

Achieving larger 'Ettinger' fruit by foliar application of Plant Growth Regulators (PGRs)



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The 'Ettinger' cultivar in Israel

A tall and vigorous tree. High and stable production. Flowering type B.



The fruit has an excellent flavor, high oil content and tender-smooth green skin.

Ready for harvest from October, but should be collected before mid December.

The 2nd most important cultivar in Israel, making about 25% of the avocado orchard's area.

An excellent pollinizer for 'Hass' and other flowering type A cultivars.

Its fruits have a high market value, and mainly the early harvested ones.

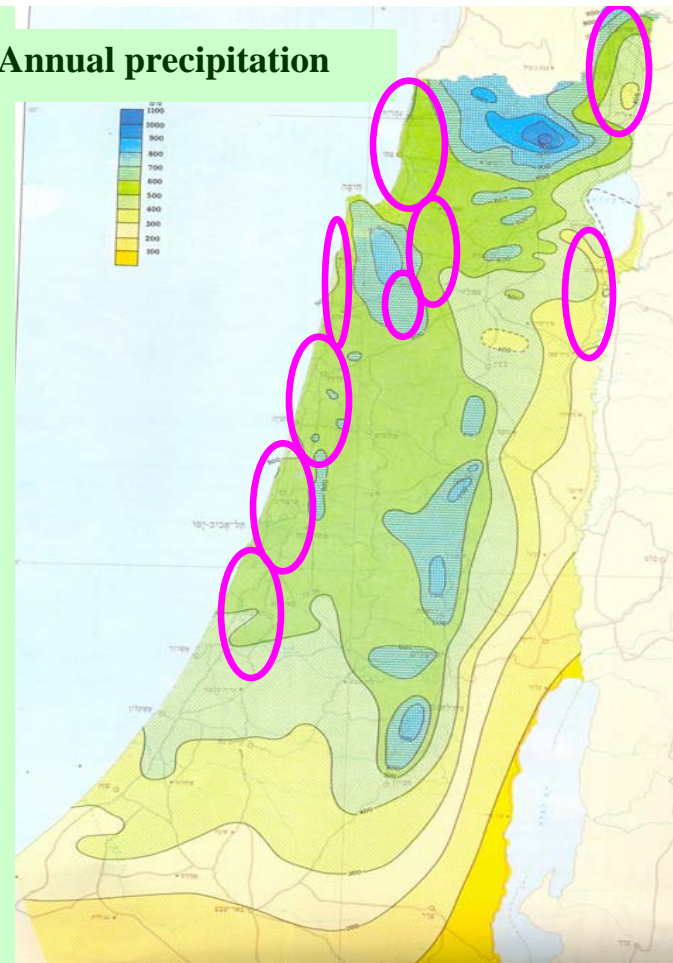
Regions of avocado growing in Israel

Altitude: The avocado is planted mostly in the coastal plain and in the internal valleys. Sometimes on hills, up to 400 m above sea level.

Precipitation: mostly during the winter. No plantations in the desert area, in the south.

Temperatures: The avocado growing area is in the mild and the hot regions only.

Annual precipitation



The avocado in the Western Galilee of Israel

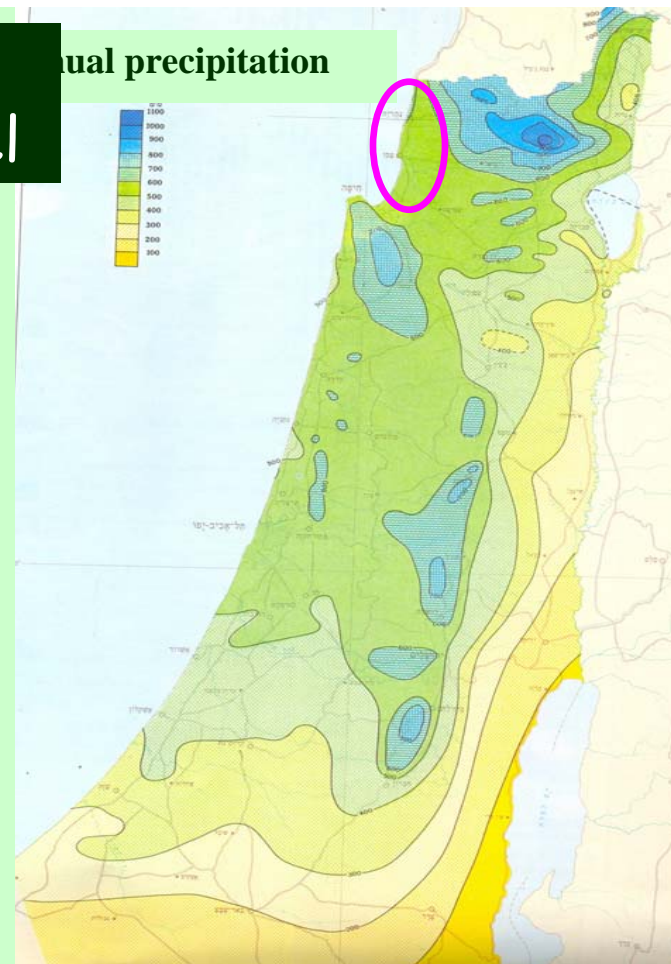
Favorable conditions for avocado growing: the winter is rainy though not cold, the summer is mild and not too hot.

About 25% of the country's avocado is planted here.

Vigorous vegetative growth and large fruits.

Early harvest: large fruits of 'Ettinger' (285 g and above) are ready for harvest two weeks before the other regions, in mid September.

They receive a better price.



The experiment objective



The experiment was aimed at developing a technology for increasing the 'Ettinger' large-fruit yield, by using foliar application of Plant Growth Regulators (PGRs)

Regulation of the avocado fruit growth

Fruit growth is a combined effect of cell division and cell growth.



Large and small 'Hass' fruits were found to differ in their cell quantity, and not in their cell size (Cowan et al., 1997).

Namely, the main limiting factor of fruit size is cell division, and less so cell growth.

The avocado fruit cell-division is predominant during the early fruit-growth stages, but nevertheless continues throughout its development.

Cytokinins are the main PGRs controlling the avocado fruit cell division (Cowan et al., 1999, 2005).

Experiment details

Materials - Plant Growth Regulators (PGRs)

Bongrow® - Benzyl adenine (BA), a synthetic cytokinin (6-Benzylaminopurine)

Maxim® - a synthetic auxin (3,5,6-TPA)

Hadranol® - a synthetic auxin (2,4-D)

Magic® - a synthetic gibberellin inhibitor (Uniconazol)

Methods

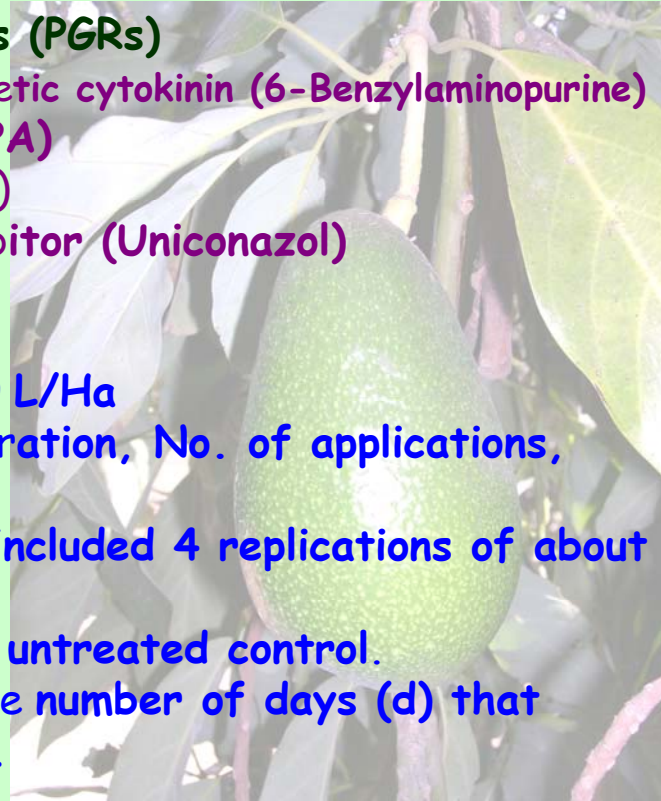
Application method: foliar spray, 700 L/Ha

Variables: PGR material, PGR concentration, No. of applications, timing of application.

Experiment setting: each treatment included 4 replications of about 0.05 ha each.

Control: each experiment included an untreated control.

Timing of application: indicated by the number of days (d) that passed from the full bloom date (FB).



2001 Season Experiments

Maxim® experiment

Location No. 1: Concentration - 3 ppm

Three applications on: FB+14d, FB+28d, FB+42d

Results - no effect (compared to the control)

BA experiments

Location No. 1: Concentrations - 5, 10, 20, 50, 100 ppm

Three applications on: FB+14d, FB+28d, FB+42d

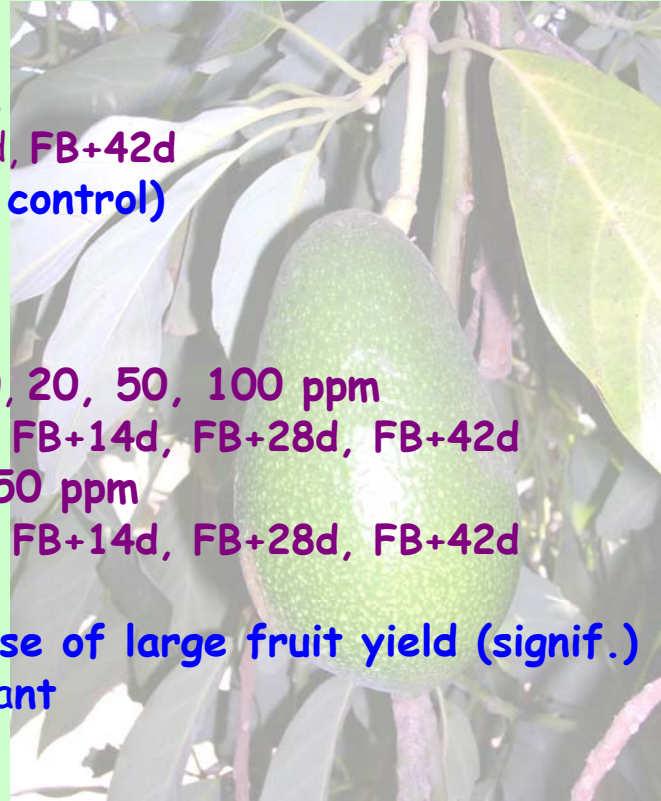
Location No. 2: Concentrations - 20, 50 ppm

Three applications on: FB+14d, FB+28d, FB+42d

Results - Best treatments:

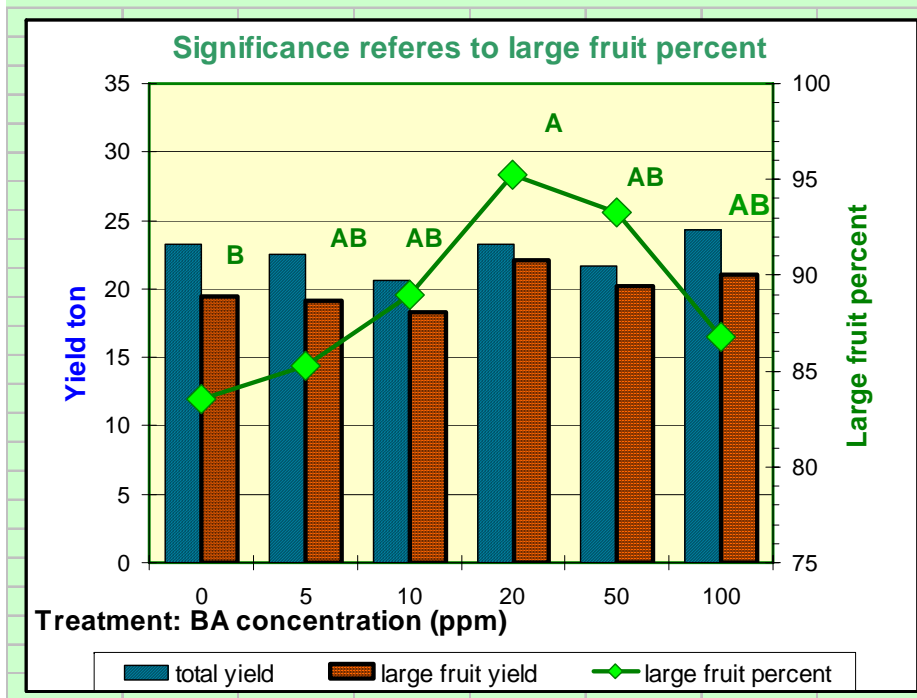
Location No. 1 - 20 ppm: +14% increase of large fruit yield (signif.)

Location No. 2 - 50 ppm: not significant



2001 Season Experiments

BA experiment: Location No. 1 - checking five concentrations, three applications, every two weeks after FB



Maximum curve:
20 and 50 ppm BA exhibited the maximum effect, while both 5 ppm and 100 ppm BA obtained no response. 20 ppm achieved a 14% increase in both large fruit yield and percent. Total yield did not change.

2002 Season Experiments

Hadranol® experiment

Location No. 3: Concentration - 0.015%; Timing: FB+14 weeks (Aug 1st)

Magic® experiment

Location No. 3: Concentration - 0.03%; Timing: FB+14 weeks (Aug 1st)

Results - Hadranol® negative effect (significant)

Magic® no effect

BA experiments

Location No. 2: Concentrations - 20, 50 ppm

Three applications on: FB+14d, FB+28d, FB+42d

Location No. 4: Concentrations - 20, 40, 60 ppm

Three applications on: FB+14d, FB+28d, FB+42d

Results - Best treatments:

Location No. 2 - 50 ppm: +20% increase of large fruit percent (signif.)

Location No. 4 - 40 ppm: +8% increase of large fruit yield (not signif.),



2003 Season Experiments

Hadranol® experiment

Location No. 4: Concentration - 0.015%; timing: First flower opening

Results - strong negative effect (significance could not be checked)

BA experiments

Location No. 2: Concent - 30 ppm; 1 or 2 applications on: FB, FB+21d

Location No. 4: Concent - 30 ppm; One application on: FB

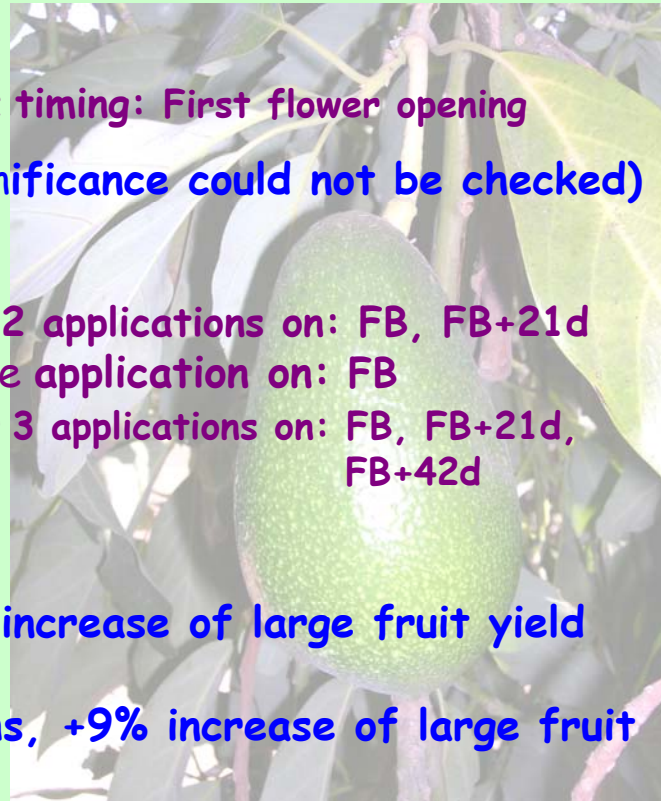
Location No. 5: Concent - 30 ppm; 1, 2, or 3 applications on: FB, FB+21d, FB+42d

Results - Best treatments:

Location No. 2: no effect

Location No. 4: one application, +18% increase of large fruit yield (significance couldn't be checked)

Location No. 5: one or two applications, +9% increase of large fruit yield (signif.)



2004 Season Experiments

BA experiments

Location No. 2: Concent - 30 ppm; 1 application on: FB-7d, FB

Location No. 3: Concent - 30 ppm; 1 application on: FB-7d, FB, FB+10d

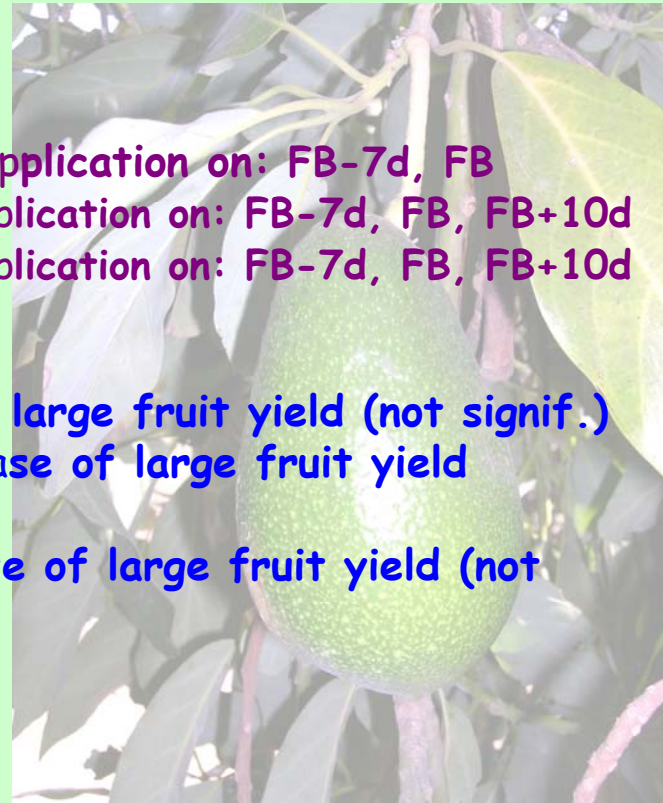
Location No. 5: Concent - 30 ppm; 1 application on: FB-7d, FB, FB+10d

Results - Best treatments:

Location No. 2 - FB: +5% increase of large fruit yield (not signif.)

Location No. 3 - FB+10d: +14% increase of large fruit yield
(significance couldn't be checked)

Location No. 5 - FB-7d: +33% increase of large fruit yield (not significant)



2005 Season Experiments

BA experiments

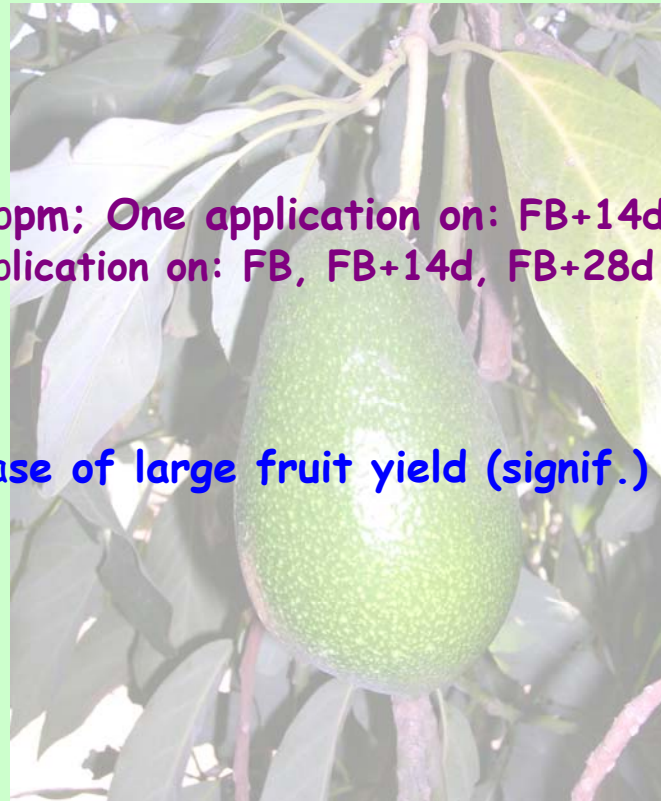
Location No. 4: Concent - 20, 40, 60 ppm; One application on: FB+14d

Location No. 5: Concent - 40 ppm; 1 application on: FB, FB+14d, FB+28d

Results - Best treatments:

Location No. 4 - 40 ppm: no effect

Location No. 5 - FB+28d: +39% increase of large fruit yield (signif.)



Summary of 12 experiments with Benzyl Adenine during 5 seasons

Exp No	Variable studied	Control yield		Best treatment * Significant	Best treatment to control ratio (%)			Comments ** Signif. couldn't been checked
		Total yield (tons×ha ⁻¹)	Large fruit percent		Large fruit yield	Large fruit percent	Total yield	
2001 season								
1	BA concentration	23.3	83.5	20 ppm	114	114 *	100	
2	BA concentration	20.9	90.9	50 ppm	99	102	97	young trees
2002 season								
3	BA concentration	32.4	46.0	40 ppm	108	94	115	
4	BA concentration	25.5	84.4	50 ppm	106	120 *	96	young trees
2003 season								
5	Number of applications	8.87	81.6	one and two applications	109	107 *	103	
6	Number of applications	16.6	88.6	control and one application	91	98	94	young trees
7	Additional replication	7.09	86.1	one application	118	105	112	**
2004 season								
8	Timing of application	19.6	78.6	FB-7d	133	103	128	
9	Timing of application	28.3	78.7	FB+10d	114	97	118	**
10	Timing of application	29.3	76.2	FB	105	99	108	
2005 season								
11	Timing of	14.6	70.1	FB+28d	139 *	106	127 *	

Exp No	Variable studied	Control yield		Best treatment * Significant	Best treatment to control ratio (%)			Comments ** Signif. couldn't been checked
		Total yield (tons×ha ⁻¹)	Large fruit percent		Large fruit yield	Large fruit percent	Total yield	
Average of all Exp		20.41	78.51		111.3	103.9	108.0	

Discussion 1

1. The Auxins, and the Gibberellin inhibitor showed no effect on the 'Ettinger' large fruit yield. They may not affect its fruit cell-division.

2. BA concentration effect appears as a maximum curve. It appears as though a concentration of 5 ppm is too low, whereas 100 ppm has an overdose effect.



3. One application obtained a higher response than 2 or 3 consecutive ones. This may also be understood as an overdose effect.

Discussion 2



4. A positive effect was obtained in 9 out of 12 experiments. Two cases, out of those three where it was not obtained, happened in a young orchard, carrying very large fruit. This may be explained as an overdose effect as well. Out of these two experiments, large fruit yield increased by 14.6% and total yield increased by 10.5%.

5. The preferred application timing is yet unequivocal: the best response has obtained between FB-7d to FB+28d. The 'Ettinger' bloom in Israel lasts about 8 weeks, with several fruit-set periods. How to hit the main fruit-set period, which differs between seasons and locations, by one application?

Conclusion



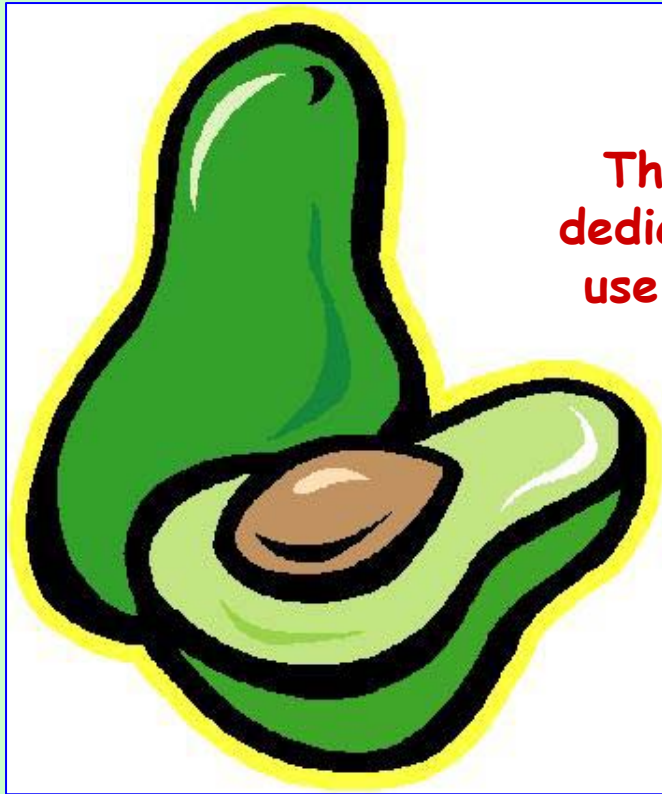
According to the present knowledge, the Benzyl Adenine (Bongrow®) should be applied on 'Ettinger' using 40 ppm concentration, in one foliar application on FB+14d (or at any time between FB-7d to FB+28d).

A young orchard, carrying large fruits should not be treated.

However, experiments should be continued, to achieve a better understanding of the connection between fruit-set periods and application timing.

Also, the trees' response should be followed for a few years, to study the accumulated effect of the PGR.

Acknowledgments



The experiment team thanks the **dedicated** Israeli farmers who let us **use** their orchards and carried out most of the work.

Thank you...