This hedgerow planting of young Valencia oranges has been sidewall-pruned after harvest each year since 1962.

high-quality fruit, evenly distributed throughout the hedge. As the experiment progressed, the zone of production on the pruned trees shifted to the top and shoulders. Fruit-set during the sixth year, which was an "on crop" year, was mainly in the upper portion of the hedge, with 35 per cent of the fruit located below a height of 6 ft and 65 per cent of the fruit from 6 to 13 feet. Increased fruit-set in the top of the hedge was probably correlated with higher light intensities at the top. The hedge was thinned by hand pruning after the 1967 harvest to allow more light into the interior, in the hope that fruit-set would be improved throughout the entire hedge. No mechanical hedging was done in 1967 and, as a result, the trees were growing beyond the 6-ft width. Mechanical hedging should have been used as well as hand thinning.

While it is much too early to draw conclusions from the data available, the hedgerow planting offers promise for platform harvesting. In this trial the spacing of trees 12 ft apart in rows was apparently too close for the vigorous top and rootstock. Allowing more room in the row, but moving rows closer together may be a way to maintain yields equal to those of non-hedged trees on a per acre basis. Trials now under way in orchards of the Kern County Land Company are expected to provide further data about the optimum spacing of trees.

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TABLE 1. WEIGHT OF FRESH CLIPPINGS REMOVED AT EACH HEDGING TREATMENT (42 TREES)

Season	12-foot hedge lbs. removed	9-foot hedge lbs. removed	6-foot hedge lbs. removed
1961	weights not taken	—	—
1962	weights not taken	—	—
1963	44	136	799
1964	103	260	290
1965	100	255	490
1966	47	178	433

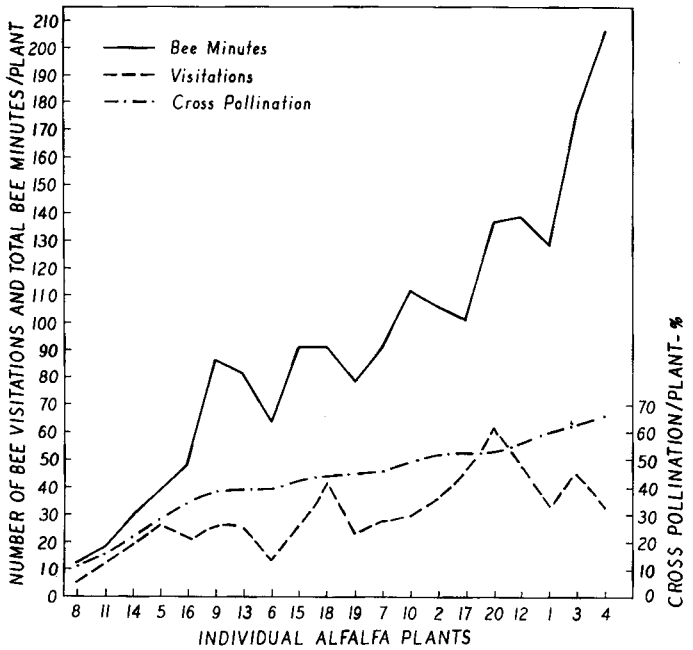
TABLE 2. FIELD BOXES HARVESTED FROM EACH HEDGING TREATMENT (42 TREES)

Season	Unpruned (control) no. boxes	12-foot hedge no. boxes	9-foot hedge no. boxes	6-foot hedge no. boxes
1962	39	32	34	35
1963	126	126	102	100
1964	98	89	66	66
1965	121	140	146	132
1966	67	65	50	47
1967	264	232	207	209
Totals	715	684	605	589

PLANT PREFERENCE OF HONEYBEES *in white-flowered* ALFALFA

R. W. HAGEMANN • L. G. JONES • J. T. FEATHER

PREFERENCE OF HONEYBEES FOR INDIVIDUAL ALFALFA PLANTS, EXPRESSED IN BEE MINUTES AND NUMBER OF VISITS PER PLANT, PLUS PERCENTAGE OF CROSS-POLLINATION TO COLORED-FLOWER ALFALFA



White-flowered alfalfa plants vary widely in attractiveness to honeybees, according to this study under open pollination conditions at University of California, Davis. Several instances of plant preference were noted, but in general, plants having the most bee activity showed the greatest amount of cross pollination. When a strain of honeybees is developed with a distinct preference for alfalfa, it would appear to be advantageous to have parental lines equal in as many of the attractiveness characteristics as possible, to insure increased alfalfa seed production.

A PREFERENCE FOR PARTICULAR PLANTS has been shown by honeybee pollinators working in both white-flowered and colored alfalfa, although the reasons for this selectiveness have not been clearly understood. Very little research has been reported involving the variations in attractiveness, as evidenced by the number of bee visits and the resultant amount of cross-pollination with distant sources of alfalfa pollen. This study was initiated to determine the differential preference of honeybees among white-flowered alfalfa plants in a California environment, and the amount of cross-pollination between white and colored alfalfas.

Twenty white-flowered clones were planted at 3-foot intervals in a 108-sq-ft area, and then were observed in the field under conditions of open pollination in 1966. These clones were located 500 ft from colored-flowered types, and 800 ft from strong honeybee hives. Half of the clones were of California origin and the others were establshed from rooted cuttings taken from clones obtained in Utah.

Bee activity was observed on each clone for five minutes per day on 10 different dates within a two-week period. Observations were begun on July 26 and were conducted between 10 a.m. and 4 p.m. The order of examination from clone to clone was randomized each day. Two items were recorded during each five-minute period: (1) the number of bees visiting each clone, and (2) the approximate length of each visit. Only honeybee visits were recorded, as visits of endemic pollinators and leafcutter bees were considered negligible.

The percentage of cross-pollination was determined by the colored hypocotyl technique on 400 seedlings grown from a random sampling of seed from each clone. Enough seed was planted in this greenhouse determination to allow seedlings to be thinned to the desired number. A white-by-white cross produces a seedling with a green hypocotyl, whereas a white-by-colored cross results in a seedling with a colored hypocotyl. Although frequent crossing probably occurred between white-flowered plants within the experiment, the amount of cross-pollination reported here refers only to the outcrossing with colored-flowered alfalfas as determined by hypocotyl color.

A significant correlation ($r = .725$ was obtained between the total length of bee visits (bee minutes) per plant and the percentage of cross-pollination. There was similar agreement ($r = .758$) between the number of bee visits and the amount of cross-pollination. An analysis of variance in both bee minutes and visits indicates highly significant differences among plants at the 1 per cent level of probability (see table). The measured variability of the clones includes differences between clones plus that due to their micro-environments.

Plants 4, 16, and 20 in the table are examples of attractiveness variation. These plants were larger than the others in the experiment; they had many flowers, and were similar in vegetative type. However, plant 16 had significantly fewer bee minutes of activity than plants 4 and 20 and had a measurably lower number of bee visits than plant 4. Two plants, 1 and 3, each had a high degree of activity during the periods of observation, although each had relatively few flowers. Plant 2 was exceptionally small but still attracted many bees.

The other 14 plants were uniform both in their size and in the amount of flowers they produced, but numerous instances of bee preference were noted. Although 70 per cent of the plants observed had between 30 and 60 visits, 20 per cent had fewer than 30. These data are summarized in the graph.

Cross-pollination

The range in cross-pollination determined through the colored hypocotyl test was 6 to 61 per cent with an average of 33 per cent. In general, the plants with the most bee activity exhibited the greatest amount of cross-pollination although, in certain cases, plants with similar numbers of visitors had widely varying amounts of cross-pollination. Variation in attractiveness observed among the 20 plants substantiates earlier evidence of honeybee preference for certain alfalfa plants.

No attempt was made in this study to determine physiological or morphological differences among the plants that might explain the preference for some over others, although data by other researchers indicate many possible reasons for plant preference. The amount of nectar produced per plant, the ease of tripping, the profuseness of flowering, the vegetative vigor, and carotene content of leaves have all been found to affect the attractiveness of a particular alfalfa plant to the pollinator. Some of these factors have been significantly correlated with seed yield. Furthermore, it is believed that certain plants impart an odor attractive to bees and that the size, shape, and age of the flowers may also be important.

These data and other studies indicate that to improve seed production certain inherent differences exist in alfalfa plants, and that all factors affecting seed setting should be considered. An important criterion to be considered in selecting alfalfa could be the final amount of seed obtained per plant.

A knowledge of the attractiveness of given plants could be especially important in hybrid production. If one parent is highly favored over the other by the pollinators, this probably would cause a reduction in crossing and lower seed yields since pollination might be extensive within parental lines but considerably less between parents. When a strain of honeybees is developed with a distinct preference for alfalfa, it would appear advantageous to have parental lines equal in as many of the attractiveness characteristics as possible to insure increased alfalfa seed production.

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VARIATIONS IN HONEYBEE PREFERENCE FOR CERTAIN ALFALFA PLANTS, BASED ON AVERAGE NUMBER OF VISITS AND TIME SPENT PER PLANT DURING FIVE-MINUTE OBSERVATION PERIODS ON TEN CONSECUTIVE DAYS

Plant No.	Honeybee visits*	Plant No.	Minutes per plant
4	6.6a	4	3.1a
3	6.3ab	3	2.7ab
1	6.0abc	20	2.5abc
12	5.6abcd	12	2.4abc
2	5.3abcde	10	2.3abcd
17	5.3abcde	1	2.2abcd
20	5.3abcde	9	2.2abcd
10	4.9abcde	7	2.0bcde
7	4.6bcdef	13	2.0bcde
19	4.5bcdef	15	2.0bcde
18	4.4bcdef	17	1.9bcde
15	4.3cdef	2	1.8bcdef
6	3.9defg	18	1.8bcdef
9	3.8defg	19	1.7cdef
13	3.8defg	6	1.6cdefg
16	3.5efgh	5	1.4defg
5	2.8fghi	16	1.4defg
14	2.3ghi	14	1.2efg
11	1.7hi	11	0.9fg
8	1.2i	8	0.7g

* Figures followed by the same letter are not significantly different at the 1% level (Duncan's multiple range test).

— CORRECTION — RECREATION VS. TIMBER GROWING

An error appeared in the flow chart of factors influencing decision to integrate recreation with timber production, as printed on page 10 of the October issue of **California Agriculture.** The diamond-shaped box at the top of the diagram should have read: Is B/C (benefit-cost ratio) $\geqslant$ (equal to or greater than) 1.