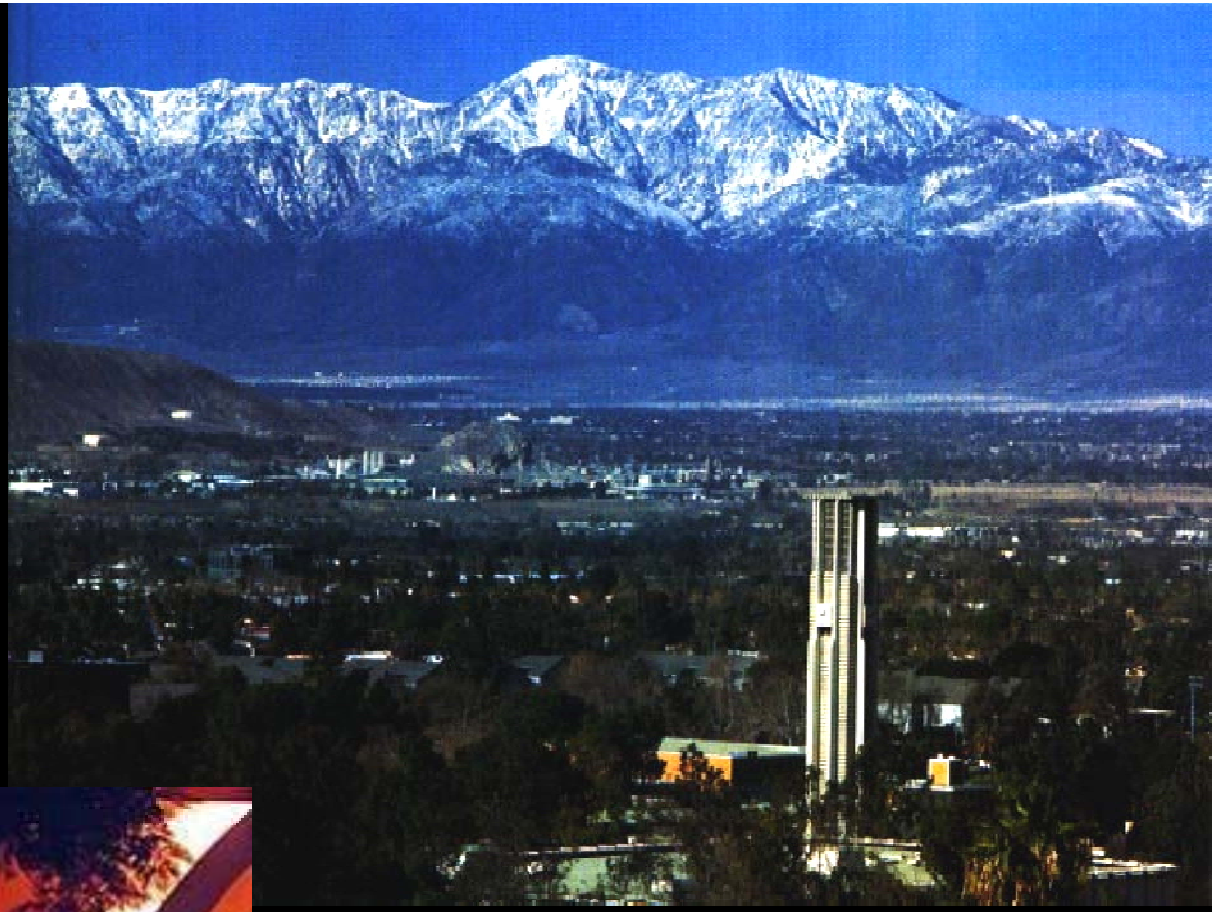

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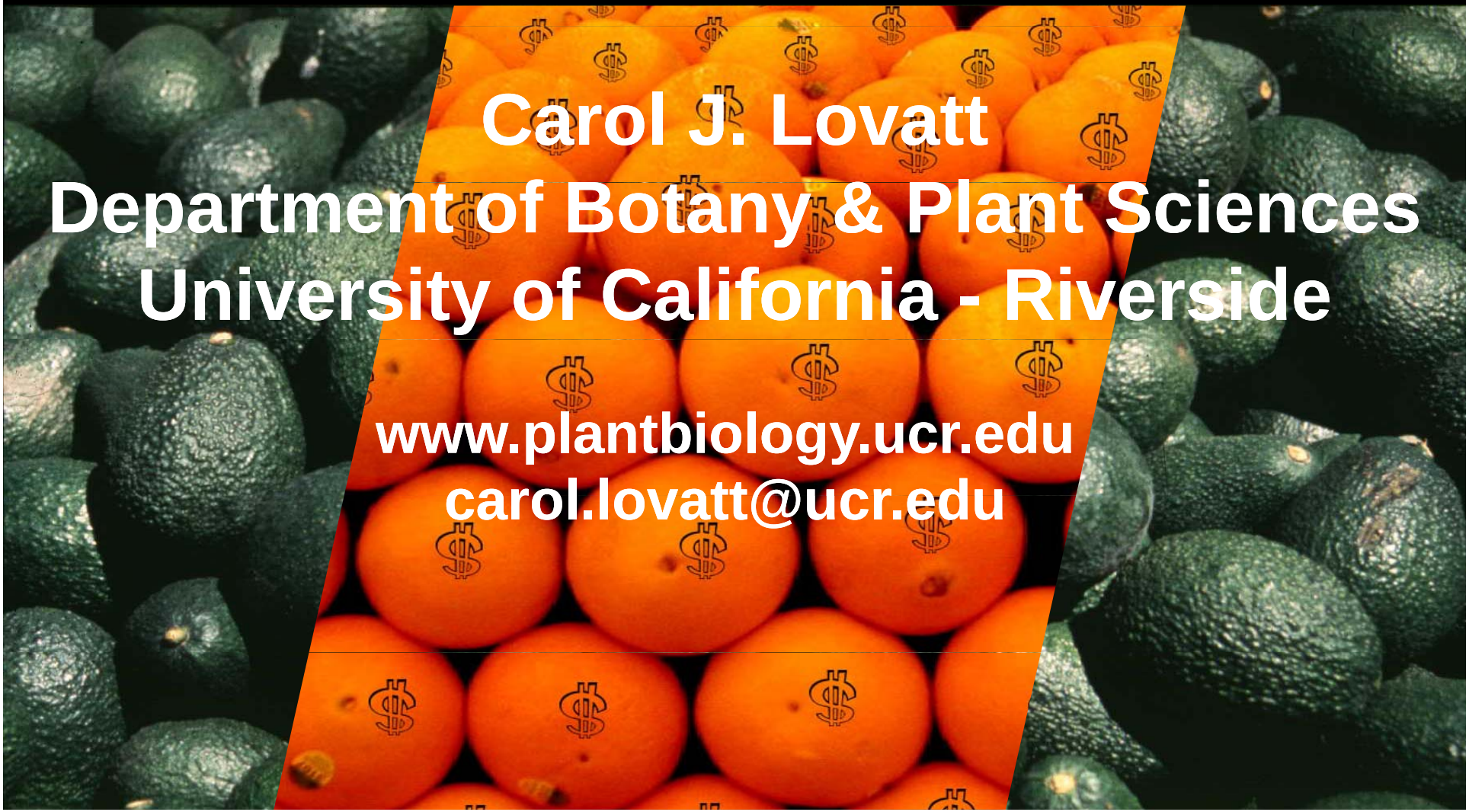
Standards for Foliar Fertilizer Effectiveness



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California Citrus and Avocado Industries

Citrus

- 271,810 acres
- 2.9 million tons
- $1.5 billion

Avocado

- 64,555 acres
- 164.2 tons
- $199.6 million

Foliar Fertilization - Benefits

Foliar fertilization reduces nutrient accumulation

- **soil**
- **run-off water**
- **surface waters (streams, lakes and oceans)**
- **groundwater (drinking water supply)**

where they contribute to euthrophication, salinity, and nitrate contamination.

Foliar Fertilization - Benefits

Many factors affect the uptake of soil-applied nutrients:

Soil moisture
Transpiration
Nutrient solubility
Soil Temperature
Root activity
Soil pH
Soil microflora
Salinity

Foliar fertilization is a rapid and efficient strategy for providing an essential mineral nutrient directly to the leaves to overcome the soil's inability to transfer nutrients to the roots or the root's inability to take up nutrients

Foliar Fertilization - Benefits

The goal in California
is to replace soil-applied fertilizers,
at least in part,
with foliar-applied fertilizers
in best management practices
(BMPs)

Foliar Fertilization - Problems

1) Not all nutrients are taken up by leaves
2) Even if taken up, not all nutrients are phloem mobile
3) *A priori* knowledge derived from research is essential to develop a foliar fertilization program for a crop

Nutrient absorption rates by leaves.

Nutrient	Time for 50% absorption
Urea	½-2 hours
Magnesium	2-5 hours
Potassium	10-24 hours
Calcium	1-2 days
Manganese	1-2 days
Zinc	1-2 days
Phosphorus	5-10 days
Iron	10-20 days
Molybdenum	10-20 days

Nutrient mobility in the phloem

Mobile	Partially	Immobile
Urea nitrogen	Zinc	Calcium
Phosphorus	Iron	
Potassium	Copper	
Chlorine	Manganese	
Sulfur	Molybdenum	
	Boron	

Our Approach

Is to provide an economic incentive

By identifying the role essential nutrients play in the physiology of the crop, and

Applying a nutrient as a foliar fertilizer at a key stage in the phenology of the tree to stimulate a specific metabolic process that increases yield, fruit size or quality, such that the foliar-applied fertilizer results in a net increase in grower income even when the tree is NOT deficient.

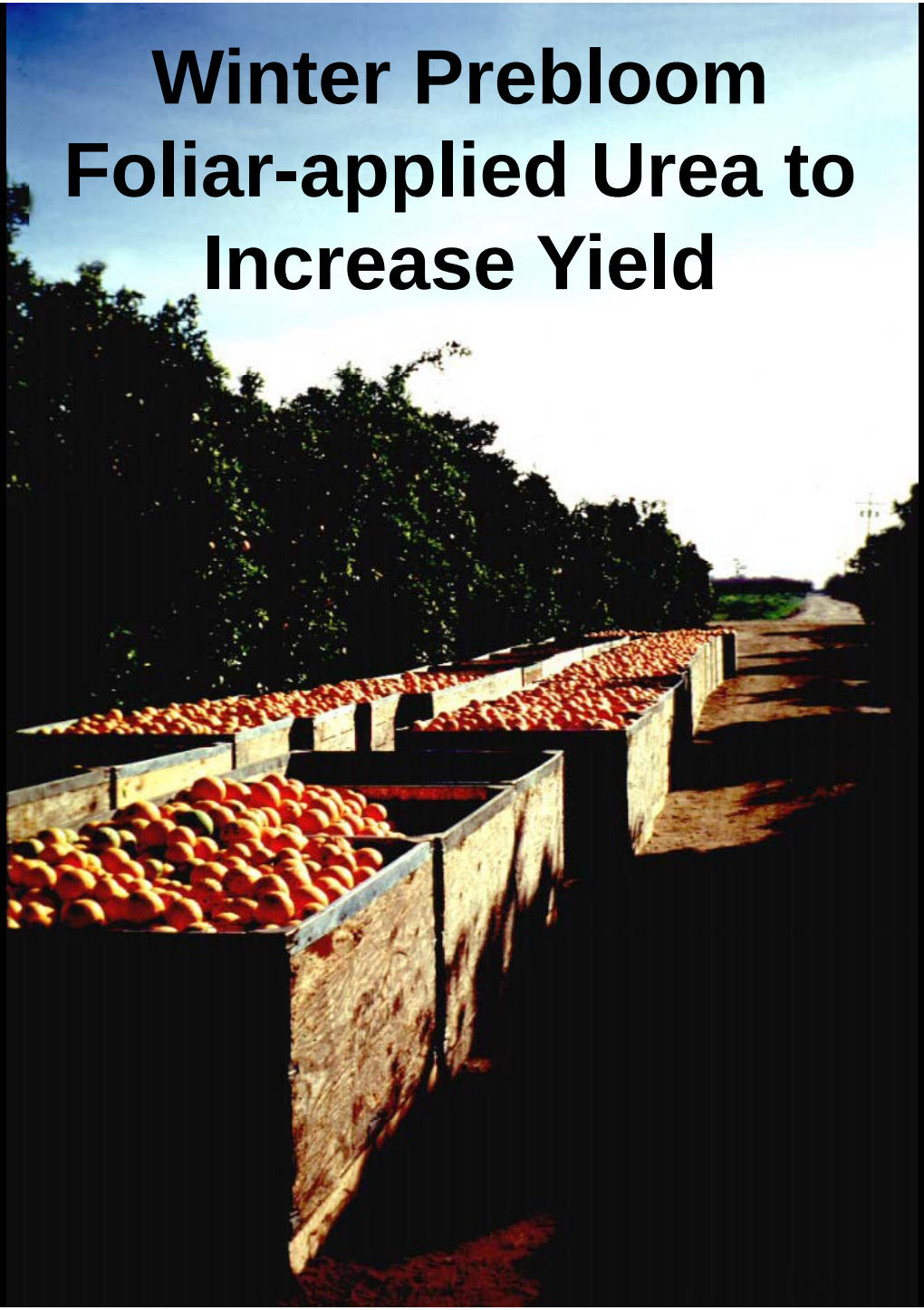
Foliar Fertilization - Benefits

**To remain competitive,
and thus, sustain the U.S.
citrus and avocado industries,
California growers must increase yield,
including fruit size,
and reduce production
costs per acre.**

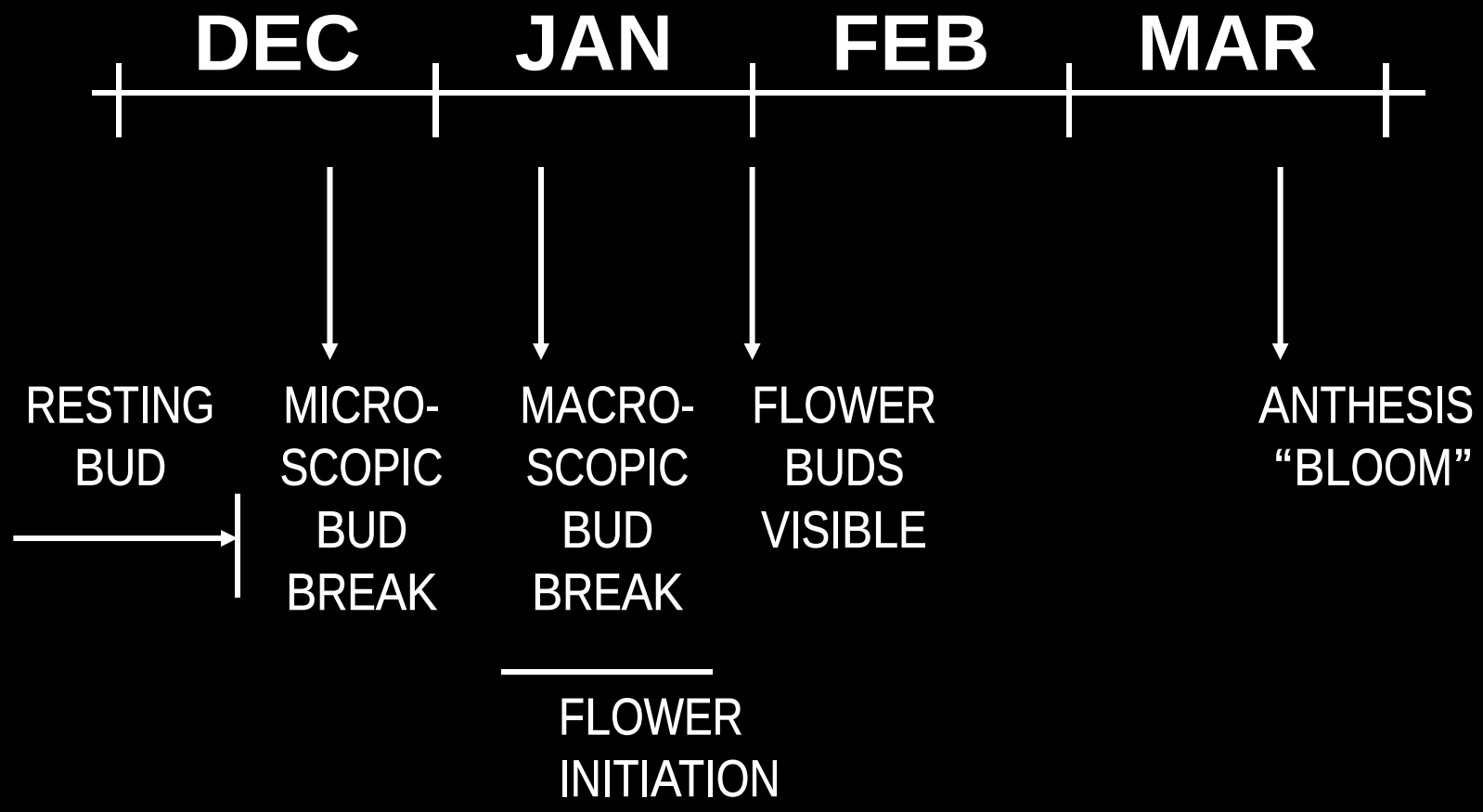
Foliar Fertilization - Benefits

Foliar fertilization
is a cost-effective strategy
for increasing yield and profitability
for citrus and avocado growers.

Winter Prebloom Foliar-applied Urea to Increase Yield

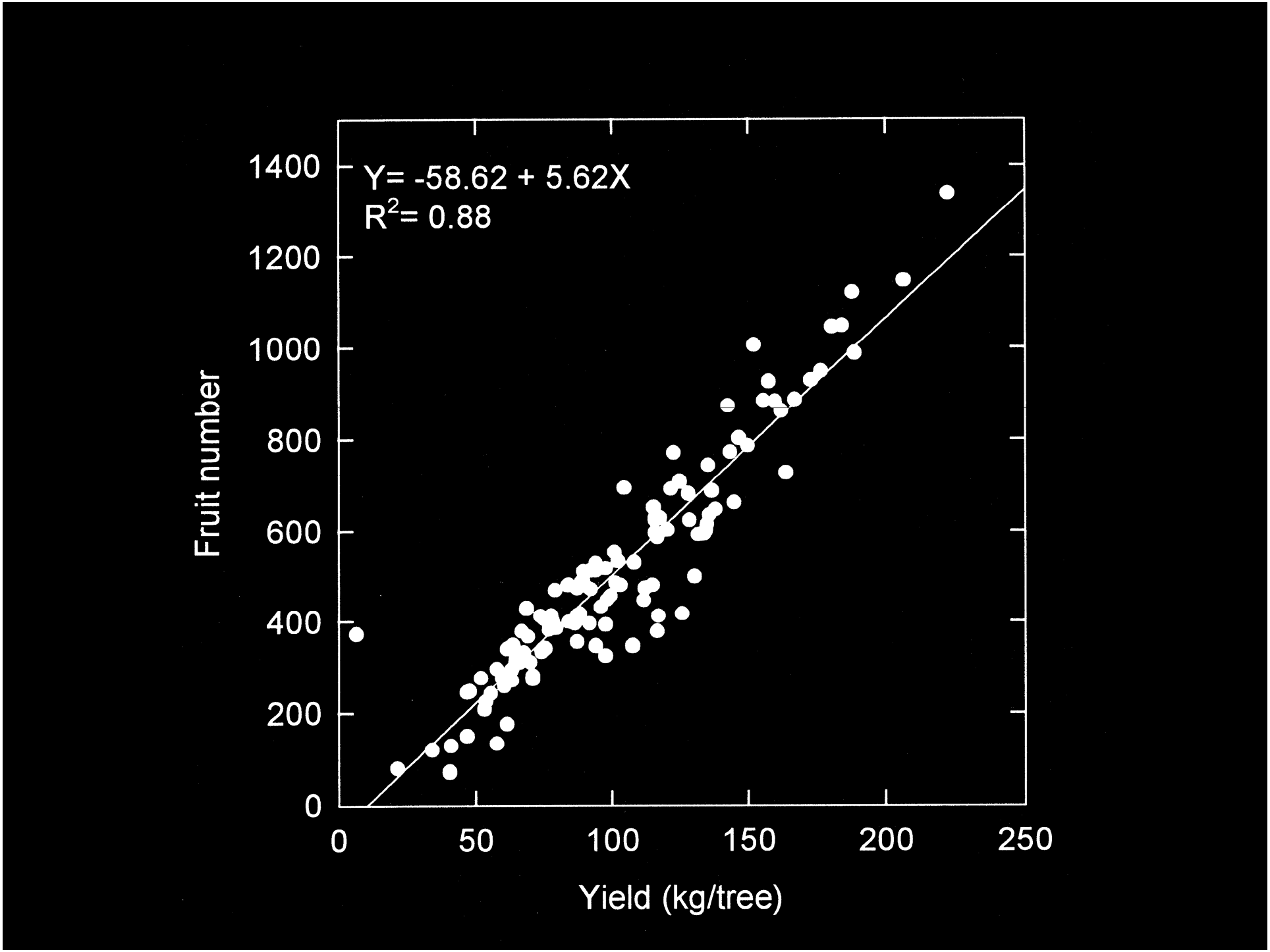


Flowering in *Citrus sinensis* (Washington Navel Orange)



Effect of winter prebloom foliar-applied low-biuret urea on navel orange yield in California.

Month urea applied	Cumulative yield/3 years lbs/ acre	net lbs/acre
None (control)	56,655 b	—
November	67, 540 a	10,885
December	67,896 a	11,241
January	75,034 a	18,379
February	71,287 a	14,632
P-value	0.001	–


Y= -58.62 + 5.62X
R2= 0.88
Fruit number
Yield (kg/tree)
0
200
400
600
800
1000
1200
1400
0
50
100
150
200
250

Effect of winter prebloom foliar-applied low-biuret urea on ‘Valencia’ orange yield in Florida.

Treatment	Yield (lbs/acre/year)	
	Average total	Net
Control	35,600	—
Urea	39,000	3,400

L.G. Albrigo, 1999.


Fruit Size


Maximum Peel
Thickness

Effect of foliar-applied low-biuret urea at maximum peel thickness on navel orange fruit size.

Treatment	Month applied	Cumulative yield/3 years (lbs/acre)		
		Total	Large fruit (2.7 – 3.5 in)	Net large fruit
Control	–	91,897 b[z]	49,071 b	—
Urea	July	104,387 a	61,562 a	12,491

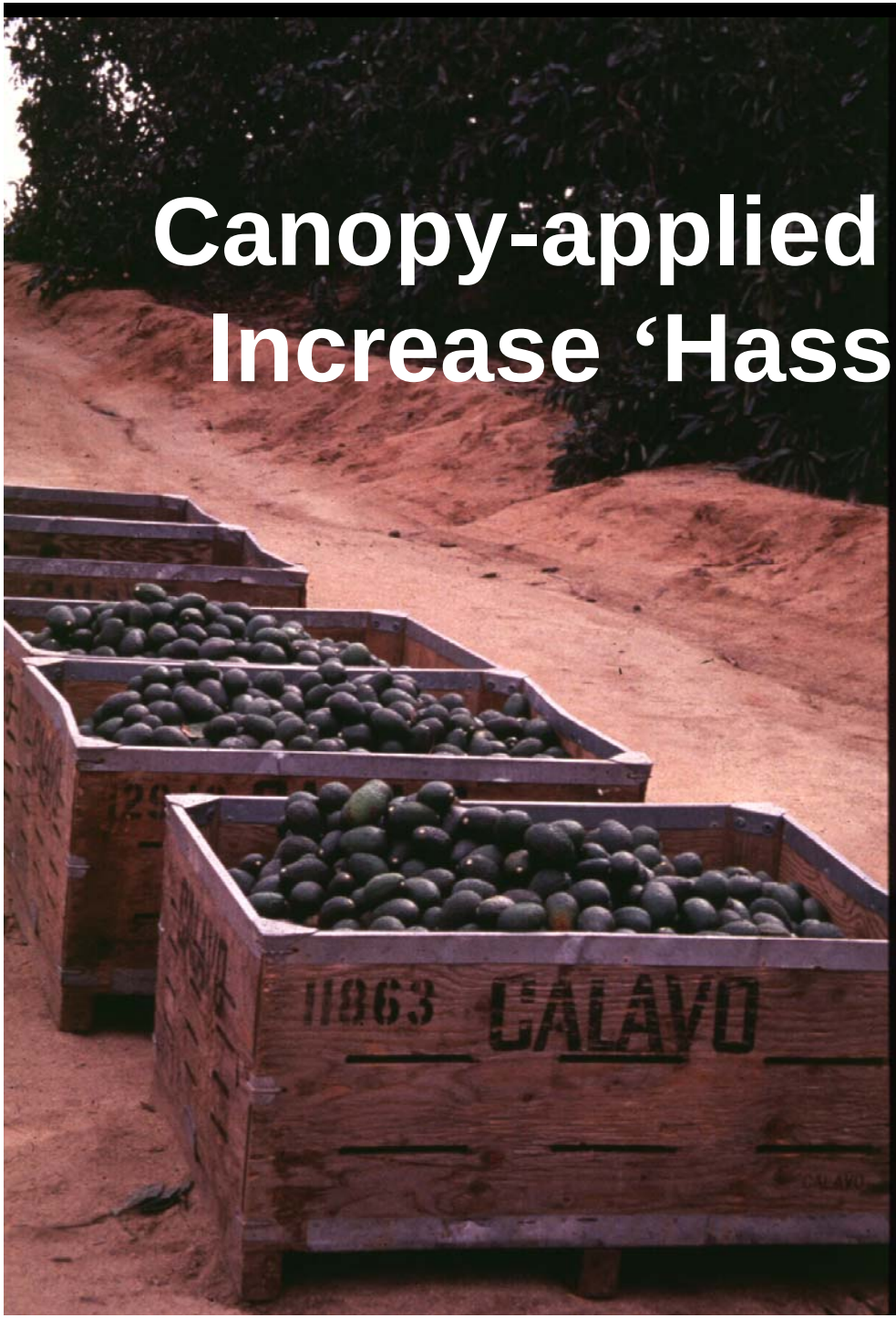
[z] Means followed by different letters are significantly different at P≤0.05.

Effect of foliar-applied KNO_3 at dormancy, post-bloom and exponential fruit growth on ‘Sunburst’ tangerine fruit size.

Size	Control	KNO_3
Large	117 b	142 a
Medium	244 b	266 a
Small	184 b	204 a
Total fruit	1170 a	1138 a
$ per tree	81.17 b	90.03 a
$ per acre per year	14,692 b	16,295 a

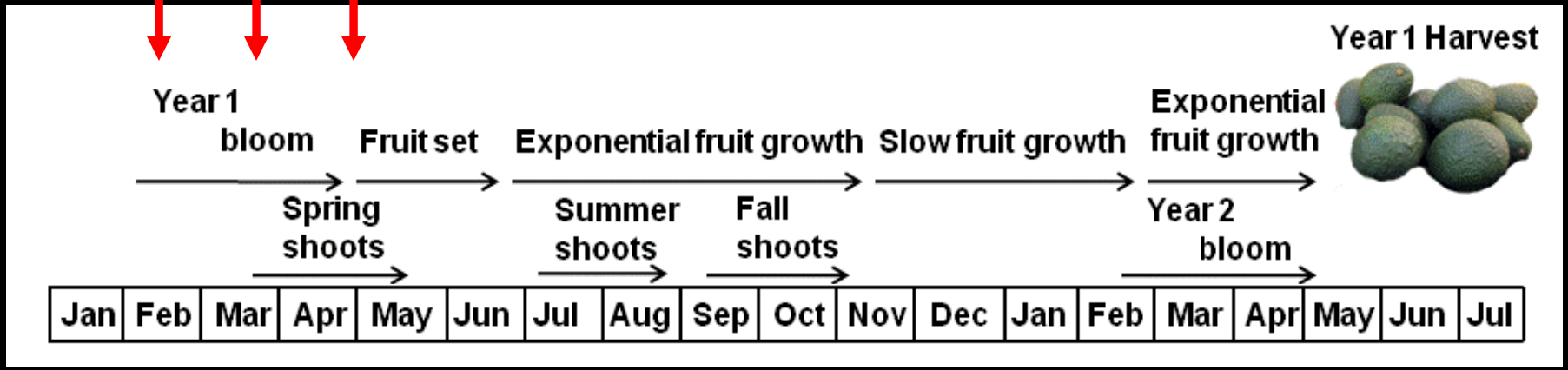
B. Boman, 2002.

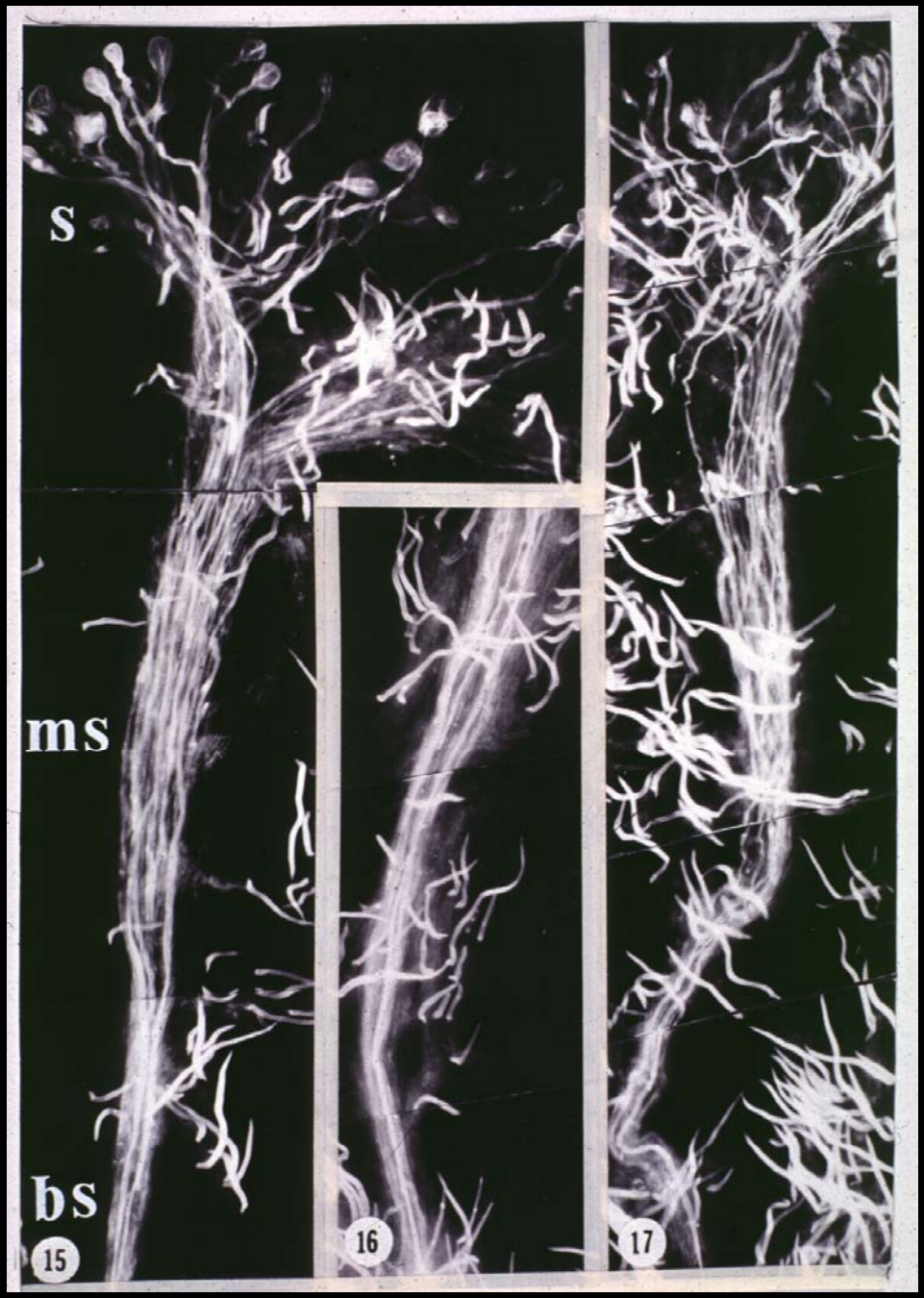
Canopy-applied Boron or Urea to Increase ‘Hass’ Avocado Yield



Canopy-applied Boron or Urea

Boron (6.2 lb B/acre) or Urea (25 lb N/acre) at the cauliflower stage of inflorescence development (CSID)

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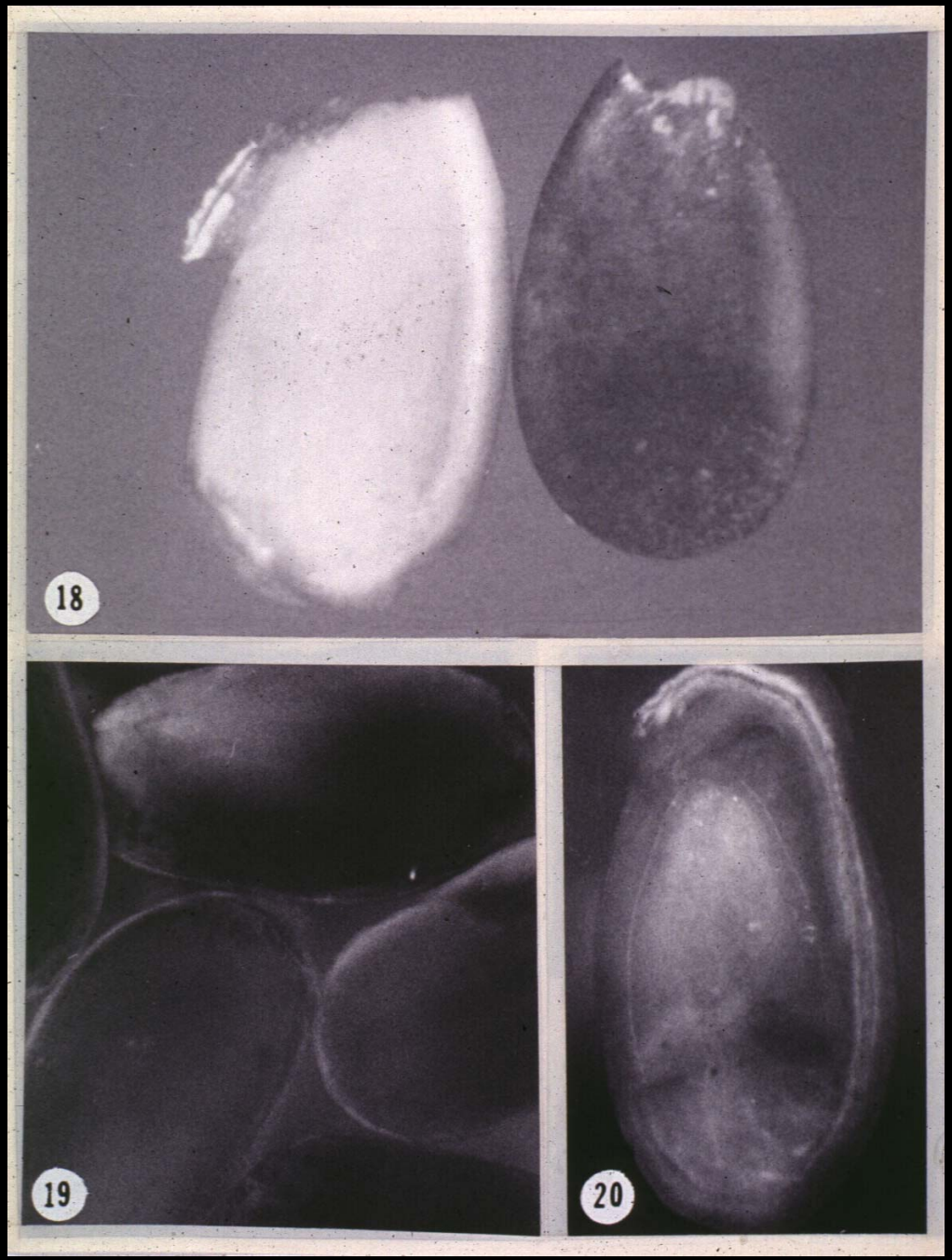
18
19
20

Effect of foliar-applied boron and/or low-biuret on the number of pollen tubes penetrating the ovule and percent viable ovules of the ‘Hass’ avocado.

Treatment	Pollen tubes (no.) penetrating the ovule	Viable ovules (%)
Control	0.77 c[z]	70 b
Boron	2.29 a	81 a
Urea	1.48 b	88 a
Boron+urea	2.10 a	78 a

[z] Means within a column followed by different letters are significantly different by Tukey’s HSD at P≤0.05.

Effect of foliar-applied boron and/or low-biuret on yield of the ‘Hass’ avocado.

Treatment	Cumulative yield/3 years		
	lbs/ tree	lbs/ acre	net lbs/acre
Control	423 b	41,665 b	—
Boron	534 a	52,551 a	10,886
Urea	523 a	51,480 a	9,815
Boron + urea	410 b	40,327 b	—

z Means within a column followed by different letters are significantly different by Tukey’s HSD at P≤0.05.

Take Home Message

Based on these results, and others not presented here, properly timing foliar fertilizers increases efficacy and makes it possible to increase yield, fruit size and quality, and grower net profit.


The power of properly timed foliar fertilizers!