Predicting Chemical Thinning Response with the Carbohydrate Model

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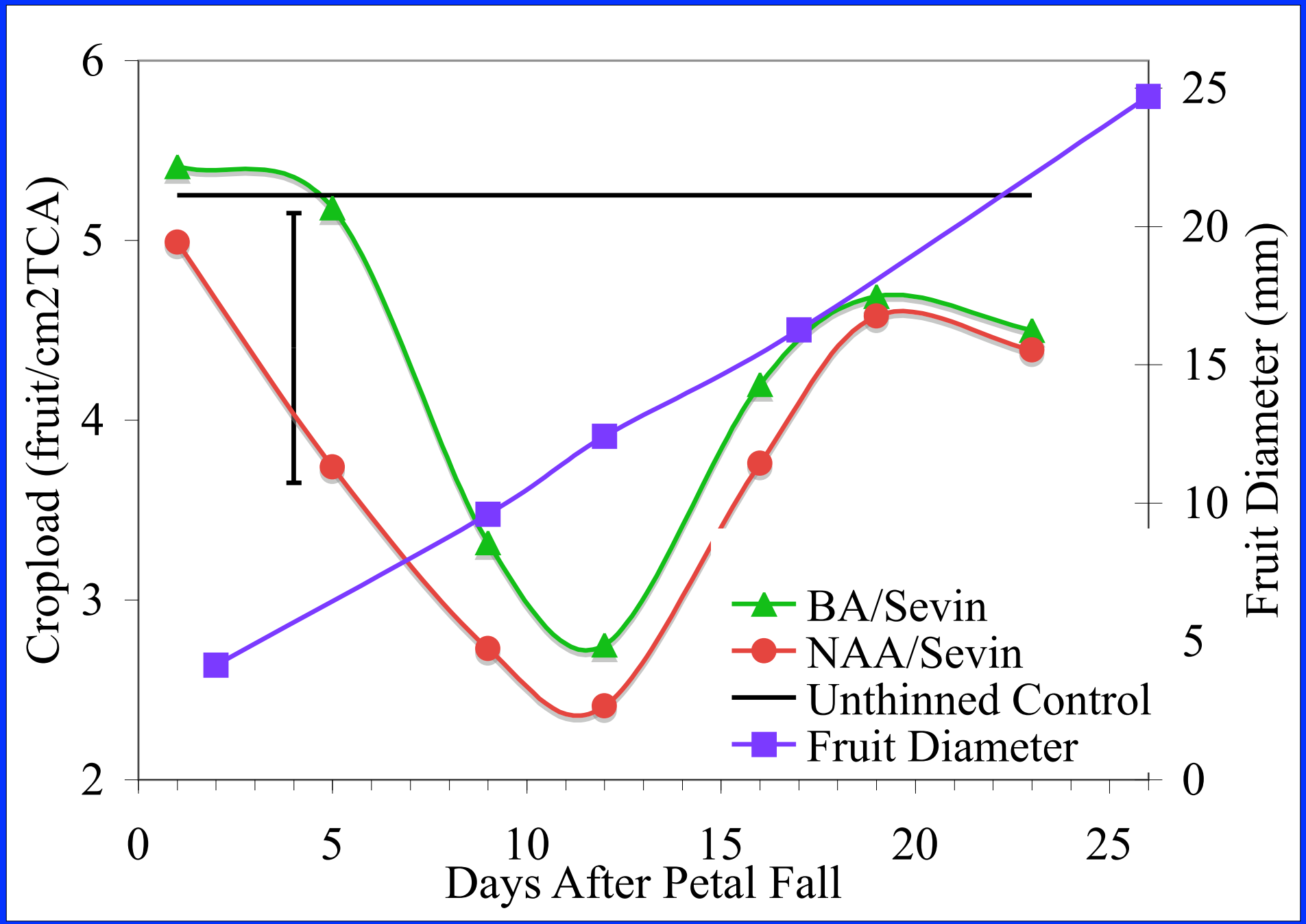
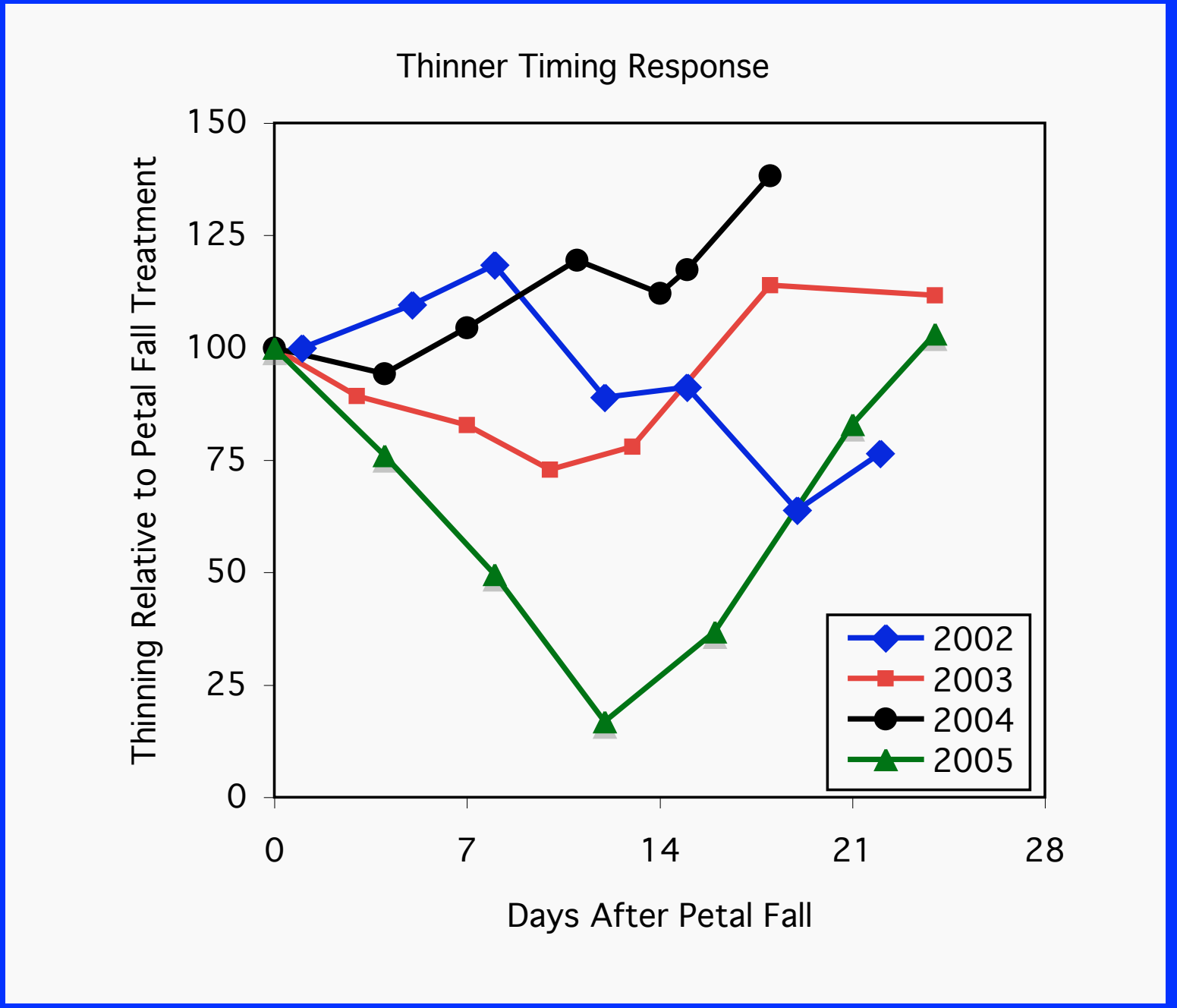
Variability in Thinning Efficacy Within a Season



Variability in Thinning Efficacy Between Seasons



Variability in Thinning Efficacy is Caused by:

1. The chemical thinner concentration
2. The application process
   - -sprayer setup- water volume, air speed, droplet size
3. The chemical uptake process
   - -cuticle thickness
   - -environment during and after applying the chemical (temperature, humidity, application coverage, drying conditions)
4. The sensitivity of the tree
   - -bloom density
   - -initial set
   - -temperature
   - -sunlight
   - -tree vigor

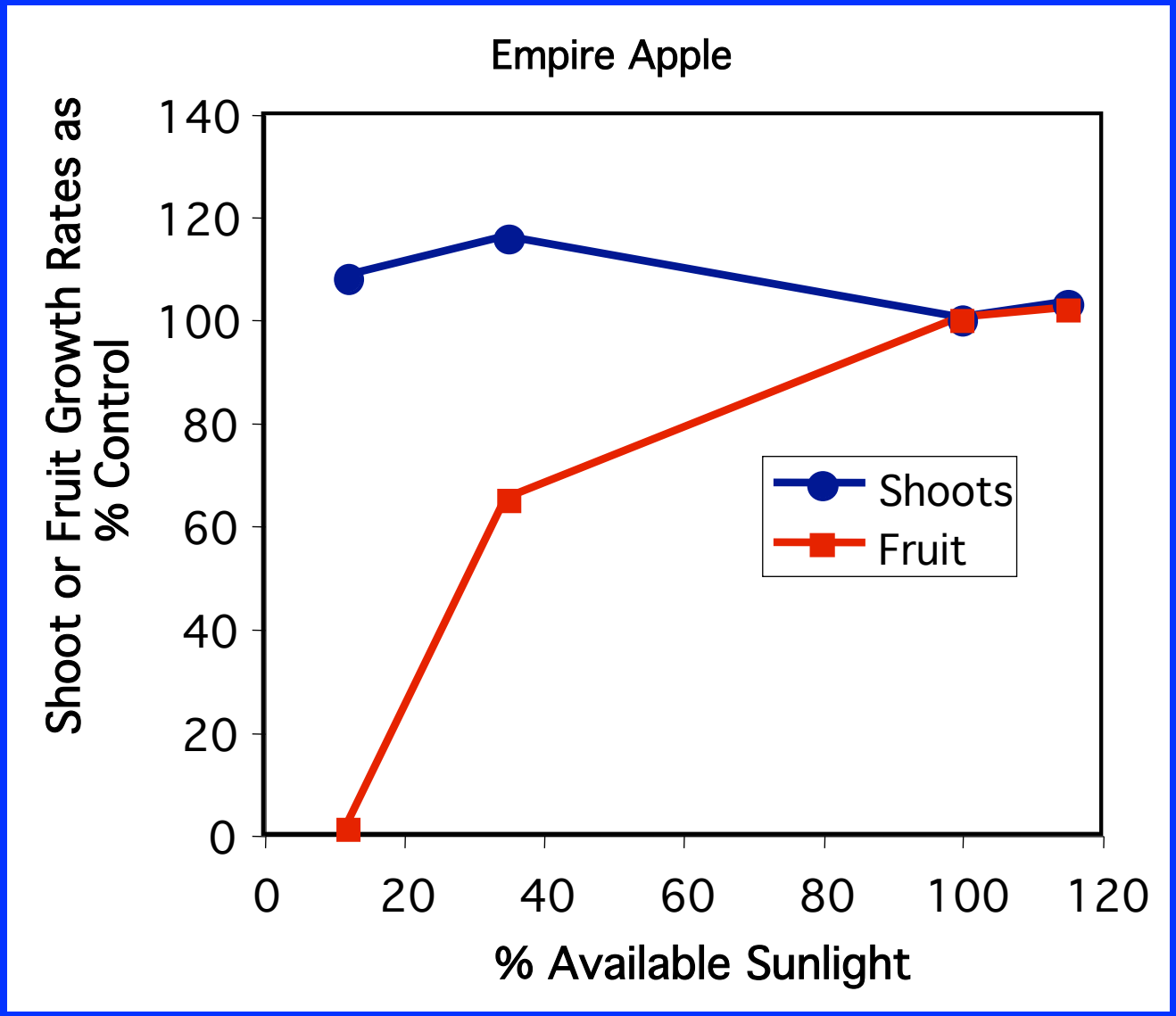
A Carbon Based Hypothesis of Fruit Growth and Abscission

- Fruitlet sensitivity to chemical thinners is primarily a function of carbon supply available for fruit growth from current production.
  - Temperature and sunlight influence the trees carbon production.
  - Temperature affects demand from competing sinks and demand from fruits.
  - When demand for fruit growth exceeds supply from current production the least competitive fruits abscise.
  - Trees are more susceptible to chemical thinners when carbon supply is limiting and less susceptible when carbon is ample.

During the chemical thinning window there is competition for resources between sinks :

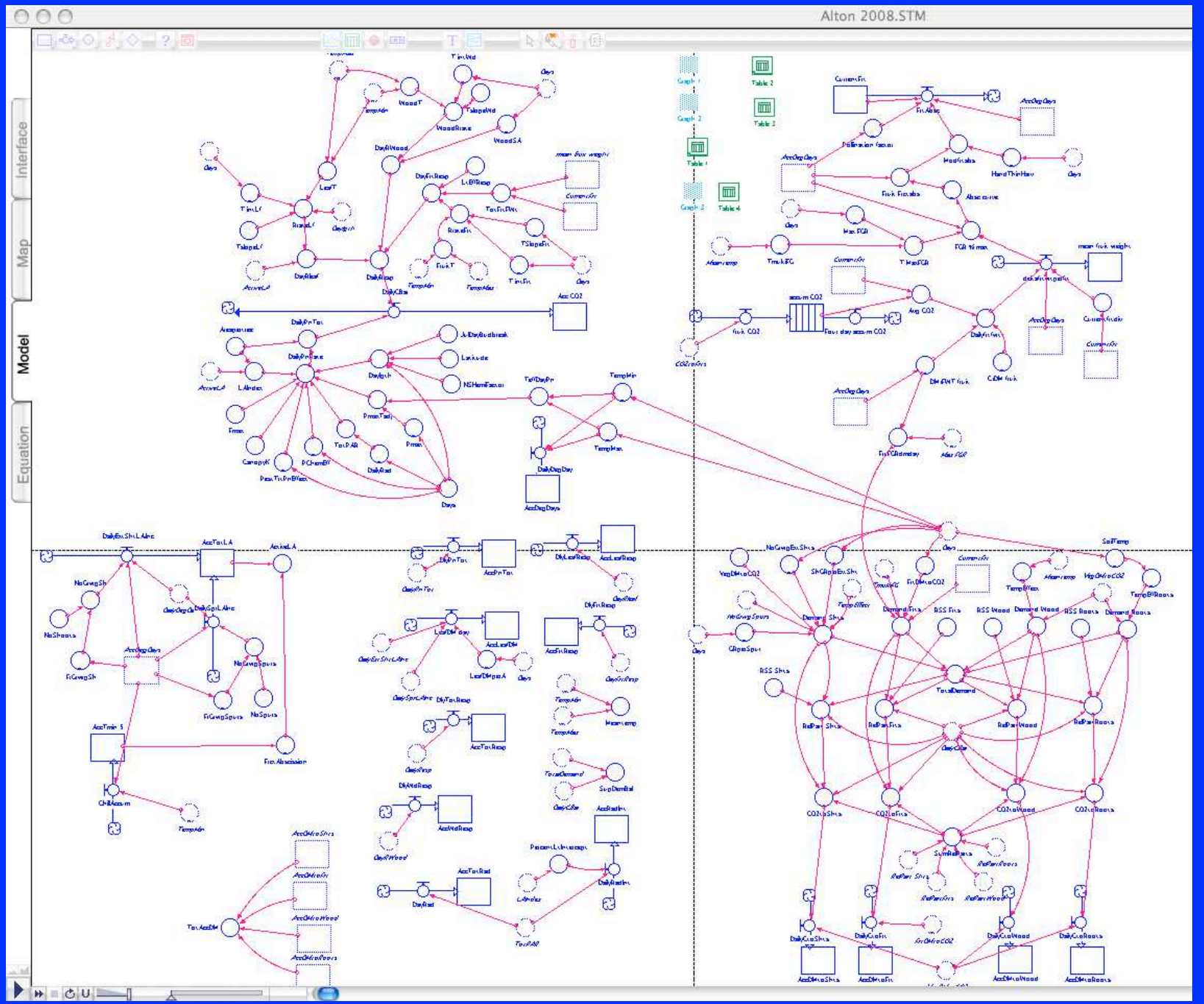
1. Between fruits in the cluster
2. Between adjacent clusters
3. Between fruits and shoots
4. Between shoots and roots

Competition between shoot growth and fruit growth in Empire apple trees at the time of thinning.

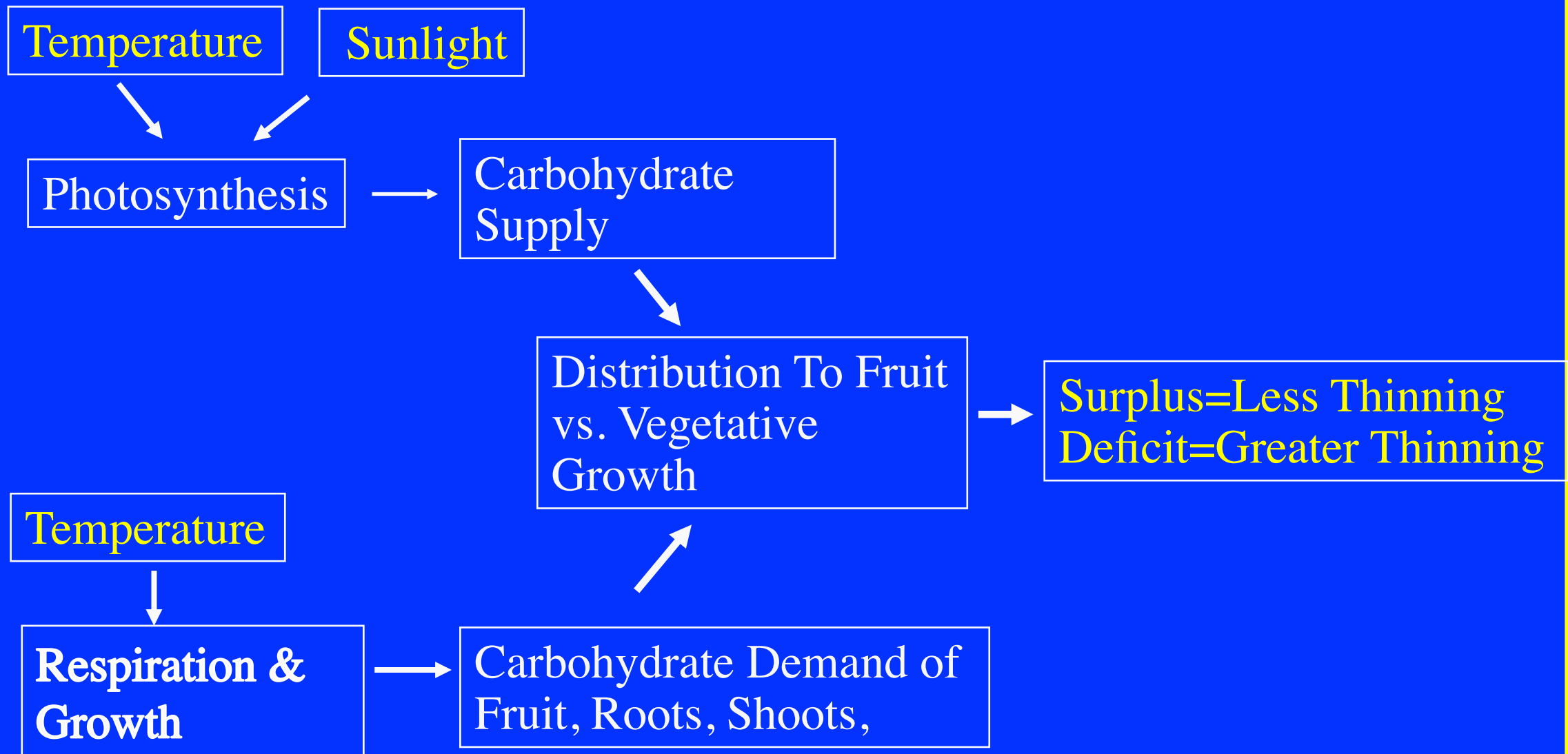


Shoot growth was not affected by the reduction in carbohydrates caused by shade, but fruit growth was severely reduced at lower light, defruiting the trees at the lowest light.

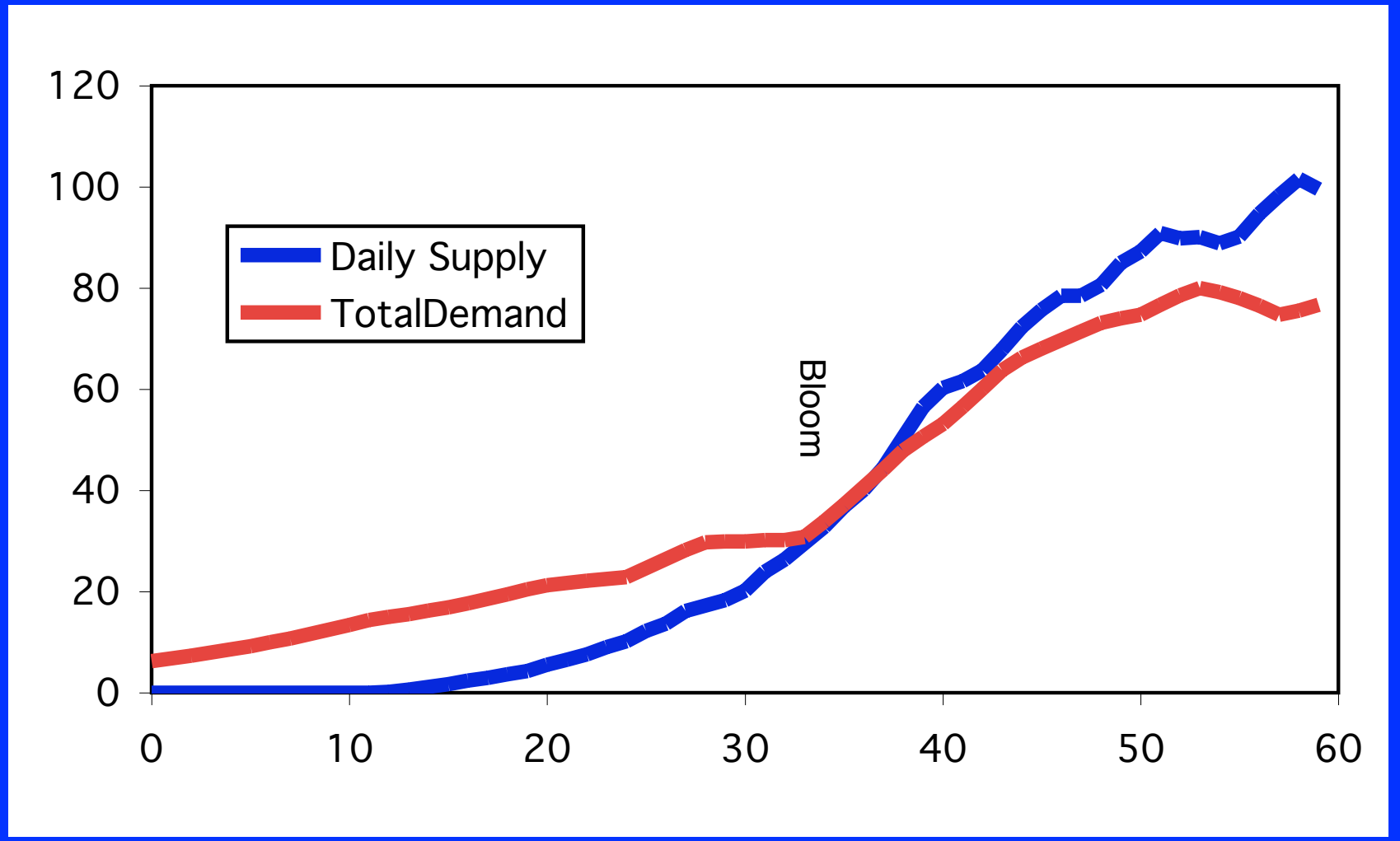
Carbohydrate Model (Stella version)



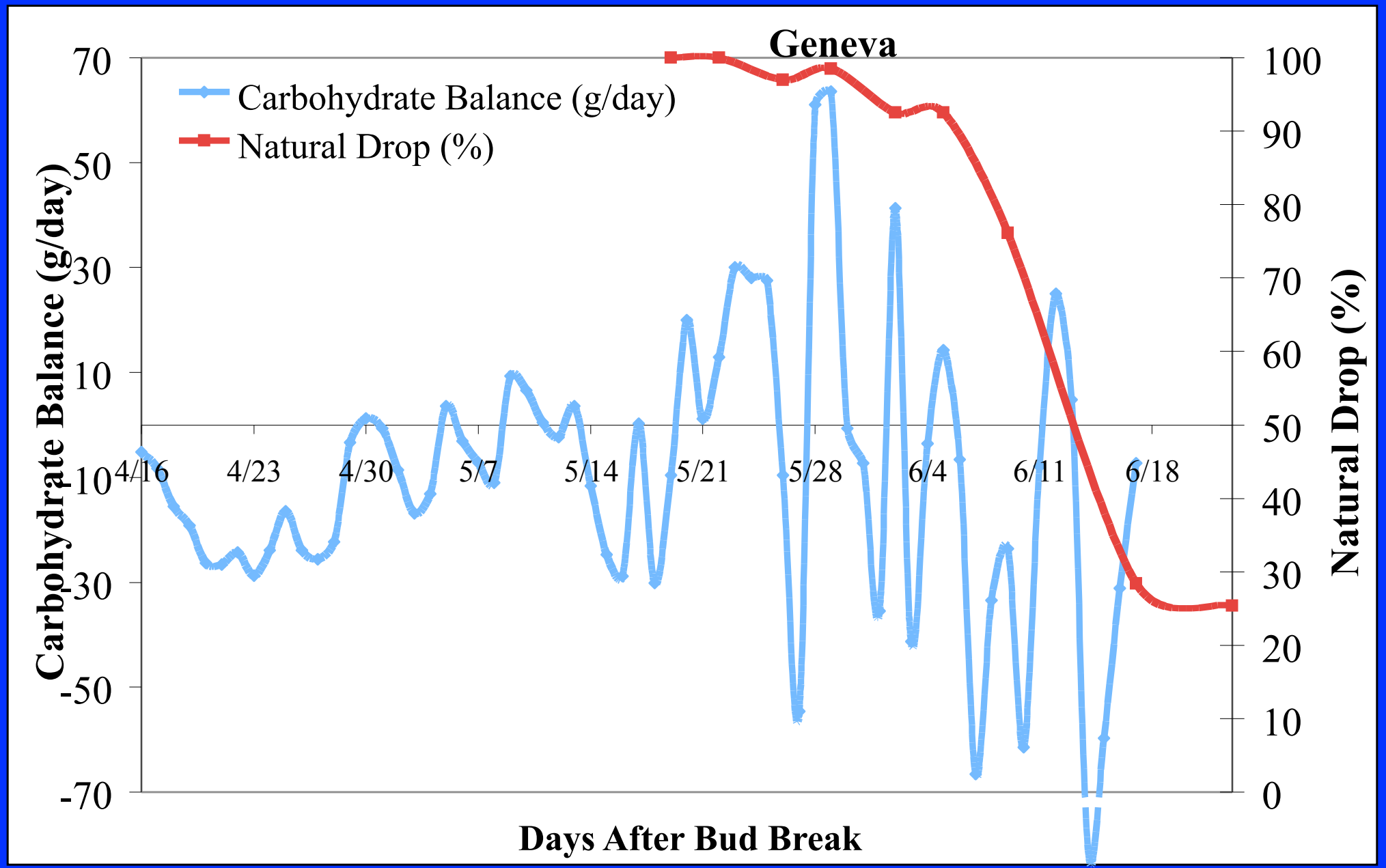
The Carbohydrate Model

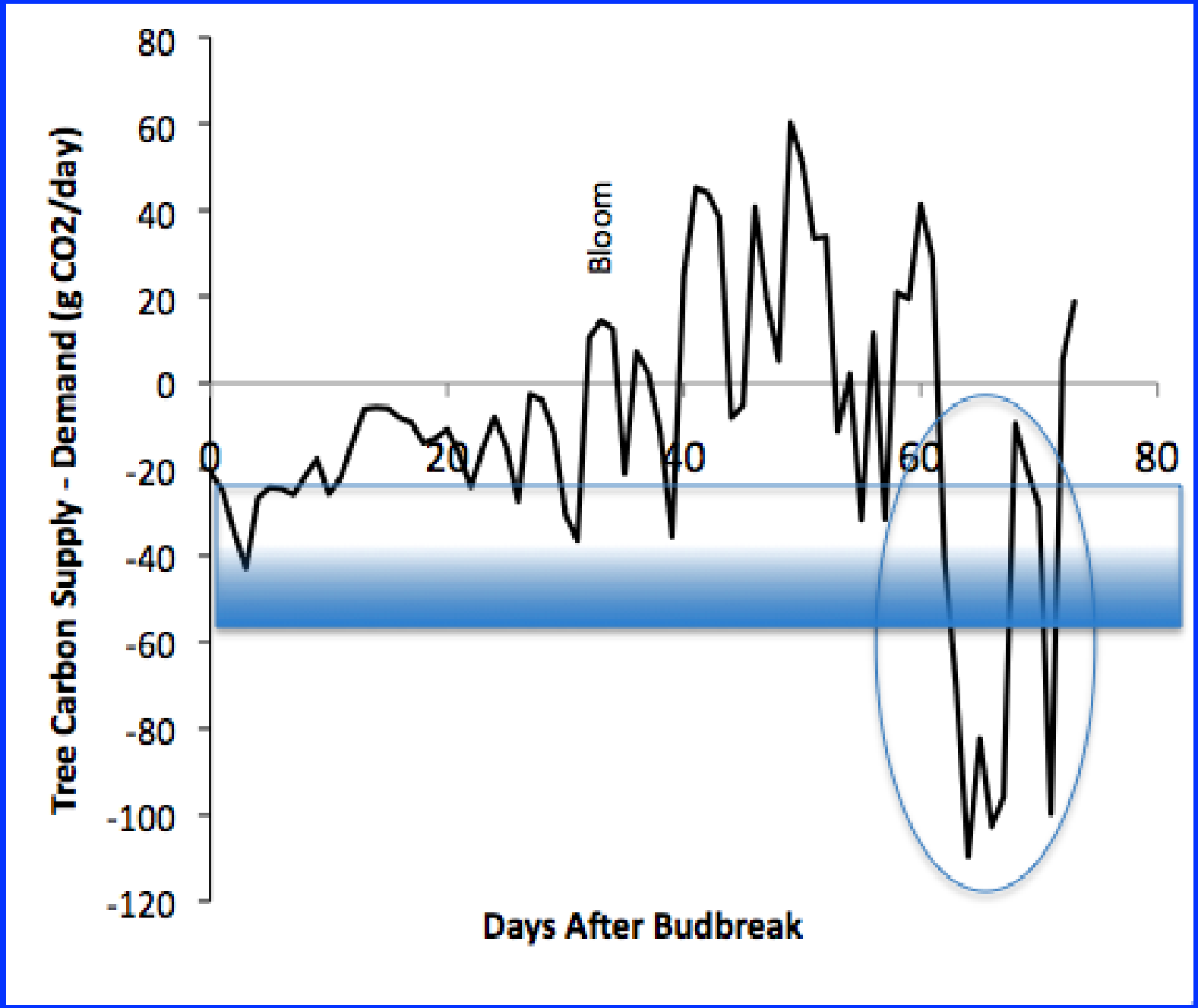


Model Simulation of Carbohydrate Production and Demand by an Empire/M.9 tree with a Crop Load of 300 Fruits (Geneva 15 year Average Weather Data)



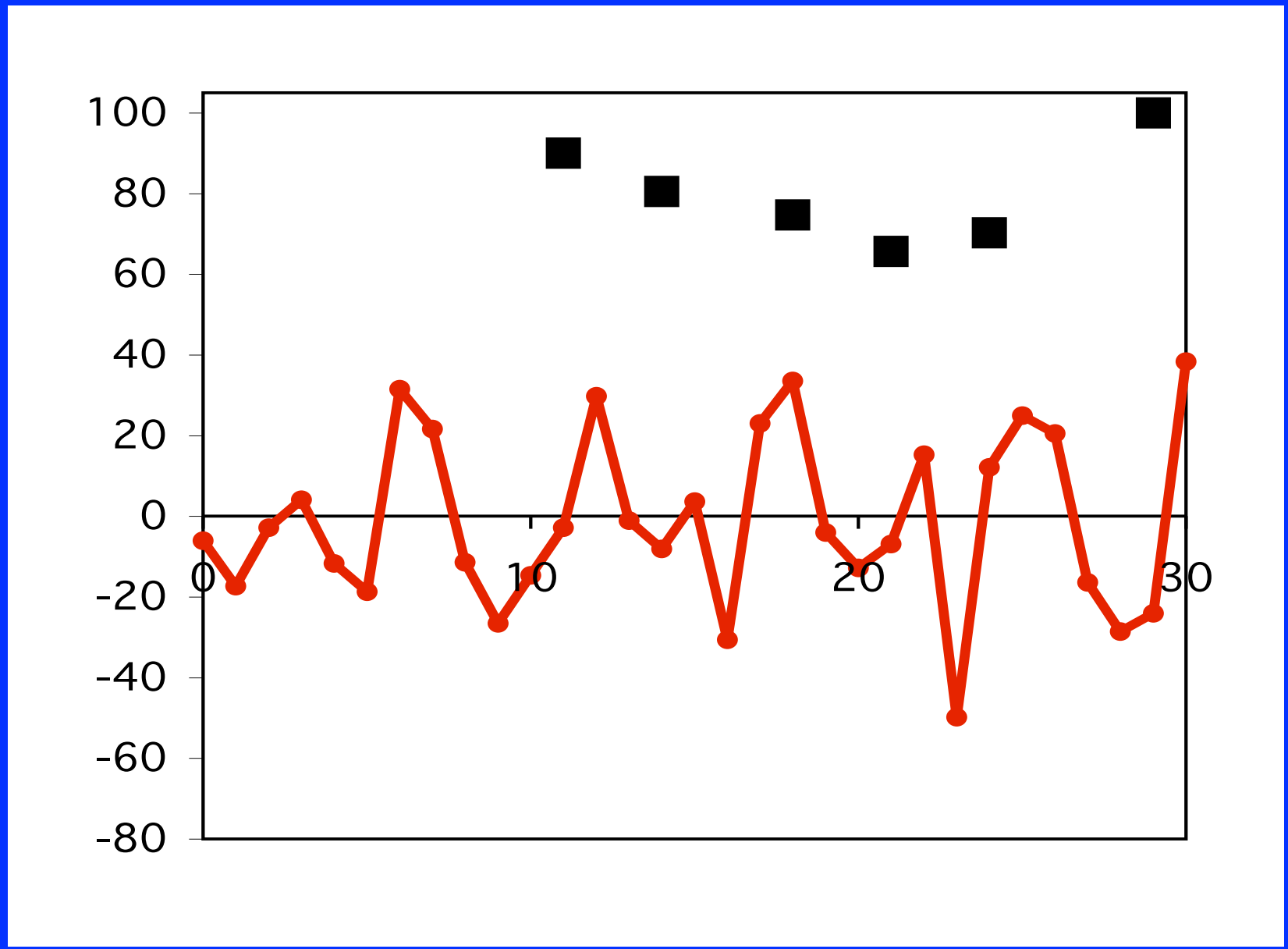
Carbohydrate Balance and Natural Drop - Geneva 2008



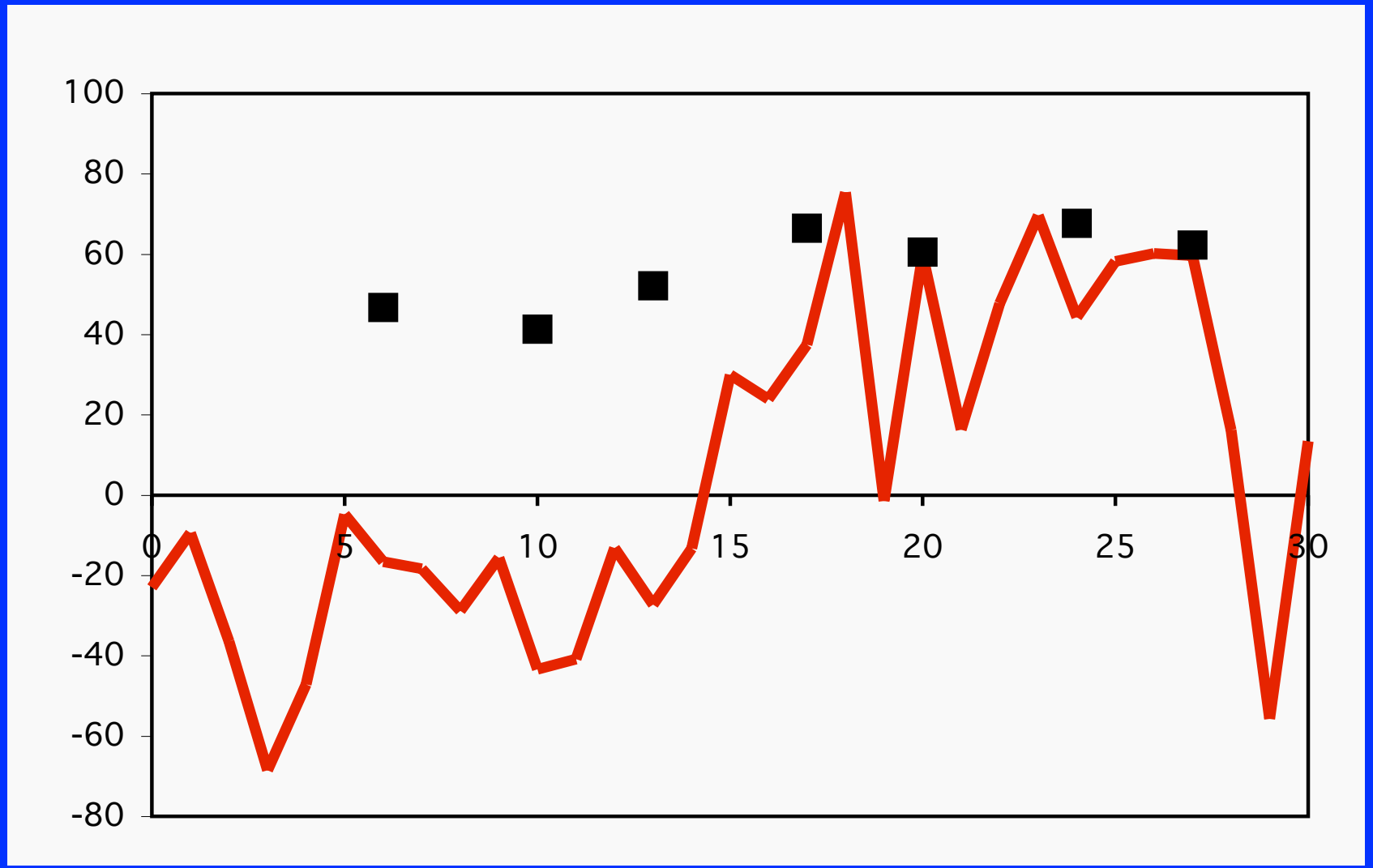


Simulation of carbohydrate balance in Uruguay in 2009.

Timing Trial Patterns vs. Carbohydrate Supply: Demand Balance - 2003



Timing Trial Patterns vs. Carbohydrate Supply: Demand Balance - 2004

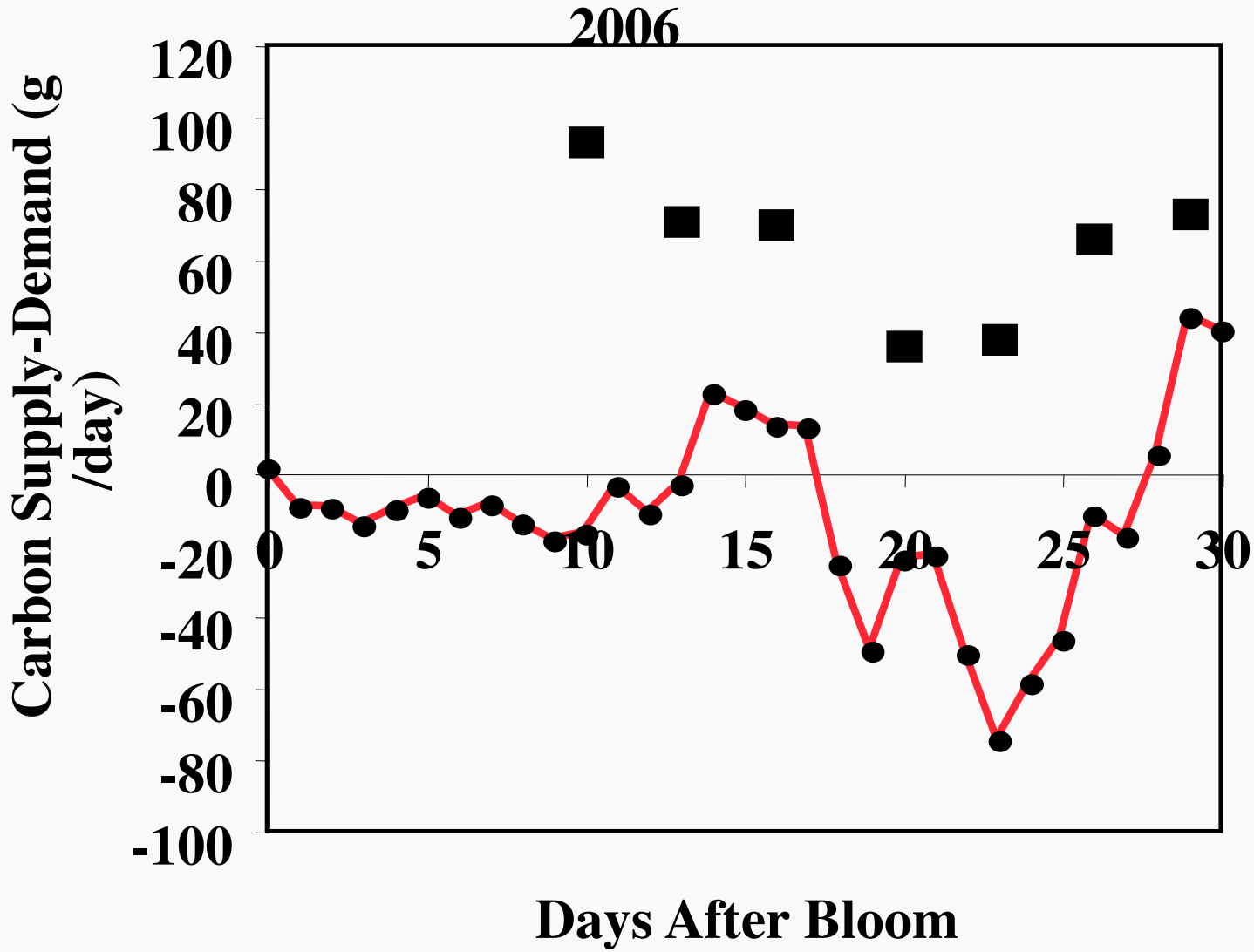


CHO Supply-Demand (g/day)

% of Untreated Crop Load

Days After Bloom

Timing Trial Patterns vs. Carbohydrate Supply: Demand Balance - 2006

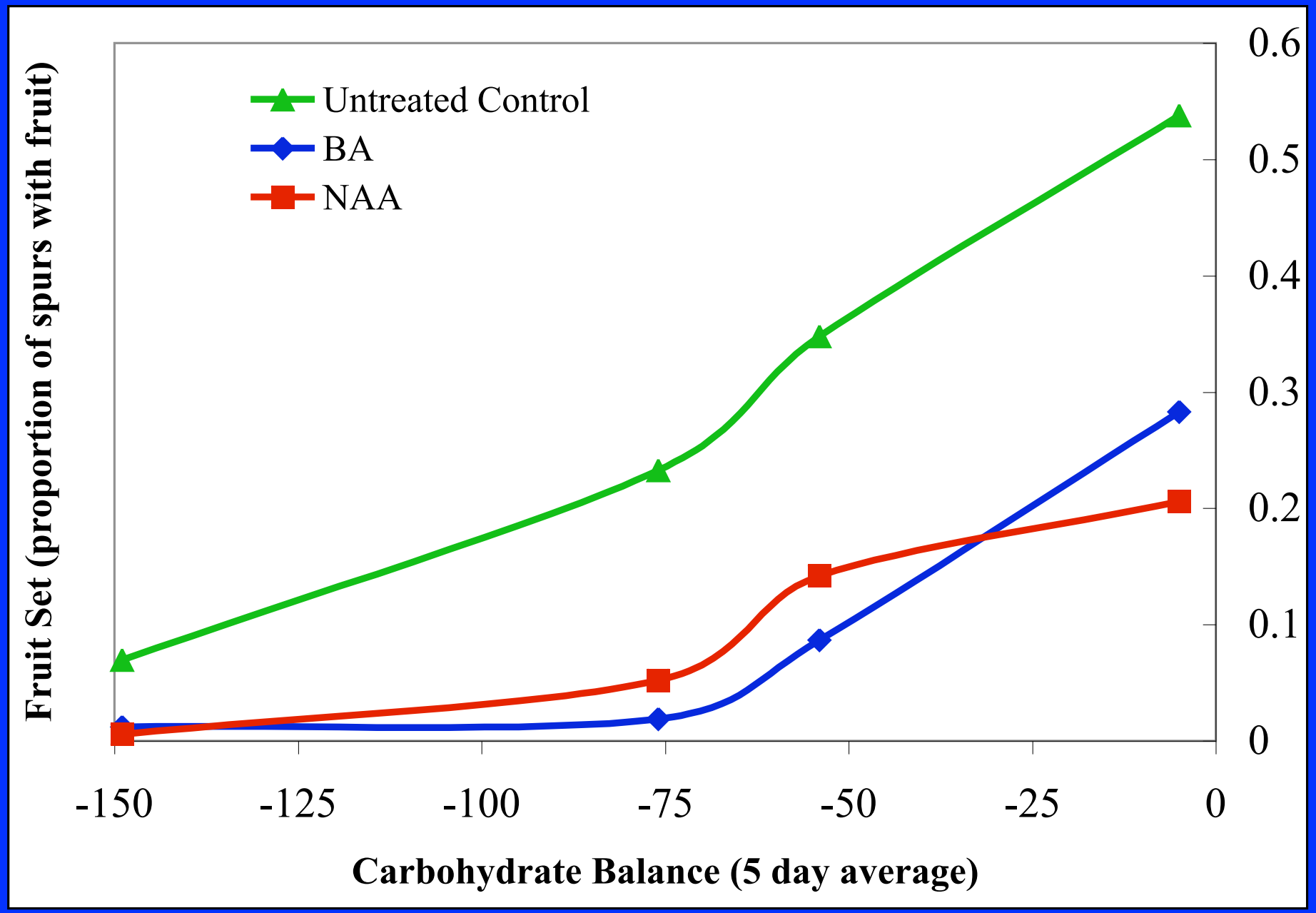


% of Untreated Crop Load

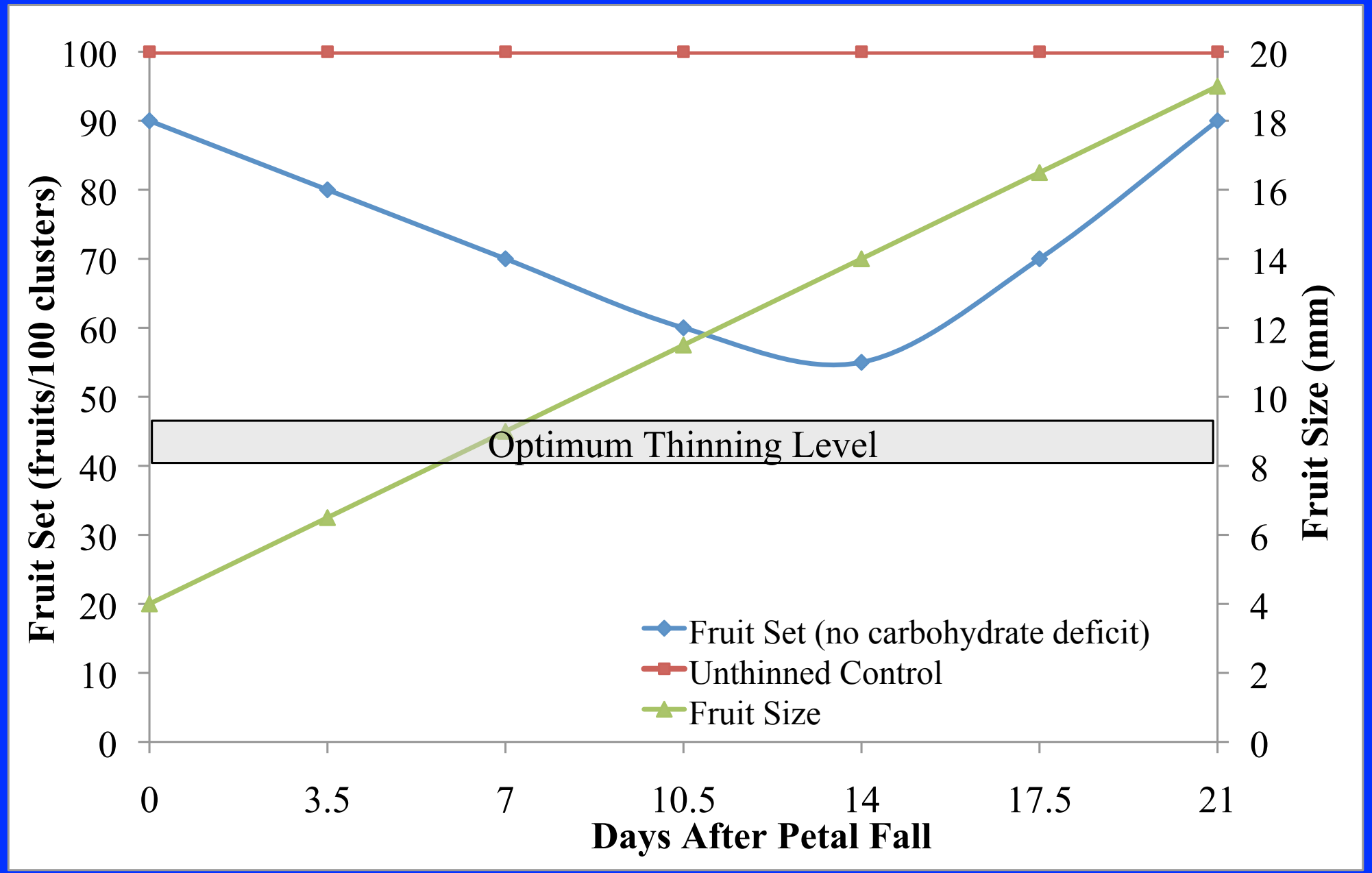
Issues with the use of the Carbohydrate Model

- The model requires good input data to have reasonable forecast value.
  - Many of the grower-owned weather stations have improperly calibrated light sensors. ~50% of sensors are wrong.
  - The NEWA web-site will only allow the model to be run with weather stations with accurate light sensors.
- The model requires good weather forecasts to give reasonable forecast values
  - Weather forecasts longer than 5 days in the future are not accurate
  - Some weather forecasting sites give 21 day forecasts but they are worthless
  - Dr. Art DeGaetano of the Northeast Climate Center has developed a better light forecasting model (6 days forward) which will be available to the NEWA region

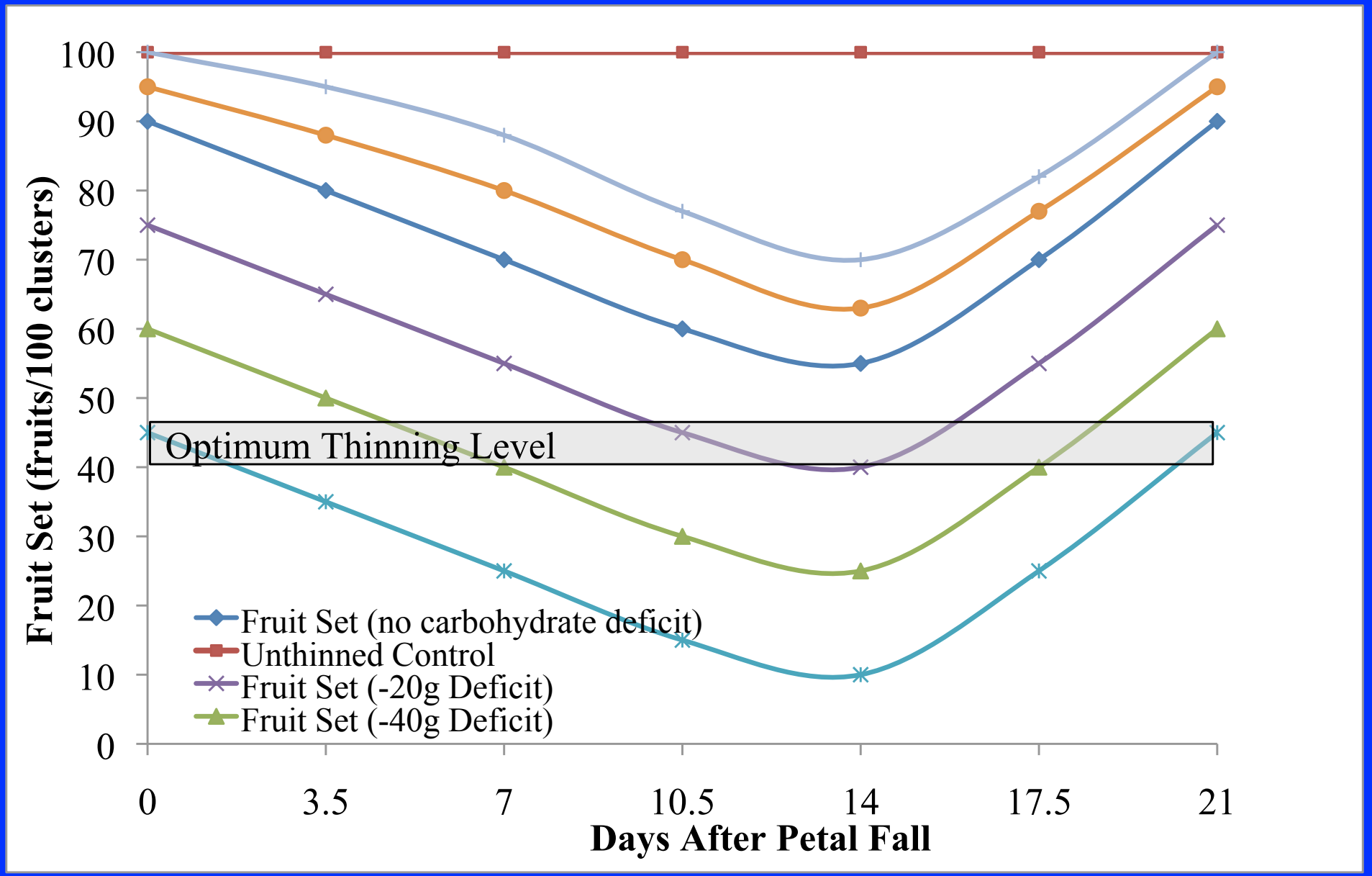
Relationship between carbohydrate balance for 5 days after application of thinners and fruit set of Empire/M.9 apple trees.



Thinning Efficacy During the Thinning Window



Effect of carbohydrate balance on thinning efficacy throughout the thinning window



Decision Rules We Use to Make Recommendations

4-day Av. Carb. Balance	Thinning Recommendation
+20g/day to 0g/day	Increase Chemical Thinning Rate by 30%
0g/day to -20g/day	Apply Standard Chemical Thinning Rate
-20g/day to -40g/day	Decrease Chemical Thinning Rate by 10%
-40g/day to -60 g/day	Decrease Chemical Thinning Rate by 20%
-60g/day to -80 g/day	Decrease Chemical Thinning Rate by 30%
< than -80g/day	Do not thin (many fruits will fall off naturally)

Precision Thinning

1. Calculate the desired fruit number per tree (This defines the target).
2. Use the carbohydrate model to assess tree sensitivity to a chemical thinning spray before application.
3. Apply a chemical thinner spray.
4. Use the fruit growth rate model to assess the effect of the chemical thinning spray after application.
5. Use the carbohydrate model to assess tree sensitivity before re-application of a second chemical thinning spray.
6. Use the fruit growth rate model to re-assess the effect of the second thinner.

Status of Carbohydrate Model for 2013:

- We have an excel version of the carbohydrate model
- Locations with a NEWA weather station will be able to use a web version of the carbohydrate model in 2013
  - NY, MA, VT, NJ, DE and Eastern PA
  - Model written in Python and linked to weather stations and forecasts (6 days)
  - Improved solar radiation forecasts are built into web version
  - Web version will give you a thinning index (running 4-day carbon balance) for each day and a recommendation
- Growers in PA, VA, NC and MI can get help with the carbohydrate model from Rob Crassweller, Greg Peck, Steve McCartney, Phil Schwallier and Amy Brown.
- We are willing to share the model with individuals in other areas.


Thank You for Your Attention
Questions?