THE importance of determining foraging behavior of insect pollinators of alfalfa (*Medicago sativa* L.) has been accentuated by the imminent development of commercial hybrid alfalfa. Significant deviation from random bee visitation between clonal or seed lines could result in considerable selfing in a hybrid seed field. Foraging behavior of bees is not well understood but previous studies indicate that pollination is not completely at random. A tendency for individual bees to forage repeatedly in the same area was reported by Butler (3), Butler et al. (4), Singh (10), and McGregor et al. (8). Specificity to a single plant species was demonstrated by Butler (3), Bateman (1), and Van Viersell and Mommers (11). Various pollinators have been observed to show preference between clonal lines of alfalfa. Pedersen and Bohart (9) reported heritable differences in preference by bumble bees between alfalfa clones differing in pollen production. Boren et al. (2) demonstrated a decided clonal preference by individual honey bees. Odor was assumed to be a major factor in this preference (2). Hanson et al. (6) observed individual bee preference for alfalfa clones differing in flower color, but there was no direct evidence that flower color in itself was a factor in attraction. Reciprocal differences, for flower color in the progeny of these clones, indicated that as high as 85 to 90% selfing had occurred. While reaction of reciprocals indicated that the selfing problem was not restricted to those clones that differed in flower color but that it was general for the experiment. Barnes et al. (3) demonstrated clonal preference by individual bees and suggested that attractiveness was due to several factors including odor, ease of tripping, nectar content and flower color. No single factor appeared to be all-important. The present study was undertaken to determine if bees, either collectively or individually, can recognize slight differences in flower color and discriminate in their visitation pattern on the basis of this color difference.

**MATERIALS AND METHODS**

In certain stocks of alfalfa Clement (5) observed a high rate of somatic mutation from white to purple. These stocks had white flowers with varying intensity of purple streaks. When mutation occurred in a primordial bud, the entire shoot which developed from that bud had purple flowers. "Isogenic" stocks were obtained by making vegetative cuttings from both the purple and white flowered shoots of six different clones. After the cuttings had rooted, 6 to 8 propagules of each color of all clones were potted and brought into flower in a controlled environment chamber. All material was in peak bloom by March 1, 1964; it was transferred into the greenhouse and kept there throughout the experiment.

The purple members of the different isogenics varied for intensity of flower color. One very light clone (41–49) was classified as 7.5 PB 9/4 bluish white with the Munsell key. The freshly opened flowers of the other 5 clones varied from 7.5 PB 8/4, very pale purplish blue, to 10 PB 7/6 light violet. Older flowers were lighter than the younger ones and in some cases difficult to distinguish from white. The "white" propagules were, in fact, not pure white but speckled with small streaks of purple resulting from mutations.

Two hives of Italian honey bees were maintained by the Department of Entomology, Fisheries and Wildlife in a small greenhouse room. No plant material was kept in this room other than that used in this experiment. Equal numbers (ranging from 3 to 5) of purple and white flowered propagules of a single clone were placed in the bee room. Selection of the propagules was made to ensure approximately equal numbers of white and purple flowers. These were arranged in two rows, alternating purple and white propagules. When sets of material were changed or when the same clone was subsequently returned to the bee room, the order of purple and white was reversed. The bees were allowed to work each clone for about one hour. From 5 to 20 bees were working each set of material at any one time. When most of the flowers were tripped, the plants were removed and a new set of propagules was introduced.

Observations on visitation patterns were made on 17 individual bees which had been marked on the thorax with water color paint. If a marked bee did not continue normal activities, it was destroyed. Visitations of marked bees were observed for several clones, over several days when possible. Some bees did not return after the first day. The initial visitation was recorded when a bee lit on a raceme and worked at least one flower. Tripping of the flower was not necessary to establish a visit. When a bee flew from one raceme to another and worked at least one flower, this was considered a new visit whether or not the raceme was on a different propagule. If it flew away and returned to the same raceme, a new visit was recorded. If a bee was disturbed by another bee and then returned to the same raceme, no new visit was recorded. Walking from one raceme to another did not constitute a visit. The number of flowers worked per raceme, and the number of flowers tripped, were not recorded.

**RESULTS AND DISCUSSION**

Three of the 17 bees observed showed a decided preference for purple flowers and 1 bee preferred white to purple (Table 1). The remaining 13 bees showed no statistically significant preference for either flower color. The 4 bees which showed a preference were consistent over all clones and all days with the exception of bee #2 on clone 41–49 (Table 2). The colored flowers of this clone were bluish white and very difficult to distinguish from the white flowers except in the freshly opened flowers. Bee #1 continued to recognize the difference in flower color and work more white than purple flowers, while bee #2 appeared to be unable to distinguish between the two. This observation indicates that some individual bees can recognize very slight differences in flower color white for other bees the color difference must be greater. If the contrast between white and purple had been greater for all clones, it is possible that more bees would have shown a color preference. It is reasonable to conclude that discrimination was based on differences in the portion of the spectrum discernible to the human eye rather than ultraviolet. Bees are known to react strongly to ultraviolet (7) but most of this portion of the spectrum was filtered by the glass in the greenhouse. The validity of the experiment would not be altered even if the bees were recognizing color not visible to the human eye.

While individual bees showed preference based on flower color, total visitations of the 17 bees over all clones showed no statistical difference between colors. Periodically during the observation period, the total numbers of bees (not just the 17 marked bees) working purple flowers, a factor in attractiveness of alfalfa clones for honey bees

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