

Thistle Biocontrol Ute Guide

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Manatū Ahu Matua



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Introduction

Thistles are among the most notorious and recognisable weeds in temperate regions of the world. For centuries thistles have been the bane of farmers, since their prickly structures prevent livestock from eating them, or injure animals that attempt to do so. While their spininess causes them to be undesirable to livestock, it is worth noting that the majority of thistle species are not chemically toxic in any way.

The common term “thistle” is often applied to any prickly plant; however, true thistles belong to a well-defined subtribe of plants, the Carduinae, within the sunflower family (Compositae). True thistles are annual to perennial herbs usually with spiny leaves and stems. Flowers are formed in a capitulum (thistle head), which is a cluster of many florets. A seed (achene) is formed at the base of each floret within the capitulum, and attached to the top of the seed is a pappus that can be long and plume-like (thistle down), or short and bristle-like. All species are monocarpic, dying after producing seed. True thistles never have milky sap (latex).

In New Zealand (NZ), there are no native true thistle species. All of the thistle weeds in NZ were inadvertently introduced, likely with the importation of crop and pasture seed during the early period of European colonisation. Currently, nine species of thistle are considered pasture weeds of economic importance in NZ.

The fact that there are no native thistles in NZ provides a unique opportunity for biological control, since there is no risk to the native flora. There are many specialised herbivorous insects that feed on thistles in their native range of Europe, and some of these have been intentionally introduced to NZ as biological control agents. From 1973 to 2007, ten insect species were introduced, specifically targeting Californian thistle, Scotch thistle, and nodding thistle. Of these ten insects, six have established and are common enough to be encountered feeding on particular thistle species.

This ute guide is intended to provide farmers and land managers with basic information on the biology of the main thistle weeds of NZ and their biocontrol agents, and aid in their identification.

Cross-section of a nodding thistle seedhead



Floret

Floret tube

Thistle down
(pappus)

Developing seed
(achene)

Receptacle

Bract

Californian thistle (*Cirsium arvense*)

Life cycle: Perennial.

Flowers: December – February.

Seeds: January – March.

Reproduces by seed and creeping roots. It is a dioecious plant meaning there are separate male and female plants. Seeds are only produced by female plants in close proximity to male plants. Most seeds fall close to the parent plant, although a small proportion are dispersed long distances by wind. In established populations the thistle spreads by creeping roots that separate into many clonal ramets (clonal reproduction). Roots survive for one year. The roots overwinter and give rise to new shoots in spring, which in turn give rise to new roots.

Distribution: Common, at high densities throughout NZ, except Westland and Northland.

Importance: The worst thistle weed in NZ. Estimated to cost the pastoral industry \$685 million per year in lost productivity.

Biocontrol agents: Green thistle beetle, Stem gall fly, Receptacle weevil, and Rust fungus. Potential attack from the Scotch thistle gall fly.

Californian thistle
(*Cirsium arvense*)



Female

Male



Marsh thistle (*Cirsium palustre*)

Life cycle: Biennial or winter annual.

Flowers: November – February.

Seeds: December – March.

Seeds are dispersed in mid-summer to autumn. Many seeds germinate in autumn and the plant overwinters as a rosette. In spring the rosette bolts and produces flowers and seeds (winter annual). Some seeds germinate in spring and remain as rosettes until the following year before bolting and producing seeds (biennial).

Distribution: Common at low to moderate densities, throughout NZ. Uncommon in low rainfall regions such as the East Coast of the SI and Central Otago.

Importance: Generally a minor weed, found at low densities in pastures. Can be problematic in higher rainfall regions such as Southland and Westland.

Biocontrol agents: None specifically, but potential attack from the Receptacle weevil, Green thistle beetle, and the Scotch thistle gall fly.

Marsh thistle
(*Cirsium palustre*)



Scotch thistle (*Cirsium vulgare*)

Life cycle: Biennial or winter annual.

Flowers: November – March.

Seeds: December – May.

Seeds are dispersed in mid-summer to autumn. Many seeds germinate in autumn and the plant overwinters as a rosette. In spring the rosette bolts and produces flowers and seeds (winter annual). Some seeds germinate in spring and remain as rosettes until the following year before bolting and producing seeds (biennial).

Distribution: Common, at moderate to high densities, throughout NZ.

Importance: Major weed, found on most farms. Frequently abundant causing significant loss to pasture grazing area. Each seedhead contains an average of 200 seeds, and individual plants can produce thousands of seeds. Most seeds fall close to the parent plant, although a small proportion are dispersed long distances by wind.

Biocontrol agents: Scotch thistle gall fly. Potential attack from the Receptacle weevil, Root-crown weevil, and the Green thistle beetle.

Scotch thistle
(*Cirsium vulgare*)



Nodding thistle (*Carduus nutans*)

Life cycle: Biennial, winter annual, or occasionally a summer annual.

Flowers: November – February.

Seeds: December – May.

Seeds are dispersed in mid-summer to autumn. Many seeds germinate in autumn and the plant overwinters as a rosette. In spring the rosette bolts and in summer produces flowers and seeds (winter annual). Some seeds germinate in spring and remain as rosettes until the following year before bolting and producing seeds (biennial), and a small proportion of spring-germinating seedlings bolt and produce seeds in summer without overwintering (summer annual).

Distribution: Common, at low to moderate densities, throughout NZ.

Importance: Formerly a serious pasture weed, and now only occasionally problematic.

Three biocontrol agents contribute to the control of this weed.

Biocontrol agents: Receptacle weevil, Nodding thistle gall fly, Root-crown weevil. Potential attack from the Green thistle beetle.

Note: Plumeless thistle (*Carduus acanthoides*). The biology and appearance of this thistle is very similar to nodding thistle. It is found throughout the NI and Canterbury, but is common only in Waikato. In contrast to nodding thistle, the seedheads of plumeless thistle do not have the typical 'nodding' appearance and the seedhead bracts are not curved. It is also attacked by all the same biocontrol agents as nodding thistle.

Nodding thistle
(*Carduus nutans*)



Winged thistles (*Carduus tenuiflorus* and *Carduus pycnocephalus*)

Life cycle: Winter annual, or summer annual.

Flowers: October – December.

Seeds: November – February.

Strictly annual plants. Seeds are dispersed in late spring to mid-summer. Seeds germinate in autumn or early spring. In spring, the plant develops quickly from a rosette to bolting and flowering.

The two species are difficult to distinguish, and potentially hybridise, so intermediate forms are possible. *C. tenuiflorus* has clusters of 3 to 8 flower heads, whereas *C. pycnocephalus* has clusters of 1 to 4 flower heads.

Distribution: Common throughout NZ, especially in drier east coast regions.

Importance: Frequently serious weeds. Often forming dense patches, especially in drier areas of pastures. Each seedhead contains an average of 15 seeds, and individual plants can produce 100 - 300 seeds.

Biocontrol agents: None specifically, but potential attack from the Nodding thistle gall fly, Receptacle weevil, Root-crown weevil, and the Green thistle beetle.

Winged thistle
(*Carduus tenuiflorus*)



Winged thistle
(*Carduus tenuiflorus*)



Slender winged thistle
(*Carduus pycnocephalus*)

Variegated thistle (*Silybum marianum*)

Life cycle: Winter annual, or summer annual.

Flowers: November – January.

Seeds: December – March.

Seeds are dispersed in mid-summer to autumn. Most seeds germinate in autumn, but germination can occur throughout the year. The plant develops quickly from a rosette to bolting and flowering. Large seeds have a bristle-like pappus, and are not wind dispersed.

Distribution: Occasional throughout NZ, and common at high densities in the east coast of the NI and Banks Peninsula.

Importance: Generally a minor weed, but serious infestations occur in the east coast of the NI and Banks Peninsula.

Biocontrol agents: None specifically, but potential attack from the Receptacle weevil and the Green thistle beetle.

Variegated thistle
(*Silybum marianum*)



T. James



T. James



T. James

Cotton thistle (*Onopordum acanthium*)

Life cycle: Biennial or winter annual.

Flowers: December – February.

Seeds: January – March.

Seeds are dispersed in mid-summer to autumn. Many seeds germinate in autumn and the plant overwinters as a rosette. In spring the rosette bolts and produces flowers and seeds (winter annual). Some seeds germinate in spring and remain as rosettes until the following year before bolting and producing seeds (biennial). Large seeds have a short pappus, and are not wind dispersed.

Distribution: Occasional in Wairarapa, Malborough, and Canterbury. Common in Otago where moderate to serious infestations occur.

Importance: Generally a minor weed, but serious infestations occur in Otago.

Biocontrol agents: None specifically, but potential attack from the Receptacle weevil, Root-crown weevil, and the Green thistle beetle.

Cotton thistle
(*Onopordum acanthium*)



Burdocks (*Arctium minus* and *Arctium lappa*)

Life cycle: Biennial.

Flowers: January – March.

Seeds: February – May.

Seeds are dispersed in autumn and typically germinate in early spring. The plant survives its first year as a rosette and then bolts to produce flowers and seeds the next year, although it can remain as a rosette for multiple years before bolting. Seedheads (burs) have hooked bracts and readily attach to livestock and clothing, which is the primary means of dispersal.

Distribution: Occasional throughout NZ, along roadsides, fence lines, and forest margins. Not common in grazed pastures since livestock will eat the rosette leaves.

Importance: Minor weeds, not considered to have an economic impact in NZ.

Biocontrol agents: None specifically, but potential attack from the Green thistle beetle.

Burdock
(*Arctium lappa*)



Receptacle weevil (*Rhinocyllus conicus*)

Introduced: 1973, common throughout NZ.

Description: About 6 mm long, dark brown, with white speckles on the body. Larvae are white and appear grub-like, but without legs, and are found inside thistle seedheads.

Life cycle: Univoltine, to partially bivoltine. The weevil overwinters in the adult stage. In spring the adults lay eggs on the developing flower buds. Larvae develop inside the flower receptacle and consume developing seeds. There are four larval instars before pupation, which also occurs inside the thistle head. Pupae form inside hardened chambers in the seedhead, which can reduce seed dispersal distance. Newly emerged adults seek sheltered sites for aestivation and overwintering. Adults that emerge in early summer may lay eggs on developing flower buds to form a partial second generation.

Impact: Contributes to control of nodding thistle by reducing seed production. Also found on winged thistles, Scotch thistle, and Californian thistle, and may attack other true thistles such as marsh thistle and variegated thistle. The contribution to control of other thistles in NZ is uncertain.

Receptacle Weevil
(*Rhinocyllus conicus*)



Nodding thistle gall fly (*Urophora solstitialis*)

Introduced: 1990, common throughout NZ.

Description: Adults 5 – 8 mm long. Black bodies with yellowish thorax, head and legs. Clear wings with four black bands (appearing like two V-shapes). Larvae are white, 3 – 4 mm long, and cylindrical with a dark brown anal plate.

Life cycle: Bivoltine. The fly overwinters as a mature larva in seedheads. In spring, the adult fly emerges from old seedheads, and seeks out new flower buds to deposit eggs. Larvae feed through the floret tube and developing seed, and into the receptacle. The next generation of adult flies emerge in summer and continue laying eggs in developing seedheads. Hardened galls are formed around the larvae. Multiple larvae can attack single seedheads causing fusion of the larval galls and formation of one large hardened seedhead.

Impact: Contributes to control of nodding thistle by reducing seed production. Potential attack on other *Carduus* thistles, such as winged thistles, and plumeless thistle.

Nodding Thistle Gall Fly
(*Urophora solstitialis*)



Root-crown weevil (*Trichosirocalus horridus*)

Introduced: 1979, common throughout NZ.

Description: Adults are 3-4 mm long, and dark brown. Larvae are white and appear grub-like, but without legs, and are found tunnelling inside root-crown area of rosettes.

Life cycle: Univoltine. The weevil can overwinter as an adult, egg, or larva. Adult weevils begin laying eggs in nodding thistle rosettes in late winter to early spring. Larvae feed through the mid-rib of rosette leaves and continue feeding into the crown of the plant. Mature larvae leave the plant and pupate in the soil. New generation adults emerge in late summer to autumn and begin feeding and laying eggs on nodding thistle rosettes.

Impact: Contributes to control of nodding thistle by killing individual stems, or entire plants. Potential attack on other true thistles, such as winged thistles, plumeless thistle, and Scotch thistle.

Root-crown weevil
(*Trichosirocalus horridus*)



Larvae and feeding damage

Green thistle beetle (*Cassida rubiginosa*)

Introduced: 2007. Present in most regions, but not yet common.

Description: Adults are 6 – 8 mm long, and green. The head is concealed by the shell (pronotum), hence *Cassida* species are sometimes referred to as “tortoise” beetles. Larvae have spines on the side of their body, and a forked tail that carries a black protective “faecal shield”.

Life cycle: Univoltine. Adults overwinter in nearby hedge rows or forest margins under leaf litter. In spring adults emerge and begin laying eggs. Five to ten eggs are laid in a case covered in a brown secretion, typically on the underside of leaves. The egg-laying period is from early October to mid-December. Eggs begin to hatch by November, and progress through five growth stages (instars) before pupating on the plant. New generation adults emerge from December to February and feed for a few weeks before migrating to overwintering locations. Most adult beetles die after one year, but a small proportion can survive up to three years.

Impact: Uncertain, and still being evaluated. Extensive defoliation has been observed at several sites, particularly in Wairarapa. Californian thistle is the primary host plant, but the beetle can potentially feed on all true thistles and knapweeds (*Centaurea* species).

Green thistle beetle
(*Cassida rubiginosa*)



Larva with faecal shield



Stem gall fly (*Urophora cardui*)

Introduced: 1976, limited distribution, and rarely encountered.

Description: Adults 5 – 8 mm long. Black bodies with yellowish thorax, head and legs. The bands on the wings form a “W” shape, which are much thicker than the bands on the other *Urophora* biocontrol flies. Larvae are white, 3 – 4 mm long, and cylindrical with a dark brown anal plate.

Life cycle: Univoltine. Flies overwinter as mature larvae inside the hardened stem galls. In spring, adult flies emerge from the galls, and begin laying eggs inside the stems of Californian thistle shoots. Stem galls form around the developing larvae. The size of the gall depends on the number of larvae developing inside, and ranges from 5 – 20 mm. Multiple galls can be formed on single shoots.

Impact: Minimal, or none. Livestock consume the galls limiting establishment. The fly is highly host-specific only attacking Californian thistle.

Stem gall fly
(*Urophora cardui*)



Scotch thistle gall fly (*Urophora stylata*)

Introduced: 1998, common throughout NZ.

Description: Adults 5 – 8 mm long. Black bodies with yellowish thorax, head and legs. Clear wings with three black bands (appearing like an IV-shape). Larvae are white, 3 – 4 mm long, and cylindrical with a dark brown anal plate.

Life cycle: Univoltine to partially bivoltine. The fly overwinters as a mature larva in seedheads. In spring, the adult fly emerges from old seedheads, and seeks out new flower buds to deposit eggs. Larvae feed through the floret tube and developing seed, and into the receptacle. Some of the next generation of adult flies emerge in late summer and continue laying eggs in developing seedheads (partially bivoltine); however most remain as mature larvae until the next growing season. Hardened galls are formed around the larvae. Multiple larvae can attack single seedheads causing fusion of the larval galls and formation of one large hardened seedhead.

Impact: Can significantly reduce seed production of individual Scotch thistle plants, but its impact on thistle populations is uncertain. Potential attack on other *Cirsium* species such as Californian thistle and marsh thistle.

Scotch thistle gall fly
(*Urophora stylata*)



Rust fungus (*Puccinia punctiformis*)

Introduced: First recorded in 1881. Inadvertently introduced with its host plant, Californian thistle. Common throughout NZ.

Description: Two distinct stages can be seen: The orange-coloured pycnial stage, and the brown-coloured uredinial stage. The fungus infects entire shoots, causing yellowing, and growth deformations such as elongated internodes and twisted stems.

Life cycle: The fungus overwinters in Californian thistle roots. In spring, diseased shoots appear bearing orange-coloured pustules (pycnia) on the underside of leaves. These infected shoots emit a sweet-smelling floral odour. The orange pustules gradually turn into brown pustules (uredinia). The spores (urediniospores) from the brown pustules can cause localised infections on neighbouring thistle shoots. In late summer to autumn the fungus produces another spore type (teliospores) that infects rosettes of Californian thistle, and the fungus again enters the roots to overwinter. The fungus is highly host-specific, only attacking Californian thistle (*Cirsium arvense*).

Impact: Variable. Usually low infection frequencies and minimal impact on Californian thistle populations, but occasionally causes epidemics that control populations. Current research is investigating how to better utilise this fungus for control of Californian thistle.

Rust Fungus
(*Puccinia punctiformis*)



07/11/2011

G. Bourdôt



07/11/2011

G. Bourdôt

Thistle and biocontrol agent associations

	Green thistle beetle	Stem gall fly	Receptacle weevil	Scotch thistle gall fly	Nodding thistle gall fly	Root-crown weevil	Rust fungus
Californian thistle	✓	✓	✓	?			✓
Scotch thistle	✓		✓	✓		✓	
Marsh thistle	✓		?	?			
Nodding thistle	?		✓		✓	✓	
Winged thistles	✓		✓		✓	✓	
Variegated thistle	?		?				
Cotton thistle	?		?			✓	
Burdocks	?						

✓ Biocontrol agent and plant association confirmed by field observations.

? Thistle species is within the host range, but field observations of biocontrol agent feeding in NZ are unconfirmed.

Glossary

Aestivation – summer hibernation or dormancy.

Bivoltine – two life cycles per year.

Bract – a small, sometimes spiny, modified leaf on the flower head.

Grub – a term applied to some types of beetle larvae.

Instar – a developmental stage of an immature insect.

Larva (plural larvae) – the immature life stage of an insect between the egg and pupal stages.

Pappus – hairs attached to the seed. It can be simple hairs, short and bristle-like, or long and feathery.

Pupa (plural pupae) – the life stage of some insects undergoing transformation (metamorphosis) to the adult stage.

Ramet – an independent unit of a clonal plant.

Receptacle – the base of a flower head, from which the reproductive organs grow.

Univoltine – one life cycle per year.

Weevil – a type of beetle with a snout-like head, and usually elbowed antennae.

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