	Slightly toxic	Caution
Schedule 6	Moderately toxic	Poison
Schedule 7	Highly toxic	Dangerous Poison

The Poison Schedule will largely determine the Safety Directions and First Aid Instructions that appear on the label. The Safety Directions specify what personal protective equipment (PPE) should be worn and what safety precautions should be taken, for example, 'Do not inhale spray mist'. The First Aid Instructions specify what action should be taken in the event of a poisoning. Safety Directions and First Aid Instructions may be different for different formulations of the same pesticides.

Note: Before opening and using any farm chemical, consult the label and Material Safety Data Sheet (MSDS) for specific Safety Directions. The *Hazardous Substances* section of the Occupational Health and Safety Regulation 2001 requires the reseller to provide the end-user with an MSDS.

If you suspect a poisoning, contact the Poisons Information Centre, emergency phone (24-hour) **131 126**.

Solvents and distillates

In addition to the active ingredient, pesticide formulations contain surfactants and carriers that may also be toxic. Many liquid pesticide formulations are based on petroleum distillates or organic solvents, which are corrosive to

the skin and eyes, and their vapours may affect the brain if inhaled. An example of such a distillate is xylene, which is highly toxic. As with the active ingredient, the exposure risk is highest when handling the concentrate. This is why pesticide labels often carry warnings to avoid inhaling the vapours, and to avoid splashes to the skin and eyes.

Routes of exposure

With **all** pesticides (except fumigants) the most hazardous route of exposure is dermal absorption (through the skin) and the most hazardous phase of application is mixing and loading the concentrated product.

With the exception of fumigants, the inhalation risk for most pesticides and application technology is low. Nevertheless, a respirator may be required when mixing/loading or applying pesticides:

- in an enclosed space (such as a shed)
- if the pesticide is highly volatile and liable to be breathed as a vapour (such as 2,4-D ester)
- if application carries the risk of inhaling the spray mist (such as having to turn back into the drift in crops with short rows).

Ingestion or swallowing is a risk to applicators who don't wash their hands before eating and drinking or who smoke during application. Unsecured storages represent a high risk to children, who could accidentally ingest a pesticide.

Many pesticide formulations can have direct or topical effects on the skin and eyes. These effects are often unrelated to whether or not the chemical is acutely toxic. Some pesticides may have low acute toxicity but severe topical effects. For example, glyphosate has very low acute toxicity but is irritating to the skin and eyes. Warnings regarding skin and eye irritation and other topical effects are usually found on the product label under 'Safety Directions'.

Re-entry intervals

The re-entry interval is the time that must elapse between applying the pesticide and re-entry of people into the sprayed crop, unless the PPE specified for re-entry on the label is worn. The reason for setting a re-entry interval is that

pesticides sometimes remain on crops in the form of foliar aerosol particles. These residues can be dislodged by contact with the crop and absorbed through the skin by those working in the crop.

Re-entry intervals appear on the labels of only a small number of pesticide products. These include newer products, or older products that have been subject to a technical review by the Australian Pesticides and Veterinary Medicines Authority. If a re-entry period is not specified on the label, the rule of thumb is to wait 24 hours after application or until the crop is dry, whichever is the longer. Crops should never be re-entered when wet from dew or light rain, irrespective of the time elapsed, unless appropriate PPE is worn.

Chronic toxicity

The effect of long-term exposure to small doses of chemical is referred to as chronic toxicity. Some of these chronic toxicity effects include:

- neurotoxic effects (toxic effects on the brain and central nervous system)
- reproductive system effects
- carcinogenicity (causing cancer)
- endocrine (hormone) disruption.

Neurotoxic effects

Organophosphate pesticides (insecticides) are suspected of having long-term, subtle effects on the central nervous system. The effects detected to date are slight and have been detected only in a tiny proportion of those exposed. What is clear is that all effects, both acute and chronic, are dose related. This means that adhering to the label directions to control acute exposure will similarly control chronic exposure.

Reproductive effects

Some pesticides are suspected of being fetotoxic (fatal to foetuses) and teratogenic (causing birth defects) on the basis of laboratory studies involving animals. However, there is little evidence that pesticides can affect human reproduction or the health of the unborn foetus at the levels of pesticide exposure that most of the population experiences through their food supply.

The Australian College of Occupational Medicine recommends that women who are pregnant or likely to become pregnant protect themselves against chemical exposures that may have adverse reproductive effects. Pregnant women should not be involved in spraying agricultural chemicals or working in recently sprayed crops. Advice on pregnancy and occupational exposure to pesticides can be obtained from a medical practitioner accredited by WorkCover NSW in occupational health.

Cancer and pesticides

Despite widespread public suspicion of pesticides as cancer-causing agents, evidence is lacking to implicate all but a few. As most cancers are caused by a multiplicity of factors, it is extremely difficult to determine whether or not a particular cancer was the result of pesticide exposure or other factors. Apart from the organochlorines and arsenic, which are now banned, only chlorothalonil, dichlorvos and amitrole have been classified as possible (less weight of evidence than probable) carcinogens by the WHO (World Health Organisation).

Endocrine disruption

The endocrine system is made up of many glands in the body and the hormones they secrete. These hormones guide the development, growth, reproduction and behaviour of all animals, including humans. The female ovaries and male testes are endocrine glands. Endocrine disruptors are chemicals that interfere with the normal functioning of the endocrine system. Large acute exposure to some chemicals such as the organochlorines has caused adverse effects to the endocrine systems of animals.

It is unclear whether long-term, low-level exposure to endocrine-disrupting chemicals will affect human reproduction. One reason why it is difficult to establish the specific effects caused by pesticides is that we are surrounded by naturally occurring sex hormones, particularly in plants. Our exposure to naturally occurring plant hormones is far greater than to synthetic ones such as pesticides – by a factor of

40 million. Nevertheless, the United States Environmental Protection Agency is developing a set of tests that will help screen pesticides for their endocrine-disrupting potential. These tests will also be adopted by other risk assessment agencies around the world, including in Australia.

The best way to manage any long-term risks of chronic pesticide effects is to reduce exposure by following all the directions on pesticide labels.

Disposal of farm chemicals and containers

After chemicals have been applied according to the label directions, empty chemical containers and any unused chemicals must be disposed of in an environmentally responsible manner.

drumMUSTER

To solve the problem of what to do with used non-returnable chemical containers, Croplife Australia, the NFF (National Farmers' Federation), the Veterinary Manufacturers and Distributors Association (VMDA) and local governments Australia-wide have developed drumMUSTER.

From 1 February 1999, farmers have paid a 4c per litre or kilogram levy on non-returnable chemical containers with capacities greater than 1 L or 1 kg. This levy funds the national collection and recycling scheme, drumMUSTER. The levy funds local government to pay staff to inspect returned containers; for processing the returned containers; and for publicising local collection sites and times.

Local councils, either individually or in groups, enter into an agreement with drumMUSTER. Farmers are then able to deliver cleaned (that is, triple or pressure-rinsed) containers to designated collection points run by participating councils. At these collection points, the delivered containers are inspected and either accepted or rejected.

To locate a drumMUSTER collection site near you, check the drumMUSTER website – www.drummuster.com.au – or ring the national office on (02) 6230 6712.

Cleaning containers for collection

When rinsing, the personal protective equipment (PPE) specified on the label for application and/or mixing and loading the pesticide should be worn. This is because the chemical remaining in a container is the concentrate – the most toxic form of the chemical – even though it is diluted during the rinsing process.

To triple-rinse a container with a capacity of up to 20 L to meet drumMUSTER standards:

- remove the cap, invert the container and allow it to drip drain into the mixing tank for 30 seconds
- add rinse water 20% (1 L/5 L of container volume)
- replace cap and shake vigorously for 1 minute
- remove cap, invert and drip drain into mixing tank for 30 seconds
- repeat twice
- wash cap separately and replace on container.

Triple-rinsing is only suitable for small containers up to 20 L.

Rinsing is most effective while the containers are still moist inside. The longer the residue has time to dry and cake on the inside of the container, the more difficult it is to remove. This is the reason for rinsing during mixing and loading. If rinsing is done during mixing and loading, the rinsate can be emptied into the spray or mixing tank of the application equipment, where it can be 'disposed of' on the crop. Using the rinsate in this way avoids the need to dispose of the container residues separately (see 'Disposal of rinsate or dilute chemicals' below).

An alternative to manually triple-rinsing small containers is a pressure rinsing nozzle. There are two main types. One has a rotating spray head that can be used to rinse an inverted container in the induction hopper or directly over the tank. The other has a hardened, pointed shaft to pierce drums, and the hollow shaft itself has four holes at 90° to spray the water around the container.

To pressure rinse a container up to 20 L:

- remove the cap, invert the container and allow it to drip drain into the mixing tank for 30 seconds
- ensure clean rinse water is between 35 and 60 psi
- insert pressure-rinsing probe either through the container opening or through the pierced base of the container (depending upon the type of nozzle)
- invert container over mixing tank and rinse for 30 seconds or longer if the water coming from the container neck is not clear, moving the probe about to ensure all inner surfaces are rinsed
- wash cap in clear rinse water from container
- turn off water, remove probe and drip drain container into mixing tank for 30 seconds
- replace lid on container.

Large containers (for instance, 200 L ones) are best rinsed with a chemical transfer probe that has a flushing cycle as well as the primary suction cycle. Such probes are standard on many boom sprays and optional on most others. The drums may have to be slightly inclined to ensure all rinsate is removed. Typical rinse time for a 200 L drum would be 3 to 5 minutes.

Non-rigid containers (that is, bags and cartons) have to be buried (see 'Disposal of rinsate' for conditions). Plastic bags should be rinsed first, and paper bags punctured or shredded. Cartons, too, must be punctured or shredded before burial. Burning is specifically prohibited.

Disposal of unwanted chemicals

In addition to unwanted chemical containers, many farms also have unwanted chemicals. To manage this problem there is an on-going collection scheme, ChemClear. This is an agreement between chemical manufacturers, NFF and local government. Currently registered chemicals in original containers with identifiable labels are collected free of charge. Unregistered, unknown and unlabelled chemicals incur a fee. Collections have to be booked through the website – www.chemclear.com.au – or by ringing 1800 008 182.

Occasionally, manufacturers run their own return/recall schemes. These are not covered by ChemClear, as the costs are borne by the manufacturers of the chemicals involved.

Disposal of rinsate or dilute chemicals

Labels contain a prohibition on disposing of concentrate on-site or on-farm, as does State environmental legislation. Unused chemical has first to be diluted and, if not applied in terms of the label use pattern, has to be disposed of in an environmentally responsible manner, such as in an evaporation pit.

The pit should be 1 metre deep and lined with plastic sheeting over which has been spread hydrated lime. Any wastes must be covered with at least 0.5 m of soil.

Disposal pits are suited only to small volumes and diluted chemicals. In the case of a concentrate spill, the chemical would have to be diluted to at least standard label rates before transfer to the disposal pit.

Reducing herbicide spray drift

by Tony Cook

When applying pesticides the aim is to maximise the amount reaching the target and to minimise the amount reaching off-target areas. This results in:

1. maximum pesticide effectiveness, and
2. reduced damage to and/or contamination of off-target crops, pastures, fallow and environmental areas.

In situations where a range of agricultural enterprises or environmentally sensitive areas co-exist conflicts can arise, particularly from the use of pesticides. All pesticides are capable of drift.

People have a moral and legal responsibility to prevent pesticides from drifting and contaminating or damaging neighbouring crops and sensitive areas.

Many labels have drift reduction recommendations that must be followed. These recommendations include wind speed, temperature, droplet size and buffer zones. Look for these recommendations in the Restraints and General Instructions sections of the label.

How to minimise spray drift problems

Before spraying

Always check for nearby sensitive areas such as houses, schools, and riparian areas. Check for susceptible crops in the area, e.g. if using a broadleaf herbicide check for broadleaf crops such as grape vines, cotton, pulse or vegetable crops. Notify neighbours of planned herbicide treatments. Under the *Pesticides Regulation 2009* of the *Pesticides Act 1999* it is essential that weather and relevant spray details are recorded (see pages 8–9).

During spraying

- Continuously monitor meteorological conditions carefully and understand their effect on 'drift hazard'.
- Don't spray if conditions are not suitable, and stop spraying if conditions change and become unsuitable.

- Record weather conditions (especially temperature and relative humidity), wind speed and direction, herbicide and water rates, and operating details for each paddock.
- Supervise all spraying, even when a contractor is employed. Provide a map marking the areas to be sprayed, buffers to be observed, sensitive crops and areas.
- Spray when temperatures are less than 28°C.
- Minimise spray release height (lowest possible boom height).
- Use the largest droplets which will give adequate spray coverage.
- Always use the least-volatile formulation of herbicide available.
- Maintain a down-wind buffer which may be in-crop e.g. keep a boom width from the downwind edge of the field.
- If sensitive crops, pastures or environmental situations are in the area, use a herbicide which is the least damaging.

Different types of drift

Sprayed herbicides can drift as *droplets*, as *vapours* or as *particles*.

Droplet drift is the easiest to control because under good spraying conditions, droplets are carried down by air turbulence and gravity, to collect on plant surfaces. Droplet drift is the most common cause of off-target damage caused by herbicide application. For example, spraying fallows with glyphosate under the wrong conditions often leads to severe damage to near-by establishing crops.

Particle drift occurs when water and other herbicide carriers evaporate quickly from the droplet leaving tiny *particles* of concentrated herbicide. This can occur with herbicide formulations other than esters. Instances of this form of drift have damaged susceptible crops up to 30 km from the source.

Vapour drift is confined to volatile herbicides such as 2,4-D ester. Vapours may arise directly from the spray or evaporation of herbicide from sprayed

surfaces. Use of 2,4-D ester in summer can lead to vapour drift damage of highly susceptible crops such as tomatoes, sunflowers, soybeans, cotton and grapes. This may occur hours after the herbicide has been applied.

Vapours and minute particles float in the airstream and are poorly collected on catching surfaces. They may be carried for many kilometres in thermal updraughts before being deposited.

Sensitive crops may be up to 10 000 times more sensitive than the crop being sprayed. Even small quantities of drifting herbicide can cause severe damage to highly sensitive plants.

What factors affect the risk of herbicide spray drift?

Any herbicide can drift. The drift hazard, or off-target potential, of a herbicide in a particular situation depends on the following factors:

Volatility of the formulation applied

Volatility refers to the likelihood that the herbicide will evaporate and become a gas. Esters volatilise (evaporate) more readily than amine formulations.

Formulation of the product

Formulations such as emulsifiable concentrates have a tendency to produce more small droplets than dry flowable products.

Type of adjuvant

Non-ionic surfactants and penetrants added to the spray solution will produce more small droplets than oils.

Susceptible crops

Closeness of crops susceptible to the particular herbicide being applied, and their growth stage affect susceptibility. For example cotton is most sensitive to Group I herbicides in the seedling stage.

Size of the area treated

The greater the area treated the longer it takes to apply the herbicide. If local meteorological conditions change, particularly in the case of 2,4-D ester, then more herbicide is able to volatilise.

Amount of active ingredient (herbicide) applied

The more herbicide applied/ha the greater amount available to drift or volatilise.

Efficiency of droplet capture

Bare soil does not have anything to catch drifting droplets as do crops, erect pasture species and standing stubbles.

Weather conditions

Weather conditions during and shortly after application both affect drift. Three influential factors include wind speed, inversion conditions and relative humidity.

Release height of droplets

As release height of droplets is increased, so is the time weather conditions can have an influence on the distribution of the droplets, hence increasing the potential to drift.

Restrictions on use of 2, 4-D

The APVMA has not finalised its review of 2, 4-D ester and HVE (High Volatile Ester) products remain under suspension with the following restricted conditions of use:

- 2,4-D HVE formulations are restricted, including the ethyl, butyl and isobutyl forms or 2,4-D and all ester 800 formulations
- LVEs (Low Volatile Esters) and amine formulations are not restricted
- Use nozzles that produce coarse-very coarse spray
- Wind speed must be 3–15 km/hr
- A 100 m downwind buffer must be maintained
- Application is prohibited except during May 1 to July 31
- Application records are mandatory

Minimising drift and maximising coverage

A significant part of minimising spray drift is the selection of equipment to reduce the number of small droplets

produced. However, this in-turn may affect coverage of the target, and therefore the possible effectiveness of the pesticide application. This aspect of spraying needs to be carefully considered when planning to spray. As the number of smaller droplets decreases, so does the coverage of the spray.

A good example of this is the use of air-induction nozzles that produce large droplets that splatter. These nozzles may produce a droplet pattern and number unsuitable for small targets such as seedling grasses. As the volume median diameter (see Table 2) of the spray becomes coarser, spray application volumes need to be increased to compensate for the fewer droplets being produced.

Use a low volatile formulation

Many ester formulations are highly volatile when compared with the non-volatile amine, sodium salt and acid formulations. Some low volatile ester formulations may have a proportion of high volatile esters present, so caution should be exercised when using these products.

Table 2. Nozzle selection guide for ground application.

Risk	High	Medium	Low
Distance downwind to susceptible crop	< 1 km	1–30 km	> 30 km
Preferrred droplet size (ASAE) (to minimise risk)	Coarse	Medium	Fine
Volume median diameter (microns)	310	210	135
Pressure (bars) Δ Note: 1 bar = 100 kPa = 14.5 p.s.i.	5.0–6.5	2.0–3.5	3.5
Flat fan nozzle size (equivalent)	11008	11004	11002
Recommended nozzles (Examples only)	Raindrop Whirljet® Air induction Yamaha® Turbodrop® Hardi Injet® Al Teejet® Lurmark Drift-beta®	Drift reduction DG TeeJet® Turbo TeeJet® Hardi® ISO LD 110 Lurmark® Lo-Drift	Conventional XR TeeJet® Hardi® S3110 Hardi® S4110 Hardi® ISO F series Lurmark® Fan Tip
CAUTION	Can lead to poor coverage and control of grass weeds. Requires higher spray volumes.	Suitable for grass control at recommended pressures. Some fine droplets.	High proportion of 'driftable' droplets. Temperature and humidity critical.

Volume Median Diameter (VMD): 50% of the droplets are less than the stated size and 50% greater.

Δ – NOTE – Refer to manufacturers' selection charts as droplet size will vary with recommended pressure. Always use the lowest pressure stated to minimise the number of fine droplets.

Adapted from P. Hughes, DEEDI, Queensland.

Reduce spray release height

- Operate the boom at the minimum practical height. Drift hazard doubles as nozzle height doubles. If possible, angle nozzles forward or back 30° to allow lower boom height with double overlap. Lower heights however can lead to striping as the boom sways and dips below the optimum height.
- 110° nozzles produce a higher percentage of fine droplets than 80° nozzles. However they allow a lower boom height while maintaining the required double overlap.
- Operate within the pressure range recommended by the nozzle manufacturer. Production of driftable fine droplets increases as the operating pressure is increased. Lower volumes such as 30–40 L/ha produce a higher percentage of fine droplets than higher spray volumes at the same pressure and nozzle design.

Control drift when spot spraying

Powered hand guns and knapsack sprayers generally have the ability to apply variable spray patterns, ranging from wide, fine spray cone patterns to coarse, thin jet streams. For most situations it is recommended to apply a moderate width cone spray pattern, in order to reduce the quantity of fine droplets produced, reducing spray drift. It is however essential to use a jet stream spray to penetrate into thick canopies of vegetation when underlying foliage requires treatment.

Size of the area treated

When large areas are treated relatively large amounts of active herbicide are applied and the risk of off-target effects increases due to the length of time taken to apply the herbicide. Conditions such as temperature, humidity and wind direction may change during spraying.

Applying volatile formulations to large areas increases the chances of vapour drift damage to susceptible crops and pastures.

The capture surface

Targets vary in their ability to collect or capture spray droplets. Well grown, leafy crops are efficient collectors of droplets. Fallow paddocks or seedling crops are poor catching surfaces. Drift hazard is far greater when applying herbicide in

these situations or adjacent to these poor capture surfaces.

The type of catching surface between the sprayed area and susceptible crops should always be considered in conjunction with the characteristics of the target area when assessing drift hazard.

Weather conditions to watch out for

Midday turbulence

Up-drafts during the heat of the day cause rapidly shifting wind directions. Spraying should stop by 11 am during summer.

High temperatures

Avoid spraying when temperatures exceed 28°C.

Humidity

Avoid spraying under low relative humidity conditions i.e. when Delta T (the difference between wet and dry thermometers) exceeds 10°C. Spraying when Delta T is between 8–10° is considered moderate risk. Evaporation rates under such low relative humidity conditions are high and will consequently reduce the size of smaller droplets, making them more prone to drift. Always measure temperatures and relative humidity before and during spraying and consult a Delta T chart (see next page) to establish whether conditions are favourable. (Delta T chart stickers can be obtained from Nufarm and placed in tractors etc.)

Wind

Avoid spraying under still (stable) conditions.

Suitable wind speeds are 7–10 km/h. This is when leaves and twigs are in constant motion – a light breeze. Turbulent airflows normally carry spray droplets down into an infestation within a very short distance from the point of release.

If using low drift nozzles or higher volume applications (80–120 L/ha) wind speeds of 11–14 km/h are also suitable for spraying. In these conditions small branches move, dust is raised and loose paper is moving – a moderate breeze.

Inversions

The most hazardous condition for herbicide spray drift is an atmospheric inversion, especially when combined with high humidity, and spraying should not be done while an inversion exists.

Inversions exist when temperatures increase with altitude instead of decreasing. An inversion is like a cold blanket of air above the ground, usually less than 50 m thick. Air will not rise above this blanket; and smoke, dust or fine spray droplets and particles of spray deposited within an inversion will float until the inversion breaks down.

Inversions usually occur on clear, calm mornings and nights. Windy or turbulent conditions prevent inversion formation. Blankets of fog, dust or smoke and the tendency for sounds and smells to carry long distances indicate inversion conditions.

Smoke generators or smoky fires can be used to detect inversion conditions. Smoke will not continue to rise but will drift along at a constant height under the inversion 'blanket'.

Night spraying

Night spraying is often undertaken because there is little wind to move pesticides off-target, and because Delta T conditions can be favourable. While the risk of spray drift is reduced at night, inversion conditions are common and have resulted in massive off-target damage in recent seasons, particularly to cotton and grapes. Night spraying is inherently high risk and should be avoided.

Helpful meteorological information

Real time data needs to be collected in the paddock at the time of spraying. This can be done with:

- handheld units which measure temperature, Delta T and wind speed
- on-farm weather stations. Some can now be accessed by mobile phone.

Hourly data

Hourly data from the Bureau of Meteorology (BOM) weather stations including temperature, Delta T, wind speed and direction is available for the

previous 72 hours from:
www.bom.gov.au/weather/nsw/nsw-observations-map.shtml – click on the relevant town.

This data can help when planning spray activities and is useful for developing an understanding of the current daily patterns of meteorological conditions.

Meteograms™ from the BOM

Meteograms™ provide 7 day forecasts of temperature, relative humidity, rainfall wind speed and wind direction.

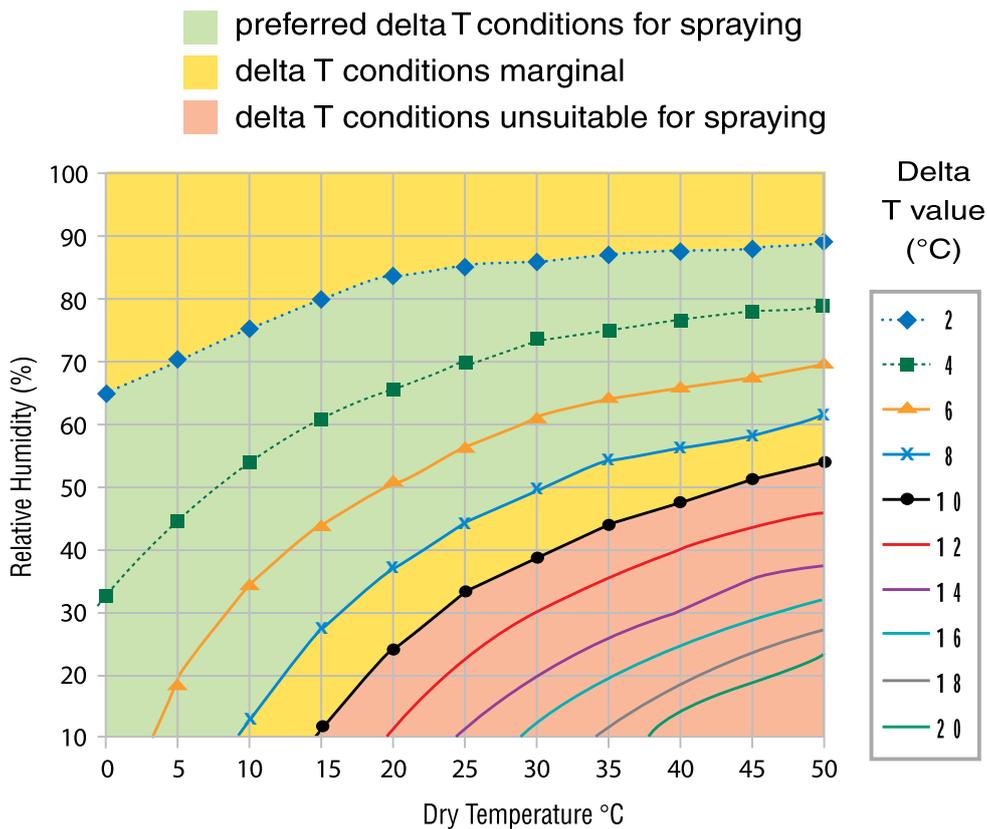
Meteograms™ are very helpful in planning spray programs for periods of lowest drift risk and highest pesticide efficacy. They are available via subscription at the cost of \$117 per 12 months.

APVMA spray drift initiative

To control spray drift, the APVMA is revising labels for boom and aerially applied pesticides to include:

- mandatory downwind buffer or no spray zones,
- specific droplet spectrum, e.g. not less than coarse droplets according to the ASAE S572 standard,
- wind speed, e.g. between 3 and 20 km/hr, and
- a prohibition on spraying if inversion conditions are present.

SELECTING THE RIGHT DELTA T CONDITIONS FOR SPRAYING.



Delta T diagram supplied by Nufarm Ltd

Using adjuvants with herbicides

by Tony Cook and Mark Scott

An **adjuvant** is any additive to a herbicide that is intended to improve the effectiveness of the herbicide. Some herbicides have sufficient adjuvant and require no additional adjuvant to perform well. However, some herbicides need help to spread across the leaf and penetrate the leaf surface of the target weed. The requirement of an adjuvant is usually detailed on the product label. **Always read the product label before opening the container.**

There are many adjuvants that have been developed to help herbicides to contact, remain on and penetrate the weed leaf.

The APVMA classes adjuvants into two categories;

- Adjuvants which enhance product efficacy
- Adjuvants which improve the ease of application

Adjuvants which enhance product efficacy

Wetters / spreaders

Wetters/spreaders enhance adhesion to and spreading of spray droplets on target surfaces by reducing the surface tension of the pesticide formulation and improving coverage, such as;

- Non-ionic surfactants – non-reactive, i.e. they do not have a negative charge or a positive charge; they remain on the leaf once dry and allow rewetting after rain, permitting additional pesticide uptake
- Anionic surfactants – negative charge
- Cationic surfactants – positive charge
- Amphoteric surfactants
- Organo-silicate surfactants
- Acidified surfactants

Stickers

Stickers increase adhesion of pesticides to target surfaces, such as;

- Latex-based
- Terpene / pinolene
- Pyrrolidone-based

Penetrants

Penetrants improve the transfer of active ingredients from the target surface to interior tissues and may include;

- Mineral oil
- Vegetable oil
- Esterified vegetable oil
- Organo-silicate surfactants
- Acidified surfactants

Extenders

Extenders enhance the amount of time the active ingredient remains toxic by increasing resistance to environmental degradation, and may include;

- Ammonium sulphate
- Menthene-based

Humectants

Humectants increase the density/drying time of an aqueous spray deposit, including;

- Glycerol
- Propylene glycol
- Diethyl glycol

Adjuvants which improve ease of application

Acidifying/buffering agents

Acidifying/buffering agents adjust the pH of alkaline or acidic water and minimise decomposition of the pesticide through alkaline hydrolysis.

Anti-foaming/de-foaming agents

Anti-foaming/de-foaming agents reduce or suppress the formation of foam in the spray tank preventing foam overflow;

- Dimethopolysiloxane

Compatibility agents

Compatibility agents permit the mixing of different agrochemicals by preventing antagonism between different ingredients in the spray solution such as;

- Ammonium sulphate

Drift control agents

Drift control agents alter the viscoelastic properties of the spray solution yielding a coarser spray with greater mean droplet sizes;

- Polyacrylamides
- Polysaccharides

Dyes

Dyes are commonly used for spot or boom spraying herbicides to detect missed spots or avoid spraying a plant or area twice.

Water conditioners

Water conditioners prevent reaction between hard water ions in spray solutions and suppress formation of precipitates or salts;

- Ammonium sulphate

Factors affecting adjuvant use

Crop safety

Addition of an adjuvant can reduce herbicide selectivity and thereby increase crop damage. This is not an issue for fallow and pre-emergent herbicides.

Effectiveness or activity

Adjuvants are usually added to increase the effectiveness of herbicides. However, using the wrong type or rate can reduce effectiveness, such as decreasing herbicide retention on leaves.

Water hardness

Hard water can lead to poor mixing of the chemical with water. This particularly occurs with emulsifiable concentrates. High levels of calcium and magnesium ions bind with amine formulations, causing them to be less soluble and therefore less effective.

Water temperature

Low water temperature can lead to jelling in the tank. High-concentration herbicides may not mix and surfactants may perform poorly.

Cleaning and decontaminating boom sprays and spot sprayers

by Tony Cook

The importance of cleaning and decontaminating spray equipment used for applying herbicides cannot be overstated. Crops and pastures have been severely damaged or destroyed by spray equipment that was not thoroughly cleaned before use.

Decontamination of spray units must be carried out to ensure that there is no possibility of crop or pasture damage, particularly to canola, sunflowers, cotton, pulses or legume-based pastures.

For example, if broadleaf herbicides, particularly sulfonylureas (such as Glean[®], Logran[®]), have been used in the spray equipment at any time prior to grass herbicides such as Verdict[®], particular care should be taken to follow the directions for cleaning and decontamination on the label of the relevant broadleaf herbicide. These grass herbicides have an ability to strip any remaining residues of sulfonylurea herbicides from spray tanks and lines, and these very small concentrations can be extremely damaging to crops

like canola, pulses and legumes or other desirable broadleaf vegetation.

WARNING: Grass control herbicides such as Verdict[®], Fusilade[®], Correct[®], Select[®], Targa[®] and Sertin[®] can be extremely damaging to winter cereal and summer crops.

*Nufarm Spraymate[®] Tank and Equipment Cleaner can also be used to decontaminate spraying equipment.

Note: Rinse water should be discharged into a designated disposal area.

Cleaning and decontaminating boom sprays and spot sprayers

Herbicide	Rate of agent/100 L water	Instructions for cleaning and decontamination
Glyphosate (Roundup [®]), Raptor [®] , Flame [®] , Spinnaker [®]	Clean water (*Spraymate [®])	Rinse thoroughly several times with clean water before use.
Hormone-type, salt or amine formulations (2,4-D amine, MCPA amine, 2,4-DB, dicamba)	2 L household ammonia (*Spraymate [®])	Thoroughly agitate and flush a small amount of solution through the system and let stand in sprayer overnight. Flush and rinse with clean water several times before use.
Hormone-type, ester formulations (2,4-D ester, MCPA ester)	500 g washing soda (crystalline sodium carbonate) + 4 L kerosene + 125 g powdered detergent (*Spraymate [®])	Rinse the inside and outside of the tank and flush a small amount through the system for 15–20 minutes. Let stand for at least 2 hours or preferably overnight. Flush and rinse before use.
Atrazine, simazine	125 g powdered detergent (*Spraymate [®])	Rinse with clean water before and after using the solution.
Sulfonyl urea herbicides (Glean [®] , Logran [®] , Ally [®])	300 mL fresh household chlorine bleach containing 4% chlorine or 300 mL BC-45 Spray Equipment Cleaning Agent (*Spraymate [®])	1. Drain and flush the tank, hoses, and boom with clean water for 10 minutes. 2. Fill the tank with clean water and add the chlorine bleach. Flush the boom and allow to stand for 15 minutes, then drain. 3. Repeat Step 2. 4. Nozzles, screens and filters should be removed and cleaned separately.
Broadstrike [®] , Eclipse [®] , Lontrel [®]	500 mL liquid detergent such as Surf [®] , Omo [®] , Dynamo Matic [®] , or 500 g of the powder equivalent	Flush the system, then quarter-fill the tank with water and add the detergent. Start the pump and circulate for at least 15 minutes. Drain the whole system. Remove and clean the filters, screens and nozzles with clean water and allow to drain.
Herbicides for grass control in broadleaf crops and pastures such as Verdict [®]	500 mL alkali liquid detergent such as Surf [®] , Omo [®] , Dynamo Matic [®] , or 500 g of the powder equivalent	Before spraying cereals, maize, sorghum or other sensitive crops, wash the tank and rinse after use. Completely drain the tank and wash filters, screens and nozzles. Drain and repeat the procedure twice. To decontaminate, wash and rinse the system as above, quarter-fill the tank, add the detergent and circulate through the system for at least 15 minutes. Drain the whole system. Remove filters, screens and nozzles and clean separately. Finally, flush the system with clean water and allow to drain.

Withholding periods

by Mark Scott

The withholding period (WHP) is the minimum mandated interval that should elapse between the last application of a farm chemical to any crop, pasture, or animal and the harvesting, grazing, cutting or slaughtering or the collection of milk and eggs for human consumption.

It is part of the direction of use within the concept of Good Agricultural Practice in the use of agricultural chemicals. This period is assessed as being the time required for the level of residues to fall to or below the permitted level, which is known as **Maximum Residue Limit (MRL)**. Observance of the withholding period stated on the registered label is a legal requirement.

To calculate the date when treated produce can be harvested or slaughtered, add the WHP, for example 7 full (24-hour) days to the time when chemical application finished. For example, if chemical application finished at 11am and harvest or slaughter needs to be carried out earlier in the day than 11am, then it must wait until the next (eighth) day.

Withholding periods

Product	Active ingredient	Withholding period (days or weeks) before grazing or cutting for hay
Access®	triclopyr + picloram	Nil
Amitrole T®	amitrole + ammonium thiocyanate	Nil
Basta®	glufosinate	8 weeks
Baton®	2,4-D	7 days
Broadstrike®	flumetsulam	3 days – 8 weeks (see label)
Bromicide 200®	Bromoxynil*	8 weeks.
Bromicide MA®	Bromoxynil* + MCPA	8 weeks
Brush-off®	metsulfuron-methyl	Nil (recommended not to graze for 7 days before treatment and for 7 days after treatment to allow adequate chemical uptake in target weeds).
Casoron G®	dichlobenil	Nil
Cut-out®	metsulfuron-methyl + glyphosate	Nil
Daconate®	MSMA	5 weeks
Fusilade®	fluazifop-P	2–7 weeks (see label)
Garlon 600®	triclopyr	Nil
Graslan®	tebuthiuron	Nil
Grazon DS®	triclopyr + picloram	Nil
Grazon Extra®	triclopyr + picloram + aminopyralid	Where product is used to control woody weeds in pastures there is a restriction of 12 weeks for use of treated pastures for making hay and silage; using hay or other plant material for compost, mulch or mushroom substrate; or using animal waste from animals grazing on treated pastures for compost, mulching, or spreading on pasture/crops.
Jaguar®	Bromoxynil* + diflufenican	8 weeks
Kamba 500®	dicamba	7 days
Kamba M®	dicamba + MCPA	7 days
Lontrel®	clopyralid	1–12 weeks (see label)
MCPA 500®	MCPA	7 days
Oust®	sulfometuron-methyl	Nil
Primatol Z®	ametryn	No stated withholding period
Reglone®	diquat	1 day in pasture, 10 days in treated water
Starane®	fluroxypyr	7 days
Tordon® 75-D	2,4-D + picloram	1–8 weeks (see label)
Tordon® Granules	picloram	Nil
Tussock®	flupropanate	4 months for blanket spraying, 14 days for spot spraying. Lactating cows or goats must not be grazed in treated areas.
Velpar L®	hexazinone	No stated withholding period
Verdict®	haloxyfop	1–4 weeks (see label)
Vigilant®	picloram	Nil

* For ground application of products containing bromoxynil a 350 m no-spray zone is required where there is livestock, pasture or land producing feed for livestock downwind from the application area. Aerial application of bromoxynil is prohibited.

Herbicide resistance

by Tony Cook

Herbicide resistance is the inherent ability of a weed to survive a herbicide that would normally control it. If a resistant plant is allowed to reproduce the resistance spreads through an infestation resulting in a whole infestation that is resistant to a particular herbicide. This is different to poor herbicide performance.

If herbicide resistance develops, other herbicides or other control methods will need to be used. These may be more expensive or less effective. Once herbicide resistance occurs it will persist for many years.

Herbicides act by interfering with specific processes in plants. This is known as the herbicide's mode of action. Different herbicides may have the same mode of action and herbicides with the same modes of action are grouped from Group A to Group Z (see below). The risk of herbicide resistance developing is higher in some Groups than in others.

The best way to prevent or combat herbicide resistance is to apply the principles of integrated weed management described in an earlier section of this handbook. The main

points for managing the risk of herbicide resistance include:

- ensuring no resistant plants are able to set seed;
- regularly monitoring the results of herbicide treatments;
- undertaking herbicide resistance testing on 'suspect' plants that survive herbicide treatments; and
- not relying on the same herbicide Group for regular weed control (rotate treatments using herbicides from different Groups).

Herbicide Groups, resistance risk and mode of action

Active ingredient	Example trade name	Group	Risk	Mode of Action
Fluazifop-P	Fusilade®	A	High	Inhibitors of fat (lipid) synthesis ACC'ase inhibitor
Haloxyfop-R	Verdict® 520	A	High	Inhibitors of fat (lipid) synthesis ACC'ase inhibitor.
Flumetsulam	Broadstrike®	B	High	Acetolactate synthase (ALS) inhibitor
Metsulfuron-methyl	various	B	High	ALS inhibitor
Sulfometuron-methyl	Oust® and various	B	High	ALS inhibitor
Bromoxynil	various	C	Moderate	Inhibitor of photosynthesis at photosystem II
Bromoxynil + MCPA	various	C + I	Moderate	Inhibitor of photosynthesis at photosystem II/ Disrupter of plant cell growth
Bromoxynil + diflufenican	Jaguar®	C + F	Moderate	Inhibitor of photosynthesis at photosystem II / Inhibitor of carotenoid biosynthesis
Hexazinone	Velpar L® and various	C	Moderate	Inhibitor of photosynthesis at photosystem II
Tebuthiuron	Graslan®	C	Moderate	Inhibitor of photosynthesis at photosystem II
Amitrole + ammonium thiocyanate	Amitrole T® and various	Q	Moderate	Inhibitor of carotenoid biosynthesis (bleachers)
Oxyfluorfen	Goal®	G	Moderate	Inhibitor of protoporphyrinogen oxidase
2,4-D amine and ester	various	I	Moderate	Causes elongation of terminal growth and plant cellular division
2,4-D + picloram	Tordon® 75-D	I	Moderate	Disrupter of plant cell growth
2,4-DB	Buttress®	I	Moderate	Causes elongation of terminal growth and plant cellular division
Clopyralid	Lontrel® and various	I	Moderate	Disrupter of plant cell growth
Dicamba	Banvel®	I	Moderate	Disrupter of plant cell growth
Dicamba + MCPA	Banvel M®	I	Moderate	Disrupter of plant cell growth
Dichlorprop	Lantana 600®	I	Moderate	Disrupter of plant cell growth
Fluroxypyr	Starane®	I	Moderate	Disrupter of plant cell growth
MCPA	various	I	Moderate	Disrupter of plant cell growth
Picloram	Tordon® Granules, Vigilant®	I	Moderate	Disrupter of plant cell growth
Triclopyr	Garlon® 600	I	Moderate	Disrupter of plant cell growth
Triclopyr + picloram (+ aminopyralid)	Grass-up® Access® (Grazon® Extra)	I	Moderate	Disrupter of plant cell growth
Dichlobenil	various	O	Moderate	Inhibitors of cell wall (cellulose) synthesis
Diquat	Reglone®	L	Moderate	Inhibitor of photosynthesis at photosystem I
Glyphosate	various	M	Moderate	Inhibitor of EPSP synthase
Glyphosate + metsulfuron	Trounce Brush-Pack herbicide®	M + B	Moderate/High	Inhibitor of EPSP synthase and ALS-methyl inhibitor
Glufosinate-ammonium	Basta®/Finale®	N	Moderate	Inhibitor of glutamine synthetase

Note: There have been recent changes made to mode of action (MOA) groups. Prior to 2008 the MOA groups ranged from Group A to Group N. Groups now range from Group A to Group Z. Furthermore, the Low risk category (out of Low, Moderate and High) has been removed due to its implication that products in the Low risk category are not susceptible to herbicide resistance. Overuse of some Low risk herbicides has led to resistance. The risk categories are now described as Moderate or High.

Control techniques using herbicides

by Rod Ensbey

Herbicides are commonly used for controlling weeds in agricultural and non-agricultural situations. Numerous forms of application techniques and equipment are available to apply herbicides. The appropriate option will be determined by the size of the infestation, the available resources, access and personal preferences. The most commonly used application techniques are listed and described below. Always remember to read the product label and any relevant permit before using a herbicide.

Foliar spraying

Foliar spraying is the use of herbicide diluted with water at a specific rate, and sprayed over the foliage to the point of runoff (until every leaf is wetted, but not dripping).

This method is most suited to shrubs, grasses and dense vines where complete coverage can be achieved. Advantages include speed of application and economy. Disadvantages include the potential for spray drift and off-target damage.

Foliar spraying can be done a number of ways, depending on the size of the weed plant and/or the infestation.



Figure 1: Foliar spraying using a knapsack.

Blanket spraying using a boom spray from a tractor or 4-wheel drive vehicle can be used to treat large areas completely infested with weeds up to approximately 1 m in height, especially with selective herbicides. For large infestations that need targeted applications of herbicide, a hose and handgun can be used to spray solution from a herbicide tank and pump carried by a tractor or vehicle. Smaller infestations can be sprayed using a backpack/knapsack spray unit. Spot spraying is used to treat individual weed plants, areas that have only small clumps of weed infestations, or regrowth areas.

Gas gun/splatter gun

Gas guns or splatter guns apply a low volume of high concentration, translocatable herbicide to the foliage of an infestation (this technique is generally applied to woody weeds. See page 80). The herbicide is squirted from a gas powered drench gun, placing very large droplets onto the leaves from 6–10 m away. The spray is arched over the top of a bush and down the front face, with splatters applied at specific intervals (refer to product labels for exact rates). Only a small portion of the foliage needs to be treated minimising off-target damage and reducing chemical usage. This technique allows for specific targeting of the herbicide and a marker dye is necessary to identify treated areas.

Rope/wick applicators

This method of applying a herbicide consists of a wick or rope soaked in herbicide from a reservoir attached to a handle or pumped to the wick with 12-volt equipment. The wetted wick is

used to wipe or brush herbicide over the weed. Commercially available equipment such as Weed Wand and Weed Wiper are available in sizes ranging from hand held to vehicle or tractor mounted.

It is sometimes necessary to provide some resistance for the wiper when the weed leaf or stem is soft. Stem swiping involves using a knife to provide resistance down the back of the stem or leaf, while manually wiping herbicide down the front.

Basal bark application

This method involves mixing an oil-soluble herbicide in diesel and spraying the full circumference of the trunk or stem of plants with basal diameters up to 10 cm and plant heights from 30 to 100 cm. Diesel helps the herbicide move through the bark.

Basal bark spraying is suitable for thin-barked woody weeds and undesirable trees. Basal bark spraying is also an effective way to treat saplings, regrowth and multi-stemmed shrubs and trees. This method works by allowing the herbicide to enter underground storage organs and slowly kill the targeted weed.

The whole circumference of the stem or trunk should be sprayed or painted with herbicide solution from ground level to a height of 30 cm. It is important to saturate the full circumference of the trunk, and to treat every stem or trunk arising from the ground.

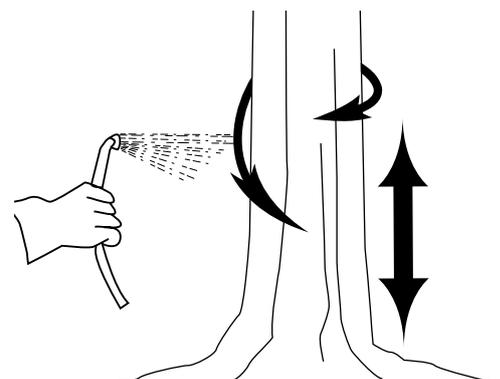


Figure 2: Basal bark application.

Basal bark spraying is a very effective control method, and is a good way to tackle inaccessible areas such as steep banks. It has the advantages of having little or no drift and it is a well-targeted form of spraying. This method will usually control difficult-to-kill weeds at any time of the year, as long as the bark is not wet or too thick for the diesel to penetrate.

Refer to the product label for further details on application. Some species can only be treated up to 5 cm basal diameter, other species can be treated up to 10 cm basal diameter.

Stem injection methods

These methods involve drilling or cutting through the bark into the sapwood tissue in the trunks of woody weeds and trees. Herbicide is immediately placed into the hole or cut. The aim is to reach the sapwood layer just under the bark (the cambium growth layer), which will transport the chemical throughout the plant.

It is essential to apply the herbicide immediately (within 15 seconds of drilling the hole or cutting the trunk), as stem injection relies on the active uptake and growth of the plant to move the chemical through its tissues.

Stem injection – drill and fill method

This stem injection method is used for trees and woody weeds with stems or trunks greater than 5 cm in circumference. This method uses

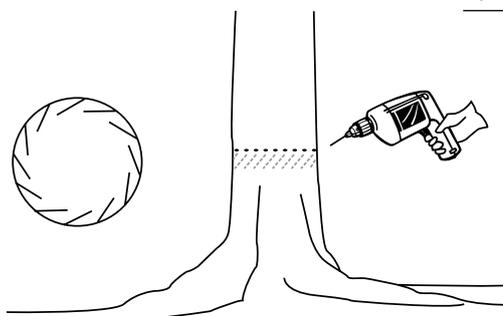


Figure 3: Stem injection, drill and fill method.

a battery-powered drill to make downward-angled holes into the sapwood approximately 5 cm apart. The placement of herbicide into the hole is usually made using a backpack reservoir and syringe that can deliver measured doses of herbicide solution.

Stem injection methods kill the tree or shrub where it stands, and only trees and shrubs that can be safely left to die and rot should be treated this way. If the tree or shrub is to be felled, allow it to die completely before felling.

Stem injection – axe cut method

This method involves cutting through the bark into the sapwood tissue in the trunk, and immediately placing herbicide into the cut. As with the drill and fill method, the aim is also to reach the tissue layer just under the bark (the cambium layer), which will transport the chemical throughout the plant.

The axe cut method can be used for trees and woody weeds with stems or trunks greater than 5 cm in circumference.

Using an axe or tomahawk, horizontal cuts are made into the sapwood around

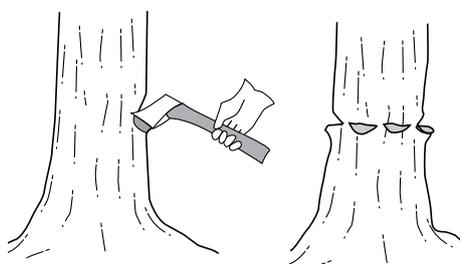


Figure 4: Stem injection, axe cut method.

the circumference of the trunk at waist height. While still in the cut, the axe or tomahawk is leaned out to make a downward angled pocket, which will allow herbicide to pool. The herbicide is then immediately injected into the pocket. Cuts should be made no farther than 3 cm apart. This method – using an axe to make the cut – is often referred to as frilling or chipping.

It is important not to entirely ringbark the trunk, as this will decrease the uptake of the herbicide into the plant.

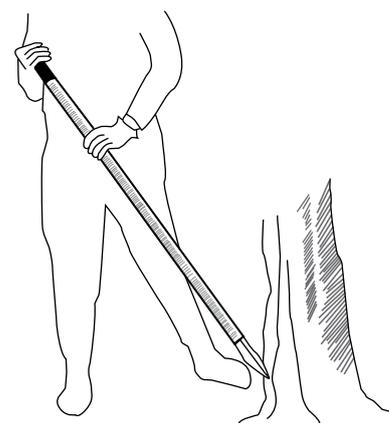


Figure 5: Stem injection, tree spearing.

Tree spearing

Tree spearing is an alternative stem injection method to the use of an axe or drill. The method uses a specifically designed tree spear and technique. The spear is thrust into the tree at an angle of 30° to 40° from the vertical, opening a cut in the tree and applying the appropriate herbicide amount. The process is repeated, forming a row of cuts approximately 50 mm apart.

Cut stump

Here the plant is cut off completely at its base (no higher than 15 cm from the ground) using a chainsaw, axe, brushcutter or machete (depending on the thickness of the stem/trunk). A herbicide solution is then sprayed or painted on to the exposed surface of the cut stump emerging from the ground, with the objective of killing the stump and the root system.

It is imperative that the herbicide solution is applied as soon as the trunk or stem is cut. A delay of more than 15 seconds between cutting and applying the chemical will give poor results. Two operators working as a team can use this method effectively. The herbicide can be applied from a knapsack, or with a

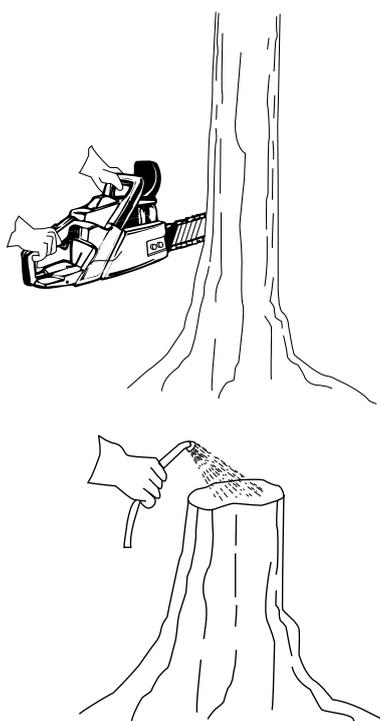


Figure 6: Cut stump method.

paintbrush, drench gun or a hand spray bottle. It is a good idea to use a brightly coloured dye in the solution to mark the stumps that have been treated.

This method has the appeal of removing the weed immediately, and is used mainly for trees and woody weeds.

Cut and swab

This method is similar to the cut stump method, but is suited to vines and multi-stemmed shrubs. Here, the plant stems are cut through completely, close to the ground. Herbicide is then applied immediately to the cut surface emerging from the ground, via spray or brush application.

In the case of Madeira vine and some other vines with aerial tubers, both ends of the cut stems must be treated with herbicide.

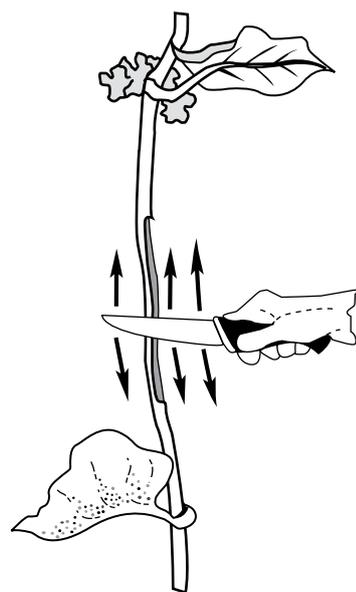


Figure 7a: Stem scrape method. A sharp knife is used to scrape the bark.

Stem scrape

Stem scraping is used for plants and vines with aerial tubers. A sharp knife is used to scrape a very thin layer of bark from a 15–30 cm section of the stem (Figure 7a). Herbicide is then immediately applied to the exposed soft underlying green tissue (Figure 7b). In the case of Madeira vine, all tubers within reach should be collected, removed and composted or destroyed before you start the scraping.

This method is also called bark stripping or stem painting. With some woody weeds you can peel away the bark surface and paint the exposed wood or spray it with herbicide.

Line Drawings by Lyn Skillings.

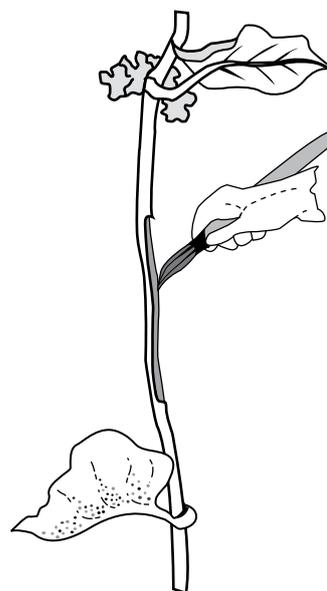


Figure 7b: Stem scrape method. Herbicide is applied to the green tissue.

Weeds declared noxious in New South Wales

by Stephen Johnson

The following weeds are currently declared noxious in New South Wales, as gazetted by Weed Control Order 28. All noxious weeds are divided into five Classes. To find the noxious weed and its category for your Local Control Authority area go to www.dpi.nsw.gov.au/weeds

Schedule of Noxious Weeds

Common name	Botanical Name	Control Class
African boxthorn	<i>Lycium ferocissimum</i>	C4
African feather grass	<i>Pennisetum macrourum</i>	C5
African lovegrass	<i>Eragrostis curvula</i>	C4
African olive	<i>Olea europaea</i> subspecies <i>cuspidata</i>	C4
African turnip weeds	<i>Sisymbrium runcinatum</i> <i>Sisymbrium thellungii</i>	C5
Aleman grass	<i>Echinochloa polystachya</i>	C2
Alligator weed	<i>Alternanthera philoxeroides</i>	C2, C3
Anchored water hyacinth	<i>Eichhornia azurea</i>	C1
Annual ragweed	<i>Ambrosia artemisiifolia</i>	C5
Arrowhead	<i>Sagittaria montevidensis</i>	C4
Artichoke thistle	<i>Cynara cardunculus</i>	C5
Arundinaria reed	<i>Arundinaria</i> spp.	C3
Asparagus fern	<i>Asparagus aethiopicus</i>	C4
Athel pine	<i>Tamarix aphylla</i>	C5
Balloon vine	<i>Cardiospermum grandiflorum</i>	C4
Bathurst burr	<i>Xanthium spinosum</i>	C4
Bear-skin fescue	<i>Festuca gautieri</i>	C5
Bitou bush	<i>Chrysanthemoides monilifera</i> subspecies <i>rotundata</i>	C2, C3, C4
Black knapweed	<i>Centaurea nigra</i>	C1
Black willow	<i>Salix nigra</i>	C2, C3
Blackberry	<i>Rubus fruticosus</i> (spp. agg.) except named cultivars	C4
Blue heliotrope	<i>Heliotropium amplexicaule</i>	C4
Blue hound's tongue	<i>Cynoglossum creticum</i>	C2
Boneseed	<i>Chrysanthemoides monilifera</i> subspecies <i>monilifera</i>	C2, C4
Bridal creeper	<i>Asparagus asparagoides</i>	C4
Broad-leaf pepper tree	<i>Schinus terebinthifolius</i>	C3
Broomrapes	<i>Orobancha</i> spp. except <i>O. minor</i> and native <i>O. cernua</i> var. <i>australiana</i>	C1
Buffalo burr	<i>Solanum rostratum</i>	C4
Burr ragweed	<i>Ambrosia confertiflora</i>	C5
Cabomba	All <i>Cabomba</i> species except <i>C. furcata</i>	C5
Californian burr	<i>Xanthium orientale</i>	C4
Camel thorn	<i>Alhagi maurorum</i>	C4
Camphor laurel	<i>Cinnamomum camphora</i>	C4

Common name	Botanical Name	Control Class
Cape broom	<i>Genista monspessulana</i>	C2, C3, C4
Cape ivy	<i>Delairea odorata</i>	C4
Cape tulips	<i>Moraea</i> spp.	C4
Castor oil plant	<i>Ricinus communis</i>	C3, C4
Cat's claw creeper	<i>Macfadyena unguis-cati</i>	C4
Cayenne snakeweed	<i>Stachytarpheta cayennensis</i>	C5
Cherry guava	<i>Psidium cattleianum</i>	C3
Chilean needle grass	<i>Nassella neesiana</i>	C3, C4
Chinese celtis	<i>Celtis sinensis</i>	C3
Chinese tallow tree	<i>Triadica sebifera</i>	C3
Chinese violet	<i>Asystasia gangetica</i> subspecies <i>micrantha</i>	C1
Cineraria	<i>Cineraria lyratiformis</i>	C4
Climbing asparagus fern	<i>Asparagus plumosus</i>	C4
Clockweed	<i>Gaura parviflora</i>	C5
Cockle burr	<i>Xanthium ambrosioides</i>	C4
Cockspur coral tree	<i>Erythrina crista-galli</i>	C4
Columbus grass	<i>Sorghum x alnum</i>	C3, C4
Coolatai grass	<i>Hyparrhenia hirta</i>	C3
Corn sowthistle	<i>Sonchus arvensis</i>	C5
Creeping knapweed	<i>Rhaponticum repens</i>	C4
Crofton weed	<i>Ageratina adenophora</i>	C4
Devil's claw (purple-flowered)	<i>Proboscidea louisianica</i>	C4
Devil's claw (yellow-flowered)	<i>Ibicella lutea</i>	C4
Dodder	All <i>Cuscuta</i> species except natives	C5
East Indian hygrophila	<i>Hygrophila polysperma</i>	C3, C4
Espartillo	<i>Amelichloa brachychaeta</i> and <i>A. caudata</i>	C5
Eurasian water milfoil	<i>Myriophyllum spicatum</i>	C1
Fine-bristled burr grass	<i>Cenchrus brownii</i>	C5
Fireweed	<i>Senecio madagascariensis</i>	C4
Flax-leaf broom	<i>Genista linifolia</i>	C4
Fountain grass	<i>Pennisetum setaceum</i>	C5
Galenia	<i>Galenia pubescens</i>	C4
Gallon's curse	<i>Cenchrus biflorus</i>	C5
Giant Parramatta grass	<i>Sporobolus fertilis</i>	C3, C4
Giant rat's tail grass	<i>Sporobolus pyramidalis</i>	C3

Common name	Botanical Name	Control Class
Giant reed/ elephant grass	<i>Arundo donax</i>	C3, C4
Glaucous star thistle	<i>Carthamus glaucus</i>	C5
Glory lily	<i>Gloriosa superba</i>	C3
Golden dodder	<i>Cuscuta campestris</i>	C4, C5
Golden thistle	<i>Scolymus hispanicus</i>	C5
Gorse	<i>Ulex europaeus</i>	C2, C3
Green cestrum	<i>Cestrum parqui</i>	C3
Grey sallow	<i>Salix cinerea</i>	C3, C5
Groundsel bush	<i>Baccharis halimifolia</i>	C3
Harrisia cactus	<i>Harrisia</i> spp.	C4
Hawkweed	<i>Hieracium</i> spp.	C1
Hemlock	<i>Conium maculatum</i>	C4
Heteranthera/ kidneyleaf mud plantain	<i>Heteranthera reniformis</i>	C1
Hoary cress	<i>Cardaria draba</i>	C4
Honey locust	<i>Gleditsia triacanthos</i>	C3
Horehound	<i>Marrubium vulgare</i>	C4
Horsetail	<i>Equisetum</i> spp.	C1
Hunter burr	<i>Xanthium italicum</i>	C4
Hydrocotyl/ water pennywort	<i>Hydrocotyle ranunculoides</i>	C1
Hygrophila	<i>Hygrophila costata</i>	C2
Hymenachne	<i>Hymenachne amplexicaulis</i> and hybrids	C1
Illyrian thistle	<i>Onopordum illyricum</i> subspecies <i>illyricum</i>	C4
Italian bugloss	<i>Echium italicum</i>	C4
Johnson grass	<i>Sorghum halepense</i>	C3, C4
Karoo thorn	<i>Acacia karroo</i>	C1
Khaki weed	<i>Alternanthera pungens</i>	C4
Kochia (other than summer or mock cypress)	<i>Bassia scoparia</i> except subspecies <i>trichophylla</i>	C1
Koster's curse/ clidemia	<i>Clidemia hirta</i>	C1
Kudzu	<i>Pueraria lobata</i>	C3
Lacy ragweed	<i>Ambrosia tenuifolia</i>	C4
Lagarosiphon	<i>Lagarosiphon major</i>	C1
Lantana	<i>Lantana camara</i>	C3, C4
Lantana (creeping)	<i>Lantana montevidensis</i>	C3, C4
Leafy elodea	<i>Egeria densa</i>	C4
Lippia	<i>Phyla canescens</i>	C4
Long-leaf willow primrose	<i>Ludwigia longifolia</i>	C3, C4
Long-style feather grass	<i>Pennisetum villosum</i>	C4
Ludwigia	<i>Ludwigia peruviana</i>	C3
Madeira vine	<i>Anredera cordifolia</i>	C4
Mesquite	<i>Prosopis</i> spp.	C2
Mexican feather grass	<i>Nassella tenuissima</i>	C1

Common name	Botanical Name	Control Class
Mexican poppy	<i>Argemone mexicana</i>	C5
Miconia	<i>Miconia</i> spp.	C1
Mikania	<i>Mikania micrantha</i>	C1
Mimosa	<i>Mimosa pigra</i>	C1
Mintweed	<i>Saliva reflexa</i>	C4
Mistflower	<i>Ageratina riparia</i>	C4
Montbretia	<i>Crocosmia x crocosmiiflora</i>	C4
Morning glory (coastal)	<i>Ipomoea cairica</i>	C4
Morning glory (purple)	<i>Ipomoea indica</i>	C4
Mossman River grass	<i>Cenchrus echinatus</i>	C5
Moth vine	<i>Araujia sericifera</i>	C4
Mother-of-millions	<i>Bryophyllum delagoense</i> <i>Bryophyllum x houghtonii</i> <i>Bryophyllum pinnatum</i>	C3, C4
Mysore thorn	<i>Caesalpinia decapetala</i>	C3
Nodding thistle	<i>Carduus nutans</i>	C4
Noogoora burr	<i>Xanthium occidentale</i>	C4
Ochna	<i>Ochna serrulata</i>	C4
Onion weed	<i>Asphodelus fistulosus</i>	C4
Pampas grass	<i>Cortaderia</i> spp.	C3, C4
Parkinsonia	<i>Parkinsonia aculeata</i>	C2
Parthenium weed	<i>Parthenium hysterophorus</i>	C1
Paterson's curse	<i>Echium plantagineum</i>	C4
Pellitory	<i>Parietaria judaica</i>	C4
Perennial ground cherry	<i>Physalis virginiana</i>	C3, C4
Perennial ragweed	<i>Ambrosia psilostachya</i>	C4
Perennial/ Canada thistle	<i>Cirsium arvense</i>	C4
Pond apple	<i>Annona glabra</i>	C1
Prairie ground cherry	<i>Physalis hederifolia</i>	C3, C4
Prickly acacia	<i>Acacia nilotica</i>	C1
Prickly pears (other than Indian fig)	<i>Cylindropuntia</i> spp., <i>Opuntia</i> spp. except <i>Opuntia ficus-indica</i>	C4
Privet (broad-leaf)	<i>Ligustrum lucidum</i>	C4
Privet (European)	<i>Ligustrum vulgare</i>	C4
Privet (narrow-leaf/Chinese)	<i>Ligustrum sinense</i>	C4
Ragwort	<i>Senecio jacobaea</i>	C4
Red rice	<i>Oryza rufipogon</i>	C5
Rhizomatous bamboo	<i>Phyllostachys</i> spp.	C3, C4
Rhus tree	<i>Toxicodendron succedaneum</i>	C4
Rubber vine	<i>Cryptostegia grandiflora</i>	C1
Saffron thistle	<i>Carthamus lanatus</i>	C4
Sagittaria	<i>Sagittaria platyphylla</i>	C4, C5
Salvinia	<i>Salvinia molesta</i>	C2, C3
Scotch/English broom	<i>Cytisus scoparius</i>	C4

Common name	Botanical Name	Control Class
Scotch thistle	<i>Onopordum acanthium</i> subspecies <i>acanthium</i>	C4
Senegal tea plant	<i>Gymnocoronis spilanthoides</i>	C1
Senna	<i>Senna pendula</i>	C4
Serrated tussock	<i>Nassella trichotoma</i>	C3, C4
Siam weed	<i>Chromolaena odorata</i>	C1
Silk forage sorghum	<i>Sorghum</i> sp. hybrid cultivar	C3, C4
Silver-leaf nightshade	<i>Solanum elaeagnifolium</i>	C3, C4
Smooth-stemmed turnip	<i>Brassica barrelieri</i> subspecies <i>oxyrrhina</i>	C5
Soldier thistle	<i>Picnoman acarna</i>	C5
South American burr	<i>Xanthium cavanillesii</i>	C4
Spanish broom	<i>Spartium junceum</i>	C4
Spiny burr grasses	<i>Cenchrus incertus</i> and <i>C. longispinus</i>	C4
Spiny emex	<i>Emex australis</i>	C4
Spotted golden thistle	<i>Scolymus maculatus</i>	C4
Spotted knapweed	<i>Centaurea stoebe</i> subspecies <i>micranthos</i>	C1
St. Barnaby's thistle	<i>Centaurea solstitialis</i>	C4
St. John's wort	<i>Hypericum perforatum</i>	C3, C4
Star thistle	<i>Centaurea calcitrapa</i>	C4
Stemless thistle	<i>Onopordum acaulon</i>	C4
Sweet briar	<i>Rosa rubiginosa</i>	C4
Sweet pittosporum	<i>Pittosporum undulatum</i>	C3

Taiwan/ tiger lily	<i>Lilium formosanum</i>	C4
Taurian thistle	<i>Onopordum tauricum</i>	C4
Texas blueweed	<i>Helianthus ciliaris</i>	C5
Trad/wandering jew	<i>Tradescantia fluminensis</i>	C4
Tree-of-heaven	<i>Ailanthus altissima</i>	C4
Tropical soda apple	<i>Solanum viarum</i>	C2, C3
Turkey rhubarb	<i>Acetosa sagittata</i>	C4
Tussock paspalum	<i>Paspalum quadrifarium</i>	C3
Vipers bugloss	<i>Echium vulgare</i>	C4
Water caltrop	<i>Trapa</i> spp.	C1
Water hyacinth	<i>Eichhornia crassipes</i>	C2, C3, C4
Water lettuce	<i>Pistia stratiotes</i>	C1
Water soldier	<i>Stratiotes aloides</i>	C1
Wild radish	<i>Raphanus raphanistrum</i>	C4
Willows (other than weeping and two pussy willows)	<i>Salix</i> spp. except <i>S. babylonica</i> , <i>S. x calodendron</i> and <i>S. x reichardtii</i>	C5
Witchweed	<i>Striga</i> spp. except native <i>S. parviflora</i>	C1
Yellow bells	<i>Tecoma stans</i>	C3
Yellow burrhead	<i>Limnocharis flava</i>	C1
Yellow nutgrass	<i>Cyperus esculentus</i>	C5

Weed control classes

The following weed control classes may be applied to a plant by a weed control order:

Control Class	Weed type	Example control requirements
Class 1	Plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also 'notifiable' and a range of restrictions on their sale and movement exist.
Class 2	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also 'notifiable' and a range of restrictions on their sale and movement exist.
Class 3	Plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.	The plant must be fully and continuously suppressed and destroyed.*
Class 4	Plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction.*
Class 5	Plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.	The requirements in the <i>Noxious Weeds Act 1993</i> for a notifiable weed must be complied with.

* In some cases the following wording has also been inserted 'the plant may not be sold, propagated or knowingly distributed'.

All Class 1, 2 and 5 weeds are notifiable weeds. All outbreaks of these weeds must be reported to the local control authority within three days of discovery. They are also prohibited from sale or purchase in any area of NSW.

Pesticide permits

by Rod Ensbey

Pesticide permits allow for the use of an off-label recommendation of a registered herbicide.

In making a decision whether or not to issue a permit, the Australian Pesticides & Veterinary Medicines Authority (APVMA) must balance the need for the permit against known and uncertain scientific and other factors.

This is particularly the case in respect of the stability and efficacy of a product for a particular purpose and the extent to which use of the product might jeopardise trade.

It is therefore important before using an active constituent or a chemical product under a permit issued by the APVMA that the users make their own judgement

as to the suitability, effectiveness and safety of the intended use and effect that use of the chemical may have on trade and do so at their own risk. It is also important for the user to obtain a copy and read the permit before use.

The following list comprises permits mentioned in this publication.

Weed	Permit number	Active ingredient	Expiry date
African boxthorn	PER10117	Metsulfuron methyl	31-10-2013
African lovegrass	PER9792	Flupropanate	30-11-2015
African olive	PER11788	Triclopyr	31-03-2015
Alligator weed	PER10653	Metsulfuron-methyl	30-06-2013
	PER12789	Metsulfuron-methyl	30-06-2014
	PER11428	Metsulfuron-methyl, Glyphosate, Dichlobenil	11-06-2014
Blue heliotrope	PER11738	Glyphosate	30-10-2013
	PER12286	Metsulfuron-methyl	03-10-2015
Bitou bush	PER12251	Glyphosate, Metsulfuron-methyl	31-12-2015
Camphor laurel	PER10615	Glyphosate	31-05-2013
Cats claw creeper/madeira vine	PER10200	Triclopyr + Picloram	31-01-2013
Chilean needle grass	PER9792	Glyphosate	30-11-2015
Chinese violet	PER6748	Dicamba + MCPA	30-09-2012
Coolatai grass	PER9792	Glyphosate + Flupropanate	30-11-2015
Environmental weeds*	PER9907	Metsulfuron-methyl, Glyphosate, Fluroxypr	31-03-2012
	PER12367	Triclopyr + Picloram Triclopyr + Picloram + Aminopyralid	03-10-2015
	PER11916	Metsulfuron-methyl Glyphosate	31-03-2012
Dodders	PER9385	Diquat	30-10-2013
	PER9384	Glyphosate	30-10-2013
Fireweed	PER10462	2,4-D Amine	31-01-2012
	PER13113	Metsulfuron-methyl	30-09-2014

* See individual permits for specific weeds controlled.

Some of the chemical use patterns quoted in this publication are approved under Permits issued by the APVMA and in force at the time the publication was prepared. Persons wishing to use a chemical in a manner approved under Permit should obtain a copy of the relevant Permit from the APVMA and must read all details, conditions and limitations relevant to that Permit, and must comply with the details, conditions and limitations prior to use.

Weed	Permit number	Active ingredient	Expiry date
Giant Parramatta/ giant rat's tail grass	PER10919	Glyphosate	31-09-2013
	PER9792	Flupropanate	30-11-15
Green cestrum	PER11427	Triclopyr	30-06-2019
	PER11154	Amitrole	31-03-2015
Hawkweeds	PER11637	Triclopyr + Picloram	30-09-2014
Horsetail	PER10537	Dichlobenil	31-03-2013
Hudson pear/ cactus	PER10544	Triclopyr, Triclopyr + Picloram	30-06-2013
Hymenachne	PER12101	Glyphosate	30-06-2012
Kudzu	PER11604	Triclopyr, Triclopyr + Picloram, Metsulfuron Methyl	31-08-2014
Lippa	PER10917	Various	31-07-2013
Ludwigia	PER9966	2,4-D Amine	30-06-2012
	PER11257	2,4-D Amine	30-06-2014
	PER10597	2,4-D Amine	01-02-2013
Ludwigia repens	PER10806	Metsulfuron Methyl	31-03-2012
Mimosa bush	PER10040	Tebuthiuron	31-07-2012
	PER11638	Clopyralid	30-09-2014
Mother-of-millions	PER11424	Metsulfuron-methyl, Glyphosate	31-08-2014
Sagittaria	PER10712	Glyphosate	30-06-2013
	PER11856	Glyphosate	30-09-2014
Salvinia	PER10461	Glyphosate	31-01-2012
	PER10529	Glyphosate	30-10-2013
	PER10423	Glyphosate	31-12-2013
Senegal tea plant/ hygrophilla	PER11567	Metsulfuron-methyl Glyphosate	30-06-2014
Serrated tussock	PER9792	Flupropanate	30-11-2015
	PER10919	Glyphosate	31-09-2013

Noxious and environmental weed control

by Rod Ensbey

Registration of a pesticide is not a recommendation from the Department of Primary Industries for the use of a specific pesticide in a particular situation. Users must satisfy themselves that the pesticide they choose is the best one for the situation and weed. Users must also carefully study the container label before using any pesticide, so that specific instructions relating to the rate, timing, application and safety are noted. This publication is presented as a guide to assist users in planning their weed control.

Only herbicides registered for use in non cropping areas are listed on the following pages. If there is any omission or error in this list of chemicals please notify the authors.

Note: The registrations for *General Mixed Weeds*, *Annual and Perennial Weeds* and *Woody Weeds* on the Roundup® label have been included in the alphabetical listing below – see under ‘General mixed’ etc. and ‘Woody’.

Product names and alternatives

The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product does not imply

endorsement by NSW DPI over any other equivalent product from another manufacturer.

Abbreviation	Details
/ha	per hectare (10 000 m ²)
g (kg)	gram (kilogram)
L (mL)	litre (millilitre)
g/L (g/kg)	grams per litre (grams per kilogram)
m (m ²)	metre (square metre)
Various trade names	There are a number of products on the market with this active ingredient registered for control of this weed.
Various trade names and formulations	There are a number of products with this active ingredient, some with alternate formulations or concentrations registered for control of this weed. e.g. glyphosate 360 g/L, glyphosate 450 g/L. Alternate formulations will have a different application rate. Always check the label.
Various trade names for aquatic use only	Only use products with this active ingredient that are registered for use around aquatic areas e.g. Roundup® Biactive.

African boxthorn – *Lycium ferocissimum*

Non-chemical option: Pull out large old bushes when soil is wet (winter) and spray regrowth.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L Grazon® Extra	500 mL per 100 L water	Apply when bushes have good leaf cover, growth and no leaf fall. Only apply to plants less than 2 m tall.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply when bushes have good leaf cover, growth and no leaf fall. Only apply to plants less than 2 m tall.
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Apply as basal bark up to 5 cm basal diameter. Cut stump application for over 5 cm diameter.
	2,4-D 300 g/L + picloram 75 g/L Various trade names	1.3 L per 100 L of water	Small bushes only. Spray soil to drip line. Thorough coverage is essential. Spray prior to budburst.
	Glyphosate 360 g/L Various trade names	0.7–1.0 L per 100 L	Low rate on young bushes, high water rate on mature bushes. Do not spray in hot dry summer periods.
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 1.5 parts water	Drill/axe cut or stem scrape.
	Triclopyr 600 g/L Various trade names	1.0 L per 30 L of diesel	Cut stump any stem diameter. Basal bark application for stems up to 5cm in diameter
	Tebuthiuron 200 g/kg Various trade names	2 g per m ²	Estimate the area within 30 cm beyond the drip line of the target plant and calculate the amount of Graslan required. Do not apply near desirable trees.
	Hexazinone 250 g/L Various trade names	Undiluted. 4 mL per spot.	1 spot per metre height. Bushes up to 3 m tall. Do not apply near desirable trees.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
PER10117	Metsulfuron-methyl 600 g/kg Various trade names	10 g metsulfuron plus 1 litre glyphosate in 100 L of water	Always add non-ionic surfactant to the spray mix. Apply to actively growing weeds.
	Glyphosate 360 g/L Various trade names		

African lovegrass – *Eragrostis curvula*

Non-chemical option: Pasture improvement and grazing management will reduce re-establishment. Minimal soil disturbance required.

	Chemical and concentration	Rate	Comments
	Glyphosate 360 g/L Various trade names	1.0 L per 100 L water 6.0 L per 100 L water	Actively growing plants. Boom application.
	Flupropanate 745 g/L Various trade names	300 mL per 100 L of water 3.0 L/ha	Spot spray application. Boom application using 150 L water/ha. Apply July to December.
PER9792	Flupropanate 745 g/L Various trade names	2–3 L/ha 200–300 mL per 100 L water	Ground and aerial application. Spot spray application. Apply January to June. Only apply to green actively growing plants.
	Hexazinone 250 g/L Various trade names	13.0–18.0 L/ha	Has residual activity. DO NOT apply if desirable plants are in close proximity.

African olive – *Olea europaea ssp. cuspidata*

Non-chemical options: Hand remove seedlings.

	Chemical and concentration	Rate	Comments
	Triclopyr 600 g/L Various trade names	4.0 L per 60 L diesel	Basal bark application up to 5 cm basal diameter or cut stump application over 5 cm.
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate per 1.5 parts of water	Spray seedlings / coppice shoots. Cut stump, stem scrape or injection, saplings or large trees and shrubs.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Algae – *Cyanobacteria*

	Chemical and concentration	Rate	Comments
	Copper Various trade names, concentrations and formulations	Refer to label.	See label dilution rate table. Apply in bright sunlight and when algae are first evident.

Alligator weed – *Alternanthera philoxeroides*

A notifiable noxious weed that must be reported to Local Control Authorities and NSW DPI (phone 1800 680 244).

Non-chemical options: Biological control agents are effective in some core coastal wetland situations for the aquatic plant form. See the *National Alligator Weed Control Manual* and *Alligator Weed Primefact* for further information.

	Chemical and concentration	Rate	Comments
	Glyphosate 360 g/L Various trade names for aquatic use only	10 mL per 1 L of water	Spot spray. Actively growing from summer through winter, floating form only.
	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L water	Apply in terrestrial situations only. A minimum of 3 years' spraying is required to achieve complete control.
PER12789	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L water (to a maximum rate of 600 L/ha of weed surface)	Aquatic areas and terrestrial areas across NSW except for the core areas of Port Stephens Council, Maitland City Council, Penrith City Council and Hawkesbury City Council. Only apply as a spot spray using a hand directed spray. Do not apply more than 3 applications per growing season. See permit for details.
PER10653	Metsulfuron-methyl 660 g/L Various trade names	10 g in 100 L of water	Hand gun application Refer to permit for critical use comments.
PER11428	Glyphosate 360 g/L Various trade names	10 mL in 1 L of water	For control in urban and residential backyards.
	Metsulfuron-methyl 600 g/L Various trade names	1 g in 10 L of water	Refer to permit for critical use comments.
	Dichlobenil 67.5 g/kg Casoron®	25–37 g per square metre	

Arundinaria/Bamboo – *Arundinaria* spp.

Non-chemical options: Physical removal gives best results.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spot spray. Spray regrowth up to 0.5 m only. Cut stump. Retreatment necessary.

Asparagus – climbing and fern – *Asparagus plumosus* and *Asparagus africanus*

Non-chemical options: Mechanically remove rhizomes where possible.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water	Spot spray application, best done between flowering and berries forming.
		1 part glyphosate to 1.5 parts water	Cut stump/scrape stem. Gouge rhizome and paint.

Asparagus – ground – *Asparagus aethiopicus*

Non-chemical options: Mechanically remove rhizomes where possible.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water	Spot spray application, best done between flowering and berries forming.
		1 part glyphosate to 1.5 parts water	Cut stump/scrape stem. Gouge rhizome and paint.
	Metsulfuron-methyl 600 g/kg Various trade names	1–2 g/10 L water plus non-ionic surfactant (0.1% or 1 mL/L)	Spot spray application, best done between flowering and berries forming.

Azolla – *Azolla filiculoides*

Non-chemical options: Small infestations can be mechanically removed.

Chemical and concentration	Rate	Comments
Diquat 200 g/L Various trade names	5.0–10.0 L/ha	Spray to wet all foliage thoroughly Observe withholding period.
Calcium dodecyl benzene sulfonate 300g/L Immerse®	1 part per 19 parts kerosene (1.0 L of mixture /100 m ²)	Sprinkle onto free floating plants and adjacent water surface lightly, just enough to change their normal colour.
Orange Oil 55.2g/kg Water Clear®	1 part product per 100 parts water	Spray on to free-floating plants.

Bathurst burr – *Xanthium spinosum*

Non-chemical options: Slash before flowering. Maintain competitive pastures.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names	80–110 mL per 150 L water	Spot spray. Seedlings only, actively growing.
MCPA 500 g/L Various trade names	2 L/ha	Apply at seedling stage.
Metsulfuron-methyl 600 g/L Various trade names	5.0 or 7.5 g per 100 L of water	Apply to actively growing plants up to early flowering. Use higher rate when plants are beyond early flowering.
Fluroxypyr 200 g/L Various trade names	75 mL per 100 L of water	Apply to actively growing plants.
Fluroxypyr 333 g/L Starane® Advanced	45 mL per 100 L water	Apply to actively growing plants.

Balloon vine – *Cardiospermum grandiflorum*

Non-chemical options: Seedlings can be manually removed.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spot spray. Spray regrowth up to 0.5 m only. Cut stump. Retreatment necessary.
Glyphosate 360 g/L Metsulfuron-methyl 600g/L Various trade names	200 mL of glyphosate plus 1.5 g of metsulfuron-methyl in 10 L of water	Spot spray application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Bamboo – *Bambusa* spp.

Non-chemical options: Physical removal will give best results.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spot spray. Spray regrowth up to 0.5 m only. Cut stump. Retreatment necessary.
Glyphosate 360 g/L Various trade names	10 mL per 1 L of water. 1 part glyphosate to 6 parts water	Foliar application between 1 and 2 m tall. Cut stump method. Cut stems to 20 cm. Pour mixture down stem or wet cut.

Bitou bush/Boneseed – *Chrysanthemoides monilifera*

Non-chemical options: Hand removal of young plants, encourage native regeneration and integrate the use of biological control agents. Fire can be effective, where practical. For further information see the *National Bitou Bush Control Manual*.

	Chemical and concentration	Rate	Comments
	Glyphosate 360 g/L Various trade names	5 or 10 mL per 1 L of water	Handgun or knapsack. Spray to wet all foliage. Apply at peak flowering to actively growing bushes during winter. Do not apply during periods of drought stress. Use the higher rate for plants over 1.5 m.
PER12251	Glyphosate 360 g/L Various trade names	2 L/ha	Aerial boom spray applications Refer to the critical use comments in the permit.
	Metsulfuron-methyl 600g/L Various trade names	20–30g/ha	
	Metsulfuron-methyl 600 g/L Various trade names	10 g per 100 L of water	Spray to wet all foliage thoroughly.
	Metsulfuron-methyl + glyphosate 63.2 g/kg + 760.5 g/kg Cut-out®	1 measured pack (95 g) per 100 L of water	Spray to wet all foliage thoroughly.
	2,4-D + picloram 300 g/L + 75 g/L Various trade names	650 mL per 100 L of water	Spray to wet all foliage thoroughly. Treat at flowering to fruiting stage.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Black willow – *Salix nigra*

Non-chemical options: Mechanical removal or use the cut-stump method of treatment.

	Chemical and concentration	Rate	Comments
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 15 L of diesel	Cut stump application method.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
	Glyphosate 360 g/L Various trade names and formulations	1.0–1.3 L in 100 L of water	Spray to wet all foliage. Use the higher rate for trees 1–2 m high.
		Undiluted	Stem injection.

Blackberry – *Rubus fruticosus* (species aggregate)

Non-chemical options: Slashing of juvenile bushes, use of goats will give some control. Biological control agents are also available. Improve pastures with a vigorous perennial species. See the *National Blackberry Control Manual* and Primefact 1014 *Blackberry* for further details.

Chemical and concentration	Rate	Comments
Triclopyr 200 g/L + picloram 100 g/L Tordon® DSH	500 mL per 100 L of water	Late spring to autumn treatment. Use an adjuvant.
Glyphosate 360 g/L Various trade names	10–13 mL per 1 L of water	Flowering to leaf fall. Use higher rate on old, dense infestations.
Glyphosate 835 g/kg + metsulfuron-methyl 10 g/kg Trounce®	1 measured pack (173 g) per 100 L of water	Apply from flowering until before leaf yellowing. Do not apply to bushes with mature fruit.
Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cut-out®	1 measured pack (95 g) per 100 L of water	Apply between January and April when bushes are actively growing. Do not apply to bushes with mature fruit.
Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Apply when bushes are actively growing. Thoroughly wet all foliage and canes at commencement of flowering.
Hexazinone 250 g/L Velpar L® and various trade names	Undiluted (4 mL per spot)	Bushes up to 1 m in height.
Picloram 20 g/kg Tordon® Granules	35–45 g/m ²	Apply granules over an area extending from main stem to 30 cm outside the drip line.
Triclopyr 600 g/L Various trade names	170 mL per 100 L of water	Late spring to early autumn. Actively growing bushes. Do not use under dry conditions.
Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 or 500 mL per 100 L of water	Late spring to early autumn when bushes are actively growing. Use the higher rate on plants which have been damaged by grazing stock or insects.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
Picloram 100 g/L + Triclopyr 300g/L + Aminopyralid 8 g/L Grazon® Extra	350 or 500 mL per 100 L water	Treat in late spring to autumn. Use an adjuvant.

Black knapweed – *Centaurea nigra*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Dig out single plants. Improve pastures with a vigorous perennial species.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	10 mL per 1 L of water	Spot spray on non-crop land – aquatic areas, dams, irrigation channels and banks.

Blue heliotrope – *Heliotropium amplexicaule*

Non-chemical options: Dig out single plants. Improve pastures with a vigorous perennial species. See the *Blue Heliotrope* Primefact for further information.

	Chemical and concentration	Rate	Comments	
	Picloram 100 g/L + Triclopyr 300g/L + Aminopyralid 8 g/L Grazon® Extra	500 mL per 100 L water	Treat at flowering.	
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply at flowering in a minimum spray volume of 1250 L/ha.	
	Dicamba 500 g/L Various trade names	130 mL per 15 L of water 0.6 L per 100 L of water 8.8 L/ha	Knapsack spray. High volume spot spray. Boom spray. Apply to young, actively growing plants.	
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	1.0 L per 100 L of water	Grass pastures only. Spot spray. Apply to young actively growing plants.	
	Fluroxypyr 333 g/L Starane® Advanced	600mL per 100 L of water	Spot spray. Apply during flowering.	
	Fluroxypyr 200 g/L Various trade names	1.0 L per 100 L of water	Spot spray. Apply during flowering.	
	Tebuthiuron 200 g/kg Various trade names	0.5 g /m ²	Do not use within 30 m of trees. Do not apply to areas greater than 0.5 hectares in size.	
PER12286	Metsulfuron-methyl 600 g/L Various trade names	10 g per 100 L of water	Plus 0.1% surfactant. Spot spray. Apply when plants are actively growing spring to autumn.	
PER11738	Glyphosate 360 g/L Various trade names	1.0 L per 100 L of water 2.0 L/ha	Spot spray Boom spray	Apply to actively growing plants, late spring to autumn at start of flowering and before seed set. Do not apply to stressed plants.
	Glyphosate 450 g/L Various trade names	1.6–2.0 L/ha	Boom spray	

Bracken fern – *Pteridium esculentum*

Non-chemical options: Manually remove small or individual plants

	Chemical and concentration	Rate	Comments	
	Glyphosate 360 g/L Various trade names	1.5 L per 100 L of water 9.0 L/ha	Apply during autumn at full front expansion, while plants are actively growing. Repeat treatments necessary. Wiper application is also recommended. Add surfactant.	
	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water 60 g/ha	Spot spray. Boom spray. Spray after full front expansion. Avoid spraying when plants are in stress.	

Bridal creeper – *Myrsiphyllum asparagoides*

Non-chemical options: Dig out all tubers and burn. A biocontrol fungus is also available.

	Chemical and concentration	Rate	Comments	
	Metsulfuron-methyl 600 g/kg Various trade names	5 g per 100 L of water	Spot spray from mid-June to late-August. Follow-up over at least 2 seasons is required.	
PER9907	Glyphosate 360g/L Various trade names	1 part glyphosate to 50 parts water 10 g metsulfuron-methyl to 100 L water	Spray August to September only.	
	Metsulfuron-methyl 600g/kg Various trade names		Spray August to September only.	

Branched broomrape – *Orobanche ramosa*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244). *O. ramosa* is a parasite and is notifiable in all States.

Non-chemical options: Plant should be carefully removed with host plant and sealed in a bag to avoid seed dispersal. Mark the site for further inspections at a later date.

There are no chemical registrations for control of the growth of this parasite. A permit exists for decontamination of spores on machinery and footwear.

Broad-leaf pepper tree – *Schinus terebinthifolius*

Non-chemical options: Small seedling plants can be removed manually. See Primefact 798 *Broad-leaf pepper tree* for further details.

	Chemical and concentration	Rate	Comments
	Fluroxypyr 333 g/L Starane® Advanced	21 mL per 1 L diesel 300 mL per 100 L water	Basal bark application. Foliar spray.
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spray seedlings and coppice shoots. Cut stump/scrape stem application for saplings. Stem injection application large trees and shrubs.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Buffalo burr – *Solanum rostratum*

Non-chemical options: Grub out single plants.

	Chemical and concentration	Rate	Comments
	2,4-D ester 600 g/L Various trade names and formulations	0.9–1.3 L/ha	Use in grass pastures only. Seedling to pre-flowering. Use higher rate as plants mature.

Cabomba – *Cabomba* spp.

Non-chemical options: Physical removal is recommended where appropriate. Draining and drying in suitable situations can control plants. Contain infestations to avoid further spread. See the *National Cabomba Control Manual* for further details.

	Chemical and concentration	Rate	Comments
	Carfentrazone-ethyl 240 g/L Shark™ Aquatic Herbicide	830 mL per 100,000 L water 2 ppm (2 mg/L) carfentrazone-ethyl	Non-flowing water bodies. Apply onto the surface or below the surface where cabomba is growing. Refer to the label for nozzle requirements. Do not apply to more than 50% of the volume of the water body in a single application. Do not apply subsequent application to the waterbody within 3 months. Retreatments of heavy infestations may be required.

Californian burr and cockle burr – *Xanthium orientale* and *Xanthium italicum*

Non-chemical options: Slash before flowering. There are a number of biological control agents that work in selected areas and situations.

	Chemical and concentration	Rate	Comments
	2,4-D amine 625 g/L Various trade names and formulations	800–1.1 L/ha	Boom spray. Seedlings only.

Macspred – Vigilant and Shark Aquatic herbicide - full page black and white

Camel thorn – *Alhagi pseudalhagi*

Non-chemical options: This is a difficult plant to control by mechanical means because of its growth habit.

There are no registered herbicides for this plant.

Camphor laurel – *Cinnamomum camphora*

Non-chemical options: Physical removal and treat the cut stump. See the *Camphor Laurel* Primefact for further information.

	Chemical and concentration	Rate	Comments
	Picloram 100 g/L + Triclopyr 300g/L + Aminopyralid 8 g/L Grazon® Extra	350 or 500 mL per 100 L water	Use higher rate on trees over 2 m tall. Apply as a thorough foliar spray.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	350–500 mL per 100 L of water	Use higher rate on trees over 2 metres tall. Apply as a thorough foliage spray.
	Triclopyr 240 g/L + picloram 120 g/L Access®	1 L per 60 L of diesel	Basal bark application for basal diameter less than 10 cm or cut stump application for greater than 10 cm.
	Triclopyr 200 g/L + picloram 100 g/L Tordon® DSH	1 part per 4 parts water (1–2 mL per cut)	Stem injection application.
	Triclopyr 600g/L Various trade names	170 mL per 100 L of water 1 L per 60 L of diesel	Seedling to three metres tall. Basal bark or cut stump application.
	Glyphosate 360 g/L Various trade names	1 part glyphosate to 1 part water, 2 mL per cut Undiluted, 2 mL per cut.	Stem injection for basal diameter up to 25 cm. Stem injection for basal diameter 25 cm to 60 cm.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spray seedlings and coppice shoots. Cut stump/scrape stem application for saplings. Stem injection application large trees and shrubs.
PER10615	Glyphosate 360 g/L Various trade names	Undiluted	4ml per drill hole / axe cut

Canna lily – *Canna indica*

Non-chemical options: Small infestations can be manually removed

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names for aquatic use only	1 part glyphosate to 50 parts water	Spot spray. Apply as foliar application. Spray regrowth after slashing.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel across the cut surface on the rhizome. (See label).

Cape broom – *Genista monspessulana*

Non-chemical options: Grazing, mechanical slashing and grubbing. If used as a hedge, must be prevented from flowering and fruiting.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L Various trade names	250 mL per 100 L of water	Spring to mid summer prior to pod formation. Apply as a thorough foliage spray.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel across the cut surface on the rhizome. (See label).
Picloram 100 g/L + Triclopyr 300g/L + Aminopyralid 8 g/L Grazon® Extra	350 or 500 mL per 100 L water	Use higher rate on trees over 2m tall. Apply as a thorough foliar spray.

Cape ivy – *Delairea odorata*

Non-chemical options: Runners can be rolled up and manually removed.

Chemical and concentration	Rate	Comments
PER9907 Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water	Spray
	1 part glyphosate to 1.5 parts water	Cut stump/scrape stem.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel across the cut surface on the rhizome. (See label).

Cape tulips – *Moraea* spp.

Non-chemical options: Cultivation is ineffective alone, renovate pastures after chemical treatment.

Chemical and concentration	Rate	Comments
Metsulfuron-methyl 600 g/kg Various trade names	5 g/ha	Apply at bulb exhaustion, usually during July/early August. Repeat treatments may be required.
2,4-D ester 600 g/L Various trade names and formulations	1.9–3.7 L/ha	Boom spray. Spray before flowering.

Castor oil plant – *Ricinus communis*

Non-chemical options: Physical removal of immature plants.

Chemical and concentration	Rate	Comments
Triclopyr 600 g/L Various trade names	1.0 L per 60 L of diesel	Basal bark application for plants up to 5 cm basal diameter. Cut stump application for plants with larger basal diameter.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
PER9907 Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water	Spray seedlings and coppice shoots.
	1 part glyphosate to 1.5 parts water	Cut stump/scrape stem application for saplings. Stem injection application large trees and shrubs.

Cat's claw creeper – *Macfadyena unguis-cati*

Non-chemical options: Difficult to manually control because of the root and rhizome system.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spray to kill regrowth Cut stump/scrape stem/inject
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
PER10200	Triclopyr 300g/L + picloram 100 g/L Various trade names	400 mL product per 100 L water.	Hand gun spray vines on ground.

Cherry guava – *Psidium cattleianum*

Non-chemical options: Physical removal gives best results.

	Chemical and concentration	Rate	Comments
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
PER9907	Fluroxypyr 300 g/L Various trade names	35 mL per 1 L of diesel	Basal bark application
	Glyphosate 360 g/L Various trade names	1 part glyphosate to 1.5 parts water	Cut stump/ stem injection

Chilean needle grass – *Nassella neesiana*

Non-chemical options: Good grazing management combined with a pasture improvement program is required for most effective control.

	Chemical and concentration	Rate	Comments
	Flupropanate 745g/L various trade names	1.5–3.0 L/ha 200 mL flupropanate plus 150 mL glyphosate 360g/L per 100 L of water	Boom application. Spot spray application Apply to actively growing plants from Spring to Autumn.
PER9792	Glyphosate 360g/L Various trade names	1 L per 100 L water 1 L/ha	Spot spray Boom spray

Chinese celtis – *Celtis sinensis*

Non-chemical options: Hand-pull young plants. See *Chinese Celtis* Primefact for further information.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 50 parts water 1 part glyphosate to 1.5 parts water	Spray seedlings and coppice shoots. Cut stump/scrape stem application for saplings Stem injection application large trees and shrubs.
	Fluroxypyr 333 g/L Starane® Advanced	21 mL per 1 L diesel	Basal bark application.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Chinese tallow – *Triadica sebifera*

Non-chemical options: Seedlings and small trees may be manually removed.

	Chemical and concentration	Rate	Comments
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Chinese violet – *Asystasia gangetica* subspecies *micrantha*

Non-chemical options: Seedlings and small trees may be manually removed. See *Chinese Violet Weed Alert* for further information.

	Chemical and concentration	Rate	Comments
PER6748	MCPA 340 g/L + Dicamba 80 g/L Various trade names	100 mL per 15 L of water per 150 sq. m. (1 L/10 m ²)	Spot spray application. Apply to actively growing weeds before seed set on the plants.

Cineraria – *Cineraria lyrata*

Non-chemical options: Mechanical control is the best means of control.

There are no herbicides currently registered for this plant.

Cockspur coral tree – *Erythrina crista-galli*

Non-chemical options: Physical removal and treat stump.

	Chemical and concentration	Rate	Comments
PER12367	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	50 mL / 10 L water	Knapsack. Spray reshotting cut limbs.
	Triclopyr 300 g/L + picloram 100 g/L Grazon DS®		
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 1.5 parts water	Cut stump/drill/axe cut/inject
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Columbus grass – *Sorghum × alnum*

Non-chemical options: Summer cultivation before heading will give some control.

	Chemical and concentration	Rate	Comments
	Glyphosate 450 g/L Various trade names	10 mL per 1 L of water	Apply at early flowering to actively growing plants.
	Flupropanate 745 g/L Various trade names	1.0 L per 100 L of water	Apply when actively growing.

Coolatai grass – *Hyparrhenia hirta*

Non-chemical options: Individual plants can be hand pulled.

	Chemical and concentration	Rate	Comments
PER979Z	Glyphosate 360 g/L Various trade names	200 mL glyphosate in 10 L of water	Spot spray application. Can be used 2–3 times from September to May.
	Flupropanate 745g/L Various trade names	200 mL glyphosate plus 20 mL flupropanate per 10 L of water	Spot spray application between July and October. Only use the tank mix once per season.
	Flupropanate 745 g/L Tussock®	300 mL per 100 L water	Apply in winter and spring between July and October.

Cotoneaster – *Cotoneaster glaucophyllus*, *Cotoneaster pannosus*

Non-chemical options: Seedlings and small plants can be hand pulled. Ensure all roots are removed

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360g/L Various trade names	1 part glyphosate per 1.5 parts of water	Cut stump or drill/axe cut/inject.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Crofton weed – *Ageratina adenophora*

Non-chemical options: Well-managed and improved pastures will assist control.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Spring to autumn. Spray all foliage to point of run-off. Actively growing plants.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL per 100 L of water	Spring to autumn. Spray all foliage to point of run-off. Actively growing plants.
	Fluroxypyr 333 g/L Starane Advanced®	300 ml in 100 L of water	Apply to actively growing seedlings and young plants up to flowering.
	Fluroxypyr 200 g/L Various trade names	500 mL per 100 L of water	Apply to actively growing seedlings and young plants up to flowering.
	Fluroxypyr 140 g/L + Aminopyralid 10 g/L Hot shot®	700 mL in 100 L of water 1.5 L/ha	Apply to actively growing plants from October to April
	MCPA 340 g/L + Dicamba 80 g/L Various trade names	190–270 mL per 100 L of water 2.8–4.0 L/ha	Spray during active growth. For use in grass pastures.
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	For use in grass pasture when weed is actively growing.
	Glyphosate 360 g/L Various trade names	500 mL per 100 L of water	Actively growing plants with full foliage.
	Metsulfuron-methyl 600 g/kg Various trade names	15 g per 100 L of water	Add surfactant. Thoroughly wet all foliage to point of run-off up to bud stage to prevent seed set.

Cumbungi – *Typha* spp.

Non-chemical options: Small infestations can be mechanically removed.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names for use in aquatic areas	13 mL per 1 L of water	Spot spray application. Apply to actively growing plants at early flowering.
Amitrole 250 g/L Various trade names	2.3 L per 100 L of water	Spot spray application. Apply during flowering between January and May.
2,2-DPA 750 g/kg Propon®	1.0–2.0 kg per 100 L of water	Hand gun, spot spray application. For use in irrigation channels and bore drains.

Devil's claw – *Proboscidea louisianica*, *Ibicella lutea*

Non-chemical options: Mechanical removal or hoe single plants before pods form.

Chemical and concentration	Rate	Comments
2,4-D LV ester 600 g/L Various trade names and formulations	0.9 L/ha	Spray before pods form.

Dodder – *Cuscuta* spp.

Non-chemical options: Quarantine the infestation and burn; maintain a grass pasture for a minimum period of 5 years to exhaust seed supply in the soil. See *Dodder* and *Golden dodder* Primefacts.

Chemical and concentration	Rate	Comments
Diquat 200 g/L Reglone®	1 mL per 1 L of water 1.5–3.0 L/ha	Spot spray. Spray at least 1 m radius around infestation. Boom spray.
Glyphosate 360 g/L Various trade names	10 mL per 10 L of water 0.5–9.0 L/ha	Spot spray. Spray at least 1 m radius around infestation. Boom spray. Non-selective. Will damage other desirable plants. Re-treat as required.
Metsulfuron-methyl 600 g/kg Various trade names	1 g per 100 L of water	Apply as a spot spray to point of run before flowering.

Duckweed – *Lemna minor*

Non-chemical options: Small infestations can be mechanically removed.

Chemical and concentration	Rate	Comments
Diquat 200 g/L Reglone®	400 mL in 100 L of water 5.0–10.0 L/ha	Spray to wet all foliage thoroughly, add Agral 600. Observe withholding period.
Orange Oil Water Clear®	1.0 L per 100 L of water	Spray on to free-floating plants.

Egeria – *Egeria densa*

Non-chemical options: Small infestations can be mechanically removed.

Chemical and concentration	Rate	Comments
Diquat 200g/L	5 L/megalitre water	Apply by injection below the surface or as a surface spray.

Elodea – *Elodea canadensis*

Non-chemical options: Small infestations can be mechanically removed.

Chemical and concentration	Rate	Comments
Copper 110 g/L Cupricide® 110	0.5–1 mL of Copper	For application follow label directions.
Diquat 200g/L	5 L /megalitre water	Apply by injection below the surface or as a surface spray.

Fireweed – *Senecio madagascariensis*

Non-chemical options: Pasture improvement and proper grazing management will assist with control. See the *Fireweed* Primefact for further information.

Chemical and concentration	Rate	Comments
Bromoxynil 200 g/L Various trade names	1.4 L/ha 2.8 L/ha	Boom spray. Seedling application. Boom spray. Early flowering application. In pastures apply with low volume boom spray during autumn/winter when weeds are young and actively growing. Observe withholding period.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Apply as a thorough foliar spray
Fluroxypyr 140 g/L + Aminopyralid 10 g/L Hot shot®	500 mL in 100 L of water 1.5 L/ha	Apply to flowering plants up to 30cm tall Treat seedling plants up to flowering
PER10462 2,4-D Amine 625 g/L	2–2.5 L/ha	Boom spray application
PER13113 Metsulfuron-methyl 600 g/kg	10 g in 100 L of water 40 g/ha	Spot spray application Boom spray

Fishbone fern – *Nephrolepis cordifoliarr*

Non-chemical options: Dig out, burn. This plant has rhizomes, which are a means of spread.

Chemical and concentration	Rate	Comments
PER9907 Glyphosate 360 g/L Various trade names	1.0–2.0 g metsulfuron-methyl per 10 L of water	Knapsack spot spray.
Metsulfuron-methyl 600 g/kg Various trade names	200 mL glyphosate plus 1.5 g metsulfuron-methyl per 10 L of water	Knapsack spot spray.

Galenia – *Galenia pubescens*

Non-chemical options: A perennial prostrate or semi-prostrate plant that is difficult to control.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL per 100 L of water 5 L/ha	Fresh spring/summer growth. High volume spot spray, treat to visual wetness. Boom spray. Apply in 2000 L water /ha.
Triclopyr 300 g/L + picloram + 100 g/L Various trade names	500 mL per 100 L of water 5 L/ha	Fresh spring/summer growth. High volume spot spray, treat to visual wetness. Boom spray. Apply in 2000 L water /ha.

Galvanised burr – *Sclerolaena birchii*

Non-chemical options: Deep cultivation to bury the seed, with pasture improvement and grazing management, will give control.

Chemical and concentration	Rate	Comments
Dicamba 500 g/L Various trade names	600 mL per 100 L of water 8.8 L/ha	High volume spot spray. Boom spray. Use a minimum of 1500 L water /ha. Add a surfactant.
2,4-D amine 625 g/L Various trade names	320 mL per 100 L of water	Apply to young, actively growing plants.
Dichlorprop 600 g/L DP600®	1.0 L per 100 L of water	Apply to young, actively growing plants.

General mixed weeds, annual and perennial weeds

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Roundup®	10 mL in 1 L water	Apply when weeds are actively growing. For best results on perennial weeds treat after flowering. Spray to wet all leaves. 1 L of spray will cover 10 square metres.

Giant Parramatta grass – *Sporobolus fertilis*

Non-chemical options: Pasture improvement and proper grazing management will assist control. See *Weedy Sporobolus Control Manual* for further information.

Chemical and concentration	Rate	Comments
Flupropanate 745 g/L Various trade names	200 mL per 100 L of water 1.5–2.0 L/ha	High volume spot spray. Boom spray. Best results during late winter and early spring when desirable species are semi-dormant. Observe 4 month withholding period for blanket spray application.
Glyphosate 360 g/L Various trade names	1.0 L per 2 L of water	Wick wiper application. Apply when plant is actively growing.
Glyphosate 360 g/L Various trade names for aquatic use only	10–15 mL per 1 L of water 6.0 L/ha	Spot spray. Apply when plants are actively growing. Boom application for pasture replacement/improvement and best done as a split treatment.
2,2-DPA 740 g/kg Propon® and various trade names	1.0 kg per 100 L of water 5–10 kg/ha	Spot spray application. Boom spray application. Apply when plants are actively growing.

Giant rat's tail grass – *Sporobolus pyramidalis*

Non-chemical options: Pasture improvement and proper grazing management will assist control. See *Weedy Sporobolus Control Manual* for further information

Chemical and concentration	Rate	Comments
Flupropanate 745 g/L Various trade names	200 mL per 100L of water 1.5–2.0 L/ha	Spot spray application. Boom spray. Best results during late winter and early spring when desirable species are semi-dormant. Four month withholding period for blanket spray application.
Glyphosate 360 g/L Various trade names for aquatic use only	10–15 mL per 1 L water 6.0 L/ha	Spot spray. Apply when plants are actively growing. Boom application for pasture replacement/ improvement and best done as a split treatment. Apply when plants are actively growing.
Glyphosate 360 g/L Various trade names	1.0 L per 2 L of water	Wick wiper application. Apply when plant is actively growing.

Giant reed/elephant grass – *Arundo donax*

Non-chemical options: Physical removal of small infestations is possible.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L	1 part glyphosate to 50 parts water	Spot spray.
	Various trade names	1 part glyphosate to 1.5 parts of water	Cut stump application.

Glory lily – *Gloriosa superba*

Non-chemical options: Physical removal for small infestations.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L	1 part glyphosate to 50 parts water	Spot spray. Spray regrowth.
	Various trade names	1 part glyphosate to 1.5 parts of water	Cut stump/ scrape stem application.
PER9907	Glyphosate 360 g/L	200 mL glyphosate plus	Spot spray application.
	Various trade names	1.5 g metsulfuron-methyl per 10 L of water	
	Metsulfuron-methyl 600 g/kg		
	Various trade names		

Gorse – *Ulex europaeus*

Non-chemical options: Physical removal of large bushes. See *National Gorse Control Manual* for further information.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	250 or 350 mL per 100 L of water 500 mL in 100 L of water	Apply to actively growing plants. Use higher rate on bushes over 1.5 m high or as an autumn treatment. Winter treatment
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	250 or 350 mL per 100 L of water 500 mL per 100 L of water	Apply to actively growing plants. Use higher rate on bushes over 1.5 m high or as an autumn treatment. Winter treatment.
	Triclopyr 200 g/L + picloram 100 g/L Tordon® DSH	375 mL per 100 L of water	September to March.
	Triclopyr 600 g/L Various trade names	170 or 340 mL per 100 L water	Add non-ionic surfactant. Spring to mid-summer, higher rate on older bushes.
	Glyphosate 835 g/kg + metsulfuron-methyl 10 g/kg Trounce®	1 measured pack (173 g) in 100 L of water	Apply to bushes up to 2 m high when actively growing.
	Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cutout®	1 measured pack (95 g) in 100 L of water	Apply to bushes up to 2 m high when actively growing.
	Glyphosate 360 g/L Various trade names	1.0 L per 100 L of water	Add Pulse (wetting agent), apply to actively growing bushes. Spray to wet all foliage.
	Metsulfuron-methyl 600 g/L Brushoff®	10 g metsulfuron-methyl plus 200 mL glyphosate in 100 L of water	Thorough spray for penetration and coverage of the whole bush. The use of an organosilicone penetrant is essential.
	Glyphosate 360 g/L Various trade names	10 g metsulfuron-methyl plus 200 mL glyphosate in 100 L of water	Thorough spray for penetration and coverage of the whole bush. The use of an organosilicone penetrant is essential.
	Metsulfuron-methyl 600 g/kg Various trade names	15 g per 100 L of water	Apply to bushes up to two metres tall. Ensure thorough spray penetration and coverage of whole plant.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Green cestrum – *Cestrum parqui*

Non-chemical options: A toxic plant in both the green and dead state. Physical removal is difficult because of the persistent regrowth from roots. See the *Cestrum* Primefact for further information.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Basal bark application.
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	Actively growing bushes in full leaf.
	Amitrole 250 g/L + ammonium thiocyanate 220 g/L Various trade names	1.1 L per 100 L of water	Active growth, before flowering.
	Triclopyr 600 g/L Various trade names	170 mL per 100 L of water	Retreat regrowth the next season.
PER11427	Triclopyr 600 g/L Various trade names	1.0 L per 30 L of diesel	Basal bark application. DO NOT over treat as excessive run-off might affect adjacent trees and shrubs through root absorption.
PER9907	Glyphosate 360 g/L Various trade names	1 part glyphosate to 1.5 parts water 1 part glyphosate to 50 parts water	Cut, scrape and paint. Spot spray.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Groundsel bush – *Baccharis halimifoliarr*

Non-chemical options: Small plants can be manually removed, ensuring total root elimination. See the *Groundsel bush* Primefact for further information.

	Chemical and concentration	Rate	Comments
	2,4-D amine 625 g/L Various trade names	320 mL per 100 L of water	Spray actively growing bushes. Thorough coverage.
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	250 or 350 mL in 100 L of water	Use lower rate on bushes 1–1.5 m high in spring and summer; use higher rate on bushes over 1.5 m high in the autumn.
	Triclopyr 300 g/L + picloram + 100 g/L Various trade names	250 or 350 mL per 100 L of water	Use lower rate on bushes 1–1.5 m high in spring and summer; use higher rate on bushes over 1.5 m high in the autumn.
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Basal bark/cut stump application.
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	Thorough coverage required on active growth.
	Triclopyr 600 g/L Various trade names	160 mL per 100 L of water 320 mL per 100 L of water	Seedlings 1 to 2 m tall. Bushes over 2 m tall.
	Glyphosate 360 g/L Various trade names	700 mL to 1.0 L per 100 L of water	Actively growing bushes. Do not apply during winter or summer drought stress.
	Clopyralid 300 g/L Various trade names	330 or 350 mL per 100 L of water	Active growth, lower rate on seedlings, higher rate on bushes over 2 m high.
	2,4-D 300 g/L Affray®	100 mL in 10 L of water	Thorough even coverage of the plant is necessary
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Hardhead thistle (creeping/Russian knapweed) – *Acrotilon repens*

Non-chemical options: Avoid cultivation, as it will increase plant populations from root pieces. See the *Knapweed* Weed Alert for further information.

Chemical and concentration	Rate	Comments
Dicamba 500 g/L Various trade names	130 mL per 15 L of water 600 mL per 100 L of water 8.8 L/ha	Knapsack spray. High volume spot spray. Boom spray. Spray at flowering, using a minimum water rate of 1500 L/ha.
Amitrole 250 g/L + ammonium thiocyanate 220 g/L Various trade names	1.1 L per 100 L of water	Actively growing plants before flowering.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	1.3–2.0 L per 100 L of water	Spot spray.

Harrisia cactus – *Harrisia* spp.

Non-chemical options: Small individual plants can be carefully manually removed.

Chemical and concentration	Rate	Comments
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Foliar application.
Dichlorprop 600 g/L DP600®	1.0 L per 60 L of water	Good soil moisture essential and spray at fruiting.
Metsulfuron-methyl 600 g/kg Various trade names	20 g in 100 L water	Spray to thoroughly wet plant, add a surfactant

Hawkweeds – *Hieracium* spp.

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

	Chemical and concentration	Rate	Comments
PER11637	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	250-500 ml per 100L plus BS 1000 or equivalent at 100 ml per 100L	Foliar application
PER11637	Triclopyr 300 g/L + picloram 100 g/L Various trade names	250-500 ml per 100L plus BS 1000 or equivalent at 100 ml per 100L	Foliar application

Hemlock – *Conium maculatum*

Non-chemical options: A toxic plant; avoid feeding animals fodder that may contain the plant.

Chemical and concentration	Rate	Comments
MCPA 340 g/L + Dicamba 80 g/L Various trade names	80 mL per 15 L of water 350 mL per 100 L of water 5.2 L/ha	Knapsack spray. High volume spot spray. Boom spray rate. Young active growth, repeat treatments may be necessary.

Hoary cress – *Cardaria draba*

Non-chemical options: Because of the plant's root system, cultivation only aids its spread.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names and formulations	1.1–1.7 L/ha	In pastures. Boom spray. Spray at rosettes to pre-flowering.
Glyphosate 360 g/L Various trade names	500 mL per 100 L of water 1.5 L/ha	Spot spray application. Boom spray. July to September, late rosette to flowering.

Honey locust – *Gleditsia trianthos*

Non-chemical options: Mechanical control is possible but will require follow up treatments.

Chemical and concentration	Rate	Comments
Triclopyr 240 g/L + picloram 120 g/L Access®	1 L per 60 L of diesel	Basal bark application for basal diameter less than 5 cm or cut stump application for above 5 cm.
Fluroxypyr 333 g/L Starane Advanced®	300 mL per 100L of water	Foliar application, up to 2 m in height.
	900 mL per 100 L of diesel	Basal bark application
	1.8 mL per 100 L of diesel	Plants up to 10 cm basal diameter.
	3.0 mL per 100 L of diesel	Plants 10–20 cm basal diameter.
Fluroxypyr 200 g/L Various trade names	3 L per 100 L of diesel	Plants above 20 cm basal diameter.
	500 mL per 100L of water	Cut stump application.
	1.5 mL per 100 L of water	Foliar application, up to 2 m in height.
	3.0 mL per 100 L of water	Basal bark application
Picloram 45 g/kg Vigilant®	5.0 mL per 100 L of water	Plants up to 10 cm basal diameter.
	5 L per 100 L of diesel	Plants 10–20 cm basal diameter.
	Undiluted	Plants above 20 cm basal diameter. Cut stump application.
		Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Horehound – *Marrubium vulgare*

Non-chemical options: Cut, stack and burn small areas. Establish a vigorous pasture and use good grazing management.

Chemical and concentration	Rate	Comments
2,4-D amine 500 g/L Various trade names and formulations	1.7 to 4.0 L/ha	Spray at seedling stage.
Dicamba 500 g/L Various trade names	80 mL in 100 L of water	High volume spot spray.
	1.2 L/ha	Boom spray.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Apply as foliar spray pre-flowering
Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL in 100 L of water	Apply as a foliar spray pre-flowering.

Horsetail – *Equisetum* spp.

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Physical removal is ineffective due to the deep root system.

	Chemical and concentration	Rate	Comments
PER10537	Dichlobenil 67.5 g/kg Various trade names	18 g /m ²	Spread granules evenly over the soil in area to be treated. Granules must be watered immediately after application.

Hudson pear – *Cylindropuntia rosea*

Non-chemical options: Small plants can be carefully mechanically removed.

	Chemical and concentration	Rate	Comments
PER10544	Triclopyr 300 g/L + picloram 100 g/L Various trade names	1 L per 100 L of water	Spot spray application, add 0.5 % Uptake spray oil.
	Triclopyr 600 g/L Various trade names	1 L per 75 L of diesel 3 L per 100 L of water	Spot spray application. Add 0.5% Uptake spray oil.

Hygrophila – *Hygrophila costata*

Non-chemical options: Small plants or infestations can be dug up, bagged and removed.

See *Hygrophila* Weed Alert for further details.

	Chemical and concentration	Rate	Comments
PER11567	Glyphosate 360 g/L Various trade names for aquatic use only	1.0 L per 100 L of water	Spray when plants are actively growing, re-treatments may be necessary. Do not spray directly onto waters surface or non-target species. Minimise off target damage and water pollution by spraying towards the bank. Do not apply more than 3 times a year.
	Metsulfuron-methyl 600 g/kg Various trade names	5–10g per 100 L of water	

Hymenachne – *Hymenachne amplexicaulis*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Physical removal of small or individual plants may be effective. Take care to remove all plant material and dispose of by deep burial or drying and burning.

	Chemical and concentration	Rate	Comments
PER12101	Glyphosate 360 g/L Various trade names for aquatic use only Various trade names	14 L / hectare	Apply by boom, handgun or knapsack, a maximum of 4 times a year. Refer to permit for further comments

Illyrian thistle – *Onopordum illyricum*

Non-chemical options: Establish a strong, perennial pasture. Grub single plants, removing 50 mm of the root. Biological control agents are available.

	Chemical and concentration	Rate	Comments
	Dicamba 500 g/L Various trade names	40 mL per 100 L water 600 mL/ha	High volume spot spray. Boom spray.

Japanese sunflower – *Tithonia diversifoliarr*

Non-chemical options: Seedlings and individual plants can be physically removed.

Chemical and concentration	Rate	Comments
Metsulfuron-methyl 600 g/kg Various trade names	10 g in 100 L of water	Apply to actively growing plants after full leaf expansion but before seed set. Add surfactant.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Apply as foliar spray pre-flowering
Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL in 100 L of water	Apply as a foliar spray pre-flowering.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Johnson grass – *Sorghum halepense*

Non-chemical options: Cultivation is ineffective because of rhizome segmentation. This only increases spread.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names and formulations	1.0 L per 100 L of water 6.0 L/ha 1.0 L glyphosate per 2 L of water	Spot spray. Boom spray. Actively growing plants at early head stage. Wiper equipment.
Imazapyr 150g/L plus Glyphosate 150 g/L Arsenal Express®	10 L/ha	Boom spray application
MSMA 800 g/L Various trade names	1.0 L per 100 L of water 10–12 L/ha in 500 L of water	Spot spraying. Boom spraying.
Flupropanate 745 g/L Various trade names	200 mL per 15 L of water 1.0 L per 100 L of water 12.0–22.0 L/ha	Knapsack spray. High volume spot spray. Boom spray.

Karoo thorn – *Acacia karroo*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

There are no registered herbicides for the control of this plant.

Khaki weed – *Alternanthera pungens*

Non-chemical options: Improve lawns and turf density to create competition, grub at least 50 mm of the root.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names and formulations	1.1 – 2.2 L/ha	Seedlings only.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL in 100 L of water	Active growth in full leaf.
Amitrole 250 g/L + ammonium thiocyanate 220 g/L Various trade names	1.1 L in 100 L of water	Spot spray. Actively growing plants.

Kidney-leaf mud plantain – *Heteranthera reniformis*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

	Chemical and concentration	Rate	Comments
PER990711604	Glyphosate 360 g/L Various trade names	200ml per 10 L of water	Foliar application
PER9907	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Foliar application in terrestrial situations only.

Kochia – *Kochia scoparia*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

There is no registered herbicide control for this plant.

Kudzu – *Pueraria lobata*

Non-chemical options: Continual grazing or cutting can kill the plant. Manual removal is difficult because of the existence of a large underground tuber.

	Chemical and concentration	Rate	Comments
PER11604	Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Foliar application from spring to autumn. For further information read the permit critical use comments.
PER11604	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Foliar application from spring to autumn. For further information read the permit critical use comments.

Lacy ragweed – *Ambrosia tenuifolia*

Non-chemical options: A perennial plant reproducing from seed and root, making physical removal unpractical. In some situations, biological agents may give some control.

	Chemical and concentration	Rate	Comments
	Dicamba 500 g/L Various trade names	600 mL per 100 L of water 8.8 L/ha	High volume spot spray. Use a minimum of 1500 L /ha of water. Add a surfactant.

Lagarosiphon – *Lagarosiphon major*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: A submerged aquatic plant that is difficult to control using chemicals. The use of mechanical control, where practicable, is recommended.

QUIK-SPRAY – full page colour

Lantana – *Lantana camara*

Non-chemical options: Manual control can be effective by slashing, burning or manual removal, integrated together with pasture improvement. Biological control research is continuing. See the *National Lantana Control Manual* and *Lantana Primefact* for further information.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL or 500 mL in 100 L of water	Wet thoroughly, use higher rate on large bushes, 1–2 m tall. Low rates for bushes up to 1 m tall. Apply from summer to autumn.
Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 or 500 mL per 100 L of water	Wet thoroughly, use higher rate on large bushes, 1–2 m tall. Low rates for bushes up to 1 m tall. Apply from summer to autumn.
Fluroxypyr 333 g/L Starane Advanced®	300 mL or 600 in 100 L of water	Apply to actively growing bushes from October to April. Use lower rate on seedlings or bushes to 1.2 m high, higher rate on bushes over 1.2 m.
Fluroxypyr 200 g/L Various trade names	500 mL or 1.0 L per 100 L of water	Apply to actively growing bushes from October to April. Use lower rate on seedlings or bushes to 1.2 m high, higher rate on bushes over 1.2 m.
Fluroxypyr 140 g/L + aminopyralid 10 g/L Hotshot®	500 mL per 100 L of water 700 mL per 100 L of water	Seedlings and regrowth 0.5–1.2 m height. Mature plants and regrowth 1.2–2.0 m. Apply to actively growing plants.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Basal bark or cut stump application.
Glyphosate 835 g/kg + metsulfuron-methyl 10 g/kg Trounce®	1 measured pack (173 g) per 100 L of water	Apply when actively growing, thoroughly wet all foliage and stems. Do not apply during stress periods.
Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cutout®	1 measured pack (95 g) per 100 L of water	Apply when actively growing, thoroughly wet all foliage and stems. Do not apply during stress periods.
Glyphosate 360 g/L Various trade names	1.0 L per 100 L of water	Actively growing with full foliage. Avoid summer stress.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	High volume spot spray. Thoroughly wet foliage and soil around the base of plant during March to May.
Dichlorprop 600 g/L DP600®	1.0 L per 200 L of water	Spot spray application, completely wet all leaves and stems.
Triclopyr 600 g/L Various trade names	1.0 L per 60 L of diesel	Basal bark application for basal diameter less than 5 cm or cut stump application above 5 cm.
Metsulfuron-methyl 600 g/kg Brushoff®	10 g metsulfuron-methyl plus 200 mL glyphosate per 100 L of water	Apply to bushes up to 2 m high. Thoroughly wet all foliage and stems. Add organosilicone penetrant.
Glyphosate 360 g/L Various trade names	10 g metsulfuron-methyl plus 200 mL glyphosate per 100 L of water	Apply to bushes up to 2 m high. Thoroughly wet all foliage and stems. Add organosilicone penetrant.
Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Apply to bushes up to two metres tall. Spray to wet all foliage and stems. Re-treatment will be necessary.
2,4-D Amine 625 g/L Various trades names	320 mL in a 100 L of water	Apply to actively growing bushes.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Leucaena – *Leucaena leucocephala*

Non-chemical options: Small plants can be mechanically removed.

	Chemical and concentration	Rate	Comments
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Cut stump/basal bark application.

Lippia – *Phyla* spp.

Commonly used as a lawn species; this practice should be discouraged.

Non-chemical options: Pasture improvement and grazing management. See *Lippia Management Manual* and Primefact 959 *Lippia* for further information.

	Chemical and concentration	Rate	Comments
	Dichlorprop 600 g/L DP® 600	5 mL per 1 L of water 1.0 L per 200 L of water or 5.0–7.0 L/ha	Knapsack rate. Completely wet plants. Boomspray using high water volumes. Minimum application of 100 L/ha. For best results spray at flowering when there is good soil moisture.
PER10917	2,4-D amine 625 g/L Various trade names and formulations	1.7–3.1 L/ha plus 1% crop oil	Pastoral land situation. Apply when Lippia is in a fresh condition, mid-flower, with good soil moisture present.

Long-leaf willow primrose – *Ludwigia longifoliarr*

Non-chemical options: Small plants may be manually removed, taking care not to spread seed. For further information see the *Long-Leaf Willow Primrose Weed Alert*.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names for aquatic use only	1.0 L per 50 L of water	Spot spray application.

Long-style feather grass – *Pennisetum villosum*

Non-chemical options: Cultivate and establish pasture cover to provide competition and prevent invasion.

	Chemical and concentration	Rate	Comments
PER9792	Flupropanate 745 g/L Various trade names	300 mL per 100 L of water	spot spray application
PER10919	Glyphosate 360 g/L Various trade names	1 L in 100 L of water	Spot spray application. Apply when plant is actively growing.

Ludwigia – *Ludwigia peruviana*

Non-chemical options: Small plants can be manually removed. Dense stands can be slashed and burnt. Take care not to spread the seed.

	Chemical and concentration	Rate	Comments
	Glyphosate 360 g/L Various trade names for aquatic use only.	1 L in 100 L of water	Actively growing at or beyond the early bloom stage of growth but before autumn change of colour. Thorough coverage is necessary for best results.
PER9966 PER10597	2, 4-D amine 500 g/L Various trade names These are limited use permits.	125 mL in 100 L of water	Apply as direct application to foliage, minimising runoff from leaf surface. Do not apply as a broadcast spray over water.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Madeira vine – *Anredera cordifoliarr*

Non-chemical options: Small seedlings and tubers can be manually removed, bagged and composted.

	Chemical and concentration	Rate	Comments
	Fluroxypyr 333 g/L Starane Advanced®	300 mL in 100 L of water	Apply at times of active growth. Avoid drift on to desirable plants.
	Fluroxypyr 200 g/L Various trade names	500 mL in 100 L of water	Apply at times of active growth. Avoid drift on to desirable plants.
PER10200	Triclopyr 300 g/L + picloram 100 g/L Various trade names	400 mL in 100 L of water	Handgun spray vines on ground Refer to permit for critical use comments
PER9907	Glyphosate 360 g/L Various trade names	Undiluted glyphosate 100 mL glyphosate per 10 L of water	Stem scraping application. Spot spray for seedling control. Add a surfactant.
	Metsulfuron-methyl 600 g/kg Various trade names	200 mL glyphosate plus 1.5 g metsulfuron-methyl in 10 L of water	Spot spray for seedling control.
PER12367	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	50 mL / 10 L water	Knapsack. Spray thoroughly.
	Triclopyr 300 g/L + picloram 100 g/L Grazon DS®		
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Mesquite – *Prosopis* spp.

A Class 2 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Blade ploughing and fire on dense infestations. Grazing management and grubbing to prevent reinfestation. See *National Mesquite Control Manual* for further information.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Controls seedlings, plants in full leaf and flowering before podding. Thoroughly wet all foliage, stems and soil around the base of the plants. Add a wetting agent to increase efficacy. Do not spray plants bearing pods.
Triclopyr 300 g/L + picloram 100 g/L various trade names	350 mL in 100 L of water	Controls seedlings, plants in full leaf and flowering before podding. Thoroughly wet all foliage, stems and soil around the base of the plants. Add a wetting agent to increase efficacy. Do not spray plants bearing pods.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark application of plants up to 5 cm in diameter. Cut stump for plants over 5 cm.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Miconia – *Miconia* spp.

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Physical removal gives best results. See NSW DPI *Miconia* Weed Alert for further information.

Chemical and concentration	Rate	Comments
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
Glyphosate 360 g/L Various trade names	1 part glyphosate per 1.5 parts water	Cut stump or stem-scraping application.

Mintweed – *Salvia reflexa*

Non-chemical options: To prevent invasion, maintain a strong, competitive pasture.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names	700 mL to 2.1 L/ha	Boom spray application
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D 2,4-D amine 625 g/L Various trade names	300 mL Tordon® plus 375 mL 2,4-D amine /ha	Tank mix for effective control.
MCPA amine 500 g/L various trade names	2.0 L/ha	Boom spray application for actively growing seedlings.
Glyphosate 360 g/L Various trade names	500–700 mL per 100 L of water 2.0–3.0 L/ha	High volume spot spray. Boom spray. Apply to actively growing plants.

Mimosa – *Mimosa pigra*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI, phone 1800 680 244.

There are no registered herbicides for this plant in NSW.

Mimosa bush – *Acacia farnesiana*

Non-chemical options: Small plants can be mechanically removed.

	Chemical and concentration	Rate	Comments
	Fluroxypyr 333 g/L Starane Advanced®	1 L in 55 L of Diesel	Basal bark application
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Cut stump/basal bark application.
PER11638	Chlorpyralid 300g/L Various trade names Metsulfuron-methyl 600 g/L Various trade names	10g of Metsulfuron-methyl plus 300mL of chlorpyralid in 100 L of water	High volume foliar application. Apply to actively growing plants in full leaf. Add a surfactant.
PER10040	Tebuthiuron 200g/kg Various trade names	2g / square m	Read and follow permit and label instructions thoroughly

Mistflower – *Ageratina riparia*

Non-chemical options: Improved pastures and well-managed grazing will assist control.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Foliarr application from spring to autumn on actively growing bushes
	Aminopyralid 10g/L + Fluroxypyr 140 g/L Hotshot®	700mL per 100 L of water	Apply to actively growing plants from October to April.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL per 100 L of water	Spring to autumn on actively growing bushes.
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	Actively growing bushes.
	Metsulfuron-methyl 600 g/L Various trade names	5 g per 100 L of water	Apply when bush is actively growing and before flowering.
	Fluroxypyr 333 g/L Starane Advanced®	300 mL in 100 L of water	Apply to actively growing seedlings and young plants before flowering
	Fluroxypyr 200 g/L Various trade names	500 mL per 100 L of water	Actively growing seedlings and young bushes before flowering.
	Glyphosate 360 g/L Various trade names	5 mL per 1 L of water 1.0 L per 9 L water (3 mL per m ²)	Actively growing bushes with full foliage. Low volume application.

Montbretia – *Crocsmia x crocosmiiflora*

Non-chemical options: A member of the bulb group of plants. Physical removal will be difficult because of the number of bulblets attached to the main bulb.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1.0 L in 50 L of water 1 part glyphosate per 1 part water	Spray between flowering and fruiting. Weed wand application.

Morning glory – *Ipomoea cairica/Ipomoea indica/Ipomoea alba*

Non-chemical options: Small seedlings can be manually removed. Vines and runners can be collected and destroyed.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	200 mL per 10 L of water 1 part glyphosate per 1.5 parts water	Spot-spray for seedling control. Stem scraping application.
	Metsulfuron-methyl 600 g/L Various trade names	200 mL glyphosate plus 1.5g of metsulfuron-methyl in 10 L water	Spot spray application
PER12367	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra [®]	50 mL / 10 L water	Knapsack.
	Triclopyr 300 g/L + picloram 100 g/L Grazon DS [®]		
	Picloram 45 g/kg Vigilant [®]	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).
	Dichlorprop 600g/L DP 600 [®]	1 L in 200 L of water	Completely wet all leaves and stem of target plants

Moth vine – *Araujia sericifera*

Non-chemical options: Physical removal of young plants; bag and remove any fruit.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	200 mL per 10 L of water 1 part per 1.5 parts of water	Treat seedling plants. Stem cut, scrape and paint application
	Metsulfuron-methyl 600 g/L Various trade names	2 L glyphosate plus 15g metsulfuron- methyl in 100L water 10–20g per 100L of water	Spot spray Spot spray
	Picloram 45 g/kg Vigilant [®]	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Mother of millions – *Bryophyllum* spp.

Non-chemical options: For best results maintain strong pasture competition.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Apply at Flowering, add a surfactant.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply at flowering, add a surfactant.
	2,4-D 300 g/L Affray®	70 mL in 10 L of water	Thorough even coverage of leaves
	2,4-D amine 625 g/L Various trade names	400 mL per 100 L of water	Thorough, even coverage of leaves and plantlets is necessary. Add a wetting agent.
	Fluroxypyr 333 g/L Starane Advanced®	360 mL in 100 L of water	Apply to actively growing seedlings and young plants before flowering
	Fluroxypyr 200 g/L Various trade names	600 mL per 100 L of water	Actively growing seedlings and young plants before flowering.
PER11424	Metsulfuron-methyl 600 g/kg Various trade names Glyphosate 360 g/L Various trade names	10 g metsulfuron-methyl plus 200 mL glyphosate in 100 L of water	Apply just prior to flowering, add a surfactant.

Murraya – *Murraya paniculata*

Non-chemical options: Seedlings may be manually removed.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360g/L Various trade names	200 mL per 10 L of water 1 part per 1.5 parts of water	Foliar application for seedlings/ coppice shoots. Stem injection / cut stump application, saplings to large shrubs.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Mysore thorn – *Caesalpinia decapetala*

Non-chemical options: Physical removal of small seedling plants.

	Chemical and concentration	Rate	Comments
	Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Spray to thoroughly wet all foliage, but not to cause run off. Apply to actively growing plants before flowering. Add wetting agent.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Nodding thistle – *Carduus nutans*

Non-chemical options: Good perennial pastures with sound grazing management.

Chemical and concentration	Rate	Comments
MCPA 500 g/L Various trade names	250 mL MCPA per 150 L of water 2.5 L MCPA /ha	Spot spray. Boom spray. Spray at early rosette stage; re-treatment is required.
Clopyralid 300 g/L Various trade names	250 mL clopyralid per 100 L of water 50 or 70 mL clopyralid plus 1.0–1.5 L of MCPA /ha	Spray at rosette to pre-flowering. Boom spray. Spray at rosette to pre-flowering.
2,4-D ester 600 g/L Various trade names and formulations	1.3–1.9 L/ha	Spray rosettes to pre-flowering. For use in grass pastures.

Noogoora burr – *Xanthium occidentale*

Non-chemical options: Noogoora burr in the seedling form is toxic to livestock. Hoeing, chipping or slashing will give control.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names	800 mL–1.1 L/ha	Seedlings only.
MCPA amine 500 g/L Various trade names	1.0–2.0 L/ha	Spray young seedlings only.
Metsulfuron-methyl 600 g/kg Various trade names	7.5 g per 100 L of water	Apply to actively growing plants. Do not apply to plants under stress.
Fluroxypyr 333 g/L Starane Advanced®	45 mL in 100 L of water	Apply to actively growing plants. Seedlings and young plants to 40 cm high.
Fluroxypyr 200 g/L Various trade names	75 mL per 100 L of water	Apply to actively growing plants. Seedlings and young plants to 40 cm high.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	1.0 L/ha	Boom spray application

Ochna – *Ochna serrulata*

Non-chemical options: Small seedlings can be manually removed.

Chemical and concentration	Rate	Comments
Fluroxypyr 333 g/L Starane Advanced®	600 mL in 100 L of water 300 mL per 10 L of Water	Spot spray, Apply to plants up to 2 m tall Gas gun application to plants up to 1 m.
PER9907 Glyphosate 360 g/L Various trade names Metsulfuron-methyl 600g/kg Various trade names	200 mL glyphosate per 10 L of water	Spot spray. Apply to seedlings/ coppice shoots and shrubs.
	1 part glyphosate per 1.5 parts of water 200 mL glyphosate plus 1.5g metsulfuron-methyl per 10 L of water	Scrape stem, cut, and paint. Cut stump saplings. Stem injection large trees and shrubs. Spot spray application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Oleander – *Nerium oleander*

Non-chemical options: Manually remove plants with care, as all parts are highly toxic to both humans and livestock.

Chemical and concentration	Rate	Comments
Triclopyr + picloram 240 g/L + 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark application plants up to 5 cm basal diameter. Cut stump application plants over 5 cm.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Onion weed – *Asphodelus fistulosus*

Non-chemical options: Good pasture management will combat invasion by onion weed.

Chemical and concentration	Rate	Comments
Amitrole 250 g/L + ammonium thiocyanate 220 g/L Amitrole T® and various trade names	1.1 L per 100 L of water	Active growth before flowering. Repeat treatments will be required.

Pampas grass – *Cortaderia* spp.

Non-chemical options: Mechanical removal, wherever possible, is best.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	1.0 or 1.3 L per 100 L of water	Actively growing plants, before flowering, spring to autumn. Use higher rate on plants over 1 m high.

Parthenium weed – *Parthenium hysterophorus*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Clean all vehicles and machinery. Maintain competitive crops and pastures. Do not spread the seed if removing by hand.

See the *National Parthenium Weed Control Manual* and *Parthenium weed* Primefact for further information.

Chemical and concentration	Rate	Comments
Dicamba 500 g/L Various trade names	40 mL per 100 L of water 600 mL/ha	Spot spray. Boom spray. Apply to young, actively growing plants.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	125 mL per 100 L of water 3.0 L/ha	Spot spray. Rosette stage when plants are actively growing. Boom application.
Metsulfuron-methyl 600 g/kg Various trade names	5 g per 100 L of water	Thoroughly wet all foliage to the point of run-off.
Hexazinone 250 g/L Various trade names	70 mL per 100 L of water	Apply uniformly over the area. When spraying single plants treat soil for 1 m around. Do not use near desirable trees.
Atrazine 900 g/kg Various trade names	3.3 L/ha	Protects against emerging seedlings.

Parkinsonia (Jerusalem thorn) – *Parkinsonia aculeata*

A Class 2 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244)

Non-chemical options: Mechanical removal or grubbing gives effective control. See *National Parkinsonia Control Manual* for integrated control methods.

Chemical and concentration	Rate	Comments
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark or cut stump application.
Hexazinone 250 g/L Various trade names	4 mL per spot 1 mL per spot	One spot per bush up to 5 m tall. One spot per bush up to 1 m tall. Do not use near desirable plants.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Parrots feather – *Myriophyllum aquaticum*

Non-chemical options: Physical removal is recommended where appropriate. Draining and drying in suitable situations can control plants. Contain infestations to avoid further spread.

There are no registered herbicides for this plant.

Paterson's curse, viper's bugloss and Italian bugloss – *Echium* spp.

Non-chemical options: Control can be achieved by using spray graze, pasture improvement and good grazing management practices and by the use of biological control agents. See the *Paterson's Curse* Primefact for further information.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	250 mL in 100 L of water	Spot spray from rosette to flowering plants
2,4-D amine 625g/L Various trade names and formulations	170–220 mL in 150 L of water 1.7–2.2 L/ha	Spot spray. Young rosettes. Boom spray.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	150 mL in 100 L of water	Spot spray. Rosettes to pre-flowering.
Glyphosate 360 g/L Various trade names	500–700 mL in 100 L of water 2.0–3.0 L/ha	Spot spray. Actively growing plants. Boom application
Metsulfuron-methyl 600 g/kg Various trade names	5 g in 100 L of water 10–15 g/ha	Apply to rosettes after full leaf expansion but before head emergence. Do not spray after emergence of first flowers, as seed set has occurred.
MCPA 500g/ L Various trade names	1.0–1.5 L/ha	Apply at early rosette stage
Dicamba 500g/ L Various trade names	280 mL per 100 l of water. 4.0 L/ha	Spot spray. Boom spray. Apply prior to flowering. Add wetting agent.

Pellitory weed/asthma weed – *Parietaria judaica*

Non-chemical options: Hand removal before flowering. Flowering plants can cause respiratory problems in humans.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	1.0 L in 100 L of water	Apply to actively growing plants before flowering. Re-treatments may be required to control seedlings.

Perennial ragweed – *Ambrosia psilostachya*

Non-chemical options: Physical removal is not totally effective because of the root system.

Chemical and concentration	Rate	Comments
Dicamba 500 g/L Various trade names	600 mL in 100 L of water 8.8 L/ha	Spot spray. Active growth, small rosettes. Boom application.

Perennial thistle/Californian thistle – *Cirsium arvense*

Non-chemical options: Cultivation is ineffective in controlling this plant because of the perennial root system.

Chemical and concentration	Rate	Comments
Dicamba 500 g/L Various trade names and formulations	200 mL per 100 L of water 2.2 L/ha	Spot spray. Young, actively growing plants. Boom spray.
2,4-D amine 625 g/L Various trade names and formulations	320–380 mL per 100 L of water 3.2–3.8 L/ha	Spot spray. Boom spray. Rosettes to early budding stage.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL per 100 L of water	Spot spray. Spray at budding stage.

Prairie ground cherry – *Physalis viscosa*

Non-chemical options: Cultivation is ineffective because of the perennial root system.

Chemical and concentration	Rate	Comments
Amitrole 250 g/L + ammonium thiocyanate 220 g/L Amitrole T® and various trade names	1.1 L in 100 L of water	Spot spray. Active growth before flowering.

Prickly acacia – *Acacia nilotica*

A Class 1 notifiable noxious weed in some council areas that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Mechanical or chain removal in both directions.

Chemical and concentration	Rate	Comments
Fluroxypyr 333 g/L Starane Advanced®	450 mL in 100 L of water 900 mL per 100 L of diesel	Spot spray, seedlings and young plants up to 2 m tall Basal bark cut stump application
Triclopyr 600 g/L Various trade names	1.0 L in 120 L of diesel	Basal bark/cut stump application.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark/cut stump application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Prickly pears

Non-chemical options: The use of *Cochineal* and *Cactoblastis* biological control agents suited to the variety of pear is the best management practice, where appropriate.

Common pest pear – *Opuntia stricta*

Chemical and concentration	Rate	Comments
Triclopyr 600 g/L Various trade names	1.0 L in 75 L of distillate. 3.0 L in 100 L of water	Apply as a thorough foliar spray.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Apply as a thorough foliar spray
Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL in 100 L of water	Apply as a thorough foliar spray.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of distillate	Foliar application; thoroughly wet plants.

Smooth tree pear – *Opuntia vulgaris*

Chemical and concentration	Rate	Comments
Triclopyr 600 g/L Various trade names	1.0 L per 75 L of distillate	Apply thoroughly as a foliar spray.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Apply as a thorough foliar spray
Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Common pear and smooth tree pear, with active phyllode (leaf) growth.

Tree pear – *Opuntia tomentosa*

Chemical and concentration	Rate	Comments
Triclopyr 240 g/L + picloram 120 g/L Access®	1 L per 60 L of diesel	Apply thoroughly as a foliar spray.
PER10544 Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Apply as a thorough foliar spray
PER10544 Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply as a thorough foliar spray

Tiger pear – *Opuntia aurantiaca*

Chemical and concentration	Rate	Comments
Triclopyr 600 g/L Various trade names	3.0 L per 100 L of water 1.0 L per 75 L of distillate	Apply thoroughly as a foliar spray.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Apply thoroughly as a foliar spray.
PER10544 Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Apply as a thorough foliar spray
PER10544 Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL per 100 L of water	Apply as a thorough foliar spray

Privet – *Ligustrum* spp.

Non-chemical options: Small plants and seedlings can be manually controlled. See Primefact 960 *Privet – broad-leaf, small-leaf and European* for further information.

Chemical and concentration	Rate	Comments
Metsulfuron-methyl 600 g/kg Various trade names	10 g per 100 L of water	Apply to bushes up to 3 m high; complete coverage is essential.
Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cut-out [®]	1 measured pack (95 g) per 100 L of water	Apply to bushes up to 3 m high, in full leaf and actively growing; complete coverage is essential.
Triclopyr 600 g/L Various trade names	1.0 L per 12 L of diesel	Basal bark/cut stump application.
Triclopyr 240 g/L + picloram 120 g/L Access [®]	1.0 L per 30 L of diesel	Basal bark/cut stump application.
Glyphosate 360 g/L Various trade names	Undiluted (1–2 mL per cut)	Stem injection technique, as per label.
Picloram 45 g/kg Vigilant [®]	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Ragwort – *Senecio jacobaea*

Non-chemical options: Physical removal of single plants.

Chemical and concentration	Rate	Comments
2,4-D amine 500 g/L Various trade names and formulations	1.4–4.8 L/ha	Boom spray. Rosette growth stage.
MCPA 340 g/L Various trade names	190–270 mL per 100 L of water 2.8–4.0 L/ha	Spot spray. Boom spray. Apply at the young growth stage.
2,4-D 300 g/L + picloram 75 g/L Tordon [®] 75-D	300 mL per 100 L of water 3.5 L/ha	Spot spray application. Boom application, rosettes to cabbage stage.
Dicamba 500 g/L Various trade names	280 mL per 100 L of water 4.0 L/ha	Spot spray application. Boom application, actively growing rosettes.
Metsulfuron-methyl 600 g/kg Various trade names	5 g per 100 L of water 15 g/ha	Spot spray application. Boom application, actively growing rosettes to cabbage stage.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra [®]	350 mL in 100 L of water	Spot spray. Apply to actively growing plants.
Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL per 100 L of water	Spot spray. Apply to actively growing plants.

Rhizomatous bamboo – *Phyllostachys* spp.

Non-chemical options: Physical removal will give best results.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	200 mL per 10 L of water 1 part per 1.5 parts of water	Spot spray application. Cut stump application.

Rhus tree – *Toxicodendron succedaneum*

The sap from the tree can cause health problems in humans; even the smoke from burning is toxic.

Non-chemical options: When manually removing this tree avoid contact with the sap. Do not mulch or chip for garden use. See Primefact 994 *Rhus* for further information.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	Undiluted (1–2 mL per cut) 1 part glyphosate to 1 part water	Stem injection technique, as per label. Cut stump application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Rubbervine – *Cryptostegia grandiflora*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Seedling plants may be manually removed.

Chemical and concentration	Rate	Comments
Metsulfuron-methyl 600 g/kg Various trade names	15 g per 100 L of water	Hand gun application. Do not apply to bushes more than 3 m tall. Apply October to April, ensuring thorough spray coverage of all foliage.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L per 60 L of diesel	Basal bark and cut stump application.
Triclopyr 600 g/L Various trade names	1.0 L per 60 L of diesel	Basal bark and cut stump application.

Saffron thistle – *Carthamus lanatus*

Non-chemical options: Control can be obtained by slashing, spray topping or pasture improvement.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names and formulations	110–170 mL 2,4-D amine per 150 L of water 1.1–1.7 L 2,4-D amine /ha	Spot spray application. Boom application, apply when in rosette stage.
MCPA 500 g/L Various trade names	100–200 mL in 150 L water 1–2 L MCPA /ha	Spot spray. Boom spray. Apply when in rosette stage. Use higher rate for larger weeds.
Clopyralid 300 g/L Various trade names	250 mL clopyralid per 100 L water 50 or 70 mL clopyralid plus 1.0–1.5 L MCPA /ha	Spot spray. Boom spray. Actively growing rosettes; use higher rate on mature plants.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	300 mL/ha	Boom spray application for young rosette or seedling plants.

Sagittaria – *Sagittaria* spp.

Non-chemical options: Isolated plants can be manually removed.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names for aquatic use only	1.0 L per 100 L of water	Spot spray application. Direct spray onto weed mats in infested areas. Do not broadcast spray over the water.

Salvinia – *Salvinia molesta*

A notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Physical removal of small infestations, the use of biological control agents where appropriate, and reduction of nutrient inflows will all help with control. See the *Salvinia* Primefact and the *National Salvinia Control Manual* for further information

	Chemical and concentration	Rate	Comments
	Diquat 200 g/L Reglone®	400 mL per 100 L of water 5.0–10.0 L/ha	Spray to wet all foliage thoroughly, add Agral 600. Observe withholding period.
	Diquat 20 g/L Vegetrol®	4.0 L per 100 L of water 50–100 L/ha	Thoroughly wet foliage. Best if water is clean; use higher rate if dense weed or dirty water. Observe withholding period.
PER10461	Glyphosate 360 g/L Various trade names for aquatic use only (also PER10529, PER10423)	1.0 L per 100 L of water	Overall spray. Follow directions on specific permits.
	Calcium dodecyl benzene sulfonate 300 g/L Immerse®	1 part per 19 parts kerosene (1 L of mixture per 100 m ²)	Do not use in potable water. Do not spray on solid mats. Plants must be floating in water with a visible water surface between plants.
	Orange Oil Water Clear®	1.0 L per 100 L of water	Spray on to free-floating plants.

Scotch/English broom – *Cytisus scoparius*

Non-chemical options: The use of goats as a grazing management tool or the use of biological control agents offers other means of control.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	250 or 350 mL in 100 L of water	Lower rate when actively growing mid-summer to pod formation. Higher rate for autumn-winter treatment.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	250 or 350 mL per 100 L of water	Lower rate when actively growing mid-summer to pod formation. Higher rate for autumn-winter treatment.
	Triclopyr 600 g/L Various trade names	170 mL per 100 L of water	Late spring to early autumn. Actively growing bushes. Do not use under dry conditions.
	Glyphosate 360 g/L Various trade names for aquatic use only	100–130 mL per 10 L of water	Foliar spot spray application.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Scotch thistle – *Onopordum acanthium*

Non-chemical options: Establish a strong, perennial, grass-based pasture. Grub single plants, removing at least 50 mm of root. There are also biological control agents available.

	Chemical and concentration	Rate	Comments
	MCPA 500 g/L Various trade names Clopyralid 300 g/L Various trade names	1.0–1.5 L MCPA plus 50 or 70 mL clopyralid /ha	Boom spray application on actively growing rosettes. Use higher rate on mature plants.

Senegal tea plant – *Gymnocoronis spilanthoides*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Do not attempt control on your own, as it can spread very easily from dislodged fragments. Contact your Local Weed Control Authority. See Primefact 993 *Senegal tea* for further information.

	Chemical and concentration	Rate	Comments
PER11567	Metsulfuron-methyl 600 g/kg Various trade names	5–10 g per 100 L of water	Spot spray application. Do not spray directly onto water or non-target species.
	Glyphosate 360 g/L Various trade names for aquatic use only	1 L per 100 L of water	Foliar application spot spray. Refer to permit for critical use comments

Senna – winter and smooth – *Senna pendula* var. *glabrata* and *Senna floribunda*

Non-chemical options: Young seedlings can be manually removed. Seed pods should be collected and removed from the site.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part per 1.5 parts of water 200 mL glyphosate per 10 L water	Stem injection/cut stump application. Spot spray application.
	Metsulfuron-methyl 600 g/kg Various trade names	1.0–2.0 g metsulfuron-methyl per 10 L water	Spot spray application.
		200 mL glyphosate plus 1.5 g metsulfuron-methyl per 10 L water	Spot spray application.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Serrated tussock – *Nassella trichotoma*

Non-chemical options: The establishment of perennial pasture together with good grazing management will assist control. Grub out single plants. For further information see the *National Serrated Tussock Best Practice Manual* and Primefact 44 *Serrated tussock – identification and control, 2nd Edition*. Also Primefact 1013 *Recognising, managing and preventing herbicide resistance in serrated tussock*.

	Chemical and concentration	Rate	Comments
	Flupropanate 745 g/L Various trade names	2.0 L/ha 150–200 mL per 100 L of water	Boom and aerial application. Spot spray, from September to May. Four-month withholding period for blanket application.
PER9792	Flupropanate 745 g/L Various trade names	1.5–2.0 L/ha 100–200 mL per 100 L of water	Boom and aerial application. June to August inclusive. Four-month withholding period for blanket application. Spot spray treatment.
PER10919	Glyphosate 360 g/L Various trade names	1 L per 2 L of water	Wick wiping application.
	Glyphosate 360 g/L Various trade names for aquatic use only	0.7–1.3 L to 100 L of water 4.0–6.0 L/ha 0.75–1.25 L/ha	Spot spray application. Boom spray. Apply to actively growing, stress-free plants. Spray topping application. Apply to actively growing, stress-free plants.

Siam weed – *Chromolaena odorata*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Mechanical removal of isolated plants. See *Siam weed* Weed Alert for further information.

Chemical and concentration	Rate	Comments
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Sifton bush – *Cassina arcuata*

Non-chemical options: Slashing, physical removal and chaining will aid control. Soil disturbance adds to the spread of sifton bush.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Foliar application, plants need to be actively growing for optimal effect
Triclopyr 300 g/L + picloram 100 g/L various trade names	500 mL in 100 L of water	Bushes need to be actively growing for optimum effect.
Glyphosate 360 g/L Various trade names	1.0 or 1.3 L in 100 L of water	Apply when actively growing. Ensure complete coverage; use higher rate on bushes over 1 m high.

Silverleaf nightshade – *Solanum elaeagnifolium*

Non-chemical options: The use of strong, competitive crops or pastures will give some control. Quarantine the infestation and prevent seeding. Cultivation is ineffective as it aids the spread from root pieces. Sheep can carry the seed in their digestive tract for periods of 7 days or more without affecting the germination capability. See *Silverleaf nightshade* Primefact 237 for more information.

Chemical and concentration	Rate	Comments
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL in 100 L of water 15.0 L/ha	Spot spray. Spray to wet thoroughly. Extend treated areas beyond the last plant for 1 m. Boom spray. Apply at early flowering before berry set.
Glyphosate 360 g/L Various trade names	2.0 L in 100 L of water	Apply at early flowering to berry set stage, spray thoroughly to wet. Use only with good soil moisture conditions.
Fluroxypyr 333g/L Starane Advanced	300 mL in 100L of water	Delay applications till majority of shoots have emerged. Follow-up treatment will be required

Singapore daisy – *Wedelia trilobata*

Non-chemical options: Small infestations can be manually removed.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	200 mL per 10 L of water	Spot spray. Foliar application.
PER9907 Glyphosate 360 g/L Various trade names Metsulfuron-methyl 600 g/kg Various trade names	200 mL glyphosate plus 1.5 g metsulfuron-methyl per 10 L water	Spot spray application.

Spiny burr grass – *Cenchrus incertus/Cenchrus longispinus*

Non-chemical options: A strong, competitive summer pasture will give assist with effective control. Ensure equipment hygiene is used to prevent seed dispersal and also quarantine the infestation.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names	500–700 mL in 100 L of water 2.0–3.0 L/ha	High volume spot spray. Boom spray. Actively growing plants before seeding. Non-selective. Application in non-crop areas and roadsides.
MSMA 800g/L Various trade names	1.0 L in 100 L of water	Spot spray application. Do not cut or graze effected area for 5 weeks.

Spear thistle – *Cirsium vulgare*

Non-chemical options: Hoe or chip to remove small infestations.

Chemical and concentration	Rate	Comments
2,4-D Amine 625 g/L Various trade names	1.1–1.6 L/ha	Boom spray. For pastures not containing legumes. Spray young rosettes.
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	150 mL in 100 L of water	Foliar application from rosette to flowering plants
MCPA 500 g/L Various trade names	1.5–2.0 L/ha	Boom spray. Apply to rosettes actively growing; use higher rate on larger plants.

Spiny emex – *Emex australis*

Non-chemical options: An autumn/winter growing plant mainly associated with winter crops; dig out single plants or encourage a dense, winter-based pasture for competition.

Chemical and concentration	Rate	Comments
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	300 mL per 100 L of water	Spot spray. For use in grass pastures.
Glyphosate 360 g/L Various trade names	500–700 mL per 100 L of water 2.0–3.0 L/ha	Spot spray. Boom spray. Young, actively growing plants.
2,4-D Amine 500 g/L	1.4–1.7 L/ha	Boom spray application for young plants
Metsulfuron-methyl 600 g/kg Various trade names	5–10 g/ha	Add surfactant, apply to young actively growing plants. Use higher rate to control dense stands.

Spotted golden thistle – *Scolymus maculata*

Non-chemical options: Encourage a dense, improved pasture.

Chemical and concentration	Rate	Comments
2,4-D ester 600 g/L Various trade names and formulations	3.7 L/ha	Boom spray in grass pastures. Apply to actively growing rosettes.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	300 mL in 100 L of water 3.5 L/ha	Spot spray. Boom spray. Apply to seedling and rosette stages.

Spotted knapweed – *Centaurea maculosa*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Hoe or chip, removing at least 50 mm of the root; improve the pasture stand.

There are no herbicides registered for this plant.

Star thistle – *Centaurea calcitrapa*

Non-chemical options: Hoe or chip, removing at least 50 mm of the root; improve the pasture stand.

Chemical and concentration	Rate	Comments
2,4-D ester 600 g/L Various trade names and formulations	1.3–1.9 L/ha	Seedling to rosette stage.
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	300–500 mL in 100 L of water 3.5–7.5 L/ha	Spot spray. Seedling to rosette stage. Boom spray application. Use higher rate on older rosettes.
Dicamba 500 g/L Various trade names	100 mL in 100 L of water 1.6 L/ha	Spot spray. Seedlings to young, mature rosettes. Boom application.

Stemless thistle – *Onopordum acaulon*

Non-chemical options: Establish a strong, perennial, grass-based pasture. Grub single plants, removing 50 mm of root. There are also biological control agents available.

Chemical and concentration	Rate	Comments
2,4-D ester 600 g/L Various trade names and formulations	2.8–3.7 L/ha	For use in grass pastures. Spray rosette to flowering.
Dicamba 500 g/L Various trade names	80 mL in 100 L of water 1.2 L/ha	Spot spray. Seedlings to young mature plants; use lower rate on seedlings and higher rate on young, mature plants. Boom application.

St Barnaby's thistle – *Centaurea solstitialis*

Non-chemical options: Encourage strong, legume-based pasture to provide competition. Slashing, if timed right, is effective.

Chemical and concentration	Rate	Comments
2,4-D ester 600 g/L Various trade names and formulations	1.3–1.9 L/ha	Boom spray. Seedlings to rosette stage.
Glufosinate ammonium 200 g/L Various trade names	150–500 mL in 100 L of water 1.5–5.0 L/ha	Spot spray. Boom spray. Actively growing rosettes.

St John's wort – *Hypericum perforatum*

Non-chemical options: The use of perennial pastures and grazing management, together with the use of biological control agents, will offer some control.

Chemical and concentration	Rate	Comments
Triclopyr + picloram 300 g/L + 100 g/L + Aminopyralid 8 g/L Grazon Extra [®]	500 mL in 100 L of water 2.0–4.0 L/ha	Foliar application from late spring to early summer, during flowering to early seed set Boom spray
Triclopyr + picloram 600 g/L Various trade names	500 mL in 100 L of water 2.0–4.0 L/ha	Late spring to early summer, during flowering to early seed set. Boom spray.
Fluroxypyr 333 g/L Starane Advanced [®]	300 mL in 100 L of water	Foliar application from flowering to early seed set. Observe withholding period.
Fluroxypyr 200 g/L Various trade names	500 mL in 100 L of water 3.0 L/ha	Spring to mid summer application. Boom application. Observe withholding period.
Aminopyralid 10 g/L + fluroxypyr 140 g/L Hotshot [®]	700 mL in 100 L of water	Foliar application from flowering to early seed set
Glyphosate 360 g/L Various trade names	3.0 L/ha	Apply November to May, flowering to post-flowering.
2,4-D ester 600 g/L Various trade names and formulations	3.7–5.3 L/ha	For use in grass pastures, before flowering, when the plants are less than 40 cm high.
Glyphosate + metsulfuron-methyl 835 g/kg + 10 g/kg Trounce [®]	1 measured pack (173 g) in 100 L of water	Actively growing from spring to summer.
Glyphosate 360 g/L Various trade names Metsulfuron-methyl 600 g/L Various trade names	200 mL glyphosate plus 10 g metsulfuron-methyl in 100 L of water	Spray to wet, but not to cause run-off.

Sweet briar – *Rosa rubiginosa*

Non-chemical options: The use of mechanical removal, grubbing or grazing with goats gives control.

Chemical and concentration	Rate	Comments
Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	500 mL in 100 L of water	Foliar application for plants up 1.5m tall
Triclopyr 300 g/L + picloram 100 g/L Various trade names	500 mL in 100 L of water	Full-leaf to ripe fruit prior to leaf fall. Use higher rate on bushes over 1.5 m high.
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark/cut stump application.
Triclopyr 600 g/L Various trade names	1.0 L in 30 L of diesel	Basal bark/cut stump application
2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL in 100 L of water	Full leaf as an overall spray.
Glyphosate 360 g/L Various trade names	1.5–2.0 L in 100 L of water	Spray to wet all foliage, from late flowering to leaf fall. Use higher rate on bushes over 1.5 m high.
Metsulfuron-methyl 600 g/L Various trade names	10 g in 100 L of water	Apply to actively growing bushes to point of run. Do not apply after end of February.
Glyphosate 835 g/kg + metsulfuron-methyl 10 g/kg Trounce®	1 measured pack (173 g) in 100 L of water	Apply as close to the flowering period as possible.
Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cut-out®	1 measured pack (95 g) in 100 L of water	Apply as close to the flowering period as possible.
Hexazinone 250 g/L Various trade names	Undiluted (4 mL per spot)	One spot per metre of height. Do not apply near desirable trees.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Sweet pittosporum – *Pittosporum undulatum*

Non-chemical options: Physical removal is best.

Chemical and concentration	Rate	Comments
PER9907 Glyphosate 360 g/L Various trade names	200 mL in 10 L of water	Foliar seedling treatment.
	1 part per 1.5 parts of water	Cut stump/basal bark application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Tiger lily – *Lilium formosanum*

Non-chemical options: Physical removal will be difficult because of bulb-like underground parts of the plant.

Chemical and concentration	Rate	Comments
PER9907 Glyphosate 360 g/L Various trade names	100 mL glyphosate plus 1.5 g metsulfuron-methyl per 10 L of water	Spot spray application between flowering and fruiting. Add wetting agent
	Metsulfuron-methyl 600 g/kg Various trade names	1.5g metsulfuron-methyl in 10 L of water
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel across the cut surface on the rhizome (see label).

Tobacco bush – *Solanum mauritianum*

Non-chemical options: Seedlings can be manually removed.

	Chemical and concentration	Rate	Comments
	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	350 mL in 100 L of water	Foliar application from spring to autumn for plants up to 2m tall
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Cut stump application.
	Triclopyr 300 g/L + picloram 100 g/L Various trade names	350 mL in 100 L of water	Foliar application from spring to autumn for plants up to 2m tall
PER9907	Glyphosate 360 g/L Various trade names	200 mL glyphosate per 10 L of water	Foliar application for seedlings.
		1 part per 1.5 parts of water	Cut stump/injection application.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Tree of heaven – *Ailanthus altissima*

Non-chemical options: Mechanical removal of mature trees, unless wet, will cause suckering from the broken roots.

	Chemical and concentration	Rate	Comments
	Triclopyr 600 g/L Various trade names	1.0 L in 60 L of diesel	Basal/bark, cut-stump application.
	2,4-D 300 g/L + picloram 75 g/L Tordon® 75-D	650 mL in 100 L of water	Foliar application, apply at full leaf.
	Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark/cut stump application. Dormant species, not to be treated in winter.
	Metsulfuron-methyl 600 g/L Various trade names Glyphosate 360 g/L Various trade names	10 g metsulfuron-methyl plus 200 mL glyphosate in 100 L of water	Apply to actively growing trees to point of run. Ensure all daughter plants are controlled.
	Metsulfuron-methyl 63.2 g/kg + glyphosate 760.5 g/kg Cut-out®	1 measured pack (95 g) in 100 L of water	Apply when trees are in full leaf and actively growing; ensure all daughter plants are treated. November to January.
	Hexazinone 250 g/L Various trade names	4 mL per spot, one spot per metre of height	For use on bushes up to 3 m tall. Do not apply near desirable trees.
	Metsulfuron-methyl 600 g/L Various trade names	10 g in 100 L of water	Apply to actively growing trees. Avoid spraying when stressed, when leaf fall has commenced, or after the end of February.
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Tropical soda apple – *Solanum viarum*

A Class 2 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: seedlings can be manually controlled taking care to remove all plant and root fragments. See *Tropical soda apple* Weed Alert for more information.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	200 mL in 10 L of water 1 part per 1.5 parts of water	Spot spray application Cut stump application
	Fluroxypyr 200 g/L Various trade names	500 mL in 100 L of water	Spot spray application

Turkey rhubarb – *Acetosa sagittata*

Non-chemical options: Grub out single plants, prevent plants from seeding.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	200 mL in 10 L of water 1 part per 1.5 parts of water	Spot spray application Scrape stem application

Tussock paspalum – *Paspalum quadrifarium*

Non-chemical options: Grub out single tussocks, slash to prevent seeding.

	Chemical and concentration	Rate	Comments
PER10919	Glyphosate 360 g/L Various trade names	1.0 L per 100 L of water	Spot spray application

Umbrella tree – *Schefflera actinophylla*

Non-chemical options: Seedlings can be manually removed.

	Chemical and concentration	Rate	Comments
PER9907	Glyphosate 360 g/L Various trade names	1 part per 1.5 parts of water 200 mL per 10 L of water	Stem injection/cut stump application. Foliar application for seedlings
	Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Wandering Jew – *Tradescantia albiflora*

Non-chemical options: Small infestations can be manually removed and composted.

	Chemical and concentration	Rate	Comments
PER12367	Triclopyr 300 g/L + picloram 100 g/L + Aminopyralid 8 g/L Grazon Extra®	50 mL / 10 L water	Knapsack. Spray thoroughly.
	Triclopyr 300 g/L + picloram 100 g/L Grazon DS®		
PER9907	Glyphosate 360 g/L Various trade names	200 mL per 10 L of water	Treat in winter or early spring. For best results, add a surfactant. Apply two sprays, 6–8 weeks apart. Repeat treatments are essential.
	Fluroxypyr 333 g/L Starane Advanced®	900 mL in 100 L of water	Foliar application. Re-treatment necessary. Young plants up to and including flowering.
	Fluroxypyr 200 g/L Various trade names	1.5 L in 100 L of water	Foliar application. Re-treatment necessary. Young plants up to and including flowering.
	Picloram 45 g/kg Vigilant®	Undiluted (16 g /m ²)	Use a long-handled paint roller or similar making sure the foliage has been completely flattened during application. (See label).

Water hyacinth – *Eichhornia crassipes*

A notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: If practicable, small infestations can be manually removed. Care needs to be taken not to spread the weed further. For further information see the *Water Hyacinth* Primefact.

	Chemical and concentration	Rate	Comments
	Diquat 200 g/L Reglone®	400 mL per 100 L of water 5.0 to 10.0 L/ha	Add Agral 600 wetter; use clean water for best results. Observe withholding period.
	Diquat 20 g/L Vegetrol®	4.0 L per 100 L of water 50–100 L/ha	Apply as an overall spray. Thoroughly wet foliage. Best if clean water is used; higher rate if dense weed or dirty water. Observe withhold period.
	Amitrole 250 g/L Various trade names	280 mL to 100 L of water	Apply prior to flowering.
	Glyphosate 360 g/L Various trade names for aquatic use only.	1.0–1.3 L in 100 L of water 6.0–9.0 L/ha	Apply when actively growing, at or beyond the early bloom stage. Use higher rate on dense infestations.
	2,4-D acid 300 g/L Affray 300®	1.0 in 200 L of water	Avoid causing submersion of sprayed plants.

Water lilies – *Nymphaea* spp.

Non-chemical options: Small infestations can be manually removed.

	Chemical and concentration	Rate	Comments
	Diquat 200 g/L Reglone®	400 mL per 100 L of water 5.0–10.0 L/ha	Add Agral 600 wetter; use clean water for best results. Observe withholding period.
	Diquat 20 g/L Vegetrol®	4.0 L per 100 L of water 50–100 L/ha	Apply as an overall spray. Thoroughly wet foliage. Best if clean water is used; higher rate if dense weed or dirty water. Observe withholding period.
	Glyphosate 360 g/L Various trade names for aquatic use only	1 L to 100 L of water	Re-treat unaffected plants.

Water lettuce – *Pistia stratiotes*

A Class 1 notifiable noxious weed that must be reported to LCAs and NSW DPI (phone 1800 680 244).

Non-chemical options: Physical removal of small infestations can be effective. See *Water Lettuce* Primefact for further information.

Chemical and concentration	Rate	Comments
Diquat 200 g/L Reglone®	400 mL per 100 L of water 5.0–10.0 L/ha	Add Agral 600 wetter, use clean water for best results. Observe withholding period.
Diquat 20 g/L Vegetrol®	4.0 L per 100 L of water 50–100 L/ha	Apply as an overall spray. Thoroughly wet foliage. Best if clean water is used; higher rate if dense weed or dirty water. Observe withholding period.
Glyphosate 360 g/L Various trade names for aquatic use only	1.0–1.3 L in 100 L of water	Best results are obtained from mid-summer through to winter. Use higher rate on dense infestations.
2,4-D acid 300 g/L AFFRAY 300®	1.0 in 200 L of water	Avoid causing submersion of sprayed plants. Coverage: 200 L spray solution per 1000 square metres.
Calcium dodecyl benzene sulfonate 300g/L Immerse®	1 part in 19 parts kerosene (1 L of mixture / 100 m ²)	Do not use in potable water. Do not spray on solid mats. Plants must be floating in water with a visible water surface between plants.

Whorled pigeon grass – *Setaria verticillata*

Non-chemical options: Slashing to prevent seed set and grazing management will aid control.

There are no herbicide registrations for this plant.

Wild radish – *Raphanus raphanistrum*

Non-chemical options: Maintain a well-balanced pasture with good grazing management.

Chemical and concentration	Rate	Comments
2,4-D amine 625 g/L Various trade names	800 mL–1.1 L/ha	Apply to rosettes before flowering.
MCPA 500 g/L Various trade names	1.0 L/ha	Apply to rosettes before flowering.

Willows – *Salix* spp.

Non-chemical options: Mechanical removal is best, ensuring that all of the root system is removed. For further information see the *National Willows Control Manual*.

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Various trade names and formulations	1.0–1.3 L in 100 L of water	Spray to wet all foliage. Use the higher rate for trees 1–2 m high.
	Undiluted	Stem injection.
Triclopyr + picloram Access®	1.0 L in 15 L of diesel	Cut stump application. Need to treat all stems.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Woody weeds

Chemical and concentration	Rate	Comments
Glyphosate 360 g/L Roundup®	15 mL in 1 L water	Apply when weeds are actively growing. Treat from flowering to leaf fall (Jan–may). Spray to wet all leaves. 1 L of spray will cover 10 square metres.

Yellow bells – *Tecoma stans*

Non-chemical options: Small trees and seedlings may be manually removed.

Chemical and concentration	Rate	Comments
Triclopyr 240 g/L + picloram 120 g/L Access®	1.0 L in 60 L of diesel	Basal bark/cut stump application.
Glyphosate 360g/L Various trade names	1.0 L in 50 L of water 1 part per 1.5 parts of water	Spray seedlings. Stem injection or cut stem application.
Picloram 45 g/kg Vigilant®	Undiluted	Cut stump/stem injection application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm (see label).

Gas gun/splatter gun application

Metsulfuron methyl 600 g/L

Various trade names

Weed	Rate	Comment
Bitou bush/boneseed	1 g/L + organosilicone penetrant	Spray as close as possible to the flowering stage.
Blackberry	1 g/L + organosilicone penetrant	Thoroughly wet all foliage and canes. Commence application at flowering as this indicates good growing conditions.
Privet	1 g/L + organosilicone penetrant	Spray only bushes up to 3 m high, when in full leaf and actively growing. Thorough coverage is essential.
Sweet briar	1 g/L + organosilicone penetrant	Apply during the flowering period. Ensure thorough coverage of all leaves and stems.

Triclopyr 600 g/L

Various trade names

Weed	Rate	Comment
Blackberry	280 L per 10 L of water	Good control will be achieved, similar to high volume application, where bush size enables good coverage of entire bush. The use of a marking agent is recommended to check on coverage.

Triclopyr 300 g/L + picloram 100 g/L

Various trade names

Weed	Rate	Comment
Blackberry	335 mL per 10 L of water	Apply to actively growing bushes
Crofton weed, camphor laurel, mistflower, St John's wort, sweet briar and tobacco bush	500 mL per 10 L of water	Apply to actively growing bushes

Glyphosate 360 g/L

Various trade names and formulations

Weed	Rate	Comment
Bitou bush /boneseed	1 part per 29 parts water or 1 part per 19 parts water	Ensure spray contacts all foliage. Use the higher rate on bushes over 1.5 m.
Groundsel bush	1 part per 9 parts water	Apply 2 × 2 mL doses per 0.5 m of bush height. Ensure that spray contacts all foliage.
Lantana	1 part per 9 parts water	Apply 2 × 2 mL doses per 0.5 m of bush height. Ensure that spray contacts all foliage.
Sweet briar	1 part per 9 parts water	Apply 2 × 5 mL doses per 0.5 m of bush height. Ensure that spray contacts all foliage.

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Appendix 1: Spray calibration methods

Calibration Calculation (Boom Sprays)

All sprayers need to be calibrated regularly to work efficiently and economically. Regular calibration ensures the right amount of chemical will be applied to the target without costly wastage. The following templates will enable you to calculate how much chemical and water to use.

Part A: General Information

Item of equipment to be calibrated.	
Spray tank capacity (litres).	L ⑤
Area to be sprayed.	ha ⑦
Chemical used.	

Part B: Recording

What is the minimum desired water application rate (if any)?	L/ha
What chemical rate is to be used?	L/ha ④
Select an appropriate ground speed.	gear rpm
Record spray operation pressure.	kPa or bar
Record nozzle type and size.	type size
Record minimum boom height above target.	cm

Part C: Measuring

Record the output from every nozzle for 1 minute.								
1 ___	2 ___	3 ___	4 ___	5 ___	6 ___	7 ___	8 ___	Total spray output ① (add all nozzles)
9 ___	10 ___	11 ___	12 ___	13 ___	14 ___	15 ___	16 ___	
17 ___	18 ___	19 ___	20 ___	21 ___	22 ___	23 ___	24 ___	
Replace nozzles that vary by more than $\pm 10\%$ from stated output.								L/min
Record actual effective spray width (metres)								m ②

Calibration Calculation (Boom Sprays) (continued)

Part D: Calculating

Actual ground speed*	$\frac{\text{Distance covered (m)} \times 3.6}{\text{Time taken (seconds)}}$	$\frac{() \times 3.6}{()}$	= _____ km/h 5
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* Determine actual ground speed by measuring a set distance, say 100 metres, under similar conditions to the area to be sprayed and timing how long it takes using the pre-determined gears and revs.

1 Total spray output L/min	2 Effective spray width m	3 Actual ground speed km/h
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Water application rate	$\frac{\mathbf{1} \times 600}{\mathbf{2} \times \mathbf{3}}$	$\frac{() \times 600}{() \times ()}$	$= \frac{()}{()}$	L/ha 6
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What adjustments could you make to your equipment if the water application rate were outside the range recommended on the label?

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Chemical rate L/ha 4	Spray tank capacity L 5
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How much chemical to mix in each tank?	$\frac{\mathbf{4} () \times \mathbf{5} ()}{\mathbf{6} ()}$ = _____ L
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How many tank loads are needed for the job?	$\mathbf{7}$ _____ (ha) \times $\mathbf{6}$ _____ (L/ha) = _____ L 8 of spray mix	$\mathbf{8}$ _____ (L) \div $\mathbf{5}$ _____ (L) = _____ tanks
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Calibration Calculation (Knapsack Sprayer)

Step 1

Part A	What is the desired water application rate? (From the product label.)	L ____ / ____
Part B	Select appropriate chemical rate (from the label).	mL ____ / ____
Part C	Record the nozzle type and size (from the equipment).	Type Size
Part D	Is there a required operating pressure? If so, what is it?	Yes No kPa or Bar ____
Part E	Tank size of equipment.	____ L
Part F	Hand-held height above target should be recorded.	____ cm above target

Step 2

Part G	Measure out an area $10\text{ m} \times 1\text{ m}$ (this is 10 m^2). This is an area of 1/1000th of a hectare ($1\text{ ha} = 100\text{ m} \times 100\text{ m}$).	
Part H	Using the required pressure (or a constant pressure), time how long it takes to spray this area. (Walk at a comfortable pace, ensuring complete coverage.)	Time in seconds
Part I	Spray into a measuring jug for the same time it took to cover the $10\text{ m} \times 1\text{ m}$ area. Record this output.	____ L
Part J	You can now multiply this figure by 10, which will give a water application rate per 100 m^2 .	$10 \times \text{____ L}$ $= \text{____} / 100\text{ m}^2$
Part K	OR you can now multiply this figure by 1000 to give a water application rate/ha.	$1000 \times \text{____} / \text{L}$ $= \text{____} / \text{ha}$

Step 3

Part L	Does this water application rate comply with the chemical label requirements?	Yes No
Part M	If not, suggest a way to change this rate to meet the requirements on the label.	

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