

# **Evaluation of Synthetic Honey Bee Brood Pheromone to Increase Pollination Efficiency in Carrot Seed Crop**

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## **Abstract**

Honey bees are crucial to the pollination of hybrid vegetable seeds in central Oregon and consistent pollination of carrot seed umbels is an ongoing challenge. During the summers of 2010-2012, we tested the hypothesis that synthetic brood pheromone (SuperBoost<sup>®</sup>) has the potential to increase pollination efficiency in carrot seed crops. Pollen and non-pollen foragers returning to the hive as well as visitation of bees on umbels showed higher numbers in colonies treated with the brood pheromone. Results of this study suggest that treatment of honey bee colonies with brood pheromone (SuperBoost<sup>®</sup>) can be of significant benefit through increased yields for carrot seed growers.

## **Introduction**

One of the biggest challenges facing growers of carrot seed is ensuring adequate pollination. Brood pheromone (BP) released by honey bee larvae is an excellent apicultural tool that has the potential to increase pollination by manipulating foraging stimulus of honey bee colonies. In this study we tested the potential of synthetic BP (SuperBoost<sup>®</sup>) to enhance pollination and yields in carrot seed crop. SuperBoost<sup>®</sup> is a commercial product based on the brood pheromone of the honey bee, *Apis mellifera*. It is a synthetic blend of 10 fatty acid esters formulated in a ratio that precisely mimics the natural composition of the brood pheromone. Worker honey bees contact milligram amounts of pheromone that exudes daily from one side of a plastic pouch that is suspended in a holder between the frames of a hive.

Specific objectives of this study: 1) Examine and compare synthetic brood pheromone-induced foraging activity of treated honey bee colonies with controls 2) Evaluate increase in crop yield resulting from increased pollination, as a result of synthetic brood pheromone use.

## **Materials and Methods:**

Honey bee colonies each containing approximately 40,000 bees were used in this study. There were two treatments: 1) Brood Pheromone (SuperBoost<sup>®</sup>) and 2) Control. Isolated carrot fields with similar varieties, irrigation type and management were used to allocate treatments. For the years 2010, 2011 and 2012 we had 2, 4 and 4 replications respectively. Brood pheromone treatment colonies received one synthetic brood pheromone device (SuperBoost<sup>®</sup>) in the brood area whereas control colonies received a blank device without pheromone. After initiation of the experiment in each experimental field, we counted number of bees visiting both male and female flowers during a 5 minute transect. We repeated bee visitation counts several times during the study period. We also documented number of pollen and non-pollen foragers entering the colonies during 5 minute intervals to analyze foraging efficiency of bees. Further, final yields of the crop were also documented in the experimental fields after harvest to compare yields between treatments.

## Results and Discussion

For both sexes of flower, there were significantly more bee visits in fields pollinated by colonies treated with brood pheromone than in control fields (male flowers  $t = 2.9001$ ,  $df = 6$ ,  $P = 0.0273$ ; female flowers  $t = 2.4660$ ,  $df = 6$ ,  $P = 0.0487$ ) (Table 1). Overall 53.7% and 46.3% of the crop was harvested from brood pheromone and control fields, respectively ( $t = 3.5184$ ,  $df = 18$ ,  $P = 0.0025$ ) (Table 2).

We conclude that treatment of honey bee colonies with brood pheromone (SuperBoost<sup>®</sup>) can be of significant benefit to carrot seed growers. Stimulation of increased foraging by brood pheromone as shown in this study could result in increased yields. The cost of treatment is so low, that even a minimal gain in yield may result in a positive ROI (Return on Investment). Our results overall suggest that brood pheromone treatment can be applied successfully to enhance bee foraging and increase yields in hybrid carrot seed crop.

**Table 1.** Comparison of visits by honey bees to male and females carrot flowers in fields pollinated by colonies treated with brood pheromone (SuperBoost<sup>®</sup>) or by untreated control colonies, and (for all fields combined) to male or female flowers. N = 4 for each sex of flower and N = 8 for both sexes of flower.

Sex of Flower	Criterion evaluated	Mean number of visits $\pm$ SE	Mean percent visits $\pm$ SE
Male	Visits to flowers in brood pheromone fields	11,089 $\pm$ 1316	59.2 $\pm$ 4.5*
	Flower visits in control fields	7,630 $\pm$ 1012	40.8 $\pm$ 4.5
Female	Visits to flowers in brood pheromone fields	6,968 $\pm$ 971	59.7 $\pm$ 5.6*
	Flowers visits in control fields	5,227 $\pm$ 1374	40.3 $\pm$ 5.6
Both sexes	Visits to male flowers	18,735 $\pm$ 1645	61.6 $\pm$ 3.5**
	Visits to female flowers	12,195 $\pm$ 2300	38.5 $\pm$ 3.5

\* Significant difference between paired mean percentages at  $P \leq 0.05$ .

\*\* Significant difference between paired mean percentages at  $P \leq 0.01$ .

**Table 2.** Comparison of yields by weight and percentage between carrot seed fields pollinated by honey bee colonies treated with brood pheromone (SuperBoost<sup>®</sup>) or by untreated control colonies. N = 10.

Treatment	Mean yield (kg/ha) $\pm$ SE	Mean percent yield $\pm$ SE
Fields pollinated by colonies- treated with brood pheromone	325.2 $\pm$ 65.0	53.7 $\pm$ 1.5**
Fields pollinated by untreated- control colonies	280.8 $\pm$ 63.7	46.3 $\pm$ 1.5

\*\*Significant difference between paired mean percentages at  $P \leq 0.01$ .