Biological Control 101 (2016) 87–93

Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

# The influence of agent rearing success and release size on weed biocontrol programs in New Zealand

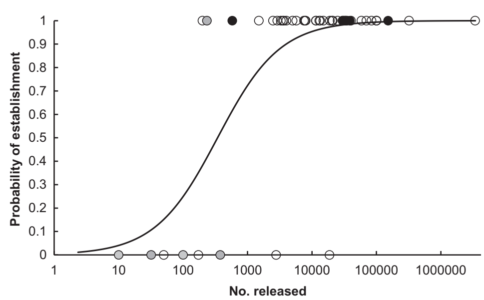
Quentin Paynter [a,*], Simon V. Fowler [b], Allan Hugh Gourlay [b], Paul G. Peterson [c], Lindsay A. Smith [b], Chris J. Winks [a]

[a] Landcare Research, Private Bag 92170, Auckland, New Zealand
[b] Landcare Research, P.O. Box 69040, Lincoln, New Zealand
[c] Landcare Research, Private Bag 11052, Palmerston North, New Zealand

## HIGHLIGHTS

- We studied agent rearing success in New Zealand weed biocontrol programs.
- Rearing problems constrain arthropod weed biocontrol agent establishment.
- We recommend some rearing solutions but some agents will always be hard to rear.
- Biocontrol success may be improved by enhancing direct field release techniques.
- Releases of *c.* 200 adult arthropod agents have a *c.* 80% chance of establishing.

## GRAPHICAL ABSTRACT




## ARTICLE INFO

*Article history:*
Received 17 February 2016
Revised 30 June 2016
Accepted 1 July 2016
Available online 2 July 2016

*Keywords:*
Host-range testing
Specificity
Mass-rearing
Biocontrol agent establishment

## ABSTRACT

We investigated the influence of biological control agent rearing success on weed biocontrol programs in New Zealand. Difficulties have been experienced in rearing approximately one third of all arthropod species imported into New Zealand containment as candidate weed biocontrol agents, and 16% of species could not be reared at all. Rearing success did not prevent agents from being approved for release because host-range testing of difficult to rear species was often completed in the native range using field-collected material. In the past, agents that could not be easily reared were directly released using field-collected material, often in large numbers. Since 1984, this approach has become harder due to the regulatory requirement for agents to be screened for the presence of pathogenic organisms, and so direct releases have been limited to very small numbers (<400 individuals). Agent establishment success was correlated to the numbers released. We conclude that the success rate of weed biocontrol could be improved by improving rearing success, or taking steps to enhance the success rate of small direct field releases.

© 2016 Elsevier Inc. All rights reserved.

**Contents**



* Corresponding author.
*E-mail address:* PaynterQ@LandcareResearch.co.nz (Q. Paynter).

http://dx.doi.org/10.1016/j.biocontrol.2016.07.001
1049-9644/© 2016 Elsevier Inc. All rights reserved.

## 1. Introduction

Arthropod weed biocontrol agents can be extremely difficult to rear in captivity. Establishment success of biocontrol agents is related to the number of propagules released and the number of releases made (Grevstad, 1999; Memmott et al., 2005, 1998). Low rearing success may therefore result in potentially effective agents either not being released, or being released in such small numbers that they fail to establish. Such failures are costly because developing each novel weed biocontrol agent requires investing several hundred thousand New Zealand (NZ) dollars (Harris, 1973; McFadyen, 1998; Paynter et al., 2015). Moreover, if a target weed is not controlled adequately due to the failure of an agent to establish, then losses in production and/or biodiversity values will continue to accrue.

We, therefore, investigated whether rearing success is likely to have influenced the establishment of weed biocontrol agents in NZ and, if so, whether we could identify factors that influence rearing success in NZ weed biocontrol programs so steps could be taken to improve the success rate of future biocontrol programs.

## 2. Materials and methods

We compiled a list of all candidate arthropod weed biocontrol agents that have been imported into containment in NZ up to June 2015 and noted whether they were successfully reared. "Broad rearing success" was defined as successful if reproduction occurred in containment and some of the resulting offspring were reared through to adults. As this was a relatively crude measure a second measure of rearing success ("narrow rearing success") was also used, where we also noted which species were so difficult to rear that this resulted in major constraints on the ability to conduct host-range testing, or on the numbers that could be reared and eventually released following host-range testing. Arthropod order and feeding guild were recorded to investigate whether these factors influenced rearing success. The potential influence of disease on rearing success could also be investigated for many of the agents. This is because since 1984 a requirement for permission to release agents from containment has been to test agent cultures for the presence of pathogenic organisms using light microscopy techniques similar to those described by Becnel (1997), to guard against the release of diseased organisms. Where species could not be successfully reared, the reasons (or suspected reasons) for failure were noted.

For species approved for release in NZ, the numbers of individuals released during the initial attempts to establish the agent (i.e. individuals that were either mass-reared in captivity and released, or imported and released directly into the field, excluding subsequent releases of individuals that were field-collected in NZ for redistribution) were compiled from published records or the Landcare Research release database.

### 2.1. Analysis

All analyses were performed using the R statistical program (R Foundation for Statistical Computing; Vienna, Austria), specifying generalized linear models, binomial errors and a logit link.

For the analysis of rearing success, the explanatory variables selected for inclusion in the models were: "guild" (the larval feeding guild of the candidate biocontrol agent; defoliator, gall-former/leaf-curler, miner/stem borer, root or rosette-feeder, flower or seed-feeder, sap sucker); "taxon" (the arthropod order to which the candidate agent belongs); and "novelty" (whether the agent had already been reared by overseas researchers; i.e. novel or repeat). Two analyses were performed where: (1) "Broad rearing success" was treated as a binomial variable and given a value of 1 if reproduction occurred in containment and some of the resulting offspring could be reared to adult and given a value of zero if no offspring were reared; and (2) "Narrow rearing success" used a stricter measure of rearing success, which also scored zero if offspring could not be reared reliably, or only in low numbers, or not at all.

Similar analyses were performed on a smaller subset of data for agents that had been tested for the presence of disease. In this analysis "disease" was included as an explanatory variable (where presence of disease was either "detected" or "not detected").

For each analysis the package MuMIn was used to select the best model, using the corrected Akaike information criterion (AICc) (Bartoń, 2015).

To test whether rearing success influenced agent establishment, a logistic regression was performed where "establishment" was treated as a binomial variable and given a value of 1, if an agent established in NZ, and given a value of zero if an agent failed to establish, and all elements of the denominator array were set to 1. The independent variable was the number ($\log_e$ transformed) of individuals of each agent that were initially released (see above). As of June 2015, 52 arthropod weed biocontrol agent species had been released into the field in NZ, of which one species (*Berberidicola exaratus* (Blanchard) was excluded from analysis because it was released too recently to determine whether the releases have resulted in establishment (defined here as persistence for at least two generations and one winter after the last release was made at a release site). Agents were considered to have failed to establish if there was no evidence of establishment at any of the release sites and 5 or more years had passed since the last release had been made. These definitions were chosen because it is often obvious when an agent has successfully established, as subsequent generations can be easily detected. By contrast, if subsequent generations of an agent are not detected following release, there can be uncertainty regarding whether it failed to establish or if numbers are low, making detection difficult. We assumed that an established agent should be likely to be detected within five years of release.

The goal of the release programs is to establish an agent at multiple sites over a wide area, so many species were undoubtedly

Download English Version:

https://daneshyari.com/en/article/4503608

Download Persian Version:

https://daneshyari.com/article/4503608

Daneshyari.com