Climate change and Biocontrol systems

Summary of the report: Possible impacts of climate change on Biocontrol systems in New Zealand (contract reference 0910-11689)

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What does the future hold for those protecting New Zealand's productive and environmental land-based sectors?

Why is biocontrol important?

Biocontrol (biological control) is a method of using natural enemies to control pests (including insects, mites, weeds and plant diseases) through predation, parasitism, herbivory or other natural mechanisms. Biocontrol affects all aspects of New Zealanders' lives, from what we produce in our own back yards and for export, to the natural environment around us.

All land-based sectors rely on biocontrol systems to:

- provide cheap, long-term, self-sustaining control of weeds and pests;
- minimize the use of pesticides in organic and Integrated Pest Management or Integrated Fruit Production systems; and
- provide control where other options are not physically or economically possible or pose unacceptable risks to the environment

Over 500 arthropod species have been introduced to New Zealand to supplement the native and self-introduced species already present. Some examples are illustrated below.

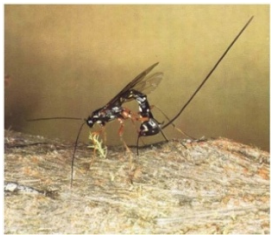
Pasture

Pest: clover root weevil.
Natural enemy: *Microctonus aethiopoides*

Horticulture

Pest: tomato fruitworm.
Natural enemy: *Cotesia kazak*

Forestry



Pest: Sirex. woodwasp
Natural enemy: *Rhyssa persuasoria*

Environment/ amenity

Pest: mist flower.
Natural enemy, White smut fungus

Future New Zealand

By 2090, New Zealand's climate is predicted to be around 2°C warmer on average than in 1990. Rainfall is expected to increase in the west and decline in the east, and extreme weather events, such as droughts, may be more common. These changes will affect what plants will grow best in a region and therefore the pattern of land use. Changing climate and land use will interact with fixed biological drivers such as day lengths and soil types to determine the future distributions and local abundance of pests, weeds and their biocontrol agents.

What is climate change likely to do?

Distribution

Most pests and their natural enemies will move with the host plants, with little change in biocontrol efficacy. However:

- Some growers cannot move (e.g. Maori landholders) and may face challenges maintaining production systems in a suboptimal climate.
- Biocontrol agents with low dispersal rates may need to be transferred manually into geographically isolated localities when weed and pest problems emerge.
- Without natural enemies, subtropical species already in the country or regular "door-knockers" could emerge as major weeds and pests in the northern North Island.
- Non-target impacts on native flora and fauna may occur if previously isolated species are brought together through shifts in distribution and life cycle timing

Species fitness and survival

Increased temperatures, CO_2 and changes in water availability are likely to affect the individual species in a biocontrol system differentially, changing rate of development and reproduction, and susceptibility to parasitism and diseases.

- Reduced fitness in weed or pest species may allow increased suppression by their biocontrol agents, but reduced fitness in a biocontrol agent may compromise pest suppression.
- Some natural enemy populations have relatively little genetic variation and thus little potential to adapt to future conditions.
- Increased frequency of extreme weather events such as droughts and floods may have disproportionate negative effects on natural enemies, which are generally more sensitive than their hosts are.
- New Zealand's fragmented landscape provides many micro-habitats that can act as refuges to conserve biocontrol systems operating in a region during extreme weather events.

Host: natural enemy synchrony

Climate change can have beneficial, neutral or harmful effects on the stability of a biocontrol system by:

- Altering synchrony between species within the system such as the time of emergence after winter, or flower availability for weed seed biocontrol agents.
- Increasing the number of generations per year of pests and/or their biocontrol agents.
- Allowing reproduction of pest species through winter.
- Having differential effects on species in systems where one has a day-length regulated life cycle.

Predictions for specific New Zealand case studies

1) Ragwort *(Jacobaea vulgaris*)

Increased rainfall will affect control of ragwort, by ragwort flea beetle, *Longitarsus jacobaeae,* by extending the areas where there is:

- poor control in inland western districts in both the North and South Island
- good control in Gisborne and Northland regions.

Ragwort flea beetle adult

2) Tomato fruitworm, *Helicoverpa armigera*

Natural enemies may be unable to control extra autumn generations of tomato fruitworm over much of the North Island, potentially limiting the viability of late-season corn and processing tomato crops.

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Tomato fruitworm larva

3) Woolly apple aphid, *Eriosoma lanigerum*

Woolly apple aphid may reach higher densities in early spring after its parasitoid has been inactive, but greater biocontrol may be possible over the summer and autumn. The overall effectiveness of the IPM programme is predicted to be maintained, but with increasing importance of an insecticide application in spring.

Woolly apple aphid parasitoid *Aphelinus mali*

4) Lucerne weevil *Sitona discoideus*

The current success of lucerne weevil control by Moroccan parasitoid *Microctonus aethiopoides* may be compromised as New Zealand's climate approaches that of South Australia, where the biocontrol agent currently fails to suppress the pest.

Lucerne weevil with parasitoid

5) Argentine stem weevil *Listronotus bonariensis*

Continuing biocontrol suppression of the Argentine stem weevil may rely on natural selection within local *Microctous hyperodae* populations as their spring emergence times shift.

Microctous hyperodae attacking Argentine stem weevil

Planning for the future

The gradual pace of climate change allows industry and land managers the time to implement strategies that will ensure biocontrol continues as a mainstream pest management tool in the productive and environmental sectors. These could include:

- The provision of habitats within the agricultural landscape to provide natural enemies with resources to promote fitness and refuges against extreme weather events.
- Pre-emptive action against “sleeper pests” already in New Zealand that are likely to become serious pests.
- Reviewing existing Integrated Pest Management/ Integrated Fruit Management systems to identify the areas at greatest risk in each system.
- Assessing the genetic variability within populations of key biocontrol agents. Where limitations may compromise the species’ ability to adapt, the potential of introductions of new genetic lines should be evaluated.
- Strengthening border biosecurity, pest surveillance in at risk localities, and the ability to respond rapidly as the risk of establishment of new pests increases.
- Using predictive models to suggest where biocontrol systems might fail or work best, and taking this into account when planning long-term plantings such as orchards, vineyards, forests and urban amenities.

For more information

For more information on climate change in New Zealand visit www.climatechange.govt.nz.

For general information for land-based sectors visit the Ministry of Agriculture and Forestry website at www.maf.govt.nz.

For a database containing information on the biocontrol agents that have been introduced to New Zealand to help manage weed and invertebrate pests visit www.b3nz.org/bcanz