

Pre-release studies: synthesis of session 3

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Abstract. During the past 30 years, efforts have been made to broaden the scientific base of biological weed control, particularly of inoculative control, to increase the predictability of its results, i.e. its success rate and effectiveness. The main emphasis has been on pre-release studies aiming at increasing the rate of establishment of selected biological control agents and improving their regulating impact on target-weed populations. The nature and extent of these pre-release studies in the context of resultant improvements in the rate of establishment and the impact of established control agents, are still a matter of discussion. This synthesis provides an overview of the pre-release studies proposed and practiced, their scientific basis, and as far as documented, the contribution of pre-release studies to the improvement of the success rate of biological weed control programmes.

Introduction

Pre-release studies address two main fields of research: investigations in the target area; and investigations in the native area of distribution of the target weed. The demand is that investigations in the target area precede those in the native range of the target weed.

Investigations in the target area

According to demands, investigations in the target area should provide information on:

- The identity of the target weed (genotypic compositions, i.e. subspecies, hybrids, genetic variability), and the existence of different life-histories and phenotypes as compared to the native area.
- The geographic distribution and habitat spectrum of the target weed (successional status, plant association, topography, soil/water type, climatic conditions, and management type in the case of crop weeds).
- The actual and potential distribution and abundance of the weed, its competitive properties, economic losses and, or, impact on local biodiversity, the reasons for its superabundance, alternative control measures, and their effects and costs.

- The population ecology of the weed to determine transitions in the life-cycle to which equilibrium density is most sensitive (for the targeted phenostage).
- The origin of the weed, and its history of introduction, if invasive.
- Surveys of herbivores and pathogens associated with the weed (assess vacant niches) and their predators, parasitoids and hyper-parasitoids.
- Potential conflicts of interest.

Although these demands are considered justified for a more systematic and scientifically-based search for potential control agents, surveys in the native range of the target weed are often undertaken without much information from the target area. Lack of scientific personnel and the reluctance of project sponsors to provide adequate funding for pre-release studies in the target area are the main factors inhibiting this research.

Investigations in the area of origin

Proposals for investigative research in the area of origin of the target weeds cover four main topics: plant studies; agent studies during field surveys; parameters for selecting agents for more detailed study; and the experimental investigations of these agents. According to the literature reviewed the following aspects are considered important:

Plant studies

- The taxonomy of the target weed within its native area of distribution (genotype composition, i.e. subspecies, hybrids, genetic variability).
- Plant physiology of the target weed, e.g. spatial and temporal content of nitrogen and secondary plant substances, stress periods, and compensatory mechanisms.
- The geographic distribution and habitat spectrum (successional status, topography, soil type, water type, climatic conditions).
- A comparison of the populations in the native distribution with that in the target area (morphology, phenology, demography, genetics).
- The population ecology of the target plant to determine transitions in the life-cycle to which equilibrium density is most sensitive (targeted phenotype).
- The phytophagous arthropods and pathogens associated with the target plant and the damage they inflict.

Agent studies during field surveys

- The taxonomy of potential agent species and related taxa (genotypic composition, i.e. subspecies, hybrids, *formae specialis* of pathogens, genetic and phenotypic variability in relation to fitness).
- The life-history of the potential agents (spatial and temporal distribution of the developmental stages, life-cycle, special adaptations to the host plant).
- The agent demography (abundance and constancy, comparative fitness of cogenetic species or biotypes, comparative life-tables, mortality factors).
- The geographic distribution, habitat and climatic requirements (niche width of the agents).
- The plant parts and phenostages attacked, and the degree of association of the agents and their synchronization with the host plant (information from the literature and from taxonomists).
- The competitive status of the agents (interspecific association, density compensation in the absence of 'competitors').
- Refuge areas (hibernation, aestivation sites, survival strategies for pathogens).

Parameters for selecting agents for further studies

- Exclude recorded pests and species that are known to be polyphagous, but consider the existence of

pathotypes (*formae specialis*) in the case of plurivorous pathogens.

- Preference should be given to: (i) species with low *per-capita* feeding rates and high rates of intrinsic increase; (ii) species that have a good climatic and habitat match compared with that in the target area; (iii) oligophagous species over those that are strictly monophagous, except for those destined for targets that have close taxonomic relationships to crops, ornamentals and endangered native plants; (iv) species causing serious damage (in relation to plant type), and those that respond to the nutritional status of the host plant; (v) species attacking a 'critical phenostage' of the host plant; and (vi) abundant and widely distributed species.

Experimental investigations of the agents

- Check for acceptance (adult feeding and, or, oviposition in the case of arthropods, and infection, penetration and disease development in the case of pathogens) and suitability of the plants from target population(s) for completion of the life-cycle of the agent species.
- Conduct more detailed studies of the life-history and ecology of the agents (design appropriate host-range screening tests).
- Determine the experimental host-range and degree of host-specificity of the agents (McClay this Volume).
- Conduct experiments to explain the underlying mechanisms for host acceptance and suitability.
- Subject host-specific agents to impact studies (e.g. agent release/agent exclosure) to estimate their potential effects after field release.

Conclusions

The list of proposed pre-release studies is long. Although all, or most, of the proposed investigations may be useful in making the outcome of biological weed control projects more predictive and in helping to increase their success rate, biocontrol scientists would seem well advised to refrain from being dogmatic, but should consider every target weed situation individually. The expectation seems to be that more detailed pre-release studies will generally improve the rate of establishment and the success rate in biological weed control, but this still needs to be demonstrated. Moreover, the choice of which of the proposed pre-release studies are indispensable and 'productive' in a

given situation, needs intelligent judgement and further critical evaluation. Thorough, post-release studies that test the value of the predictions deriving from the pre-release studies are considered of overriding importance for further improvement of biological weed control methodology.

There are indications that, because of persistent financial constraints, there will be very few cases where biocontrol scientists will be able to carry out the whole range of, apparently, desirable pre-release

studies. It is, therefore, suggested that certain of the pre-release studies should be carried out in collaboration with colleagues in universities, research stations and museums.

(An expanded version of this review article will be published in *Biocontrol News and Information* Vol. 17, No. 4, 1996).