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Comparison of Determinate vs. Indeterminate Shoots to Determine the Roles of PGRs, Carbohydrate, Nitrogen and other Nutrients in Fruit Set of the 'Hass' Avocado

Continuing Project; Year 4.5 of 5

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Benefit to the Industry

The results of this project will provide basic information on the regulation of fruit set in avocado necessary to develop practical methods for improving fruit set and yield in the field. Our research is the first to investigate the hormonal regulation of fruit set in avocado and the first to determine the yield potential of determinate and indeterminate floral shoots. As part of this research, a study of the microscopic changes related to the transition from vegetative to floral shoot development was undertaken in order to identify factors influencing the number of determinate vs. indeterminate inflorescences produced each spring.

Objectives

The research objectives are (1) to determine when flowering begins and the rate of development of inflorescences borne on summer and fall shoots, (2) to examine if fruit set is affected by the time when inflorescences (early vs. late) are produced, (3) to document which type of inflorescence (determinate vs. indeterminate) contributes more fruit to harvested yield, (4) to determine the developmental factors resulting in the production of determinate vs. indeterminate inflorescences, and (5) to quantify the effect of tryptophan on yield and fruit size of the 'Hass' avocado.

Summary

Avocado flowering is characterized by the presence of determinate and indeterminate inflorescences. The main axis of determinate inflorescences ends in a flower bud, whereas a vegetative bud is present at the indeterminate inflorescence apex, which develops into the spring vegetative growth (Reece, 1942; Schroeder, 1944).

Indeterminate inflorescences are the most abundant type, representing 80 to 95% of total floral shoots under California conditions (Schroeder, 1944). Thorp et al. (1994) found this proportion to be 65% for the 'Hass' avocado growing in Australia. Indeterminate inflorescences have long been suggested to be less successful in setting fruit but research quantifying the contribution of each type of inflorescence to yield of the 'Hass' avocado in California is scarce. Reports from other avocado producing areas indicate a higher initial fruit set for determinate inflorescences of the 'Fuerte' avocado (Bertling and Köhne, 1986).

As part of this project, a two-year study of the productivity of summer and fall vegetative shoots and determinate and indeterminate inflorescences was undertaken in two commercial 'Hass' avocado groves in southern California. Flowering started earlier on shoots produced in the fall than on shoots produced in the summer, however, no differences in the date of full bloom were observed between the two types of shoots. Time of anthesis was not a critical factor for fruit set in the 'Hass' avocado; however, indeterminate inflorescences showed the highest potential to set fruit during the early part of the bloom period. For determinate inflorescences, the highest fruit set was observed towards the end of bloom. Fruit set per each type of inflorescence revealed that determinate inflorescences are almost three times more productive than the indeterminate ones. However, our results confirmed that 'Hass' avocado trees in California produce predominantly indeterminate inflorescences (90% of the total inflorescences), which, as a result, contributed 74% of the total fruit yield. Summer shoots produced more determinate than indeterminate inflorescences, whereas fall shoots produced predominantly indeterminate inflorescences.

The use of gibberellic acid (GA_3) to manipulate flowering of the 'Hass' avocado in California has produced exciting results (Salazar and Lovatt, 1995). Prebloom foliar application of GA_3 not only increased the earliness of flowering but the proportion of indeterminate inflorescences was stimulated by reducing the production of determinate ones. In addition, GA_3 modified inflorescence phenology by stimulating precocious development of leaves relative to flowers of indeterminate inflorescences and relative to leaves of indeterminate inflorescences from untreated branches. This response appears to have a positive effect on fruit set and yield. Shifting the time of avocado bloom and/or the proportion of determinate vs. indeterminate inflorescences has the potential to impact fruit set and yield of the 'Hass' avocado. GA_3 sprays might also be used to stimulate the production of summer shoots.

Floral development of apical buds on summer shoots, those producing both determinate and indeterminate inflorescences, was studied during "on" and "off" crop years in a commercial 'Hass' avocado orchard in Corona, California. Changes in the visual (macroscopic) appearance of buds were correlated with anatomical changes occurring at the microscopic level during the transition of vegetative meristems to floral meristems and during subsequent inflorescence development. When published, these results will provide growers with a pictorial developmental chart that enables then to identify the average stage of floral development in their orchard based on visual observation of the buds. This is important for timing the application of nutrients and PGR canopy sprays.

The anatomical study revealed that the presence of a conical-shaped shoot apical meristem was related to an active state of growth, capable of producing either leaf or

inflorescence bracts. On vegetative shoots, the conical (active) shoot apical meristem produced leaves. As leaf expansion ceased, the shoot apical meristem flattened and if environmental conditions were appropriate, the apex became conical again but now produced floral primordia. At no time was the apex at rest. The results are the first to establish that a period of dormancy is not a prerequisite for the shift from the vegetative to the reproductive condition in the 'Hass' avocado. The transition from vegetative apex to floral apex occurred during August to October, which identified the period of floral induction and initiation in the 'Hass' avocado in California. Thus, the results established that floral induction and initiation of the 'Hass' avocado in California, and likely elsewhere, is much earlier than previously believed. Hence, seven and a half months were needed from the initiation of the first floral primordium to anthesis. This is longer than reported for other cultivars in California. Floral bud development was related to daily minimum temperature <15C. In the two years of the study, 81 and 77 days with temperatures <15C were required for complete floral bud initiation (presence of six secondary axis meristems and four secondary axis primordia) (approximately Nov. 30) for "on" and "off' years, respectively. From floral bud initiation to anthesis, 213 and 210 days with temperatures <15C were needed, for the same cropping years, respectively. Fruit load did not significantly affect the development of individual floral buds. However, the higher fruit crop in the "on" year was associated with a significant reduction in flowering intensity during the spring bloom due to (a) low production of summer and fall vegetative shoots during the "on" year that would eventually bear floral shoots in the spring, and to (b) production of vegetative shoots instead of inflorescences by the existing shoots.

This project also includes a full field experiment testing the effectiveness of foliar-applied tryptophan, at different concentrations made on several applications dates, to increase yield and/or fruit size. Harvest of this experiment is scheduled for April 1997.

Literature Cited

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