Developing Field Strategies to Correct Alternate Bearing (II)

Carol Lovatt
UC Riverside

Jess Ruiz - Irvine Company
O'Hara Ranch

Project overview

In alternate bearing 'Hass' avocado orchards, yield is reduced below the potential of the orchard and grower income is significantly reduced during off-crop years. The goal of this research is to increase grower profitability by developing strategies to correct alternate bearing. Our prior research identified the following mechanisms and underlying physiology by which the young developing on-crop of fruit influences flowering and yield the next year:

1. The developing on-crop reduces floral shoot development and increases vegetative shoot development and the number of inactive buds.
2. The contribution of shoot flushes to return bloom is summer > spring > fall.
3. Early fruit removal increases floral shoot development, but fruit must be removed before mid-September for the number of determinate inflorescences to increase; fruit removal in October and after reduces floral shoot number and increases vegetative shoot number. Harvest your mature crop before mid-September, if possible harvest earlier. Fruit thinning by size picking will help increase return bloom.
4. Mature fruit have only a slightly stronger effect than young fruit on spring and summer flush shoots; young fruit have a stronger effect on fall flush shoots
5. Axillary buds on summer shoots are floral, the on-crop inhibits the development of summer shoots and greatly reduces return bloom; axillary buds on fall shoots are predominantly vegetative and contribute vegetative shoots in spring.
6. The on-crop inhibits spring bud break.
7. Fruit export hormones that inhibit the growth of buds producing the summer and fall shoots by correlative inhibition and inhibit bud break in spring with inhibition greatest in axillary buds of summer flush shoots > axillary buds of fall flush shoots.

This was first year of this project. To meet Objective 1 (Year 1), we trunk injected the following PGR treatments: (i-ii) a cytokinin, 6-benzyladenine (BA) in early July; (iii) an auxin transport inhibitor, triiodobenzoic acid (TIBA) in early July; and (iv) a gibberellic acid, GA_3 applied as a canopy spray in early July. For treatment (v), we will repeat treatments i-iv above on a separate set of trees in mid-January and mid-February, respectively. These treatments are being tested in two separate orchards located in Irvine and Santa Paula. In addition, at these sites we initiated the preliminary screening of natural compounds that would not require registration as a PGR and we also started adapting the treatments to foliar sprays.

To get a head start on the proposed research, we trunk injected on-crop 'Hass' avocado trees in Irvine with BA, GA, and proprietary compounds X + Y in January 2009 to test the capacity of the PGRs to increase bud break in spring following the setting of a heavy on-crop.

Results

The January PGR treatment of compound X combined with compound Y increased the total number of floral shoots (*P* = 0.0693), the number of determinate inflorescences (*P* = 0.0789), which are typically absent during the spring bloom following the setting of a heavy on-crop, and the number of floral shoots that developed on branches bearing fruit (*P* = 0.0793) compared to untreated on-crop control trees (Table 1). These results demonstrate the potential of this treatment to overcome the inhibitory effect of the heavy on-crop of fruit on spring bud break and return bloom. The treatment combining compounds X + Y numerically, but not significantly, increased the number of indeterminate floral shoots that developed and the number of floral shoots that developed on branches not bearing any fruit, demonstrating that combination of compounds X + Y had no negative effects. The combined treatment was effective because both compound X and compound Y had an intermediate effect on the number of floral shoots that developed on branches with fruit and compound X also had an intermediate effect on increasing the number of determinate floral shoots that developed. Yield for these trees will be determined in June-July 2010.

The initial results presented in Table 1 are encouraging given that fact that no treatments had been used to increase summer vegetative shoot development.

Table 1. Effect of Trunk Injected PGRs on Spring Bloom of 'Hass' Avocado Trees Bearing an On-crop.

Treatment	Time	Total floral shoots	Determinate floral shoots	Indeterminate floral shoots	Floral shoots (on branches with fruit)	Floral shoots (on branches without fruit)
		No. of shoots per 100 nodes				
On-crop control	Jan	6 b[z]	1 b	5	5 c	7
Compound X	Jan	10 ab	3 ab	7	8 abc	10
6-BA	Jan	9 b	1 b	8	9 abc	9
GA_3	Jan	7 b	2 b	6	6 bc	8
Compound Y	Jan	9 b	1 b	8	11 ab	8
Compounds X + Y	Jan	15 a	8 a	7	12 a	16
P-value		0.0693	0.0789	0.2906	0.0793	0.1618

[z] Means within a column followed by a different letter are significantly different at specified *P*-value by Fisher's Protected LSD Test.

Take home message

Having sufficient summer flush shoots is the key to having a good return bloom and a good return crop when the trees have set a heavy on-crop. Both setting and mature fruit inhibit the development of these shoots, which in turn reduces the number of sites that are available to bear inflorescences the next spring. The setting on-crop also inhibits bud break of axillary buds in spring on the reduced number of summer and fall shoots that develop, further reducing the floral intensity of the return bloom. Carrying mature fruit past July significantly reduces return bloom and, in particular, the number of highly productive determinate inflorescences. The summer vegetative shoot flush must be stimulated to grow to increase return bloom in the spring following the setting of a heavy on-crop to increase return yield and prevent an off-crop. Promoting fall shoot development will do little to increase floral intensity in the spring following an on-crop year. In addition to the need to increase the number of summer flush shoots to increase return bloom and yield, spring bud break needs to be increased. This project tests the efficacy of PGR treatments to increase return floral intensity and yield.

Benefits of the research to the industry (includes achievements and future prospects)

Alternate bearing is initiated by environmental factors, especially climatic events, e.g. freeze, high temperatures, etc. Thus, there is a recurring need for a strategy to mitigate alternate bearing once it is initiated. The results of this research will provide a strategy that can be used in such cases to mitigate alternate bearing. This will contribute significantly to grower profitability. The results of a single experiment using PGR treatments to overcome the inhibition of spring budbreak are promising, must await the yield results at harvest in June-July 2010.

To enhance my ability to conduct research on behalf of the avocado growers of California, I wrote and submitted, with an Israeli colleague, a BARD grant in September 2008. We were asked to collect preliminary data and resubmit the proposal. We are in the process of doing this and will resubmit in 2010. I wrote and submitted an IR-4 proposal in October 2008 and again in October 2009 to continue research with GA_3, and a CDFA Specialty Crops grant in April 2009. We plan to resubmit this proposal. To date I personally have obtained $257,218 in funding from the CDFA-FREP program to conduct research optimizing fertilization of the 'Hass' avocado and an additional $245,000 from the CDFA-FREP in collaboration with Dr. Richard Rosecrance, CSU-Chico, and Dr. Ben Faber, UCCE-Ventura and Santa Barbara, for the avocado tree dissection research to determine up-take and partitioning of soil nutrients in response to crop load and for the development of a demand driven web-based fertilization program. Further, Dr. Rosecrance was awarded partial matching funds from CSU for the two collaborative projects. Thus, I have played a key role in bringing over half a million dollars from outside CAC to avocado research for improving fertilization and, hence, productivity and grower profitability.