Phase III for GA_3 and Phase II for 2,4-D and AVG for Commercial Use on 'Hass' Avocado

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Project overview

California avocado growers must increase yield, including fruit size, and/or reduce production costs to remain competitive in the US market, which now receives fruit from Mexico, Chile, New Zealand, Dominican Republic and an increasing number of other countries (http:// www.ers.usda.gov/ Data/ Fruit VegPhyto/Data/fr-avocados.xls). Despite its popularity, the 'Hass' cultivar (*Persea americana* Mill.) is known to be problematic with regard to fruit retention, fruit size and alternate bearing. Plant growth regulators (PGRs) are powerful, cost-effective tools for increasing yield of commercially valuable large size fruit and mitigating alternate bearing in the field. The goal of my research program is to provide growers with a basic understanding of 'Hass' avocado tree phenology and physiology and the tools to increase net income per acre for growers of the 'Hass' avocado in California. To meet this goal we are developing fertilization and plant growth regulator (PGR) strategies to increase total yield and yield of commercially valuable large size fruit. For the PGR strategies we are simultaneously collecting the efficacy data necessary to satisfy the requirements of the California Department of Pesticide Regulation (DPR) to have the successful plant growth regulators added to an existing label so that they can be legally used in avocado production in California.

The specific goal of the proposed research is to obtain the efficacy data necessary to add a PGR use for avocado to an existing PGR label. To achieve this goal, the specific objectives of the proposed research are: (1) to collect dose response data for GA_3 during an on-crop year; (2) to demonstrate that the ability of AVG, 2,4-D and 3,5,6-TPA to increase fruit size is reproducible in a second avocado orchard representing a different avocado-growing area of California; and (3) to demonstrate that the yield of large size fruit responds incrementally to increases in dose of one or more of the following - AVG, 2,4-D, and 3,5,6,TPA.

To meet objective 1 GA_3 will be applied at 10, 25, 60 and 120 mg/L at the cauliflower stage of inflorescence development. To meet objective 2 AVG (250 mg/L) will be applied *i*) at the cauliflower stage of inflorescence development or *ii*) at full bloom, *iii*) 2,4-D (40 mg/L; 38 g acid equivalents/acre) applied when fruit are 17-20 mm in diameter and *iv*) 3,5,6-TPA (10 mg/L) applied when fruit are 16-20 mm in diameter to increase yield by increasing fruit retention during June drop and by increasing fruit size. To meet objective 3, strategies using AVG, 2,4-D or 3,5,6-TPA that successfully (significant at the 5% level) increase total yield or yield of large size fruit in this second orchard for two consecutive harvests or as the 2-year average or 2-year cumulative yield compared to the untreated control and are

deemed cost effective will be included in a new experiment to demonstrate dose response. Untreated trees will serve as the control in each case.

Results

All PGR treatments were applied to 20 individual trees (replications) in a randomized complete block design that included 20 untreated control trees. All PGR treatments were included in a minimum of two orchards; some were incorporated into experiments at three separate orchards. The research is on schedule. All PGR applications were made according to avocado tree phenology. To facilitate the use and reliability of PGR treatments that are applied just prior to the period of exponential increase in fruit growth, we are testing whether fruit transverse diameter between 17 and 20 mm can serve as a biological marker for timing the application. To do this we are comparing how close in time the two phenological events occur each year in the different orchards and comparing the efficacy of the PGR applied just prior to the period of exponential increase in fruit growth on one set of trees with the efficacy of the PGR applied when fruit are 17 to 20 mm in transverse diameter on another set of trees in the same orchard. Data collected on fruit set and fruit size in September suggest that the application times are comparable, but yield results from harvest in 2010 and 2011 will be required before making a final decision. Note that 2,4-D was always applied when fruit were 17-20 mm in diameter and is, thus, not included in this comparison.

Fruit set and fruit size was determined at the end of September (7 months after treatment application) in the two orchards in which we are conducting the GA_3 dose response research. In commercially bearing 'Hass' avocado orchard 1 located in Santa Paula, 25 mg/L GA_3 significantly increased both fruit set and fruit size compared to the untreated control (Table 1). The negative effect of 60 mg GA_3/L on fruit set in this orchard was unanticipated; there was no negative effect at this rate in orchard 2. Higher concentrations were included to test for phytotoxicity. Whereas no damage was observed to the canopy, GA_3 at 120 mg/L significantly reduced fruit set by September in both orchards. In Orchard 2 in Somis, the effect of increasing GA_3 concentration followed the same trend as in orchard 1 but the treatment at 25 mg GA_3/L did not result in a statistically significant increase in fruit set or fruit size compared to the untreated control. In orchard 2, we only collected data from a subset of the replications. Harvest for both orchards will be between June and September 2010. Maturing fruit from year 1 receive a second treatment in year 2 (March-April) before harvest. Application of GA_3 to mature fruit at this time has been shown to have a positive effect on fruit size (Salazar-Garcia and Lovatt, 2000). Thus, we are cautiously optimistic that 25 mg/L will prove an effective label rate but the yield results from the harvests in 2010 and 2011 are required.

Table 1. Concentration effect of GA_3 applied at the cauliflower stage of inflorescence development on fruit set (average number of fruit per branch) and fruit size (transverse diameter in mm) of young, developing 'Hass' avocado fruit in commercial orchards in two different avocado-growing areas of California.

GA_3 concentration mg/L	Orchard 1-Santa Paula		Orchard 2-Somis	
	Fruit set	Fruit size	Fruit set	Fruit size
0 - Control	1.67 bc [z]	47.40 c	2.69 a	48.03 bc
10	1.87 b	47.63 bc	2.55 a	47.61 c
25	2.33 a	48.38 a	2.92 a	48.67 ab
60	1.40 c	48.07 ab	2.58 a	49.13 a
120	1.50 c	48.05 ab	1.54 b	49.00 a
P-value	<0.0001	0.0238	<0.0001	<0.0001

[z] Values in a vertical column followed by different letters are significantly different at specified *P*-value by Fisher's Protected LSD Test.

In this research we included a treatment in which GA_3 (25 mg/L) is applied at the cauliflower stage of inflorescence development and again when fruit are 17-20 mm in transverse diameter. This treatment significantly increased fruit diameter by the end of September with no effect on fruit set. Analysis of fruit set and fruit size data for AVG, 2,4-D and 3,5,6-TPA will be completed in November.

Take home message.

This research includes PGRs that have proven efficacious in at least one avocado-growing area of the state for increasing total yield and the yield of commercially valuable fruit of packing carton sizes 60 + 48 + 40. The goal of the current project is to reproduce these results in a second orchard in a different avocado-growing area. For GA_3, we are at the stage of demonstrating that yield parameters respond incrementally with GA_3 application rate (dose). The research for this project is on schedule. To avoid delays caused by adverse climate events, all treatments have been replicated in two orchards located in different avocado-growing areas. Some are replicated in three orchards. Whereas the results from GA_3 dose response experiment and positive effect of applying GA_3 (25 mg/L) at the cauliflower stage of inflorescence development and again when fruit are 17-20 mm in transverse diameter on fruit size are consistent with the yield benefits we hope to achieve at harvest, we must await the final results on yield from the harvests in year 1 in 2010 and year 2 in 2011.

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

The research being conducted in this project supports the objectives, expectations and vision of the California avocado industry of increasing grower profitability. Over the past years, we have gained experience regarding the response of the 'Hass' avocado to several commercial PGRs applied at specific stages of tree phenology. We are striving to collect the efficacy data necessary to make these PGRs available for commercial use by California avocado growers.

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 additional 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.

Literature Cited

Salazar-Garcia, S. and C.J. Lovatt. 2000. Use of GA_3 to manipulate flowering and yield of the 'Hass' avocado. J. Amer. Soc. Hort. Sci. 125:25-30.