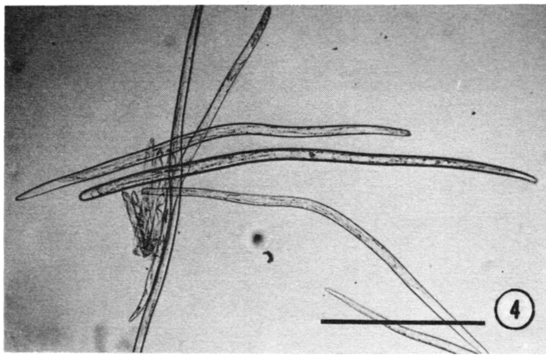

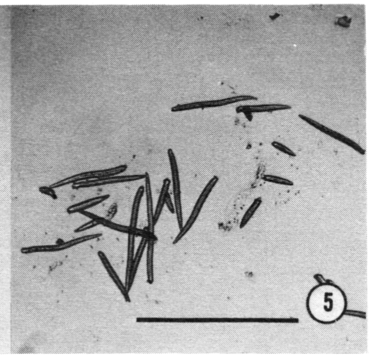

Fig. 4. Light micrograph of a sample of trichomes taken from the ovary at petal fall illustrated in Fig. 3. Note the group of young short hairs in left center. Bar = 0.5 mm. Fig. 5. Light micrograph of representative trichomes from a ripe fruit. Bar = 0.5 mm.

These equations were found to explain 90.1% of the variation in trichome length, indicating an excellent fit.

Fig. 2 shows a sample exocarp from which trichome densities were measured. From 11 ovaries sampled (3 at anthesis, 2 at petal fall, and 6 at shuck-off), there is no correlation ($r = .112$, $P > 25\%$) between trichome density and ovary weight. The mean density on immature ovaries is 30.36 trichomes per 2,500 μm^2. The density on the ripe fruit sampled is 6.7 trichomes per 2,500 μm^2, or only 0.2 times the density on the young ovary. Clearly, new trichomes are produced during the period when fruit sizes are 0.025 g to 0.227 g. However, obtaining accurate density estimates of fruits in the more advanced developmental stages was hampered by difficulties in removing the smaller trichomes and in rupturing the more fragile exocarp.

To determine how the decrease in trichome density relates to increase in surface area, one can apply the formula $x = (b2/3)/(a2/3)$, where x is the multiplication factor of the original surface area, a is the weight of an ovary at anthesis, and b is the weight of a ripe peach. For purposes of estimation, it is assumed that tissue densities of young and mature fruits are the same. Therefore, use of weights is justified because they are proportional to volumes, assuming equal densities.

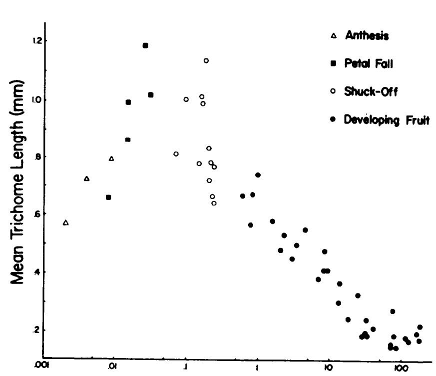

Fig. 6. Scatter plot of mean trichome length and ovary weight in 'June Gold'. Trichome length is maximal at petal fall and minimal in the ripe fruit.

The estimated difference in surface areas between fruit weighing 0.025 g to 146 g is 324 times. Since occasional ovaries at anthesis weigh 0.002 g and ripe fruit may weigh 175 g, the increase in surface area may be 1971 times the surface area at anthesis. These estimates may be conservative if pubescence weight of young ovaries is significant.

These studies suggest that trichome length is a major contributor to the dense appearance of pubescence on the ovaries at petal fall. It is hypothesized that the pubescence at petal fall provides physical protection of the succulent ovary from predation and could, in part, be responsible for ineffectiveness of some spray applications.

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A Commercial Bee Attractant Ineffective in Enhancing Apple Pollination[1]

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***Abstract.* 'Delicious' and 'Golden Delicious' apples (*Malus domestica* Borkch.) were sprayed with a high-conversion corn syrup consisting of 38–40% glucose, 28% maltose, 10% maltotriose, and 22% higher sugars plus, strawberry flavoring, red dye, and a preservative (Beelure) designed to increase plant attractiveness to honey bees. No difference was found between the number of foraging bees or the percentage of bees collecting pollen on sprayed versus unsprayed trees or in fruit set. Bees were not attracted to non-floral foliage in sprayed blocks.**

Many substances found in flowers have been shown to be attractive to bees and may encourage flower visitation and hence are probably important for pollination (3, 4, 6). Some attempts have been made to use these substances to attract bees to crops to improve yield and quality as reviewed by Free (2). Recently, certain commercial products have emerged that are claimed to attract bees and enhance pollination when sprayed on a crop. Beeline, a wettable powder food supplement that is marketed as a pollination attractant, was tested by Burgett and Fisher (1). When sprayed at recommended rates on fields of red clover *(Trifolium pratense)*, Beeline had no effect on the number of foraging bees or on seed set.

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The product we tested is a colored syrup concentrate made by Helena Chemical Co. marketed under the name Beelure. In the present study, the attractant was tested on apple trees in Virginia to determine its effect on the behavior of honey bees and its potential for increasing fruit set.

During 1980 and 1981, tests were conducted at the horticulture research farm in Blacksburg, Va. In 1980, an apple orchard consisting of several cultivars, each planted in single rows (19 trees/row) was used. All trees were about 10 years old, 4.6 m high and spaced 6.1 × 6.1 m apart. Three cultivars—spur-type 'Delicious', standard 'Delicious', and 'Golden Delicious'—were chosen for study. Four strong honey bee colonies were placed next to the test plots and several other colonies were within 500 yards. Throughout the experiment there was heavy flight activity at the hive entrances. Temperatures ranged from 18°C to well above 23°.

On April 25, 1980, half of the trees in each row were sprayed to runoff (at about 0900 hr) with the maximum recommended dosage of the attractant and water (1:50) using an air-blast sprayer (Test 1).

On May 5, 1980, alternating blocks of 2 trees, separated by guard trees, were treated with a hand-gun sprayer (Test 2). Trees were sprayed to runoff with the same concentration of the attractant and water. In both tests control trees were unsprayed.

Number of foraging bees. Following spray application, honey bees in each tree were counted. Each of 2 observers standing on opposite sides of a tree counted the number of bees seen in a 15-sec period and the average recorded. In Test 1, bees on 20 sprayed and 20 control trees, spur-type and standard 'Delicious', were counted 6 times from 1110 to 1500 hr. In Test 2, bees on 36 trees of the above 2 cultivars plus 'Golden Delicious' were counted 3 times between 1000 and 1445 hr.

Since the cultivar × treatment interaction was not significant, cultivars were pooled. In the first test there was a significantly higher (*t*-test, P = 1%) number of bees counted on check vs. treated trees. We believe that this was due to the confounding effects of a frost. The sprayed trees were at the bottom of a hill and had more frost-damaged flowers than the check trees. This damage to the flowers probably made these trees less attractive to the bees. In Test 2, the plot design was changed to negate the effects of frost. Alternate groups of trees within a row were sprayed. In this case no difference could be shown in the number of bees between treated and check trees (Table 1). Free (2) showed that small plots can be treated with attractant materials without affecting the attractiveness of adjacent plots.

Table 1. The effects of an attractant spray on honey bee behavior and fruit set within an orchard.

Treatment	Mean foraging bees per tree	Bees with pollen (%)	Fruit set (%)
Beelure	3.3 ± .31[z]	12.5 ± 3.8	84.5 ± 3.5
Control	3.9 ± .35	11.8 ± 5.2	82.4 ± 3.9

[z]Mean ± SE.

Percent of bees with pollen. Separate counts were made of honey bees with pollen loads to identify any change in foraging behavior. Stephen (5), and later Free (2), found that spraying sugar syrup on fruit trees stimulated honey bees to collect the syrup. Since the attractant contains sweet substances that are similar to nectar components and may stimulate nectar foraging in preference to pollen foraging, it was tested for this attribute. In both tests no difference could be shown in the percent of honey bees collecting pollen between treated and check trees (*t*-test, P = 9%) (Table 1), indicating no shift occurred in the foraging preferences of the honey bees from pollen to nectar collection.

Extrafloral attraction. To determine if the product attracted bees away from flowers onto non-floral foliage, counts were made of bees foraging in 4 categories—apple flowers, apple leaves, competitor flowers, and non-floral ground foliage. No difference could be shown in the numbers of bees foraging among the foliage categories in spray vs. check plots. There was no indication that the spray, even though it was sprayed on non-floral foliage, drew honey bees away from apple blossoms.

Percent fruit set. In the second test, the effect of the attractant applications on fruit set was also examined. Following a 5-day period of inclement weather which greatly reduced bee foraging, random newly opened flowers were tagged on freshly sprayed and unsprayed 'Golden Delicious' and standard 'Delicious' trees. One week after petal fall, these marked blossoms were checked for fruit set. No significant difference could be shown in percent fruit set (number of fruit set/number of blossoms tagged × 100) between treated and check trees (*t*-test, P = 69%) (Table 1). Sprayed trees had a mean fruit set of 84% (311 marked; 265 set) while check trees set 82% (406 marked; 337 set).

Table 2. The effect of an attractant spray on the number of bees per tree in a sprayed vs. unsprayed orchard.

Treatment	Mean foraging bees per tree (± SE)	
	Prespray	Postspray
Beelure	4.1 ± .61	3.38 ± .54
Control	5.48 ± .64	4.05 ± .46

Tests between orchards. In 1981, the effect of the sprays was investigated using 2 distinct orchard blocks, mostly 'Delicious', completely separated by a grassy hill 430 m wide. One block was sprayed with the maximum commercial rate of the attractant, the other was used as a control and not sprayed. An apiary, consisting of 8 hives, was positioned so that both orchards were at different flight angles and less than 540 m away. Four pretreatment counts of the number of bees per tree on 5 trees in each orchard (previous method) were made to determine the relative attractiveness of each orchard before treatment. Four post-treatment counts were made to assess the impact of the sprays. No difference could be shown in the pretreatment counts (*t*-test, P<13%) (Table 2), therefore both the treated and untreated blocks were assumed similar enough for direct comparison. No difference could be shown in post-treatment counts (*t*-test, P<35%) indicating that the spray had no effect on the number of bees foraging in the trees.

The attractant, sprayed at the recommended rate, had no visible effect on fruit set of apples. The foraging behavior of honey bees measured as the percent of the foraging force gathering nectar, the propensity to forage on plant parts other than apple blossoms, the number of bees in individual trees, or the number of bees in an entire orchard was not shown to differ between treated and check plots. We conclude that the attractant does not enhance pollination and would not be a beneficial addition to an apple orchard spray program.

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