Midges and wasps gain tarsus hold — successful release strategies for two *Hieracium* biocontrol agents

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*Hieracium* gall midges (*Cecidomyiidae: Macrolabis pilosellae*) and gall wasps (*Cynipidae: Aulacidea subterminalis*) have been released in New Zealand to combat invasive *Hieracium* species (*Hieracium pilosellae*, *Hieracium praealtum*, *Hieracium caespitosum* and *Hieracium aurantiacum*). Gall wasps were first released in 1999 and gall midges in 2002. A strategy of releasing small numbers of individuals at many dispersed sites was adopted to overcome site specific factors, which may have precluded insect establishment. Wasp releases comprised either 100 newly emerged adults or 100 over wintered galls containing ready to emerge adults. Midge releases comprised 20–40 galled plants containing larvae and pupae, planted at each site. To date, 99 wasp and 136 midge releases have been made, with proven establishment at 32% and 92% of sites, respectively. In many instances, failed establishment or establishment and subsequent failure was attributed not only to drought but also to changes in land management, e.g. cultivation and spraying. Wasp gall densities were measured at up to 122 chambers per square metre six seasons post release. Midge galled plants were measured at up to 1.2 per square metre two seasons post release. Long-term biocontrol agent and vegetation monitoring has been established to quantify impact of wasps and midges on hawkweeds and other exotic and native plant species.

Are seedfeeding insects adequately controlling yellow starthistle (*Centaurea solstitialis*) in the western USA?

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Yellow starthistle, *Centaurea solstitialis* L. (Asteraceae), is an exotic plant infesting 7.5 million ha of land in the western USA. Six seedhead-feeding insects were released against this plant between 1984 and 1992. We conducted insect exclosure experiments at four yellow starthistle field sites in the Hell’s Canyon ecosystem (Idaho) to determine whether insects solely targeting seedheads can adequately control yellow starthistle or whether the release of additional agents targeting different plant parts is warranted. We compared several plant response variables between plots sprayed with pyrethroid and imidacloprid insecticides and plots sprayed with equal amounts of water over the course of two consecutive field seasons. More than 80% of seedheads in control plots were attacked in 2005; more than 93% were attacked in 2006. Seed production in insecticide-treated seedheads was reduced by 27.1% and 58.5% in 2005 and 2006, respectively. However, yellow starthistle plant density increased from 2005 to 2006. Despite the continued high abundance and attack rates of seedhead feeding insects, it does not appear that the soil seed bank of yellow starthistle is sufficiently impaired to cause reductions in plant populations. Thus, the planned release of additional agents targeting roots and stems may greatly benefit the biological control program against yellow starthistle.