Lantana — a Weed of National Significance

Using herbicides on lantana

a guide to best management practices

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Photographs
Front cover: pink flowered lantana (J. Wright); splatter gun technique, Border Ranges National Park, New South Wales (D. Stock).
Back cover: spraying lantana, Yarraman, Queensland (A. Clark); two-man team using cut stump method (M. Richards).

Planning flow chart for using herbicides in lantana control

Use this flow chart to work your way through the brochure.

1. Application method — **Page 5**
Identify the application method that suits your situation using Table A.

2. Safety and legislation — **Page 12**
Be familiar with:
- safety when using herbicide
- compliance with the law.

3. Develop a lantana control plan — **Page 15**
Develop a lantana control plan and be strategic about which areas you have the capacity to treat and maintain over time. Estimate the area of target land to be controlled.

4. Calculate volume of herbicide mix — **Page 17**
Estimate the lantana density of each situation using the photo guide in Table B, then determine the volume of mix required per hectare using Table C as a guide.

5. Select the best herbicide — **Page 16**
1. Determine the herbicide that best suits your needs, the season, available equipment and budget.
2. Using Table D, calculate the following:
   (A) Total herbicide mix volume (L) = Area for treatment (ha) x the volume of mix per hectare (L/ha)
   (B) Volume of herbicide concentrate = (A) Total mix volume (L) x mix rate (mL/L)
   (C) Approximate costs ($) = (B) Volume herbicide concentrate x $/L (or $/kg)

6. Read manufacturers' recommendations and tips — **Page 24**
Implement your lantana control plan in the best season and using manufacturers' recommendations—see Tables E and F. Ensure adequate records are maintained.

Introduction

Lantana (*Lantana camara*) was introduced to Australia as a garden ornamental plant in the 1840s. Since then, it has adapted to the Australian climate and has been allowed to spread virtually unimpeded. Lantana is now a Weed of National Significance due to its detrimental impacts on Australia's environment and agriculture. Its invasiveness and its potential for fuelling intense wildfires are threats to biodiversity. Lantana is toxic to stock, and reduces profitability for many landholders by out-competing pasture and increasing mustering costs.

By using integrated management practices, lantana can be controlled in most land-use situations.

Herbicide is one way to control lantana, but there is a large range of control options available to suit every situation. Other methods are detailed in the *Lantana control manual*.[1] Investment in control can achieve good returns for landholders in terms of increased production and conservation of natural vegetation.

Knowledge of the variety of herbicides available is required to select those suitable for each situation. Cost is one factor that influences selection, but there can be many other reasons for choosing one herbicide over another. This publication will guide landholders through this selection process. The information provided will aid in identifying the correct volume of mix that should be applied at various lantana densities to achieve effective and economic use of herbicides.

Why use herbicides?

Herbicides can increase the carrying capacity of a property by removing lantana from otherwise good grazing land. Often, herbicides allow safe and simultaneous use of the land (with some stock withholding periods). Herbicide spraying has some advantages in specific situations such as aerial application or splatter gun techniques, where dense lantana prevents other conventional methods being used. Herbicides also minimise the disturbance of natural vegetation and soil, thereby minimising germination and invasion by other weeds.

[1] Department of Natural Resources, Mines and Energy 2004, *Lantana control manual: current management and control options for lantana* (Lantana camara) *in Australia*, NRM&E, Queensland.

However, there are many situations where the use of herbicide should not be the first or the only method considered. All control methods should be integrated with herbicide use to develop best management outcomes. This makes sense for both economic and environmental reasons.

Herbicides are suitable for lantana heights from 0.5–2.0 m at times of active growth. Some herbicide labels make recommendations for use against large, dense bushes; however, herbicide is not likely to be the most economical method available in these situations. Landholders should consider extremes of lantana size and plant health before using herbicide as a control option. Any control operation should be planned and properly managed to increase the likelihood of success. A landholder's money and effort are wasted if treatments merely stunt or suppress lantana. Planning can be developed into a property pest management plan, to include other weeds and pests that threaten enterprises or land value.

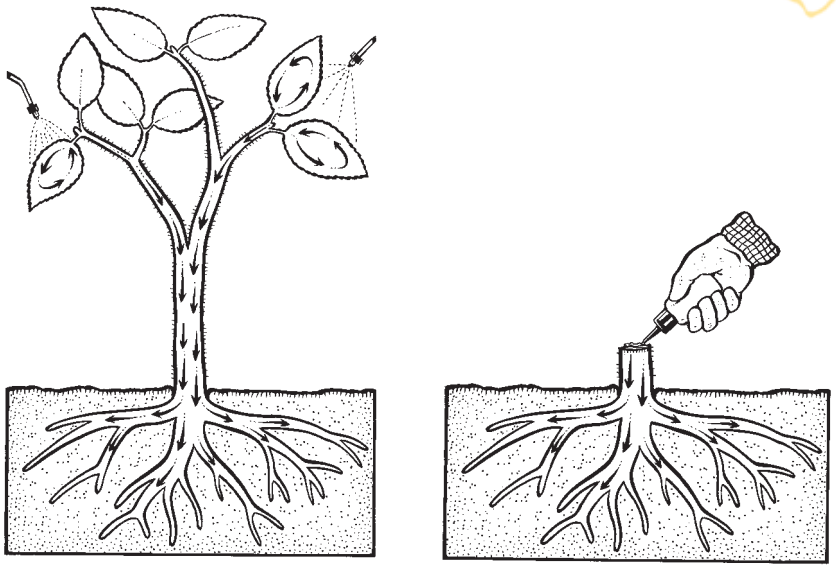
Herbicides can provide a selective approach to control. Some selective herbicides have the advantage of not affecting pasture or eucalypt trees. Some have a residual capacity to help control new lantana seedlings, thus providing an opportunity for pasture to gain a competitive edge. Other herbicides are useful in sensitive native vegetation areas and break down immediately on contact with soil. These choices must be considered before undertaking an operation. Any planned herbicide treatment should include follow-up controls and consolidate previous work before beginning work on new infested areas.

Legal implications

The control methods in this publication should only be used in accordance with regulations and registrations found in legislation or on product manufacturers' labels. These restrictions may prevent the use of one or more of the methods referred to, depending on the individual circumstances.

How do they work?

Herbicides are absorbed into lantana's sap system through its leaves and roots. Spraying foliage is a common method of application as it allows herbicide to absorb (translocate) into this sap system. Low volume applications—using splatter guns on foliage, spraying the base of stems (basal barking) and painting cut surfaces (cut stump)—are also very suitable for achieving herbicide absorption. Other forms of lantana, such as *Lantana montevidensis* (creeping lantana) can be controlled with registered herbicides that specifically target their biology.



Herbicide entering lantana's sap system

1. Application method

There are many application techniques for using herbicide, and different situations in which to use each method. Choosing which application method to use depends on the situation in which it is to be used, and the equipment available. The information below and Table A will provide some guide. Further information can be sought from the herbicide labels. Always check the label to ensure that the method chosen is registered for the intended use.

Methods for use can be selected from high volume methods (e.g. handgun, knapsack, aerially by helicopter) and low volume methods (e.g. splatter gun, basal bark, cut stump).

High volume methods deliver large amounts of herbicide mixture, at a low concentration, to thoroughly wet plants.

Handgun, hose, reel and tank
High-pressure foliar spray via a handgun is a common technique to spray lantana over larger areas. Vehicles which have retractable hoses and pumps loaded, such as Quikspray® units, are an advantage to deliver high volumes easily.

- This method is useful to obtain maximum spray coverage of plants where vehicles can access spray area.
- It is likely to achieve application of herbicide in the quickest time frame.
- Plants should be sprayed to the point of run-off.

Using a high volume Quickspray unit (Photo: D. Stock)

Foliar spraying with dye (Photo: D. Stock)

Knapsack

This method involves a low-pressure foliar spray delivered via a hand-held container (usually 15 L or less) with spray nozzle. The volume and rate used is the same as for handgun foliar spraying.

- It allows mobile delivery on foot or by quad-bike around the plants where access by vehicles may be restricted.
- It is useful for spot-spraying seedlings and regrowth where only small amounts of herbicide are required.
- Plants should be sprayed to the point of run-off; otherwise, failure of control is likely.

Spraying using a hand-held container (Photo: M. Richards)

Aerial spraying

This method allows application by helicopter (not fixed wing aircraft) using a higher concentration of herbicide.

- It is useful for areas with difficult access or dense infestations.
- It may be economical for controlling large areas of dense lantana in open areas.
- Application should use a half overlap, opposite pass technique with a nozzle configuration to ensure lantana canopy penetration.

Close view of spray jets (Photo: A. Clark)

Spraying lantana by helicopter can be cost effective for large dense areas—Yarraman, Queensland (Photo: A. Clark)

Low volume methods deliver small volumes of high concentrate herbicide mixture to plants to reduce chemical usage and off-target damage.

Splatter gun or gas gun
This method involves applying a concentrated herbicide mixed with water to foliage, squirting large droplets from 6–10 m away.

- All foliage does not need to be covered, so it is useful in areas of difficult access or sensitive vegetation.
- It allows specific targeting of herbicide, so a marker dye is recommended to identify splattered bushes.
- Apply approximately 15–20 mL per splatter to achieve the registered rate of 2 x 2 mL per 0.5 m of bush height.

Drenching gun used for splatter technique (Photo: A. Clark)

Using splatter gun with dye (Photo: D. Stock)

Basal bark spraying

This method consists of low-pressure spray application or painting the stem base with oil-soluble herbicides and diesel.

- Use on larger mature plants and those defoliated.
- Use this method year-round, with the best results when lantana is actively growing.
- Completely saturate the circumference of the stem base from ground level to 30 cm of height.

Basal barking lantana (Photo: M. Richards)

Spray completely around the base of the stem (Photo: M. Richards)

Cut stump control

This method involves the application of concentrated herbicide, sometimes with diesel, to cut area of stump by spraying or painting.

- It allows germination of other species in sensitive areas by clearing foliage, but retains stump roots in the ground to help prevent potential erosion.

Cutting lantana stem (Photo: M. Richards)

4 Use this method year-round, with the best results achieved when lantana is actively growing.

4 Cut the stem 5–10 cm above the ground and apply herbicide to the cut surface within 15 seconds.

Dousing freshly cut lantana stump (Photo: M. Richards)

Penetrants and surfactants

The addition of penetrants and surfactants (adjuvants) to some herbicides may increase the ability of the herbicide to absorb into the lantana's sap system. Surface-wetting agents reduce the surface tension of water and increase the herbicide's spreading or wetting properties. Some adjuvants are designed for use with specific herbicides. Please read the label carefully.

Some commonly used adjuvants are:

- non-ionic organosilicone penetrants/surfactants such as Pulse® or Input®
- non-ionic alcohol alkoxylate surfactants such as Chemwet® 1000 or Wetspray® 1000
- spraying oils such as Uptake® Spraying Oil
- specially designed surfactants for use with specific herbicides such as Bonus®.

Dyes

Manufacturers and herbicide users recommend using a marking agent. Dyes should be used to mark areas already treated, to ensure that an adequate volume has been sprayed and areas are not missed.

Painted stumps with dye (Photo: D. Stock)

Table A: Application method by land use

This is general information only. Always adhere to registered methods and rates on the product label.

Land use \ Density	Light	Medium	Heavy (reduce bio-mass before using herbicides)
Pasture	Handgun or knapsack. Follow up control of regrowth and seedlings.	Handgun or aerial spray. Follow up control of regrowth and seedlings and restore pastures by seeding and de-stocking.	Mechanical, fire or aerial spray to reduce lantana bio-mass. Follow up control of regrowth and seedlings by spot spraying and restore pasture by seeding and de-stocking.
Open eucalypt forest and other woodland	Handgun, knapsack or splatter gun (dependent on accessibility). Follow up with the same technique until native grasses or vegetation is re-established.		Options: 1. Mechanical or fire to reduce lantana bio-mass (vegetation clearing and fire permits may be required). 2. Splatter gun in areas of difficult access. 3. Handgun or knapsack in accessible areas. Follow up regrowth and seedlings with foliar spraying or splatter gun until native grass or vegetation is re-established.
Watercourses	Handgun or knapsack using a non-residual herbicide registered for use near waterbodies. Low volume applications: basal bark, cut stump, or splatter gun to reduce off-target damage. Follow up control of regrowth and seedlings ensuring use of revegetation/regeneration techniques. Be cautious of over-spraying watercourses to prevent off-target damage and degradation of water quality. The addition of a surfactant will negate the environmental rating given to some some herbicides		
Roadsides, easements, railways and fence lines	Handgun. Follow up control of regrowth and seedlings.		Mechanical or handgun. Follow up control of regrowth and seedlings.

2. Safety and legislation

Safety when using herbicide
Always read the label carefully before using any herbicide product and use only as directed. The herbicide label and Material Safety Data Sheet (MSDS) are available for all products for your safety.

Note the poison schedule ratings below. Some herbicides are 'unscheduled' and they do not appear on the schedule. This information is contained in the herbicide MSDS.

Ensure personal safety and practise safe work procedures. You should:

- wear personal protective clothing and use equipment in accordance with the manufacturer's label recommendations. This may require wearing full head and body covering with respirators and filters, and impermeable boots and gloves
- minimise exposure to herbicides when mixing, by wearing elbow-length PVC gloves and a face shield
- keep equipment leak-free and in good working order
- use equipment that meets Australian standards
- spray only in ideal wind and weather conditions to reduce drift and spray away from the direction of the wind.

Keep first aid equipment on hand and have an adequate knowledge of appropriate procedures. You should:

- treat any personal contact with chemicals immediately by washing the skin or contacted area and seeking medical advice. Remove contaminated clothing, hats and shoes and wash separately from other clothing.
- recognise over-exposure symptoms (such as nose bleeds, skin irritation or nausea) requiring urgent medical attention.

Poisons schedule

Schedule level	Toxicity	Signal words present on product label
Schedule 7	Extremely toxic	Dangerous Poison
Schedule 6	Moderately toxic	Poison
Schedule 5	Toxic	Caution

Mixing herbicides wearing correct safety gear (Photo: M. Richards)

Compliance with the law
Be responsible to the law.
You should:

- read the registered label of the chemical thoroughly to understand all the requirements
- adhere to legislation when using herbicides and chemicals. Regulatory requirements differ between state governments and local governments. Check the requirements in your area
- use only pesticides and herbicides registered with the Australian Pesticides and Veterinary Medicines Authority (APVMA), for the intended situation of use, at the suggested rates and only by methods registered on the label.

Record chemical applications and give appropriate notification of chemical use. Make note of the following information as a record:

- landholder (name, address and other contact details of the owner/occupier of the property being sprayed)
- date and time of spraying (start and finish)
- operator details (name, address and contact details)
- crop or place where pesticide was applied (include fallow land and land adjacent to spraying)
- type of equipment and methods used
- name of herbicide used (all chemicals and adjuvants)
- amount of concentrated herbicide used

- total quantity of mix applied (including water or other wetters mixed with herbicide)
- size of block sprayed
- order in which the blocks were sprayed
- weather conditions (wind speed and direction, temperature and humidity), particularly if labels describe limiting weather conditions for use.

Undertake training and ensure people applying the herbicide have met the appropriate certification and training requirements necessary for handling or using herbicides. Obtain an APVMA permit if you or they wish to vary the label directions or use.

For more information regarding record keeping, notification requirements and training in the use of herbicides and pesticides, contact your state government or refer to the appropriate legislation.

Spaying herbicides wearing correct safety gear (Photo: M. Richards)

3. Develop a lantana control plan

The most important step when undertaking lantana control is to develop a plan of action. This ensures that control methods will be effective, saving time and money while also increasing the success of control.

1. Set targets

Rather than trying to eradicate an infestation over the entire property in the first attempt, set smaller milestones to gradually achieve the final goal:

- Restore one site or small infestation at a time.
- Restore one heavily infested site by small sections.
- Aim to prevent further spread from current infestations.

2. Prioritise

Identify which areas will provide the best return on investment or are of the highest value:

- Choose a site based on the ease of achieving eradication or with the highest future production or conservation value.
- Deal with smaller outlying infestations first and minimise the spread of weeds.

3. Plan and implement

- Consider the site location when choosing the application technique, especially when it is near environmentally sensitive areas, watercourses, nearby crops, residences or native vegetation.
- Choose the herbicide according to its registered use and plan the application methods given current site conditions. High volume options may be the most cost-effective and practical applications, but in some locations a low volume application may be the most appropriate to minimise risk of off-target damage.
- Check seasonal conditions and only use herbicides in optimum seasons and weather conditions.
- Integrate techniques to increase effectiveness of control methods.
- Follow up control of regrowth and seedlings by re-spraying and planting competitive species (e.g. pasture).
- Monitor actions over a series of years.

4. Record progress

Keep notes of herbicide use (see section 2):

- Track the effectiveness of the control methods on your property in a diary or record changes on a map.
- Take photos at pre-determined intervals to give a visual record of changes to the infestation over time.
- Assess the cost efficiency of various treatments from your records.

4. Calculate volume of herbicide mix

Table B: Lantana density

Light
- Plants are sporadic with grass areas between them
- < 500 plants per hectare *
- Usually less than 1.0 m high**
- Access available to individual bushes

Medium
- Plants in clumps with some grass areas
- 500–2000 plants per hectare *
- About 1–2 m high**
- Access diminished to vehicles, but not to humans

Heavy
- Plants are generally impenetrable without cutting access trails
- > 2500 plants per hectare *
- Usually > 2 m high**
- Access denied except through initial mechanical or fire treatments

* Plants per hectare will depend on the maturity of the lantana and whether recent controls have influenced density of new seedlings.

1000 plants/hectare = 400 plants/acre

** Height of plant may vary with maturity

Grazing paddock	Eucalypt/woodland areas	Woodland edges
 (Photo: A. Clark)	 (Photo: A. Clark)	 (Photo: D. Stock)
 (Photo: A. Clark)	 (Photo: A. Clark)	 (Photo: D. Stock)
 (Photo: M. Day)	 (Photo: A. Clark)	 (Photo: M. Day)

Table C: Volume (approx.) of herbicide mix required for treating lantana

Method of application	Lantana density	Lantana height			
		<0.5 m	0.5–1.0 m	1.0–1.5 m	1.5–2.0 m
High volume and high pressure foliar spraying (handgun, hose and reel)	Heavy Medium Light		3000 L/ha 2000 L/ha 1000 L/ha	4000 L/ha 3000 L/ha 2000 L/ha	5000 L/ha 4000 L/ha 3000 L/ha
High volume and low pressure foliar spraying (knapsack and spot spraying)	Medium Light		20 L/100 m^2 10 L/100 m^2		
Aerial application by helicopter (boom)	Heavy			200 L/ha	200 L/ha
Splatter gun (approximate values to equate to registered rate)	Heavy Medium Light	4 mL 4 mL 4 mL	12 mL 10 mL 8 mL	16 mL 14 mL 12 mL	20 mL 18 mL 16 mL
Basal barking (sprayed)	Light to medium		< 100 mL/bush		
Cut stump	Light to medium	Dependent on density and thickness of stems			

5. Select the best herbicide

Table D: Active herbicide ingredients, rates and approximate costs

Active constituent	Brands + mixes	Registered rates	States registered	Nominal retail price*/L or kg (incl GST) *at time of publishing	Approx. costs / 100 L	Indicators for use against lantana
Foliar spray high volume either handgun or knapsack						
Glyphosate (360, 540 g/L)	360 g/L Roundup® Roundup® Biactive™ Weedmaster® Duo Wipe-out® 360	Handgun: 1 L/100 L water; Knapsack: 150 mL/15 L water + penetrant at 200 mL/100 L (e.g. Pulse®, Freeway Gold®)	Qld NSW (NT for some)	$6–7/L plus Pulse $40-42/L	$14–16 (with surfactant) or $6–8 (without surfactant)	Non-residual, non-selective. Use where off-target damage can be limited. Will affect pasture and legumes. Clear amber or light green liquid, with faint amine odour. Poisons schedule: S5.
	540 g/L Roundup® PowerMAX™ Credit® and Bonus® pack	Hand gun; 660–670 mL/100 L water Knapsack; 100 ml/15 L water + Powermax™ add penetrant at 200 mL/100L (e.g. Pulse) + Credit® and Bonus® surfactant at same rate as herbicide	All states	$10–12/L + Pulse $40–42/L or Bonus (included with Credit®)		
Picloram + Triclopyr (100 g/L + 300 g/L)	Grazon® DS Conqueror® Fightback®	Height 1m; 350 mL/100 L water + adjuvant at 500 mL/100 L (e.g. Uptake® Spraying Oil) or + penetrant at 100 mL/100 L (e.g. Pulse®) Height 1–2m; 500 mL/100 L water Mature lantana; 750 mL/100 L water	All states	$42–45/L + (At 350 mL rate include Uptake® $7–9/L or Pulse $40–42/L)	$19–21 (low rate) or $21–23 (mid-rate) or $32–35 (high rate)	Selective, residual. Use in non-crop areas, forests, pasture and rights of way. Will affect legumes. Clear brown liquid. Compatible used with 2,4-D amine. Also treats creeping lantana. Poisons schedule: S6.

Active constituent	Brands + mixes	Registered rates	States registered	Nominal retail price*/L or kg (incl GST) *at time of publishing	Approx. costs / 100 L	Indicators for use against lantana
Picloram + 2,4-D amine (75 g/L + 300 g/L)	Tordon® 75-D	650 mL/100 L water	Qld NSW SA WA Vic.	$53–55/L	$33-36	Selective, residual. Use in pasture and rights of way. Will affect legumes. Dark brown to black liquid. Poisons schedule: S5.
Dichlorprop (600 g/L)	Lantana® 600 (previously DP® 600)	Handgun: 1 L/200 L water Spot spray: 5 mL/1 L water	Qld NSW NT	$11–12/L	$6-7	Selective, residual. Use in non-crop areas. Will affect legumes. Brown liquid with faint phenolic odour. Also treats creeping lantana. Poisons schedule: S5.
Fluroxypyr (200 g/L)	Starane® 200 Flagship® 200 Comet® 200	Height 0.5–1.2 m; 500 mL/100 L water Height 1.2–2 m; 1 L/100 L water	Qld NSW	$31–33/L	$16-17 $31-33	Selective, residual. Use in non-crop areas, forests, pasture and rights of way. Will affect legumes. Black to brown liquid. Also for creeping lantana. Poisons schedule: S5.
2,4-D amine (625 g/L or 300 g/L)	2,4-D Amine 625 Amicide® 625	320 mL/100 L water	Qld NSW ACT SA	$7–8/L	$3-4	Non-selective, non-residual. Use in pastures, non-agricultural land and rights of way. will affect legumes. Results may only suppress lantana. Clear red-brown liquid with ammonia odour. Poisons schedule: S5.
	Affray® 300	7 L/ 1000 L water (for creeping lantana only)	Qld	$13–15/L	$9-11	Only for creeping lantana. Light straw-coloured liquid. Poisons schedule: S5.

Active constituent	Brands + mixes	Registered rates	States registered	Nominal retail price*/L or kg (incl GST) *at time of publishing	Approx. costs / 100 L	Indicators for use against lantana
Metsulfuron methyl (600 g/kg)	Brush-Off® Brushkiller® 600 Lynx® 600 Bushwacker® WG Metsulfuron 600 WG	10 g/100 L water or can be mixed with + 200 mL glyphosate 360 + non-ionic surfactant at 100–200 mL/100 L (e.g. Wetspray® 1000, Chemwet® 1000)	Qld NSW + (WA, ACT some brands)	$155–165/kg + glyphosate $6–7/L + surfactant $5–6/L	$2 0r $4-5 with mix	Non-selective, residual. Use in native pastures and rights of way. Will affect pasture and legumes . Results against lantana variable in the tropics. Off-white granulated solid with no odour. Poisons schedule: not scheduled, glyphosate S5.
		3 g/100 L water + 400 mL glyphosate 360 + penetrant at 100 mL/100 L (e.g. Pulse®) (not for Brush-Off® or Brushkiller®)	All states	$155–165/kg + glyphosate $6–7/L + Pulse $40 –42 /L	$7-8	
	Cut-Out® (pack includes glyphosate)	95 g/100 L water + penetrant at 100 mL/100 L (e.g. Pulse®)	Qld NSW ACT	$35–37/kg + Pulse $40–42/L	$7-9	Non-selective, residual. Use in pastures and rights of way. Will affect pasture and legumes. Results against lantana variable in the tropics. White to fawn odourless solid. Poisons schedule: S5.
	Trounce® Brush-pack™ (pack includes glyphosate)	173 g/100 L water + penetrant at 100 mL/100 L (e.g. Pulse®)		$51–53/kg + Pulse $40–42/L	$13-15	
Aminopy-ralid + fluroxypyr (10 g/L + 140 g/L)	Hotshot®	Height 0.5–1.2 m: 500 mL/100 L water Height 1.2–2.0 m: 700 mL/100 L water	All states	$23–25/L	$11-13 (low rate) or $16-18 (high rate)	Selective and residual. Use in non-crop areas, forests, pasture and rights of way. Will affect legumes, but not pasture and eucalypts. Also for creeping lantana. Poisons schedule: S6.

Active constituent	Brands + mixes	Registered rates	States registered	Nominal retail price*/L or kg (incl GST) *at time of publishing	Approx. costs / 100 L	Indicators for use against lantana
Aerial spraying (helicopter only)					**Approx $/100 L**	
Dichlorprop (600 g/L)	Lantana® 600	6-8 L/ha	Qld NSW NT	$11–12/L	$33–48	Spray mix at 200 L/ha. Poisons schedule: S5.
Picloram + Triclopyr (100 g/L + 300 g/L)	Grazon® DS	10 L/ha	Qld NSW NT	$42–45/L	~$220	Spray mix at 200 L/ha. Limit spraying over native trees. Poisons schedule: S6.
	Grazon® DS + 2-4,D amine	1.5 L Grazon + 2,4-D Amine 625 at 6 L/ha		$42–45/L + Amine 625 $7–8/L	$52–58	
Glyphosate	Glyphosate is registered for aerial application at 4 L/ha (but not specifically for lantana); however, this would not provide effective kills for mature lantana.					
Splatter or gas gun		**Ratio: X parts product + Y parts water**			**Approx $/5L**	
Glyphosate (360 g/L or 540 g/L)	Roundup® 360 Weedmaster® Duo Roundup® Biactive	1:9 glyphosate + water 2 x 2 mL dose per 0.5 m bush height	Qld NSW NT	$6–7/L	$3–4	Non-selective and non-residual herbicide. Poisons schedule: S5.
	Credit®	1:13 glyphosate + water + Bonus® surfactant at same rate as Credit®	All states	$10–12/L	$3–5	
Metsulfuron-methyl (600 g/kg)	Brushkiller® 600 Lynx® 600	2 g/L water + surfactant at 10 mL/5 L (0.2 %) (e.g. Pulse®)	Qld NSW (WA included for Lynx 600®)	$155–156/kg + Pulse® $40–42/L	$2–3	Non-selective and non-residual herbicide. Poisons schedule: not scheduled.

Active constituent	Brands + mixes	Registered rates	States registered	Nominal retail price*/L or kg (incl GST) *at time of publishing	Approx. costs / 100 L	Indicators for use against lantana
Basal bark and cut stump					Approx $/5L	
Picloram + Triclopyr (120 g/L + 240 g/L)	Access®	1 L/60 L diesel Basal bark: Plants < 50 mm diameter Cut Stump: Plants > 50 mm diameter	All states	$81-83/L + diesel $1.40/L	$13–15	Clear brown liquid. Poisons schedule: S6.
Picloram (43g/kg)	Vigilant® Herbicide Gel	Cut stump: Neat 3–5 mm gel on cut surface If diameter > 20 mm use minimum of 5 mm gel thickness	All states	$104–107/kg	N/A	Direct application. Brown translucent water-soluble gel. Poisons schedule: not scheduled.
Triclopyr (600g/L)	Garlon® 600 Safari® 600 Invader®	1 L/60 L diesel Basal bark: Plants < 5 cm diameter Cut Stump: All plants sizes	All states	$55–58/L + diesel $1.40/L	$11–12	Clear amber liquid with characteristic odour. Poisons schedule: S6.
2,4-D n-butyl ester (800 g/L)	Rubber Vine Spray®	Basal bark/cut stump: 1 L/40 L diesel	Qld	$17–19/L + diesel $1.40/L	$9–10	For pink lantana only. Clear brown liquid. Poisons schedule: S5.
Glyphosate (360 g/L)	Roundup® Weedmaster® Duo	Cut stump: Neat	Off-label permit (check your state)	$6–7/L	N/A	Clear amber liquid or light green liquid with faint amine odour. Poisons schedule: S5.

6. Read manufacturers' recommendations and tips

Table E: Recommended spray season

Active ingredient	Example product name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Foliar spraying, aerial spraying and splatter gun													
Glyphosate	Roundup®, Glyphosate 360, Weedmaster Duo, Credit	6	6	t	4 4	4 4	4 4	4	t	6			
Picloram + Triclopyr	Grazon® DS, Conqueror®, Fightback®					6							
Picloram + 2,4-D	Tordon® 75-D		6		6		6	6	t	4 4	4 4	4	t
Dichlorprop	Lantana® 600			6	6		t	t		t	4 4	4 4	4
Fluroxypyr	Starane® 200, Flagship®, Comet® 200	6	6	6	6	t	4 4	4 4		4	t		6
2,4-D amine	Amicide 625, Amine 625	6	6	6		6	6	6		6	6		
Metsulfuron methyl	Brush-Off®, Brushkiller®, Lynx® 600, Bushwacker® WG, Savannah®	6	6	6	6	6	6	6	6	4 4	4	6	
Metsulfuron methyl + glyphosate	Cut-Out®, Trounce®	6	6	t	t	t	t	t	t	4 4	4	6	
Aminopyralid + fluroxypyr	Hotshot®	6	6	t	t	t	t	4	4 4	4	4	6	
Basal bark and cut stump													
Picloram + Triclopyr	Access®	t	t	4 4	4	4 4				4		4 4	4
Picloram	Vigilant® Herbicide Gel	t	t	4 4	4	4 4	4 4	4 4		t			
Triclopyr	Garlon® 600												
2,4-D n-butyl ester	Agricrop Rubber Vine Spray®					t	t						

Key to spraying: 4 = optimal to spray at this time 6 = not effective to spray at this time t = if conditions are suitable and plant is actively growing

General advice and manufacturers' recommendations

General advice may vary between herbicides, therefore any use of these recommendations should be in strict accordance with the label of the herbicide product being used.

Mixed spray

- Only mix herbicide in quantities that are likely to be used in one day, and use promptly. Some herbicides, like Grazon® DS, Starane® 200 and Tordon® 75-D, can remain in diluted form for up to one week. Other herbicides cannot be stored for more than two days (e.g. metsulfuron methyl) and some cannot be stored for prolonged periods in direct sunlight (e.g. Lantana® 600).
- Some herbicides require agitation to keep active ingredients in suspension, but for others this can create excessive foaming.
- Be aware of the mixing container being used. Some herbicides such as metsulfuron methyl and glyphosate cannot be mixed in galvanised steel or unlined steel containers, as this will produce hydrogen gas. Other herbicides may have corrosive effects on aluminium.
- Some herbicides are pre-packed with two mixer chemicals or solid herbicides in water-soluble bags to allow easier mixing and reduce the chance of mess or spillage. Some pre-packed herbicide gels are also available for cut stump work for ease of application.
- Be aware of the hardness of the water. Reduced results may occur if the herbicide is mixed with water containing soil or calcium salts. Some herbicides are readily miscible in hard or soft waters.

Cleaning

- Clean all equipment by thoroughly washing with water for at least 10 minutes (or as per the label directions) and clean tanks by using the cleaning chemicals specified for that product. When some cleaning chemicals are mixed with certain herbicides they may have chemical reactions and produce harmful gases that are flammable or toxic.

Application of herbicides

- Spray lantana in the best season according to product guidelines. As a rule of thumb, only spray lantana when it is actively or vigorously growing. A sign of active growth is after rain when lantana is flowering. Some herbicides have higher registered rates for mature lantana.
- Spray lantana to thoroughly wet all foliage and stems to the point of run-off. Apply thoroughly and evenly to wet all foliage and stems, ensuring the herbicide penetrates through the bush to hidden foliage. Use a nozzle configuration that ensures canopy penetration. It is recommended to use a side-by-side pattern to ensure the herbicide is evenly applied to all sides of the plant. Some selective herbicides also recommend wetting the soil around the base of the plants with herbicide mix, to help with uptake through the root system and residual control of seedlings that may germinate.
- Do not treat lantana that may be stressed, as a reduced level of control may result. The best results will not be achieved with lantana that is stressed from prolonged periods of extreme cold, moisture stress (water-logging or drought), poor nutrition, presence of disease, heavy insect attack or previous herbicide treatment. Some herbicides (e.g. fluroxypyr) may still be able to achieve good kill rates with poor foliage cover, but only by using the highest registered rate. Re-treatment of lantana may be required if the herbicide only suppresses the plant.
- Spray in the cooler parts of the day when evaporation will have less effect.
- Ensure clean water is used when mixing. A reduced result will occur if using glyphosate with water containing suspended clay or organic matter from dams, streams or irrigation channels or high levels of calcium, magnesium or bicarbonate ions.
- Do not spray if rain is predicted, and delay treatment of plants with heavy dew or when rainwater droplets fall off leaves when touched. Heavy rain is likely to wash any chemical off the leaves and produce a poor result. If rain is predicted within 4–6 hours do not commence work;

however, products containing fluroxypyr, picloram and triclopyr are rainfast in one hour. Rainfastness of herbicides varies, so refer to the herbicide label for these constraints. Rainfastness can be reduced if lantana is not actively growing, is under stress or is in conditions of low light.

- The addition of a surfactant or penetrant may improve the success of control efforts for specific herbicides. Use the label recommendations.
- Weather conditions are important at the time of spraying. Do not use when weather conditions are expected to cause spray drift onto nearby susceptible plants, usually at times of high wind. Treatment should also commence after any annual flooding.
- While large mature lantana plants can be treated using herbicides, the best results will occur for lantana 0.5–2.0 m high, actively growing and flowering. Some variation in results may occur between herbicide products, seasonality, operator methods and lantana variety and maturity.

Visible damage

- The visible damage to lantana from herbicides can be slow, appearing over a period of weeks. Wilting, yellowing and dieback of the leaves occurs, which then advances to complete browning of above-ground growth and deterioration of root stems. When using most knockdown herbicides, complete brownout occurs in 4–6 weeks and death of the plant occurs in 9–12 weeks. For metsulfuron, full brownout may take up to 3–6 months.
- Seedling germination and growth will often have to be treated with a separate application.
- In adverse conditions, the visible damage may be slower or may only stunt or suppress lantana, requiring repetition of herbicide treatment during the best season.
- Spraying early in the season after the first flush of growth may result in brownout of leaves and defoliation, but the resultant kill rate may be low. Spraying of new growth will be necessary the following season.
- Lantana, native plants, crops, legumes and some native grasses are likely be affected by most herbicides.

- Selective herbicides may control lantana without impacting on improved pasture and eucalypt trees. For example, picloram and dichloroprop can remain active in the soil for extended periods depending on soil type, rainfall, temperature, humidity, soil moisture and organic matter; however, they do allow most pastures to establish quickly after treatment. In addition, fluroxypyr does not usually affect pasture and eucalypts.

Minimise off-target damage

- Spray drift from some herbicides will cause off-target damage. When foliar spraying, ensure spray drift does not affect desirable plants, crops, cropping land, pasture legumes or native vegetation. Read the herbicide label to ensure the use is appropriate and reduce off-target damage by careful application.
- Ensure spray drift does not drift over the operator, by standing up-wind. Still days with no wind are not ideal, as spray drift cannot be predicted.
- Be aware of draining or flushing equipment near native or non-target trees or other plants, on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots.

Coffs Harbour, New South Wales
(Photo: A. Clark)

Aerial spraying

- Spraying lantana by helicopter can provide a good rate of dieback to allow access and follow up. Always spray with a properly calibrated boom to ensure adequate coverage of the target infestations. Use a half overlap, opposite pass technique to ensure lantana is sprayed from two different directions, as this will also ensure maximum coverage. Do not apply herbicide aerially in wind greater than 15 km/hr and air temperatures above 35°C.
- While glyphosate is registered for aerial spraying (but not specifically for lantana), the registered rates are not suitable for killing lantana. The risk of damage to pasture and other native species can be high depending on the situation.

Environmental considerations

- Exercise caution when spraying in riparian areas due to herbicide toxicity to marine animals. Do not contaminate waterways, streams or rivers, especially potable water supply.

Gold Creek, Queensland (Photo: B. Wilson)

Herbicide labels recommend not spraying over water bodies and provide guidelines to spraying distances from any potable water source—either still reservoirs or flowing creeks.

- Roundup® Biactive™ is specifically developed for use in aquatic situations, but adding a surfactant will negate its environmental suitability.
- Herbicides such as glyphosate break down immediately on contact with soil and have no residual effect. Glyphosate that reaches the soil is tightly bound to soil particles.
- Some herbicides are considered toxic to birds, bees, fish and crustaceans.

Withholding periods

- Some herbicides will make lantana more palatable to stock after treatment. Do not allow stock to re-enter paddocks until treated poisonous plants have browned out and died down.
- Although some herbicides have a nil withholding period for stock animals, the advantage of de-stocking areas is that it allows the herbicide to uptake into the plant for at least seven days without disturbance.
- If using pasture for fodder, follow the label recommendations regarding time requirements before harvesting pasture, which can be up to eight weeks.

Ongoing control

- Delay follow-up spray treatment until regrowth has reached about 0.5–1.0 m in height.
- Burning (after complete brownout), pasture improvement and/or further treatment are recommended to control lantana seedlings and regrowth when using glyphosate. Some herbicides (e.g. Grazon® DS) do not recommend cutting or clearing for at least six months after spraying.
- If regrowth occurs, follow-up by respraying or using another control option.
- To improve paddock pasture, broadcast pasture seed and keep stock off during the following summer to allow pasture to establish.

Cut stump

- Do not apply herbicides to charcoal-coated or wet stems when using basal barking or cut stump treatments, as this can repel the diesel mixture.
- Tough barky stems can absorb more herbicide than smooth stems.

Permits

- Permits may be required for use of herbicides in your state or local area. Check the herbicide label or your local authority. For example, permits are required for using 2,4-D n-butyl ester in certain areas of south-east Queensland.

All herbicides are at risk of being overused, leading to the targeted species building a resistance to the herbicide in question. Herbicides are allocated a herbicide group code according to the science behind killing the weed. This determines the level of risk for becoming ineffective. Most lantana herbicides have a low risk of this occurring; however, to avoid this problem, herbicides from different categories should be used from time to time.

Table F: Herbicide resistance

Resistance level	Herbicide group	Mode of action	Active ingredients
High	A & B	*Targets specific plant cell processes* Individuals in the weed population may have cell processes varying from those targeted by herbicides in this group, making them resistant to the chosen herbicide. These varieties soon thrive to form an infestation uncontrolled by the original herbicide.	metsulfuron methyl
Moderate	C to H	*Targets general plant cell processes* Plants with resistance to these herbicides are less common. These herbicides can be used over a number of seasons with few problems of resistance, though; it is a possibility resistance may occur.	
Low	I to M	*General or multiple modes of action* Due to the multiple modes of action, there is a smaller chance that weeds will be able to resist each action the herbicide takes, making resistance less likely to occur—though still not impossible.	glyphosate, picloram, triclopyr, dichlorprop, fluroxypyr, 2,4-D amine, 2,4-D n-butyl ester, aminopyralid

Tips for using herbicides

- The effectiveness of individual herbicides can depend upon the genetic variation between lantana plants.
- Spray plants in subtropical areas in the late summer or autumn when flowering occurs. Remember that plants in tropical areas may be more resistant to herbicides containing metsulfuron-methyl.
- Encourage coordinated land management. Work with neighbours to control weeds along property boundaries.
- Be flexible in your approach. If a more economical control opportunity presents itself, which also minimises environment impacts, use it!
- Look for other weeds that can be treated while carrying out lantana management.
- Remember the importance of following up and monitoring for regrowth and seedlings in your control program.
- Plan activities seasonally by developing a property pest management plan.
- Don't attempt a larger area than you can handle in any one season. Adequately control an area before moving on to the next infestation.

Yarraman, Queensland (Photo: D. Stock)