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Paterson's curse

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INTRODUCTION

Paterson's curse (*Echium plantagineum*), also known as salvation Jane, is a major weed in winter pastures throughout southern Australia and can be a problem in areas of natural vegetation.

The weed is native to Mediterranean Europe and northern Africa. It was both accidentally and deliberately introduced to Australia in the 1850s and by 1890 it was showing potential as a major weed.

Paterson's curse now occurs in all States and Territories in Australia. However, the most serious infestations occur in pastoral regions of New South Wales, Victoria, South Australia and in the south-west region of Western Australia where a winter rainfall climate dominates. Although Paterson's curse is more common in winter-rainfall areas, its wide tolerance of different climates and soils allows it to grow almost anywhere in Australia.

THE WEED

Paterson's curse is a winter annual herb that often becomes the dominant species in pastures. It is a prolific seeder that can produce more than 5000 seeds per plant per year. Large quantities of seeds may accumulate in the soil over several years. For example, a seedbank of up to 30 000 seeds per square metre has been reported. Seeds may remain dormant in the soil for up to five years.

Seeds may germinate at any time of year given sufficient moisture and warm temperatures and plants can be found at any of the growth stages at any time of year.

Flowers of a mature Paterson's curse plant.

Seeds mainly germinate following summer and autumn rains. After germination plants grow vegetatively as a rosette during autumn and winter. Flowering stems are produced in early spring, and seed in late spring to early summer. Plants that germinate in summer may produce seeds from autumn through to spring if conditions are suitable. Plants die after flowering.

In any locality the density of Paterson's curse fluctuates widely from year to year. The plant is likely to be abundant during years when the autumn break is early. It is also likely to be abundant in paddocks that have not been cropped or grazed, or have only been lightly grazed, for several years.

DISTINGUISHING PATERSON'S CURSE FROM CLOSELY RELATED WEEDS

Paterson's curse is an erect herb commonly 60 cm high, but it can grow up to 150 cm.

- Rosettes have green to light-green hairy, egg-shaped leaves that may grow to 30 cm long. The rosettes are stalked and have distinct, branched veins.
- Stem leaves are also hairy, but are smaller and narrower than rosette leaves and are almost stem-clasping.
- Stems are branched, with multiple stems often arising from the plant base. All stems are covered with stiff hairs.
- Flowers are mostly purple, but white, blue and pink flowering plants are sometimes found. The 2-3 cm long flowers are shaped like curved trumpets. Each flower has five stamens, two of which protrude past the end of the flower tube. Flowers generally appear from September to December.
- Seeds are dark-brown to grey and have a roughened seed coat. Up to four seeds develop from each flower.
- The plant has a stout taproot with numerous lateral roots.

Viper's bugloss (*Echium vulgare*) is a closely related weed. It usually grows in cool areas mainly on the Central and Southern Tablelands of New South Wales particularly along roadsides.

Paterson's curse rosette. Note leaf shape and distinct branched veins.

Paterson's curse flower. Note that two stamens protrude past the end of the flower tube.

Viper's bugloss is often confused with Paterson's curse but differs in many ways:

- It is usually a biennial, or sometimes a perennial plant, whereas Paterson's curse is usually an annual.
- Its rosette leaves are stalkless and spear-shaped.
- All its leaves have a warty appearance and are narrower than those of Paterson's curse.
- Its leaf veins are not prominent – they are longitudinal and unbranched.
- The flowers are usually more of a blue in colour and are on a pronounced flower spike. Flowers are smaller (about 1.5–2 cm long) and have four of the five stamens protruding well past the end of the flower.
- The main flowering period begins later in the season than that for Paterson's curse and extends over a longer period.

Viper's bugloss rosette. Note the shape and warty appearance of leaves.

- The stems are more erect and the stout taproot is usually much longer.

Italian bugloss (*Echium italicum*) is an uncommon plant that is found in a few small patches in south-west NSW:

- It has five protruding stamens.
- Flowers are pinkish or white.
- It is more hairy than Paterson's curse or viper's bugloss.

THE PROBLEM

Paterson's curse is considered a weed because:

- It reduces pasture productivity and is toxic to livestock.
- It can degrade the natural environment, compromising habitat values by crowding out and suppressing native vegetation.
- Hay and grain infested with it fetch lower prices.

Viper's bugloss flower. Note that four stamens protrude past the end of the flower tube.

- It affects human health. Some people are allergic to the pollen and the rough hairy texture of the leaves and stems causes skin irritation in people having close contact with the plant.

Despite these problems, some farmers consider Paterson's curse to be beneficial. In the drier regions of southern Australia, it is considered the salvation of grazing because it is often the only source of feed (despite being poisonous). Paterson's curse is also valuable to the honey industry. It flowers early in the apiarists' productive season, providing both the large amount of pollen necessary to build up bee numbers in a short time and a high level of nectar, which provides an early flow of honey.

Pasture productivity

Paterson's curse reduces pasture value as it out-competes the more nutritious and palatable pasture plants. The quick early growth of seedling roots allows it to out-compete pasture seedlings and better equips it to survive moisture stress, particularly after a false break. In autumn, seedlings may be so dense that they completely dominate other species. In winter, the large, broad rosette leaves shade and smother most other species. Where Paterson's curse replaces legumes in a pasture, nitrogen fixation is reduced and soil fertility declines unless fertiliser is applied.

When Paterson's curse flowers it is unattractive to grazing stock and after dying provides little useful fodder, resulting in lower stocking rates.

Effects on livestock

Paterson's curse contains **pyrrolizidine alkaloids**. These alkaloids cause liver damage if livestock graze the weed for extended periods. Liver damage reduces livestock productivity, reduces their productive lifespan (increasing stock replacement rates) and may result in death. The damage is irreversible and cannot be treated.

It has been observed that the production of pyrrolizidine alkaloids in Paterson's curse increases at the full flowering stage. This suggests that the weed is the most toxic to livestock if grazed while it is flowering. Further research is being conducted to confirm this trend.

Susceptibility to poisoning by Paterson's curse varies with different livestock species. Pigs and horses are highly susceptible, cattle moderately susceptible and sheep and goats the least susceptible.

Pigs and horses are non-ruminants and do not have the necessary micro-organisms in the stomach to break down the pyrrolizidine alkaloids.

Individual horses vary in their susceptibility, with some dying after a few weeks grazing Paterson's curse. Others may graze the weed for successive seasons before signs of poisoning appear. There is usually a gradual loss of condition over four to six weeks followed by listlessness and poor appetite. Some horses show nervous signs such as head pressing, blindness and aimless walking. This is because toxins, normally removed by the liver,

Horses are highly susceptible to Paterson's curse poisoning and should be removed from pastures dominated by the weed.

build up in the bloodstream and interfere with brain function. Most horses die once the illness is apparent, even after being removed from Paterson's curse infested pasture. On post-mortem the liver appears small, firmer than normal, and fibrotic. Jaundice of the carcase and an excessive amount of yellow fluid in body cavities can also be expected.

Although pigs are highly susceptible to pyrrolizidine alkaloids, Paterson's curse poisoning is rarely encountered in today's intensive piggeries: it only occurs where pigs have grazing access to the weed or when they are fed grain contaminated with Paterson's curse seed. Pigs are often found dead while others may be noticed sick for a few days before death. Signs of poisoning include loss of appetite, a swaying gait and arching of the back. Post-mortem examination shows jaundice of the carcase and an increase in yellow fluid throughout body cavities. The liver appears yellow and is firmer than normal.

Cattle are moderately susceptible to pyrrolizidine alkaloid poisoning because the rumen (first stomach) contains micro-organisms which can break down the alkaloids before they enter the liver and cause damage. However, if they are forced to graze large quantities of Paterson's curse for long periods an ill-thrift condition due to liver damage may result. Cattle lose condition, may scour, waste away and die. On post-mortem, livers are characteristically hard, small and fibrotic.

Sheep and goats are relatively resistant to pyrrolizidine alkaloids because the rumen breaks down the alkaloids, and the alkaloids are metabolised in such a manner that products are produced that are less toxic. However, if sheep graze Paterson's curse over several years some liver damage will occur and the damage will cause copper to accumulate in the liver. In sheep, under certain conditions, the copper is suddenly released into the bloodstream, resulting in death. This condition is called **chronic copper poisoning.**

Chronic copper poisoning occurs if copper levels in the liver are high and sheep are stressed, that is, by management practices such as mustering, shearing or lambing. Affected sheep usually separate from the flock, are reluctant to move, are jaundiced and show signs of respiratory distress. Death usually occurs within one to two days. If the animal lives as long as a week, recovery often occurs although the animal rarely thrives thereafter. Post-mortem examination shows jaundice of the carcase, black swollen kidneys, dark urine and an enlarged and fibrotic liver.

Increasing molybdenum in the diet appears to reduce the risk of chronic copper poisoning. Therefore the use of a molybdenum supplement may be advantageous.

Although sheep are relatively resistant to pyrrolizidine alkaloids there is a difference in breed susceptibility. Merino sheep are considered to be more resistant than British breeds and their Merino crosses. British breeds and their crosses tend to graze the plant more readily than Merinos, hence poisoning is more common in these breeds. Wethers are more resistant to poisoning than ewes; however there is wide variation between individual sheep.

PREVENTION OF SPREAD

Preventing Paterson's curse from spreading to uninfested areas should be given a high priority. Once it becomes established in an area it is extremely difficult to eradicate. Paterson's curse spreads only through the movement of seeds; therefore methods which prevent seed moving to uninfested areas should be employed. Methods include:

- Feeding only hay or grain which is known to come from an uninfested source.
- If hay or grain is known to be contaminated with Paterson's curse, only feeding it in infested areas or areas where Paterson's curse will be easy to control when seeds germinate. Regularly check the feeding areas and treat any new infestations.
- Sowing certified seed.
- Avoiding moving stock from infested to uninfested areas.
- Quarantining stock. Paterson's curse seeds are able to pass through stock without losing viability. Hold stock in a quarantine paddock for at least seven days if they are known to come from a Paterson's curse-infested area or if their origin is unknown. Monitor the quarantine paddock for the weed and treat any new infestations. Remember, the roughened seedcoat of Paterson's curse allows the seeds to be carried on the coats of stock.
- Cleaning machinery and vehicles before moving out of infested areas.
- Suppressing infestations on land adjacent to uninfested land.

CONTROL OF PATERSON'S CURSE

Integrated weed management

Farmers battling Paterson's curse will need to rely on an integrated approach to prevent seed set and reduce the populations in the long term. Integrated weed management involves using a combination of control methods. It

Paterson's curse can be controlled on your property using an integrated weed management strategy.

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has economical and environmental benefits by reducing the reliance on herbicides, reducing the risk of herbicide resistance and allowing weed management in most environments.

Integrated weed management of Paterson's curse includes the use of several of the following control methods at the appropriate time:

- competitive crops and pastures
- grazing management
- a range of herbicide groups
- spray grazing
- biological control
- slashing
- hand weeding.

Competitive crops and pastures

Paterson's curse is often one of the first plants to colonise bare ground. The key to preventing seedling establishment is to aim for full ground cover by using competitive crops or pastures.

Things you can do to achieve competitive crops and pastures:

- Choose crop and pasture varieties that are best suited to your climate and soil type.
- Ensure good agronomic practice such as appropriate sowing time and depth, adequate fertility and moisture at sowing.
- Apply high sowing rates for crops and pastures to achieve full ground cover quickly.
- Introduce narrow row spaces which will provide full ground cover much quicker than wide row spaces.
- Direct drill to minimise disturbance.
- Band nitrogen in crops. It is more directly available to the crop than broadcasting or undersowing.
- Include a high proportion of perennial species in your pasture mix.
- Allow pasture to set seed in the establishment year.
- Prepare paddocks for at least two years prior to sowing pasture to reduce the weed seed burden.
- Be prepared to spray weeds in a newly sown pasture.

Grazing management

Grazing can be used to manage Paterson's curse quite effectively; it can weaken plants and prevent prolific seeding. When grazing the weed it is essential to maintain the competitive nature of the pasture. Pastures should be maintained with enough green leaf to promote good growth. This is particularly critical during autumn as high amounts of green leaf and full ground cover will reduce the establishment of Paterson's curse seedlings.

When grazing Paterson's curse it is essential to consider the following issues:

- Grazing should be concentrated when plants are young and continued at regular intervals during the year while the plants remain in the rosette stage.
- Grazing should be stopped once Paterson's curse begins to flower to minimise stock poisoning.

- Pyrrolizidine alkaloids are present in Paterson's curse during the rosette stage, albeit at lower levels. Therefore, only use sheep for a maximum of two years in a grazing management program.
- Avoid long periods of continuous heavy grazing.
- Fence off severe infestations to allow intensive management while protecting areas of productive pasture.
- Crash graze areas dominated by the weed with large numbers of stock for short periods.
- Non-pregnant, non-lactating adult Merino sheep should be used to graze Paterson's curse.
- Do not allow horses, pigs, or cattle to graze Paterson's curse.
- Grazing management will need to be maintained as dormant seed will allow reestablishment of Paterson's curse.

Spraying Paterson's curse

Today there is a wide range of selective herbicides available for controlling Paterson's curse. Non-selective herbicides can also be used to spraytop the weed. Spraytopping uses low rates of non-selective herbicide to sterilise flowers and minimise seed set. It is essential to consider the following issues when deciding to use herbicides:

- The chemical sensitivities of your crop or pasture species and surrounding crops, pastures and environment. Be aware that the sensitivity of some crops and pastures may change with plant growth stage.
- The residual nature of the chemical, particularly on different soil types.
- The volatility of the chosen product.
- The weather and forecasts for the next few days.
- The keeping of all necessary records.
- Communication with your neighbours.
- The need to spray when plants are actively growing. Stresses such as drought, waterlogging, and extremely hot or cold weather can all reduce the effectiveness of spraying.
- The need to spray small, vigorously growing plants in the rosette stage. These are easiest to kill, require less chemical and avoid major competition with crops and pastures.
- The need to ensure that correct rates are applied and equipment is accurately calibrated.
- The need to read and understand the label instructions including safety precautions, chemical compatibilities, withholding periods and safe spraying conditions.

Advice on chemicals can be sourced from your local agribusiness suppliers, your local agronomist and the publications *Weed control in winter crops, Weed control in lucerne and pastures* and *Noxious and environmental weed control handbook,* available from NSW Department of Primary Industries.

Spray-grazing

Spray-grazing is a method which combines the application of an appropriate herbicide at a reduced rate followed by a short period of intensive grazing.

Spray-grazing works because the low dose of herbicide, which by itself does not kill the weeds, causes Paterson's curse to become more palatable to stock. Palatability increases because the sugar levels in the plants rise for a short period following spraying. The combination of spraying and grazing provides a severe stress which kills the plant. If Paterson's curse is not heavily grazed, most plants will recover from the low dose of herbicide applied within three weeks. Additional benefits include minimal effect on clovers and grasses by the use of a selective herbicide, reduced herbicide cost and improved pasture productivity.

Spray-grazing is most successful in light to medium infestations where pasture has the potential to compete with and replace Paterson's curse. Actively growing Paterson's curse plants are sprayed six to eight weeks after germination. When the grazing withholding period has elapsed stock are introduced at five to 10 times the normal stocking rate. Non-pregnant, non-lactating adult Merino sheep should be used. Individual sheep should only be used for a maximum of two years in a spray-graze management program. Heavy grazing should continue until the Paterson's curse has been satisfactorily reduced, but before pasture survival is threatened. Remove stock and allow the pasture to recover. Normal grazing can then resume. The spray-grazing program will need to be repeated each year until the dormant weed seed bank is exhausted.

Biological control

Although biological control was first suggested for Paterson's curse in 1928, it took more than 40 years for the program to begin. In 1972, the CSIRO began surveying the western Mediterranean region for the plant's natural enemies. The first agent, a small leaf-mining moth (*Dialectica scalariella*), was released in 1980, but did not establish because

of drought and grasshoppers. Shortly after moths were released, two beekeepers and two graziers obtained an interim injunction from the High Court preventing further releases. An eight-year legal battle followed. The Biological Control Act 1984 was enacted on 22 November 1984. This prevents further legal problems for biological control programs where the majority good is circumvented by legal challenges. All state and territory governments passed complementary biological control legislation between 1986 and 1988. The above injunction was lifted on 17 November 1988.

Of the many insects found damaging Paterson's curse in Europe, seven were approved by Plant Quarantine for release in Australia (see Table 1). These insects attack the weed during all stages of growth.

All these insects have been released and are established in the field except for the root hair flea beetle (*Longitarsus aeneus*) which was released but did not establish.

The leaf-mining moth (*Dialectica scalariella*) was released by NSW Agriculture between 1988 and 1991 at more than 900 sites throughout New South Wales. It is now widespread and common on Paterson's curse and viper's bugloss. Larvae of this moth feed within the leaves to form mines (mainly on the lower side). These mines turn to blisters as the larvae increase in size. Leaves are attacked from spring to autumn and this may reduce the competitiveness of Paterson's curse when moths are present in high numbers. Native wasps sometimes parasitise these moths but do not appear to reduce the size of moth populations.

The second agent released was the crown weevil (*Mogulones larvatus*). Crown weevils were first released in 1992. Adult weevils emerge in spring and feed on leaves, producing circular-to-oval shaped holes before entering a summer inactive period. This inactive period is broken by decreasing

The leaf-mining moth *Dialectica scalariella* is common and widespread in New South Wales.

Larvae of the leaf-mining moth burrowing through the leaves form blisters.

Table 1. Insect agents currently approved for the biological control of Paterson's curse

Species	Common name	Insect length	Generations per year	Plant part(s) attacked
Dialectica scalariella	Leaf-mining moth	5 mm	5–7	Leaf, below stem surface
Mogulones larvatus	Crown weevil	3.5–4 mm	1	Leaf, crown, leaf stalks
Mogulones geographicus	Root weevil	4–4.5 mm	1	Leaf, root, leaf stalks
Longitarsus aeneus	Root hair flea beetle	< 2 mm	l	Leaf, root hairs
Longitarsus echii	Tap root flea beetle	> 2 mm	1	Leaf, inside taproot
Phytoecia coerulescens	Stem beetle	10–15 mm	l	Leaf, stem
Meligethes planiusculus	Pollen beetle	2.5 mm	1–2	Flower bud, flower, developing seed

number of daylight hours in late summer to early autumn. Feeding, mating and egg-laying soon commence and continue until spring. Young larvae initially feed inside leaf stalks, moving down into the root crown. Most damage is caused by larvae feeding in the crown during autumn, winter and spring. Plants under heavy attack may die before seeds can be produced. Crown weevils are established at hundreds of sites in NSW.

The root weevil (*Mogulones geographicus*) was first released in 1993. This weevil attacks Paterson's curse in a similar way to the crown weevil except that root weevil larvae feed more in the tap root than the root crown. It has a similar life cycle to the crown weevil. Root weevils are established at more than 30 sites in NSW.

Two flea beetle species have also been released. Adult *Longitarsus aeneus* feed on rosette leaves and larvae feed on root hairs. *L. aeneus* was released directly into the field but did not establish. Adults of the other flea beetle (*Longitarsus echii*) emerge in winter. Adults feed on rosette leaves and larvae feed inside the main root. Flea beetles are established at more than 20 sites in NSW.

Larvae of the crown weevil *Mogulones larvatus* damage the crown of Paterson's curse and often destroy plants before flowering.

Damage caused by larvae of the crown weevil is often apparent as black ooze.

Larvae of the root weevil *Mogulones geographicus* damage the taproot of Paterson's curse and also often destroy the plant before flowering.

The root hair flea beetle *Longitarsus aeneus* feeds on root hairs.

Adults of the tap root flea beetle *Longitarsus echii* feed on rosette leaves, but larvae feed inside the main root.

Stem beetles (*Phytoecia coerulescens*) emerge in late spring and lay eggs that hatch a week later. Larvae feed inside larger stems and move to lower plant parts where they remain until the following spring. These beetles are cannibalistic with usually only one survivor emerging from each plant. Stem beetles have established at several sites in southern NSW.

The pollen beetle (*Meligethes planiusculus*) was the last of the insects to be released into the field. Eggs are laid in the terminal flower buds in spring. Larvae quickly emerge and feed on flower buds, flowers and developing seeds. After flowering finishes, the adult flower beetle remains fairly inactive through the remainder of summer, autumn and spring. Pollen beetles have established at several sites in southern NSW.

The pollen beetle *Meligethes planiusculus* has established at several sites in southern NSW.

Slashing

Slashing does not kill Paterson's curse outright but can delay and suppress flowering. Slashing forces the plant to regrow, using up reserves stored in the root system and weakening the plant.

Paterson's curse needs to be slashed regularly (fortnightly or monthly) during flowering as curse plants regrow quickly from the crown after slashing. Slashing should only be considered as a short-term control tool and should be used in combination with other control measures.

Hand weeding

Hand weeding, either by pulling Paterson's curse plants out by hand or digging plants out using a hoe or shovel, is very effective on single plants, small patches or other situations where labour is not limiting. Paterson's curse does not regenerate from small root segments left in the ground.

Larvae of the stem beetle *Phytoecia coerulescens* feed inside Paterson's curse stems.

The best time to pull or hoe plants is before they begin to flower. If removal occurs after flowering has commenced, it is important that plants are removed from the site prior to the seeds dropping to the ground and that the plants are burnt so that developing seed does not replenish the soil seed bank. Viable seed is capable of developing on Paterson's curse after plants have been pulled.

Burning

Burning will kill many Paterson's curse seeds and stimulate others to germinate. However, follow-up treatment with cultivation or herbicides may be required. Burning is generally only a suitable control method when it can be incorporated as part of seedbed preparation for pasture or crop establishment. In established pastures, burning has a more detrimental effect on the pasture than on the weed.

FURTHER INFORMATION

For further information contact your local office of NSW Department of Primary Industries.

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

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