

Flower Bud Formation and the Biennial Bearing Puzzle in Apple

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Acknowledgements:

Peter Hirst, Dick Unrath, Emily Hoover, Toshi Foster, Duane Greene,
Tory Schmidt, JD Obermiller

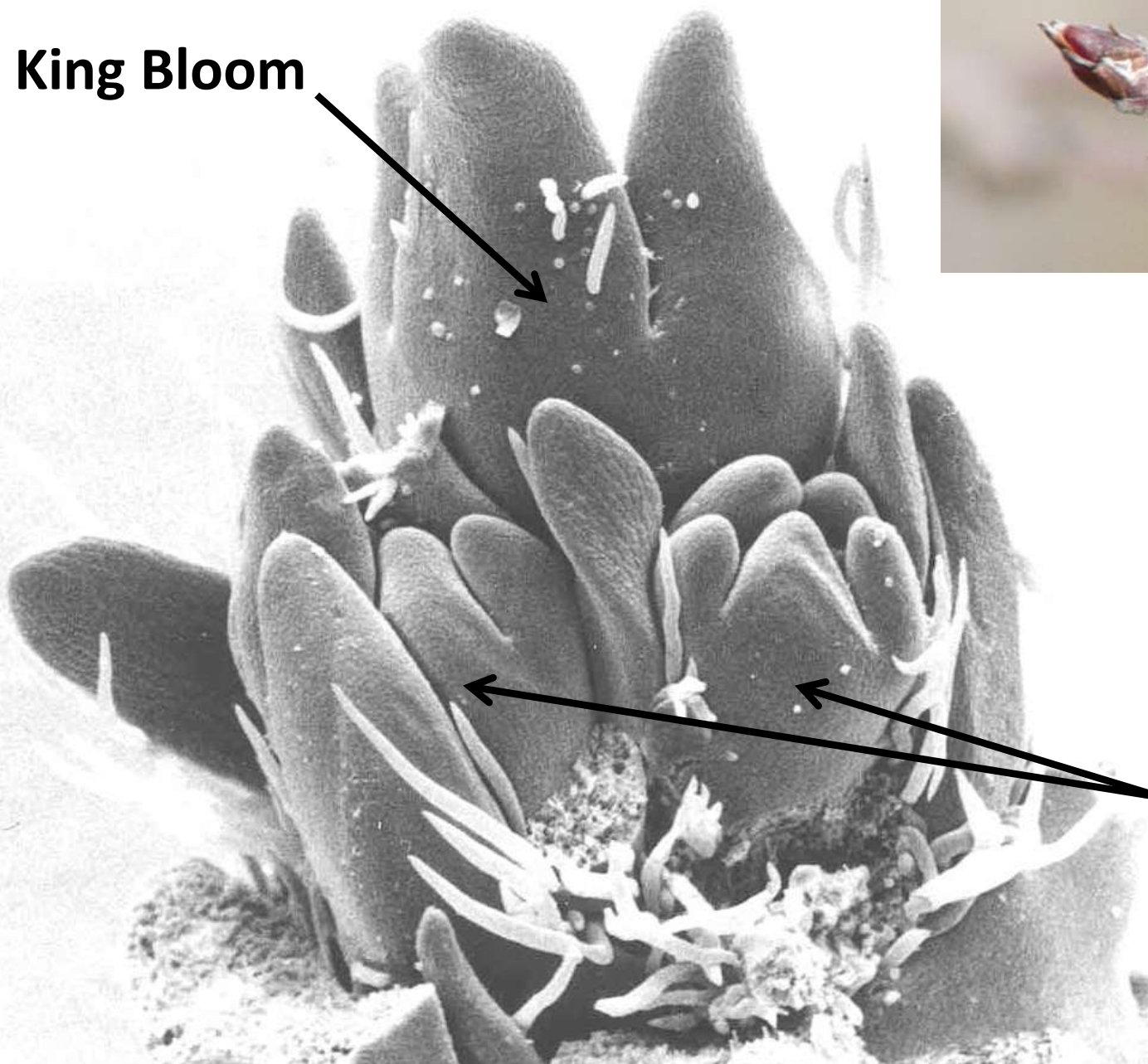
NC STATE UNIVERSITY







King Bloom

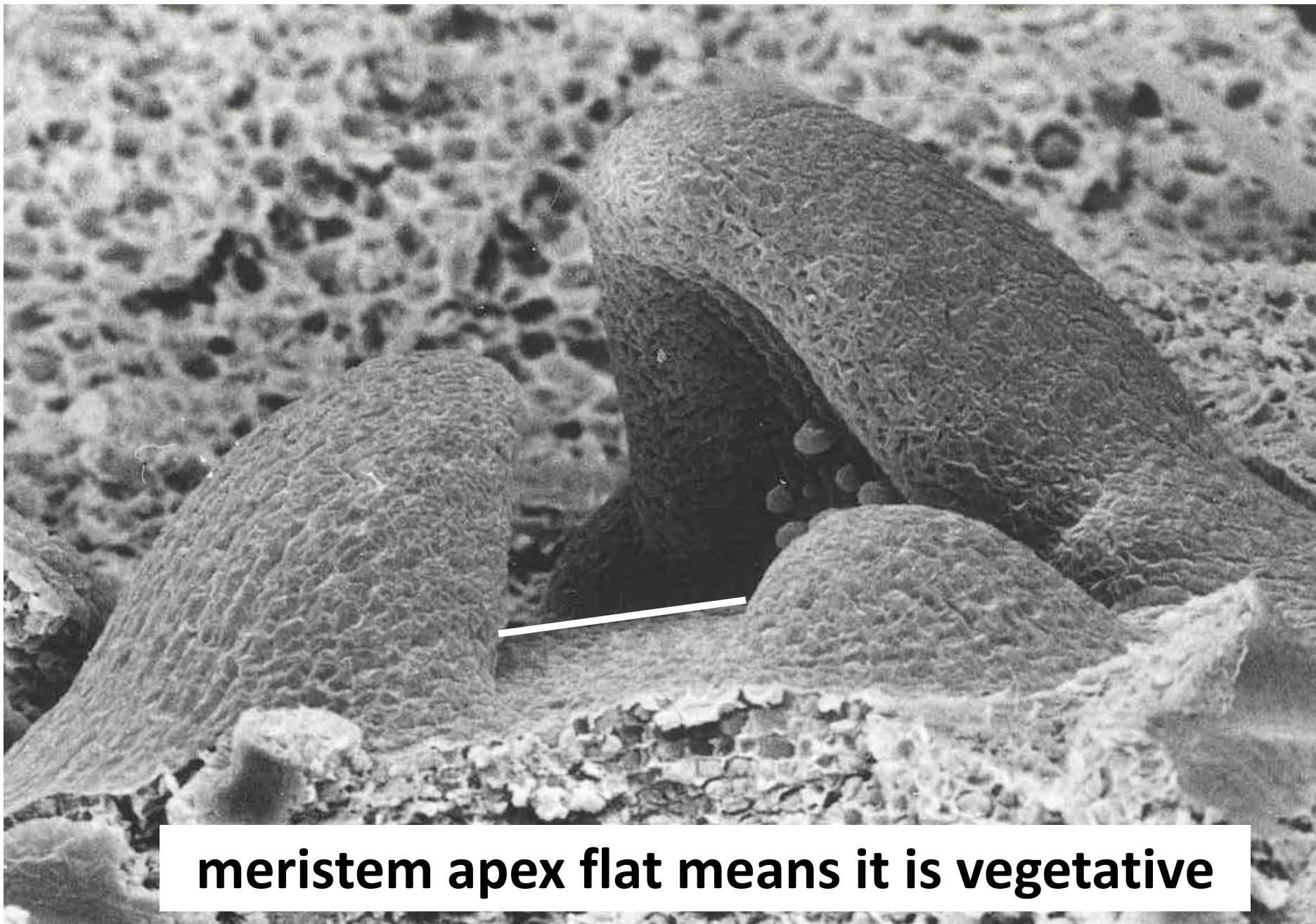


Lateral Blooms

Courtesy Toshi Foster







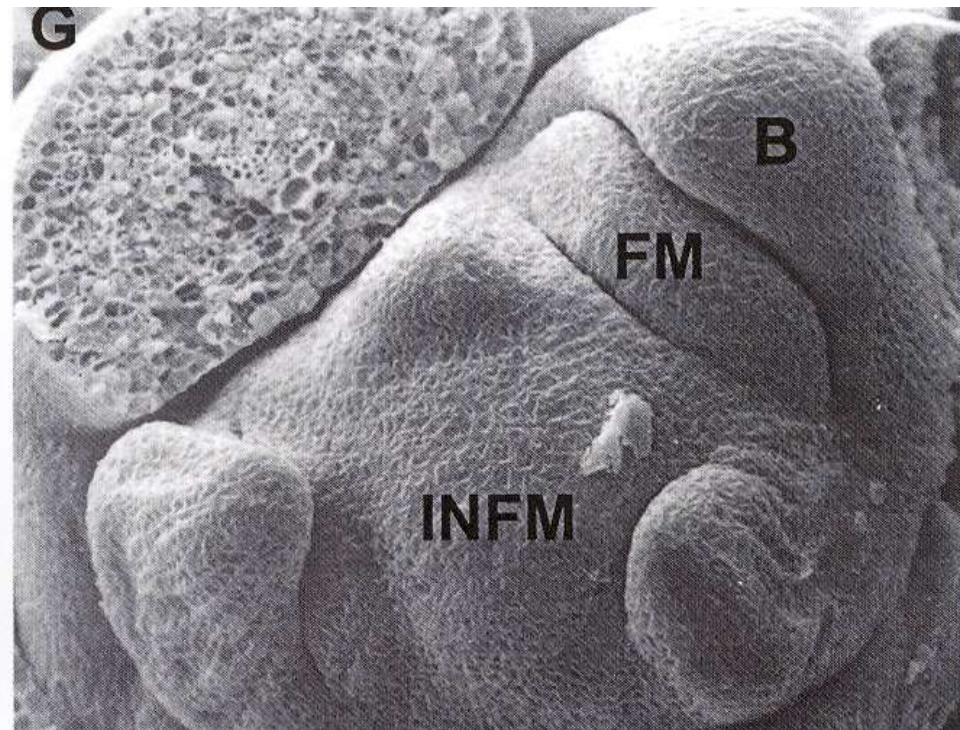
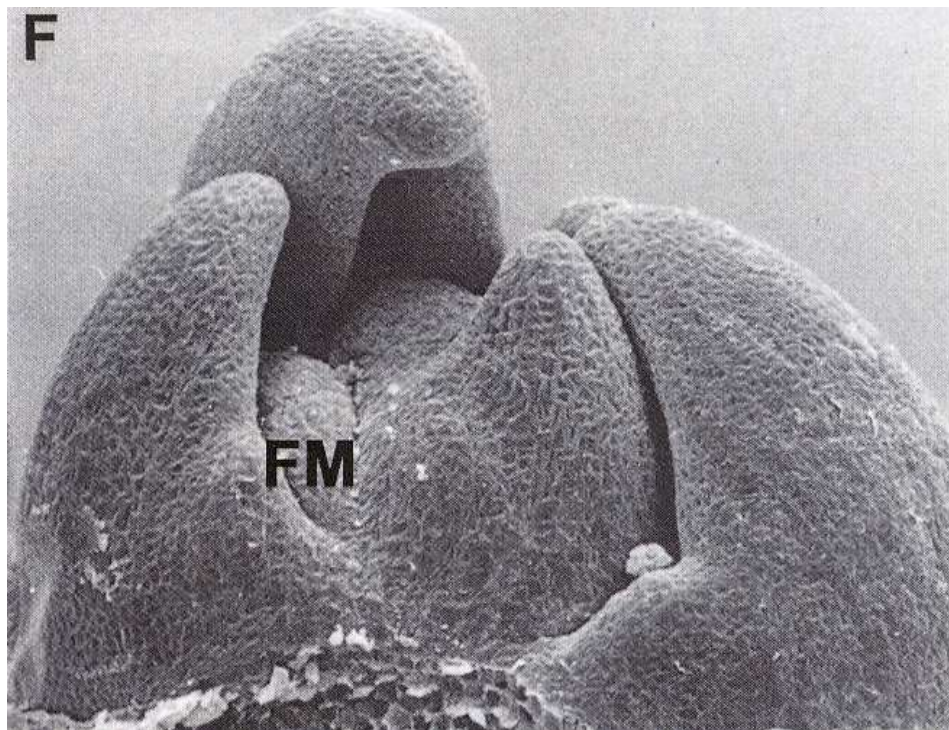
meristem apex flat means it is vegetative

Courtesy Toshi Foster

Courtesy Toshi Foster

A scanning electron micrograph (SEM) showing a close-up of a plant meristem apex. The structure is elongated and covered in a dense, fine-grained texture. A white curved line is drawn across the middle of the structure, highlighting its domed shape. The background is out of focus, showing other plant structures.

meristem apex domed means it is floral



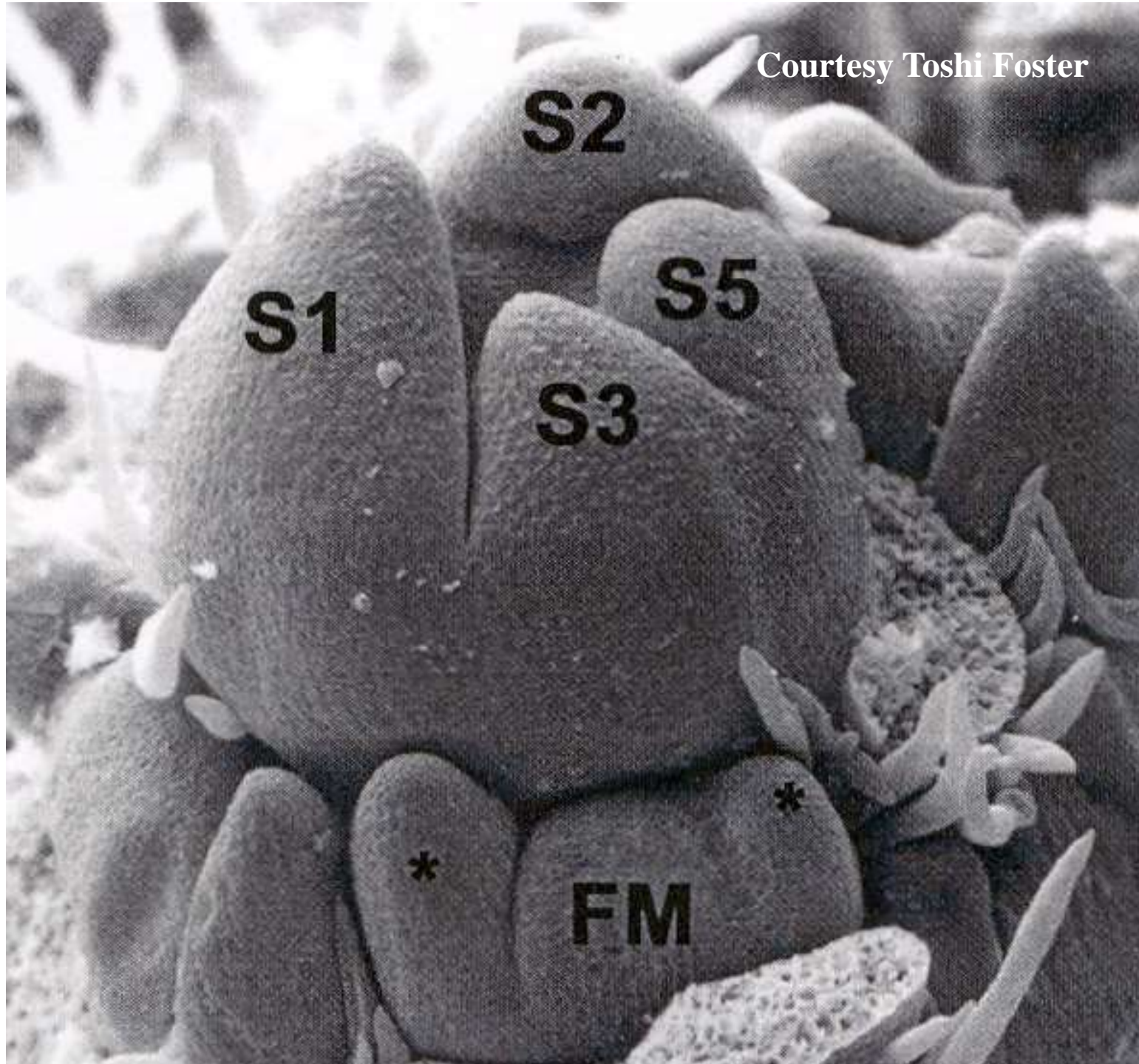
FM = Flower meristem

B = Bract

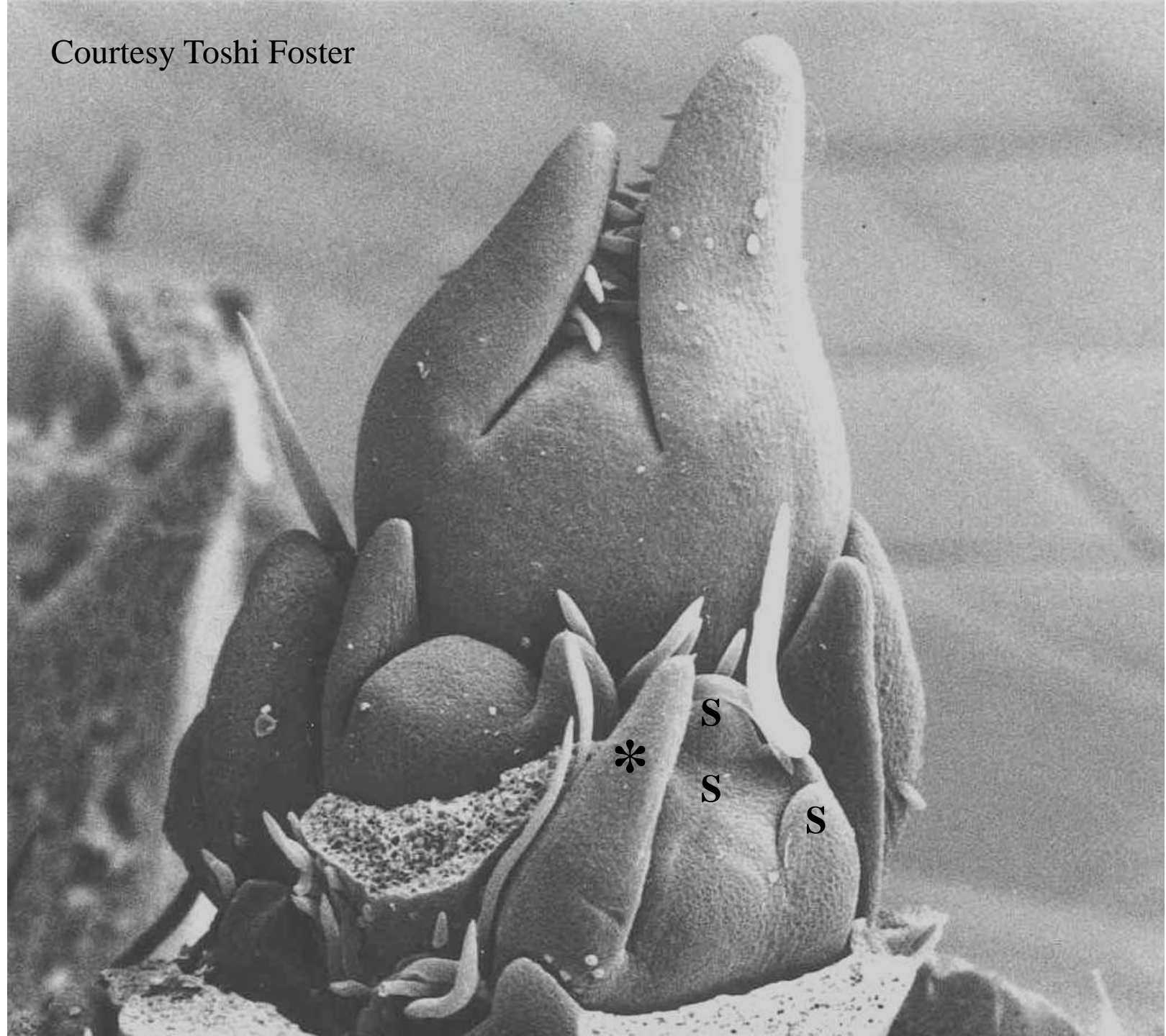
INFM = Inflorescence meristem

Courtesy Toshi Foster

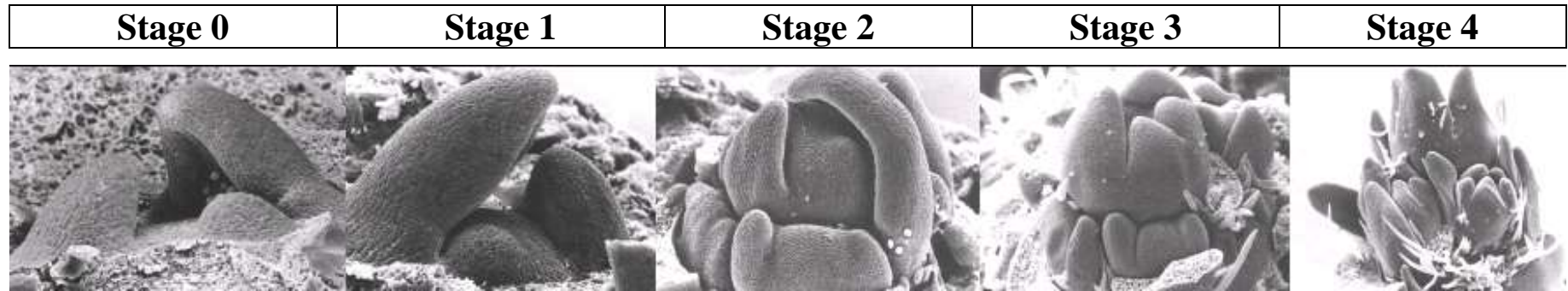
Courtesy Toshi Foster



Courtesy Toshi Foster



Stages of Floral Development in Apple Buds



Stage 0: meristem flat

Stage 1: meristem domed

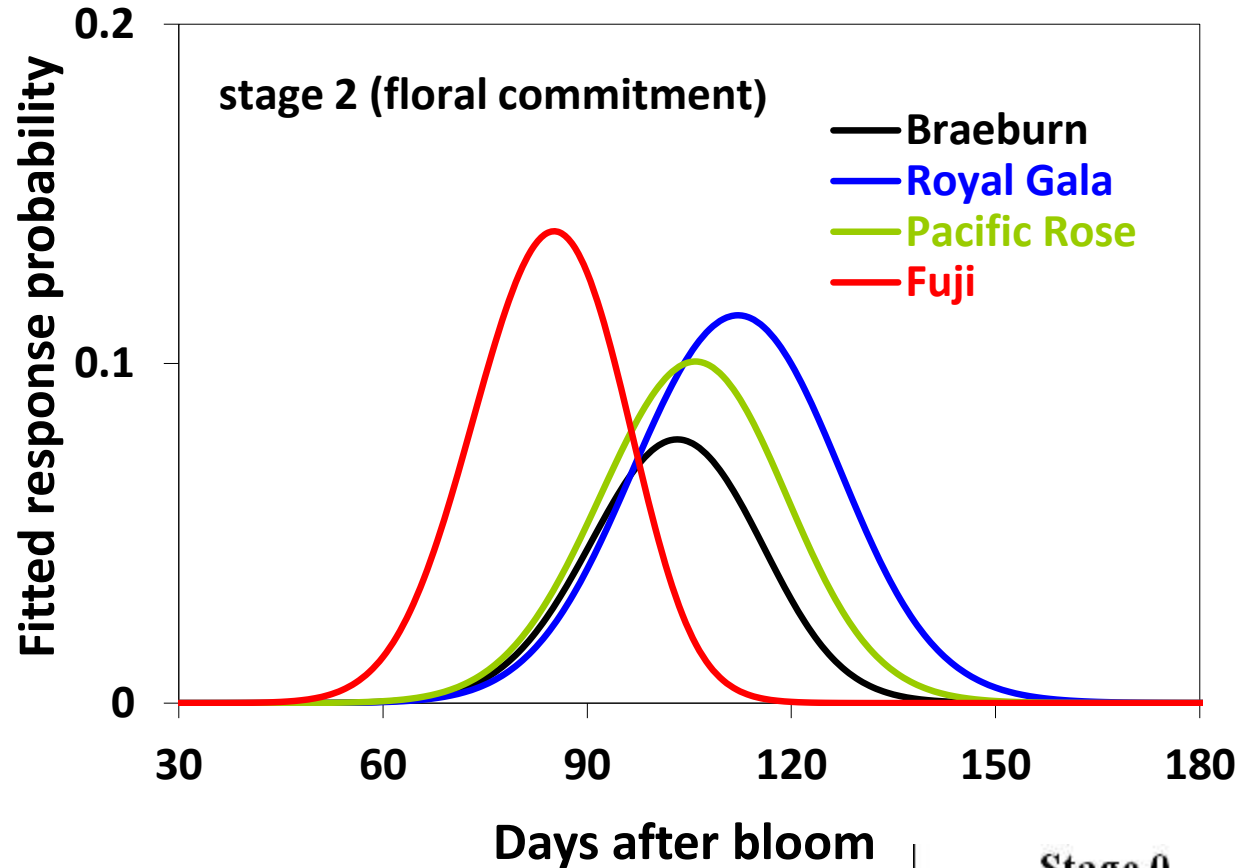
Stage 2: bractlets developing on the terminal floral meristem

Stage 3: sepals clearly differentiated on terminal floral meristem

Stage 5: Sepals clearly differentiated on the lateral floral meristems

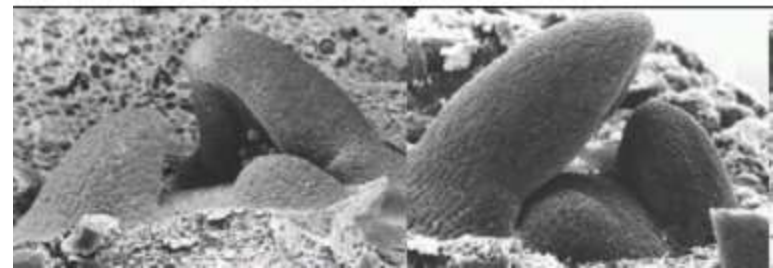
(After Hoover et al)

Does Doming Occur at the Same Time in all Apple Varieties?



Stage 0

Stage 1



(Source: Hoover et al)

Differentiation of Flowers Proceeds Rapidly After Doming

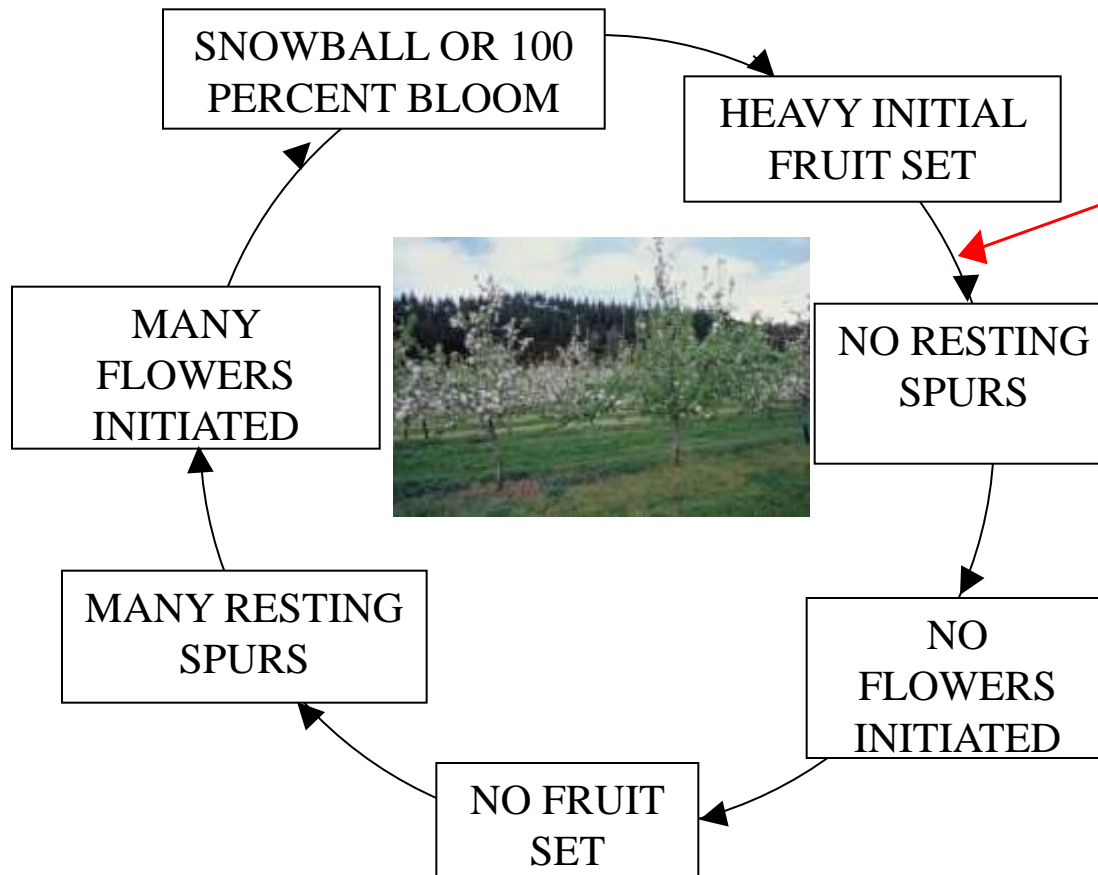


Doming starts 60-100 days after bloom

Stage 4 (sepals on lateral blooms) is first seen approx. 30 days after doming

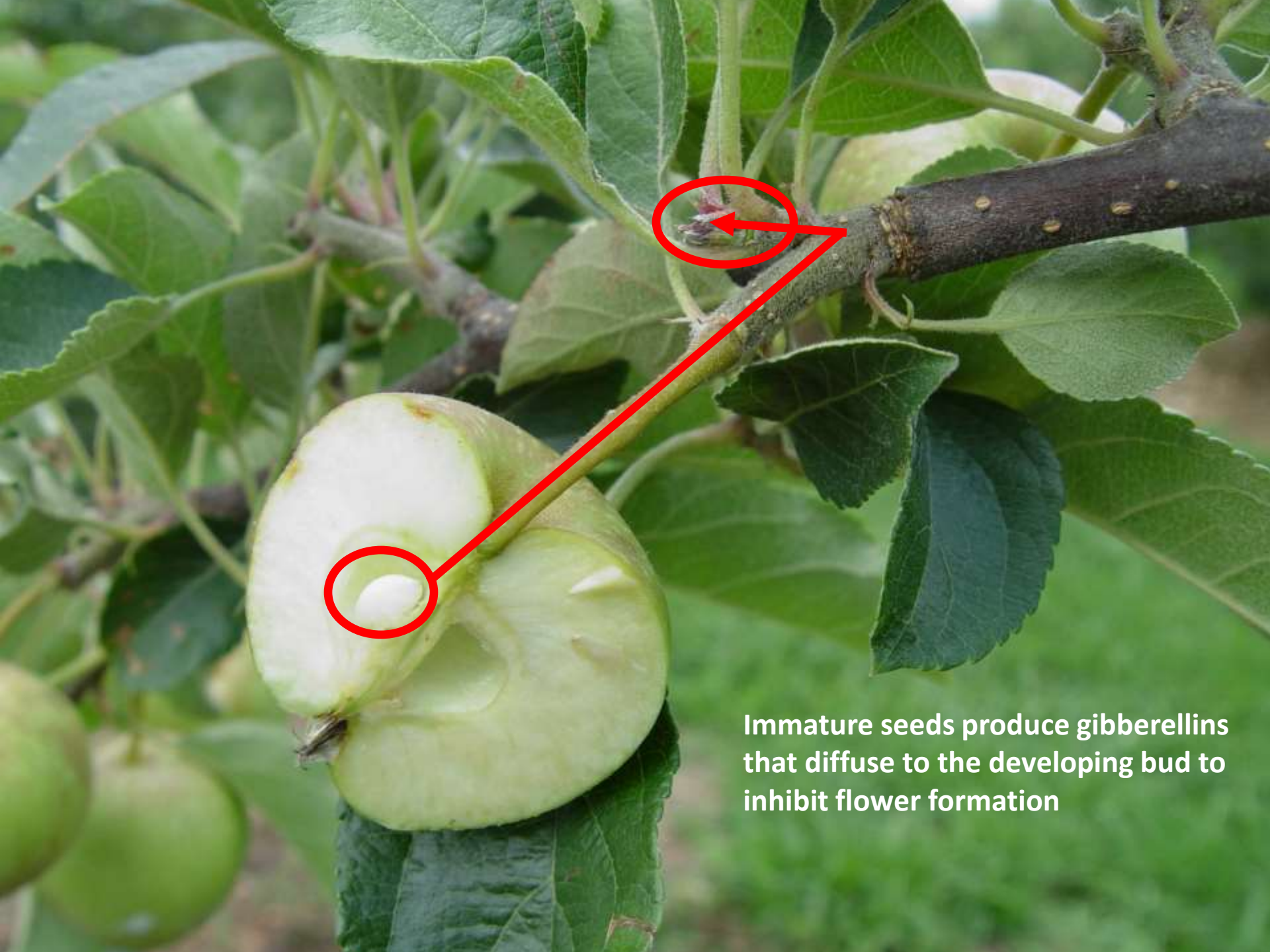
The Biennial Bearing Cycle

Williams and Edgerton, 1981



**Increase flower bud
formation in the on year**

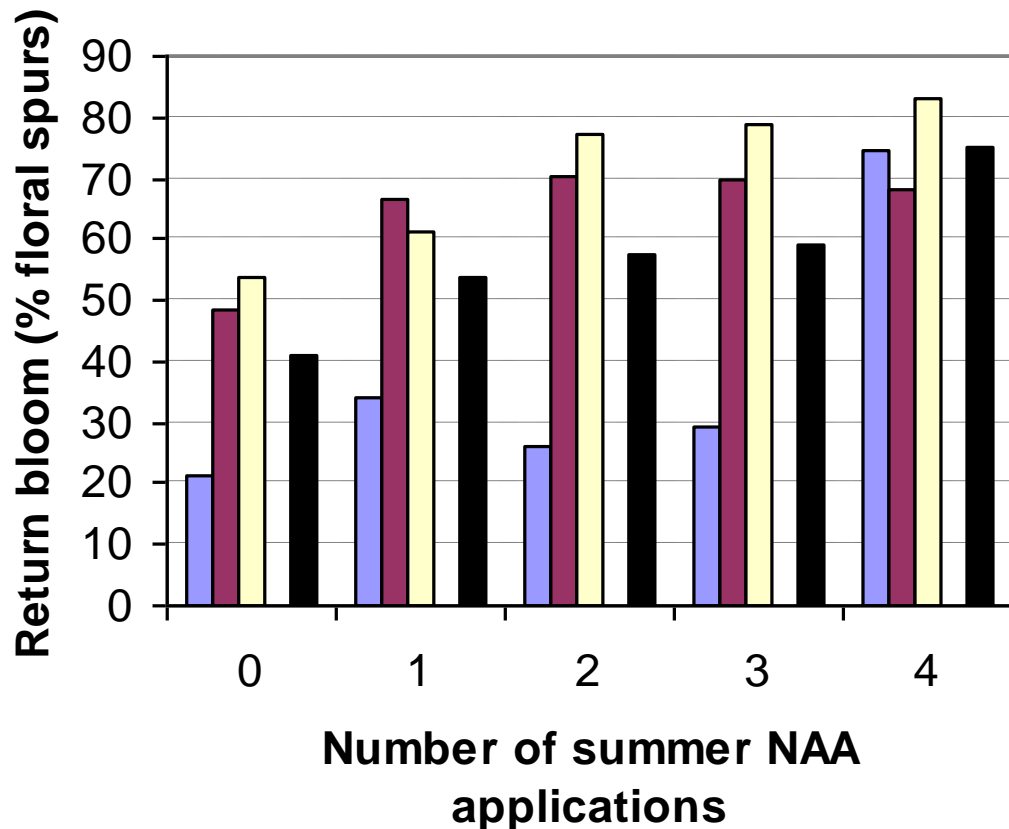
**chemical thinning
Ethrel
NAA**



Immature seeds produce gibberellins that diffuse to the developing bud to inhibit flower formation



How Many NAA Sprays are Needed?



Red Delicious
Smoother Golden Delicious
Golden Delicious
Average

1 application: 6/7

2 applications: 6/7, 6/21

3 applications: 6/7, 6/21, 7/2

4 applications: 6/7, 6/21, 7/2, 7/16

NAA Programs for Return Bloom

Summer NAA

Four bi-weekly applications of 5 ppm NAA beginning in mid-June

Preharvest NAA

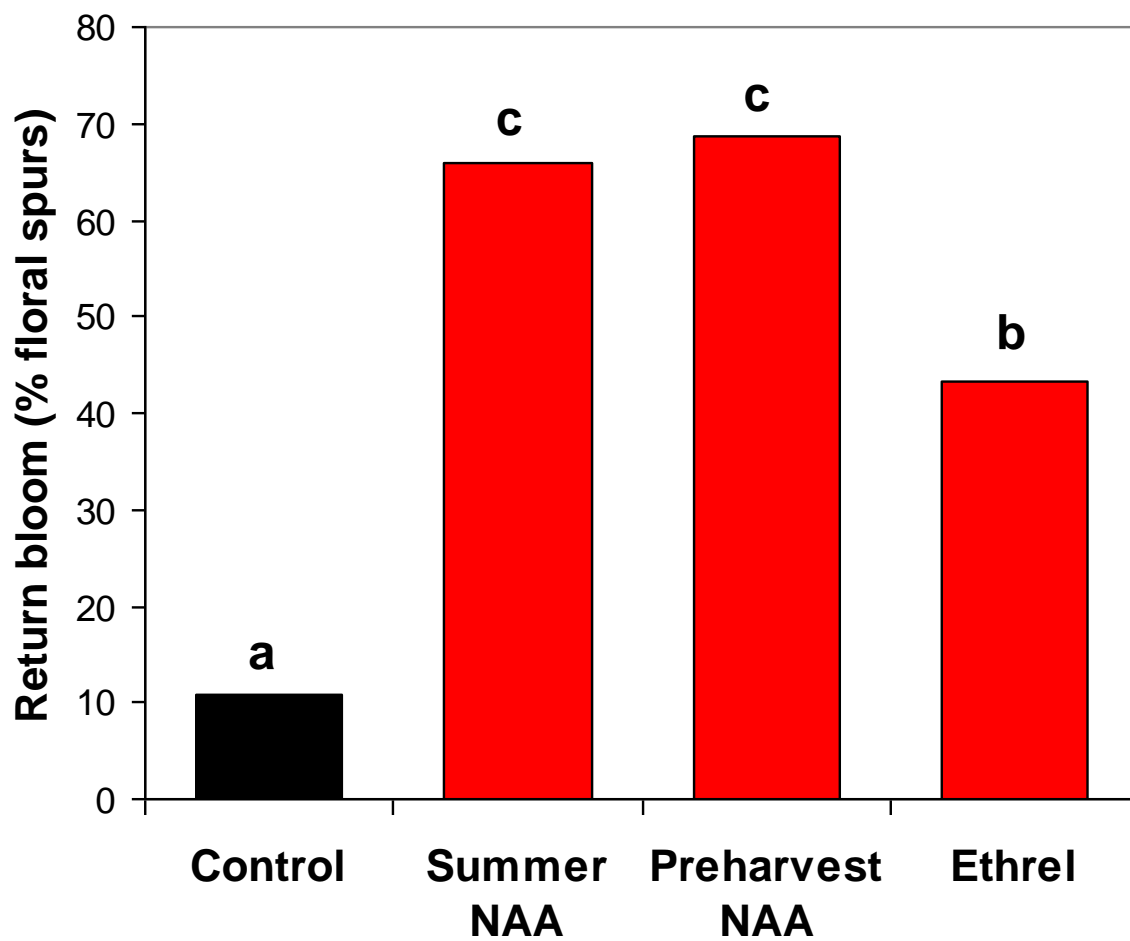
Four, weekly applications of 5 ppm NAA beginning one month prior to anticipated harvest. Primarily applied for stop drop control.

Comparison of NAA and Ethrel programs for return bloom

	Summer NAA	Ethrel
Timing:	Start program in late June.	Make one application 5-6 weeks after bloom when the thinning window is over.
Frequency:	Four bi-weekly applications.	Usually only one application is needed.
Rate:	5 ppm NAA (Fruitone L) for all varieties.	Rate is variety dependent. 16-24 oz/acre: Gala, Rome, Red Delicious 24-48 oz/acre: Golden Delicious 48-72 oz/acre: Fuji, Cameo
Notes:	Can be included with cover sprays.	Not recommended on early season varieties prone to pre harvest drop eg. Honeycrisp.

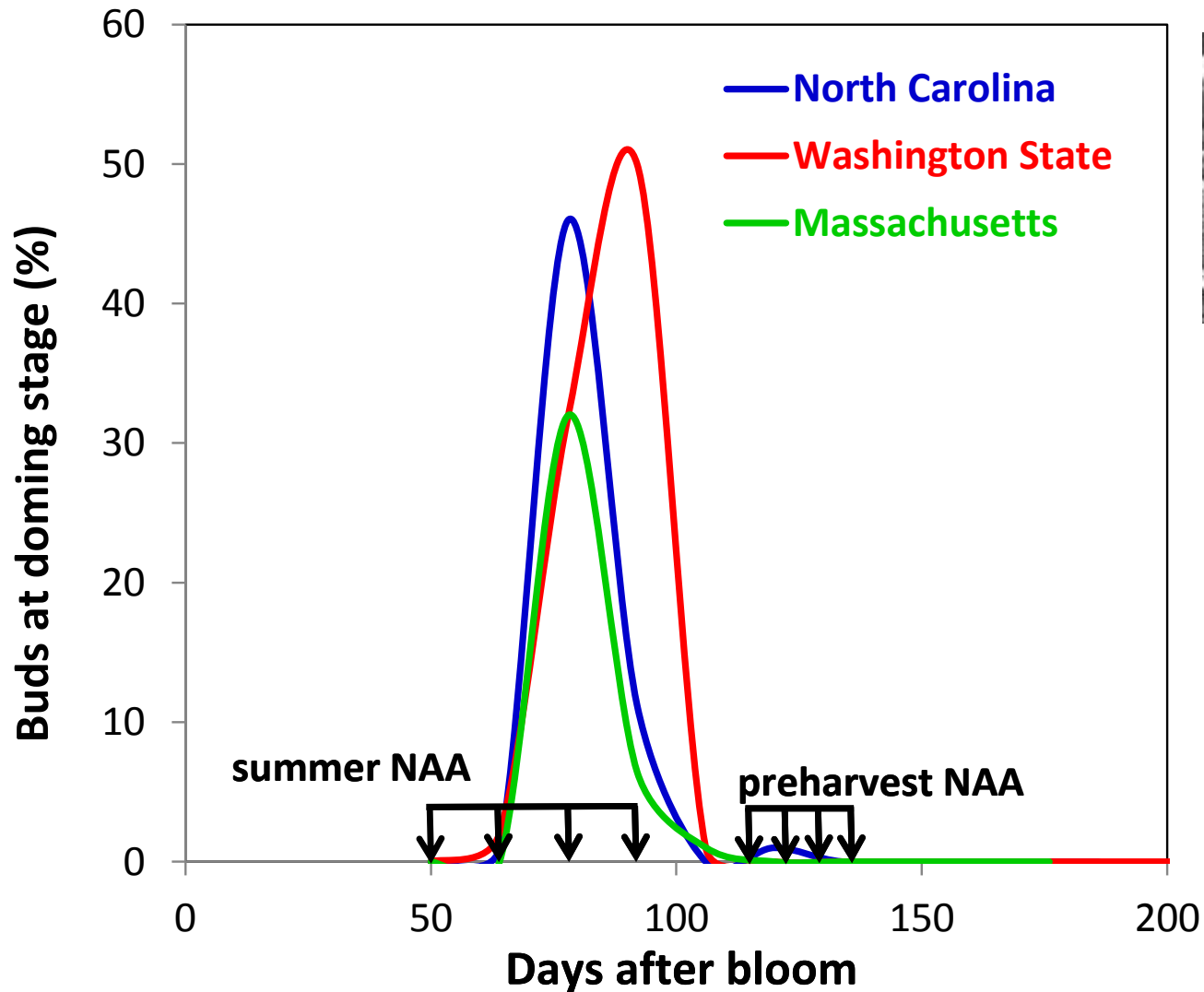
Ethrel and NAA treatments for Return Bloom

('Golden Delicious', 2006)

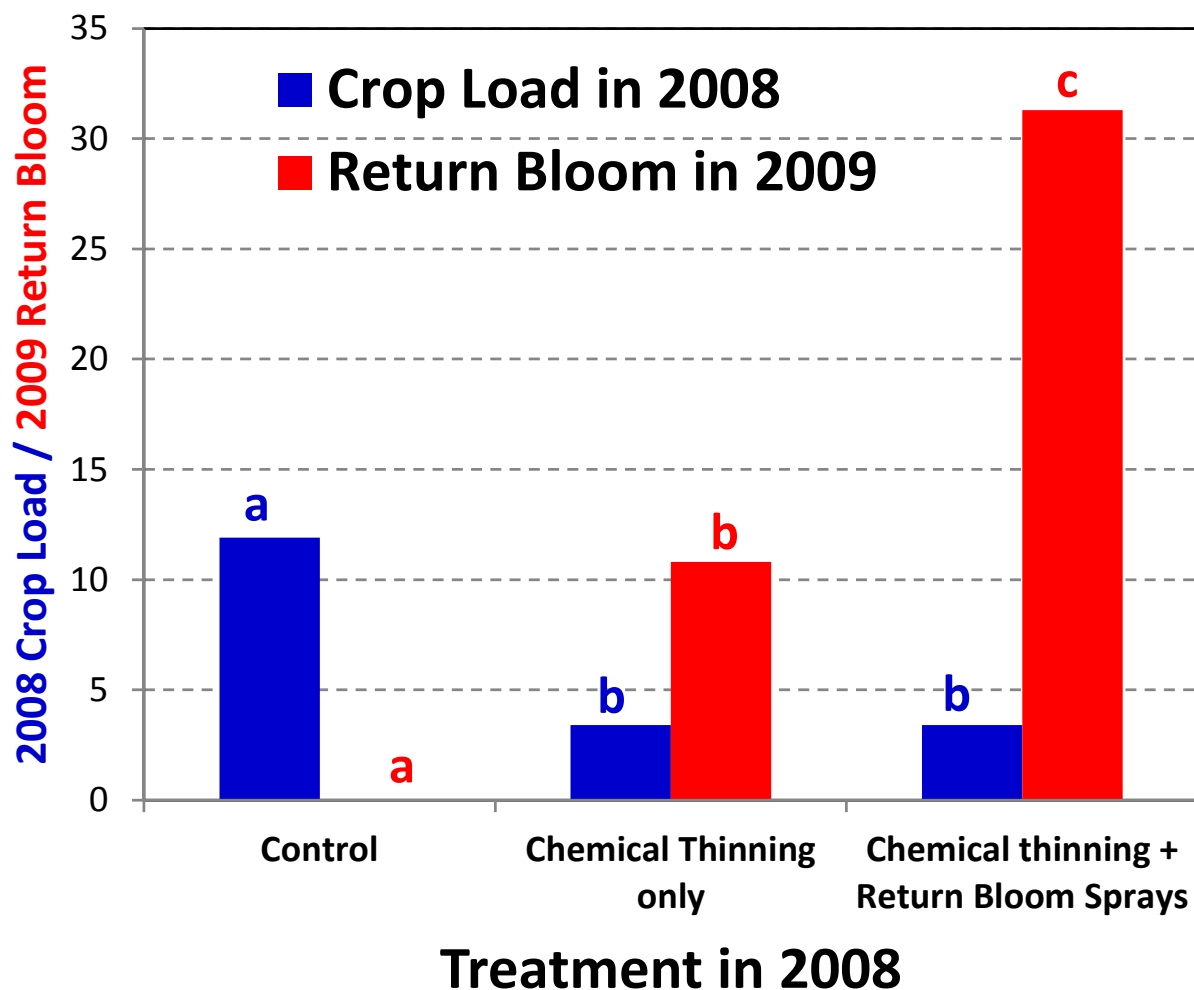


Preharvest NAA sprays are applied after doming is over???

Buds were sampled from non-flowering spurs on two year old or older wood



A Successful Chemical Thinning Program is NOT enough to Guarantee Return Bloom of Strongly Biennial Varieties



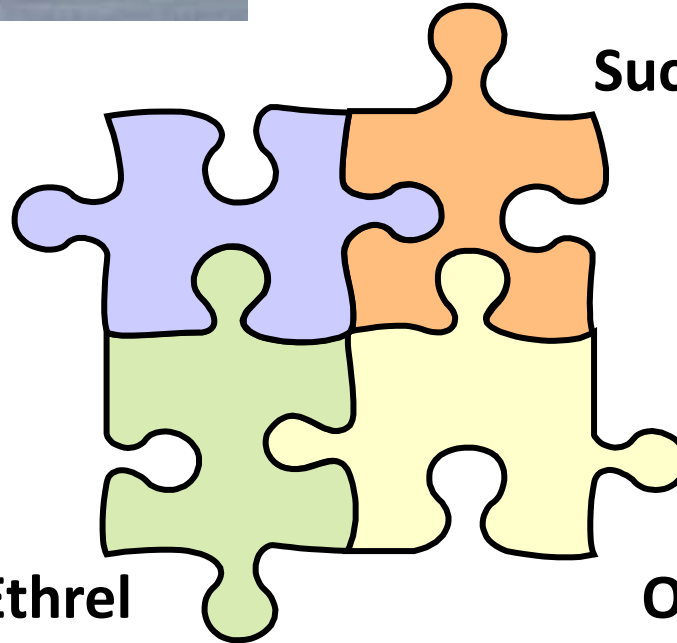
- York Imperial
- Thinned with carbary + 6-BA
- Return bloom spray was 3 x NAA + ethephon





When it comes to having a good bloom every year -
There is no such thing as a silver bullet!

**Initial Fruit Set
Initial Seed Set**



Success of Thinners

**Summer NAA and Ethrel
programs**

Other factors:

- Nutrition
- Tree vigor
- ???

The King Flower Continues to Grow after Harvest (and leaf fall?)

- Golden Delicious
- Three different regions
NC, MA, WA
- Buds sampled at harvest, leaf fall, 1 month after leaf fall
- Diameter of the king flower measured

