THE INFLUENCE OF A FLY ATTRACTANT ON HYBRID CARROT POLLINATION

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ABSTRACT

Three hybrid carrot seed crops in Canterbury were used to investigate the effect of odour lures on fly activity and pollination. Thirteen lures containing liver and sodium sulphide were placed adjacent to male carrot rows at the northern end of each field. Insects numbers caught in yellow water traps, numbers of insects visiting female flowers and seed weight were measured. Fly numbers caught in water traps and observed on flowers were significantly higher ($P < 0.001$) only within 5 m of the lures. Lures had no significant effect on seed weight.

Keywords: pollination, hybrid carrots, flies, odour lures, seed yield

INTRODUCTION

Hybrid seeds of carrot *Daucus carota* L. (Apiaceae) are a high value export crop. Yields in Canterbury are lower than desired (C. Green 1994 pers.comm.). Cross-pollination is vital for optimal seed quality and quantity (Rodet *et al.* 1992; Borthwick and Emsweller 1932). Pankratova (1958) reported that carrot plots visited by insects yielded 15 times as many seeds and 10 times the weight of seeds as plants covered with muslin to exclude insects. Pollen transfer from the male to the female flowers is most efficiently achieved by short-tongued insects as they take nectar from the short corolla tubes of the carrots (Bohart and Nye 1960). However, populations of natural pollinators are often low and may limit seed yield (Hawthorn *et al.* 1956).

Studies in Utah have shown flies (including Calliphoridae, Muscidae, and Bibionidae) and honey bees (Apidae) to be particularly important pollinators of carrots. Their efficiency is related to a combination of size, abundance, labium length and foraging behaviour (Bohart and Nye 1960). In New Zealand, insect activity and abundance has not been previously recorded in flowering carrot crops.

Habitat manipulation by adding suitable attractants for known pollinators may benefit pollination and hence seed yield. Offering carrion to attract fly pollinators has been suggested and practised by growers, but the effects have not been quantified (Bohart and Nye 1960).

The aims of this work were to offer attractants to enhance the abundance and activity of Diptera and to establish whether seed yield was related to insect activity.

MATERIALS AND METHODS

Experiments were carried out on three adjacent hybrid seed crops at Barhill, South Canterbury. An experimental area of 5 hectares was used in each field. The odour lures consisted of liver soaked in a solution of sodium sulphide (5 g/litre) which were placed at the north end of each field. This was done to take advantage of the prevailing winds to maximise the entry of odour into the crop. Each lure contained 1 kg of liver placed in a 25 litre plastic container and then covered with a muslin sleeve. Liver was replenished fortnightly. Thirteen containers were placed at the treatment end of each of the fields, adjacent to male carrot rows.

Insect numbers were monitored using yellow water traps (170 x 170 x 85 cm). Detergent (to break surface tension) and 5 g of sodium benzoate as a preservative were

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added to each trap. Ten traps were placed at equal spacings along the treatment and control ends of each field; depending on field size, the control rows were from 3 m to 30 m in from the boundary. This was to standardise the distance between control and treatment traps at 225 m for all three fields. Two rows of water traps were also placed in a gradient at distances of: 5, 10, 15, 20, 25, 30, 50, 90, 150 and 225 m from the treatment end. The number of flies in traps were recorded weekly from 15 December 1994 until 19 January 1995.

Visual assessments of the number of flies visiting the open female flower nearest to each trap were made. Assessments lasted 5 seconds and were made on 29 December, 5 January and 12 January 1995.

To assess seed yield, six carrot umbels from thirteen female rows were covered with a muslin bag to prevent further pollination in two of the three experimental fields on 26 January 1995. These umbels were collected just prior to commercial harvest of the crop on 8 March 1995. Seeds from six umbels pooled were dressed using a Westrup machine and then weighed.

Fly numbers caught in water traps at increasing distances from the treatment area were compared using an ANOVA. Fly numbers in water traps and the number observed on flowers <5 m and ≥5 m from the treatment end were compared using *t*-tests. Seed yields were compared between treatment and control areas also using a *t*-test. All variables were log transformed prior to analysis to stabilise variances. Means and confidence intervals are thus presented as back-transformed values.

RESULTS

Overall, higher numbers of flies/trap were captured in treatment (mean = 655, 95% confidence interval = 564 - 760) compared with control (mean = 263, 95% confidence interval = 241 - 286) traps ($P < 0.001$). There were more flies trapped in treatment than control traps on 5 January, 12 January and 19 January, 1995 ($P < 0.001$; Fig. 1).

FIGURE 1: Mean number of flies per trap in treatment and control areas on all dates between 15 December 1994 and 19 January 1995.

This was a function of the high numbers caught within 5 m of the liver, with these traps having significantly higher catches (mean = 655, 95% confidence interval = 564 - 760) than all other distances combined (mean = 279, 95% confidence interval = 257 - 303). This localised effect was particularly evident on 12 Jan (Fig. 2).

There was a similar trend in the visual counts to that seen in the water trap catches, with decreasing numbers of flies as the distance from the liver lures increased. The results however, were highly variable and did not differ significantly overall ($P > 0.05$). However, the number of flies/trap observed within 5 m of the liver treatment on 12 January was higher (mean = 1.0, 95% confidence interval = 0.55 - 1.73) than the number of flies greater than, or equal to, 5 m away from the liver treatment (mean = 0.43, 95% confidence interval = 0.26 - 0.62) ($P < 0.01$).

Only three hover flies and seven honey bees were observed on carrot flower heads during this experiment.

FIGURE 2: The mean number of flies caught per trap in the week preceding 12 January 1995 at increasing distances from the lures.

There was no significant difference ($P > 0.05$) in seed weight/head between treatment (mean = 0.85 g, 95% confidence interval = 0.45 - 1.90) and control areas (mean = 1.05 g, 95% confidence interval = 0.50 - 2.10).

DISCUSSION

This work identified flies as potentially important in carrot pollination in Canterbury. Honey bees are also likely to be important pollinators of carrots but only in the absence of competing crops (Bohart and Nye 1960). In the current work very few honey bees visited the carrot flowers. This may have been due to crops of white clover (*Trifolium repens* L.) tansy leaf (*Phacelia tanacetifolia* Benth.) and oilseed rape (*Brassica napus* L.) being grown nearby offering greater rewards.

It was possible to increase the number of flies in an area by providing lures. However, this increase in insect numbers was not matched by an increase in seed yield. A possible explanation for the lack of a localised effect of treatment on seed yield, may have been the aggregation of flies observed on and around the lures themselves, instead of contributing to pollination by visiting the adjacent carrot flowers. Future work may need to increase the quantity and reduce the size of lures to achieve a higher rate of fly pollination, although the economics of this need to be considered. If successful, such a method may have associated negative effects (Bohart and Nye 1960). For instance, in view of the recent spread of the Australian green blow fly (*Lucilia cuprina* Wied.) responsible for fly strike (P. Robinson, pers. comm.) such population enhancements, if more than local and transient, would need to be carefully considered.

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