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Pollination Habit of Avocado Cultivars in South Florida

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Abstract. **Avocado flowering is synchronously dichogamous in two separate floral openings. Stigmas tend to desiccate during the second opening and avocado pollen has been perceived to be sticky. It has thus been assumed that flowers are pollinated by flying insects only during the first floral opening. Although caged tree investigations have supported such a conclusion, few studies have tested this assumption directly. Pollination habits of avocado cultivars grown in South Florida have been investigated for five consecutive years since the initial observations that greater than 90% of pollen deposition was occurring during the second opening in several cultivars. The observations were subsequently verified using cheesecloth bags and insecticides to prevent pollination by flying insects, such as bees and wasps, and by small, less mobile insects, such as flower thrips, during either opening. Contrary to the conclusions of others, we have found that 1) pollen generally dries and is dispersed within one hour after dehiscence of anthers, 2) that a substantial number of stigmas are apparently receptive to this pollen during the second floral opening, and 3) that insects are not necessary for this transfer. All results indicate that wind is the primary vector transferring pollen to stigmas within flowers during the second opening. Ample fruit set in six cultivars studied thus far appears to result from self-pollination. Insects appear to play a minor role in both cross- and self-pollination in Florida avocados.**

The flowering behavior of avocados was first examined in the early 1920's by B. S. Nirody (1922) and A. B. Stout (1923). At that time, it was discovered that flowers were synchronously dichogamous, opening twice each for approximately half a day. The first opening was classified female since no pollen was present. The second opening, which occurs on the following day, was classified male. Pollen was released during this opening, but the stigmas typically were desiccated, making it difficult for pollen tubes to germinate or grow. These observations led to the conclusion that self pollination within flowers was unlikely. Cross pollination between complementary flowering cultivars, A and B, was considered the most likely method of pollination. Type A cultivars display female flowers in the morning hours and male flowers during the afternoon of the next day. Type B cultivars display female flowers in the afternoon of the first day and male flowers during the morning of the second. Pollination between flowers within the same tree or cultivars is also possible when flower openings overlap during low night and warm day temperature conditions. Details of these flowering events and their implications have been fully reviewed by Bergh (1976) and Davenport (1986).

Based on these observations, it has been assumed that virtually all pollen arrives on stigmas during the first opening, thus facilitating cross pollination and pollination from nearby flowers of the same tree or cultivar. Few studies have actually made observations of pollen counts to determine the timing of major pollen transfer onto stigmas. The purpose of our research has been to determine when pollen is transferred in flowers and the implications of possible self pollination on yield. Observations of pollen deposition presented in this paper are a summary of research results obtained over the past five years in south Florida on cultivars of the West Indian race or their hybrids with the Guatemalan race. More detailed information is forthcoming in primary publications.

We began examining rates of pollination (percent of flowers which have pollen deposited upon the stigmas) to determine their role in fruit setting characteristics of a number of interplanted Florida cultivars such as 'Booth 8', 'Tonnage', 'Simmonds', and 'Lula'. Results indicated that most of the pollen arrived on the stigmas during the second opening (Davenport 1989) rather than the first opening. At no time during these or later experiments did flower openings overlap during the collection periods.

Materials and Methods

Year 1. Experiments were conducted on two interplanted cultivars, 'Simmonds' and 'Hardee'. Branches were enclosed in cheese cloth bags just prior to the onset of flowering. The bags prevented pollen transfer by flying insects. Treatments included branches which were enclosed only during the first opening, during both openings, or left open to pollination. Flowers were sampled at the end of the female stage and end of the male stage and stored in FAA (formalin-alcohol-acetic acid) fixative. The dissected stigmas were subsequently observed under a light microscope for pollen counting.

Year 2. Experiments were conducted during the next flowering season with popular Florida-grown cultivars such as 'Tonnage' 'Tower 2', 'Choquette', 'Monroe' and 'Brooks Late'. All trees were interplanted among rows with complementary cultivars. The size of the cheese cloth enclosures were enlarged for these experiments. Sampling of enclosed female flowers was included to determine if percentage of pollinated stigmas was the same inside as outside the enclosures during that stage. Comparisons of fruit set inside and outside enclosures were also made.

Results

Year 1. Less than one percent of the 'Simmonds' female flowers outside the bags were pollinated. Approximately 17 percent of the male flowers were pollinated regardless of whether they were in bags or not. A similar relationship occurred in 'Hardee', but there was a higher rate of pollination in both stages of 'Hardee' than 'Simmonds' flowers. Pollen deposition during the second opening was consistent with the percent of stigmas which remained white throughout the second opening of both cultivars. It was confirmed that the greatest amount of pollen transfer occurs during the second opening in these

two cultivars. Moreover, the results proved that flying insects were not involved in pollen transfer during the second opening since the same amount of pollen arrived on male flowers regardless of whether they were enclosed in bags or not.

Year 2. Female flower pollination inside all enclosures was zero. Pollination rates outside the enclosures were 1 percent or less as in previous years. Pollination during the male opening ranged from 10 to 40 percent depending upon cultivar. Male flower pollination inside the enclosures was virtually the same as pollination outside for each cultivar. Moreover, the amount of fruit set occurring inside the enclosures was consistent with the level of fruit set observed on branches located adjacent to the enclosed branches. The result confirmed that self pollination within flowers is a predominant event in avocado pollination in Florida. It also suggested that subsequent fruiting is possible from these selfed flowers.

We examined flowers to determine if thrips were involved in pollen transfer within flowers during the following season. Systemic and contact insecticides were applied to female flowers weekly and daily, respectively, to control the large populations of thrips which occur in the groves. Rates of pollen deposition during the two stages were consistent with all previous years. There was no correlation between thrips populations and pollination during either stage. Wind was thus considered the primary mediator of pollen transfer within flowers.

Finally, experiments were conducted last season to investigate the influence of wind on pollination. Data are still being evaluated. One discovery which supports the possibility that wind mediates self-pollination is the observation that pollen was not adhesive as suggested by Stout (1923, 1927; Stout and Savage, 1925). Pollen was initially cohesive due to wetness at the time of dehiscence. At that time, it was difficult to transfer even by hand. It became transferable by hand within about 1 5 minutes and completely dispersed after 1 hr. The distance between anthers and stigmas is about one millimeter. If stigmas were moist, the pollen adhered and quickly germinated.

Discussion

These results demonstrate that self pollination within flowers is a dominant feature of pollination in south Florida avocado flowers. Pollination in the male stage does not insure, however, that the pistil is conducive to pollen tube growth or fertilization of the egg (Bringhurst, 1952; Davenport, 1986; Sedgley, 1977). Moreover, abscission of developing fruit in favor of those derived from cross pollination has been reported (Degani and Goldring, 1989; Degani *et al.,* 1986, 1990). Thus, selfing which we observe may not be important to yield. Isozyme studies of developing embryos in several cultivars are currently underway to evaluate the theory of self-pollination in avocado cultivars growing in the Florida condition.

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