

**INSECT FLORAL VISITORS AND THEIR BEHAVIOUR IN HYBRID
CARROT SEED CROPS IN TASMANIA**

by

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DECLARATION

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For George and Margaret

ABSTRACT

Carrot inflorescences are unspecialised in form and structure and as such, may be pollinated by a large range of insects. Although there is some literature published on insect visitation to open-pollinated carrot seed crops in several regions around the world, there are none in Australasia and there is none on insect visitation to hybrid carrot seed crops worldwide. With much geographic and seasonal visitation evident among these published studies and a growing hybrid carrot seed crop industry in Southern Australia and New Zealand, this study was undertaken to investigate insect visitation to carrot seed crops. Surveys and observation studies of insect visitation were undertaken over three consecutive seasons in the south of Tasmania in order to identify and determine the behaviour of potential pollinators in carrot seed crops.

Over 100 morphological groupings of insects were discerned visiting hybrid carrot seed crops. The majority of insects were classified into the grouping small insects (< 5 mm), and made up 78 % of all insects with the largest group among these being thrips. Among the insects observed visiting umbels, nectar scarabs (*Phyllotocus* spp.) were the most abundant taxa but honey bees (*Apis mellifera* Linnaeus), muscoid flies and ladybirds were more frequently observed but at lower numbers. Weather conditions, site location, time of day, and season all affected the composition of the insect cohort and the frequency of visitation. Honey bees were the most reliable visitors due to the provision of hives by local bee-keepers.

Nectar scarabs (*Phyllotocus* spp.), honey bees (*Apis mellifera* Linnaeus) and the hover fly, *Eristalis tenax* (Linnaeus), carried high carrot pollen loads on their bodies. Based on pollen loads, honey bees and muscoid flies appeared to forage mostly within the male-fertile carrot row whereas nectar scarabs and *E. tenax* foraged across rows. All observed insect taxa were more frequently seen visiting male-fertile (MF) than cytoplasmically male-sterile (CMS) umbels. Lower pollen loads on the honey bee's body were six times more likely on bees collected on male-sterile than on MF umbels and eight times more likely on nectar collecting than pollen collecting worker bees. Honey bees were found to be visiting a wide range of alternative pollen sources and made relatively few (ca. 1.4 %) visits to carrot plants over the entire flowering season.

Insect visits were more abundant on certain carrot cultivars. Significant differences in insect visitation were also found between cultivars from different carrot root types but not CMS types (brown anther or petaloid) or flower colours. The visitation rates of honey bees, nectar scarabs (*Phyllotocus macleayi* Fischer), muscoid flies and wasps

each significantly differed between cultivars but differences were not consistent between seasons.

At an individual umbel level as umbel diameter increased, visitation by soldier beetles increased. The presence of soldier beetles on umbels had a negative effect on visitation by *A. mellifera*. Differences in a number of chemical attributes were found between cultivars and were linked to attractiveness to pollinators. Fructose and glucose were dominant in the nectar of all cultivars with only small amounts of sucrose present. Twenty-six chemical compounds were detected in the inflorescence headspace of carrot flowers with all showing significant levels of variation between flowers. Honey bee visitation was found to be influenced by cis-2,6-dimethyl-2,6-octadiene, decanal, bornyl acetate and sucrose, whilst visitation by other insects was influenced by a combination of camphene, alpha-terpinene and umbel diameter. Further work considering functionally similar insect groups, whose species make-up may change considerably between years, but which collectively do not vary in their relative importance to the carrot flower should be the focus of further study.

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