Weed Biocontrol

WHAT'S NEW?

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Contents

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The new broom psyllid

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Plant Metabolomics and Weed Biocontrol

Agent establishment, effectiveness, and safety are the crucial elements for a successful weed biocontrol programme. Although well-established research protocols are used to predict agent impact on the target weed and the probability of non-target impacts, the effect of host plant biochemistry on agent success is often not considered.

The biochemical profile of plants determines their nutritional value and levels of plant secondary defences, and it can be altered by both abiotic (e.g. temperature, light, nutrient availability) and biotic (e.g. herbivory and plant pathogens) factors. These chemical compounds are well known to have significant effects on insect performance and population dynamics, both of which are key determinants of the establishment success and effectiveness of weed biocontrol agents. Hence an understanding of the biochemical phenotypes (observable characteristics) of invasive alien plants, and the biotic and abiotic factors that determine that particular phenotype, could provide valuable information to help decisions on the selection of biocontrol agents, and could even help improve establishment rates and agent impact.

In a recent publication, two of our weed biocontrol researchers, Simon Fowler and Ronny Groenteman, in collaboration with researchers at Massey University (Paul Barrett, who led the review, Andrea Clavijo-McCormick) and AgResearch (Arvind Subbaraj), review how plant metabolomics could be applied to weed biocontrol programmes to improve agent establishment, effectiveness and safety. According to Ronny, this paper explores how and why invasive alien plants are likely to exhibit altered biochemical phenotypes in their introduced range, and how the biochemical phenotype of plants exposed to variable environments with their complex and interacting biotic and abiotic influences might affect the performance of insect herbivores. The authors also identify a range of potential applications of plant metabolomics that could benefit weed biocontrol programmes. Here we provide a summary of the review paper, but first, what is *metabolomics?*

Plant metabolomics is the study of plant biochemistry at the molecular level, elucidating both known and unknown metabolites (intermediate or end products of metabolism) in biological samples. This technique uses analytical chemistry, bioinformatics and multivariate statistics to characterise the biochemical profile of a plant and identify biochemical phenotypes.

Plant metabolites play an important role in a plant's growth, development, and response to environmental conditions. They include a wide array of primary metabolites essential for growth and reproduction, and secondary metabolites essential for interactions and defence. Since abiotic and biotic influences can significantly alter the metabolic profiles of plants, it would not be unexpected for invasive plant species to exhibit altered metabolite profiles in their introduced ranges compared to their native range. This is potentially significant for weed biocontrol programmes, since alterations to plant chemical profiles (in terms of their nutritional value and their secondary chemical defences) can have a direct influence on insect survival and development.

Exactly how abiotic and biotic stressors influence the balance of secondary metabolite mixtures produced by plants remains largely unexplored. Subtle changes to a particular mix of plant metabolites could affect host plant selection and/or utilisation, either directly via deterrents or toxicity, or by changing the volatile compounds that trigger host finding or avoidance behaviour in insect herbivores. Hence, subtle changes to the chemical composition of a small number of compounds could affect the performance of a specialist insect or pathogen on a specific plant biochemical phenotype in its invaded range. Realistically, it would be difficult and costly to test individual abiotic and biotic factors, and all possible combinations, to predict the effects of altered chemical profiles of invasive plants on introduced biocontrol agents. Using an approach such as metabolomics is promising for determining the combined effects of biotic and abiotic factors on the resulting plant metabolic phenotype.

Potential applications of metabolomics in weed biocontrol

1. *Matching target plant metabolomes at agent collection and release sites*

There are many documented reasons why weed biocontrol agents fail to establish or are ineffective when they do, but it is not often considered that establishment failure could be due to changes to the biochemical phenotype of the invasive weed in its introduced range. Since abiotic and biotic fluctuations occur across and within geographical regions following seasonal patterns, changes in plant biochemistry could positively or negatively affect insect herbivore performance.

Being able to determine variation in the metabolomes of invasive plants in their native and introduced ranges would enable biocontrol practitioners to select collection and release sites where the target weed has similar metabolite profiles. This would reduce the need for agents to overcome any plant defensive or nutritional challenges, especially when they are vulnerable during the early stages of establishment.

2. *Determining the greatest plant defensive response to a single agent*

Predicting the performance and impact of a biocontrol agent in a new environment is often difficult. The authors suggest that metabolomic analysis to gain an understanding of plant response to a particular insect species or feeding guild could provide additional information for the agent selection process.

Plants elicit defences which can be specific to a particular species of herbivore or plant pathogen, or to a particular feeding guild, meaning essentially they produce an appropriate cocktail of compounds directed at the attacker or attackers," explained Ronny. "Under controlled conditions, we may expect a single attacking herbivore species to elicit a particular profile of chemical compounds, so by using metabolomics, we can measure this response both quantitatively and qualitatively. Taking this a step further, a large defensive metabolite response to a certain herbivore or guild may indicate a plant suffering significant stress which could help select candidate biocontrol agents with potential for the greatest impact on the target weed."

3. *Identifying supplementary or additional agents*

Insect herbivores and pathogens are applied as weed biocontrol agents individually or in combination, and often a suite of agents is released against one target weed. There is a small amount of evidence to suggest that in some plant–insect systems, the plant chemical response induced by one herbivore may facilitate the preference and/or performance of another herbivore. Alternatively, the induced plant response to one herbivore may reduce the preference and/or performance of another.

Studying these associations using metabolomics could help with matching agents that work well together. It could also help explain why a certain agent may be failing if a co-agent has not been introduced in tandem, or it can signal which agents should never be combined.

4. *Augmenting host range and specificity testing*

To determine whether potential weed biocontrol agents are safe for release, their host specificity is determined through rigorous testing of phylogenetically related plant taxa from the invaded range. In the case of specialised insects, the assumption is that the host range will be restricted to plant taxa with similar morphological and biochemical characteristics.

The identification of biochemical similarity of plant species through broad spectrum metabolite testing could augment host specificity testing protocols currently focused on phylogenetic relatedness. This could improve host range testing by including species that could be at risk due to similarity in their biochemical profile to the target weed, and which would otherwise have been overlooked because they are phylogenetically distant from the target weed. Also, this could be particularly valuable when phylogenetically related or other plants of interest are difficult to obtain, and metabolomics could be used as a proxy 'plant'.

In conclusion, although the field of metabolomics has yet to develop to an operational level, the potential for adding metabolomic analysis to the existing weed biocontrol toolkit could provide weed biocontrol projects with a suite of applications for greater effectiveness and safety. This would be multi-faceted, complex and even costly, however metabolomics is a powerful technology that could be at the core of beneficial collaborative research between biocontrol practitioners, plant biochemists and plant-insect ecologists.

Further reading: Barrett DP, Fowler S, Subbaraj AK, Groenteman R, Clavijo-McCormack A 2021. Metabolomic analysis of host plant biochemistry could improve the effectiveness and safety of classical weed biocontrol. Biological Control 160: 104663. https://doi.org/10.1016/j.biocontrol.2021.104663

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Science New Zealand Team Award in the Bag

MWLR is very proud to report that its weed biocontrol group was a recipient of a 2021 Science New Zealand Team Award. The Science New Zealand awards are held annually to recognise the contributions and achievements of scientists and teams across New Zealand. This year's awards celebrated 24 awardees across three award categories – Early Career Researcher, Individual/Lifetime Achievement, and Team.

"It's wonderful to see the acknowledgement of our hard work over several decades," said Team Leader Lynley Hayes. "But we didn't do it alone – one of the reasons that our group has managed to be so successful is due to the steadfast support we have received from many quarters over the years."

For two decades, regional and district councils and the Department of Conservation (DOC), operating as the National Biocontrol Collective, have pooled resources for weed biocontrol funding, undertaking collaborative decision-making about weed prioritisation and assisting with releases and monitoring of agents. In addition to these applied research programmes, fundamental, underpinning research is supported by the Ministry of Business, Innovation and Employment's Strategic Science Investment Fund. This research has resulted in significant knowledge breakthroughs in weed biocontrol science to make it even safer and more effective, and also more cost-effective.

This award acknowledges the weed biocontrol group's contributions to the sustainable management of invasive alien weeds in New Zealand. The group has conducted research facilitating the release of biocontrol agents to control serious intractable weeds across all regions of New Zealand, from native forests to farms throughout the North and South Islands. This research has benefited all sectors required to effectively and more sustainably manage invasive alien weeds, including government agencies such as regional councils and DOC, farmers and forestry operators, and community groups focused on saving local bush remnants.

Team Leader Lynley Hayes with the award

Over the past three decades the weed biocontrol group has gained permission to release 45 weed biocontrol agents against 22 target weeds, and has worked with an additional 19 agents approved for release against seven target weeds in the years before MWLR (and its predecessor) came into being. Some of these programmes have been highly successful, with substantial economic and environmental benefits. There has been a 40,000-hectare reduction in infestations of heather (*Calluna vulgaris*) in Tongariro National Park resulting from the introduction of the heather beetle (*Lochmaea suturalis*). Economic analyses show that the Net Present Value for biocontrol of St John's wort (*Hypericum perforatum*) is between $140 million and $1.49 billion over 70 years, with benefit-to-cost ratios of 10:1 and 100:1, respectively. The savings in control costs at the more conservative estimate of $140 million more than covers the costs of all weed biocontrol programmes in New Zealand to date. For ragwort (*Jacobaea vulgaris*), a major pasture weed, biocontrol is estimated to have saved the dairy industry approximately $44 million annually in herbicide costs alone, with a benefit-to-cost ratio of 14:1.

In classical weed biocontrol, international collaboration is a crucial aspect since natural enemies are sought from all over the world, from wherever the target weeds originate. The group has been fortunate to work with researchers in Argentina, Australia, Canada, China, Chile, Colombia, Ecuador, France, Hawai'i, India, Jamaica, Japan, Papua New Guinea, South Africa, Spain, Switzerland, the UK, the USA and Uruguay. They have also collaborated with researchers at AgResearch and Scion, and with five New Zealand universities.

From 2012 the MWLR weed biocontrol group has assisted developing countries in the Pacific with sustainable solutions for invasive weed management, with highly successful results already evident in the Cook Islands. In 2019 they were invited to become a founding partner of the Pacific Regional Invasive Species Management Support Service (PRISMSS). Better weed management in the Pacific will improve the well-being and livelihoods of people living in the Pacific by improving food security and human health, assisting with climate change adaptation, and protecting unique and threatened biosecurity.

Well done team and keep up the excellent work!

Current team members at MWLR: Alana Den Breeyen, Angela Bownes, Arnaud Cartier, Simon Fowler, Hugh Gourlay, Ronny Groenteman, Lynley Hayes, Richard Hill, Chris McGrannachan, Zane McGrath, Stephanie Morton, Quentin Paynter, Paul Peterson, Chantal Probst, Temo Talie, and Robyn White. Also acknowledged are former group members and others who have provided systematics, molecular, and other support.

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Broom Delivers a Psyllid Surprise

Until recently the only psyllid species attacking broom (*Cytisus scoparius*) in New Zealand was the broom psyllid (*Arytainilla spartiophila*), released as a classical biocontrol agent in 1993. However, in 2019 several individuals of a new psyllid (*Arytaina genistae*), which we're now calling the 'stripy broom psyllid', were caught on sticky traps near Christchurch by Jon Sullivan (Lincoln University).

Stripy broom psyllids have black striped forewings, while our usual broom psyllid has mostly clear wings. However, stripy broom psyllids can have weak wing markings, and adult body colour varies from black/brown to pale green. Likewise, the usual broom psyllid is normally pale brown, but can be pale green. Adult stripy broom psyllids are noticeably larger (3.5mm body) with wider heads, compared with the usual broom psyllids (3mm).

In spring 2021 we started some detective work on Jon's psyllid surprise. Our first question was simple: could we rediscover the stripy broom psyllid on broom near Christchurch? But first, the two broom psyllids need further introduction.

In the native range of broom in the UK these are the only two psyllid species commonly found attacking the plant. The species we call the broom psyllid was preferred for biocontrol of broom in New Zealand because it causes substantial stunting of broom plants and is host specific. The stripy broom psyllid is seldom found in sufficient numbers to damage broom in the UK, and can reproduce on other plant species that are closely related to broom, such as tagasaste (*Chamaecytisus palmensis*) and *Genista* spp.

During our spring 2021 surveys we easily rediscovered the stripy broom psyllid on broom close to where Jon had found it on sticky traps. Widening our search, we found the stripy broom psyllid was common over the Canterbury Plains and Banks Peninsula. If some of you readers further afield are interested in a bit of detective work, it would be great if you could check your local broom for a psyllid surprise. Just sharply tap broom over a beating tray and quickly check for psyllids. From about Christmas you can't be confused by finding the deliberately released broom psyllid, because this species only has one very early season generation: from mid-summer to the next spring the minute, dormant, first instar nymphs remain hidden inside broom shoots. So in the latter part of the growing season any adult psyllids on broom, especially if they have dark wing patterns, and *all* psyllid nymphs, are highly likely to be the stripy broom psyllid. Please send the insects in preservative, or good close-up photos, to Simon Fowler.

Now, on to the next obvious question: how did the stripy broom psyllid get to New Zealand? One possibility we are keen to rule out is an escape from our quarantine facilities at Lincoln, near Christchurch. Almost 10,000 broom psyllids, including many nymphs, were imported from the UK into containment at Lincoln during the 1990s. The nymphs of the two broom psyllids are similar, so some stripy broom psyllids may have inadvertently been imported with the broom psyllid nymphs. However, strict rearing and identification protocols determined that only adults of the broom psyllid were released. In the extremely unlikely event of the stripy broom psyllid somehow getting out of containment and establishing a field population in the 1990s, we are very sure that it would have been discovered during the many field surveys carried out since the psyllid was held in containment. Two surveys in the last decade were particularly exhaustive. From 2012 to 2017 we searched for psyllids on broom at many sites across New Zealand as part of our studies on the plant pathogen, *Candidatus* Liberibacter europaeus (Leu). In this nationwide survey no stripy broom psyllids were identified, by either visual or molecular techniques. In addition, no stripy broom psyllids were found between 2014 and 2017 by Francesco Martoni, an enthusiastic Lincoln University PhD student, when creating his checklist of New Zealand psyllids.

We also can't blame strong winds across the Tasman Sea for this psyllid invasion: the stripy broom psyllid is not known from Australia. We therefore think the most plausible explanation is that the stripy broom psyllid arrived as a stowaway on a boat or plane from either its native range in Europe, or its adventive range in the USA. Molecular investigation could sort out the source of our psyllids and reveal whether the stripy broom psyllid has acquired Leu in New Zealand, or brought its own *Liberibacter* spp. There are other unresolved questions relating to the host range and potential impact of the stripy broom psyllid on broom in New Zealand. So watch this space for part 2 of the story.

This project was funded by the Ministry of Business, Innovation and Employment as part of Manaaki Whenua – Landcare Research's Beating Weeds programme.

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Stripy broom psyllid adult and nymph Inset: broom psyllid

Mick Talbot

Environmental Weeds in the Spotlight

In late November last year the Parliamentary Commissioner for the Environment (PCE), Simon Upton, released a long-awaited report which reviews how well New Zealand is managing weeds that threaten native ecosystems. The PCE, appointed for a period of 5 years, is an officer of Parliament who investigates environmental concerns independently of the government. This report is the first time that environmental weeds have come into the parliamentary spotlight and received such a high level of attention. The report also attracted interest from the public, resulting in several days of intense media focus following its release.

Major contributors of information and data for the report included regional and district councils, the Department of Conservation (DOC) and the Ministry for Primary Industries (MPI). MWLR also played a major role, with one of our plant invasion ecologists, Angela Brandt, being seconded to the Commissioner's report team. The weed biocontrol group also had an opportunity to provide input.

The report is much longer than would be expected for documents of this type. This is perhaps quite fitting given how massive the issue of invasive weeds is. The report puts this into perspective in black and white: New Zealand is far more concerned about the environmental impacts of a handful of the worst naturalised mammalian predators than it is about the hundreds of invasive environmental weeds and the many, many more naturalised plant species that are already found in our native ecosystems. The Māori world view of 'what is a weed' gets a special focus in the report and provides a sound reminder of the subjective nature of declaring any plant a weed. The Māori world view also gives a special reminder of the upset to the balance of ecosystems by a weed rather than any inherent properties of the weed.

In providing a summary of the report, it's important to point out what the report does *not* do: it does not identify which invasive weed species should be prioritised for management, and it also doesn't evaluate the effectiveness, or other properties, of any weed management methods. What the report does is identify four key focus areas on how the current biosecurity system in New Zealand deals with weeds of native ecosystems, and recommends what a well-functioning system would do in each of these areas.

1. We don't really know what's out there. Although the report acknowledges there is plenty of information being collected, there are several key issues: the information is stored in multiple databases that do not connect; much of the information is either difficult to access or inaccessible; the taxonomy used in different databases is not standardised; and systematic surveillance of weeds is lacking. The report proposes a vision for what a good information system could look like, highlighting that the information must not only cover weeds that are already harming native ecosystems, but all exotic plants that have naturalised here. We cannot target weeds early on the invasion curve if we don't know they are becoming a problem. National priorities can save a lot of time and a lot of limited resources that are currently wasted on prioritising weeds regionally and deciding management options. Even with clear national priorities we would still need improved tools to support management actions on any scale, starting with a national weeds database that follows an agreed taxonomy, gets regularly updated, and is linked to spatial distribution information to guide decisions about emerging weeds. The report recommends that MPI work with other relevant ministries, regional councils and Crown research institutes to "develop, administer and maintain a single authoritative and publicly accessible database" for this purpose.

2. We don't have a good way to prioritise which weed species to manage in native ecosystems. The well-realised fact is that we are operating in a system that has limited resources, both financial and human, so we won't be able to manage all ecosystem weeds, let alone all naturalised species that have not yet become a serious problem. Trade-offs are inevitable, but are they transparent? The report asks what systems are used to guide decisions on where to mobilise scarce resources. Are we only looking at the current worst offenders, or do we try to manage future challenges early on? Do we have the evidence we need to make these decisions, and is the system for prioritisation flexible enough to adapt to new information? Do we know with sufficient clarity what the goal is in the long run? Are we allocating enough resources to be able to reach this end goal? Or are we setting ourselves up for failure? The report suggests that it is the role of the Minister for Biosecurity together with the Minister of Conservation to provide a clear direction on priorities. The report also recommends that the ministries and regional councils work with iwi and hapū and other relevant organisations to coordinate the management of new, emerging weeds of native ecosystems.

3. The regulatory framework we operate under is complex, to put it mildly. The Biosecurity Act 1993 spans pre-border, border, and far past the border, covering an enormous range of living organisms with vastly different biologies, invasion paths, risks and management options. The biosecurity system that results from this Act puts an enormous amount of focus – and rightly so – on how to prevent unwanted organisms from entering the country in the first place. But it has little to offer on where to direct attention when it comes to species that are already here, are well established, and are causing harm. In addition, the biosecurity system spans many vastly different agencies: central government, local government, industry and communities. It is not at all straightforward to understand how the variety of entities that deal with weeds of native ecosystems are intended to work together. And,

lest we forget, some weed control activities are governed by additional Acts, mainly the Resource Management Act 1991 and the Conservation Act 1987, so it is not always clear who is responsible for taking action. The stark fact that a national pest management plan and a national pathway management plan have never been prepared for a terrestrial exotic plant (harmful or otherwise) under the current regulatory system indicates that this group of organisms is not regarded as a high priority, certainly not as high as it ought to be. New Zealanders appear to be far more captivated by the harm caused by a small number of species of destructive mammalian predators than they are by the slow, encroaching, equally serious harm caused by weeds of native ecosystems.

4. New Zealand's biosecurity system lacks coordination, direction and clear leadership at a national scale on managing weeds of native ecosystems. More specifically, the report highlights that under the Biosecurity Act it is the role of MPI to provide overall leadership in this area, but that in practice MPI focuses on pre-border and border incursions, and relies on DOC, councils, landowners, and local communities to manage weeds and run surveillance programmes. The report acknowledges that this approach can work, at least to some extent, for weeds in the productive sector, where managing weeds makes economic sense. But an economic case is more difficult to make for weeds of native ecosystems, where public funding is required. Consequently, some weed problems grow far beyond the ability of regional authorities and local efforts, and by the time MPI steps into the role of national coordinator of the problem it is too costly and too late. Wilding conifers are the key example for this type of scenario, where MPI has taken the lead on coordination and is investing $100 million in controlling a problem that has been escalating for decades on a highly visible trajectory. We simply cannot afford for more weeds to reach this devastating stage. Other agencies, such as DOC and regional councils, are not at all well positioned to take national coordination roles on weeds of native ecosystems. Since the current legislation does not provide a clear framework for a nationwide approach to weeds of native ecosystems, the report proposes that a way forward could be for the Minister for Biosecurity and the Minister of Conservation to jointly provide direction. Furthermore, it proposes that MPI and DOC work closely with regional councils to develop a national policy direction on weeds of native ecosystems. It also recommends that iwi and hapū be engaged on a national policy direction. It may be that amending the Biosecurity Act would be the most efficient way to enable such national policy directions, not only for weeds of native ecosystems but also for other groups of pests.

The report also acknowledges that even with good national-level coordination and resourcing, a top-down, centralised approach is not going to be enough when it comes to weed management. The role of grassroots (or weed-roots, as the report calls them) initiatives is highlighted as an essential component for a successful way forward. National coordination will be hugely important for sharing the technologies and solutions these local groups come up with, widely sharing their unique local insights and long-term perspective, and securing their ongoing funding.

Front cover of the PCE report on weeds

Finally, the report reminds us that we must take a deep, long breath when we think about weeds of native ecosystems. Their management is here to stay, and we, as a country, must recognise this commitment. Of course adopting these recommendations by government requires resources to be associated with their implementation. But at least no government, now or in the future, can claim ignorance of the seriousness of the threat of weeds to native ecosystems.

The weed biocontrol group was fortunate to have an opportunity to engage with the Commissioner and his team while they were working on the report. Although biocontrol does not feature in the report, we feel we were able to showcase an excellent model for national coordination in the form of the National Biocontrol Collective, and spur hope that there is an effective option for managing environmental weeds.

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Autumn Activities

Gall-forming agents

- Check broom gall mite (*Aceria genistae*) sites for signs of galling. 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.
- Check hieracium sites, and if you find large numbers of stolons galled by the hieracium gall wasp (*Aulacidea subterminalis*) you could harvest mature galls and release them at new sites. Look, also, for the range of deformities caused by the hieracium gall midge (*Macrolabis pilosellae*), but note that this agent is best redistributed by moving whole plants in the spring.
- Check nodding and Scotch thistle sites for gall flies (*Urophora solstitialis* and *U. stylata*). Look for fluffy or odd-looking flowerheads that feel lumpy and hard when squeezed. Collect infested flowerheads and put them in an onion or wire-mesh bag. At new release sites hang the bags on fences, and over winter the galls will rot down, allowing adult flies to emerge in the spring.
- Check Californian thistle gall fly (*Urophora cardui*) release sites for swollen deformities on the plants. Once these galls have browned off they can be harvested and moved to new sites (where grazing animals will not be an issue), using the same technique as above.
- Look for swellings on giant reed (*Arundo donax*) stems caused by the giant reed gall wasps (*Tetramesa romana*). These look like small corn cobs on large, vigorous stems, or like broadened, deformed shoot tips when side shoots are attacked. Please let us know if you find any, since establishment is not yet confirmed.

Honshu white admiral (*Limenitis glorifica*)

- Look for the adult butterflies at release sites, 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 pier-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. The butterflies are strong fliers and are likely to disperse quite rapidly without any assistance.

Privet lace bug (*Leptoypha hospita*)

- Examine the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching.
- If large numbers are found, cut infested leaf material and put it in chilly bin or large paper rubbish bag, and tie or wedge this material into Chinese privet at new sites. Aim to shift at least 1,000 individuals to each new site.

Tradescantia leaf, stem and tip beetles (*Neolema ogloblini, Lema basicostata, N. abbreviata*)

- Look for the distinctive feeding damage and adults. For the leaf and tip beetles, look for the external-feeding larvae, which have a distinctive faecal shield on their backs.
- If you find them in good numbers, aim to collect and shift at least 100–200 beetles using a suction device or a small net. For stem beetles it might be easier to harvest infested material and wedge this into tradescantia at new sites (but make sure you have an exemption from MPI that allows you to do this).


Tradescantia yellow leaf spot fungus

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 needed in the future, 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 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. Please let us know if you find any, as establishment is not yet confirmed.
- It will be too soon to consider harvesting and redistribution if you do find the moths.

Woolly nightshade lace bug (*Gargaphia decoris*)

- Check release sites by examining the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching or black spotting around the margins.
- It is probably best to leave any harvesting until spring.

National Assessment Protocol

For those taking part in the National Assessment Protocol, autumn 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	Broom gall mite (*Aceria genistae*)
Lantana	March–May	Leaf rust (*Prospodium tuberculatum*) Blister rust (*Puccinia lantanae*)
Privet	Feb–April	Lace bug (*Leptoypha hospita*)
Tradescantia	Nov–April Anytime	Leaf beetle (*Neolema ogloblini*) Stem beetle (*Lema basicostata*) Tip beetle (*Neolema abbreviata*) Yellow leaf spot fungus (*Kordyana brasiliensis*)
Woolly nightshade	Feb–April	Lace bug (*Gargaphia decoris*)