

Undermining WEEDS

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Undermining Weeds is a programme of scientific research that sees three CRIs, AgResearch, Scion and Landcare Research, and Plant Protection Chemistry NZ Ltd (PPCnz) working in partnership to improve the management of weeds in the pastoral and forestry sectors. It is funded jointly by the Ministry of Science and Innovation, local authorities and a wide range of industry organisations from both sectors.

Progress update

- We have discovered that mowing Californian thistle (*Cirsium arvense*) during rainfall improves the level of control by 30% on average, and recommend this technique to pastoral farmers throughout NZ. See a video created by members of the Undermining Weeds science team. <http://www.agresearch.co.nz/our-science/biocontrol-biosecurity/weed-control/Pages/californian-thistle.aspx>
- The biocontrol agent *Cleopus japonicus* is causing widespread damage to the forest plantation weed *Buddleja davidii* in the central North Island. This agrees with predictions from our population dynamics model. Further research will provide foresters with guidance on where further releases of *C. japonicus* are likely to be most effective.
- Our work on process-driven models for spray droplet bounce, adhesion and shatter has gained international recognition as one of the most interesting analyses of the problem of spray retention and an extremely promising model. Further development of these models will make it possible to tailor spray formulations, as well as application technologies, to maximise retention to plant foliage and minimise loss to the environment.
- Our climate-based model of the potential distribution of Chilean needle grass across New Zealand's productive grasslands has been used to categorise this weed as a "Containment" species on the Canterbury Regional Council's Regional Pest Management Strategy. This classification provides the legal

basis for the CRC to take actions necessary to prevent the weed spreading from the 80ha of infested pasture at its only known site of occupation (in North Canterbury), to the 1.2 million ha that are climatically suitable throughout eastern Canterbury.

In the following pages we give more in-depth details of a further three projects undertaken within the programme under the general theme "integrated weed management".

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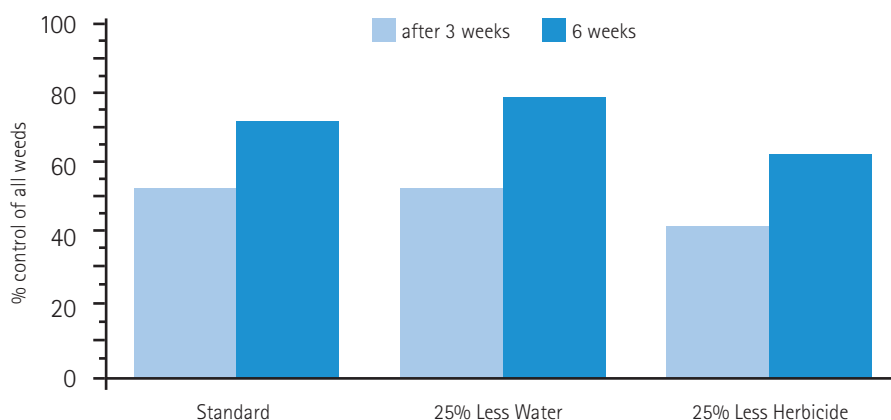
Aerial spray trial in a pine cutover in Kinleith Forest

Pre-plant forestry sprays

New Zealand has over 1.8 million ha in planted forests and without weed control plantation forestry is not commercially viable. The industry is totally dependent on the use of herbicides, but is under constant pressure to reduce the cost and use rates of these chemicals.

The use of specialised spray adjuvants, called organosilicone penetrants, in herbicide sprays to control woody weeds such as broom, gorse, blackberry, buddleja, bracken, etc. is routine practice in forestry. The mode of action of these unique adjuvants ensures that more herbicide spray lands on the weeds and penetrates through their protective plant cuticles, to kill them more efficiently. These adjuvants are now being exploited to reduce spray carrier volumes of herbicides which are applied aerially, to control forest weeds before tree planting. Flying time is the biggest cost in herbicide operations; halving the spray volume can save over 30% in spraying costs. Improving the effectiveness of herbicides in lower water volumes can additionally result in reduced amounts of herbicide required to control troublesome scrub weeds.

An operational trial was carried out on a pine cutover in Kinleith Forest managed by Hancock Forest Management Ltd. Scrub weed cover was vigorous (1-2m tall), predominantly broom, blackberry and annual weeds, with significant amounts of bracken, grasses and buddleja present. The trial confirmed that spray carrier



Control of forestry weeds with a standard glyphosate-metsulfuron spray mix, and applied in 25% less water or with 25% less herbicide using modified organosilicone adjuvant (osi) rates

(water) volumes can be reduced by 25% with no loss of herbicide efficacy if the organosilicone adjuvant is correctly prescribed, and that the low volume spray was noticeably more effective than the higher volume 'control' spray on blackberry and bracken (data not shown). Additionally, using 25% less herbicide, with a modified prescription of the adjuvant, controlled weeds similarly to the full (standard) herbicide rate. Further operational trials are currently underway to verify

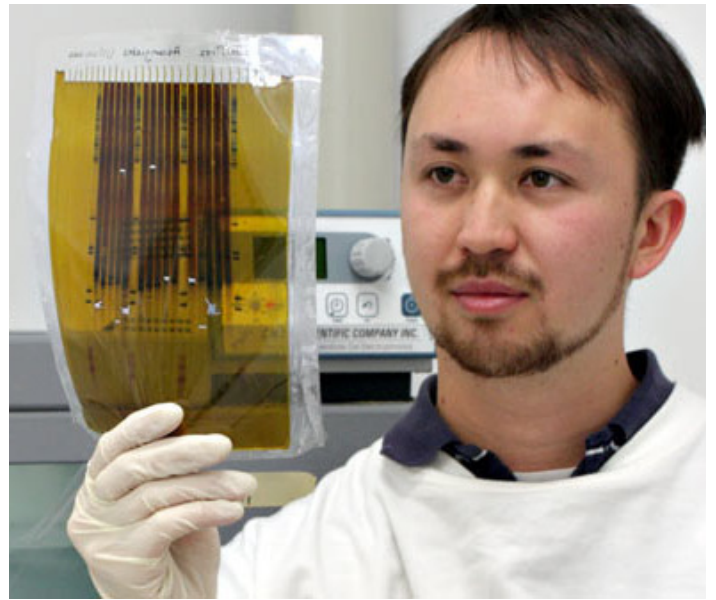
aerial prescriptions for reduced-volume herbicide sprays. Adjuvant technology is a valuable tool to maximise economic and environmental benefits of aerial herbicide sprays for the New Zealand forestry sector.

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Californian thistle seedlings, pre-treated with fungal endophytes, are inoculated with *Sclerotinia sclerotiorum*, a potential mycoherbicide for controlling this weed



Daniel Than (Landcare Research Scientist) analyses a DGGE gel

Endophytes & weed biocontrol

Many plant-pathogenic fungi have potential as bio-herbicides but their efficacy in field trials is often highly variable. We have found that other fungi, that live inside the weed Californian thistle (*Cirsium arvense*), can either promote or inhibit the activity of a bio-herbicide fungus being considered for use against this weed.

Fungal endophytes are symptomless microbes which live inside all plants. Some of these endophytes have been shown to be beneficial, increasing the host plant's environmental tolerances or increasing resistance to pests and diseases, including ones used as biocontrol agents.

With these ideas in mind we started investigating the endophytes present in Californian thistle regarding whether they could impact the effect of biocontrol agents. Over 60 fungal species were isolated using both culturing and molecular methods (a technique called DGGE).

The endophytes identified include a range of types from saprobes, which mostly live off dead material, to known pathogens of Californian thistle and other plants, such as grasses. One of the species detected is a rust mycoparasite (*Eudarluka caricis*). The presence of this sort of endophyte, which is a pathogen of rust fungi, could make it difficult for rust diseases to infect the plant. This is significant because rusts often make good biocontrol agents, and

it might explain the localised impact of the Californian thistle rust (*Puccinia punctiformis*) on this weed.

Having identified the endophytes in Californian thistle the next step was to work out whether they influence the activity of biocontrol agents proposed for this weed. Preliminary glasshouse trials were conducted to assess their influence on *Sclerotinia sclerotiorum*, which causes white soft rot disease in Californian thistle. In the field the fungus has an inconsistent effect on Californian thistle when applied as a mycoherbicide; some plants are killed completely, others recover, and some are not affected at all. Could an endophyte be responsible for this varying result?

Plants were inoculated with one of twenty endophytes. After this the plants were infected with the white soft rot fungus. Some endophytes had no influence on the disease, some enhanced the disease, and others, such as *Colletotrichum acutatum* reduced its intensity. *Colletotrichum* appeared to induce a resistance response

in Californian thistle, a bit like immunising it against disease. It is possible that this fungal endophyte, along with others, could be impacting the effectiveness of the *Sclerotinia sclerotiorum* biocontrol agent.

Those endophytes that promote biocontrol agent activity may potentially be used to improve the reliability of bio-herbicides.

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Mature yellow bristle grass in a dairy pasture

Yellow bristle grass

Yellow bristle grass (*Setaria pumila*) is a highly invasive weed of dairy pastures and is rapidly spreading. In late summer and autumn it can lower farm productivity due to lower feed quality and stock avoidance.

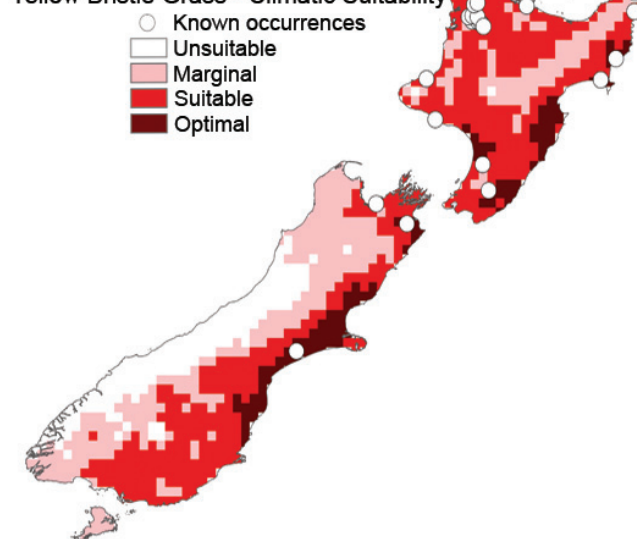
As a summer growing annual, yellow bristle grass reproduces entirely by seed. Seeds probably disperse with agricultural activities such as topping and production of maize silage and also via the dung of grazing animals. Yellow bristle grass usually occurs where the annual rainfall exceeds 500 mm although it can tolerate dry conditions once established. Typically seedlings emerge in late spring and summer when soil temperatures are 20-35°C and there is ample soil moisture. Seeds generally last in the soil for only 1-2 years before they either germinate or decay. Yellow bristle grass usually begins to set seed after Christmas and after this cows avoid grazing it. As it is frost tender it will not persist through the winter.

Yellow bristle grass was first observed as a serious weed of pasture on dairy farms in western Waikato but within ten years has spread throughout Waikato, South Auckland, Bay of Plenty and northern coastal Taranaki. Climate matching studies have shown that its potential distribution covers most of New Zealand.

It is important to identify the vectors of its spread and instigate management practices which will curtail or limit the movement of this weed before it moves to non-infested areas such as the southern North Island and the South Island.

Herbicides to control yellow bristle grass are under investigation but are only part of the solution. Managing pastures to minimise its ingress is also very important. New pastures can be established free of this weed by going through a two-summer cropping programme and not allowing yellow bristle grass to set seed over that period. Farmers should be vigilant in spotting this weed and small

Yellow Bristle Grass - Climatic Suitability



infestations removed immediately. Roadsides should be watched with care, as these appear to be primary incursion routes, and steps should be taken to control yellow bristle grass before it infests pastures. A booklet with more detailed information on identifying and managing yellow bristle grass is available from AgResearch.

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