

Chapter 2

Preventing and controlling fireweed

'At a glance'

- Limiting the spread, establishment and seeding of fireweed is critical for its effective control.
- There are various ways to prevent and control fireweed, and combining these achieves better results.
- Establishing and maintaining competitive pastures, or other dense groundcovers, is the key.
- Rotational grazing is needed to avoid overgrazing of paddocks.
- Grazing by sheep or goats can provide excellent fireweed suppression, but a diet very high in fireweed may pose poisoning risks.
- A range of herbicides are available to suit different situations.
- Cutting needs to be frequent to be effective.
- Hand removal can be effective for very small properties or where fireweed is very limited in current extent.
- Cultivation can control fireweed but also stimulate further germination.
- Mulches are only suited to amenity areas.
- Biological control is yet to be an option.

2.1 Integrated weed management for fireweed

Fireweed is a challenging weed to manage, but there are various ways to control it and, better still, to prevent it. The key is increasing resilience to fireweed invasion by building and maintaining groundcover such as competitive perennial pastures. This is supplemented by biosecurity measures to limit its seed spread.

Preventing the entry and spread of fireweed seed, and limiting seedling establishment and seed production, requires a multi-pronged approach. This is called integrated weed management (IWM) and combines various control options in a strategic manner. IWM for fireweed includes:

- hygiene measures
- early detection and control of new outbreaks
- promotion and maintenance of pastures or other competing groundcovers
- carefully planned and monitored grazing, including possible use of sheep or goats
- strategic use of herbicides, and
- physical controls (cutting, hand pulling, cultivation, mulching).

Ideally, IWM would also include biological control; however, despite extensive research, no agents are yet available for use in Australia (as of May 2023).

In developing an IWM approach for your property, consider the advantages, disadvantages and timing of fireweed prevention and control methods available. These methods are summarised in Table 2.1, and each is described in this chapter. Examples of

Chapter 2

IWM approaches are presented in the property case studies in Chapter 4.

There is no single IWM 'recipe' to be adopted by all properties. IWM should be tailored according to fireweed burden, property type and management goals, environmental conditions (e.g. climate, soil

type, other plant species present), financial and technical capacity, broader biosecurity needs and other land management issues and opportunities. IWM also needs to take a multi-weed species approach because there are often other important weeds also present.

The management challenges of fireweed

- It produces high numbers of seeds over long periods.
- Seeds disperse efficiently by many means, including wind, as a produce contaminant (e.g. hay), on machinery (e.g. slashers) and livestock.
- Seed can remain viable in the soil for years.
- Seeds readily germinate on exposed soil following heavy grazing and other disturbances.

- Fireweed is avoided by cattle and horses, giving it a competitive advantage in pastures.

These features of fireweed mean that complete eradication is extremely difficult and time-consuming to achieve unless it is caught at a very early stage and there are no nearby infestations. In areas where fireweed is widely established, ongoing management using a range of control and pasture management methods is required to keep fireweed density low.



John Virture

Table 2.1 Summary of fireweed prevention and control measures. Note that biocontrol is in *grey italics* as its inclusion in fireweed IWM is pending any biological agents becoming available in future years.

	 Advantages	 Disadvantages	 Caution!	 Timing	 Integrate with
Property biosecurity	<ul style="list-style-type: none"> Prevents weed entry and spread Avoids future costs and impacts Low ongoing cost 	<ul style="list-style-type: none"> Setup costs for washdown areas Ongoing time commitment to manage spread pathways Ongoing effort needed to obtain everyone's compliance 	<ul style="list-style-type: none"> Difficult to limit natural pathways of spread – particularly wind 	<ul style="list-style-type: none"> Year-round 	<ul style="list-style-type: none"> All on-property activities All other fireweed control measures
Surveillance	<ul style="list-style-type: none"> Early detection and intervention reduces impacts and costs 	<ul style="list-style-type: none"> Searching is time-consuming and ongoing (every 2–4 weeks) 	<ul style="list-style-type: none"> Difficult to detect fireweed until it is flowering, by which time it may have set seed 	<ul style="list-style-type: none"> Autumn–spring May be occasional plants in summer in wetter areas 	<ul style="list-style-type: none"> All other fireweed control measures
Competitive pasture	<ul style="list-style-type: none"> Limits fireweed germination and establishment Can increase livestock grazing capacity and farm profits Suppresses other weeds and protects soil from erosion 	<ul style="list-style-type: none"> High upfront establishment costs Need for ongoing, careful pasture management, including rotational grazing Fireweed plants may still grow, albeit at a low density 	<ul style="list-style-type: none"> Seek professional advice on establishing locally adapted pasture species and a sustainable grazing system Need to manage fireweed at pasture establishment phase 	<ul style="list-style-type: none"> Year-round Focus on having dense cover leading into autumn 	<ul style="list-style-type: none"> Biosecurity Surveillance Sheep/goat grazing Herbicides Cutting Hand removal
Sheep/goat grazing	<ul style="list-style-type: none"> Can substantially reduce fireweed density Can integrate with cattle enterprises Reduces need for herbicidal control 	<ul style="list-style-type: none"> Cost of fencing and other infrastructure requirements Ongoing health and welfare requirements Ongoing marketing needs of animals and their products 	<ul style="list-style-type: none"> While much more tolerant than cattle or horses, sheep and goats may still be poisoned by very high intake of fireweed 	<ul style="list-style-type: none"> Year-round 	<ul style="list-style-type: none"> Biosecurity Competitive pasture
Herbicide application	<ul style="list-style-type: none"> Can enable targeted control of fireweed Quick to apply to multiple plants Range of herbicides to suit different situations 	<ul style="list-style-type: none"> Long withholding periods for some herbicides Risk of off-target effects on desirable plants Risk of spray drift and environmental contamination 	<ul style="list-style-type: none"> Various legal requirements apply when using herbicides Follow safety directions Follow directions on managing drift and residue risks 	<ul style="list-style-type: none"> Most effective boom sprayed on seedlings in autumn–winter Spot spraying at other times of year 	<ul style="list-style-type: none"> Biosecurity Competitive pasture Soil cultivation Hand removal

Table continued on next page/...

	 Advantages	 Disadvantages	 Caution!	 Timing	 Integrate with
Cutting	<ul style="list-style-type: none"> Can control fireweed if done frequently Can stimulate vigorous pasture grass regrowth, depending on species and timing Applicable to domestic and amenity situations (e.g. mown lawns) 	<ul style="list-style-type: none"> Cut fireweed can regrow, requiring further treatment Risk of spreading seed Cut fireweed remains toxic and stock cannot avoid eating it in clippings 	<ul style="list-style-type: none"> Machinery hygiene required to minimise risk of spreading weed seeds Cannot use pastures containing fireweed for hay or silage Cannot graze until cut fireweed is decomposed 	<ul style="list-style-type: none"> Winter–spring for cool season pasture grasses, mid-spring for warm season grasses Avoid seeding fireweed Avoid cutting in late spring to reduce risk of over-summering of fireweed Multiple passes needed 	<ul style="list-style-type: none"> Biosecurity Competitive pasture Sheep/goat grazing Herbicides
Hand removal	<ul style="list-style-type: none"> Low cost Suitable for early intervention where there are small infestations Minimal environmental impact Good for ‘mopping-up’ after other controls 	<ul style="list-style-type: none"> Need to locate all individual plants before seed set Time-consuming and labour intensive Generally not practical for large infestations and properties 	<ul style="list-style-type: none"> Wear gloves Take precautions to avoid strain injuries 	<ul style="list-style-type: none"> Year-round 	<ul style="list-style-type: none"> Biosecurity Surveillance Competitive pasture Herbicides
Soil cultivation	<ul style="list-style-type: none"> Non-chemical means of controlling fireweed seedlings Suitable for gardens May be used in pasture establishment 	<ul style="list-style-type: none"> Promotes fireweed germination, requiring further control Risk of soil erosion and damage to soil structure Risk of fireweed regrowth in moist soils Cost of machinery 	<ul style="list-style-type: none"> Frequent cultivations can damage soils and expose them to erosion 	<ul style="list-style-type: none"> Autumn–winter for fireweed seedlings 	<ul style="list-style-type: none"> Biosecurity Surveillance Competitive pasture Herbicides
Mulches	<ul style="list-style-type: none"> Suitable for gardens and amenity areas 	<ul style="list-style-type: none"> Fireweed seed may blow onto and then grow in mulch Cost of materials Risk of weed seed contamination in certain mulches Not practical for use across large areas 	<ul style="list-style-type: none"> Remove existing weeds before applying to the soil surface and any weeds that grow in the mulch Take precautions to avoid strain injuries 	<ul style="list-style-type: none"> Any time 	<ul style="list-style-type: none"> Biosecurity Surveillance Herbicides Hand removal Soil cultivation
Biocontrol	<ul style="list-style-type: none"> Potential to reduce growth and reproduction of fireweed Self-sustaining 	<ul style="list-style-type: none"> Not an eradication tool – unlikely to give sufficient control on its own 	<ul style="list-style-type: none"> A potential biological control agent cannot be released where it poses an unacceptable risk to non-target plants 	<ul style="list-style-type: none"> An agent would be active at certain times of year according to its life cycle 	<ul style="list-style-type: none"> All other fireweed control measures

2.2 Preventing weed entry and movement

Key points

- Fireweed and other weeds may be brought to and spread within a property in many ways.
- Ensure vehicles, machinery and equipment arrive and depart clean.
- Establish a dedicated clean-down area.
- Quarantine livestock on arrival.

Legal requirements to control fireweed

In certain parts of Australia you may be legally required to take measures to prevent the spread of fireweed – such as avoiding fireweed seed contaminating produce (e.g. hay, turf). You may also be required to control fireweed infestations on your property.

Section 5.1 lists the current declaration status of fireweed (as of May 2023) in each state and territory. Contact your local weed management authority for further information in relation to your location.



2.2.1 Biosecurity and property hygiene

Key information source for this section: AHA and PHA (2022).

Biosecurity at the property level involves measures to prevent the entry, spread and establishment of new weeds, pests and diseases. It also applies to not 'exporting' weeds, pests and diseases from your property to other properties (e.g. through contaminated produce or machinery). Developing and routinely implementing a property biosecurity plan is a valuable, low-cost investment to prevent and lessen incursions of a wide range of weeds and other pests and diseases.

Guidance on property biosecurity planning is available on the **Farm Biosecurity website** (www.farmbiosecurity.com.au/) and from other government and industry sources (see Section 5.6). A biosecurity plan considers the pathways for how pests, weeds and diseases can enter, spread within and move off a property. For fireweed, various biosecurity practices can be implemented to prevent the movement of seed to and across the property.

Fodder and seed

Historically, fireweed is thought to have moved into some districts via contaminated hay or crop and pasture seed. This can be a common means of spread for many weeds, and the risk increases in times of widespread feed shortages, such as during droughts or following bushfires or floods.

- Only purchase weed-free hay and other livestock feed such as grains. Where possible, determine where fodder has come from and ask for a vendor declaration, such as the Australian Fodder Industry Association's **Fodder Vendor Declaration Form** (www.afia.org.au).
- Feed out fodder to livestock in set areas where you can check regularly for new weeds.
- Ensure pasture and crop seed has been cleaned and certified free of weed seeds.
- Do not make hay or silage in paddocks infested with fireweed.



Fodder Vendor Declaration Form

VDF No.: _____
Contract No. _____

1. Vendor's Details Vendor's name: _____ Address: _____ Tel: _____ Fax: _____	2. Buyer's Details Buyer's name: _____ Address: _____ Tel: _____ Fax: _____
3. Production Details If vendor not the producer, provide corresponding producer's VDF No.	
Paddock identification: _____	Delivery date: _____
Commodity: _____	Cutting date: _____
Is 95% free of genetically modified organisms: Yes <input type="checkbox"/> No <input type="checkbox"/>	
4. Fodder Quality Product description: _____ Species: _____ (if mixed include estimate of percentage) Quantity: _____ Bale size: _____	
Analysis: Lab Reference no.: _____ Dry matter: _____ % Crude protein: _____ % of DM Metabolisable energy: _____ MJ/kg of DM Other: _____	
5. Weeds Biosecurity Is it likely that this fodder contains weed material / seeds? Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes, please list what weed species may be present: _____	
6. Testing and Chemical Status This form only applies to a single "lot" of hay (see Sampling Protocol on pressure sheet) Has the fodder sample been taken according to AFIA Yes <input type="checkbox"/> No <input type="checkbox"/> Sampling procedure? (one test per 200 tonne lot or paddock)	
Has the fodder been tested for ARGV or Prussic acid? Yes <input type="checkbox"/> No <input type="checkbox"/> <i>If yes name, the Laboratory..... Case or Sample No..... and Result</i>	
Has the fodder been tested for pesticide residues? Yes <input type="checkbox"/> No <input type="checkbox"/> <i>If yes, attach details of testing results on the delivered product</i>	
Has the crop been grown on a property with either an organochlorine (OC) status classification, or under quarantine because of OC residues, within the past 12 months? <i>If yes give details</i> Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know <input type="checkbox"/>	
Does the property from where the fodder is grown carry accreditation under an independently audited QA program? Yes <input type="checkbox"/> No <input type="checkbox"/> <i>If yes give name of program</i>	
Has the fodder crop been subject to spray drift during its production? Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know <input type="checkbox"/> <i>If yes attach a list of chemicals applied to neighbouring crops, the date sprayed and application rates.</i>	
If selling fodder to a client, operating within a livestock QA program, who require a full list of chemical names, rates and dates both applied to the fodder crop, as well as those applied to neighbouring crops within 100 metres, please attach the details to this form.	

6 Declaration

I/We (name of fodder supplier) declare that I/we have the systems in place to ensure that the fodder complies with all State and Federal laws and the requirements relating to chemical and pesticide residues and specified Government designated maximum residue levels. These systems include:

- (i) any chemical treatment applied to any component of this consignment during storage on our premises or otherwise in our possession was applied as per product label approved by the National Registration Authority for Agriculture and Veterinary Chemicals and that the withholding period specified on that label has been observed; and
- (ii) In relation to the sourcing of raw materials:
 - a) the property on which the fodder was grown, or the storage facility in which the fodder has been stored, carries accreditation under a recognised, and independently audited QA program, which includes chemical residue management provision, **OR**
 - b) has been purchased under a contract in which the supplier warrants that the fodder complies with all State and Federal laws and requirements relating to chemical and pesticide residues and specified Government designated maximum residue levels, **OR**
 - c) in relation to direct farm purchases that the supplier of the fodder has attested to the effect that any pesticides/insecticides used on the fodder have been applied in accordance with the registered labels of these chemicals, at rates not exceeding the maximum rate set out on the label of these chemicals and the appropriate withholding periods have been observed.

I/we further declare that this consignment at the time of the sale:

1. Is free from animal material as defined and required under State legislation and
2. It is otherwise fit for the purpose of feeding to the category of livestock indicated in the product description above.

Intended Use/Purpose:

VENDOR'S SIGNATURE _____ **DATE** _____

* AFIA Ltd does not accept responsibility or any liability for the information contained in this declaration. January 2017

An example fodder vendor declaration form (used with permission Australian Fodder Industry Association).



Sandy Carter

Feed out hay in the same area.

Vehicles, machinery and equipment

Fireweed and other weed seeds may lodge in or on vehicles, machinery and other equipment when used in paddocks, on roadsides or other infested areas. Weed propagules can also be picked up in mud. A range of measures can be put in place to reduce the spread of weeds.

- Limit where vehicles that come onto your property can go. Install biosecurity signage advising drivers to stay on tracks and park in designated areas, or to stay out of paddocks.
- Clean vehicles, machinery, equipment and tools with a high pressure wash/blow down at a designated site, on exiting a known infestation area and before entering clean properties. Mud in tyres, on mudguards, and soil cultivation and excavation equipment poses a high risk for spreading weed seeds. The clean-down site should be frequently inspected for weeds. Soil and plant residue from cleaning should be collected for disposal. Biosecurity Queensland has a comprehensive **guide for vehicle and machinery clean-down** available at www.daf.qld.gov.au/__data/assets/pdf_file/0011/58178/cleandown-procedures.pdf (Biosecurity Queensland, 2019).



Sandy Carter

Tractor tyres cleaned of mud.

- Because slashers and mowers collect and spread weed seeds along roadsides, in parks and in paddocks, slash or mow from the least to most weed-infested areas. Avoid times when weeds are flowering and seeding if possible. Wash down or blow down equipment and machinery before moving to new areas.
- Ensure farm equipment and tools that you loan to or borrow from neighbours are clean before they leave each property.
- Avoid driving through patches of flowering fireweed because seed can be drawn up into radiators and vents and through open vehicle windows, and mud and manure can stick to tyres, mudflaps and wheel arches (Johnston, 2007).
- Monitor farm infrastructure and storage areas (e.g. fence lines, tanks, sheds, livestock yards, irrigation infrastructure) that may act as refuges for weeds such as fireweed, and control weeds here.

Chapter 2

People

Biosecurity is about managing people's behaviours and actions.

- Install biosecurity signage at entry points to ensure visitors are aware of your biosecurity expectations, including what they should do to minimise risks.
- Brush off weeds that can attach to footwear and clothing before entering fireweed-free areas. Mud on footwear should be removed with boot scrapers and brushes.

Livestock

Farm animals can carry weed seeds externally, lodged in coats, wool and hooves. Many weeds can also be dispersed internally if they pass through the digestive system. Viable fireweed seed has been detected in both cattle and sheep manure (Moxey, 2016).

- Visually inspect stock for attached weed seeds before transporting them to and from your property.
- Request a vendor declaration stating what weeds are known or not known to be present on the property from which the livestock originates.
- Quarantine stock in a defined area on arrival for 10 days to allow time for weed seeds to be excreted. This is also important from an animal health perspective to detect and isolate animals posing disease risks. Monitor this area seasonally for at least two years to detect any new weeds.
- Record which paddocks newly introduced livestock are placed in. Focus on these for routine inspections to detect any new fireweed or other weed incursions.
- Maintain fencing between properties to prevent stock movement.

Fertilisers, composts and manures

These products are broadcast across paddocks, and hence their cleanliness from weed seeds is vital.

- Follow industry standards in the production of processed animal manures and composts to reduce risks of weed seed contamination. Buyers should ensure these standards have been followed (e.g. via certification) when purchasing these products.
- Cover (where possible) stored or stockpiled fertilisers, manures and composts and keep the area weed free.

Landscaping supplies

Gravel, sand, topsoil and mulches for use in road building, earthworks and landscaping are known sources of weed propagules. Turf is also known to carry a risk of introducing fireweed (ACT Government, 2014).

- Where possible, source landscaping supplies from weed-free areas and check that vendors keep their bulk storage sites weed free.
- Seek a vendor declaration stating purchased turf is free of fireweed.

See also 'Fireweed and turf production' box on next page.

Natural spread

Spread by wind, water and wild animals is more difficult to manage, but should still be considered in seeking to prevent new weeds arriving and spreading on your property. Wind dispersal is the main mechanism of local spread of fireweed.

- Consider windbreaks around property edges and within (e.g. around paddock boundaries), which can reduce the distance that wind-borne weed seeds may spread, and even capture and concentrate seed fall.

Fireweed and turf production

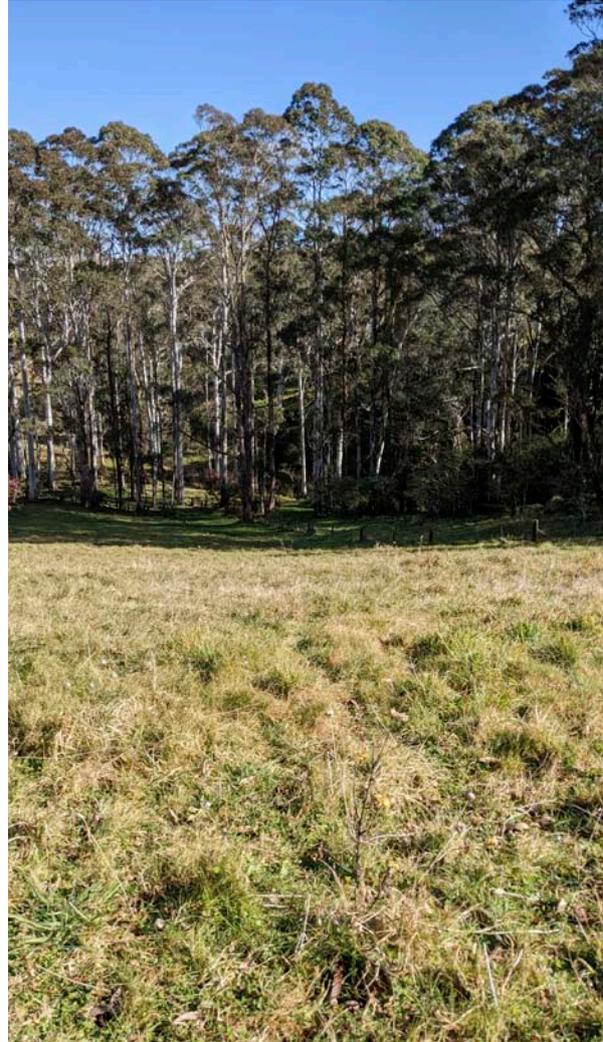
Incursions of fireweed into the ACT as a contaminant of laid turf led to legal requirements for products supplied in the territory to be fireweed free (ACT Government, 2014).

A weed management system of a weed-free seedbed, pre-emergent herbicides and regular mowing controls a wide range of broadleaf weeds on turf farms, including fireweed. Nonetheless, fireweed seed may still blow in from surrounding properties and settle on turf – hence, a further preventative measure is application of pre-emergent herbicide just prior to delivery.

Turf should be purchased from certified/ accredited producers that have been audited to meet production quality standards, including for weed control practices.



Megan Ford, AusGAP



John Virtue

A tree windbreak can slow fireweed movement.

- Inspect property fences and other physical obstructions where wind-borne weed seeds may have dropped and established.
- Find which parts of your property tend to be more prone to fireweed invasion due to local wind movements and topography. Inspect these more often.
- Monitor areas that feral and native animals frequent because they may introduce weeds.
- Bear in mind that watercourses may be an occasional pathway of spread for fireweed.

Chapter 2

2.3 Finding and removing new fireweed outbreaks

Key points

- **Fortnightly to monthly searching is needed to detect and remove fireweed plants before flowering.**
- **Focus on areas that are a high risk for fireweed incursions.**
- **Record locations where fireweed is found in order to check again in future searches.**

In addition to hygiene measures, another component of a property biosecurity plan is regular surveillance to detect new incursions of pests, weeds and diseases. To detect new outbreaks of fireweed, conduct monitoring at sites of high risk for new weed incursions, and remove or otherwise kill any plants before they set seed.



John Virtue

An isolated fireweed in a farm shelter belt.

To detect fireweed, search the following higher risk areas on a fortnightly to monthly basis from autumn to spring (Sindel and Coleman 2012):

- parking areas and machinery washdown bays/ areas
- roads, tracks and other vehicle access areas
- in and around windbreaks
- property boundaries
- hillsides known to 'catch' windblown fireweed from surrounding areas
- livestock camps, feeding areas and other areas where trampling occurs
- around dams and other wet areas
- gateways and fence lines
- near sheds, tanks, stockyards and other structures
- where materials such as fodder, mulch, topsoil have been introduced
- where service vehicles and borrowed machinery have been into paddocks
- newly cultivated areas
- areas of earthworks.

Areas of bare or disturbed ground are more likely to have fireweed growing. Locations of treated or removed plants should be recorded and mapped, so that it is easy to return to the same location to search for further fireweed emergence.



Paul Carter

Farm tracks can provide bare, disturbed ground suitable for fireweed.

2.4 The importance of ground cover

Key point

- **Dense ground cover will suppress fireweed germination and growth.**

Establishing and maintaining dense, competitive ground cover is one of the best ways to limit the germination and establishment of fireweed. Fireweed germinates in response to bare and disturbed ground and reduced vegetative cover. Maintenance of competitive ground cover is particularly critical during the peak fireweed germination period in autumn.

Achieving good competition will depend on your situation and management purpose:

- For properties with livestock – aim to establish and maintain dense, vigorous pastures.
- For amenity areas – maintain dense lawns (e.g. raised mower height) and plant groundcover plants.
- On roadsides – maintain or establish competitive, low-growing native vegetation, or otherwise maintain grass swards.
- In areas of degraded and disturbed native vegetation that fireweed may invade – regenerate and restore with indigenous plantings of quick-growing ground covers, dense shrubs and shading trees.

Note that dense ground cover does not completely prevent fireweed establishing. For example, occasional plants can even emerge through dense kikuyu. However, the number of fireweed plants that need to be controlled by other means will be much lower.



John Virtue

A lack of competitive pasture species enables high fireweed density.



John Virtue

Thick native kangaroo grass on a roadside keeping fireweed at a low density.



John Virtue

A dense, well-maintained kikuyu pasture limits fireweed establishment.

Chapter 2

2.5 Growing competitive and productive pastures

Key points

- Grow locally adapted, competitive, perennial pasture species to suppress fireweed and other weeds.
- A mix of warm and cool season pasture grasses will provide productivity and cover throughout the year.
- Soil exposure or disturbance while establishing or renovating pastures can stimulate fireweed germination, which in turn needs controlling to avoid competition with pasture seedlings.
- Seek local, professional advice on pasture establishment and management tailored to your property.

Vigorous, nutritious, sustainable pastures are the fundamental basis of productive, grass-fed livestock enterprises. Maintaining the density and growth of such pastures brings yield benefits for meat, milk and fibre production as well as sustained feed supply for companion animals (e.g. horses). It also provides competitiveness to suppress fireweed establishment and growth. The key is to ensure well-adapted, well-managed pasture species.

The key elements of growing and maintaining healthy pastures are:

- selecting pasture species and varieties suited to local climatic and soil conditions
- diversity of pasture species for growth in different seasons
- nutrition (including fertilisers, planting legumes and liming)
- rotational grazing
- weed and other pest control, especially at establishment.



John Virtue

A thick winter sward of cocksfoot pasture.

It is acknowledged that dense pastures can be challenging to achieve. Constraints include:

- dryland pastures subject to seasonal drought
- less productive soils
- non-arable country
- hobby farms with low (or nil) economic returns per hectare
- high-stocking densities
- small properties lacking economies of scale
- lack of time, expertise or equipment.

Nevertheless, the focus should still be on the 'bigger picture' of achieving more productive pastures, rather than solely on controlling fireweed.

Note that some existing native pastures can have legal conservation protection – determine whether this applies to you before undertaking any activity that may harm them.



2.5.1 Pasture species competitive against fireweed

A dense pasture sward from early autumn into winter is important to reduce fireweed germination (Figure 2.1). This includes both actively growing pasture and dead plant material (leaf litter) covering the soil surface. Warm season (also known as 'tropical') perennial grasses, such as kikuyu, should not be grazed hard in late summer; this allows them to regrow and thicken up by autumn. Similarly, the density of cool season (also known as 'temperate') perennial grasses, such as phalaris (*Phalaris aquatica*), should be maintained to enable quick recovery of ground cover each autumn. From mid-autumn to early spring, actively growing, cool season pasture species are important for suppressing fireweed.

A diverse pasture mix of annual and perennial, warm and cool season grasses, legumes and other forbs

provides greater resilience, more consistent growth during the whole year and variation in livestock diet. It also ensures greater competitiveness with fireweed. Figure 2.1 demonstrates that a 'feed gap' typically occurs in winter for warm season grasses and in late summer to early autumn for cool season grasses – hence the importance of having a mix of both.

Different grasses, legumes and other forbs are suited to different livestock enterprises, climates and soil types. Seek local advice from an agronomist or pastures officer for the best options and varieties for your property. Information sources to select and manage pasture species include state government departments of primary industry and various livestock industry websites (see Section 5.2). For example, NSW DPI provides information on an extensive list of species and varieties, available at www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties.

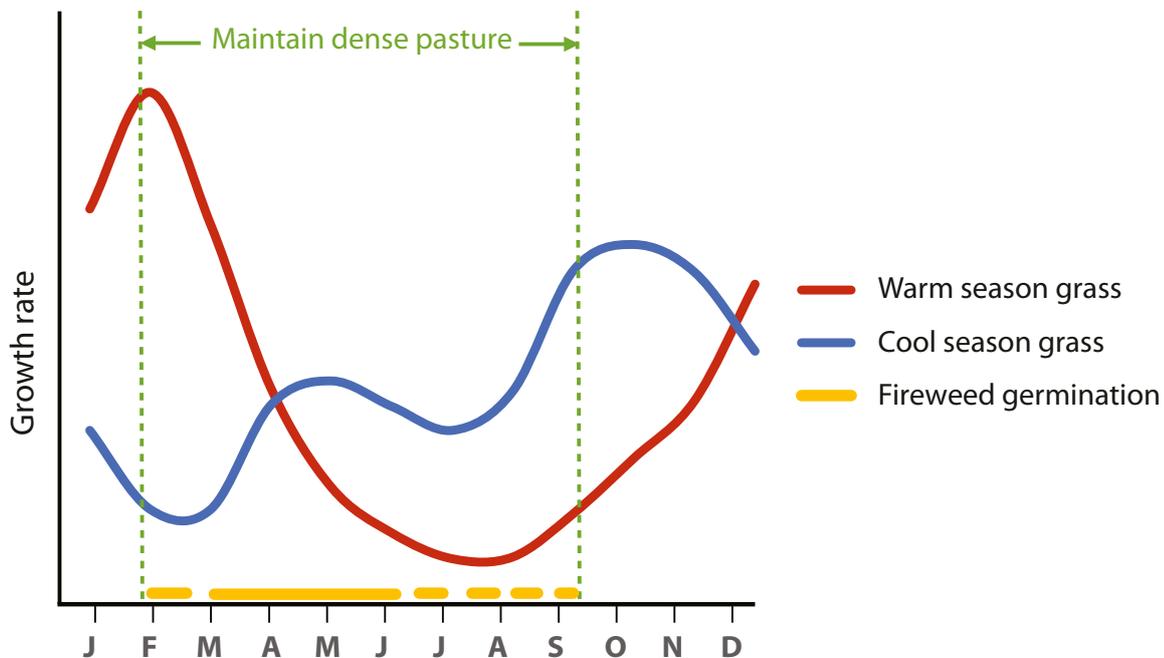


Figure 2.1 Growth pattern of warm season and cool season perennial grasses during the year, overlaid with timing of fireweed germination and seedling growth.

Chapter 2

Pasture species reported to provide good suppression of fireweed are:

- cocksfoot (*Dactylis glomerata*)
- kikuyu (*Cenchrus clandestinus*)
- paspalum (*Paspalum dilatatum*)
- phalaris (*Phalaris aquatica*)
- Rhodes grass (*Chloris gayana*)
- ryegrasses (annual, biennial and perennial forms of *Lolium* spp.)
- setaria (*Setaria sphacelata*)
- tall fescue (*Festuca arundinacea*)
- weeping grass (*Microlaena stipoides*)
- white clover (*Trifolium repens*).

Further detail on these species is given in Section 5.3.

Among the warm season pasture grasses, kikuyu is particularly effective at suppressing fireweed because its active growth continues further into autumn than that of other warm season species such as paspalum (Sindel, 2009).

In pastures, low-growing species such as couch grass (*Cynodon dactylon*), carpet grass (*Axonopis fissifolius*) and buffalo grass (*Stenotaphrum secundatum*) provide less ground cover, giving poorer suppression of fireweed than that of taller grasses.

2.5.2 Establishing or renovating a perennial pasture

Key information sources for this section: Ayres et al. (2016), NSW DPI (2022a).

A new or renovated perennial pasture is an investment in future livestock productivity and carrying capacity, delivering increased financial returns over multiple years. However careful planning is required, including determining:

- the sequence and timing of steps required
- what inputs (e.g. pasture species and varieties, fertilisers, herbicides, liming) and equipment are needed
- costs and budgets
- alternative locations for livestock until the new pasture is ready for grazing
- how to manage the risk of stimulating fireweed germination during pasture establishment.

Establishing or renovating a pasture can be expensive. Seek professional advice and any necessary assistance to ensure successful pasture establishment. There are farm advisory and contractor businesses that can assist you.

Paddock selection

Choose which paddocks are best to be pasture-improved first. Paddocks with lower fireweed density and those where fireweed flowering has been prevented for several years should be prioritised. These would have a smaller fireweed soil seedbank and therefore less fireweed emergence to manage during pasture establishment.

Soil fertility needs

Test paddock soils (pH and nutrient status) to determine whether liming is required to reduce acidity and what fertiliser will be needed for strong pasture growth. Key nutrients that may be deficient include nitrogen (N), phosphorus (P), sulphur (S), potassium (K) and molybdenum (Mo). Pasture legumes will fix soil nitrogen but still require other nutrients to grow well, particularly P, S and Mo (Leech et al., 2009).

Stop weed seed set

Seed set of all weeds should be limited in the one to two years prior to pasture sowing to reduce competition with pasture seedlings. Techniques to do this include spray topping or pasture topping, spray grazing for broadleaf weeds (not suitable for toxic weeds such as fireweed), slashing, and spray or cultivated fallow. Each are described in more detail in NSW DPI's **Temperate perennial pasture establishment guide** available at <http://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt/establishment/temperate-perennial-pasture-establishment-guide> (Ayres et al., 2016).

Pasture sowing techniques

There are three different ways to sow pasture seed.

Direct drilling involves making narrow slots or drills in the soil for sowing seed, leaving most of the soil surface intact. Existing pasture and weed biomass

should be removed just prior to sowing by hard grazing (but not if fireweed is present and poses a poisoning risk), mulching to near ground level, broad-spectrum herbicides and/or burning.

Conventional sowing involves several soil cultivations (e.g. ploughing, harrowing) to prepare a fine seedbed to plant into. This stimulates weed germination, including fireweed. Herbicides or further cultivations are required to control weeds prior to sowing.

Broadcasting involves dropping pasture seed onto the soil surface from ground machinery or a plane after the surface cover has been removed by hard grazing and/or herbicide treatment. This is a higher risk approach in terms of successful pasture establishment because seeds are left more exposed.

Table 2.2 lists the pros and cons of these methods. From a fireweed perspective, minimal soil disturbance is preferred to avoid triggering germination.

Table 2.2 Comparison of three methods of sowing pasture seed.

Sowing method	Pros	Cons
Direct drilling / Minimum tillage	<ul style="list-style-type: none">Minimises soil disturbance – less fireweed seed brought to the soil surface and triggered to germinatePrecise seed placement aids germination and seedling establishmentReduced soil erosion risk and damage to soil structureConserves soil moisture	<ul style="list-style-type: none">Removal of existing pasture and weed biomass can expose the soil surface, stimulating fireweed germination
Conventional sowing	<ul style="list-style-type: none">Suitable for heavy clay or compacted soilsSmooths out uneven soil surfacesDigs out weedy perennial grassesCan incorporate limePrecise seed placement aids germination and seedling establishment	<ul style="list-style-type: none">High soil disturbance can trigger mass fireweed germinationDamage to soil structureSoil exposed to erosion
Broadcasting / Surface sowing	<ul style="list-style-type: none">No soil disturbance to trigger fireweed germinationSuitable for large-seeded species such as ryegrassEnables sowing in non-arable and highly inaccessible areas	<ul style="list-style-type: none">Pasture seeds and seedlings are more vulnerable to desiccation, pests (including ant harvesting) and weed competition

Chapter 2

Post-sowing weed control

Weed control continues to be important as new pasture seedlings are establishing. Many pasture species are slow growing as seedlings and are susceptible to weed competition. Herbicides can provide selective control of weeds, and local advice should be sought on what to use for the problem weeds present.

It is highly likely that fireweed will need to be controlled in newly establishing pastures (see Section 5.4 for selective herbicide options). Short-term, high-stocking rates of sheep can be used for fireweed control (see Section 2.6) in young pastures, but only after the species sown are at least 10 cm tall and well-anchored in the soil to withstand grazing. Ideally, new perennial pastures should not be grazed in the first year of establishment so that they thicken up and set seed.

2.5.3 Oversowing into existing pasture

Key information sources for this section: Dairy Australia (2019), Dart and Fulkerson (2014), Leech et al. (2009).

Adding greater species diversity to an existing perennial grass base can increase pasture competitiveness, productivity and sustainability. This includes ensuring a legume component in pastures to build soil nitrogen levels.

For example, kikuyu is a common and persistent pasture species in coastal and other seasonally warm, high rainfall areas of eastern Australia. However, its growth slows from late autumn to early spring due to low temperatures, which coincides with the period of fireweed germination and growth. Cool season species such as ryegrass, oats and/or clovers can be sown into the kikuyu pasture in autumn to address the winter feed gap and compete with fireweed.

When oversowing, conflicts arise between, on the one hand, opening-up the existing pasture for the newly sown seeds to germinate and grow quickly, and on the other, stimulating fireweed to germinate.



John Virtue

Fireweed seedlings emerging after sod seeding to renovate a pasture.

Oversowing can be done by direct drilling into the pasture (i.e. 'sod seeding') using narrow seeding rows to minimise soil disturbance. Alternatively, oversowing can be done by broadcasting seed. Mulching the existing pasture following broadcasting provides a thin covering of the seed and soil surface. Such 'mulch planting' is suitable for larger seeded species like ryegrass and clovers.

General requirements for oversowing

- Reduce existing pasture to close to ground level, so that newly germinating pasture seedlings can access light. This may be achieved through:
 - heavy grazing – but not if there is a fireweed poisoning risk
 - cutting (i.e. mulch, mow or slash)
 - non-selective herbicide, or
 - a combination of these.
- Direct drilling (i.e. sod seeding into the existing pasture) is best for small seeded species with less vigorous seedlings, such as phalaris, cocksfoot, fescue and lucerne (*Medicago sativa*).
- Broadcasting seed onto the soil surface is an option for larger seeded species.
- Apply fertiliser to encourage rapid growth of the pasture.
- Control seedling fireweed (and other weeds), where required, with selective herbicide.
- Allow the new pasture to establish before reintroducing livestock.

2.5.4 Established pasture management

Weed control, fertilising and strategic grazing (see Section 2.6) are important ongoing actions to build and maintain the proportion of desirable pasture species in grazing paddocks (Leech et al., 2009). Regularly conduct a paddock health check.

- What pasture species and weeds are present?
- What does a soil test say about fertility and acidity?
- Is grazing uneven and are some areas prone to overgrazing?

This assessment will inform how and where to invest to improve pasture performance. Local professional advice should be sought before making a final decision on how to proceed.

Weed control

Herbicides can be used to manipulate the balance between pasture weeds and desirable pasture species. Selective herbicides can be used to target particular types of weeds while limiting impacts on pasture species (e.g. a broadleaf herbicide sprayed over a grass pasture). Spot spraying of target weeds can be done if a herbicide may damage pasture species. Some weeds can also be selectively controlled using a wick wiper if the desirable pasture species is shorter or has been grazed down.

Non-palatable, perennial tussock grasses, such as giant Parramatta grass (*Sporobolus fertilis*) and African lovegrass (*Eragrostis curvula*), are also problematic in many fireweed-affected areas and should not be overlooked in the quest to control fireweed.

Soil fertility needs

As with pasture establishment, monitoring soil fertility and pH is important to maintain pasture productivity. Matching the timing of fertiliser application to the start of periods of active pasture growth is crucial, such as spring application for warm season grasses and winter top-dressing with nitrogen for ryegrass pastures.



John Virtue

African lovegrass and fireweed in a kikuyu pasture.

Fireweed can also grow rapidly in response to fertilisers, particularly superphosphate. Desirable pasture species need to be present at sufficient density to be able to quickly respond to the additional nutrients. Plans should be made for selective control of fireweed following fertiliser application in case it has stimulated a flush of germination and growth (Allan et al., 2005).

Soil pH has significant effects on pasture plant performance. It can affect the availability of soil nutrients and the health of beneficial microorganisms. Liming should be considered for acidic soils with a pH (Ca) of less than 5.0.

2.5.5 Further information and training on pasture management

Section 5.2 lists sources of further information, online decision tools and training on establishing and growing pastures. Providers of information include state government primary industries departments, regional natural resource management bodies (e.g. NSW Local Land Services), commercial agronomy and farm advisory and training services, rural supplies stores, pasture seed suppliers and livestock organisations (e.g. Meat and Livestock Australia, Dairy Australia, Future Beef).

It can also be beneficial to talk with neighbours about their local experiences in establishing pastures and to attend farmer meetings, field days and paddock walks.

Chapter 2

2.6 Strategic grazing

Key information sources for this section: Graham (2017), Ayres et al. (2016), O'Sullivan et al. (2013).

Key points

- Overgrazing favours fireweed and increases risk of poisoning.
- Determine a sustainable stocking rate to avoid overgrazing.
- Practise rotational grazing to optimise pasture growth and competitiveness.
- Horse pastures are highly prone to selective grazing and need regular rest for pasture recovery.

Grazing pressure is a major driver of pasture productivity, competitiveness and composition. An appropriate grazing strategy is required that optimises the use of pasture throughout the year, maintains ground cover and gives desirable plants time to recover and regrow after periods of grazing. Stocking rate is critical.

Long-term overstocking risks bare paddocks prone to soil erosion, death of valuable pasture species and proliferation of weedy, non-palatable species – including dense fireweed, which increases the risk of cattle or horse poisoning.

Stocking rate

'Stocking rate' is the current number of grazing animals per unit area of land; it is a measure of livestock density often determined as 'head per hectare'. 'Carrying capacity' is the stocking rate that a paddock or whole property can sustainably have, considering various factors such as pasture type and productivity, climate, soil fertility and livestock type. Carrying capacity is not a fixed number and will vary throughout the year (e.g. caused by slow pasture growth due to winter cold or to summer dry



John Virtue

Match stocking density to fodder availability to avoid overgrazing.

conditions). Carrying capacity will also decline with periods of extended drought or waterlogging.

Pasture availability should be regularly monitored to detect any long-term changes in carrying capacity and to determine when livestock should be moved to another paddock. Feed gaps throughout the year can be addressed through conserving fodder (e.g. making hay or silage) for later supplementary feeding, where economical to do so.

Rotational grazing

Grazing pressure is the combination of stocking rate and how long and often stock are kept in a paddock. Rotational grazing is a way to regulate grazing pressure and is important both for pasture productivity and fireweed management. Frequently rotating stock between paddocks, with periods of pasture recovery in between, can enable higher stocking rates. The pasture species are grazed down so that they are encouraged to stay in a vegetative stage of growth rather than going to seed. The pasture is then given a rest period to recover leaf area and photosynthesise, rebuilding reserves for new growth.



John Virtue

Rotate between paddocks to allow pastures to recover.

Warm season (tropical) perennial grasses are most productive when kept at a green, leafy stage of growth by rotationally grazing smaller paddocks at high stock densities (Lodge, 2010). Perennial pasture grasses also need a rest period every few years, of at least six weeks during their flowering season, to allow for seed set and to replenish root reserves.

There are many ways to practise rotational grazing. These vary in the length, frequency and intensity of pasture rotation and in the length of the rest period. The number and size of paddocks, pasture growth rate at various times of year and livestock herd sizes are all factors in designing the optimal grazing system for a property.

For example, a system could be one week's grazing and six week's rest for a paddock, although it is better to base stock movements on monitoring of seasonal pasture growth in individual paddocks rather than on fixed timing. This simple example of one week on, six weeks off requires seven paddocks of similar size through which to rotate.

Paddocks should ideally be fenced according to land type, so that pasture growth is even throughout and no areas are frequently subject to over or under grazing.

Pasture mulching

Pasture mulching is a mechanical technique commonly used to reinvigorate pastures. Pasture is cut to a short height and finely chopped to be spread as a surface mulch. Removal of tall, rank pastures encourages new pasture growth and reshooting from near ground level. It also cuts down ungrazed, weedy species so they do not have a competitive advantage as the pasture recovers.

Mulching after a period of grazing is common practice in dairy farms with kikuyu pastures. Mulching can also be used to reinvigorate pastures hit by frosts. However, the potential for fireweed regrowth (or germination) needs to be considered, including the need for any herbicide treatment.



Rowley Beckett

Rotational grazing provides the opportunity to monitor and treat paddocks for fireweed between grazing periods. The herbicide bromoxynil is highly effective to control young fireweed, but any herbicide products containing this active ingredient have an eight-week withholding period after spraying until stock can again graze the pasture.

Chapter 2

Use various pasture management information sources and seek local, professional advice to determine your property's carrying capacity and optimal rotational grazing system.



Types of grazing systems

Further information: Graham (2017), Ayres et al. (2016) and O'Sullivan et al. (2013).

Rotational grazing

Pastures have a period of grazing followed by a period of rest. This may be on a fixed-timing basis or vary according to seasonal pasture growth rates and differences in paddock size and productivity.

Cell or strip grazing

Electric or other temporary fencing is used to split paddocks into small areas for high intensity grazing of 2–3 days (or even less depending on herd size), followed by a long recovery period for regrowth. Stock access to drinking water needs to be considered. This system is commonly used in dairy farming.

Set stocking

A low-input form of long rotation grazing. A paddock may be grazed for an extended period (e.g. three months) when there is a high level of feed available, and then rested or kept at a much lower stocking rate at other times. From a fireweed perspective, spring grazing is preferred, allowing recovery of the pasture sward over summer to then inhibit the weed's germination in autumn.

Tactical grazing

A strategic, flexible grazing system based on setting specific objectives and determining strategies to achieve these. Tactics may vary year to year, according to monitoring of pasture growth and composition and livestock productivity. This is the optimal approach promoted in PROGRAZE™ (Graham, 2017).

Continuous stocking

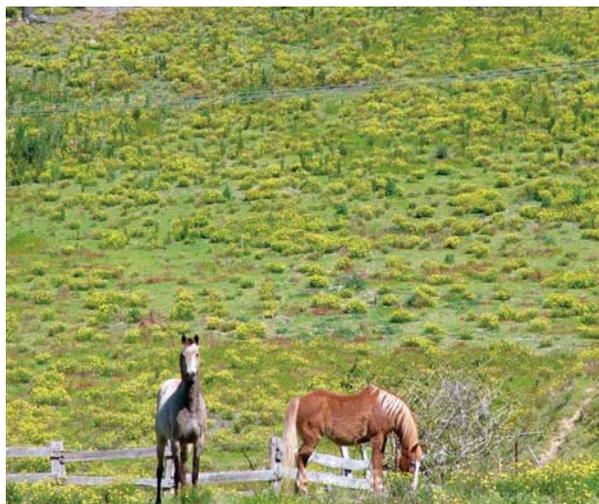
A paddock constantly has stock year-round. This grazing system is the most sensitive to correct stocking rate. It is the least preferred grazing system because there are high risks of overstocking leading to:

- overgrazing and death of palatable, productive pasture species
- selecting for low palatability fodder or non-palatable weeds (e.g. fireweed)
- selecting for low-growing pasture species lacking competitiveness and surface cover to suppress fireweed
- exposing bare soil to erosion and loss of organic matter.

Understocking risks are also associated with continual grazing. Having too few stock means there is no competition for fodder; consequently, only highly palatable species are eaten and hence overgrazed. The lower palatability species and weeds can then gain a competitive advantage and become dominant.

2.6.1 Horse paddocks and fireweed

Key information sources for this section: Allan et al. (2007), SEQ Catchments (2018).



Brian Sindel

Horse paddocks are highly prone to fireweed invasion.

Pastures are challenging to manage in horse paddocks. Horses are highly selective grazers and like to graze close to the ground. This puts intense grazing pressure on palatable pasture grasses, especially in small paddocks. Unmanaged horse paddocks tend to become dominated by non-palatable weeds and bare areas of ground. This is ideal for fireweed, which is highly toxic to horses.

As with other grazing livestock, maintaining pasture cover in horse paddocks is important to suppress weeds and prevent soil erosion. Access to nutritious pasture also reduces the need for additional purchased feed.

Pasture species for horses

Ryegrass, fescue, cocksfoot and Rhodes grass are pasture species suitable for horses that also offer competitiveness with fireweed. In choosing perennial ryegrass and fescue varieties, consideration should also be given to endophyte status (i.e. fungi strains that grow within the plant, some of which can pose toxicity problems).

Kikuyu is a common coastal horse pasture, but it also poses the risk of oxalate poisoning. This risk is typically reduced by providing a calcium supplement. *Setaria* and a range of other tropical pasture grasses should be avoided owing to their high levels of oxalates.

Carrying capacity

Allan et al. (2007) suggest a carrying capacity of one horse per 2 ha where there is poor pasture, low soil fertility and mainly summer-dominant pasture. For a horse farm with improved, fertilised and irrigated pasture of summer and winter pasture species, a carrying capacity of four horses per 2 ha is suggested.

Rotational grazing

Paddock rotation is critical with horses to maintain or re-establish pastures. It is desirable to have at least three paddocks to rotate among. Horses should be grouped in one paddock at a time while the other paddocks are spelled.

Large paddocks can be split into smaller paddocks to enable pasture rotation. Where this is not possible because of small property size, alternatives are to stable or yard horses during pasture recovery periods, or to section off parts of a paddock using electric tape.

Horses should be removed from a paddock when the pasture is grazed down to around 5 cm high. Slash or mulch the paddock and apply fertiliser if soil fertility is low. Spread out manure across the pasture to distribute its nutrients. Paddocks should have an average pasture height of around 10–20 cm, depending on the pasture species, before horses are reintroduced.

Control weeds

Hand pull fireweed at any time, or spray with a selective herbicide during the pasture recovery phase. In addition to fireweed, other weeds poisonous to horses include annual ragweed (*Ambrosia artemisiifolia*), Crofton weed (*Ageratina adenophora*), mother of millions (*Bryophyllum* spp.)

Chapter 2

and Paterson's curse (*Echium plantagineum*). Be on the lookout for new weeds introduced in feed and spread in horse manure.

Seek local, professional advice on the best ways to maintain and improve horse pastures for your situation.

2.7 Sheep and goat grazing of fireweed

Key points

- **Sheep and goats will eat fireweed and can substantially reduce its density.**
- **While relatively tolerant of fireweed's pyrrolizidine alkaloids toxins, caution is still advised if grazing dense infestations.**
- **Sheep and goats have specific management requirements, including health, fencing and shearing (for some breeds).**

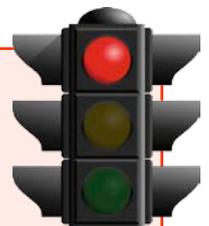
Sheep and goats readily eat fireweed and have a higher tolerance of the pyrrolizidine alkaloid (PA) toxins in fireweed than do cattle and horses (NSW DPI, 2012). They are being successfully used to keep fireweed at low levels in pastures on both farming and lifestyle properties (see case studies 4.2, 4.3, 4.6). Typically, fireweed flowers are eaten first and the rest of the plants are grazed later. A range of sheep and goat breeds are being used, often integrated with other livestock.

It should be noted that sheep and goats are not immune from fireweed poisoning, and their level of intake of the weed still needs to be managed. Sheep and goats' ability to detoxify PAs is thought to be through microbial breakdown during digestion in the rumen and through specific liver enzymes (Giaretta et al., 2014; Johnston, 2007; Panziera et al., 2018). They are estimated to be 10–20 times less susceptible

to PA poisoning than are cattle and horses (Hooper, 1978).

However, a diet very high in PA intake may cause sudden or long-term chronic poisoning in sheep or goats. In addition to the typical symptoms of PA poisoning in animals (see Section 1.4.1), internal build-up of copper to toxic levels can also occur (Ilha et al., 2001; Seaman, 1987). Incidents of PA poisoning in sheep have been described in Brazil (Giaretta et al., 2014; Grecco et al., 2011; Ilha et al., 2001; Karam et al., 2011), where sheep were grazing pastures heavily invaded by *Senecio* spp. and where there was little alternative feed available. One incident of sheep poisoning by fireweed in Australia was documented in Seaman (1987). However, there are no documented records since of fireweed clinically affecting sheep or goats in NSW (Schaefer, 2023).

Take care in exposing sheep or goats to high levels of fireweed, whether in a short period with limited other feed available or over a prolonged period in pastures with a high content of fireweed. Sheep or goats should always have plentiful access to pasture grasses and forbs as alternative sources of feed. Manage nutrition to avoid high levels of copper in the diet.



John Virtue

Wiltshire sheep providing fireweed control at Bega.

Lessons from overseas – research on sheep and goat suppression of fireweed

Research from Brazil has shown that fireweed density rapidly declines and remains at negligible levels under continuous sheep grazing (Bandarra et al., 2012; Stigger et al., 2018). Liver biopsies undertaken for the Brazilian research did not detect any damage in sheep during the experiments, which ranged from grazing periods of 90 days to two years in length (Bandarra et al., 2012; Stigger et al., 2018). However, it should be noted that sheep were grazing in mixed pastures containing grasses and legumes in addition to fireweed and *S. brasiliensis* (another *Senecio* weed containing toxic PAs).

While sheep and goats do not eradicate fireweed, a Hawaiian study found that removing feral goats led to an increase in fireweed from <0.01% to 14.7% ground cover (Kellner et al., 2011). Research in Brazil similarly observed that fireweed starts to return once sheep are removed. Hence, they should be considered part of a long-term grazing system for ongoing fireweed suppression.

In Brazil, recommended stocking rates of sheep for controlling fireweed are three to four adults per ha (Bandarra et al., 2012; Stigger et al., 2018). Sheep or goats can be integrated with a cattle enterprise, either co-grazing or 'cleaning up' paddocks prior to introducing cattle.

2.7.1 Management requirements of sheep and goats

Sheep and goats have specific management requirements and can be much more labour and time demanding than cattle. The following should be considered before deciding to introduce them to your property.

Health and welfare

- **Control internal parasites** – These include roundworms, tapeworms and flukes, all of which can cause severe health issues. Barber's pole worm (*Haemonchus contortus*) is a major problem in coastal pastures. These roundworms cause anaemia and can be fatal in sheep and goats. Control advice is given at www.wormboss.com.au.
- **Prevent flystrike** – This is favoured by extended periods of warm season rains. It is more prevalent in highly wrinkled Merino sheep, but other breeds can also be susceptible in certain circumstances. Management information is available at www.flyboss.com.au/sheep-goats/.

- **Control wild dogs** – Sheep and goats are highly prone to wild dog attack, causing severe injury and death. Participating in district wild dog control programs, having companion animals (e.g. donkeys) and/or securely yarding small flocks at night can reduce this risk. However, in some areas the wild dog burden may mean it is not possible to safely run sheep or goats.

Infrastructure and marketing

- **Fencing** – This includes boundary and internal ringlock fencing and livestock holding yards. Goats, and some sheep breeds such as Dorpers, can be more challenging to contain.
- **Shearing and/or crutching** – Managing certain sheep and goat breeds will require facilities to do shearing. Modifying existing infrastructure may provide innovative and low-cost options. Self-shedding breeds of meat sheep, such as Dorper and Wiltshire, do not need shearing.
- **Access to markets** – How to sell animals and their products profitably? Factors include transport costs to market and the amount of produce to be traded. Consider collaborating with neighbours and developing local business models (Johnston 2007).

Chapter 2

2.8 Herbicide control

Key points

- A range of herbicides are available for use on fireweed.
- These differ in their recommended timing, off-target risks, withholding periods and methods of application.
- It is a legal requirement to follow the instructions on a herbicide label.
- Fireweed seedlings are more susceptible to herbicides than are adult plants.
- Fireweed should be sprayed before flowering.

Herbicides are a fundamental tool in the control of fireweed. They are most effective when used in combination with other control measures. A range of herbicides are registered for use on fireweed. Each has strengths and weaknesses, including recommended timing, withholding periods for livestock and risks of off-target damage to desirable plants.

Types of herbicides that can be used on fireweed are discussed below, and current registrations and permitted uses are detailed in Section 5.4. There can be many commercial products for a particular type of herbicide and concentration. Their availability may change over time and new products also come onto the market. Check with your agronomist or chemical reseller. Registered products and uses can be searched at the Australian Pesticides and Veterinary Medicines Authority (APVMA) PubCRIS database website, portal.apvma.gov.au/pubcris.

Only herbicides legally approved by the APVMA may be used. These are available either as **registrations**, where instructions for control of fireweed is specifically mentioned on a herbicide product's label, or where a **minor use permit** has been obtained from the APVMA for a particular purpose. In both cases, the herbicide may only be used in the specified

situation. State and territory laws may enable use of other herbicides on a weed, but at the user's risk (see Section 5.4).

Minor use permits enable specified uses of herbicides that are not otherwise registered (and presented on product labels) for a particular weed. A number of state-based permits cover fireweed, as listed in Table 5.8. Note that permits have expiry dates, and these should be checked to ensure such use is still permitted. Permits and their current status can be accessed on the APVMA website.

To choose the most appropriate herbicide for your situation, you will need to check which herbicides are registered or permitted for use on fireweed in your state or territory. Most state and territory jurisdictions provide specific herbicide advice for declared weeds on their websites. For fireweed, the NSW and Qld governments' biosecurity websites (see Section 5.5) provide current advice on herbicides for use in their state.

2.8.1 Safe use of herbicides

All herbicides come with a label that is a legal document. The user is required to read and follow all instructions when preparing and applying the herbicide.

A herbicide label details the personal protective equipment (PPE) required, the mix rate and the appropriate growth stage for application, and how to use the herbicide safely and effectively. Each herbicide also has a Safety Data Sheet.

Operator safety

For safety, herbicide users should wear:

- chemical resistant gloves
- eye protection
- respirator (with a filter appropriate to the level of herbicide toxicity)
- clothes, hat and boots that cover the whole body.



Peter Casey

PPE may include gloves, eye protection, mask and covered clothes and shoes.

For higher safety risk herbicides, more PPE and additional precautions may apply, including wearing a full face respirator and chemical-resistant overalls. Follow label requirements and consult the Safety Data Sheet on the health risks of exposure.

Environmental protection

In addition to personal safety, herbicide labels also have mandatory requirements to protect the environment and non-target plants during their use. As a chemical user, you have a legal obligation to avoid spray drift damage and to ensure that the chemicals you apply stay within the target area.

Prevent herbicide drift during application to protect crops, native vegetation and other plants, and to avoid 'chemical trespass' onto neighbouring properties. Measures to reduce the risk of spray drift include spraying when the wind is 3–20 km per hour or when there are no surface temperature inversion conditions, using a coarse spray quality nozzle type, and having buffer zones. Mandatory spray drift instructions may be given on herbicide labels.

Avoid use near streams, rivers and waterways, unless a herbicide is specifically registered for use in aquatic situations. Follow label directions regarding any risk of soil-applied herbicides spreading via runoff following rainfall or irrigation.

Many weeds across Australia have developed resistance to particular types of herbicides – rendering them much more difficult to control.

Herbicides are classified into 'groups' based on mode of action, which relates to the herbicide's chemistry type and its mechanism for causing plant death. In Australia, indication of these groups is shifting from letters to numbers to align with international herbicide classification (CropLife Australia, 2022).

Frequent use of herbicides with the same mode of action risks selecting for individual plants with genetic changes that render them resistant to the herbicide's effects. These plants and their progeny survive subsequent treatments of such herbicides, building up in numbers over time.

Herbicide resistance has not yet been detected in fireweed in Australia, but two other *Senecio* species have cases of herbicide resistance overseas (WeedScience.org, 2022).

To avoid herbicide resistance, it is important to rotate the use of different groups of herbicides. Using mixtures of herbicides with different modes of action also reduces the risk, although there are limited registered choices for such mixtures for fireweed (see Section 5.4). Do not mix herbicides unless approval to do so is given on the label. Any case of suspected herbicide resistance should be promptly reported to local weed management authorities.

Withholding periods

Certain herbicides have withholding periods during which livestock must be excluded from grazing treated areas and cutting of pastures for hay or silage should be avoided. This minimises the risk of herbicide residues in livestock products sold to market. Some herbicides also provide separate, specific label instructions on managing the risk of herbicide residues in other farm products such as manures and composts.

Chapter 2

2.8.2 Effective use of herbicides

Successful herbicidal control depends on selecting the correct herbicide for the target species and growth stage, the weather conditions during and after spraying, how thoroughly the herbicide is applied, and the herbicide mix and application rate.

For spraying, wind speeds should be low (<15 kph), and no rain should be expected in the following six hours.

Do not apply herbicide to plants under stress because herbicide will not be absorbed and translocated effectively, resulting in a reduced level of control. Plants may be stressed because of:

- dry soil
- low humidity
- air temperatures above 30°C
- frost.

Take steps to maximise effectiveness of herbicides

- Mix dye with the herbicide to help minimise missed areas and prevent over spraying (double spraying). Similarly, a foam marker can be used to indicate the edges of boom spraying.
- Use an adjuvant to improve herbicide uptake. Always read the adjuvant's labels to ensure it is compatible with a particular herbicide and check any restrictions on its use (e.g. avoiding use near waterways).
- Ensure spray equipment is correctly calibrated and maintained.

Calibrate your spraying

Herbicide spraying can be performed by boom, knapsack or handgun. A herbicide's label lists which method can be used.

Herbicide control techniques are described at: www.dpi.nsw.gov.au/biosecurity/weeds/weed-control/herbicides/control-techniques-using-herbicides

The particular spray equipment you use must be calibrated so that the correct herbicide rate is applied. This refers to both the amount of herbicide active ingredient applied per hectare and the water volume to be applied per hectare (where this is specified on the label).

The NSW DPI provides instructions on how to calibrate spray equipment: www.dpi.nsw.gov.au/biosecurity/weeds/weed-control/herbicides/spray-equipment-calibration-methods

2.8.3 Herbicides for fireweed

A range of herbicides and herbicide mixes are registered or allowed under APVMA permit for fireweed control in pastures. The main types of herbicides are summarised in Table 2.3, and further detail is provided in Table 5.8.

Other types of herbicides are registered for use on fireweed in cropping or non-agricultural situations (see Table 5.8). There are also herbicides registered for annual weeds generally, or annual broadleaf weeds (e.g. glyphosate may be used for spot spraying in certain circumstances).

'Organic' herbicides that are registered for control of annual weed seedlings include pine oil and acetic acid products. These may be effective against small fireweed plants. Complete spray coverage is required, and older plants may still regrow from the base.

Table 2.3 Herbicides registered or permitted for use on fireweed in pastures (see further information in Table 5.8).

Herbicides containing ^a :	Timing	Withholding period	Pasture legume damage risk	Limits on use	Other considerations
Bromoxynil Group 6	Most effective prior to flowering	8 weeks	Some – consult label for species at risk and temperature constraints	Check whether product is registered for use in your state or territory	Less effective on mature fireweed – risk of regrowth
Diflufenican Group 12	Seedlings up to 4-leaf stage	1 week or 8 weeks ^b	Some – consult label for species at risk and temperature constraints	Check whether product is registered for use in your state or territory	
2,4-D or MCPA Group 4	Young, actively growing plants	1 week	Some – consult label and seek local professional advice	2,4-D Qld only ^c	Spray drift risk Many crops, ornamentals and native plants are highly susceptible
Metsulfuron-methyl Group 2	Autumn	Nil	Yes – consult label and seek local professional advice	NSW and Qld under permits	Can impede growth of some grasses Soil persistence
Aminopyralid, halauxifen, fluroxypyr, picloram, triclopyr, aminocyclopyrachlor Group 4	Seedling and flowering plants	Consult label for residue advice	Yes – consult label and seek local professional advice	Check whether product is registered for use in your state or territory	Many crops, legumes, ornamentals and native plants are highly susceptible Soil persistence

^a Herbicides that contain these active ingredients, including mixtures with other herbicides. The group number refers to the mode of action.

^b One week for products that also contain MCPA, eight weeks for products that also contain bromoxynil.

^c 2,4-D only registered for use of fireweed in Qld (as of May 2023). NSW has a permit for bromoxynil + 2,4-D amine.

Chapter 2

2.8.4 When to spray fireweed

It is recommended to spray young fireweed plants in autumn, following rainfall events that trigger flushes of germination. This limits plant numbers for the year, their potential to dominate winter–spring pastures, and annual seed set. Learning to recognise fireweed seedlings for spraying is important (see Section 1.1.3). ‘Rules of thumb’ for timing are:

- waiting two to three weeks after the first significant rainfall event in autumn (Johnston, 2007)
- spraying when fireweed plants are small, with up to 8–10 leaves (Southern Rivers CMA, 2009)
- spraying before no more than 10% of plants have started to flower (Southern Rivers CMA, 2009).

Notwithstanding these rules, it may be best to wait for a second flush of germination in autumn

to capitalise on a herbicide treatment (Sindel and Coleman, 2012). Spraying before flowering commences is vital – besides preventing seed set, large flowering plants can also be more difficult to kill.

Since fireweed can germinate in flushes from autumn to spring, a single annual herbicide application will likely not control all plants that year. Hence, herbicide use should be integrated with other control measures, particularly fostering competing vegetation (e.g. vigorous pastures) and managing grazing pressure. Spring spot spraying of individual plants can also be performed to ‘mop up’ areas of high fireweed density.

Figure 2.2 provides a calendar of herbicide use timing, based on the typical flush of autumn fireweed germination. Note that timing should be adjusted when flushes occur at other times of year.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growth stage	Dead	Increasing germination				Establishment and early growth			Flowering and senescence		Death	
Action	AVOID herbicide use		Spray seedlings. Best time for application is two to three weeks after first main rainfall and before 10% of the seedlings open their flowers			Spraying may be effective, but may require higher rates which has the potential to cause damage to non-target species			Spot spraying with herbicides registered for this use may be effective		AVOID broadacre spraying	
									Plan management strategies for next year			

Figure 2.2 Calendar of herbicide timing for control of fireweed. From Hunter Regional Weeds Committee (2019), after Johnston (2007) and Southern Rivers CMA (2009).



Budgeting for herbicide use should consider the following:

- cost of herbicide, at required application rate per ha
- total area to be treated and density of fireweed
- application equipment required, including fuel costs
- time and/or labour costs
- profitability of enterprise (expected return on investing in control of fireweed)
- alternative fodder needed during a grazing withholding period.

2.9 Physical control methods

Key points

- **Timing and frequency is critical if attempting to control fireweed by cutting pastures or lawns.**
- **Hand removal is labour intensive and requires ongoing commitment. It is best suited to small, isolated infestations.**
- **Soil cultivation stimulates fireweed germination.**
- **Mulches may assist fireweed suppression in amenity areas but need to be maintained.**

While a combination of competitive groundcover, grazing management and herbicides is at the core of optimising integrated management of fireweed, other control methods can further assist control. It is also recognised that some landholders prefer not to use herbicides.

2.9.1 Cutting

Cutting of fireweed by slashing, mowing or mulching is not an effective control measure unless it is done frequently *and* pasture or turf grasses are present that regrow faster to outcompete it. Fireweed can resprout when cut, even if cut close to ground level. The livestock poisoning risk of cut fireweed material also needs to be managed.

Frequent cutting is needed to weaken fireweed plants over time. Two cuts over a two-month period were found to reduce fireweed plant survival by up to 70% (Sindel et al., 1998). Repeated cutting at less than six-week intervals reduces fireweed growth and seeding (AWC, 2012).

Timing is important. Cutting in autumn and winter risks fireweed regrowth having a competitive advantage, unless the pasture is dense with actively regrowing, cool season grasses. Cutting from mid-spring onwards is more suitable for competitive regrowth of warm season grasses (e.g. kikuyu).



Delaying cutting of fireweed plants until they are large can be problematic. Fireweed will likely be in flower and setting seed at this time, hence there is a risk of spreading seed across a paddock. The regrowing fireweed can also become woody. This makes it more difficult to kill with herbicides and increases the risk that it will over-summer and regrow rapidly the following autumn.



John Virtue

Grass cutting needs to be frequent to suppress fireweed.



Cut fireweed material remains toxic to livestock, which find it hard to avoid when grazing mixed clippings. Pastures cannot be grazed again until they have regrown above the cut fireweed material and it has decomposed. To prevent poisoning, stock should be excluded for at least two weeks (Allan et al., 2005), longer in cooler times of the year.

2.9.2 Hand removal

Hand pulling of fireweed plants prior to flowering is commonly undertaken by land holders as a low-cost control measure for new, small or isolated infestations. It is most effective for scattered infestations that are less than 1 ha (Sindel et al., 2012). Hand removal is also good for areas at high

Chapter 2

risk of seed dispersal, such as around cattle yards or sheds, and as a follow-up of occasional plants missed by herbicide treatment.

Depending on fireweed density and area, it can be time-consuming and labour intensive to detect, remove, bag and dispose of plants. It can also be hard to detect plants prior to flowering, risking seed being set before being found.

The basic method of hand pulling is to grab individual fireweed plants at the base of the stem and gently extract so that the whole plant, including the upper roots, is removed. This is easiest to do in wet soil after rainfall. Fireweed will not regrow from fine roots, so these do not need to be dug out.



John Virtue



John Virtue

Hand pulling and bagging of a fireweed plant, including roots.

Work health safety is important



To minimise risk of injury or exposure to plant chemicals:

- wear sturdy, impervious, comfortable gloves
- bend at the knees or work on your knees (with knee guards)
- be careful of footing in pugged or stony paddocks
- avoid repetitive strain – take rests and do not work in awkward positions
- work to your ability
- work in teams.

Plants should be placed into a sturdy bag (e.g. a used fertiliser bag) for disposal. This is particularly important for plants coming into flower or already seeding (being careful not to dislodge any seeds so that they are captured in the bag). Removing plants from paddocks also prevents livestock eating them.

Hand pulling is an ongoing, labour intensive commitment, best suited to very small properties or where fireweed is not widely established. In initial years, many long days might be required to remove high densities of plants. Long-lived seed in the soil and seed blowing in from surrounding properties means searching on a fortnightly basis to catch plants before they set seed. Often, certain parts of the property are 'hot spots', which require more frequent searching.

Disposal

Fireweed can be allowed to rot down in a bag or container and buried on the property or offsite at a council waste facility. While fireweed readily breaks down in compost, the effect on fireweed seed viability is not known. If composting at home, then the hot composting technique (Raabe, n.d.) is reputed to kill weed seeds because of the high temperatures generated, and hence is likely to be safer than traditional, fixed-heap composting. Fireweed should not be added to green waste for use in council or commercial composting.

2.9.3 Soil cultivation

Soil cultivation is the use of machinery (on a paddock scale) or hand tools (on a garden scale) to prepare planting beds for sowing crops or pastures, to control weeds and to incorporate organic materials such as crop stubbles into the soil.

The disturbance caused by soil cultivation can stimulate a flush of fireweed germination. Subsequent cultivations may be used to kill fireweed seedlings, but frequent cultivation can damage soil structure and risks erosion. The 'false seedbed' technique of very shallow 'tickle' cultivation can encourage surface weed seeds to germinate while having less effect on soil health than deep cultivation.

Cultivation is a control option for fireweed in cropping systems and home gardens, but it has limited use in other situations, such as pasture paddocks.

2.9.4 Mulches

Mulches are a physical barrier covering the soil surface. They can reduce germination, growth and spread of weeds. Mulches can be thin, impenetrable barriers to weed growth, such as black plastic used in strawberry production or biodegradable woven weed matting used to stabilise embankments. Alternatively, they can be thick, permeable layers of loose material, such as composted woodchips, straw or gravel.



Mass fireweed emergence stimulated by soil cultivation.

Mulching tips

- Use another weed control method before mulching, such as herbicide application or manual removal.
- Ensure the mulch layer is thick to smother emerging weeds effectively: a depth of 10 cm or greater is recommended.
- Regularly top-up mulch since it often settles and decomposes.
- Regularly monitor and spot spray or manually remove weeds that appear in the mulch.
- Establish desirable plants in the mulch to provide competition with weeds.

Mulches may assist in reducing the risk of fireweed germination in and around amenity plantings, gardens, urban roadsides and other heavily trafficked areas. However, the wind-borne seeds of fireweed can be deposited on top of mulch and may grow through it.

2.10 Pests and diseases to control fireweed

A wide range of native insects and pathogens that affect native *Senecio* have been found on fireweed. The most common of these include a leaf-feeding beetle, seed-head-feeding bugs, leaf-feeding and stem-boring moths, stem- and leaf-mining and gall-forming flies, and three rust fungi (Sindel et al., 1998).

Some of these native insects and pathogens can cause localised damage to fireweed under suitable environmental conditions. For example, larvae of the native blue stem borer moth (*Patagoniodes farinaria*) ringbarks stems and has been observed to occasionally kill plants on the north coast of NSW. The native rust fungus (*Puccinia lagenophorae*) can retard growth on heavily infected plants. However, none are known to cause long-term, sustained reductions in fireweed density in pasture.

In recent years, the introduced cotton aphid (*Aphis gossypii*) has been observed by landholders to damage fireweed plants severely during winter in parts of the south coast of NSW. This insect is also a

Chapter 2

pest of many crops grown where fireweed occurs, including melons, potatoes, strawberry, asparagus and many ornamental plant species (Graham, 2021). Since it is non-specific, attacking many crops and also spreading plant viruses, it is not viewed as a prospective control tool for fireweed.

2.10.1 Biological control

Biological control (or biocontrol) is the use of natural enemies of weeds, usually a herbivorous insect, parasite or pathogen, to reduce the weed's population density and reproductive output to levels that reduce its impacts in the invasive range. Biological control agents should not be regarded

as weed eradication tools, but they ideally reduce the pressure of weed invasion in combination with chemical, mechanical, cultural, and other weed control methods. Biocontrol agents typically have the greatest impacts at sites with a high density of healthy, actively growing plants (of the target weed). This allows for the agents to build up their population, spread and reach a level where they can significantly damage the weed.

As of May 2023, there are currently no biological agents available for fireweed control in Australia. Box 2.1 details the extensive research that has been undertaken to date.

Box 2.1 Fireweed biocontrol research

Investigations into biological control of fireweed have been underway for over 20 years. A major challenge has been understanding where fireweed in Australia came from and which other *Senecio* it is related to (for agent selection and host testing).

Genetic studies have identified that fireweed in Australia is likely to have originated from the KwaZulu-Natal region of eastern South Africa (Scott et al., 1998; Radford et al., 2000). Knowing the origin has tightened the focus of searching for potential biocontrol agents.

Genetic studies have also helped quantify how similar or dissimilar fireweed is to other *Senecio* species (Schmidt-Lebuhn et al., 2022a). This has helped to prioritise which Australian *Senecio* species should be included in host specificity testing.

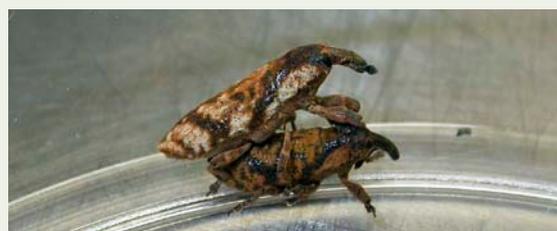
Dani Egli, University of KwaZulu-Natal



Larva of the stem-boring weevil *Gasteroclisus tricostalis*.

Research has found that South African strains of the rust fungus *P. lagenophorae* are less virulent than forms of the same rust already present in Australia (where it is considered native). This indicated there would be no gain in introducing new forms of the rust (McFadyen and Morin, 2012).

Studies into insects found on fireweed in its native range have been completed (Egli and Olckers 2015; 2020). Candidate biocontrol agents prioritised for further investigation have included a root-feeding flea beetle (*Longitarsus basutoensis*), a stem-boring weevil (*Gasteroclisus tricostalis*) and a stem-boring moth (*Metamesia elegans*). Unfortunately, host testing found that the flea beetle feeds on a range of *Senecio* species, including Australian species, rendering it unsuitable for further consideration as a biocontrol agent. The current research focus is on the stem-boring weevil.



Peter Jones, CSIRO

Adults of the stem-boring weevil *Gasteroclisus tricostalis*.