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factsheet

Biological control of weeds: host testing

An adult leaf-feeding beetle on a mimosa leaf.
Photo: Tim Heard

Background

Australian scientists have been in the vanguard of weed biological control (biocontrol) since the success with prickly pears in the 1920s. Since then, the science and on-ground implementation of biocontrol has evolved enormously. However, there are still some critical issues that need to be addressed. One of these is the question of safety, ensuring that the biocontrol agent does not stray from its intended host weed. Host-testing is necessary to determine the potential range of plants (hosts) which will be attacked by the agent in the new country.

Issue

Biocontrol of this kind involves the deliberate introduction of a living organism into an environment where it has not previously occurred, with the intention that populations will establish permanently and irreversibly and become widespread in the new location. This decision requires a clear understanding of potential impacts on both target and non-target species in the new environment. This is not a trivial matter and proper safeguards are essential. In particular, potential adverse economic or environmental impacts must be greatly outweighed by the benefits.

Experimental investigations are undertaken in the field and laboratories overseas and in quarantine in Australia. Methods have changed since the 1920s but are always tailored to the particular agent and seek to understand the potential range of plants accepted by the agent after its release in the field.

Key principles

In Australia, the deliberate release of new biocontrol agents requires permits from the Australian Government quarantine and environment protection agencies. Their decision includes consideration of the results from host-testing. Testing methodology must be based on sound science and subjected to constant review against international best-practice.

Quarantine staff surrounded by cages and containers in which host specificity testing is being conducted.
Photo: Tim Heard

Guidelines

Plants to be tested: until the 1980s, testing concentrated on plants of economic importance such as crops, forestry and major ornamentals. Modern test lists now start with plants closely related to the target weed and generally extend out to the plant tribe, concentrating on plants which occur in the same climatic and ecological zone as the target weed.

Biology of the agent: different agents have different life-cycles and all aspects must be tested. Plant pathogens have spores which germinate on the plant surface and can penetrate and colonise plant tissue. Insects such as scales and mealybugs have crawlers which are blown or placed directly onto the plant surface and any development closely monitored.

For most insects, the adults actively select plants to lay their eggs, and larvae are then restricted to these plants. Test design must include an understanding of how the insects choose host plants, and how their behaviour may be changed by laboratory confinement. The suitability of plants as a food source to support normal development from egg to adult is also tested.

...case study

A leaf-feeding beetle on *Mimosa pigra*

Mimosa pigra is an introduced thorny shrub which forms dense thickets in water-courses and floodplains in northern Australia. It has been the focus of an intense biocontrol program since 1979. The beetle *Nesaecrepida infuscata*, from Central America, was one of four species recently tested. The long-lived adult beetles feed on the leaves and larvae feed mainly on roots. Research has shown that adults always accept a wider range of plants than do larvae, so testing had to be done on both the adult and larval host range. Hungry adults may accept previously rejected plants so this was also tested. Results showed this beetle to be completely safe and it has now been released in northern Australia. The other three leaf beetles were rejected as they were insufficiently specific.

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The leaf-feeding beetle larva feeds on a cotyledon.
Photo: Tim Heard

Staff at the CSIRO Mexican field Station conducting an open field trial to test the host specificity of a group of leaf-tying moth species being evaluated as potential biocontrol agents of *Mimosa pigra*.
Photo: Tim Heard

Test design: testing conditions range from small containers in a high-security quarantine laboratory to open field conditions in the country of origin.

Impacts recorded may be agent presence on the plant, feeding damage, number and fertility of eggs laid, visible disease symptoms, larval development, successful pupation and adult emergence. Tests may expose the agents to single plants or plant species, a range of plants together or in succession, or to choices with the normal plant host present or absent.

Enough individual insects must be tested to detect all possible variations. All insects, pathogens and plants used must be healthy and in an appropriate stage of maturity for the test. In all cases, quantitative measurements must be taken to permit statistical analysis and comparison of the acceptance of the different plants tested. The results must establish the full range of host acceptance or susceptibility and the limits on this.

Other considerations

Post establishment, host-testing results must be confirmed by adequate monitoring of field impacts, including any non-target impacts (see factsheet on *Biological control of weeds: impact evaluation*). If there is any discrepancy between predicted and actual host-range, further experiments will be conducted, which will help develop the science of biocontrol and increase the safety and acceptability of the process.

Any changes in procedures require agreement of all stakeholders involved in approving agent release.

Current Australian regulations

www.daff.gov.au/aqis/import/application/forms/biological-materials

Further information

Briese, D.T. (2005). Translating host-specificity test results into the real world: The need to harmonise the yin and yang of current testing procedures *Biological Control* **35**:208–214.

Sheppard, A.W., van Klinken R.D. and Heard, T.A. (2005). Scientific advances in the analysis of direct risks of weed biological control agents to non-target plants. *Biological Control* **35**:215–226.

Spafford Jacob, H. and Briese, D. (eds) (2003). *Improving the selection, testing and evaluation of weed biological control agents*. CRC for Australian Weed Management Technical Series no. 7.

For further information visit the following websites:

CRC for Australian Weed Management
www.weeds.crc.org.au
www.weedscrc.org.au (from 1 July 2008)

Weeds in Australia
www.weeds.gov.au

Australian Quarantine and Inspection Service
www.daffa.gov.au/aqis

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