Foliage (Carbon) based damage thresholds

Jim Flore

with data from:

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Poalo Sabbitini

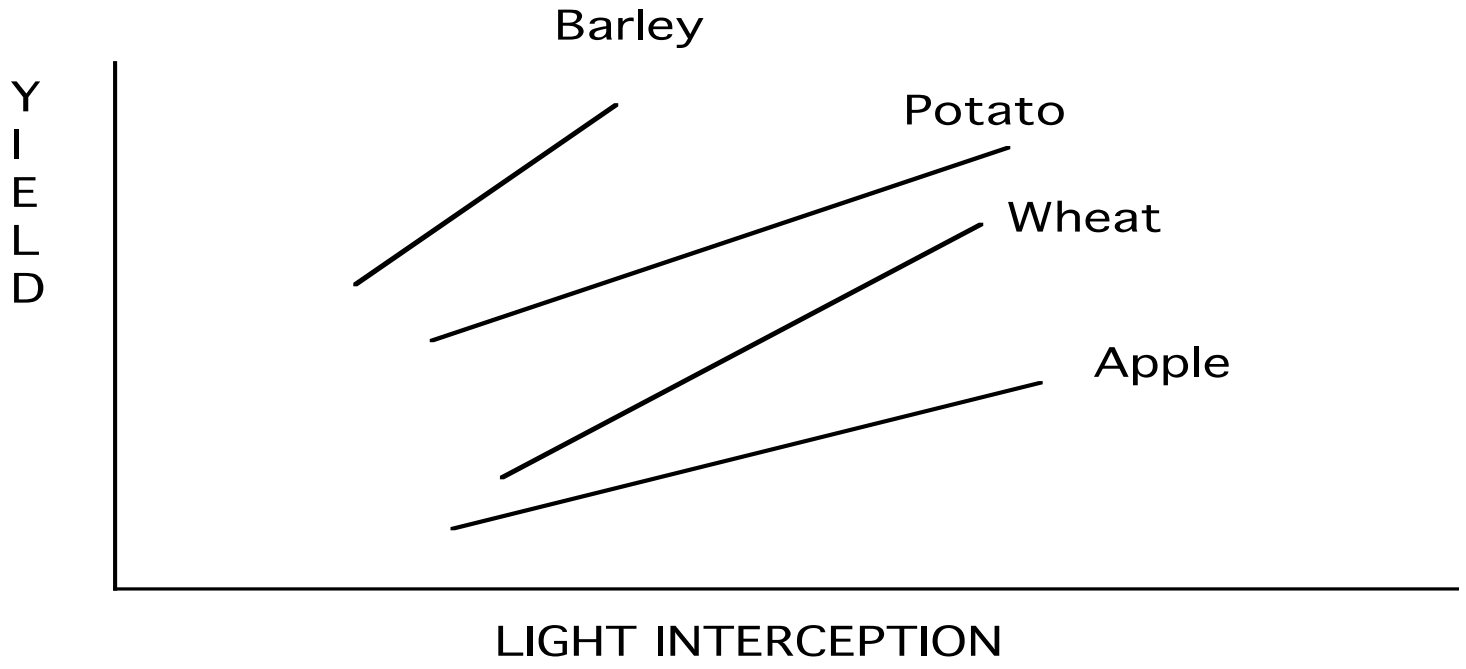
Foliage damage thresholds

- The leaf and photosynthesis
- Yield is related to light intercepted
- However, shade effects quality
- How is carbon partitioned in fruit
- What is a damage threshold, and when is it most important to the crop (biological or environmental damage to the leaf)

The primary organ to trap energy and synthesize carbon into carbohydrates is the Leaf

- The major process that assimilates carbon dioxide into starch and sugar is Photosynthesis
- The driving force for photosynthesis is light energy from the sun.
- Therefore it isn’t surprising that light interception per land area is directly related to yield.

LIGHT INTERCEPTION LIMITS YIELD (MONTHIETH; JACKSON AND PALMER



Light interception is affected by plant shape and plant density

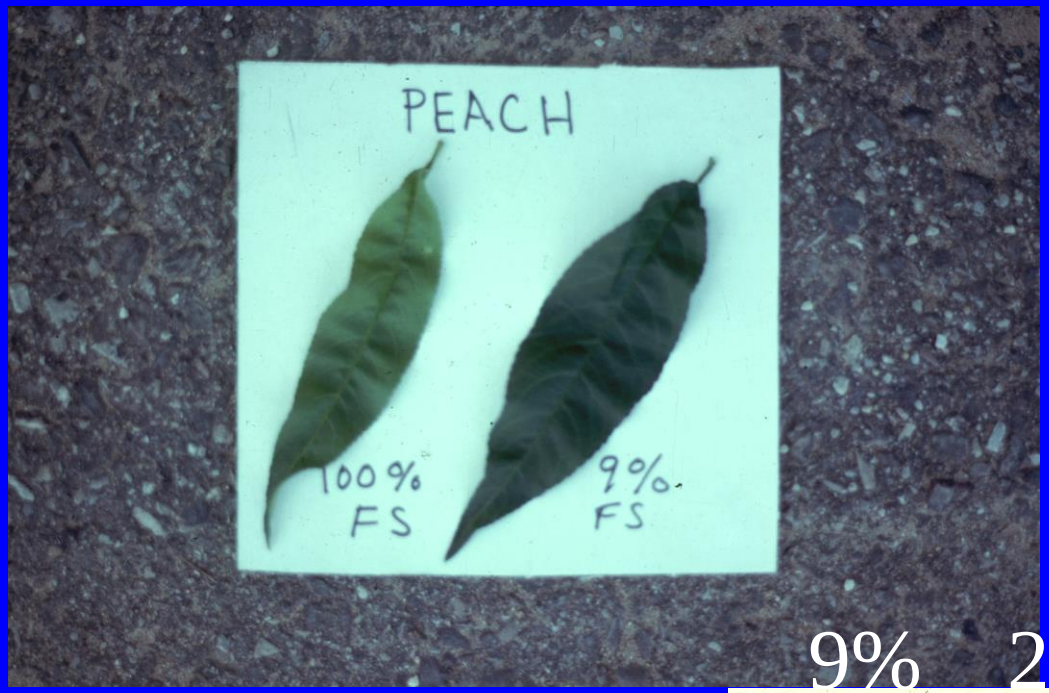
What about Shate in the tree: Canopy effect on light

Close spaced Montmorency Sour cherry 10 x 15 ft

Fruit tree responses to shade

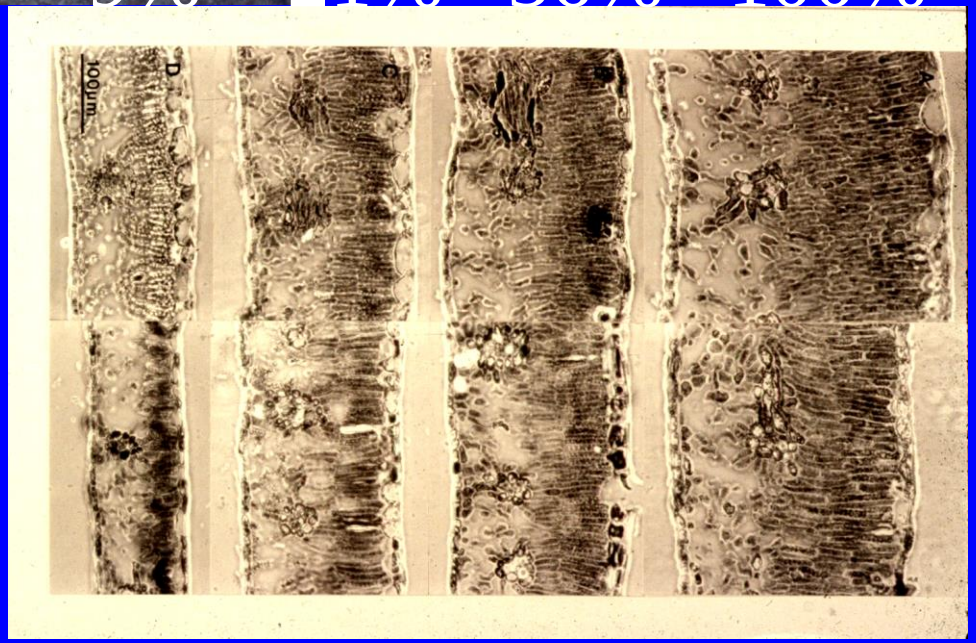
- Morphology
- Flowering and fruiting
- Cold Hardiness

THE EFFECT OF SHADE

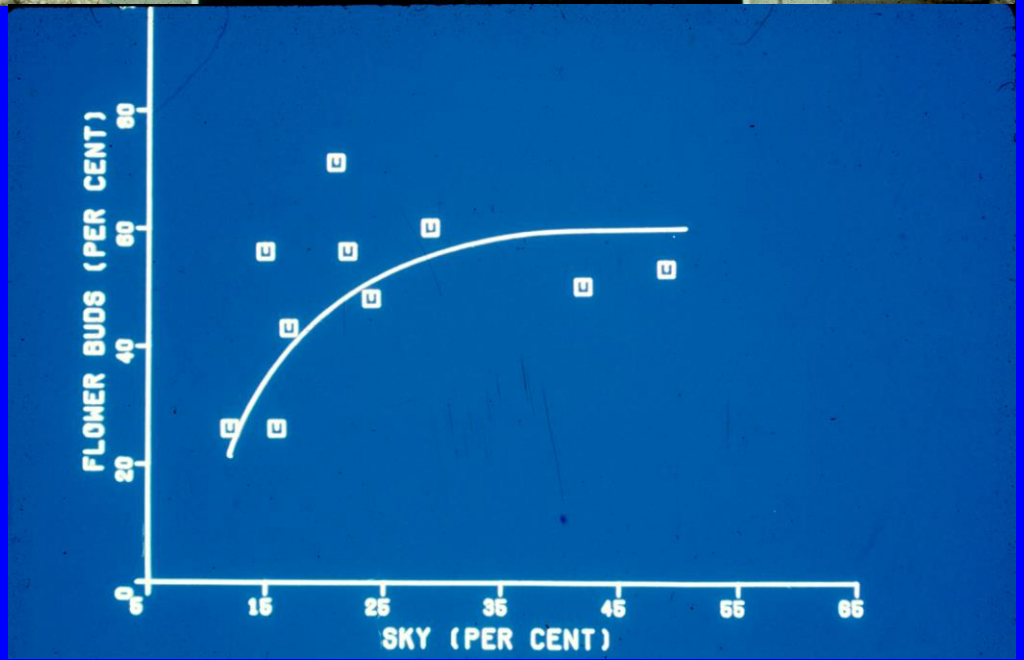


9% 21% 36% 100%

Thinner
Larger unless < 10%FS
Flatter
Dark Green/Blue in color



Grown in shade 36, 21, 9 %FS The previous Year



Fewer flower buds the following year. Threshold = 15-20% FS

The Effect of Shade on Fruit and Vegetative Buds Developed, Peach

	% Full Sun		
	100	27	3
Fruit Buds	86	32	1
Leaf Buds	27	40	87
Shoot Length (in)	16	16	8

THE EFFECT OF SHADE ON COLOR IN PEACH

- RED HAVED SHADED IN STAGE III
- FROM LEFT TO RT
  - 18 DAYS SHADE
  - 9 DAYS SHADE
  - 6 DAYS SHADE
  - 3 DAYS SHADE
  - 0 SHADE

Final Swell Stage III lasted 18 days

THE EFFECT OF SHADE ON VEGETATIVE AND REPRODUCTIVE GROWTH FOR MONTMORENCY TART CHERRY

• TREE GROWTH	-	50%
• LEAF SIZE	+	35%
• SHOOT GROWTH	+	35%
• LEAF CHLOROPHYLL	+	25%
• FLOWER INITIATION	-	10-15%
• FRUIT GROWTH	-	35%
• COLD HARDINESS	-	20%

JAF-480

THE EFFECT OF SHADE ON GROWTH AND MORPHOLOGY OF APPLE

% SUN	100	37	25	11
# shoots	83	90	74	60
shoot length	1934	2387	1833	1468
shoot wt	184	162	162	158
leaf thickness	11.7	8.6	7.8	6.3
girth increase	61.4	37.8	34.3	22.8
leaf area	21.1	21.7	26.9	28.8

Jackson and Palmer (1977) J. Hort. Sci. 52:245-252.

JAF-480

THE EFFECT OF SHADE ON # OF FLOWER BUDS PER TREE (APPLE) COX ORANGE PIPIN

% SUN IN 1970	100	37	25	11
FLOWERS IN 1971				
#	159	96	69	33
%	100	60	43	21

Jackson and Palmer (1977) J. Hort. Sci. 52:245-252.

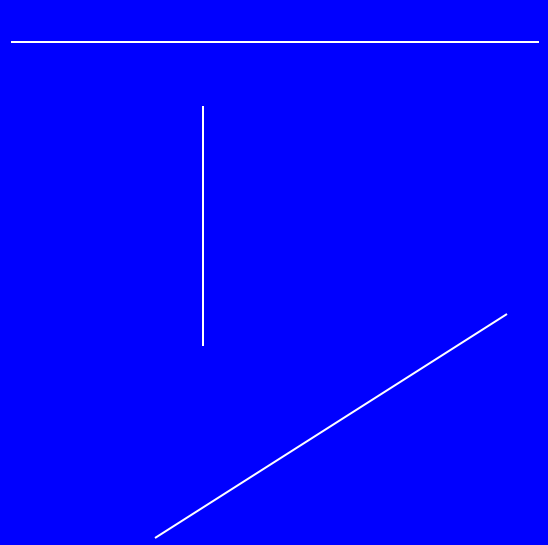
High density apple

FOLIAGE ANGLE

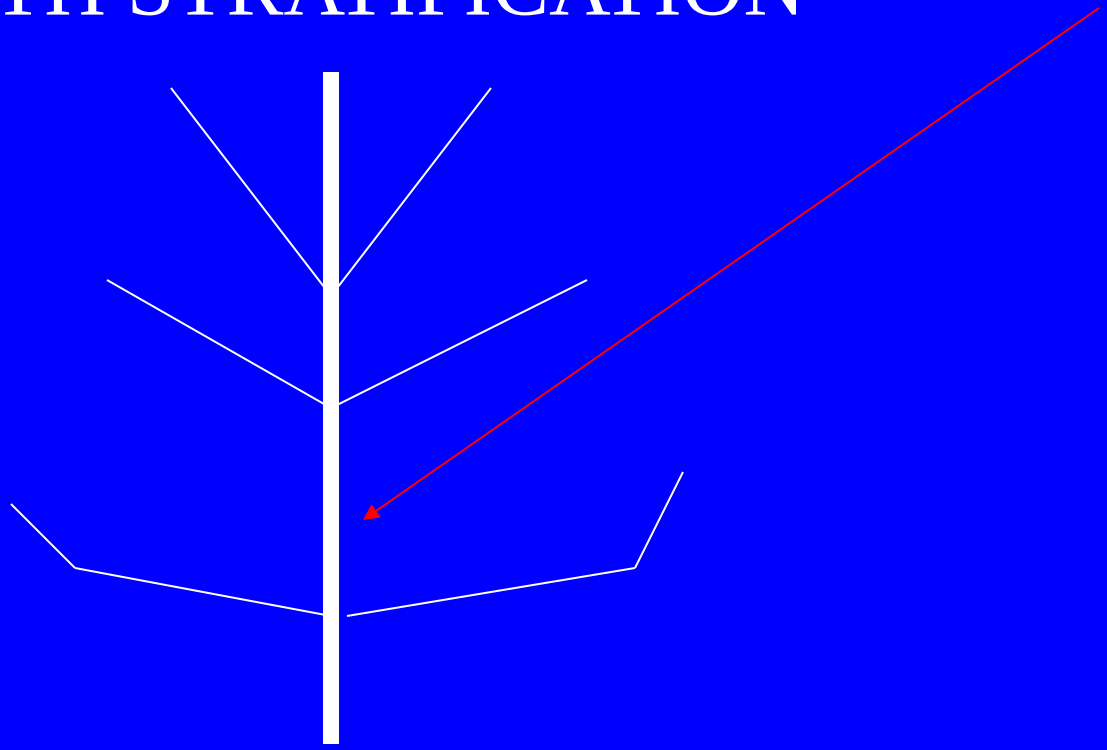
PLANOPHILE

ERECTOPHILE

PLAGIOPHILE



BRANCH ANGLE CAN CHANGE WITH STRATIFICATION



TREE SHAPE

- TRIANGLE=LESS SHADE FROM ONE ROW TO THE NEXT
- WINDOWS OF LIGHT PENETRATION

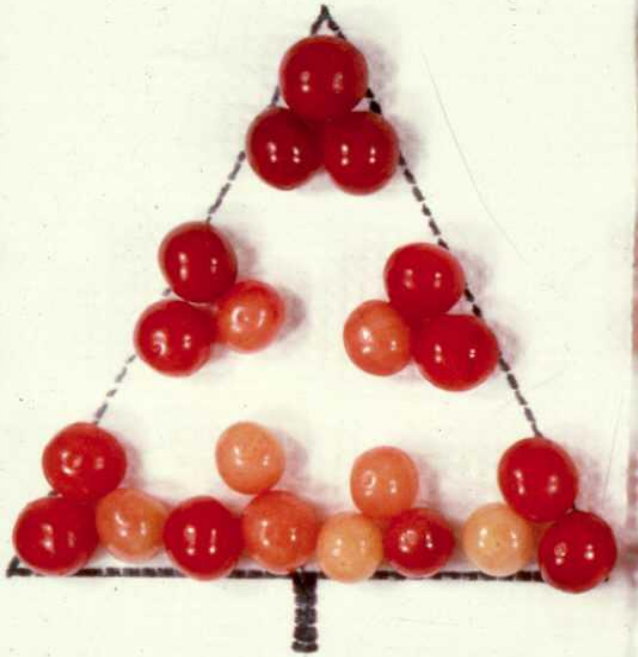

POST

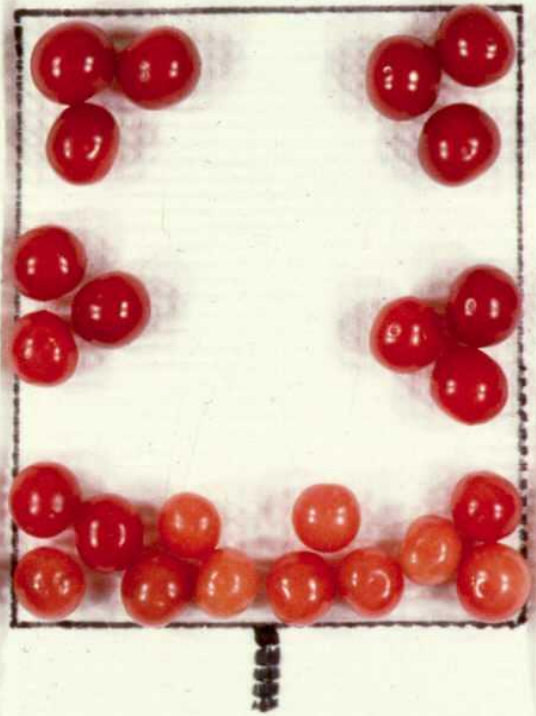
EFFECT OF ROW SPACING

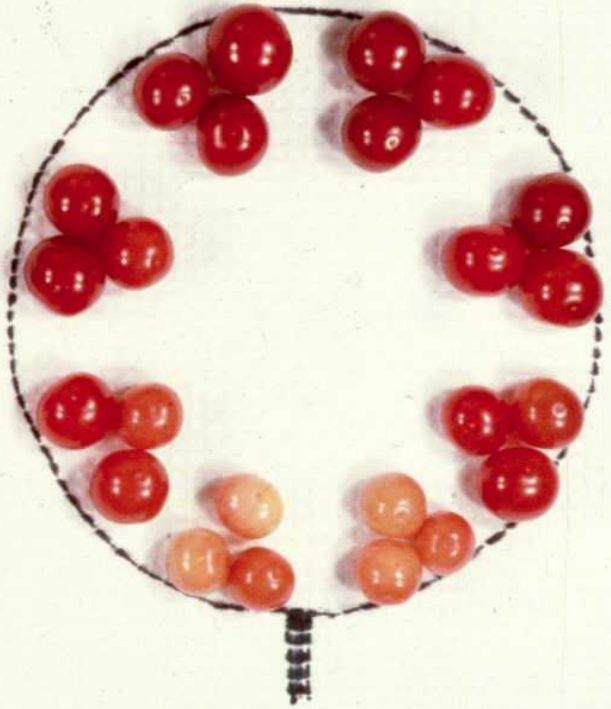
- MONTMORENCY SOUR CHERRY 10’ BY 15’
- ROWS ARE TOO CLOSE TOGETHER

WIDE SPACING, TRIANGLE SHAPE

Unconventional Orchard
Design 7-21-92







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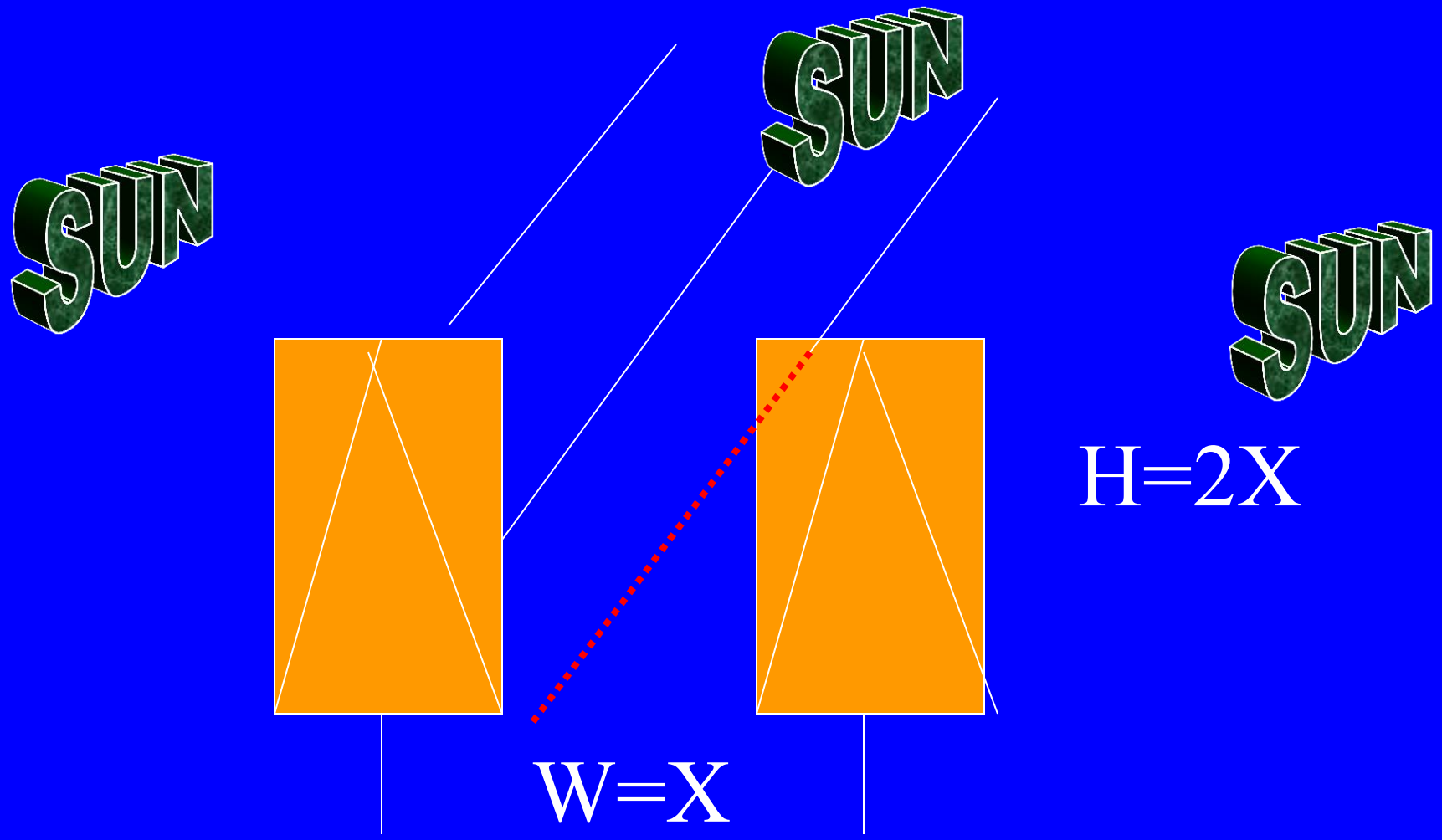


RECTANGLE=2X CLEAR ALLEY

TRIANGLE=3X CLEAR ALLEY

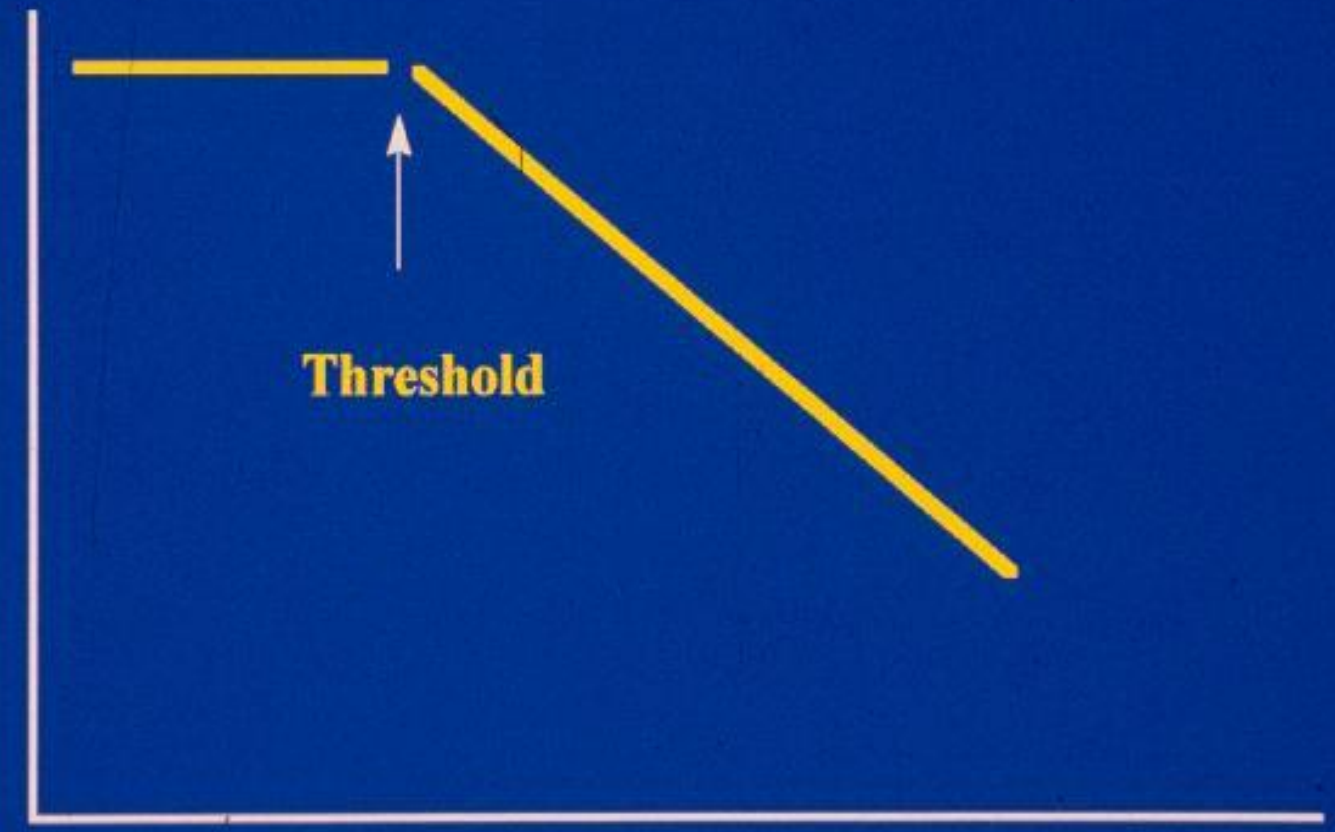
N-S ORIENTATION IS BETTER UNDER THE FOLLOWING CONDITIONS

- Northern (southern) latitudes-because of the in coming angle of the sun
- Better at mid-summer than spring or fall
- Depends on tree height. Best if H=2X or more the clear alleyway width.

E-W ORIENTATION IS BETTER UNDER THE FOLLOWING CONDITIONS

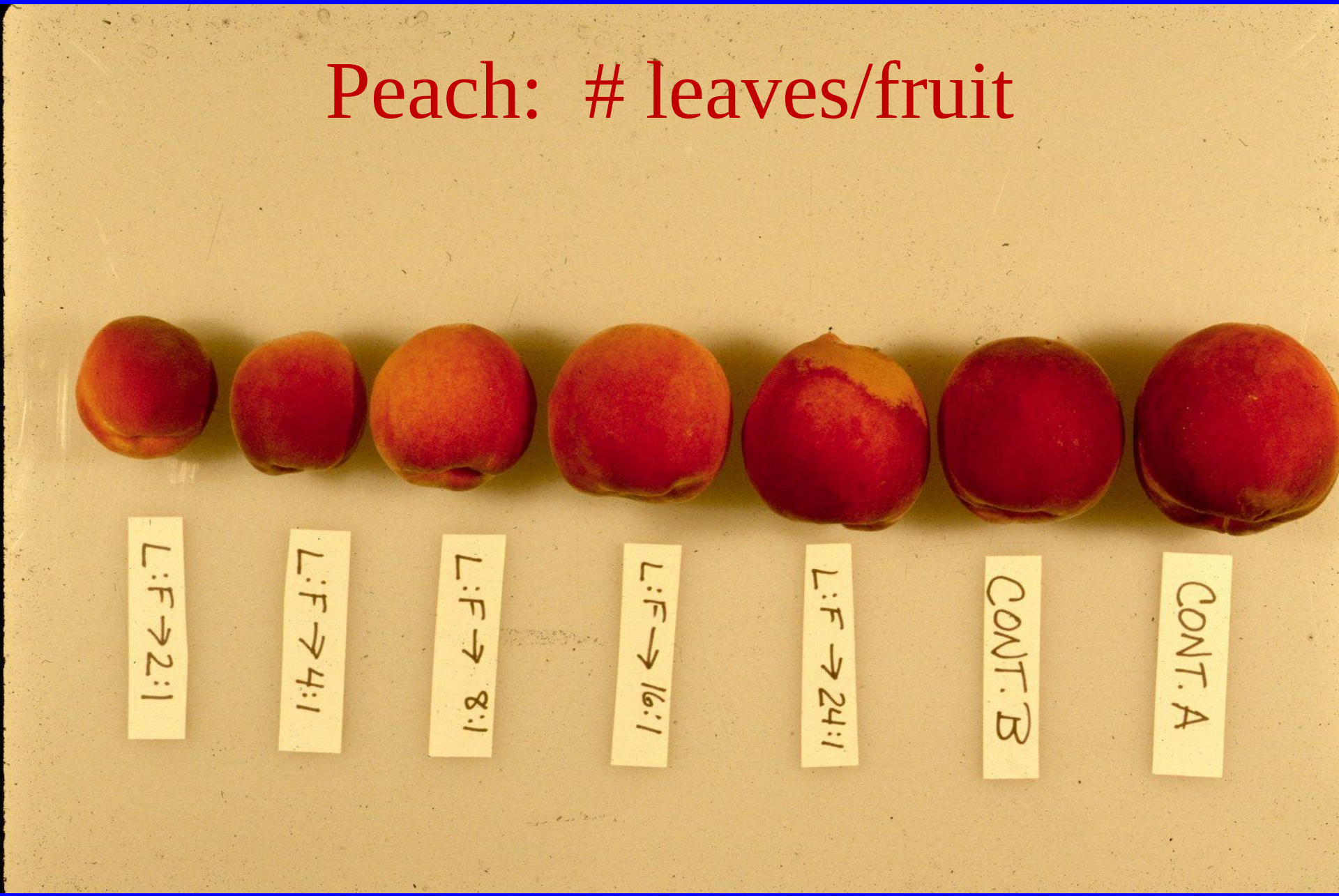
- At the equator
- Spring or fall crop
- Low growing trees; best if H=1X the clear alley way width or less.

Threshold of Response to a Pest Stress



Lakso, Francesconi, et al.
Cornell University

Peach: # leaves/fruit



How many leaves are needed?

No demand for carbohydrate =

Lower pn rate in afternoon


Source Limitation in Sour Cherry

The effect of leaf to fruit ration in 'Montmorency' sour cherry on growth, maturity, and carbon relations during the current season's growth.

	Leaf to fruit ration				
	0	0.5	1.0	2.0	4.0
Fruit wt (gm)	1.1	2.2	2.9	3.1	3.4
soluble solids (%)	5.9	9.3	12.1	15.1	18.6
Color	0.0	0.2	0.4	0.6	0.8
Retention force (gm)	285	426	421	375	301
Pn^z ($MgCO_2 dm^{-2} hr^{-1}$)	--	23.7	26.9	25.9	9.6
Carbon export^y (%)	--	--	1.2	--	0.2

^{z}Treated June 1, 1985, measured June 18, 1985.
^{y}5uCi aplied per leaf, export determined 4 hours after application.

Sink Limitation = lower Pn rate

SOURCE LIMITATION

- MONTMORENCY, 2 LEAVES PER FRUIT
- SMALLER SIZE,
- LESS COLOR
- LESS SUGAR
- GREATER FRF

Cherry

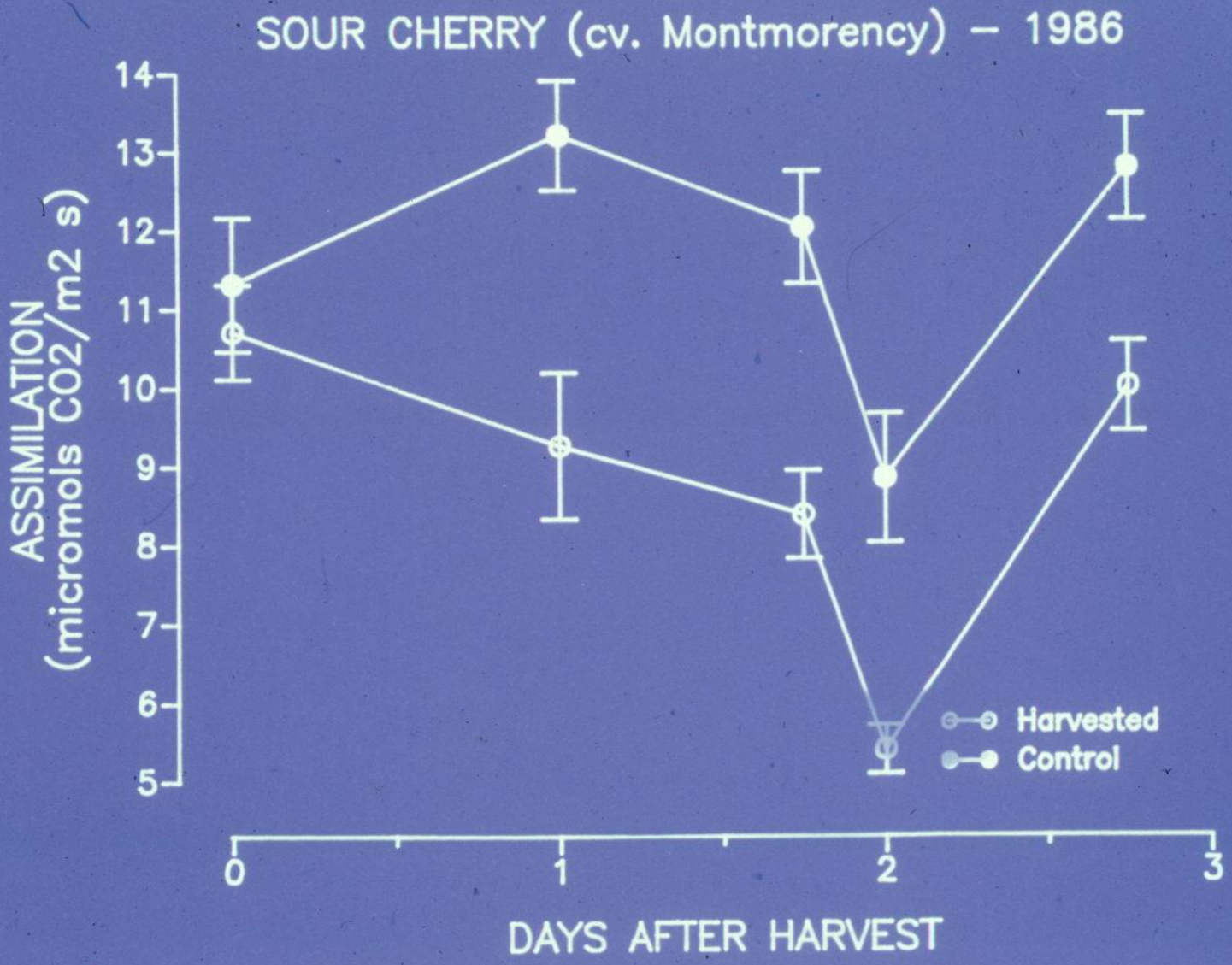
- Leaf to Fruit Ratio
- Affect on ripening

SOURCE LIMITATION

- DECREASE IN COLD HARDINESS
- HOWELL AND STACKHOUSE 1972
  - REDUCED HARDINESS, REDUCED BUD SET THE FOLLOWING SPRING CAUSED BY MID SUMMER DEFOLIATION

Harvest Effects afternoon PN

The influence of harvest on photosynthesis



Similar fruit effect on the following crops

Plum Gucci and Flore

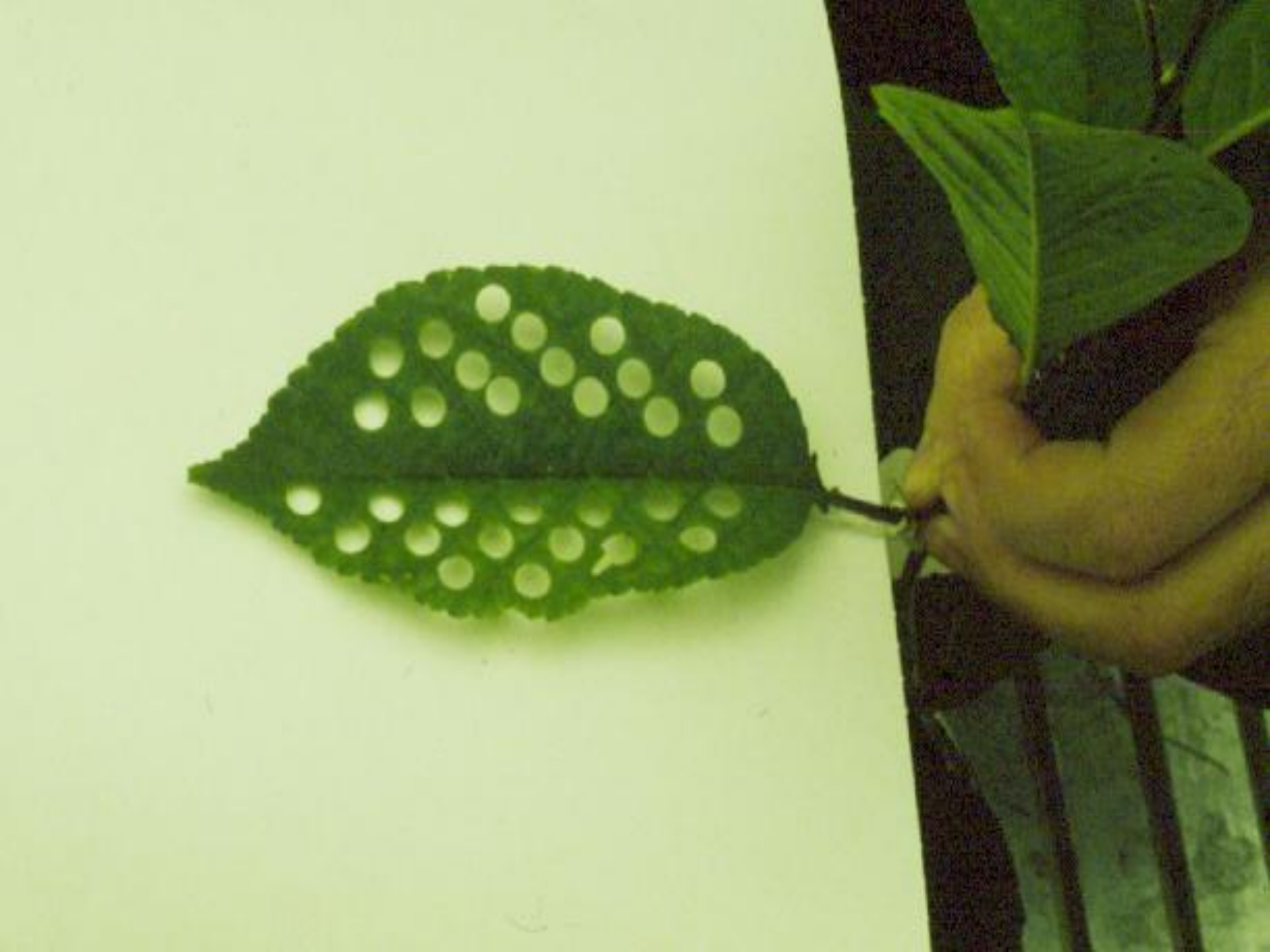
Apple Lakso and Flore

Grape Lakso

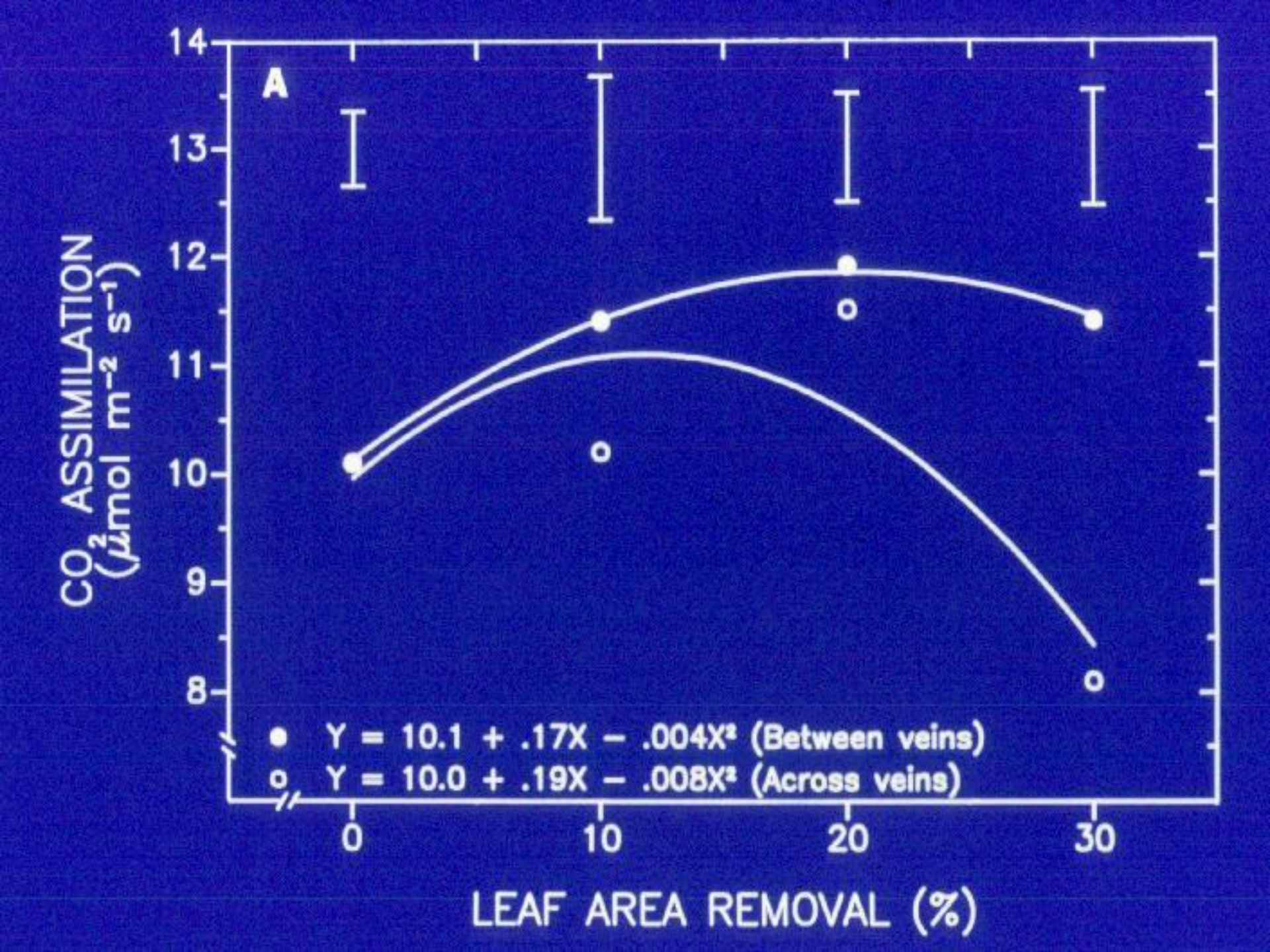
COMPENSATION TO DAMAGE

- TOMATO
- APPLE
- POPLAR
- CHERRY

- 25% DRY WT
- 20% DRY WT ;20% Pn
- 40% DRY WT
- 20% Pn; DRY WT



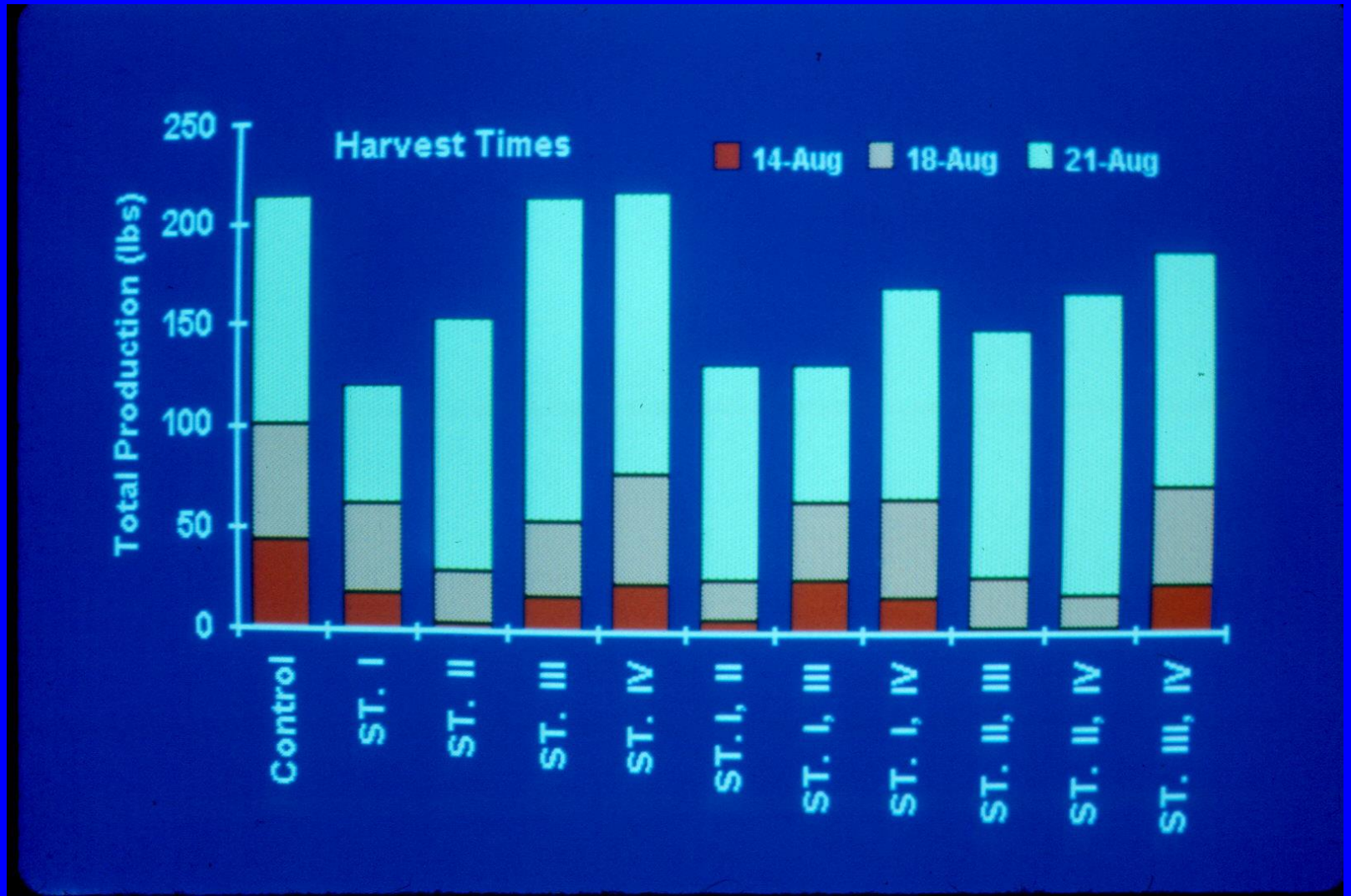

42
69
38
59
5
7

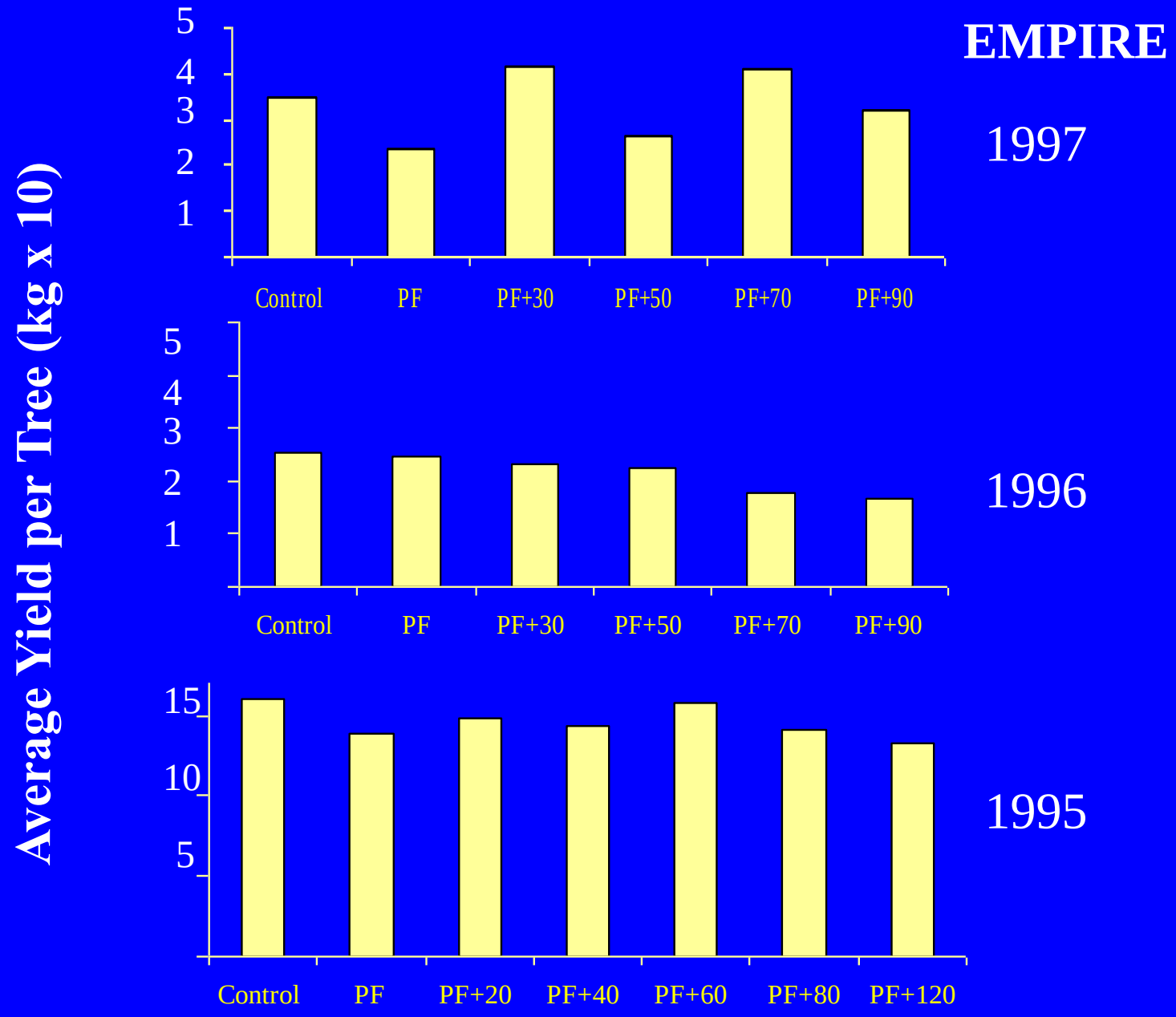

A
14
13
12
11
10
9
8
CO_2 ASSIMILATION (μmol m^{-2} s^{-1})
● Y = 10.1 + .17X − .004X² (Between veins)
○ Y = 10.0 + .19X − .008X² (Across veins)
0
10
20
30
LEAF AREA REMOVAL (%)

Using a PN inhibitor as a method to simulate stress

Terbacil on cherry (Hubbard), peach (Catania) apple (Desegnia)

Pn inhibition on peach
M. Catania




EMPIRE
Average Yield per Tree (kg x 10)
1997
5
4
3
2
1
Control
PF
PF+30
PF+50
PF+70
PF+90
1996
5
4
3
2
1
Control
PF
PF+30
PF+50
PF+70
PF+90
1995
15
10
5
Control
PF
PF+20
PF+40
PF+60
PF+80
PF+120

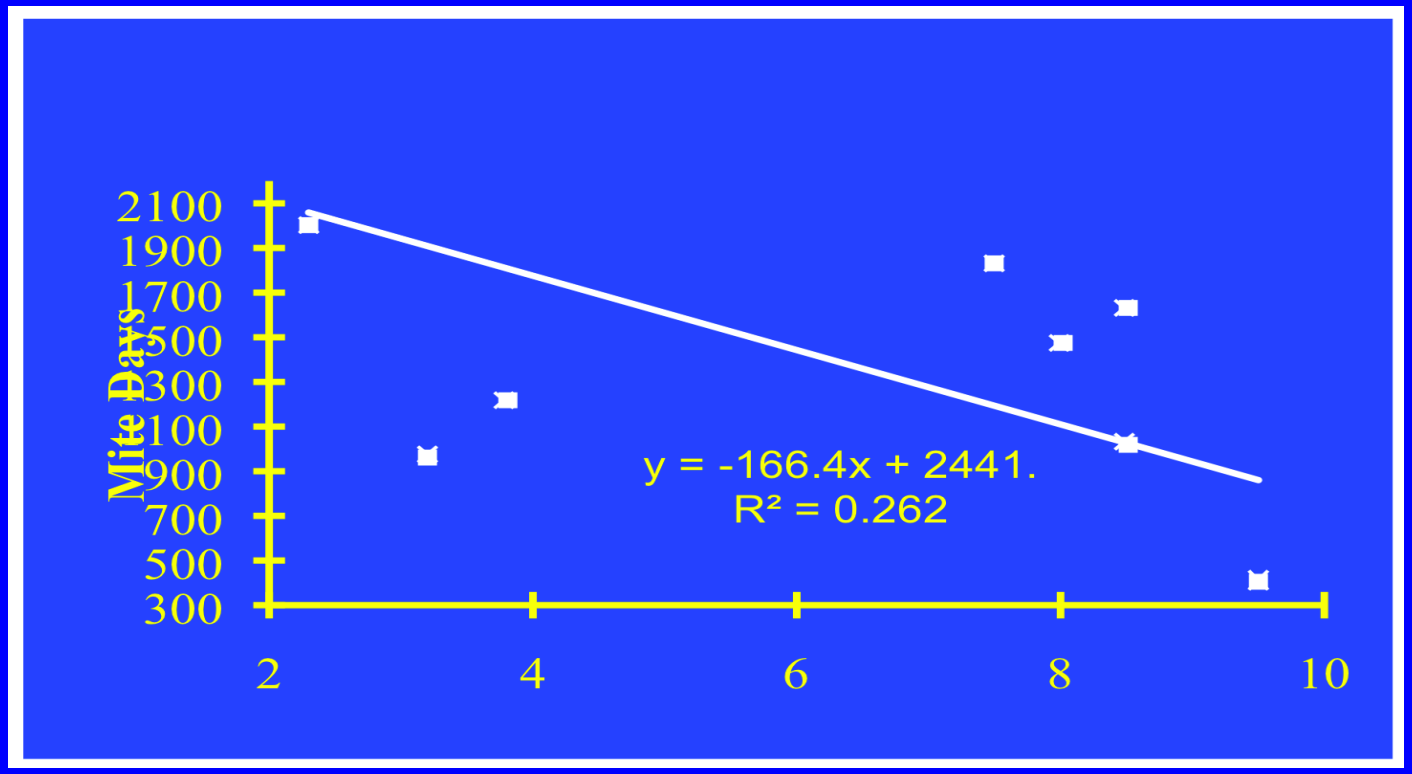
The Use of Whole Plant Chambers to Determine Threshold for Mite Damage in Sour Cherry

J.A. Flore[1], S.L. Breitkreutz[1], and J.W. Johnson[2]

[1] Department of Horticulture, Michigan State University, East Lansing, MI

[2]Department of Entomology, Michigan State University, East Lansing, MI

Single Leaf Photosynthesis vs Mite Days July, 1995



How many mites

- A mite day = 1 mite per day/lear
- Example 10 mites x 10 days = 100 mite days
- Thresholds:
  - High vigor 1500 mite days
  - Low to moderate 1000 mite days

Influence of Crop Load

- Apple
- Cherry

PARTITIONING OF CARBON

TREATMENTS

Honeycrisp Apple, 3 orchards; Randomized complete block design
5 treatments (4 trees/treatment); Crop load adjustment applied after June drop

High Crop Load
(**HCL**)

~270

~4 Fruit / Spur
Natural cropping

Medium -High
Crop Load
(**M-HCL**)

~200

3 Fruit / Spur or
Hand-spread

Medium Crop Load
(**MCL**)

~140

2 Fruit / Spur or
Hand-spread

Medium -Low
Crop Load
(**M-LCL**)

~70

1 Fruit / Spur or
Hand-spread

Low Crop Load
(**LCL**)

~30

1 Fruit / 2 Spur

The influence of crop load adjustment at fruit set on production characteristics of Honeycrisp at the Sparta site.

2002 Orchard

		2006 Crop Load Treatment									
Season	Defining Data	High		Med. High		Medium		Med. Low		Low	
2006	Fruit / TCSA	15.7		8.1		6.2		2.4		1.9	
2006	Leaf to Fruit Ratio	6.6		10.4		16.1		25.4		37.8	

		2006 Crop Load Treatment									
Season	Resulting Data	High		Med. High		Medium		Med. Low		Low	
2006	Yield (kg/tree)	11.1	a	7.8	b	7.6	b	3.6	c	3.1	c
2006	Fruit weight (g)	197.2	a	211.5	b	225.3	b	269.3	c	285.0	c
2006	Fruit diameter (mm)	79.6	a	82.5	b	84.8	b	86.5	b	87.6	b
2006	Bitterpit (%)	4.6	a	3.6	a	9.6	a	23.1	b	65.0	c

~4 Fruit / Spur
Natural cropping

3 Fruit / Spur or
Hand-spread

2 Fruit / Spur or
Hand-spread

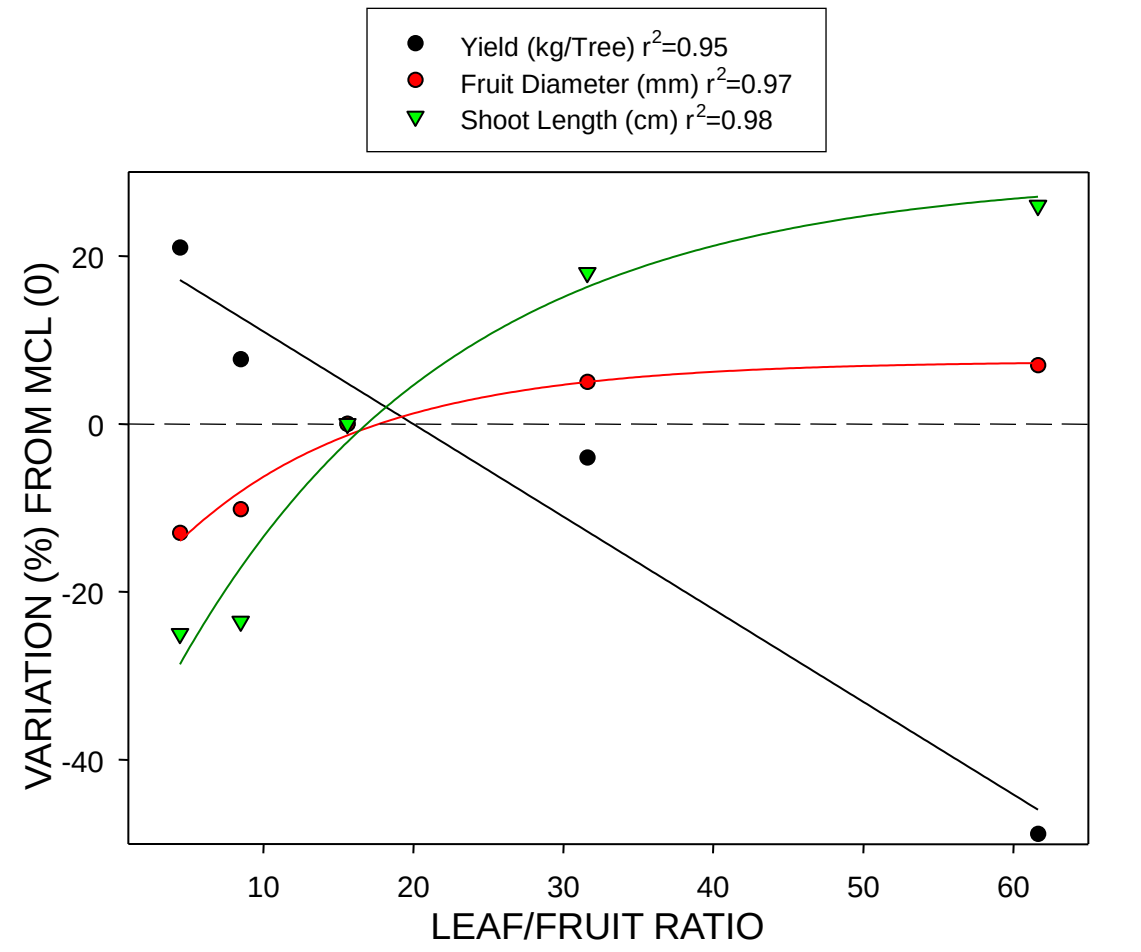
1 Fruit / Spur or
Hand-spread

1 Fruit / 2 Spur

PARTITIONING

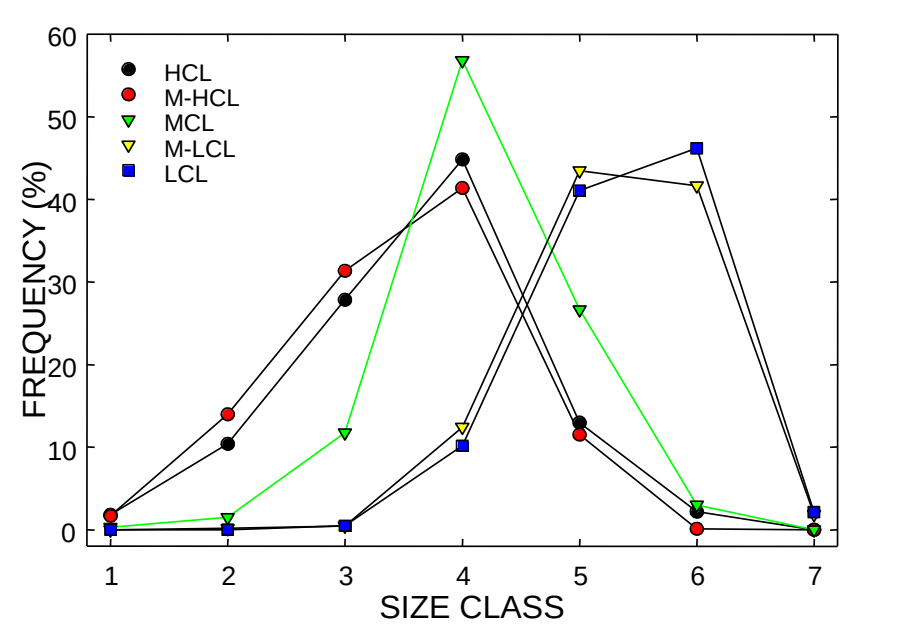
VARIATION (%) FROM MEDIUM CROP LOAD (0)

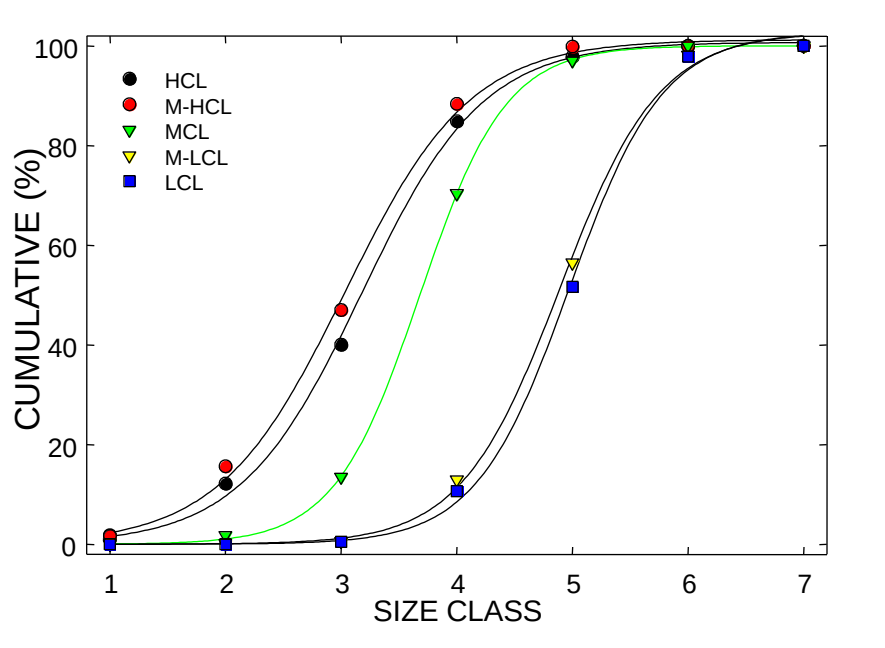
LEAF/FRUIT RATIO 15.6



Sabbatini P., Flore J.A., 2006. HortScience Vol. 41 (4).

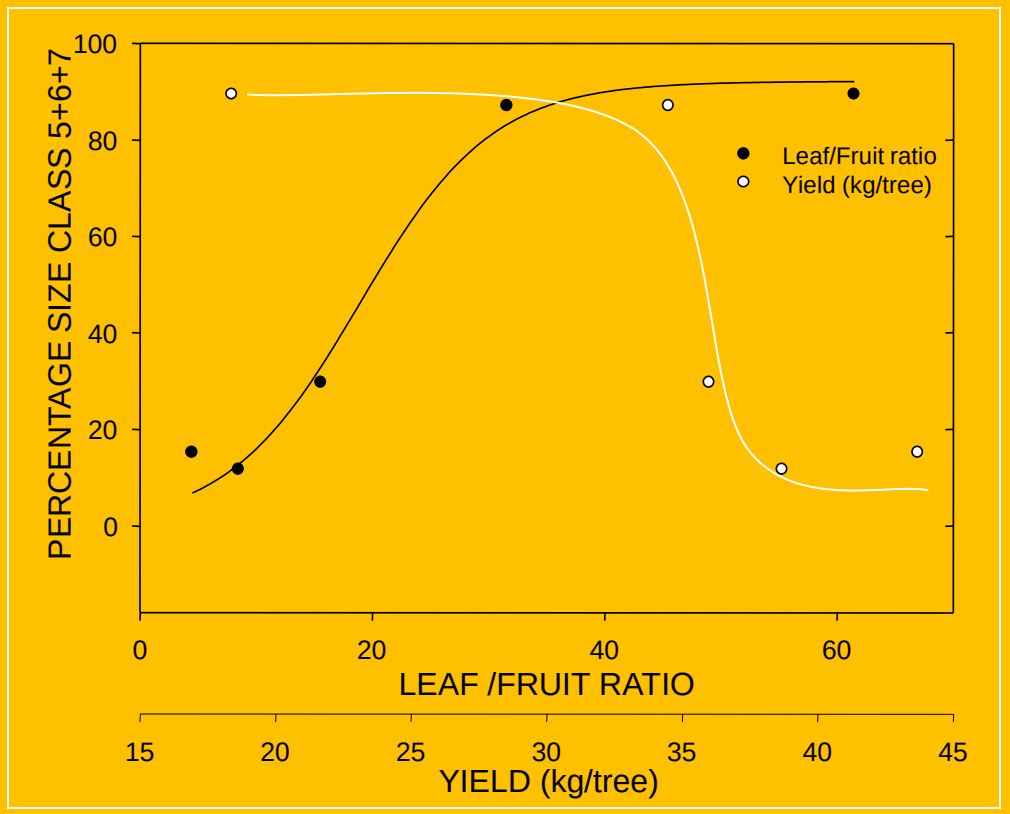
Fruit size distribution





1	2	3	4	5	6	7
<51 mm	51-56 mm	57-63 mm	64-69 mm	70-75 mm	76-82 mm	83+ mm

The problem of the partitioning



Horticultural value

Same size class but different crop load

Conclusions

- Decide on management system (intense, moderate, or low intensity).
- Site selection is most important
- Planting system, and orchard design
- Processing or fresh market
- Damage threshold depending on market
  - Fruit quality, size, color
  - Timing of pest control, early better than late