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Feasibility of Biological Control of the Hawkweeds Hieracium Pilosella and H. Patagonicum with the Cecidomyiid Macrolabis Pilosellae in the XII Region of Chile

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Abstract

Two studies were conducted in the SAG (Servicio Agrícola y Ganadero) quarantine facilities in Lo Aguirre, Santiago, Chile, to evaluate the effect of the cecidomyiid dipteran *Macrolabis pilosellae* Binnie during 3 and 4 cycles of the insect, on growth of stolons, above ground parts, production of flowers, and fresh and dry weight of *Hieracium patagonicum* Hook plants, a native weed, and *H. pilosella* L., a species originary from Eurasia. Both have invaded cattle lands in the Magallanes region in far south Chile. The infestation of *Hieracium* spp. causes a loss of production in national reserves and parks, represents a threat to native flora, and decreases plant conservation in agriculture areas. The insect produced galls only on *H. pilosella* and not on *H. patagonicum*, but did not affect significantly the growth, biomass, and production of flower stems of *H. patagonicum* in the laboratory. The great affinity of *M. pillosellae* for *H. pilosella* indicates that biological control of this with through releases of the dipteran would be feasible.

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Introduction

The *Hieracium* genus is a large group of herb species of the Northern hemiesphere belonging to the Asteraceae family. In Chile, *Hieracium* is represented by seven species, of which three are exotic, and four are native from South America (Correa, 1971)

A research study was conducted with the objective of evaluating the possible damage caused by the cecidomyiid dipteran *Macrolabis pilosellae* Binnie on *Hieracium pilosella* L. (Figure 1, left) and *H. patagonicum* Hook in a laboratory under quarantine conditions to verify the affinity of the insect for both weeds. *Macrolabis pilosellae* is an insect native of central Europe (Switzerland), with antennae and legs relatively large, with gregarious larvae that live on plants of *Hieracium* where they form galls. The adults are diminute orange flies with a small head and no mandibles (Borror *et al.*, 1989) (Figure 1, right).

Figure 1. *Hieracium pilosella*, a hawkweed causing damage to cattle prairies in the Magallanes region in austral Chile (left), and adult of *Macrolabis pilosellae* (right).

The larvae (Figure 2) produce galls on the crowns, stolons, and leaf basis of the main leaves (Grosskopf, 2006) of plants of *Hieracium*, particularly *H. pilosella* (Grosskopf *et al.*, 2007). An important difference between these two weeds is that *H. pilosella* grows stolons during its cycle in the field, but *H. patagonicum* does no produce them. The extensive presence of *Hieracium* spp. in prairies of the XII Region in Chile constitutes a problem because of its invasive conduct, because a tradicional control with herbicides is not probable because of its high cost and negative environmental consequences due to difficult to handle water contamination. These weeds displace other plants of the prairie, which translates in to a lower production of forage for the cattle, and may even eliminate the resident vegetation cover as they grow a closed mantle of low leaves which render the prairie with no value for cattle feeding (SAG, 2001). According to Salinas (2002), the cattle capacity of a farm invaded by *Hieracium* spp. may decrease up to 80%.

Figure 2. Larvae (left column), larval exuviae (upper right), and pupa (lower right) of *M. pilosellae* (lower pictures are from Grosskopf, 2006).

Material and methods

This study was conducted in the Weed Taxonomy Laboratory, Department of Laboratories and Quarantine Stations of the Agriculture and Cattle Service (Servicio Agrícola y Ganadero, SAG) in Lo Aguirre, Pudahuel Commune, Metropolitan Region, Santiago, Chile.

For both species of *Hieracium*, the experiment units consisted of four pots with plants per insect cycle, on a 1:1:1 mixture of decomposed dry leaves soil, sand, and peat. For *H. pilosella*, on each cycle two plants of similar size were infested with three couples of *M. pilosellae* adults obtained from laboratory rearing. For *H. patagonicum*, two healthy plants were set on pots covered with a fine cloth, together with a galled *H. pilosella* plant. Four pots per cycle were set in both bioassays, with two control plants without insects, under the same temperature and humidity conditions of the plants subjected to infestation. To evaluate the damage four visual parameters were used, the number of leaves, development of galls and stolons, and production of flower stems. Also, the

development of plant biomass was measured through the accumulation of fresh and dry weight, during three cycles of the insect (each generation is completed in 35 d at 15ºC-18°C (Grosskopf, 2006). *H. pilosella* was studied during four cycles (140 d) and *H. patagonicum* during three cycles (105 d).
The multiplication of *M. pilosellae* began in 2006 with a breeding stock of plants with galls from New Zealand, in the quarantine facilities of SAG in Lo Aguirre, Santiago, Chile. The insect reproduced and was maintained under rearing cloth cupules in a greenhouse with light temperature of 16 light hours at 18-20ºC and 8 dark hours at 15ºC. The plants of *H. patagonicum* and *H. pilosella* were grown from material brought from Punta Arenas, Chile, by germinating seeds on filter paper humidified with 2.5 mL of gibberellic acid at 100 ppm in a Petri dish at 18-20ºC. Plants were also obtained by vegetative reproduction, and were renewed periodically with new material brought from Punta Arenas. In both bioassays, the data of the number of galls, and fresh and dry weight of the aerial portion at the end of each generation were subjected to anovas, and Tuckey test ($p \leq 0.05$) for *H. pilosella*.

Results and discussion

Not any plant produced flower stems. The data obtained from counting galls and measuring fresh and dry weight are presented in Table 1, were no significant differences appear between treatments…

Table 1. Development of fresh and dry weight (g ± SD) of *H. pilosella* and *H. patagonicum* plants during 3-4 cycles of *M. pilosellae*.

Cycles	**Fresh weight (g)**	**Dry weight (g)**	**Fresh weight (g)**	**Dry weight (g)**
	H. patagonicum		***H. pilosella***	
	Infested plants			
C0	9.5 ± 0.8 a	1,6 ± 0,1 a	----	------
C1	11.1 ± 1.8 a	1,3 ± 0,1 a	14,4 ± 3,4 a	1,8 ± 0,4 a
C2	11.4 ± 4.3 a	1,7 ± 0,8 a	8,2 ± 3,7 a	4,6 ± 0,2 a
C3	13.6 ± 3.9 a	3,1 ± 0,8 a	2,8 ± 1,0 a	1,4 ± 1,0 a
C4	----	------	10,6 ± 2,2 a	3,9 ± 0,5 a
	Uninfested control plants			
C0	9.4 ± 1.1 a	1.5 ± 0.2 a	5.1 ± 1.7 a	0.6 ±1.9 a
C1	9.5 ± 2.3 a	1.0 ± 0.3 a	3.4 ± 2.0 a	0.4 ± 0.5 a
C2	10.5 ± 3.0 a	1.1 ± 0.5 a	7.3 ± 8.8 a	3.3 ± 2.4 a
C3	9.3 ± 6.0 a	3.0 ± 1.5 a	8.8 ± 1.9 a	3.6 ± 1.1 a
C4	----	------	6.4 ± 2.8 a	3.8 ± 0.8 a

The same letter in a column indicates absence of significant differences, according to Tuckey tests ($p \leq 0.05$).

Nueva Tabla 1:

Cycles	Number of galls	Fresh weight (g)	Dry weight (g)	Number of galls	Fresh weight (g)	Dry weight (g)
	H. patagonicum			***H. pilosella***		
	Infested plants					
C0	0 a	9.5 ± 0.8 a	1,6 ± 0,1 a	----	----	------
C1	0 a	11.1 ± 1.8 a	1,3 ± 0,1 a		± 3,4 a	1,8 ± 0,4 a
C2	0 a	11.4 ± 4.3 a	1,7 ± 0,8 a		± 3,7 a	4,6 ± 0,2 a
C3	0 a	13.6 ± 3.9 a	3,1 ± 0,8 a		± 1,0 a	1,4 ± 1,0 a
C4	----	----	------		± 2,2 a	3,9 ± 0,5 a
	Uninfested plants					
C0	0 a	9.4 ± 1.1 a	1.5 ± 0.2 a		5.1 ± 1.7 a	0.6 ±1.9 a
C1	0 a	9.5 ± 2.3 a	1.0 ± 0.3 a		3.4 ± 2.0 a	0.4 ± 0.5 a
C2	0 a	10.5 ± 3.0 a	1.1 ± 0.5 a		7.3 ± 8.8 a	3.3 ± 2.4 a
C3	0 a	9.3 ± 6.0 a	3.0 ± 1.5 a		8.8 ± 1.9 a	3.6 ± 1.1 a
C4	----	----	------		6.4 ± 2.8 a	3.8 ± 0.8 a

Necesito las letras de significación estadística del número de agallas en *H. pilosella*. Y si son promedios, ¿no deberían tener algún decimal? Revisar

The results obtained, together with those of Villalón (2009) of the la extreme filogenetic specificity of the control agent, which affected only *H. pilosella* but not other species of *Hieracium*, including herein *H. patagonicum*, indicate that the release of the insect is feasible for the biological control of *H. pilosella* in the Magallanes region. The results of the host specificity by Villalón (2009) are presented in Figure 3.

In New Zealand, Grosskopf (2006) did also specificity tests using a larger number of plant species, and his results were equally negative for parasitism, and verifies the great selectivity of the insect.

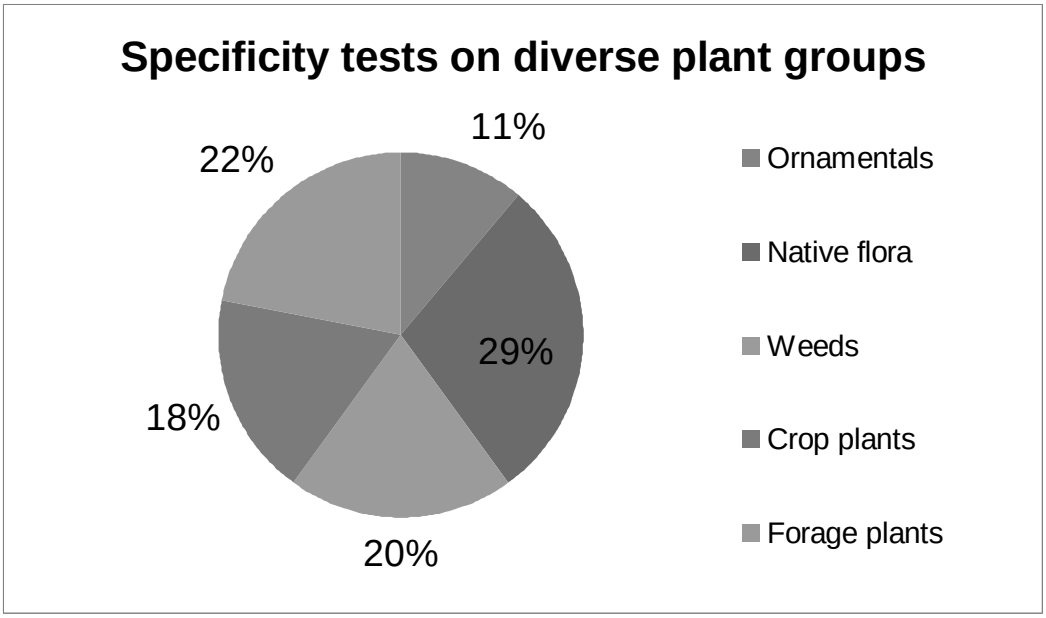

Figure 3. Specificity tests on diverse plant groups (Villalón, 2009).
The results reported here in could improve in field tests, and also including other control agents for the weed.

Conclusions

Macrolabis pilosellae produced galls in *H. pilosella* under quarantine conditions in a greenhouse, and affected the dry weight of plants infested as compared with uninfested control plants, but no significant differences occurred in growth, biomass, and flower production. However, *M. pilosellae* did not infest *H. patagonicum*, as no significant differences occurred in fresh and dry weight, and the number of leaves of infested and uninfested control plants, neither galls developed. Thus, a biological program of *H. pilosella* with *M. pilosellae* to decrease the vigor of this weed would be feasible in the Magallanes XII region of Chile. These results should be complemented evaluating the infestation of *Hieracium* spp. in field tests at conditions controlled by SAG. It is also important to consider the possibility of studying other biocontrol agents, as it occurs in New Zealand, as their action together could reduce significantly the incidence of the weed.

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