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DOES AN AVOCADO EARLY BLOOM SPRAY MAKE DOLLARS AND SENSE?

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The avocado is a seeded fruit. Therefore, pollination and fertilization are both critical to fruit set and final yield. Pollination is the arrival of the pollen (the male part of the reproductive cycle) on the stigma of the pistil (the female part of the flower) (Figure 1). Under optimal conditions, the pollen germinates producing a pollen tube which grows through the tissues of the stigma, style, and ovary to the ovule, which contains the egg (Figure 2). The pollen tube delivers the sperm to the egg. The fusion of sperm and egg is fertilization. The product of fertilization is the embryo, which develops into the young avocado seedling within the ovule. After fertilization, the ovule develops into the seed within the ovary, which develops into the avocado fruit (Figure 2). The successful completion of these two processes is essential to fruit set.

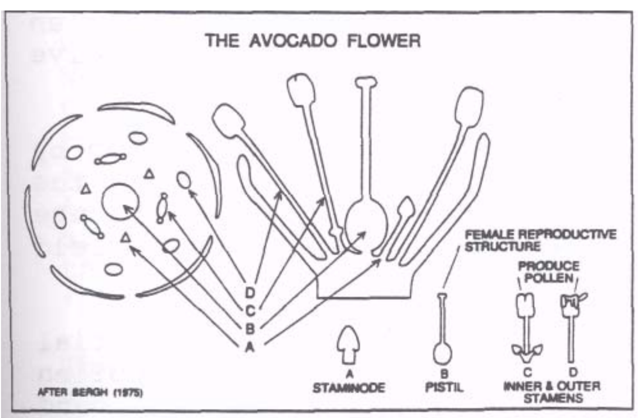


Figure 1.

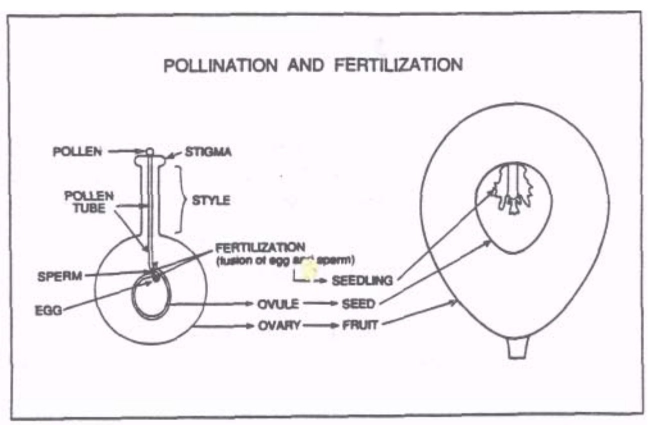
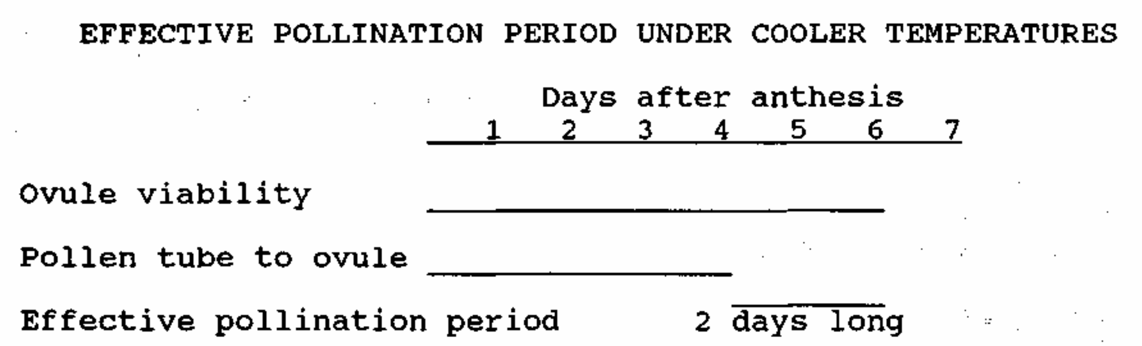


Figure 2.

The goal of our research is to increase fruit set and yield by improving the probability that fertilization will occur. Our approach is to lengthen the duration of the effective pollination period by increasing the growth rate of the pollen tubes and extending the period of ovule viability. The finite period of time during which fertilization can successfully take place is called the effective pollination period. Conceptually and mathematically, the effective pollination period of a crop is the longevity of the ovule minus the length of time required for the pollen tube to reach the ovule to deliver the sperm to the egg so that fertilization can take place.

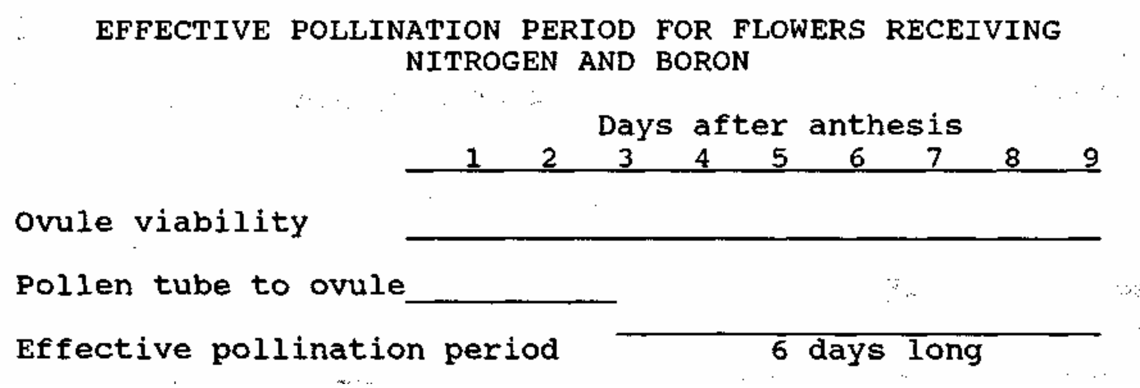


Temperatures prevailing during bloom are known to influence the effective pollination period of a seeded-fruit crop, such as avocado, and thus influence fruit set and yield. Cool temperatures which prevail during the flowering period decrease the viability of the ovule and increase the length of time it takes for the pollen tubes to grow from the stigma to the ovule. Thus, the duration of the effective pollination period is significantly shortened and fruit set is reduced. Warm temperatures during flowering increase both ovule longevity and the growth rate of the pollen tubes. This correspondingly increases the effective pollination period and thereby fruit set.

Ovule viability has been improved in deciduous tree crops by a summer application of nitrogen despite the fact that the trees were not nitrogen-deficient (Williams, 1965). The use of nitrogen to enhance ovule viability, fruit set and yield in avocado has not been investigated.

It has been known for a long time that boron is essential for pollen germination, for successful growth of a pollen tube through the stigma, style, and ovary to the ovule, and for the mitotic divisions necessary to produce the sperm (for review, see Lovatt and Dugger, 1984) . Boron applied during fall or spring to trees that were not boron deficient increased fruit set in a number of deciduous fruit tree crops (Batjer and Rogers, 1953; Chaplin *et al. ,* 1977; Thompson and Batjer, 1950), especially when cooler temperatures prevailed during bloom (Hanson and Breen, 1985) . An investigation of the effect of boron on fruit set of the 'Hass[1] avocado has recently been initiated in South Africa. Fruit set and yield were improved, although not significantly, by spraying trees with 0.27 oz. Solubor per gallon of water at the early stages of flowering (Robbertse et *al*., 1992).

On the basis of these findings, we designed a field trial to test the hypothesis that fruit set and yield of avocado can be improved by increasing the effective pollination period by prolonging ovule viability with a bloom application of nitrogen and accelerating pollen tube growth rate with a bloom application of boron.



Warren Currier, Secretary of the California Avocado Development Organization, was the driving force behind this research, which was funded for the first two years by CADO. The research was initiated in collaboration with Dr. Howard Ohr, Cooperative Extension Plant Pathologist, and Dr. Guy Witney, Farm Advisor, University of California, Riverside. We have completed two years of field research, will harvest the third year this June, and will continue the research for two additional years with matching funds from the California Avocado Society and the California Department of Food and Agriculture Fertilizer Research and Education Program. We are indebted to Dick Whiley of AgriSpec and Chris Taylor of the Limoneira Company for their cooperation and use of the 'Hass' avocado orchards.

The first year of the field experiment was a screening trial employing only 8 individual tree replicates per treatment. The optimum treatment conditions determined in the first year were employed in the second and subsequent years in well-replicated experiments employing 16 individual tree replicates per treatment.

Nitrogen was applied to the canopy as 1.6 pint Unocal Plus, liquid low-biuret urea (20% N, 0.1% biuret) in 2 to 4 gallons of water at pH 5.5 to 6.5. This application rate supplies 6 oz. (0.375 lbs.) N to the tree.

Boron was applied to the canopy as 1.06 oz. (0.066 lbs.) Solubor, granular sodium tetraborate (20.5% B) in 4 gallons of water at pH 5.5 to 6.5. This application rate supplies 0.22 oz. (0.014 lbs) B to the tree.

Maximum increase in yield was obtained by spraying the canopy when approximately 50% of the trees in the orchard had 50% of their inflorescences at chest height at the early bloom stage of inflorescence development depicted in figure 4, approximately mid-March. Inflorescences on some trees, especially at the top of the tree, were more advanced. A positive but less dramatic response in yield was obtained when the majority of inforescences were at the more advanced stage shown in Figure 5, approximately mid-April. Application of nitrogen or boron at budbreak (early January) (Figure 3) did not have any effect on yield.

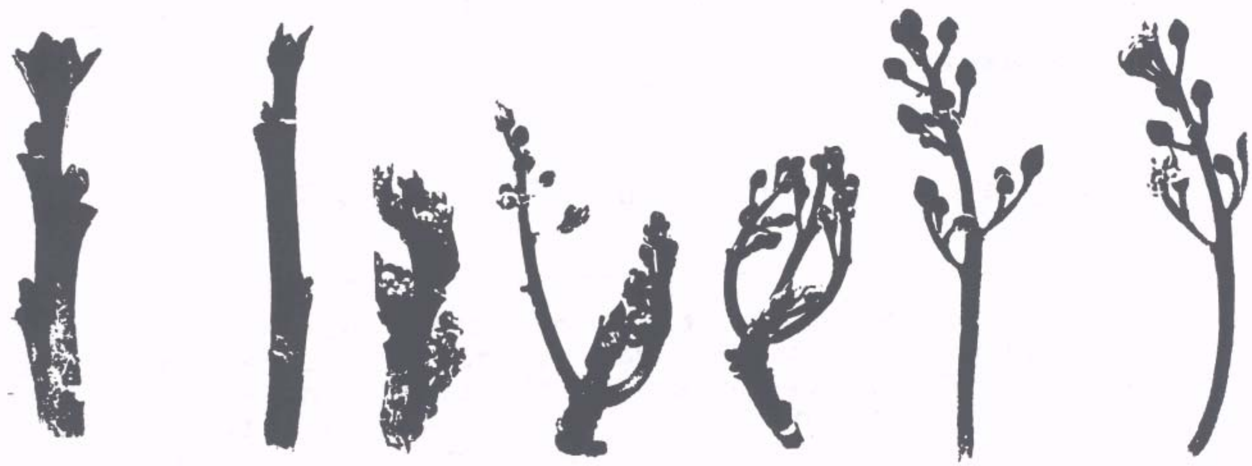


Figure 3. Figure 4. Figure 5.

Although not significant at the 5% level, for the first year of the study (an "off" year) the single application of low-biuret urea to the canopy during early bloom (Figure 4) resulted in 75 lbs. more fruit per tree, a 50% increase in yield over the untreated control trees. This resulted in an increase of $275 per tree net return to the grower. Two canopy sprays of boron, one at early bloom (Figure 4) and a second approximately 30 days later when the inflorescences were more expanded (Figure 5) , were required to increase yield over the control trees, but the increase was only half that obtained with the single early bloom spray of urea.

In the second year of the study (an "on" year) , the single application of boron to the canopy during early bloom (Figure 4) resulted in 126 lbs. more fruit per tree, a 50% increase in yield over the untreated control trees ($P<0.05$). This resulted in an increase of $40 per tree net return to the grower. No other treatment significantly increased yield over the control.

Two additional results obtained from this research must be noted. First, there was a significant negative interaction resulting in a reduction in yield for trees receiving early bloom sprays of both urea and boron, regardless of whether urea was applied simultaneously with boron or 72 hours prior to boron. Second, use of trunk injections of urea or boron to raise the tree nutrient status at early bloom without spraying the developing flowers provided strong evidence that the nutrients must be applied directly onto the developing flowers. Trunk injections successfully increased the nutrient content of the leaves but did not increase yield. This result is consistent with the fact that the early bloom canopy spray of urea increased yield despite the fact that urea is not taken up by mature avocado leaves on the trees at the time of treatment (Nevin et al. , 1989).

In deciding whether to apply urea or boron during avocado bloom, the boron status of the orchard must be considered in order to avoid increasing leaf boron content to *a* toxic level. The results obtained in South Africa (Robbertse et *al.,* 1992) suggested that boron uptake by mature avocado leaves was limited. Our results demonstrated an average 10 ppm increase in leaf boron content in response to the early bloom boron spray.

If and when the application of either nutrient is made, it is critical to check and, if necessary, to adjust the pH of the spray solution to a value between pH 5.5 to 6.5 prior to spraying the trees to avoid damaging the flowers.

The author thanks the members of Dr. Ohr's and her laboratory for assisting with the harvests. Use of tradenames in this publication does not imply endorsement of the products named nor criticism of similar products not mentioned.

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