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Weed Biocontrol

WHAT'S NEW?

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Remembering Robin van Zoelen

Sadly, Robin van Zoelen, a Biosecurity Officer for Tasman District Council, and a stalwart of the National Biocontrol Collective (NBC), passed away in September aged 64. Rob had battled leukaemia on and off for 12 years. He was so passionate about weed biocontrol that he chose to leave his sick bed to attend the NBC annual meeting in Wellington in October 2020 rather than miss it.

Robin was a fantastic supporter of weed biocontrol activities in New Zealand for 36 years. He thoroughly enjoyed all aspects of the work, from releasing, monitoring, and reporting on the progress of weed biocontrol agents, to organising 'swapsies' with other regions, and speaking to community groups and schools about this work.

Lynley Hayes, a Science Team Leader with Manaaki Whenua – Landcare Research (MWLR), worked with Robin for three decades and remembers him well:

"Robin told me many times that the weed biocontrol work was where he felt he could make the biggest difference and leave the greatest legacy. It was always fun going out in the field with him. He loved to tease me about gorse thrips at every opportunity since they were so small and underwhelming in terms of impact. However, Robin was delighted that the agents he released against ragwort, and nodding and Scotch thistles, led to substantial declines in these weeds."

"He was also excited to see inroads being made into broom and tradescantia due to the agents released more recently against these targets. It is a shame Robin did not get to see agents released against banana passionfruit (he was the NBC project representative for this project for a number of years) or get to release the new mite against another of his old arch enemies, old man's beard."

"Robin was a patient man, a quality you certainly need when working with biocontrol. We also really appreciated being able to tap into Robin's excellent memory about how weed problems in the Tasman District had changed over the last four decades, and the excellent photos he took and shared."

Thanks Robin, for all you did to support our work at MWLR. You will be missed!

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Left: Robin at EcoFest in 2012. Right: Robin releasing the privet lace bug.

It is a numbers game for the field horsetail weevil

Fortunately for the Rangitikei Horsetail Group and New Zealand farmers, it appears the field horsetail weevil (*Grypus equiseti*) plays a numbers game. The group, chaired by Ferryview Farm manager Alistair Robertson, was formed to target field horsetail for biocontrol due to difficulties with controlling this weed with any other methods.

Field horsetail (*Equisetum arvense*) is native to Europe, Asia and North America but has naturalised in countries where it was intentionally introduced such as New Zealand, and elsewhere in the southern hemisphere. Field horsetail is a primitive, fern-like plant with a complex and extensive underground root system which can reach up to 2 meters deep. This makes it very difficult to control manually, or with herbicides, which don't reach the lower roots and are not effective at killing the tubers.

Once the field horsetail weevil was approved for release by the Environmental Protection Authority in 2017, staff from Manaaki Whenua – Landcare Research struggled to establish a population in the field. The main issue appeared to be due to the low numbers of adults available for field releases. This prompted a change in rearing technique in 2020, which proved to be very effective. The field horsetail culturing pots were upscaled by changing to much larger tub-like containers. With more space and depth, the field horsetail plants were able to produce larger and longer stems and rhizomes which better suit the requirements of field horsetail weevil larvae which mine the stems and rhizomes.

"As a result, 2670 weevils have now been released, with over 80% of these released after rearing methods were improved,"

Feeding damage to field horsetail by the weevil in Rangitikei

The field horsetail weevil

said Paul Peterson who is leading the project. All the releases have taken place in Rangitikei which has well established and widespread populations of field horsetail, particularly on the floodplains of the lower Rangitikei River. "And at last, weevil damage has been recorded at three of the six release sites, strongly suggesting the weevils have established there, and signalling a turning point in the project," continued Paul. After these findings, Horizons Regional Council ran a field day at the Ferryview release site in April to update the Rangitikei Horsetail Group on progress and for them to see the weevils.

The immediate focus of the project is now on rearing more weevils for field releases in the 2021/22 summer. "Now that we have developed a highly effective rearing technique for the weevil, everyone involved agreed the sensible approach is to ensure we have well established sites before winding up the rearing work on this agent," explained Paul. "Also, in addition to rearing more weevils, assessment plots have been set up at five of the six release sites so that the impacts of the weevil on field horsetail populations at these sites can be evaluated," he added.

In subsequent years, the plan will be to keep a close eye on field horsetail weevil populations to assess when they will be ready for collection and redistribution to other field horsetail sites. The weevils are weak fliers, and some may not fly at all during their lives, so they will need assistance with moving to new field horsetail sites. Despite the long wait to get the first signs of establishment, the future of field horsetail biocontrol is looking a lot brighter, with weevil establishment seemingly possible when high numbers of adults are released.

This project was funded by the National Biocontrol Collective and the Ministry for Primary Industries' Sustainable Farming Fund. Mass rearing and releases are funded by Horizons Regional Council.

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Permit for Rust Export Renews Hope for Biocontrol of Chilean Needle Grass

In 2011, we received permission from the Environmental Protection Authority (EPA) to release a rust fungus (*Uromyces pencanus*) as a biocontrol agent for Chilean needle grass (*Nassella neesiana*). Little did we imagine that it would be 10 more years before we received permission from the Argentinean government to export the rust from Argentina.

The holdup was due to the Argentinian government implemeting a document called the Convention for Biological Diversity (CBD). This is a treaty that was signed by 150 countries at the 1992 Rio Earth Summit. The treaty has three main goals: the conservation of biodiversity; the sustainable use of its components; and the fair and equitable sharing of benefits arising from genetic resources. The convention was considered necessary because plants, animals and fungi in developing countries were being exploited by pharmaceutical and seed companies in developed countries.

Imagine a US-based pharmaceutical company finds a fungus originating from a small patch of the Amazon Forest which produces a powerful antibiotic. The company conducts preliminary experiments which show the antibiotic has potential benefits for humans; however, the fungus also contains a toxin to which many people are allergic. So, the company returns to the rainforest to look for a closely related fungus that produces the same antibiotic, without the toxin. In the meantime, a local farmer has cleared the patch of rainforest to grow crops, and all the fungi have been destroyed. This adversely affects not just the pharmaceutical company, but the people it could have helped. The CBD was created to ensure that the benefits from harvesting particular life forms reach the people who live near them, giving them an inducement to preserve them. In this case, the CBD would have ensured that the company wanting to take the fungus from one country to another would have had to pay local government authorities before it could do so, and this money, and the idea that more might be forthcoming if other fungi proved useful, would give those authorities some incentive to stop deforestation.

The problem is, living organisms with potential as classical biocontrol agents are also covered by the CBD. While we do indeed need biodiversity to be preserved so that potential biocontrol agents continue to exist, the organisations that research and implement biocontrol (e.g. Manaaki Whenua – Landcare Research) are not able to share the financial benefits of classical biocontrol, because they don't receive any. It is farmers, local government agencies, conservation departments and local economies etc. that benefit from biocontrol. The benefits of biocontrol are substantial, but diffuse, and there is no easy way to transfer funds from those who benefit to the people/governments who can protect the ecosystems where biocontrol agents live.

Since the CBD was signed, research institutions wishing to move potential biocontrol agents from one country to another, and the government departments that issue permits for such movements, have been wrestling with this issue. Biocontrol practitioners have pointed out that most countries (rich and poor alike) are both importers and exporters of agents, and it is therefore in everyone's best interests to come up with workable systems. They also explain that countries that import biocontrol agents can (and do already) reimburse those that export biocontrol agents in many ways, including:

- Employing local researchers and providing them with facilities, training, and equipment they could not otherwise afford
- Increasing local knowledge of the studied agents, their hosts and ecosystems
- Publications regarding biocontrol increase the profile of researchers and their institutions
- There is an active cooperative network of biocontrol practitioners worldwide. When researchers in an exporting country join this network, it becomes easier for them to gain assistance when their own country requires biocontrol agents.

In the case of the biocontrol project against Chilean needle grass, Australia and NZ have indeed provided all of the above to Argentina since the project began in 1999. However, the CBD was not written with this sort of contribution in mind, so it took time to create paperwork that recognised this as appropriate 'access and benefit sharing.' And we cannot blame the Argentinean authorities for being cautious. While they have exported a few insects for biocontrol since the CBD was signed, the Chilean needle grass rust will be the first pathogen exported from Argentina for biocontrol.

"Now that appropriate application forms have been written, and I know what is required, and who requires it, we can hope that future permit requests will be processed faster" said Freda Anderson (CERZOS – CONICET). Freda, who has been working on this project in Argentina since the beginning, was the unfortunate person having to wrestle with the new CBD-based requirements and we are extremely grateful for her 10 years of perseverance. And we now can finally proceed with the last remaining tests that need to be conducted to assess the pathogen's suitability for release here. Chilean needle grass is predominantly a pasture weed in New Zealand, especially in dry, low-fertility soils. There are a couple of infested sites in Auckland; about 130 sites in the Hawke's Bay region; about 170 sites in the Marlborough region; and it is also present, and rapidly spreading (affecting over 300 ha) in Northern Canterbury. Overall, there are about 4000 ha of infected pastures in New Zealand and unfortunately, climate modelling

Rich Langley

Chilean needle grass seeds

has shown that this is only a small fraction (about 0.5%) of its potential distribution here. In areas where Chilean needle grass outcompetes and displaces more desirable plants, it reduces pasture and crop yields. When seeding from late October to March, it is unpalatable to stock and easily spread and so famers avoid grazing infested pastures during this time and can support fewer animals. In addition, the sharp, needle-like seeds that give the grass its name can penetrate the skin, eyes, mouths and even muscles of stock causing major animal health and welfare issues, including painful sores and blindness. The weed seeds prolifically, and seed reserves in the soil make it difficult and costly to control long-term using herbicide or grubbing.

After years of research in both the field and laboratory in Argentina, where CNG is native, it was decided that the rust fungus was the best biocontrol candidate. "The rust showed itself to be quite host specific during preliminary testing, it is simple (although not always easy) to mass culture, its spores can be frozen for later use, and we saw it causing significant damage to Chilean needle grass populations in the field," explained Freda.

Host range testing was undertaken in Argentina with a single strain of the rust (UP 27). Because the rust was wanted for both Australia and New Zealand, and because there are so many native and valued plants in the grass family, the list of test plants was long, including 65 species and cultivars. In these tests, UP 27 was shown to be highly host specific: it only formed spores on the target weed, on nine of the 12 Chilean needle grass populations evaluated. Unfortunately, the few Chilean needle grass plants from the Hawke's Bay Region that were tested were found to be resistant to the rust, and if further testing confirms these plants are typical, then another strain, or other control methods may be required for the North Island. Fortunately, the more common and problematic South Island variety of Chilean needle grass is highly susceptible to UP 27.

It was these results that satisfied New Zealand authorities that the rust fungus is safe when an import permit was granted in 2011. Unfortunately, that 5-year-permit expired before it could be used. When a new application to the EPA was prepared and submitted in December 2017 (by Richard Hill and Jane Barton - contractors to MWLR) further host range test results were available. This is because Australian authorities had requested testing of more *Austrostipa* species that are native to Australia, and quite closely related to *Nassella*. In those experiments, the rust was able to produce spores on two non-target species of *Austrostipa*: *A. compressa* and *A. macalpinei*.

While neither of these *Austrostipa* species occur in New Zealand, the team decided, through an abundance of caution, that additional testing was advisable. There are only three grass species in New Zealand that belong to the same tribe as *Nassella* (the Stipeae) and are native here: *Austrostipa stipoides, Acnatherum petriei* and *Anemanthele lessoniana*. While *A. stipoides* plants originating in Australia had already been included in host ranges tests and shown to be resistant, it was decided that plants originating in New Zealand should also be tested. "Since *A. petriei* and *A. lessoniana* are endemic to New Zealand, they had to be sent to me as seed and then grown in a containment facility in Argentina for testing," explained Freda. "But despite considerable effort, I wasn't able to cultivate enough plants of either species for testing. We did include another *Acnatherum* species as a surrogate for *A. petriei* (*Acnatherum caudatum*) however, a subsequent taxonomic revision moved this species to another genus (*Amelichloa caudata*) making it a poor substitute." Since we now have a pathogen-proof containment facility in New Zealand (a luxury we did not have when testing was done in Argentina) we have decided to test these three grasses in containment, in Auckland. The EPA agreed to put the 2017 application on hold until this had been done.

Unfortunately, the permit that took us 10 years to obtain, only allows us 3 months in which to get the rust fungus out of Argentina and into New Zealand. Freda will have her work cut out for her packaging frozen spores and filling out even more paperwork in order to get them to us by the end of the year. If all goes well with testing, and the EPA issues a permit, the first releases may be possible in spring of 2022. In the meantime, we wish Freda and the team luck!

This project was previously funded by Manaaki Whenua – Landcare Research, and is now funded by the National Biocontrol Collective and the Ministry for Primary Industries' Sustainable Food and Fibre Futures (Grant #20095).

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Tackling Moluccan Albizia for the Pacific

Moluccan albizia (*Falcataria moluccana*) is a fast growing, nitrogen-fixing tree native to the eastern islands of the Indonesian archipelago, Papua New Guinea and the Solomon Islands. It was introduced to the Pacific region to provide shade and nutrients to crops, to stop erosion, to reforest degraded areas and for ornamental purposes. However, it soon became invasive in several of these islands, including Hawai'i, American and Western Samoa, the Cook Islands, Fiji, Guam, Niue, French Polynesia, Palau, Wallis and Futuna, the Federated States of Micronesia and New Caledonia.

Moluccan albizia exhibits many characteristics that contribute to its invasiveness. It is among the fastest growing tree species, with a specimen from Malaysia featuring in the Guinness World Records for reaching a height of 10.74 m in 13 months. Moluccan albizia produces large amounts of long-lived, wind-dispersed seeds, can establish easily in disturbed areas, and can grow in a variety of soil types. In its invasive range, Moluccan albizia outcompetes native species, and can reach heights of 35-40 m, producing an expansive, umbrella-shaped canopy. It has been shown to alter terrestrial and aquatic ecosystems in Hawai'i by preventing the establishment of native flora in favour of exotic species, increasing decomposition rates and soil nutrient availability, modifying food webs in streams and increasing nitrogen in waterways.

Due to its fast growth rate, Moluccan albizia easily loses large branches with age, wind or heavy rain which constitutes a major hazard for infrastructure, waterways and humans. As a result, trees can cause severe damage during tropical storms and cyclones. For example, tropical storm Iselle which hit Hawai'i in 2014, brought down thousands of trees, stranding residents for days and costing millions of US$ in repairs. Further, the safe removal of a mature Moluccan albizia tree in Hawai'i was estimated to cost between US$2000 and $10,000, making control efforts extremely costly.

"Although Moluccan albizia is not yet seen as a threat to the environment and communities in many of the Pacific islands it invades, the severe impacts of this species in Hawai'i and Samoa are an indication of what might happen if control measures are not implemented," said Chantal Probst who led a feasibility study on biocontrol options for this invasive tree in the Pacific. "Climate change is also expected to exacerbate the ecosystem and socio-economic impacts of this weed. Therefore, exploring the feasibility of biocontrol was a high priority for our Pacific programme," she added.

In southern Asia, where Moluccan albizia is cultivated for timber, a high number of damaging arthropods and pathogens have been recorded from plantation trees. Further, Moluccan albizia is already a biocontrol target for Hawai'i. Surveys for natural enemies in Indonesia and Papua New Guinea were undertaken by the United States Department of Agriculture

Moluccan albizia invading in Rarotonga

Forest Service and the Hawai'i Invasive Species Council, with several arthropod species collected that attack the leaves, stems and roots of Moluccan albizia. A total of 70 arthropods from 34 families were included in the feasibility study. Two of these, a stem-boring weevil and a leaf-galling mite, which are potentially very damaging with narrow host ranges have been selected for further study. Both of these candidates still need to be formally identified and named by taxonomists.

A total of 64 fungal species were found to be associated with Moluccan albizia. Among the pathogens, the most promising is a gall-forming rust fungus (*Uromycladium falcatariae*). "This rust causes galls to develop on the leaves, petioles, pods, branches and stems of Moluccan albizia. The galls can girdle stems and shoots, preventing the flow of nutrients, defoliating trees, and eventually killing seedlings and even mature trees," explained Chantal. "The rust is clearly a damaging natural enemy of Moluccan albizia. Its infection of plantation trees in Indonesia and Malaysia sparked research into finding resistant varieties to minimise impacts on forestry production," she added. *Uromycladium* species are also known to be highly host specific, and two species have been used as biocontrol agents for other leguminous trees in South Africa.

"The next step is for Manaaki Whenua – Landcare Research to import the mite and the rust from Papua New Guinea for host range testing," said Chantal. Our colleagues in Hawai'i plan to import the stem-boring weevil from Indonesia for further study. We are working together now to seek solutions. "If these potential biocontrol agents look to have promise, there will be further dialogue with Pacific communities about the opportunity they present, and where they might be deployed in addition to Hawai'i," she added.

This feasibility study was undertaken as part of the Managing Invasive Species for Climate Change Adaptation in the Pacific (MISCCAP) programme, funded by the New Zealand Ministry of Foreign Affairs and Trade.

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The Old Man's Beard Mite Has Finally Landed

"Well, finally it has happened". These were the words of Craig Davey (Horizons Regional Council) after the first release of the old man's beard mite (*Aceria vitalbae*) took place in Rangitikei in the North Island in September. This is more than 10 years after the mite was first imported into containment in New Zealand, and, after numerous failed attempts at establishing a laboratory colony for host range testing.

The old man's beard mite is extremely difficult to rear under laboratory conditions, so host range testing was eventually conducted by acarologist, Dr Biljana Vidovic (University of Belgrade) in its native range of Serbia. Then, after receiving approval for release from the Environment Protection Authority (EPA) in October 2018, a starter colony of the mite was hand-delivered to Lincoln by Biljana in July 2019. Once in containment, the microscopic mites were individually collected on pinheads under a microscope and transferred onto fresh old man's beard plants, which were later moved to outdoor greenhouses after MPI approved the removal of the mites from containment. Eighteen months later, with improved mass-rearing techniques and much patience and perseverance, we were able to mass-produce enough mites for releases across the country this spring.

"Since the mites are microscopic, confirming their presence on old man's beard plants is not always easy,' explained entomology technician, Arnaud Cartier. "Buds need to be dissected under the microscope to view the mites, and the damage is not very obvious or is quickly hidden by new plant growth when they are at low densities," he added. Even though the old man's beard mite is closely related to the broom gall mite (*Aceria genistae*) which produces impressive galls, feeding by the old man's beard mites stunts the growth of stem and leaf buds, but doesn't induce obvious gall formation. Deformed, curled and atrophied leaflets are the first sign of feeding by the mites, and at high densities, plant growth is significantly reduced. Arnaud regularly dissects a random selection of plant material from the mass-rearing greenhouses to confirm the plants are well infested and that the mite population is increasing.

The old man's beard mite is the fourth biocontrol agent to be released against this very serious environmental weed, and it has not been released anywhere else in the world. The first two agents released, a leaf-mining fly (*Phytomiza vitalbae*) and a fungus (*Phoma clematidina*), have been unsuccessful, and the third agent, a sawfly (*Monophadnus spinolae*), has recently established at a new site in the Waipara District in the South Island. This was following a re-release in 2019 after its importation from Serbia, and this new population is now being closely monitored for growth and impact.

Aceria mites can be very damaging to their host plants and have the advantage of being able to disperse themselves over long distances by floating in the air, much like aerial plankton. Evidence of this was found close to home when a population of the mite was discovered on an experimental patch of old man's beard (*Clematis vitalba*) growing on our Lincoln campus, at least 100 m from the mass-rearing greenhouses. This self-established population provides an excellent opportunity to monitor the impact and spread of the mite. Even better, the finding confirms that once established in an area, no effort to intentionally spread the mites around will be required.

Following the first release of the old man's beard mite in Rangitikei, more releases were conducted by several regional councils in both the North and South Islands, totalling 14 releases altogether within a few weeks. The most recent, conducted by Environment Canterbury and Manaaki Whenua – Landcare Research (MWLR) staff in Timaru was an occasion to celebrate, and one that was 10 years coming.

This project was funded by the National Biocontrol Collective (NBC) and is now jointly funded by the NBC and the Ministry for Primary Industries' Sustainable Food and Fibre Futures (grant #20095).

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The old man's beard mite release site in Rangitikei

Summer Activities

Summer is a busy time for many biocontrol agents, so you might need to schedule the following activities.

Broom gall mites *(Aceria genistae)*

- Check for galls, which look like deformed lumps and range in size from 5 to 30 mm across. Very heavy galling, leading to the death of bushes, has been observed at some sites.
- Harvesting of galls is best undertaken from late spring to early summer, when predatory mites are less abundant. Aim to shift at least 50 galls to each site and tie them on to plants so the tiny mites can move across.

Giant reed gall wasp *(Tetramesa romana)*

- Check release sites for swellings on the stems caused by the gall wasps. These look like small corn cobs on large, vigorous stems, or like broadened, deformed shoot tips when side shoots are attacked. The galls often have small, circular exit holes made by emerging wasps.
- It will probably be too soon to consider harvesting and redistribution if you do see evidence of the gall wasp establishing.

Green thistle beetles *(Cassida rubiginosa)*

- December is often when green thistle beetle activity is at its peak. Look for adult beetles, which are 6–7.5 mm long and green, so they are well camouflaged. Both the adults and the larvae make windows in the leaves. Larvae have a protective covering of old moulted skins and excrement. You may also see brownish clusters of eggs on the undersides of leaves.
- If you find good numbers, use a garden leaf vacuum machine to shift at least 100 adults to new sites. Be careful to separate the beetles from other material collected, which may include pasture pests. Please let us know if you discover an outbreak of these beetles.

Honshu white admiral *(Limentitis glorifica)*

- Look for the adult butterflies from late spring. Look also for pale yellow eggs laid singly on the upper and lower surfaces of the leaves, and for the caterpillars. When small, the caterpillars are brown and found at the tips of leaves, where they construct pontoon-like extensions to the mid-rib. As they grow, the caterpillars turn green, with spiky, brown, horn-like protrusions.
- Unless you find lots of caterpillars, don't consider harvesting and redistribution activities. You will need to aim to shift at least 1,000 caterpillars to start new sites. The butterflies are strong fliers and are likely to disperse quite rapidly without any assistance.

Moth plant beetle *(Freudeita cupripennis)*

- We think this beetle has established in the Bay of Plenty and Waikato but it may still be at low densities due to a limited number of releases so far. Look for adult beetles on the foliage and stems of moth plant. The adults are about 10mm long with metallic orangey-red elytra (wings) and a black head, thorax and legs. The larvae feed on the roots of moth plant so you won't find them easily.
- It will probably be too soon to consider harvesting and redistribution if you do find the beetles.

Tradescantia yellow leaf spot *(Kordyana brasiliensis)*

- Look for the distinctive yellow spots on the upper surface of the leaves with corresponding white spots underneath, especially after wet, humid weather.
- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is necessary, again you will need permission from MPI to propagate and transport tradescantia plants. These plants can then be put out at sites where the fungus is present until they show signs of infection, and then planted out at new sites.

Tutsan beetle *(Chrysolina abchasica)*

- The best time to look for this agent is spring through to mid-summer. Look for leaves with notched edges or whole leaves that have been eaten away. The iridescent purple adults are around 10–15 mm in size, but they spend most of the day hiding away so the damage may be easier to spot. Look also for the creamy-coloured larvae, which are often on the undersides of the leaves. They turn bright green just before they pupate.
- It will be too soon to consider harvesting and redistribution if you do find the beetles.

Tutsan moth *(Lathronympha strigana)*

- Look for the small, orange adults flying about flowering tutsan plants. They have a similar look and corkscrew flight pattern to the gorse pod moth (*Cydia succedana*). Look also for fruits infested with the larvae.
- It will be too soon to consider harvesting and redistribution if you do find the moths.

National Assessment Protocol

For those taking part in the National Assessment Protocol, summer is the appropriate time to check for establishment and/or assess population damage levels for the species listed in the table below. You can find out more information about the protocol and instructions for each agent at: www.landcareresearch.co.nz/publications/books/biocontrol-of-weeds-book

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Target	When	Agents
Broom	Dec–April	Gall mite *(Aceria genistae)*
Privet	Feb–April	Lace bug *(Leptoypha hospita)*
Tradescantia	Nov–April	Leaf beetle *(Neolema ogloblini)* Stem beetle *(Lema basicostata)* Tip beetle *(Neolema abbreviata)*
	Anytime	Yellow leaf spot fungus *(Kordyana brasiliensis)*
Woolly nightshade	Feb–April	Lace bug *(Gargaphia decoris)*