

Field Abundance Patterns and Odor-Mediated Host Choice by Clover Seed Weevils, *Apion fulvipes* and *Apion trifolii* (Coleoptera: Apionidae)

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ABSTRACT The clover seed weevils *Apion fulvipes* Geoffroy, 1785 and *Apion trifolii* L., 1768 (Coleoptera: Apionidae) cause major losses to seed production of white clover (*Trifolium repens* L.) and red clover (*Trifolium pratense* L.), respectively. Clover is important as animal forage and an alternative to inorganic fertilizers. Because clover is mainly pollinated by bees, the use of insecticides in management of these weevils is discouraged. To gain basic knowledge for development of alternative management strategies, we investigated weevil field abundance over two growing seasons, as well as feeding and olfactory host preferences by *A. fulvipes* and *A. trifolii*. Field trap catches in southern Sweden revealed that white clover was dominated by *A. fulvipes* and red clover by *A. trifolii*. For both weevil species, female catches were positively correlated to the number of clover buds and flowers in the field. In feeding and olfactory bioassays, females of *A. fulvipes* and *A. trifolii* showed a preference for *T. repens* and *T. pratense*, respectively. However, the feeding preference was lost when the antennae were removed, indicating a significant role of olfaction in host choice. Male weevils of both species did not show clear olfactory or feeding preferences for host plant species. The field study and laboratory bioassays demonstrate that, at least for female weevils, olfaction is important for selection of host plants. We discuss these novel results in the context of managing these important pests of clover by exploiting olfaction and behavioral attraction to host plant volatiles.

KEY WORDS *Trifolium repens*, *Trifolium pratense*, olfaction, feeding, behavior manipulation

Introduction

Insects use constitutive and induced plant volatiles to locate and select their host plants (Bernays and Chapman 1994, Schoonhoven et al. 2005). This knowledge is often utilized in insect pest management through behavioral manipulation (Foster and Harris 1997, Pickett et al. 2006, Prokopy and Roitberg 2007, Roitberg 2007), mainly using attractants (Szendrei and Rodriguez-Saona 2010). The response of insects to plant volatiles is influenced by innate factors including sex and level of maturity (e.g., Adesso and McAuslane 2009), physiological state (e.g., Nissinen et al. 2008), degree of ecological specialization (e.g., Vargas et al. 2005), and previous experience (e.g., Webster et al. 2013). Therefore, to develop an effective semiochemical-based pest management strategy, it is important to study how the behavior of the focal insect is organized

in space and time in its natural habitat (Prokopy and Roitberg 2007).

The clover seed weevils *Apion* (*Protapion*) *fulvipes* Geoffroy, 1785 (syn. *Apion flavipes* Paykull, 1792; *Apion dichroum* Bedel, 1886) and *Apion trifolii* L., 1768 (syn. *Curculio trifolii* L., 1768; *Apion aestivum* Germar, 1817) (Coleoptera: Apionidae) are economically important pests reducing seed yields of white clover (*Trifolium repens* L.) and red clover (*Trifolium pratense* L.), respectively (Langer and Rohde 2005, Hansen and Boelt 2008, Lundin et al. 2012). Clovers are important nitrogen-fixating crops and green manure legumes, particularly in organic farming where inorganic fertilizers are prohibited (Carlsson and Huss-Danell 2003, Thorup-Kristensen et al. 2003, Fustec et al. 2010). Sufficient and reliable seed supply of clover is, therefore, crucial for the organic farming sector. Conventionally, pyrethroid and neonicotinoid insecticides are used for crop protection against clover seed weevils. Recent studies, however, indicate that pyrethroids have limited efficiency for pest control, whereas for the more efficient neonicotinoids, there are concerns for negative sublethal effects on bees and natural enemy parasitoids (Lundin et al. 2012, Godfray et al. 2014). Therefore, we sought to empirically collect baseline information to be able to develop a

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