

USE OF THE PLANT GROWTH REGULATOR GA₃ TO INCREASE AVOCADO FRUIT SIZE AND YIELD



Plant Stimulants first reported in 1920s

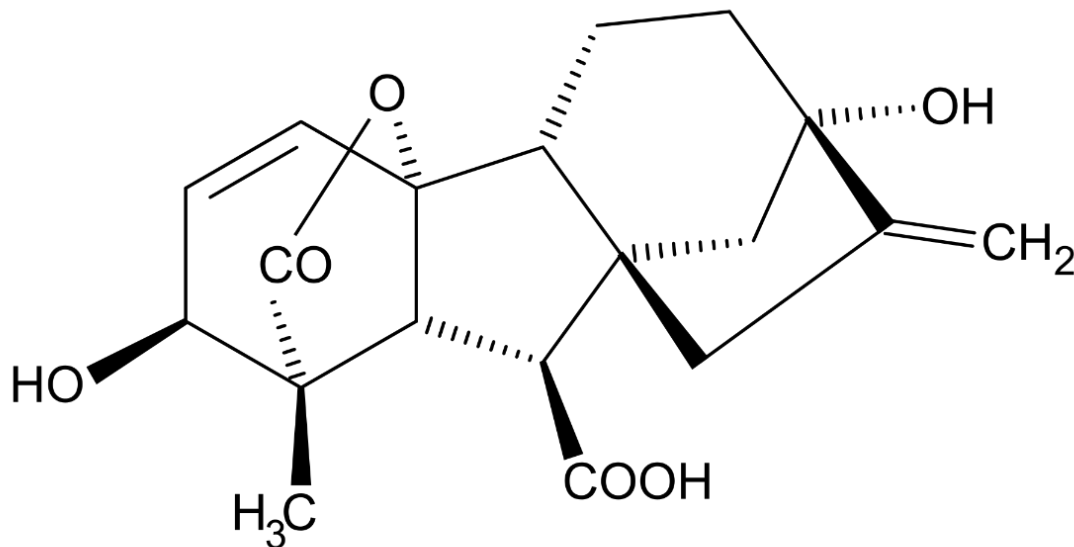
- Hormone – “to set in motion”, a trigger, generated by the plants as opposed to a nutrient, which is externally supplied to the plant usually through root
- Phytohormones – hormones generated by plant cells,
- Plant Growth Regulators (PGR) – synthetic/natural stimulants applied to plants, need to be registered
- Biostimulants/bioregulators – substances/organisms applied to stimulate plant processes
- Systemic Acquired Resistance (SAR) – salicylic/jasmonic acid pathways to resist pathogen infection
- Plant Chemical Communication

Hormone Groups

- First identified was Ethylene* - Egyptians/Chinese for ripening
- Gibberellic Acid/Gibberellin/GA3* in 1920s – shoot, seeds etc.
- Auxins – shoot elongation, e.g. IAA, IBA, NAA* in 1920s
- Cytokinins – cell division
- Abscisic Acid – inhibits growth
- So all aspects of growth - rooting, dormancy, germination, flowering, stress tolerance, etc. and are often used as PGRs to improve plant performance
- Many of these PGRs are naturally occurring, some like uniconazole and paclobutrazol for controlling tree size and improving fruit set are not naturally occurring

*hormones registered for use in avocado

- GA3 is naturally occurring, but is produced commercially by fermentation
- It stimulates cell division and elongation, breaks seed dormancy, increases seed germination
- Increases fruit size in grapes, reduces seediness in mandarins
- Many different Gibbs – labeled 1-130, not all bioactive



PGRs in various concentrations, combinations and ratios have significant effects if they happen at the right time and the right conditions.

They can have radically different effects at high and low concentrations.

Like when temperatures are right, pollinators are flying, and trees are healthy.

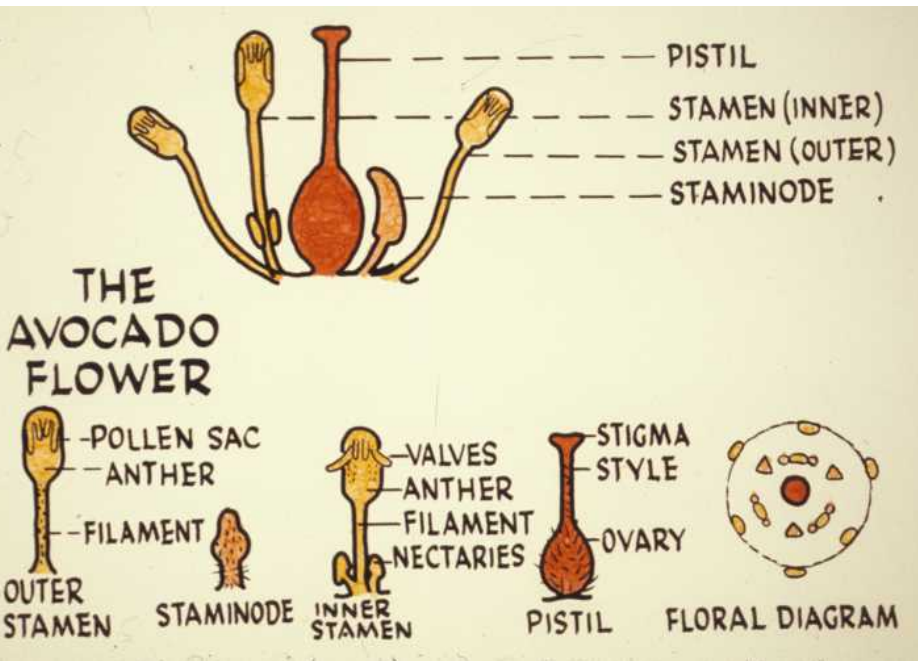


For fruit set, things need to happen in the right order and conditions, much of this timed by hormones

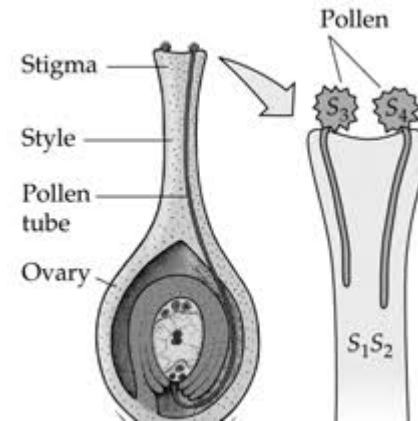
- Pollination – movement of pollen to pistil
- Pollen Tube growth
- Fertilization – pollen tube contacts ovule
- Need egg to grow
- Not exactly clear how GA3 affects the process

And the conditions need to be right for this to happen –
weather - sun, temperature, tree/flower condition

Pollination

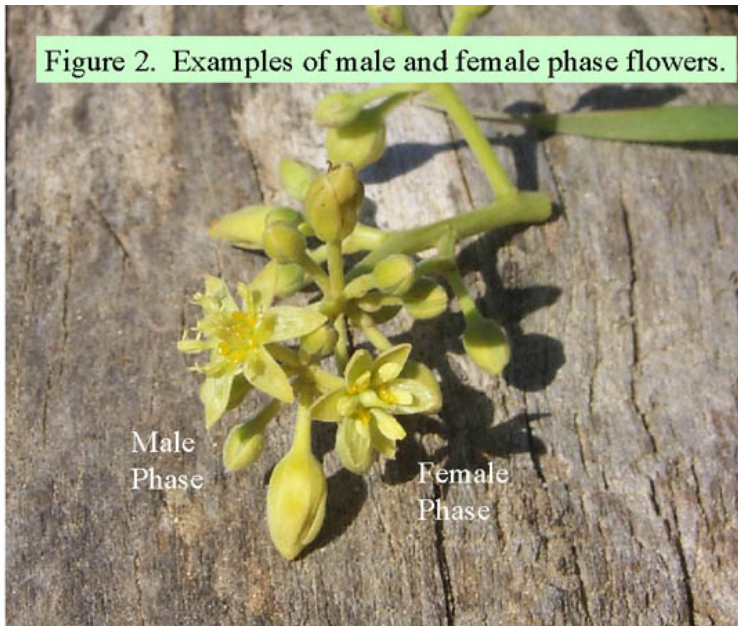


Fertilization



And the temperatures need to be right for pollen tube growth

Figure 2. Examples of male and female phase flowers.



A close-up photograph of an avocado branch with several small, light-colored flowers and large, dark green leaves. The background is slightly blurred, focusing attention on the flowers and leaves in the foreground.

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Increasing Avocado Yield and Profit

Plant growth regulators (PGRs) are the most powerful tools available for increasing fruit size and yield in an existing orchard to increase grower net profit.

On March 27, 2018, gibberellic acid (GA_3) was approved for use on avocado to increase fruit size and yield.



ProGibb LV Plus®

- 1) Manufactured by Valent BioSciences, Corporation (Libertyville, IL) is the only GA₃ registered for use on avocado to increase fruit size and yield – SLN.
- 2) ProGibb LV Plus® is a low volatile organic compound (LVOC); little offsite drift potential
- 3) ProGibb® and generic GA₃ products *cannot* be used.
- 4) ProGibb LV Plus® has the advantages that:
 - (a) restricted entry interval is only 4 hours;
 - (b) preharvest interval is 0 days; and
 - (c) it can be used in certified organic orchards.

Application Time

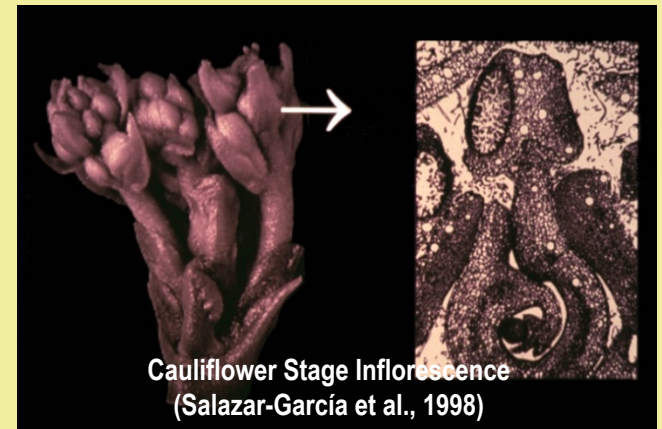
1) ProGibb LV Plus[®] is applied as a foliar spray at the cauliflower stage inflorescence development

2) When 50% of the trees in the block have 50% of their bloom

at the cauliflower stage, i.e., 25% of the bloom will be at an earlier stage and 25% will be approaching bloom (open flowers).

3) If you are unable to make the application at this time, being slightly late in applying GA₃ gives better results than being too early.

4) Applications made at full bloom are typically not effective.



Timing can be difficult because of different stages top and bottom of hill, north and south side of trees, top and bottom of tree



And need to avoid unusual weather —
hot or cold weather will affect fruit set
Early sprays may be too cool for fertilization

- At this time, it's not clear how long the gibb effect is. Whether in a normal prolonged bloom, multiple sprays would be effective or safe. (With coastal lemons, late season sprays can cause phytotoxicity.)
- Only one application is allowed at this time.
- Treated trees should always be adequately well watered.

Late cauliflower
popcorn

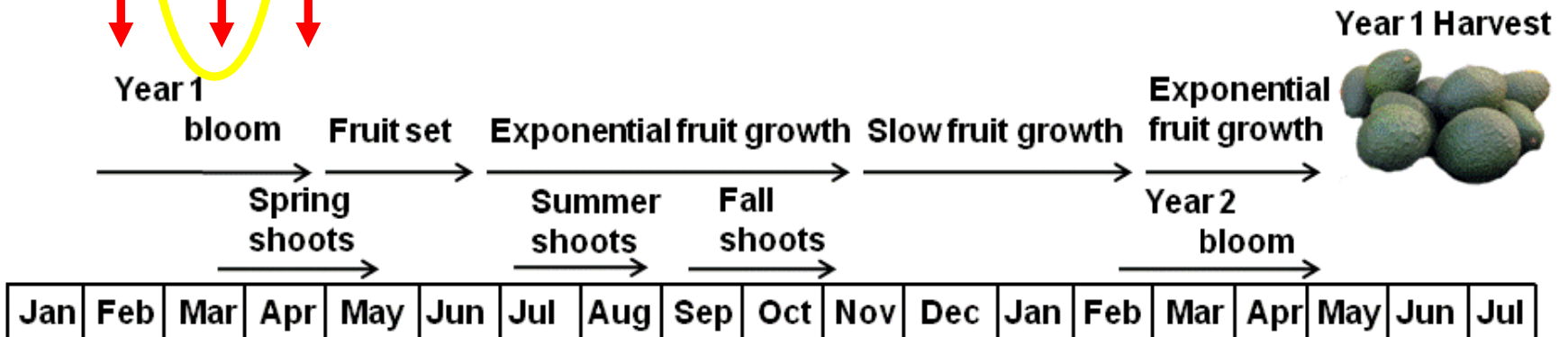
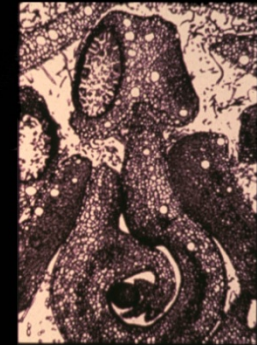
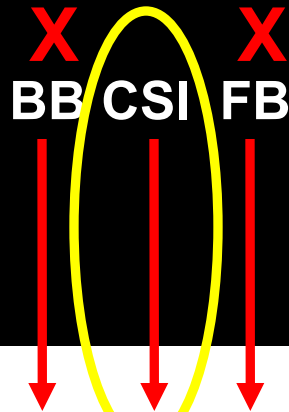


GA₃ Application Time Related to 'Hass' Avocado Tree Phenology

BB = Bud break

CS = Cauliflower stage inflorescence

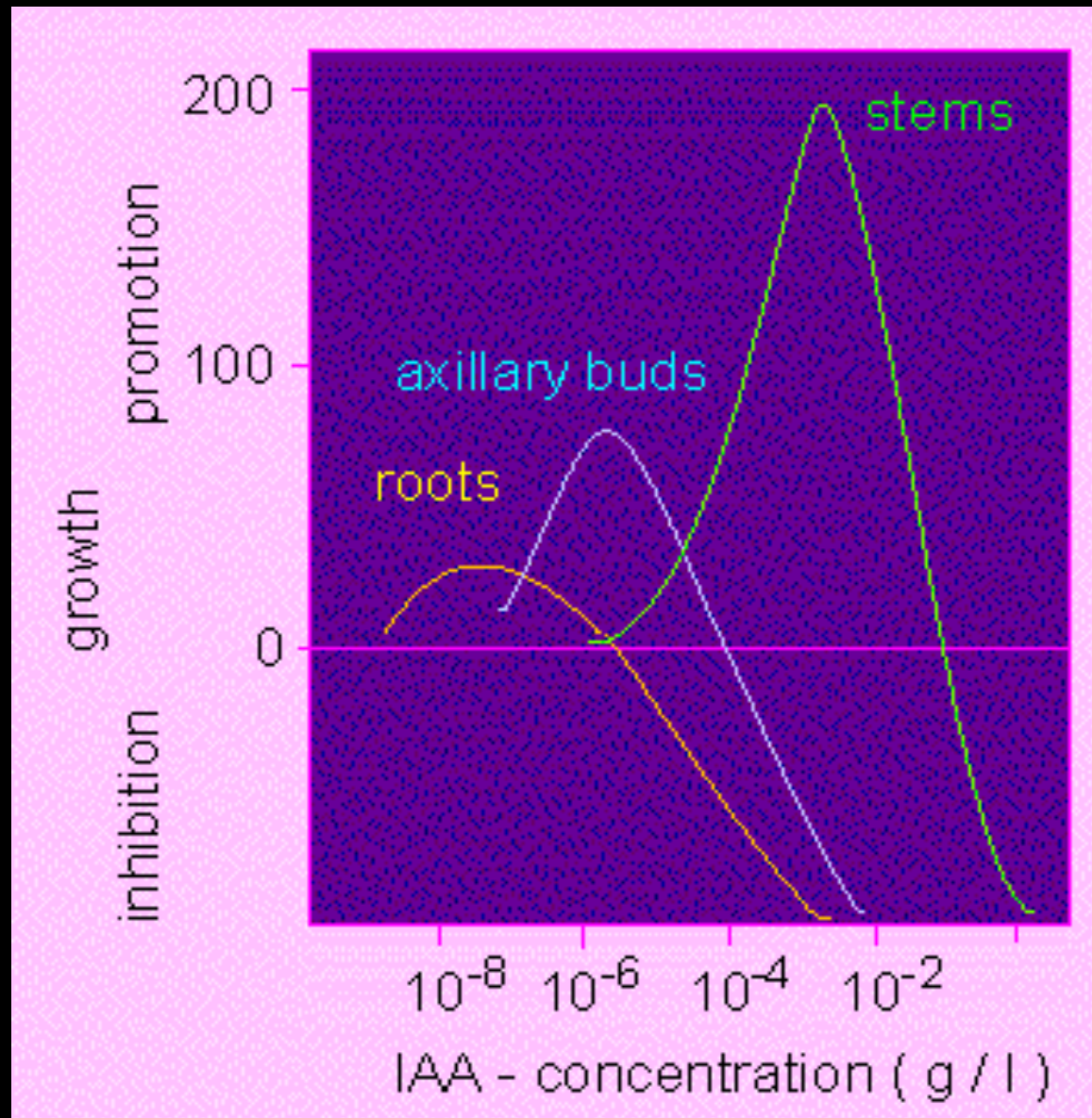
FB = Full bloom



Dose and Dilution Rate

- 1) ProGibb LV Plus[®] is applied like a pesticide spray:
 - (a) to give full canopy coverage;
 - (b) especially of the developing inflorescences;
 - (c) do not spray to run-off.
- 2) Ground application - 12.5 fluid ounces of ProGibb LV Plus[®] (25 grams active ingredient [g ai]) in 100 gallons of water/acre.
- 3) Aerial (helicopter) application - 12.5 fluid ounces ProGibb LV Plus[®] (25 g ai) in 75 gallons of water/acre.
- 4) Maximum allowed - 25 g ai GA₃/acre.
- 5) Note that lower and higher doses are less effective.

Classic PGR Response Curve



GA3 dosage
is less sensitive

Spray Solution pH and Wetting Agent

1) Final pH - 5.5 to 6.0.

(a) ProGibb LV Plus[®] is stable at pH 4.0 to 8.5.

(b) GA₃ should *not* be exposed to a pH > 8.5 to prevent breakdown of the material.

2) Wetting agent - pure organosilicone surfactant:

(a) 0.05% (final concentration) Silwett L-77[®]

(b) 0.05% Widespread Max[®]

(c) similar product

Information on Spray Volume

- 1) **Ground applications – In our research we used GA₃ (25 g ai/acre) in 200 to 250 gallons of water/acre to achieve maximum coverage, no run off and minimal solution left in the tank.**
- 2) **Label rate is 100 gallons of water/acre for ground application.**
- 3) **County Agricultural Commissioners must approve the use of more than 100 gallons of water/acre for ground application.**
- 4) **Aerial (helicopter) application - ProGibb LV Plus[®] (12.5 fluid ounces, 25 g ai) in 75 gallons of water/acre provided the greatest efficacy.**

Yield Increases

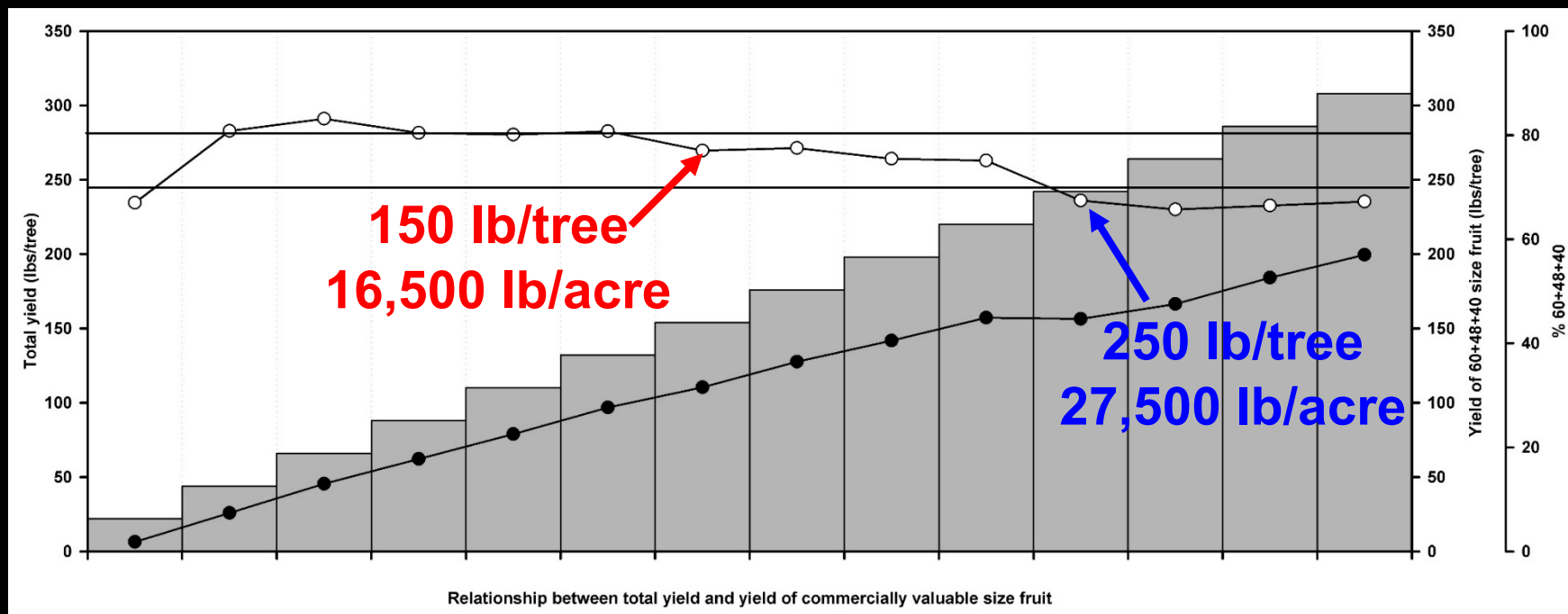
Yield parameters of control vs. GA₃-treated trees in each orchard were averaged across all orchards and years.

- 1) GA₃ produced a minimum 22 lbs net increase in total yield per tree in orchards having control trees yielding from 44 to 373 lbs/tree (~80 to 750 fruit/tree).
- 2) This is a minimum net increase of 2,425 lb/110 trees/acre in orchards producing 4,850 to 41,000 lb/acre (orchards at 3,300 lb/a had a 51% increase of 1,884 lb/a).

Yield Increases

- 3) In all cases, yield of commercially valuable size fruit increased in parallel with the increase in total yield.
- 4) Average net increases in yield were:
 - (a) 54% as lbs/tree with a 62% net increase in fruit of packing carton sizes 60+48+40 and
 - (b) 68% as number of fruit per tree with a 61% net increase in fruit of packing carton sizes 60+48+40.

As Total Yield Increases, sizes stay about the same



GRAY bars indicate total yield (lb/tree).

BLACK circles indicate average yield of commercially valuable size (CVS) fruit (60+48+40) (lb/tree).

WHITE circles are the percent CVS fruit of total yield.

Average of 20 years of ALL avocado trials, GA trials are similar

Most fruit crops decrease fruit size as yield increases !!!!!

Additional Benefits of GA₃ Applied at the Cauliflower Stage

- Significantly increases lbs and fruit number per tree if yield potential is ≥ 30 lbs/tree.
 - Yield increases are significant when averaged across ON- and OFF-crop years and as 2-year cumulative yield in alternate bearing orchards.
 - Effect on maturing crop
 - reduces pre-harvest fruit drop, increases fruit size, delays fruit blackening with no effect on ripening or on fruit quality
 - Effect on setting crop
 - increases yield and fruit size, stimulates leaf growth, which protects fruit from sunburn
-

For use of ProGibb LV Plus[®] Plant Growth Regulator on Avocado to Increase Fruit Size and Yield

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ProGibb LV Plus[®]. On March 27, 2018, gibberellic acid (GA₃) was approved for use on avocado to increase fruit size and yield. The only material registered for this purpose is ProGibb LV Plus[®], a low volatile organic compound (LVOC) formulation, manufactured by Valent BioSciences, Corporation (Libertyville, IL). Only this product may be used; the older formulation sold under the name ProGibb[®] and other generic GA₃ products cannot be used. Note: (i) the restricted entry interval is only 4 hours; (ii) the preharvest interval is 0 days; and (iii) ProGibb LV Plus[®] can be used in certified organic orchards.

Application Time. ProGibb LV Plus[®] is applied as a foliar spray at the cauliflower stage of avocado inflorescence development (Fig.1). The applications should be made when 50% of the trees in the block have 50% of their bloom at the cauliflower stage. This means that 25% of the bloom will be at an earlier stage of inflorescence development and 25% will be approaching bloom (open flowers). If you are unable to make the application at this time, being slightly late in applying the treatment affords better efficacy than being too early. Note: applications made at full bloom are typically not effective.

ProGibb LV Plus[®] Dose and Dilution Rate. The sprays should be applied like a pesticide spray to give full canopy coverage, especially of the developing inflorescences, but not sprayed to run off. For ground application, use 12.5 fluid



Fig. 1. Cauliflower stage inflorescence. Source: Salazar-García et al., 1998.



At this point, GA3 applications are under a Special Local Needs (SLN) registration which limits its use to exactly what the label says:

- One application
- No more than 25 g a.i.

More work needs to be done to see if other rates and application frequencies are more compatible with different flowering/weathering patterns.

Also with different stages of fruit growth.

- Yield improvements are only seen on healthy orchards.
- GA3 is not going to resurrect poor trees and could make them worse by adding stress.

