Section 4

Control methods

Control methods

Integrated weed management

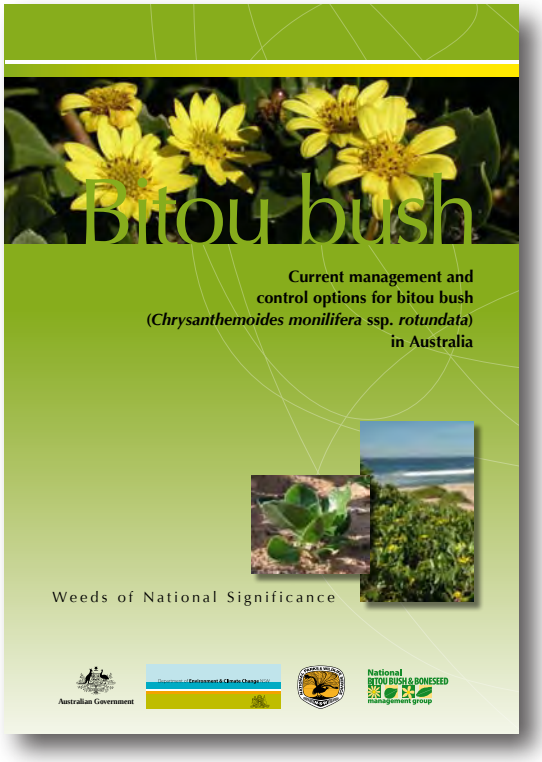
Best practice broom management requires an integrated approach that combines prevention activities, such as good hygiene practices, a variety of control techniques and long-term, follow-up management. Preventing further spread should be a key consideration in your overall management plan, and when choosing your specific control techniques.

Using one control technique alone will rarely produce satisfactory long-term control. For example, once mature plants are controlled, different techniques are often required to deal with regrowth from seedlings. The best range of control techniques to choose will depend on:

- the life cycle stage of the plants,
- the situation in which plants are growing,
- site accessibility and assets on the site,
- time of year,
- available time and resources, and
- the stage of your control program.

Controlling individual broom plants is a relatively straightforward task. The challenge lies in gaining access to infestations, especially in steep and remote country, and maintaining a consistent effort over many years to deal with regrowth from the highly persistent seed bank. Left untreated, broom will quickly grow and dominate the vegetation community. Efforts to control large infestations of broom across vast landscapes are best prioritised to target outlier plants and populations first, before treating well established core infestations. Within core populations, particular assets may be identified, such as a threatened species, where asset protection should be undertaken using techniques that have a low risk of off-target damage.

Methods for undertaking broom control are detailed in this chapter. Much of this information is based on other WoNS National Best Practice Management Manuals, in particular for gorse, lantana and bitou bush. These are available for download at www.weeds.org.au/WoNS. Gorse is a leguminous invasive shrub, closely related to brooms, that occurs in similar environments and causes comparable impacts. The similarity in response to control techniques, as well as issues around gorse seed longevity and seed bank persistence means that many of the same management considerations are needed. Lantana and bitou bush are weedy shrubs that can invade similar environments to Montpellier and flax-leaf broom and also share some common control techniques and considerations.

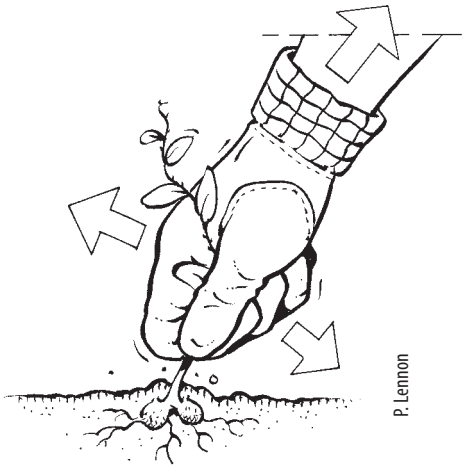


See Case Study 5 on page 129 to learn how City of Greater Geelong has matched flax-leaf broom control methods with different sites and conditions.

Mechanical and physical options

Hand pulling

Young seedlings and small plants can usually be pulled out easily from softer and moist soils. In harder, compacted and/or rocky ground, plants may break at the roots and reshoot. There is also a risk of back strain when hand pulling larger plants. If you can't pull the plant out easily, it is better to use the cut stump method or leverage hand tools, such as Tree Poppers™, Pullerbears™, Weed Wrenches™ or similar devices, which can remove larger plants that are not easily removed by hand pulling.



Hand pulling – grasp the stem close to the ground

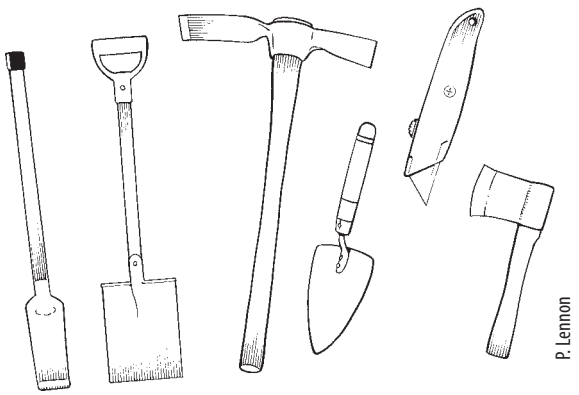
Hand pulling

Timing	Suitability of method	Advantages	Disadvantages
Use this method at any time of the year, but in areas with heavier soils you may need to wait until the soil is moist. Young plants should be removed before they first flower and set seed. Adult plants should ideally be removed before seed set to prevent the spread of seeds.	**Plant age** – smaller plants **Habitat type** – any **Size of infestation** – isolated infestations, scattered plants or infestations that cover a small area	▪ Causes no or minimal damage to desirable vegetation ▪ High kill rate ▪ Selective (i.e. only broom is removed) ▪ Whole plants are removed preventing regrowth ▪ Provides easy access for follow-up works ▪ No chemicals and minimal equipment required ▪ Low cost ▪ Applicable for use in areas containing sensitive habitats or threatened species	▪ Causes soil disturbance ▪ Labour intensive and time consuming ▪ Not suitable for most plants, other than seedlings ▪ Risk of back injury or strain injury if done incorrectly

Hand cutting without herbicide

Older, senescent broom plants can be cut at or below ground level without the subsequent use of herbicide, as they usually do not resprout or coppice at that stage of their life cycle. In California, Scotch broom plants cut off at or below ground level during the dry season were significantly less likely to resprout, regardless of shrub size or height of the cut (Bossard and Rejmanek 1994). Similar results could be expected in Australia during times when plants are stressed, such as drought.

Removal of above ground plant parts will open up the canopy and may stimulate germination from an existing broom seed bank. Follow-up control of seedlings and resprouting mature plants will be necessary.



Tools for manual control

Hand cutting without herbicide

Timing	Suitability of method	Advantages	Disadvantages
This method is ideally used when older broom plants are stressed from drought or frost.	**Plant age** – older, senescent plants **Habitat type** – any **Size of infestation** – older infestations that cover a small area	▪ Causes no or minimal damage to desirable vegetation ▪ Selective (i.e. only broom is killed) ▪ Provides better access for follow-up works ▪ No chemicals and minimal equipment required ▪ Low cost ▪ Applicable for use in areas containing sensitive habitat or threatened species	▪ Method only trialled for Scotch broom ▪ Labour intensive and time consuming ▪ Some plants may resprout ▪ Limited use, as only applicable at specific times, and with older plants

Mechanical clearing

Mechanical clearing aims to reduce the above ground biomass of broom to provide easier access for follow-up treatments. Clearing will not kill mature, actively growing broom, so it must be integrated with other control methods (e.g. spraying with herbicides, restoring pasture, grazing or cultivation) to achieve long-term broom control. It can be an effective primary control method in situations, such as pastures, forestry and some more accessible, less sensitive natural areas. However, some broom may grow back from stumps and roots left behind after clearing. Older broom plants approaching senescence often don't reshoot after mechanical clearing.

Spraying regrowth after mechanical clearing typically requires only 20–25% of the amount of herbicide needed for spraying uncleared broom, and the infestation is much easier to access, reducing the risk of spray drift. This is particularly effective in pastures where a combination of over-sowing with fodder crops, followed by grazing and spot spraying, can lead to productive land in a short period of time.

If you clear broom infestations, remember that:

- the use of heavy machinery can:
  1) increase the risk of erosion and soil structure degradation,
  2) may seriously impede regeneration of other species, and
  3) may contribute to further degradation of natural areas by removing or damaging the native seed bank,
- a permit may be necessary to do earthworks on river banks or to clear vegetation,
- broom seed that is buried deeper than 8 cm is likely to stay dormant for many years or decades until being exposed by erosion, digging or other earthworks, and
- removal of above ground plants will open up the canopy and may stimulate germination from an existing broom seed bank. Follow-up control of seedlings and resprouting mature plants will be necessary. See page 44 'Brooms 'fight back' swiftly after control, so…'.

Applying the method

A variety of mechanical clearing techniques are effective on brooms.

Dozing with a bulldozer, tractor with blade, or similar machine. The aim of using a bladed machine is to break broom stems off at soil level, or to push plants over and trample them to provide easier access for spraying and/or a fuel structure suitable for burning. Avoid scalping the surface soil.

Grubbing with an excavator, tractor with bucket, front-end loader, bobcat or similar machine. The aim is to break the broom off at soil level. This is most effective on old, hard broom and least effective on young, soft and actively growing broom. Avoid scalping the surface soil.

Root raking or **stick raking** with an excavator or bulldozer fitted with a root rake or stick rake. The aim is to pull bushes and larger roots out of the ground. This method results in less regrowth than dozing, but creates more soil disturbance and buries seed.

Mulching or **grooming** with a tractor or excavator-mounted mulcher, hammer mill, groomer or similar. This method cuts bushes off at ground level and processes them to fine mulch. The mulch provides some suppression of seedling growth. This method leaves a 'cleaner' site after control than some other mechanical methods. Excavator mounted groomers can be used to access creek banks and steep sites, but must be kept away from streambeds. Some operators have found that broom is too flexible for top down mulchers to be used effectively.

S. Cummings

Groomers can be used on weeds such as gorse and brooms

S. Welsh

Tractor-mounted mulcher

Crushing with a tractor-mounted 'Meri Crusher' or similar. This method breaks bushes, including the root crown, into pieces and incorporates broken material within the top 10 cm of the soil profile. With gorse, this method has resulted in less regrowth than other mechanical methods because the leaves and green stems are buried, however it can also lead to deep burial of seeds.

A. Laird

Meri Crusher

Slashing with roadside or grass slashing equipment can be used to reduce the height of broom. Slashing will not kill broom and broom subject to repeat slashing may flower and set seed at a height of only 10–15 cm. It may also develop an extensive root system. The reduced stem and leaf growth means that there may not be enough foliage surface area to absorb sufficient herbicide for effective follow-up spraying. Plants should be allowed to regrow to a height of around 1 m to avoid this problem. The deep mulch layer left after slashing broom may also limit effective herbicide coverage when spraying regrowth or seedlings.

With all mechanical removal methods that involve machinery, good hygiene to prevent seed spread is critical. See pages 47–56 in Section 3 for tips on simple hygiene procedures that can make a big difference!

Control methods

J. Gouldthorpe

Machinery hygiene – the blower is carried on slasher deck for cleaning in field

B. Jepson

Cultivation tractor with disc plough

Pulling with a tractor and chain or other tools (see page 67 for hand tool examples) is effective at reducing above ground biomass. Pulling should not be used where soil disturbance is unacceptable, such as in riparian or conservation areas.

Cultivation or **tillage** with disc or mouldboard ploughs is useful for breaking established roots and for follow-up treatment of seedlings and regrowth in large infestations. Due to the flexible nature of broom stems, cultivation of living, mature bushes can create a tangle of stems and may damage equipment. Cultivation as part of a cropping regime or for pasture maintenance is very effective at killing broom seedlings or promoting germination prior to other follow-up methods. While rarely used for broom control, many land managers believe that three to four years of cultivation and cropping will control gorse effectively on arable land, and the same may apply to broom.

Mechanical clearing

Timing	Suitability of method	Advantages	Disadvantages
Any time of year – but avoid when broom is in seed, as seed can spread on machinery.	**Plant age** – any, but may depend on type of machinery and method used **Habitat type** – pastures, fire-breaks, roadsides, flat and open country **Size of infestation** – large, dense infestations	▪ Can treat large plants across a large area ▪ Provides improved access for follow-up work ▪ No chemicals in initial works ▪ Reduced amount of herbicide needed for follow-up	▪ Soil disturbance and compaction from heavy machinery ▪ Plants may resprout ▪ May increase soil erosion ▪ Machinery may spread seed or bury seed into the soil ▪ Broom seeds may be buried deeper and remain dormant longer ▪ Can damage native plant regeneration potential ▪ Heavy machinery may damage tree roots ▪ Not appropriate for use in conservation areas

Chemical options

Chemicals (herbicides) can be a practical and efficient way of controlling brooms when used as part of an integrated management strategy. Seven herbicide application methods are currently registered and/or permitted for use on brooms (Note: these herbicides and their application methods are specific to each state/territory, and all label and permit directions and conditions should be followed).

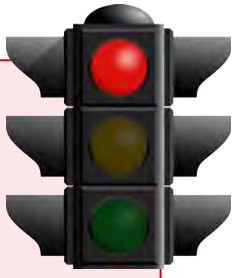
Herbicide application methods are:

- cut-and-paint,
- basal barking,
- stem injection (drill-and-fill),
- scrape-and-paint,
- foliar spraying,
- splatter or gas gun, and
- aerial spot spraying.

The information below can assist you to use herbicides in a safe manner and in accordance with the relevant legislation. However, this information is only a guide and should be used in conjunction with advice from weed management professionals and applied following all relevant legislation and regulations.

Herbicide labels and legislation

Registration of all pesticides, including herbicides is controlled by the Australian Pesticides and Veterinary Medicines Authority (APVMA). In Australia, by law, only herbicides registered by the APVMA for broom control can be used on broom, and only in the manner specified on the label or permit (but for Victoria, see box page 74). Chemical use is regulated by relevant state or territory legislation, and by the relevant state or territory agencies.



Safe herbicide use is your responsibility

All herbicides come with a label, which is a legal document. You must read the label. You are breaking the law by using a herbicide in a manner other than that stated on the label, unless covered by an off-label permit (but see information on page 74 for Victoria).

The label tells you how to use the herbicide:

- safely,
- effectively, and
- in a way that reduces the risk of off-target impacts.

The same applies to off-label permits.

Because new chemical products are registered on a regular basis, and existing chemicals are reviewed routinely, you should check the APVMA website regularly to ensure you are following the most updated information (www.apvma.gov.au). The PUBCRIS search engine for registered herbicides is also available at portal.apvma.gov.au/pubcris.

The APVMA also issues 'off-label' permits for herbicide applications that are not otherwise registered. A variety of off-label permits for broom control are held by government departments and individuals and can be used by other individuals or groups as directed in the permit. Current off-label permits (at the time of writing) relating to the use of herbicides for brooms are included in the table on pages 75–84 for each state/territory. See the APVMA website (portal.apvma.gov.au/permits) to search for current off-label permits relating to herbicide treatments for brooms in your state/territory and situation.

Be aware of legislation in your state/territory regarding herbicide use. For example, a written record of herbicide use may be required. In addition, some chemicals are restricted in certain states/territories or in specific areas of the state/territory, and you may require a licence or permit to use these chemicals

Herbicides must be stored in properly labelled containers, preferably in the original container and in a locked cabinet. Only chemicals that are registered for use in aquatic situations may be used in and around waterways, and all prohibitive statements (e.g. 'Do Not' statements) must be observed.

Safety and training

Personal protective equipment (PPE), such as protective clothing, eye or face shields, and respiratory protection, must be used in accordance with the recommendations stated on the herbicide label or permit. Chemical use training and/or licences may be required for people using herbicides as part of their job or business, and the requirements vary for each state. Training is recommended for community groups and may be required if working on public land. Training courses are run by registered training organisations (RTO) and Technical and Further Education (TAFE) colleges in each state/territory. Other training courses may be available through agencies (e.g. AusChem in Victoria, SMARTtrain in NSW and AgForce in Queensland), local councils or non-government organisations (see the 'Funding, organisational and training resources for volunteer groups' table in Section 7 on page 139).

Registered herbicides

The table on pages 75–84 lists the herbicides registered for use on brooms and the states/territories in which these registrations apply. Herbicides that are not registered for use on brooms but which have off-label permits covering their use are also shown. Check the APVMA website for current registration and permit information (www.apvma.gov.au), and always check the label for the correct application rates and methods.

M. Richards

Wearing personal protective equipment (PPE)

Choosing herbicides that can treat multiple weed species at one time may be beneficial. For information on which herbicide is most appropriate at your site, contact your local agronomist, weeds or biosecurity officer, or chemical reseller.

The active ingredients in herbicides currently registered for use on brooms are glyphosate, metsulfuron-methyl, fluroxypyr, picloram, aminopyralid and triclopyr; some of these are used in combination. The characteristics of the most

commonly used herbicides are described on pages 73–74.

This information does not imply any recommendation of a specific herbicide, and individual site and user requirements must be considered when choosing a herbicide.

In natural areas, both short- and long-term off-target damage should be considered and minimised. Non-selective herbicides, such as glyphosate, may have a risk of larger off-target damage in the short term, but have a low residual effect. Glyphosate is also available in formulations that can be used in aquatic situations, such as wetlands and riparian areas. Selective herbicides, such as those based on picloram and aminopyralid, can have lower immediate off-target damage but, due to their residual nature, may have delayed off-target impacts due to root uptake by adjacent plants.

Note: Herbicides in the pyridine carboxylic acid group, which include fluroxypyr, picloram, aminopyralid and triclopyr, can remain active in stock manure even after composting. Apply caution when using potentially affected stock manure as fertiliser.

These herbicides are moderately residual and can also remain active in the soil for an extended period. Some practitioners have reported severe impacts to the tree canopy in areas that have received several years of herbicide treatment due to uptake of these herbicides through tree roots. Alternating treatments between herbicide groups can minimise these impacts and also reduce the risk of herbicide resistance.

Glyphosate

Glyphosate is a non-selective herbicide used on grasses, broad-leaf and woody plants. It is absorbed through leaves and green stems and rapidly transported to actively growing parts of the plant. The herbicide interferes with the formation of amino acids that are essential for the growth of plant cells. The amino acids disrupted are present in plants, fungi and bacteria, but not in animals. Glyphosate is rapidly deactivated on contact with the soil because it binds to soil particles (but markedly less so in sandy soils, as it binds only to the clay fraction). It is broken down in the soil by microbial activity. The average half-life of glyphosate in soil is 47 days, with a range 3–130 days, depending on temperature, soil moisture and soil type.

Metsulfuron-methyl

Metsulfuron-methyl is a broad-spectrum, selective herbicide for use on broad-leaf plants and some annual grasses. It is also effective on most geophytes (perennial plants that reproduce by buds on underground bulbs, tubers, or corms), including orchids. It is absorbed through the roots and leaves and moves rapidly through the plant, but can be slow acting. It inhibits an enzyme required for the production of amino acids necessary for plant cell division. The residual activity varies with soil type, soil pH and organic matter. High carbon levels in the soil following fires may reduce residual activity of metsulfuron-methyl. Metsulfuron-methyl is broken down by microbial activity and chemical hydrolysis. The average half-life of metsulfuron-methyl in soil ranges from five days in acidic soils to 69 days in alkaline soils. Leaching of metsulfuron-methyl may be greater in alkaline soils and sands.

Picloram

Picloram is a selective herbicide for use on broad-leaf and woody plants. Grasses tolerate picloram at label rates. It is absorbed through roots, leaves and cut stems, and translocates throughout the

plant. Picloram affects the synthesis of proteins and disrupts plant cell growth. It is relatively slow-acting: signs of severe damage may take 2–3 months to show and total plant death up to six months after application. Picloram is residual and can persist in the soil for more than a year, and for up to two years within the plant. It does not bind strongly with soil: it is water-soluble and can move vertically and horizontally in the environment. The chemical can suppress seed germination and plant growth for some time after treatment. Picloram is degraded in soil and water mainly by microbial activity.

Triclopyr

Triclopyr is a selective herbicide used for control of woody weeds and broad-leaf plants, but does not affect conifers or grasses. It is absorbed through leaves or roots, and translocates throughout the plant. Triclopyr disrupts hormone balance and protein synthesis, resulting in abnormal plant growth followed by death. This herbicide breaks down in soil with a half-life of between 30 and 90 days, depending on soil type and environmental conditions.

Herbicides for use on brooms

The herbicides listed in the table below are currently (at the time of writing) permitted for use according to the relevant label or permit instructions. Before using any herbicide, always read the label or permit carefully. All herbicides must be applied strictly in accordance with the directions on the label and the conditions in the APVMA permit (but see box below for Victoria).

This table is only a guide. Do not rely solely on this table. You should only rely on current label or permit directions, so check the permit or label before application to ensure it is still valid. Commercial products listed here are examples only, and many other products containing these active ingredients may be registered, for example, visit portal.apvma.gov.au/permits. To search registered chemical products visit portal.apvma.gov.au/pubcris.

Herbicide use in Victoria

The use of some chemicals off-label is allowed without a permit in specific circumstances in Victoria, as explained in 'A guide to using agricultural chemicals in Victoria', which can be found at www.depi.vic.gov.au/agriculture-and-food/farm-management/chemical-use/publications/a-guide-to-using-agricultural-chemicals-in-victoria.

Herbicides for use on brooms

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
All states	High volume spraying	Triclopyr 600 g/L	Garlon 600	170 mL per 100 L	Agricultural non-crop areas, commercial and industrial areas, forests, pastures, and rights of way	*C. scoparius* *G. monspessulana* *G. linifolia*	As per label instructions	
	High volume spraying	Triclopyr 300 g/L + picloram 100 g/L	Grazon DS	250 mL per 100 L 350 mL per 100 L	Agricultural non-crop areas, commercial and industrial areas, forests, pastures, and rights of way	*C. scoparius* *G. monspessulana* *G. linifolia*	As per label instructions	Apply as a thorough foliage spray ▪ 250 mL per 100 L spring to mid-summer prior to pod formation ▪ 350 mL per 100 L autumn to winter
	High volume spraying	Triclopyr 300 g/L + picloram 100 g/L + aminopyralid 8 g/L	Grazon Extra	250 mL per 100 L 350 mL per 100 L	Agricultural non-crop areas, commercial and industrial areas, forests, pastures, and rights of way	*C. scoparius* *G. monspessulana* *G. linifolia*	As per label instructions	Apply as a thorough foliage spray ▪ 250 mL per 100 L spring to mid-summer prior to pod formation ▪ 350 mL per 100 L autumn to winter
	Cut-and-paint	Picloram 43 g/kg	Vigilant gel	Neat herbicide gel	Native vegetation, conservation areas, gullies, reserves and parks	*C. scoparius* *G. monspessulana* *G. linifolia*	As per label instructions	Cut stems horizontally and preferably no higher than 1 cm above ground level. Use and squeeze the brush bottle to apply a 3–5 mm thick layer of gel over the cut surface of the plant. In the case of multi-stem plants treat at least 80% of stems including all main stems.
	Foliar application: high volume (knapsack or handgun)	Glyphosate 360 g/L	Roundup Biactive	10–13 mL per 1 L	For general weed control in domestic areas (home gardens), commercial and industrial areas, public service areas, agricultural buildings and other farm situations, forests, pasture	*C. scoparius*	As per label instructions	Spray to wet foliage. When using the low rate add Pulse (2 mL/L spray solution) to improve coverage. At full leaf only the high rate can be used without Pulse.
New South Wales	Cut stump/ drill/ axe cut/ inject	Glyphosate 360 g/L	All registered products	Undiluted to 1 L per 6 L water	Urban bushland and forests, coastal reserves	*C. scoparius*	PER11916 expires 31/3/2020 Glyphosate and metsulfuron / Various weeds	Use higher rate for plants with stem diameter >5 cm

continued on page 76/...

Herbicides for use on brooms.../continued from page 75

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
New South Wales continued	Spot spray	Glyphosate 360 g/L	All registered products	Up to 1 L per 50 L water	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bush land reserves); Lands controlled by the Botanic Gardens Trust; Non cropland areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 Glyphosate, metsulfuron methyl and fluroxypyr / Areas of native vegetation and non crop areas / A range of environmental and noxious weeds	
	Cut stump, basal bark spray or cut/scrape and paint, drill, frill, axe or injection	Glyphosate 360 g/L	All registered products	1 L per 1.5 L water to undiluted herbicide	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Splatter gun	Glyphosate 360 g/L	All registered products	Rate of up to 1 L per 9 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Spot spray	Metsulfuron-methyl 600 g/kg	Brush-off plus other registered products	10–20 g per 100 L water plus surfactant	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/kg	All registered products	Tank mix of up to 2 L glyphosate + 15 g metsulfuron methyl per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Cut-and-paint, stem injection	Glyphosate 360 g/L and metsulfuron-methyl 600 g/kg	All registered products	Tank mixes of 1: 1.5 glyphosate + 1 g metsulfuron-methyl per 1 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Spot spray	Glyphosate 835 g/kg + metsulfuron-methyl 10 g/kg	Trounce Brush-Pack Herbicide plus other registered products	173 g pack per 100 L water plus surfactant	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
New South Wales continued	Spot spray	Glyphosate 760.5 g/kg + metsulfuron-methyl 63.2 g/kg	Cut-out Brush Controller plus other registered products	95 g pack per 100 L water plus surfactant	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bush land reserves); Lands controlled by the Botanic Gardens Trust; Non cropland areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 Glyphosate, metsulfuron methyl and fluroxypyr / Areas of native vegetation and non crop areas / A range of environmental and noxious weeds	
	Spot spray	Fluroxypyr 333 g/L	Starane Advanced plus other registered products	300 mL to 600 ml per 100 L water; or 3–6 L per ha; or label rate for specific weed	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Basal bark spray	Fluroxypyr 333 g/L	Starane Advanced plus other registered products	21 mL per 1 L diesel/kerosene	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Spot spray	Fluroxypyr 200 g/L	Nufarm Comet 200 Herbicide plus other registered products	500 mL to 1 L per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Basal bark spray	Fluroxypyr 200 g/L	Nufarm Comet 200 Herbicide plus other registered products	35 mL per 1 L diesel/kerosene	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER9907 expires 31/3/2020 as above	
	Helicopter spot spray	Glyphosate 360 g/L	All registered products	1–1.3 L per 100 L water	Natural ecosystems (non-agricultural)	*C. scoparius*	PER12363 expires 31/12/2015 Glyphosate and metsulfuron methyl / Areas of native vegetation / A range of environmental and noxious weeds	Apply using helicopter mounted spot spraying equipment only. Spray to wet foliage. Surfactant approved for aquatic situation ONLY is used with lower rate otherwise use higher rate

continued on page 78/...

Herbicides for use on brooms.../continued from page 77

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Australian Capital Territory	Cut stump	Glyphosate 360 g/L	All registered products	Undiluted to diluted product at 1 L per 1 L to 1 L per 5 L water	Urban open space, national parks, reserves, non-crop areas, commercial and industrial areas, forests, pastures and rights-of-way	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 Glyphosate, metsulfuron, triclopyr and picloram / Various situations / Environmental weeds	Treat stump IMMEDIATELY after cutting. The higher cut-stump glyphosate concentration (1:1) is needed for brooms
	Cut stump and basal bark	Triclopyr 600 g/L	Garlon	Diluted at 1 L per 30 L diesel	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 as above	
	High volume spray	Metsulfuron-methyl 600 g/kg	Brush-off, Ally	10 g per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 as above	
	High volume spray	Triclopyr 300 g/L + picloram 100 g/L + aminopyralid 8 g/L	Grazon Extra	250 mL to 500 mL per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 as above	
		Triclopyr 600 g/L	Garlon	170 mL per 100 L water				
	Stem injection (Stem drilling)	Triclopyr 600 g/L	Garlon	Diluted at 1 L per 12 L diesel. 2 mL per drill hole	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 as above	Drill holes are to be spaced at 10 cm apart around the tree trunk
	Cut stump	Glyphosate 360 g/L	All registered products	Undiluted to diluted product at 1 L per 1 L to 1 L per 5 L water	Domestic (home garden)	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13420 expires 31/3/2017 as above	Treat stump IMMEDIATELY after cutting. The higher cut-stump glyphosate concentration (1:1) is needed for brooms

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Queensland	Drill, frill, axe or stem injection	Glyphosate 360 g/L	Roundup	Undiluted to 1 L per 2 L water at 1 mL per 2 cm of hole or cut	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 Various products and chemicals / Non-Agricultural areas / Environmental weeds	
	Cut stump	Glyphosate 360 g/L	Roundup	Undiluted to 1 part product to 2 parts water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Paint stump immediately after cutting; or paint basal green bark and/or crown
	Spot spray	Metsulfuron-methyl 600 g/Kg	Brush-off, Ally	10 g per 100 L water plus wetting agent; or 100 g per ha plus wetting agent	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	
	Spot spray	Fluroxypyr 200 g/L	Starane 200	500 mL to 1 L per 100 L water; or 5 L to 10 L per ha; or label rate for specific weed	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	
	Basal bark spray	Fluroxypyr 200 g/L	Starane 200	35 mL per 1 L diesel/kerosene	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	
	High volume spray	Fluroxypyr 333 g/L	Starane Advanced	45 mL to 900 mL per 100 L water. Label rate for specific weed.	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Dilute with water as per label instructions
	Basal bark application	Fluroxypyr 333 g/L	Starane Advanced	900 mL to 3 L per 100 L diesel; or 6 mL undiluted per plant for specific weed application as per label; or label rate for specific weed.	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	As per label instructions
	Cut stump/ brush-cutter application	Fluroxypyr 333 g/L	Starane Advanced	900 mL to 3 L per 100 L diesel; or label rate for specific weed.	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	As per label instructions

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Herbicides for use on brooms.../continued from page 79

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Queensland	Low volume/ high concentrate drench or gas powered gun (splatter gun)	Fluroxypyr 333 g/L	Starane Advanced	300 mL to 600 mL per 10 L water; or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 Various products and chemicals / Non-Agricultural areas / Environmental weed	As per label instructions
	Spot spray	Triclopyr 200 g/L + picloram 100 g/L	Tordon Double Strength [DS] Herbicide	500 mL per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Spot spray where residual weed control is required away from waterways
	Drill, frill, axe or stem injection.	Triclopyr 200 g/L + picloram 100 g/L	Tordon Double Strength [DS] Herbicide	1 L per 4 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	
	Cut stump	Triclopyr 200 g/L + picloram 100 g/L	Tordon Double Strength [DS] Herbicide	50 mL per 1 L	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Cut stumps to less than 10 cm above the ground and immediately paint stump after cutting or spot spray cut stump
	Cut stump/ basal bark	Triclopyr 240 g/L + picloram 120 g/L	Access	1 L per 60 L diesel	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Either paint stump immediately after cutting or paint or spray basal bark
	Spot spray	Triclopyr 300 g/L + picloram 100 g/L	Grazon DS	350 mL to 500 mL per 100 L water plus wetting agent or spray oil; or label rate for specific weed	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Spot spraying where residual weed control is required
	Spot spray	Triclopyr 300 g/L + picloram 100 g/L + aminopyralid 8 g/L	Grazon Extra	350 mL to 500 mL per 100 L water plus wetting agent or spray oil; or label rate for specific weed	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER11463, expires 30/6/2015 as above	Spot spraying where residual weed control is required

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Western Australia	Spot spray	Glyphosate 360 g/L	Roundup Biactive	1 L per 100 L water; or 10 L per ha; or label rate for specific weed	Non-agricultural areas bushland and forests, wetlands, roadsides, industrial areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13333 expires 31/3/2017 Various products and chemicals / Non-Agricultural areas / Environmental Weeds	Spot spraying in dry land areas
	Cut stump	Glyphosate 360 g/L	Roundup Biactive	Undiluted to 1 L per 5 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13333 expires 31/3/2017 as above	Paint stump immediately after cutting or paint basal bark
	Drill, frill, axe or injection	Glyphosate 360 g/L	Roundup Biactive	2 mL per hole or cut	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13333 expires 31/3/2017 as above	
	Spot spray	Clopyralid 300 g/L	Lontrel	500 mL per 100 L water plus wetting agent; or 5 L per ha; or label rate for specific weed	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13333 expires 31/3/2017 as above	
	Cut stump/ basal bark	Triclopyr 240 g/L + picloram 120 g/L	Access	1 L per 60 L diesel	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13333 expires 31/3/2017 as above	Paint stump immediately after cutting or paint or spray basal bark
South Australia	Spot spray	Metsulfuron-methyl 600 g/kg	Brush-off	15 g per 100 L water + surfactant	Non-crop areas, rights of way, roadsides and easements, forest and conservation areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 Glyphosate and/or metsulfuron-methyl / Nature reserves and other native vegetation / Environmental weeds	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/ kg	Weedmaster Duo, Roundup Biactive, Brush-off	(Roundup 1 L + Brushoff 3 g) per 100 L water + surfactant	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/ kg	Weedmaster Duo, Roundup Biactive, Brush-off	(Roundup 200 mL + Brushoff 10 g) per 100 L water + surfactant	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/ kg	Weedmaster Duo, Roundup Biactive, Brush-off	(Roundup 1 L + Brushoff 10 g) per 100 L water + surfactant	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Cut stump	Glyphosate 360 g/L	Roundup, Roundup Biactive, Nufarm Weedmaster Duo	1 L per 1 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	

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Herbicides for use on brooms.../continued from page 81

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
South Australia continued	Stem injection by drill	Glyphosate 360 g/L	Roundup, Roundup Biactive, Nufarm Weedmaster Duo	1 L per 1 L water	Non-crop areas, rights of way, roadsides and easements, forest and conservation areas	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 Glyphosate and/or metsulfuron-methyl / Nature reserves and other native vegetation / Environmental weeds	
	Cut stump	Glyphosate 450 g/L	Roundup CT, Roundup ProBiactive 450	Undiluted	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Cut stump	Glyphosate 450 g/L	Roundup CT, Roundup ProBiactive 450	1 L per 1 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Stem injection by drill	Glyphosate 450 g/L	Roundup CT, Roundup ProBiactive 450	Undiluted	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Spot spray	Glyphosate 450 g/L	Roundup CT, Roundup ProBiactive 450	1 L per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13371 expires 31/3/2017 as above	
	Cut stump/ basal bark	Triclopyr 600 g/L	Garlon 600	1 L per 30 L diesel oil	Nature reserves and other native vegetation, roadsides, urban open space and forests	*C. scoparius* *G. monspessulana* *G. linifolia*	PER12932 expires 31/8/16 Triclopyr (Garlon 600) / Nature reserves and other native vegetation / Environmental weeds	
	High volume spot spray	Triclopyr 600 g/L	Garlon 600	170 mL per 100 L water	as above	*G. monspessulana*	PER12932 expires 31/8/16 as above	
Tasmania	Spot spray, knapsack	Glyphosate 360 g/L where product has an aquatic registration	Roundup Biactive	10–13 mL per 1 L plus adjuvants ONLY in accordance with label as required	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 Various actives / Non-crop and bushland / Environmental weeds	Only those specific glyphosate products which have label approvals currently in place for aquatic use may be used in or near aquatic areas
	Drill, axe	Glyphosate 360 g/L where product has an aquatic registration	Roundup Biactive	Undiluted per hole/cut	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	as above

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Tasmania continued	Cut stump	Glyphosate 360 g/L where product has an aquatic registration	Roundup Biactive	1 L per 5 L water to undiluted. Trees and shrubs generally. Undiluted for blackberry, bulbs and hard to kill weeds	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 Various actives / Non-crop and bushland / Environmental weeds	Only those specific glyphosate products which have label approvals currently in place for aquatic use may be used in or near aquatic areas
	Spot spray, knapsack, wiper	Glyphosate 540 g/L (where product has an aquatic registration)	Sickle	As per existing registrations or if weed not recorded on label: 7 mL per L plus adjuvants ONLY in accordance with label as required	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	as above
	Drill, axe	Glyphosate 540 g/L where product has an aquatic registration	Sickle	Undiluted per hole/cut	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	as above
	Cut stump	Glyphosate 540 g/L where product has an aquatic registration)	Sickle	1 L per 5 L water to undiluted. Trees and shrubs generally. Undiluted for blackberry, bulbs and hard to kill weeds	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	as above
	Cut-and-paint	Triclopyr 240 g/L + picloram 120 g/L	Access	As per existing registrations or if weed not recorded on label: 1 L per 60 L diesel	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	
	Spot spray, knapsack	Triclopyr 300 g/L + picloram 100 g/L	Grazon DS	At label rate or 250–350 mL per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	
	Spot spray, knapsack	Triclopyr 300 g/L + picloram 100 g/L + aminopyralid 8 g/L	Grazon Extra	At label rate or 250–350 mL per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	
	Spot spray, knapsack	Metsulfuron-methyl 600 g/kg	Brush-off	As per existing registrations or if weed not recorded on label: 10–15 g per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	

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Herbicides for use on brooms.../continued from page 83

	Application method	Active ingredient	Examples of commercial products	Rate	Situation as per label / permit	Species	Label / Permit (APVMA) requirements	Comments
Tasmania continued	Gas gun	Metsulfuron-methyl 600 g/kg	Brush-off	As per existing registrations or if weed not recorded on label: 1 g/L + Pulse penetrant (2 mL/L)	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 Various actives / Non-crop and bushland / Environmental weeds	
	Spot spray, knapsack	Triclopyr 600 g/L	Garlon 600	As per existing registrations or if weed not recorded on label: 170 mL per 100 L water	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	
	Cut stump	Triclopyr 600 g/L	Garlon 600	At label rate or 1.25 L per 60 L diesel	as above	*C. scoparius* *G. monspessulana* *G. linifolia*	PER13160 expires 31/3/2017 as above	

Products may be registered for use on brooms in all states and territories (shown as 'All') or only in the specific states and territories listed.
Please note that this is not a full list of herbicides and applications for use on brooms. Seek further advice from APVMA or your local weed authority.

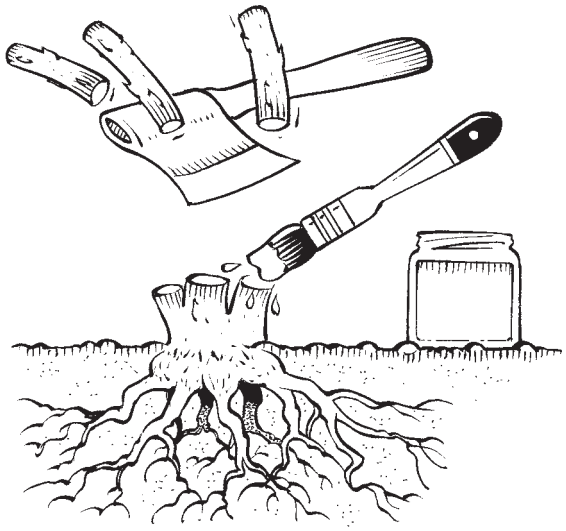
Stem treatments – chemical control

Cut-and-paint

Also known as 'cut stump' or 'cut-and-swab', the cut-and-paint technique involves cutting the plant stems off as close as possible to ground level and then immediately (within 15 seconds) applying herbicide to the stump. This can be used on any broom plant but is generally used where:

- plants are too large to hand pull,
- off-target damage from foliar spraying or mechanical removal is unacceptable, and/or
- soil disturbance needs to be minimised to prevent erosion and/or reduce germination of broom seedlings.

Cut-and-paint is an ideal technique for use in native vegetation and sensitive areas, as there is little chance of off-target herbicide damage if it is done correctly. It is a labour intensive technique but is relatively safe and simple to use.



P. Lennon

Cut-and-paint application

This control technique is the most likely to kill the plant on the first treatment. Glyphosate herbicides are the most commonly used for cut-and-paint, as they have few restrictions on their use and require less safety training, making them ideal for use by community groups.

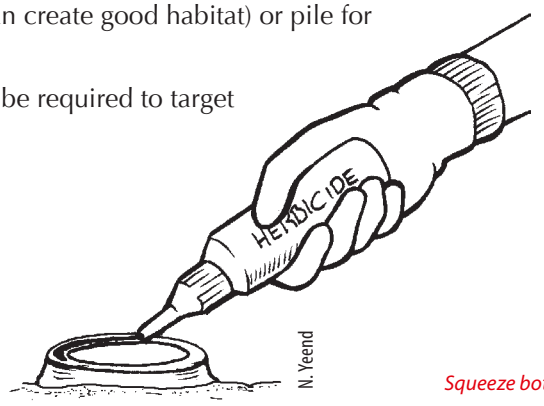
P. Tucker

Cut-and-paint technique is commonly used by community groups

Applying the method

- Cut through the stem horizontally as close to the ground as possible using a bush saw, secateurs, loppers, chainsaw or brush-cutter. A horizontal cut is important to prevent herbicide run-off.
- Immediately (within 15 seconds) apply herbicide to the cut surface of the stump. On large stems, apply the herbicide to the outer sapwood (cambium layer) only. Sapwood will transport the herbicide to the roots.
- Herbicide is most commonly applied using a squeeze bottle. A paint brush, or a sponge-tipped bottle (such as a shoe polish bottle) may be used, but these can get clogged very quickly. Atomiser spray bottles set on stream can also be used however some do not stand up well to continuous use. Some herbicide products come with a special sponge-tipped attachment.
- Leave plants on site to decay (small piles of dead broom can create good habitat) or pile for burning.
- Follow-up will be required to target seedlings.

Stumps cut too high are a trip hazard, and have the potential to resprout due to reduced herbicide translocation to roots. It is important to cut stumps as low as possible and parallel to the ground. The effectiveness of cut-and-paint is reduced the higher the stump is cut above the ground, and angled cuts can lead to herbicide run-off.



N. Yeend

P. Tucker

Squeeze bottles can be used to apply herbicide to cut stems

Cut-and-paint

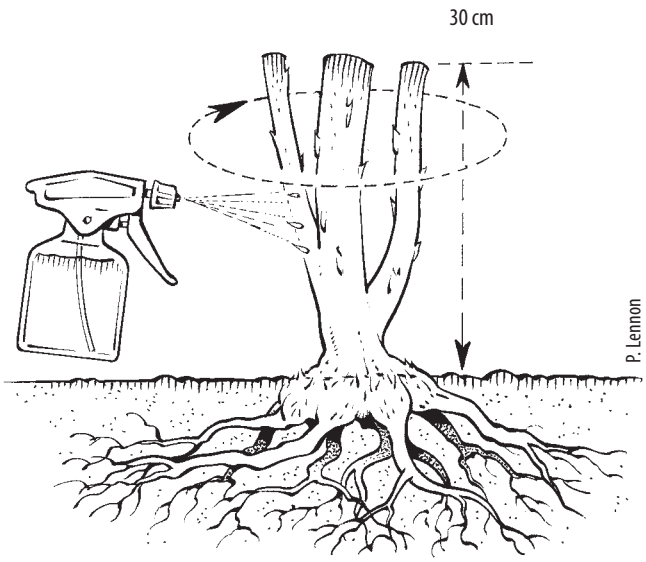
Timing	Suitability of method	Advantages	Disadvantages
Any time of the year (weather permitting), as long as broom plants are actively growing, so that herbicide is rapidly transported to the roots. Also refer to label directions for specific herbicides.	**Plant age** – all plants with hard stems; useful for plants that are too large to hand pull **Habitat type** – any; ideal for use in conservation areas as there is limited chance of off-target damage or soil disturbance **Size of infestation** – isolated infestations, scattered plants or infestations that cover a small area	▪ High certainty of plant kill if applied correctly ▪ Selective (i.e. only broom is controlled) ▪ No soil disturbance ▪ Improved safety for operators; very suitable for volunteers ▪ Limited, or no off-target damage (no drift) ▪ Increased ability to recognise treated or untreated plants, so unlikely to treat twice or miss plants ▪ Small quantities of herbicide used ▪ Ideal when working in high-quality vegetation	▪ Labour intensive ▪ Time consuming when dealing with large infestations ▪ May need to dispose of broom waste material (especially if presenting a fire hazard) ▪ May require training ▪ Not applicable in some situations (e.g. on steep slopes or near cliffs without trained personnel)

Basal barking

This method involves applying herbicide mixed with an adjuvant such as diesel or kerosene to the lower trunk or stem of woody plants. The adjuvant helps move the herbicide through the bark and into the cambium, allowing the herbicide to enter the root system.

Applying the method

- Spray or paint the whole circumference of the stem or trunk with herbicide solution from ground level to a height of 30 cm.
- The herbicide solution is best applied using a hand held pump sprayer, as it avoids the need to bend over. The pump also does not get as dirty as a paint brush, and there is less chance of spilling the herbicide. The sprayer need not be pressurised as the herbicide will gravity feed from the spray nozzle. If pressurised, use low pressure to reduce splashing and off-target damage.



Basal bark application

The Nature Conservancy in Nebraska has developed a tool called a kill stick, similar to a weed wand, which can be used for basal barking. Detailed instructions on making and using a kill stick can be found at prairienebraska.org and click on downloadable guides.

Basal barking

Timing	Suitability of method	Advantages	Disadvantages
Any time of the year (weather permitting), and when broom is actively growing so that herbicide is rapidly transported to the roots and foliage. Do not apply when the bark is wet, as it will repel the herbicide and adjuvant mix.	**Plant age** – all plants with woody stems **up to** approximately 10 cm in diameter (but check label or permit directions); useful for plants that are too large to hand pull **Habitat type** – any, though consider the potential for contamination of soil from run-off **Size of infestation** – isolated infestations, scattered plants or infestations that cover a small area	▪ High kill rate ▪ Selective (i.e. only broom is controlled) ▪ No soil disturbance ▪ Gradual defoliation of the plant *in situ* may offer habitat or cover for native species ▪ Suitable for targeted control over a small area, when other methods are unacceptable (e.g. around threatened species) ▪ No waste material to remove ▪ Possible reduced germination of broom seedlings due to minimal disturbance	▪ Labour intensive ▪ Time consuming when dealing with large infestations ▪ Difficult to apply when plants are densely clustered, or when plants have numerous stems ▪ Dead broom vegetation remains *in situ* which may become a fire hazard ▪ May require training

Stem injection

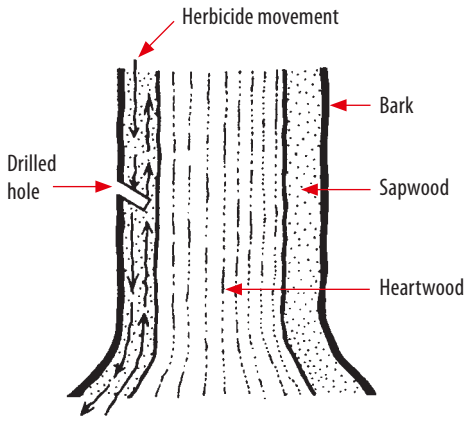
Also called 'drill-and-fill', stem injection delivers herbicide directly to the sapwood. It is rarely used on brooms, but could be an effective technique if appropriate to the situation or if operators are already using this technique on other woody weeds in the vicinity (such as willows in riparian areas). This method is most appropriate in well-established, large broom infestations, as it is only applicable to mature plants (with stems over 5 cm in circumference).

Note that trials on white weeping broom (*Retama raetam*, see page 29) in Western Australia using 50% glyphosate only achieved 50% plant mortality 12 months after treatment (Bettink and Brown 2011). Thus, small-scale trials in your local area with specific broom species may be useful before applying this method on a large scale.

Applying the method

For use on plants with stems over 5 cm in circumference.

- Use a cordless drill or hand drill to make holes around the base of the trunk, no more than 50 mm apart. Holes should go no deeper than the sapwood layer (just under the surface of the bark; approximately 5 mm depending on stem size) as the heartwood (inner) layer will not transport herbicide around the plant. Drill holes at a 45 degree angle (downwards) to aid herbicide retention by creating a reservoir. This will increase opportunity for herbicide uptake by the plant and reduce run-off.
- Alternatively, a chisel and hammer, a tomahawk or machete can be used to make 45 degree angled incisions down into the sapwood. Ensure the flat side of the chisel is facing upwards. Inject the herbicide within 15 seconds of drilling/cutting the hole, using a squeeze bottle or plastic syringe.
- Do not overfill the holes. Excess herbicide mixture can contaminate the environment. Using a drill to make the holes will minimise spillage. Drills are also more manoeuvrable in dense infestations, where it can be difficult to swing a mallet or axe. Injection guns are also available that can drill the hole and deliver a precise amount of herbicide at the same time.



Stem injection

Timing	Suitability of method	Advantages	Disadvantages
Any time of the year (weather permitting). Most effective when broom is actively growing so that herbicide is rapidly transported to the roots.	**Plant age** – mature plants with woody stems over 5 cm in circumference **Habitat type** – any; particularly useful for remote and hard to access areas as tools and amount of herbicide are minimal and easy to carry **Size of infestation** – isolated infestations, scattered plants or infestations that cover a small area	▪ High kill rate ▪ Selective (i.e. only broom is controlled) ▪ No soil disturbance ▪ Gradual defoliation of the plant *in situ* may offer habitat or cover for native species ▪ Suitable for targeted control over a small area, when other methods are unacceptable (e.g. around threatened species) ▪ No waste material to remove ▪ Possible reduced germination of broom seedlings due to minimal disturbance	▪ Labour intensive ▪ Time consuming when dealing with large infestations ▪ Difficult to apply when plants are densely clustered, or when plants have numerous stems ▪ Dead broom vegetation remains *in situ* which may become a fire hazard ▪ May require training

Scrape-and-paint

This method involves scraping away a small section of the bark and applying herbicide directly onto the sapwood. It is an effective, but rarely used technique for broom control.

Applying the method

- Using a knife, chisel or sharp axe, scrape a 15 cm long length of bark off the base of the main trunk, running vertically along the trunk and getting as close to the ground as possible. Only scrape off enough bark to expose the sapwood (i.e. a few millimetres deep).
- Immediately (within 15 seconds) apply herbicide to the exposed surface (sapwood) using a squeeze bottle, sponge-topped applicator bottle or paint brush.
- Herbicide dyes are useful to show treated plants.
- Depending on the diameter of the stem, multiple scrapes may be required around the circumference of the stem.
- Place each scrape a few centimetres apart to ensure maximum herbicide uptake without ringbarking (removing a complete ring of bark and conductive tissue from the stem, which prevents herbicide transport to stems and roots).

S. Booth

Scrape-and-paint involves removing the outer bark from the base of the main trunk and immediately applying herbicide

Scrape-and-paint

Timing	Suitability of method	Advantages	Disadvantages
Any time of the year (weather permitting). Most effective when broom is actively growing so that herbicide is rapidly transported to the foliage and roots.	**Plant age** – saplings or mature plants with woody stems **Habitat type** – any, access permitting **Size of infestation** – isolated infestations, scattered plants that cover a small area	▪ Moderate to high kill rate ▪ Selective (i.e. only broom is controlled) ▪ No soil disturbance ▪ Suitable for targeted control over a small area, when other methods are unacceptable (e.g. around threatened species) ▪ Gradual defoliation of the plant *in situ* may provide some continued cover or habitat for native species ▪ Good for use in remote areas (limited tools or herbicide needed)	▪ Labour intensive ▪ Uses more herbicide with a lower kill rate when compared to cut-and-paint or stem injection ▪ Time consuming when dealing with large infestations ▪ Difficult to apply when plants are densely clustered, or when plants are multi-stemmed; may be hard to access stems of plants in dense infestations ▪ Dead broom vegetation remains *in situ* which may become a fire hazard ▪ May require training

Foliar treatments – chemical control

Foliar spraying

Foliar spraying is the application of herbicide solution to weed foliage in the form of a fine spray. A range of other chemicals may also be added (e.g. penetrants, adjuvants, surfactants, wetting agents). The application rate, volume and concentration of herbicide vary with the application technique used.

Foliar spraying can be used to treat plants of all ages, but can be less effective on older plants. It is especially effective for treatment of dense 'carpets' of broom seedlings because large areas can be treated quickly. Foliar spraying is useful for treating infestations in steep terrain where erosion is an issue. It is also practical when few workers are available, because it can be done relatively quickly by one person. 'Spot spraying' refers to the foliar spraying of individual plants or clumps of plants, and is used on small infestations or isolated plants.

No broom-selective herbicide currently exists, so care needs to be taken not to damage desirable vegetation by off-target spraying, over-spraying or spray drift. Desirable vegetation includes both native vegetation and that on productive lands. Herbicides commonly used for foliar spraying of brooms include glyphosate, triclopyr and triclopyr/picloram based products. Triclopyr and picloram based products are considered more selective than glyphosate as, while they can damage many broadleaf species, they are generally tolerated by grasses.

There are several techniques available, including back-pack and vehicle-mounted sprayers, splatter guns and aerial spot spraying. The technique selected will depend on:

- the size of the infestation,
- site access and specifications,

D. Stock

Hand held spray equipment, such as a splatter gun, is useful for small infestations

- habitat (e.g. native vegetation, pasture, roadside),
- access to equipment and chemicals, and
- the availability of resources, including trained staff and contractors.

Applying the method

Foliar spraying of broom is usually done using a spray gun and backpack or vehicle-based spray unit (see later in this section for splatter gun and aerial spot spray applications). Spray units connected to

B. Rayner

Vehicle-mounted spray rig suitable for high volume spraying

a tank and pump mounted on a vehicle are very useful when treating large areas, but are restricted by vehicle access.

- Back-pack/knapsack/hand held pump spraying – for low pressure spraying using a low concentration of herbicide and high volume of liquid (e.g. 1:100 for glyphosate 360 g/L). This can be used for spot spraying large or small infestations.
- Vehicle-mounted spray rigs – for high pressure, high volume spraying using a hose with a hand-gun. A low concentration of herbicide and high volume of liquid is sprayed on broom over larger areas accessible by vehicles. A small boom attachment is useful for spraying a dense cover of seedlings. The registered application volumes and rates are the same as for knapsack foliar spraying.

Successful control requires plants to be free from salt-spray, water, dust or other vegetation (e.g. vines). Plants must be sprayed thoroughly, wetting all foliage to the point of run-off. Plants that are not completely covered or that are under stress will often survive. Surviving plants may take more than 12 months before they reshoot, so treated areas should be inspected annually.

Foliar spraying

Timing	Suitability of method	Advantages	Disadvantages
Use this technique when broom plants are actively growing, and not stressed by hot, dry, cold, wet or other extreme conditions. Herbicide is most readily absorbed through the leaves during periods of active growth. Herbicides can also be absorbed by photosynthetic stems, but less so than the leaves. For this reason, Scotch broom can be harder to kill using foliar sprays when it has lost its leaves. Spraying when Scotch broom has very few leaves can cause more off-target damage than normal, as less herbicide is retained on the plant. Treatments should ideally be scheduled for autumn or early winter. A second treatment for missed plants should be applied later in winter or spring when plants are in flower, to prevent seed set. Scattered plants are also easier to locate and identify when flowering. **When to spray to avoid spray drift?** Before you spray with herbicides, it is important to understand the best weather conditions for spraying and to take steps to avoid spray drift. Check your state/territory weed management agency website for information on spray drift specific to each jurisdiction. Useful information can also be found on the APVMA website www.apvma.gov.au/use_safely/spray_drift.	**Plant age** – all plants, but can be less effective on older plants **Habitat type** – any except where prohibited by legislation; caution is needed around water and high value vegetation **Size of infestation** – the area treated should be matched to the appropriate application technique: for example, a backpack spray unit is only suitable for small infestations or isolated plants. Larger areas can be treated with vehicle mounted spray units (e.g. on a quad bike or tractor). Do not treat large areas unless resources are available for follow-up control ***Protecting native species*** *Make sure you thoroughly check the area for native plants prior to spraying, particularly for threatened or at-risk species. If native plants occur in the area to be sprayed, clear an area (buffer) of broom away from native plants using hand weeding techniques prior to herbicide applications. Alternatively, small native plants can be covered with hessian or cardboard prior to spraying. Ensure that these coverings are removed once the herbicide has dried. If a native plant is inadvertently sprayed, remove the affected leaves or immediately rinse off the herbicide with water. Although this may protect native plants when spraying, please refer to the herbicide label for any soil residual impacts. In these cases, leaving a buffer around certain native species may be more appropriate.*	▪ Large areas can be treated quickly. ▪ Not labour intensive; can be done by one person. ▪ Cost effective. ▪ Can be used in steep or erosion prone areas. ▪ No soil disturbance, as plants are left to die *in situ*	▪ Risk of off-target damage ▪ Kill rates can be variable ▪ Cost of spray equipment and herbicide ▪ Weather conditions and site location (e.g. near water) limit when it can be used ▪ May require training ▪ Herbicide can be washed off by rainfall; check forecast before spraying ▪ Double-spraying or off-target spraying may occur if marker dye is not used ▪ Limitations on individual methods (e.g. backpack spraying requires the regular refilling of the tank, which increases time and costs and there may be long walking distances from the spray site to the nearest water supply)

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Vehicle based Quick Spray® unit

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Broom control in the alpine area of Kosciuszko National Park – red dye is evident. Use dye in the herbicide mixture to indicate coverage

Best practice spraying

Remember these points when spraying herbicides on broom to get the best results:

1. **Follow the label or permit directions and read the critical comments section.**
2. **Complete coverage of foliage is essential.**
3. **Only use a wetting agent/penetrant/adjuvant/surfactant as directed by the label.**
4. **Only spray actively growing broom plants.**
5. **Regrowth of cleared or previously sprayed plants (not seedling growth) should be at least 40 cm tall – and preferably around 1 m tall – before spraying.**
6. **Leave sprayed broom plants undisturbed for at least 12 months after treatment.**
7. **Use clean water. 'If you wouldn't drink it, don't use it'. Water quality can mean the difference between a poor result and a total kill. Trucking clean water to a site may actually save money.**
8. **Do not spray stressed broom plants (during extremes of heat, cold and/or drought).**
9. **Calibrate spraying equipment and clean and replace nozzles/jets regularly. Worn nozzles or poor calibration can deliver four to 20 times the required amount of herbicide. This increases herbicide costs and increases the chances of off-target damage.**
10. **Spray in suitable weather and at the most appropriate time of day. Labels can provide guidance or ask an expert. Avoid wet, very cold, very hot or windy weather. Spraying in these conditions reduces effectiveness and/or increases off-target damage.**
11. **Use dye in the herbicide mixture to indicate coverage.**

Splatter gun (or gas gun)

Splatter guns were developed over thirty years ago for sheep drenching. They have recently been adapted for weed spraying and are proving increasingly useful in the treatment of weeds such as lantana, blackberry, pampas grass and bitou bush. The splatter gun (or gas gun) control technique uses a pressurised gun to deliver a low volume, high concentration application of herbicide to broom foliage. The splatter gun administers large droplets of herbicide solution in one direct stream, and thus is used with more concentrated herbicide solutions than other foliar applications. This application technique uses a much lower volume of spray mixture than standard foliar spraying and the larger droplets are less likely to drift. Due to the high concentration, complete coverage of all foliage is not required.

This technique is particularly useful in areas that are difficult to access or have sensitive vegetation because the tool is easily portable and targeted application in one direct stream causes limited off-target damage. Splatter gun application can also be less expensive than traditional foliar spray methods, as it uses less herbicide. While splatter guns are not commonly used on brooms, they may be effective for mature broom control, particularly for *Genista* spp. They are not recommended for use on seedlings or immature plants, or for leafless Scotch broom.

Applying the method

Splatter guns are usually used with a small backpack spray unit and may be hand or gas powered (gas gun). While there are no herbicides currently registered for splatter gun application on brooms, New South Wales, Queensland and Tasmania have off-label permits for using splatter or gas guns that may be applicable for use on brooms (see table on pages 75–84).

Splatter gun spraying involves applying a low volume of concentrated herbicide mix to small portions of foliage. Because the herbicide is so concentrated, it is only applied in a few 'strips' (or squirt lines) to limited areas of total plant leaf cover (e.g. approximately 16 mL of mixed herbicide in total for a 2 m bush). The following recommendations have been adapted from the lantana control manual and provide a guide for use on brooms. **This method should only be used when broom plants have a dense cover of leaves.**

H. Cherry

Splatter gun equipment

M. Winkler

Hand powered splatter gun equipment

M. Winkler

M. Winkler

Gas powered splatter gun equipment

- To apply the herbicide, angle the spray gun at 45 degrees (to the ground) and arc the stream of herbicide over the top of the bush and down the front face.
- If treating dense thickets of broom, apply one vertical spray line every two strides, with an occasional horizontal pass low across the front edge of the bushes to treat any low growth.
- Ensure you only apply the recommended volume of herbicide (for glyphosate 360 g/L that is two squirt lines of 2 mL chemical mix per half meter of plant height ~ approximately 16 mL of mixed herbicide in total for a 2 m bush).
- It is vital with this technique that you do not spray to the point of run-off as you would with conventional foliar spray techniques. Application of too much chemical at this concentration will put the plant into shock and inhibit herbicide uptake.
- Always use clean water for mixing and cleaning as dirty/heavy water can bind the herbicide and dramatically reduce the kill rate.
- A specialised nozzle that produces large droplets of herbicide mix must be used to achieve the desired low volume, high concentration application. A fine spray or mist will not be effective.
- The commercial gas powered devices enable the application of a stream of herbicide from a distance of 6–10 m allowing the delivery of herbicide from an elevated position into gullies or hard to reach areas.
- The splatter gun technique does not work well on spindly or thin bushes as it is difficult to apply the total volume of required herbicide to the leaves in this situation.
- Apply only to actively growing plants with full foliage and ensure leaves are not wet from rain or dew.
- A marker dye is recommended to identify splattered bushes.
- Manual drench guns or gas powered guns are commercially available. The gas powered option will allow a longer day's work compared to the manual option but costs more to buy and operate.
- Follow-up treatments are critical to control seedlings and/or regrowth.

Splatter gun

Timing	Suitability of method	Advantages	Disadvantages
As with foliar spraying, this technique must be used when broom is actively growing (and the plants are not stressed by extreme conditions) so that the herbicide is taken up by the plant. The best times to spray are typically before 10 am and after 3 pm, when there is reduced evaporation and the plant will be more susceptible to herbicides (but check the label or permit). Splatter gun application should be avoided on windy days or when rain is forecast.	**Plant age** – medium to large plants; not suitable for seedlings or plants with limited leaf area **Habitat type** – any; particularly useful in dense infestations that are difficult to access with vehicles, or on steep slopes and cliffs **Size of infestation** – heavy infestations or dense, scattered clumps	▪ Large areas can be treated quickly ▪ Cost effective and equipment costs are relatively low ▪ Easy to operate and useful in steep terrain, erosion prone areas, and remote and difficult to access areas ▪ Minimal soil disturbance ▪ Can treat plants long distances (up to 10 m) away ▪ Splatter gun herbicide mix requires minimal water, and thus is easier to transport in a backpack and will allow more plants to be treated	▪ Not trialled comprehensively on brooms ▪ Not effective for Scotch broom when leaves are absent ▪ Off-target damage can be amplified due to high concentration of herbicide ▪ Cost may be prohibitive for large infestations ▪ Cannot be used in wet weather ▪ May require training

Aerial spot spraying in New South Wales

Aerial spot spraying is a foliar spraying application technique that is commonly used for bitou bush in NSW. It uses the ground-based, foliar spraying technique, but applies it from a helicopter rather than a backpack or ground spray rig. This technique was developed by the NSW National Parks and Wildlife Service and uses a modified spray rig with a hose and nozzle assembly, protected by a large cone, which is suspended from beneath a helicopter. Aerial spot spraying enables targeted treatment of individual plants or small clumps that may not otherwise be treatable due to limited, difficult or dangerous access (e.g. on a cliff face).

Aerial spot spraying is only currently permitted for use in NSW with glyphosate on Scotch broom, and requires a specially trained pilot. For more information on this technique, see the Bitou Bush Management Manual at www.weeds.org.au/wons/bitoubush and/or the 'Best practice guidelines for aerial spraying of bitou bush in New South Wales' (www.environment.nsw.gov.au/resources/pestsweeds/bestPracticeAerialSprayGuidelines.pdf).

Many aspects from the bitou bush aerial spraying guidelines will apply to brooms (e.g. techniques, notifications, helipads, limiting public access, etc.). Follow-up will be required to target recruitment of broom seedlings which may require repeated aerial or ground-based herbicide applications.

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Fire and grazing

Fire

Fire, as a control technique, can only be employed successfully in broom infestations as part of a holistic and integrated management program. While fire can kill broom plants, it will also stimulate a mass germination of broom seeds and can create a worse situation if follow-up control measures are not taken. Herbicide or mechanical control of broom may be required prior to burning to ensure the fire burns appropriately (i.e. broom plants are dry enough to carry fire). For more information on managing broom with fire see Section 3 page 57.

Grazing

Stock availability, adequate fencing and the establishment of strong pasture grasses are the keys to using grazing to improve broom management. These methods should always be used as part of an integrated approach with other control methods and pasture management techniques.

Livestock such as goats, sheep and cattle will graze brooms, and can be used to manage broom in pastures. While toxic alkaloids are known to occur in broom, there are no known records of livestock poisoning. Goats are more effective at controlling mature stands of broom than sheep and cattle, which only graze on small plants up to head height. Broom plants that are suppressed by continual grazing over several years will eventually develop a large root system, with relatively small biomass above ground. At this point, growth rates can then quickly exceed the rates of grazing by sheep and cattle, and plants may escape grazing to flower and set seed. Broom plants that are along fences or are outside the paddock will not be grazed and will need another form of control.

To learn more about how primary producers James and Mandy O'Brien have managed large-scale Scotch broom infestations in their pastures since the 1970s, see Case Study 4 on page 126.

Biological control

Weed biological control (biocontrol) has been successfully used as part of integrated weed management in Australia for over 100 years. The agents used in biocontrol programs include insects such as psyllids, moths and beetles, as well as mites and pathogens, such as rust fungi. They are selected through a rigorous process, using internationally recognised protocols, formal government approvals and risk assessment processes. The agents are sourced from the home range of the weeds, in the case of brooms, from Europe and North Africa. Once an agent is selected, it undergoes rigorous host specificity testing to ensure there is no risk of non-target impacts to native species.

Biocontrol has the potential to be a cost effective way of suppressing large infestations of broom. In Europe, brooms host many natural enemies that are not present in Australia. These natural enemies make brooms significantly less vigorous in their home range than in Australia. The selection and introduction of some of these highly specific natural enemies for use as biocontrol agents has the potential to limit broom spread and reduce their ability to dominate Australian landscapes.

In Australia, biocontrol programs began for Scotch broom in 1989 and for Montpellier broom in 1999, led by the CSIRO (Commonwealth Scientific and Industrial Research Organisation) and state government agencies, in collaboration with New

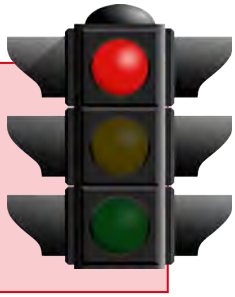
Parks Victoria

Gall mite monitoring

Zealand and the USA. To date, four agents have been tested and released for Scotch broom, and one for Montpellier broom. Only one of the Scotch broom agents (the broom gall mite) is showing clear levels of impact and so is being actively distributed. The one agent for Montpellier broom (the Cape broom psyllid) is also being distributed to sites around south-eastern Australia in order to maximise agent effectiveness. Although flax leaf broom is an approved candidate for biological control in Australia, no agents have yet been tested.

There are also a number of exotic pathogens and accidentally introduced insects that damage brooms to varying degrees. Detailed information on the history and research of broom biocontrol agents can be found in the Biological Control of Weeds in Australia (Julien *et al.* 2012).

Management note:
Biological control takes many years and must be integrated with other management techniques to control infestations.



Research and Action in Partnership:
The Atlas of Living Australia Weed Biological Control website gets everyone involved

A new national website for information on the locations, availability and redistribution of weed biocontrol agents can be found at root.ala.org.au/bdrs-core/wbiocont/home.htm or simply enter 'weed biological control ALA' into an internet search engine. This Atlas of Living Australia (ALA) based website provides a single location to 1) find out what agents are available for major weeds (including brooms), 2) find places to source agents for redistribution, and 3) document releases of biocontrol agents for some of Australia's most damaging weeds. It is a key online resource for researchers, the public, or anyone who wants to assist biocontrol efforts in their region. Check it out today and get involved!

Broom biological control agents in Australia

Key agents for broom in Australia

Cape broom psyllid (*Arytinnis hakani*)
Target: Montpellier (Cape) broom
Currently in NSW, SA, Vic, Tas

Description The Cape broom psyllid is a small, sap sucking insect that can complete four to five generations in a year. Adults are approximately 2–3 mm long, and are green with clear wings that make them highly mobile. Up to 200 eggs per female are laid in fresh leaves and buds. Eggs are laid in the growing terminal and are very difficult to detect with the naked eye. The five nymph stages vary in size from 1 mm to just over 2 mm depending on the growth stage. The nymphs are wingless but can be quite mobile on the plant. The colour of the nymphs varies from orange in the early stages to bright green in the later stages. Psyllids are generally found in the growing tips of Montpellier broom and their presence can be indicated by white deposits that look like sugar crystals. Psyllid numbers decline during hot dry summer months and over winter. During this time they are usually found as nymphs or adults sheltering in young shoots.

Impacts The Cape broom psyllid feeds on the sap of the host plant, reducing plant health, vigour and seed set. Plant damage can be severe in Australia,

P. Crisp

Cape broom psyllid nymph

P. Crisp

Cape broom psyllid adult

P. Sullivan

Montpellier broom killed by Cape broom psyllid, Captains Flat, NSW

A. Sheppard

Cape broom psyllid impacts in New Zealand

with large sections of plants dying back, and occasionally resulting in complete plant death. This contrasts with the native range, where these levels of damage have not been observed.

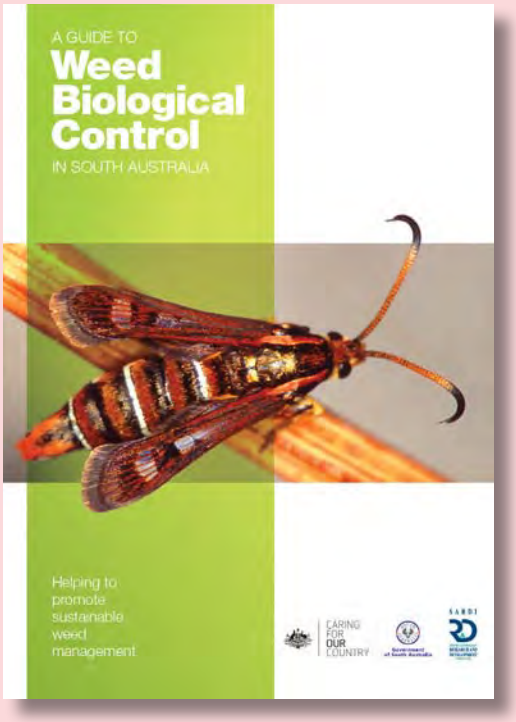
Redistribution The Cape broom psyllid can easily be redistributed from sites where it has formed well-established populations. To locate the psyllids, look for the white, sugary crystals in growing tips of plants and check broom plants for the small green insects. Adult psyllids can be easily located by lightly beating or shaking the foliage over a tray or any other suitable receptacle and looking for green winged adults. Cape broom psyllids can be collected by pruning off infested branches. These should then be placed in a suitable container for transport, such as a plastic food container that should be placed in a cooler. The release should be made within 24 hours of collection. This is done by tying the psyllid-infested branches to the branches and foliage of broom plants at the new sites. The psyllids will move on to the new plants to establish new colonies. This can be done at any time of the year when broom is actively growing, but hot, dry summer weather should be avoided as the adults and nymphs are very sensitive to temperatures over 26°C.

S. Ivory

Cape broom psyllid nymphs – note sugary residue

A GUIDE TO WEED BIOLOGICAL CONTROL IN SOUTH AUSTRALIA

This excellent guide contains more photos and information on the key broom biological control agents, as well as other significant weed biological control agents in Australia (e.g. for gorse, blackberry, St John's wort and other weeds). It has in-depth information on how to collect and redistribute agents, as well as how to monitor their establishment and success. The Guide can be found at: www.sardi.sa.gov.au/pestsdiseases/publications.



Broom gall mite (*Aceria genistae*)
Target: Scotch broom
Currently in NSW, Vic, SA and Tas

Description The broom gall mite is a microscopic mite that lives in colonies within galls established on the stem buds of Scotch broom. The mites themselves are less than a quarter of a millimetre in length making them best viewed under a microscope. The galls are much more distinctive, being an abnormal, rounded and hairy growth up to 1 cm in diameter on stem buds. One gall can contain hundreds of mites. The galls also attract other small insects and larger predatory mites. Female mites will lay eggs in the gall, or will leave the gall to find new stem buds on the same plant. They can also move to other plants on the wind. The broom gall mite has four stages to its life cycle, and there can be several overlapping mite generations in a gall over spring and summer. At the end of summer and in autumn, the galls dry out and the mites crawl to dormant stem buds where they spend the winter.

Impacts The mites suck sap from the plant and trigger the growth of galls. These galls limit the allocation of resources to normal plant growth and reduce plant health and vigour. As galls form on successive years of stem growth, they can induce stunting, reduced flowering and even plant death.

Redistribution Plants infected with the broom gall mite are distinguished by the presence of furry galls on the stems. In late summer, autumn or spring, branches infested with galls can be cut and tied to the branches of broom plants at new sites. When being transported, the branches should be kept cool by placing them in a cooler. The release should take place within 24 hours of collection. As the transported gall and branches dry out, the mites will emerge and colonise the buds of the live plants. A minimum of 50 galls should be collected and released to enable mite establishment at the new site.

Other broom agents in Australia

Broom seed bruchid (*Bruchidius villosus*)
Target: Scotch broom, but will attack other broom weeds
Currently in NSW, Vic and SA

The broom seed bruchid is a small black beetle that eats pollen and lays its eggs on the developing seed pods of brooms. While the introduced population


Parks Victoria


Parks Victoria

Galls on Scotch broom stems


Parks Victoria

Gall mite monitoring

was sourced from Scotch broom, the beetle can feed in the pods of other broom weeds, including Montpellier broom. The adults are around 2–4 mm in length with clubbed antennae. The beetle larvae feed on the developing seeds. They pupate within the outer shell of the seed and are expelled with the seed itself, overwintering in the seed husk. Adults emerge from the leaf litter in late winter and spring and congregate around early flowers for feeding and mating. In late summer and autumn, mature beetles may be found sheltering in seed pods. In New Zealand, this agent is reported to have seed predation rates of over 80% at some sites. In Australia, there are currently no redistribution programs being conducted as, since its release in Australia, the beetle has been found to feed on the pods of tagasaste (a fodder crop) in New Zealand. The beetle has established at several sites in NSW, Victoria and South Australia and appears to be spreading.

Broom twig mining moth (*Leucoptera spartifoliella*)
Target: Scotch broom
Currently present (but in decline) in SA, Tas, Vic, NSW

The broom twig mining moth is a small silvery white moth whose larvae burrow along stems of previous years' growth of Scotch broom plants. The adults are 2–4 mm long with a small dark, silver patch and fringing on the end of each forewing. Over summer, moths lay around 100 eggs in the furrow of broom stems. Upon hatching, the larvae bore into the stem where they live and feed until they pupate in the spring. During development, the larvae may burrow through a 30–50 cm length of stem. In mid to late spring, the larvae emerge and form cocoons made of silk where they pupate for a month. The cocoon stage is the most easily detected of any of the life stages of the twig mining moth, as they are exposed on the lower branches. Broom plants heavily infested with twig mining moth larvae will have considerable areas of dead wood, stunted growth and reduced flowering. In Australia, recent surveys indicate that numbers of twig mining moths may be declining at release sites. Research suggests that this agent will not provide effective suppression of broom.

Scotch broom psyllid (*Arytainilla spartiophila*)
Target: Scotch broom
Currently not established in Australia

The Scotch broom psyllid is similar to the Cape broom psyllid but the adults are light brown to light red brown in colour and have only one generation per year. The psyllid sucks plant sap, and in Europe can occur in large populations that cause significant plant damage. Several releases of the Scotch broom psyllid were made in Australia from 1999. However, recent surveys of release sites have failed to locate any surviving populations. It is possible that another concerted effort to import and release this agent could be successful. However, with only one generation a year, this psyllid is unlikely to be as effective as the Cape broom psyllid.

Other insects and diseases found to damage Scotch brooms
There are a number of other enemies of Scotch broom present in Australia that are either native or were not deliberately introduced. These include:

- *Parthenolecanium rufulum* – a scale insect at the Barrington Tops and in southern NSW which sucks sap and has been credited with a 33% reduction in broom seed production in some years.
- *Etiella behrii* (lucerne seed-web moth) – a native moth in southern NSW, the larvae of which eats broom seeds. This can be a pest of lentils so should not be redistributed.
- Cerambycid beetles – borers found in southern NSW, the larvae of which can cause stem girdling, particularly in older mature plants.
- *Uromyces pisi-sativi* – a rust fungus first discovered in Canberra in 2003 but was subsequently found to be widespread throughout the distribution of Scotch broom in Australia.