FINAL PROJECT REPORT

Project Title: Management of vegetative growth in apple trees with bioregulators

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Other funding sources:

Agency Name: Valent BioSciences, Agro-K
Amt. requested/awarded: (will partially defray harvest costs in 2010)

Total Project Funding: $9,320

Budget History

Item	2010	2011
Salaries[1]	-0-	-0-
Wages[2]	2,500	3,000
Benefits[2]	370	450
Equipment	-0-	-0-
Supplies[3]	200	300
Travel[4]	1,000	1,500
Miscellaneous	-0-	-0-
Total	4,070	5,250

Objectives:

1. Explore possible methods for improving the efficacy of prohexadione-Ca (Apogee) for control of unwanted vegetative vigor, including application timing, concentration and combinations of Apogee with abscisic acid (ABA).
2. Examine whether ABA, the dormancy-inducing hormone, can be used either alone or in combination with other bioregulators to force terminal bud set or otherwise control extension growth in actively-growing apple shoots.
3. Determine if any successful growth-control treatments compromise fruit load, fruit growth or fruit quality in any way.

Significant findings:

1. ABA (100 mg/liter a.i.) applied all season (six applications over 4 months beginning on 23 April) had no effect on shoot growth at all. ABA applied in a similar manner at 500 mg/liter a.i. paralleled the control shoot expansion until warm weather started in June, after which the shoot elongation rate was reduced by ABA such that the ABA 500 trees showed a reduction of about 26% in terminal shoot extension over the last half of the season (not statistically significant; see Fig. 1).

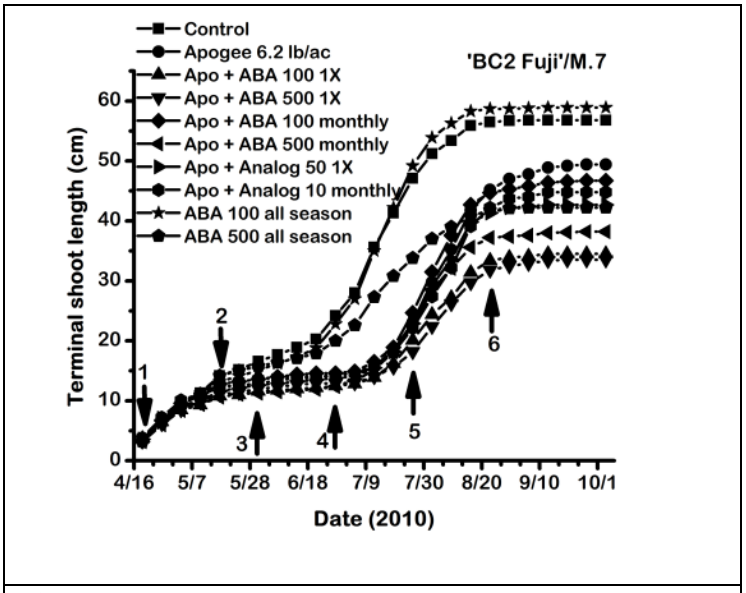

Figure 1

2. The full seasonal label rate of Apogee per acre was divided into two sprays applied 22 days apart (arrows 1 and 2 in Fig. 1). The first spray was made in late April and trees were retreated in mid-May (total of 6.2 lb. Apogee/acre). Shoot growth was strongly inhibited until the first week of July, when regrowth began that brought final terminal shoot extension on trees receiving Apogee only to within 87% of the growth of untreated trees (not statistically significant), despite application of the full seasonal labeled amount of Apogee.
3. Other Apogee-treated trees in the trial received one of several follow-up applications of either abscisic acid (ABA) or a chemically similar analog of ABA (arrows 3-6 indicate application dates) to assess if any combination of Apogee plus follow-up treatments could help control the persistent problem of late summer regrowth observed even when full label rates of Apogee are used.
4. The three combination treatments that resulted in a significant reduction in total shoot extension regrowth were the following: Apogee applied twice as described above followed by 1) ABA (100 mg/liter a.i.) applied once (1 June), or 2) ABA (500 mg/liter a.i.) applied once (1 June), or 3) ABA 500 applied four times, on 1 June, 29 June, 27 July and 24 August.

5. Although the analog is estimated to be 10-fold more active than ABA itself, applying the analog (50 ppm) once or 10 ppm monthly to previously Apogee-treated trees did not significantly reduce terminal shoot extension growth.
6. Treatments with Apogee, ABA and/or the analog showed no effects at all on flowering, fruit set, fruit growth, fruit size, fruit drop, fruit appearance or total yield.
7. ABA is reported to reduce stomatal aperture; this effect could contribute to reduced photosynthesis. However, even a season-long ABA program did not produce any signs of a significant reduction in photosynthetic production, which would most likely have manifested itself as a reduction in fruit size.
8. The latest application of ABA was made 24 Aug. 2010. Although other work of ours shows that ABA can stimulate defoliation, even a season-long ABA program that ended on 24 Aug. did not show any sign of producing early defoliation.

Significant findings 2011:

1. In 2011, Apogee was applied at the equivalent of 3.1 lbs. per acre over the season (half the full labeled rate). We chose this half rate because the results of 2010 studies clearly showed no advantage in terms of shoot growth control to applying twice as much of this product. The seasonal per-acre amount of Apogee was either divided into 4 equal spray amounts (arrows 1,2,4,6 indicate Apogee or Apogee/ABA tank-mix spray dates) or applied in 3 sprays as ¼, ½ and ¼ of the seasonal labeled amount (arrows 1,2,4 indicate Apogee or Apogee/ABA tank-mix spray dates). Applying a greater concentration of Apogee as the treated shoots were approaching their first period of controlled elongation was carried out to determine if the mid-summer period of non-elongation could be extended with this larger Apogee dose.

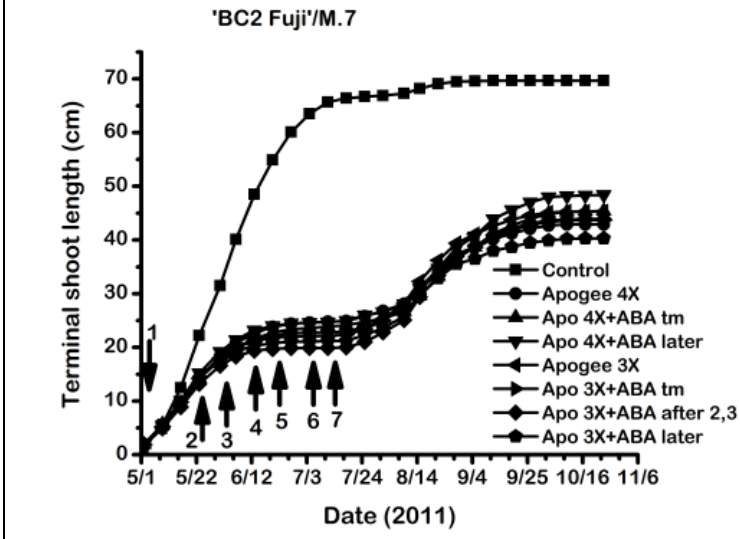

Figure 2

2. ABA was applied either as a tank-mix with Apogee (Apo4X+ABA tm or Apo3X+ABA tm, see Fig. 2) or as a follow-up application after the last 2 Apogee sprays. The amount of ABA applied in any spray was adjusted so that the equivalent of a total of 500 mg/liter was applied in each treatment.
3. The growth graph (Fig. 2) clearly shows that shoot growth behavior in 2011 was controlled by Apogee with little impact from any of the ABA application strategies. Shoot growth control in 2011 was better with the half-rate program than it was in 2010 with twice the amount of Apogee. The reasons for these observations are unknown.
4. For the second year in a row, treatments with Apogee and/or ABA produced no effects on flowering, return bloom, fruit set, fruit size or total per tree yield (measured as total number of fruit per tree). The likelihood of significant suppression of photosynthesis due to effects of ABA on stomatal aperture appears to be non-existent.

Methods:

Two trials were initiated in 2010 and one in 2011 to carry out follow-up trials to test various ways of combining Apogee and ABA applications that might produce some form of synergistic or interactive effects on apple terminal shoot growth extension or terminal-bud formation.

Results and discussion:

One of the key questions tested in 2010 was to what degree might ABA alone beneficially affect apple shoot extension growth. Applying 500 mg a.i./liter ABA alone 6 times to 'Fuji' apple trees did not produce satisfactory reduction in vegetative shoot extension. Applying the full labeled amount of Apogee in 2010 also did not produce acceptable control of growth. Hence the notion of examining Apogee/ABA tank-mixes and follow-up ABA treatments became the focus of the 2011 growth-control program. It is clear from Fig. 2 that no tested strategy of combining ABA and Apogee applications was effective for producing acceptable shoot extension control in 'Fuji' apple in 2011. It appears safe to conclude that ABA is unlikely to have a useful role to play in management of vegetative growth in apple.

Acknowledgements:

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Reports Published:

Elfving, D.C., D.B. Visser and J.L. Henry. 2011. Gibberellins stimulate lateral branch development in young sweet cherry trees in the orchard. **International Jour. of Fruit Sci. 11:41-54.**

Elfving, D.C. 2010. Plant bioregulators in the deciduous fruit tree nursery. **Acta Horticulturae 884:159-166.**

Elfving, D.C. and T.R. Schmidt. 2010. Bioregulator sprays. p. 133-146. In: M. Bush (coord.), **2010 Crop Protection Guide for Tree Fruits in Washington. EB 0419.**

Executive Summary

1. The amount of Apogee applied to an apple orchard is not directly related to the degree of shoot-growth control observed. It is likely that seasonal weather patterns may play an important role.
2. At cost-effective concentrations, abscisic acid (ABA, ProTone, Valent BioSciences) does not appear to produce effective control of vegetative growth in apple, either alone or in combination with Apogee.
3. ABA does not demonstrate the ability to encourage terminal-bud formation in actively-growing apple shoots.