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An insect-plant pathogen interaction between two biocontrol agents, the stem-gall fly and leaf-spot pathogen released against crofton weed, ageratina adenophora

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Abstract

Classical biological control (biocontrol) of invasive plants involves the deliberate introduction of biocontrol agents, termed natural enemies, such as insects, mites and pathogens, from the country of origin into the invaded country to control an invasive alien plant (weed) infestation. This thesis evaluates the biocontrol of crofton weed, *Ageratina adenophora*, in South Africa, with a stem gall fly, *Procecidochares utilis*, and a leaf-spot pathogen, *Passalora ageratinae*. The issues of multiple biocontrol agents, pathogen-insect interactions, the assessment of agent efficacy and post-release evaluations in biocontrol are addressed using crofton weed biocontrol as a case study.

Laboratory trials showed an additive interaction between the fly and pathogen on crofton weed control. The fly inhibited vertical stem growth, with the gall acting as a nutrient sink, but crofton weed compensated with increased sideshoot growth. The pathogen inhibited sideshoot (vegetative reproduction) growth. Field trials showed an equivalent interaction between the two biocontrol agents. The pathogen inhibited sideshoot growth, however the fly did not inhibit stem height but the galled stems had less biomass allocated to bare stems, than sideshoots or live leaves, indicating weakened stems. Growth of crofton weed stems was slower in the field than the laboratory, therefore the effect of the biocontrol agents on the vegetative growth of crofton weed may be different in the laboratory, or field trials may need to run for a longer period to see an effect of the biocontrol agents. The fly reduced the reproductive output of crofton weed by 53.8% in both the laboratory and field, and the pathogen reduced the reproductive output by 26.7%. There was an equivalent effect with the agents in combination.

The fly and pathogen together have an equivalent effect on crofton weed ecophysiology, with the pathogen being the predominant agent. The pathogen reduced the transpiration, stomatal conductance and photosynthetic rate, as well as the functioning of Photosystem II of crofton

weed leaves. These ecophysiological results show that crofton weed compensated for infection by investing resources into vertical growth with healthy new leaves, thereby leaving fewer resources for sideshoot growth.

Three crofton weed infestations were surveyed at Barberton (pathogen present), Magaliesberg (pathogen present) and Pietermaritzburg (pathogen and fly present). The Barberton site was located under a pine forest canopy, with 30-50 stems/m^2 ranging in height from 100-1200mm. The Magaliesberg site, along a stream bank, had 20-50 stems/m^2 with stems of 100-2200mm in height, even after manual clearing. Stems at Pietermaritzburg, along a roadside, were 100-2000mm high and stem density was 80 stems/m^2. The pathogen infected up to 95% of stems, but only infected 1-30% of leaves per stem. Fly prevalence was low, 20% of stems were galled, and repeated galling of stems was rare. Parasitism was expected to explain the low fly population, however only 30% of galls were parasitised. The fly did however reduce the reproductive output of crofton weed stems. These post-release evaluations highlight the necessity to define success and collect pre-release data in biocontrol programmes prior to agent releases.

Surveys for new biocontrol agents for crofton weed have been undertaken. The selection of the new agent will need to consider the interaction with the fly and pathogen. In addition, based on this study, the new agent will need to inflict damage which will minimise compensatory growth in crofton weed.

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Keywords: Crofton weed, *Procecidochares utilis*, *Passalora ageratinae*, multiple biocontrol agents, insect-pathogen interactions, post-release evaluations