Cold hardiness in sour cherry

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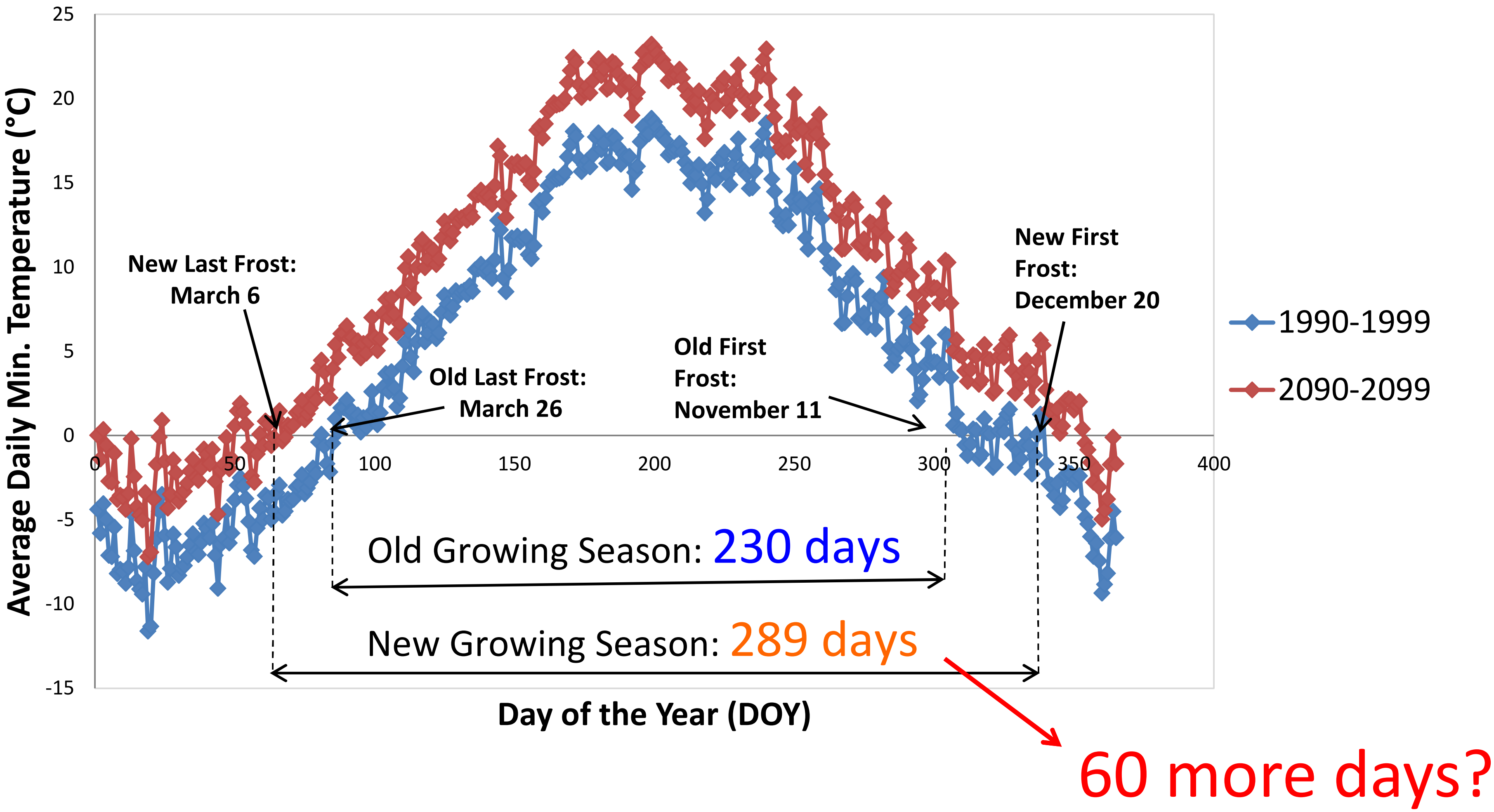
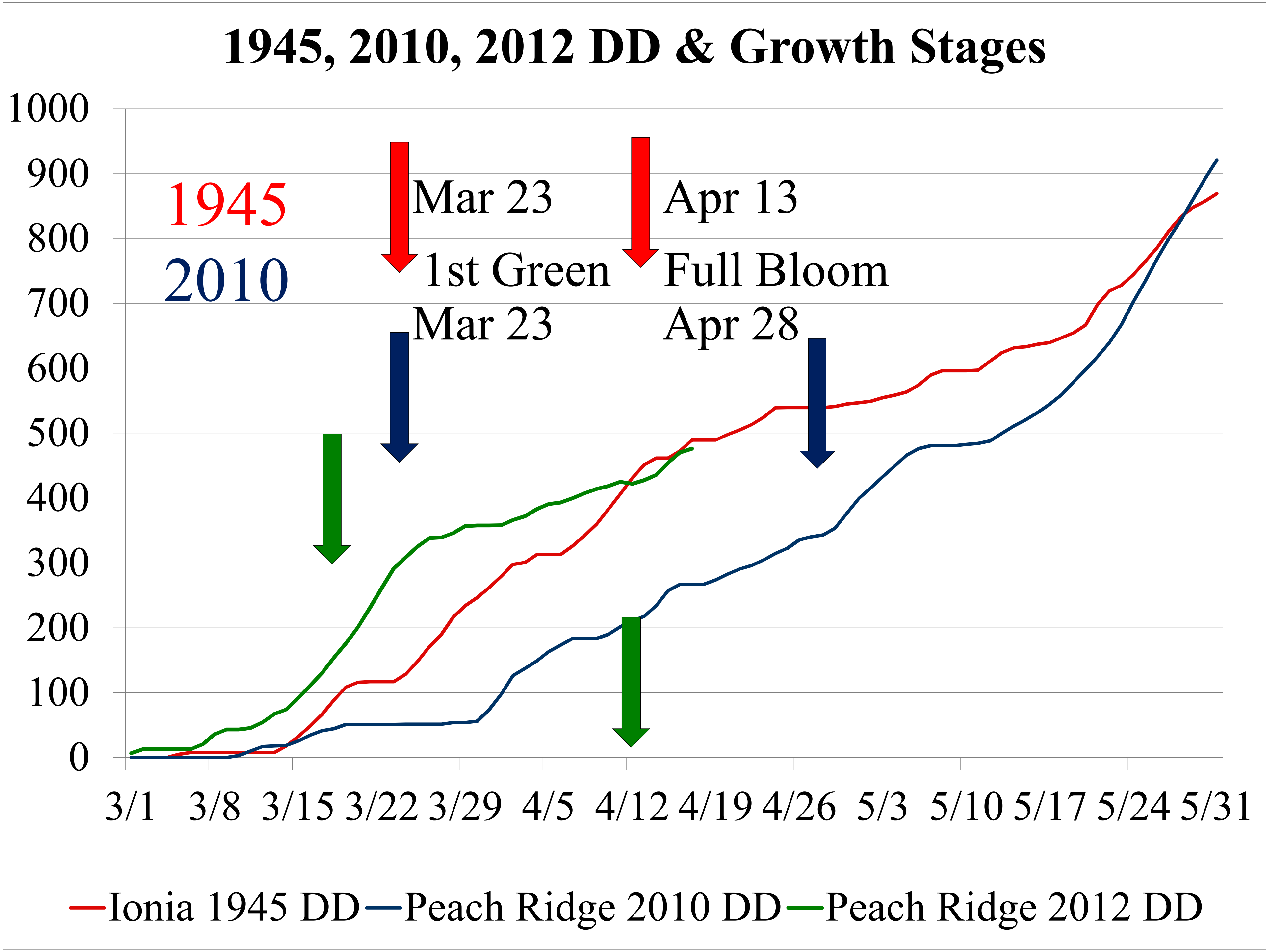
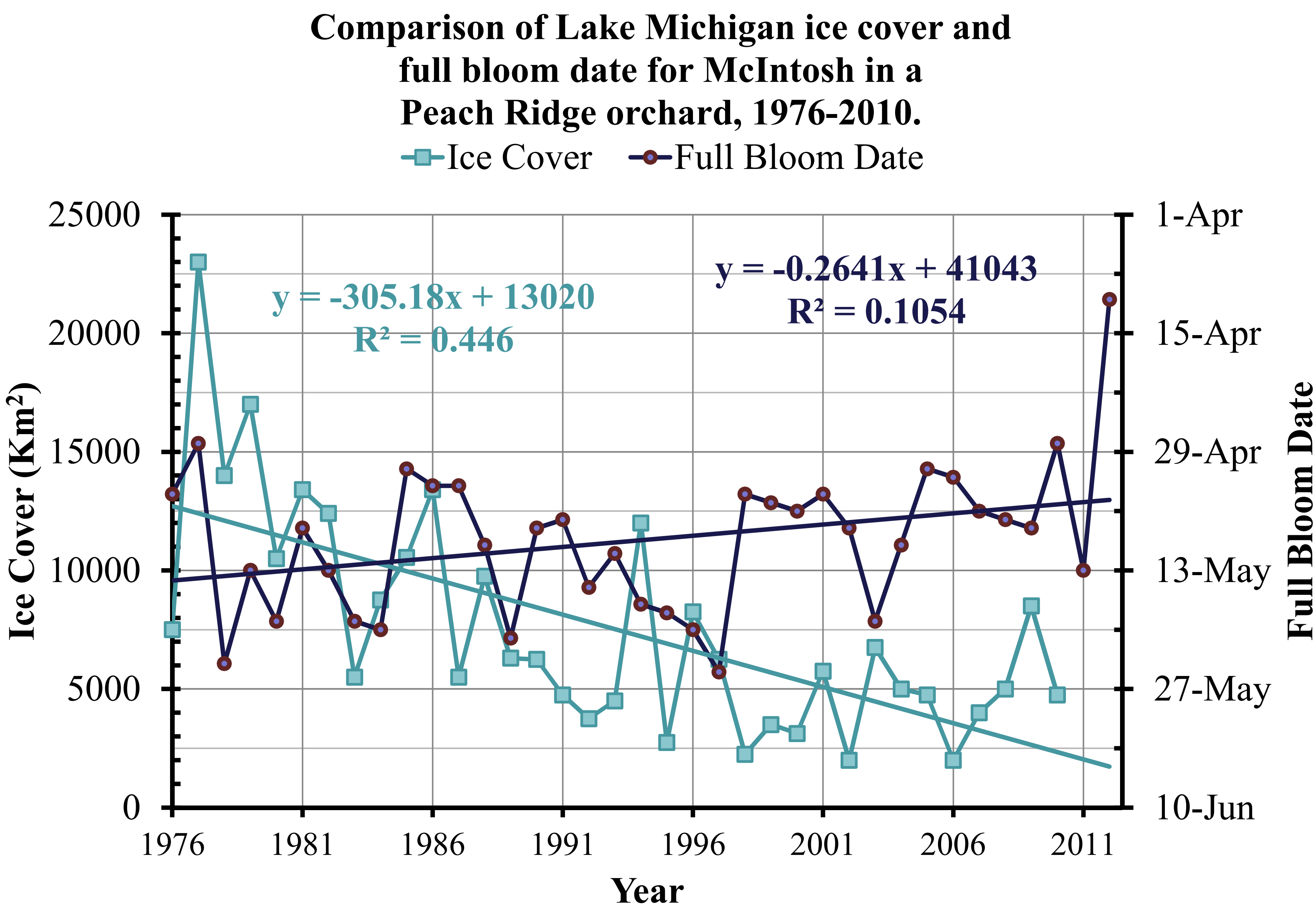
Longer Growing Season



Slide from Bruno Basso, MS

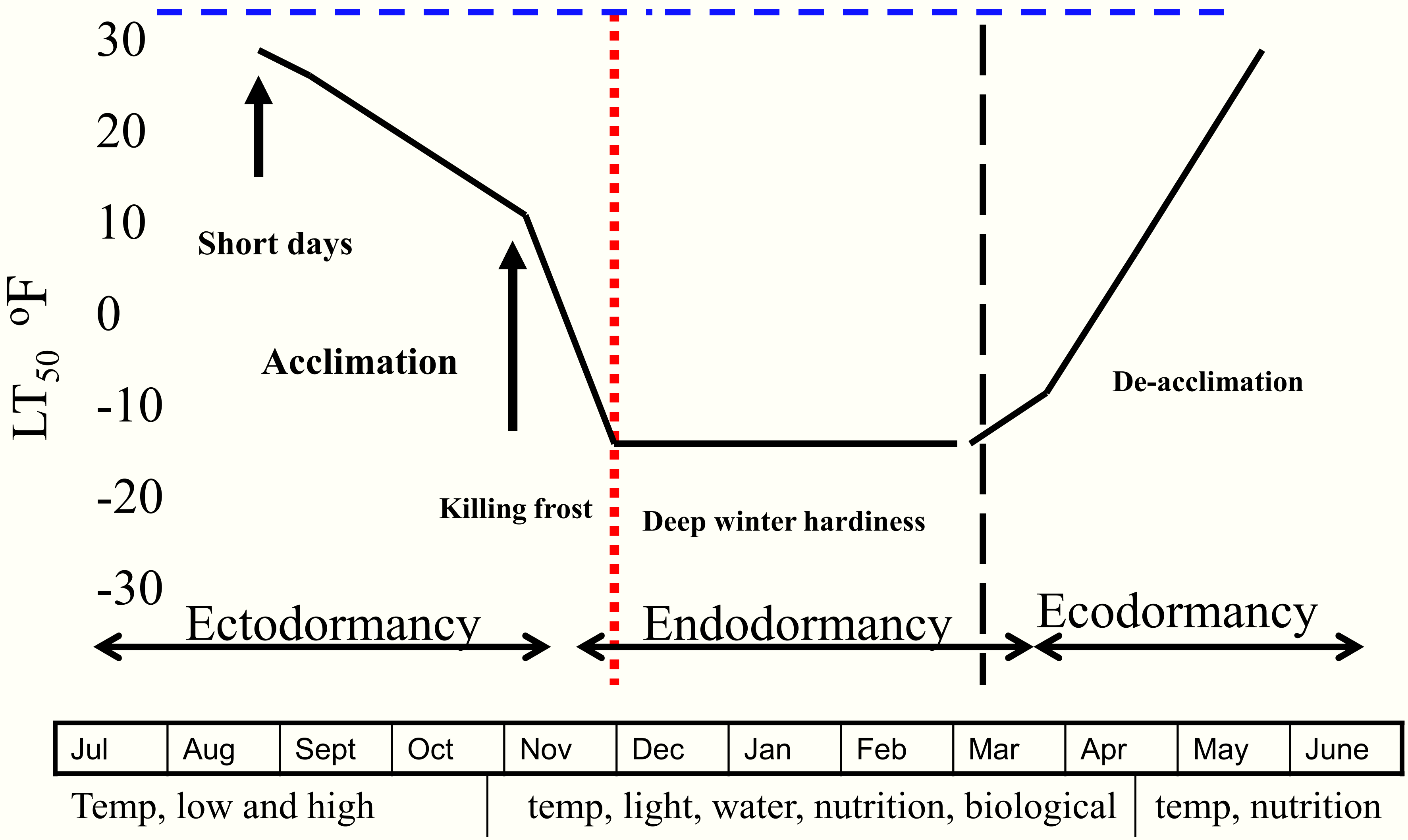


1945, 2010, 2012 DD & Growth Stages
1945
2010
Mar 23
1st Green
Mar 23
Apr 13
Full Bloom
Apr 28
1000
900
800
700
600
500
400
300
200
100
0
3/1
3/8
3/15
3/22
3/29
4/5
4/12
4/19
4/26
5/3
5/10
5/17
5/24
5/31
Ionia 1945 DD
Peach Ridge 2010 DD
Peach Ridge 2012 DD



Ice cover data extrapolated from Figure 4b in Wang et al. (2010).
Bloom data compliments Phil Schwallier.

Cold Hardiness (Dormancy) in Montmorency



Example of how a Plant may Experience Different Types of Dormancy throughout a Season

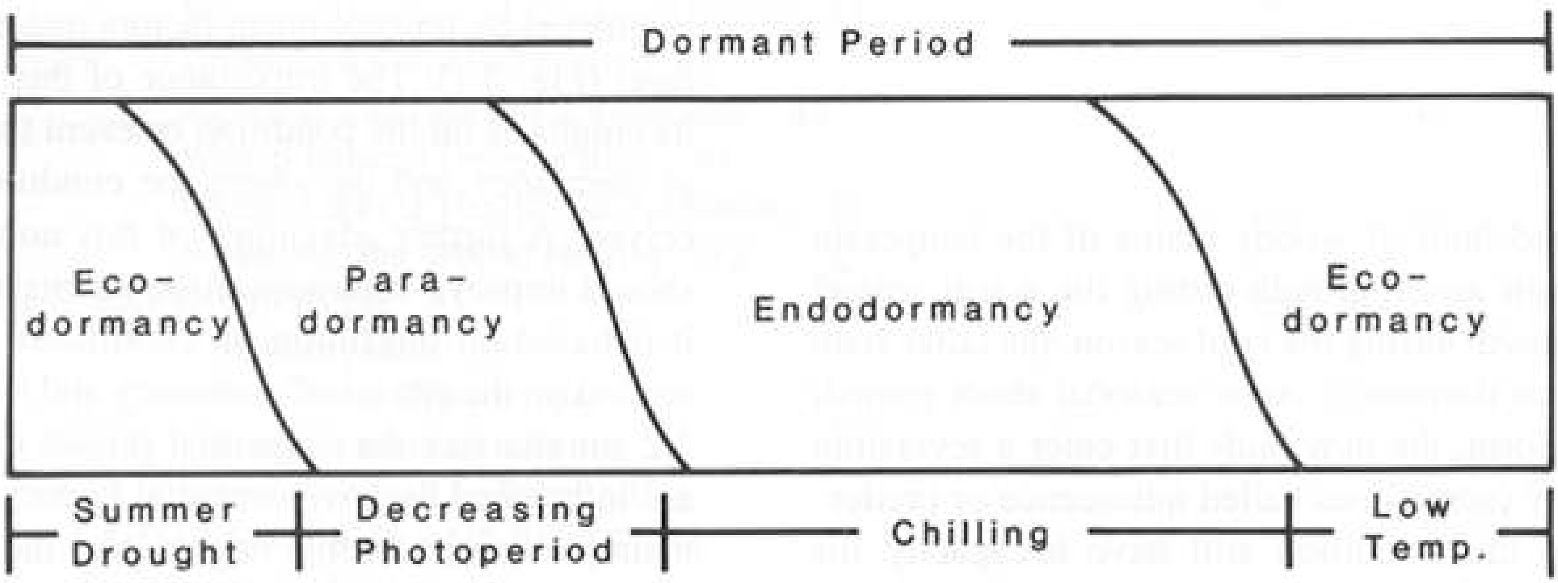


FIGURE 3.2. Relative contribution of the various types of dormancy during a hypothetical dormant period for an apical bud. From Lang *et al.* (1987). *HortScience* **22**, 371–377.

Chilling requirement

- Temperate Fruit Crops require a period of chilling (temp between 0-7 or 10 C) before they can break bud in the spring.
- The exact mechanism is not known
  - Development of a promoter
  - Decline of an inhibitor
- When to start accumulation of chilling units?
- How do we know when the process is completed?

Spring Dormancy

- Fruit and vegetative buds may have different chilling requirements.
- Implications for global warming.
- No ice in the lakes, earlier chilling, results in earlier bloom.
- This increases our risk. (Jeff Andresen project.)

Induction of cold acclimation Stage I

- Growth cessation
- Leaves are the site of perception of SD
- SD induced leaves are the source of a translocatable factor which promotes Acc.
- The hardiness promoting factor moves from the leaves to overwintering stems
- Plants exposed to long-day and cold-night temps will eventually become fully hardy
- Plants CHO deficient cannot acclimate

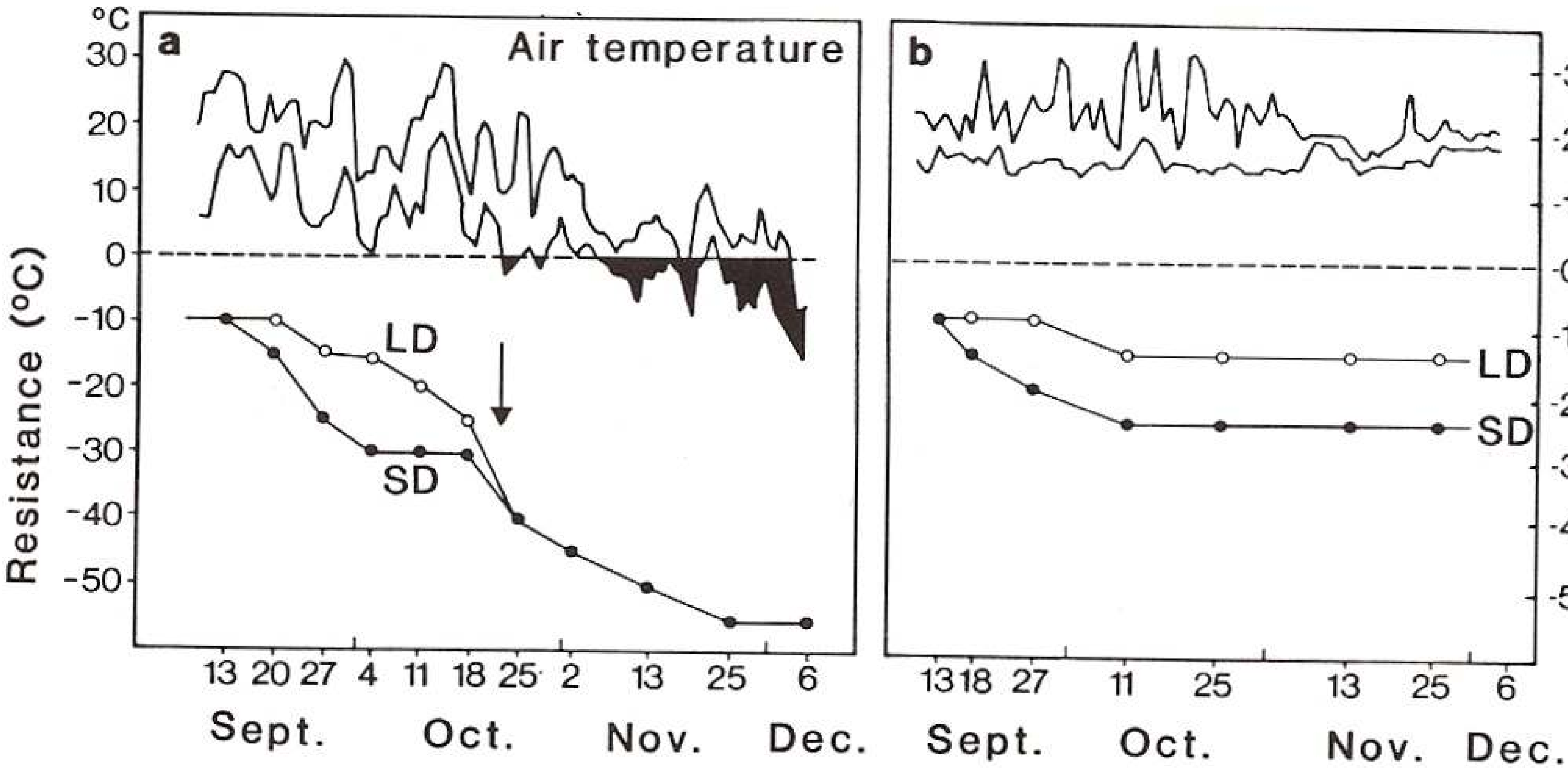


Fig. 5.8a,b. Seasonal hardening patterns of young apple trees at different photoperiods in (**a**) the field and (**b**) in a warm greenhouse. *SD* natural short days in autumn; *LD* long-day treatment (photoperiod 18 h using additional incandescent light). Air temperatures are daily maxima and minima. *Arrow:* First leaf-killing frost. (From Howell and Weiser 1970a)

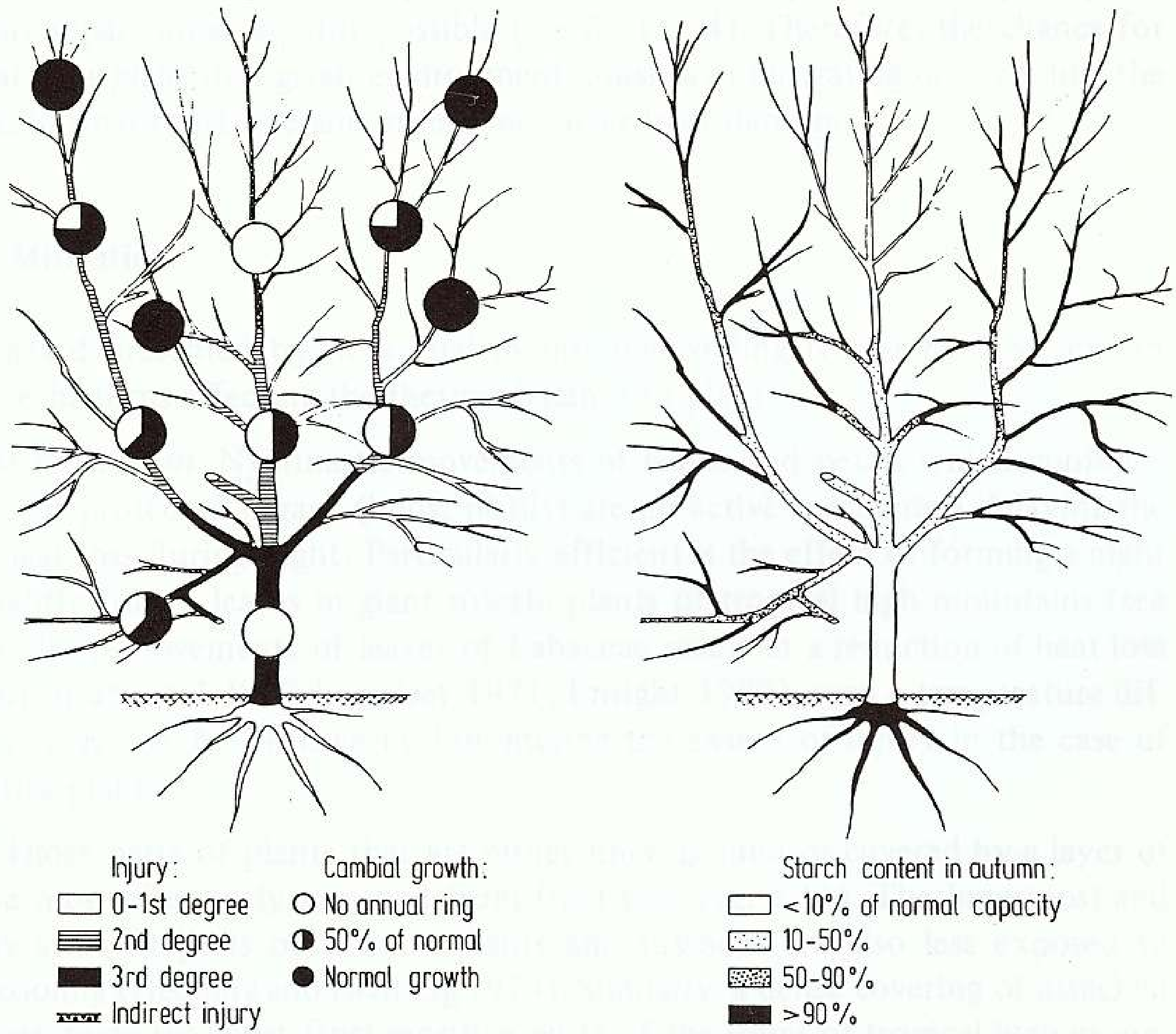
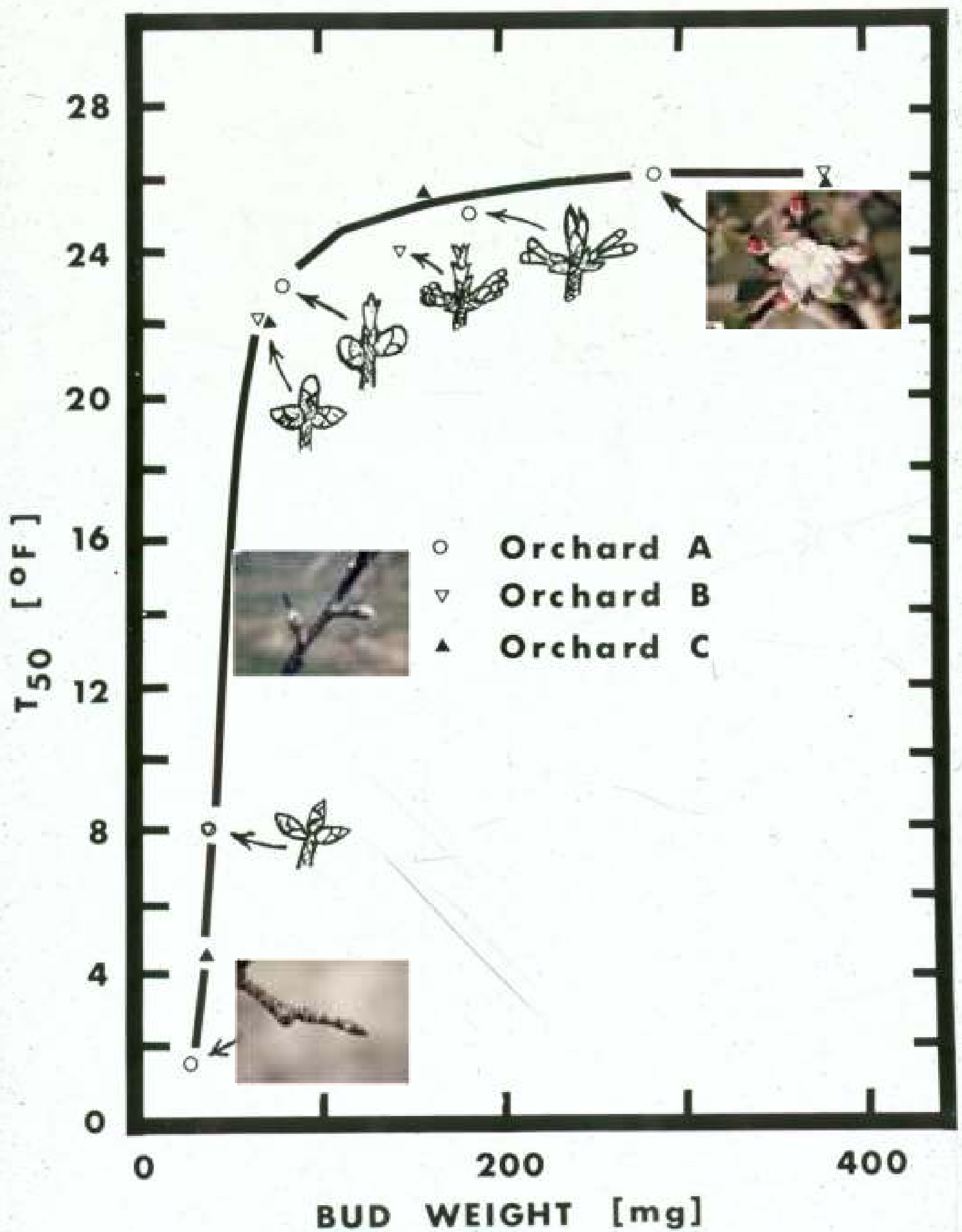


Fig. 3.14. Extent of tissue injury, and amount of cambial growth and starch accumulation in apple trees 1 year after an early November frost. *Injury degrees: 0* no visible injuries; *1* completely reparable slight injuries of cambium and xylem, frost rings visible; *2* moderate to severe xylem and bark injuries, restitution possible by intact cambium; *3* irreparable injuries, no or little cambial activity. *Indirect injuries:* secondary dieback of twigs. (From Larcher 1981a)



28
24
20
16
12
8
4
0
T_{50} [°F]
0
200
400
BUD WEIGHT [mg]
Orchard A
Orchard B
Orchard C

SOURCE LIMITATION

- DECREASE IN COLD HARDINESS
- Grower dogma "starve them in the fall to get them to harden off"
- HOWELL AND STACKHOUSE 1972
  - EARLY LOSS OF LEAVES REDUCED HARDINESS, REDUCED BUD SET THE FOLLOWING SPRING CAUSED BY MID SUMMER DEFOLIATION

What effect does this have on killing temperature?

THE EFFECT OF SHADE


Light
Medium
Heavy
Shade
Treatments

The effect of shade on hardiness of Montmorency cherry and Redhaven peach.

% Full sun	Hardiness		
	Cherry	**Peach**	
	Wood	Wood	Buds
100	-22.5	-22.5	-17.5
36	-20.5	-22.5	-17.0
21	-17.5	-16.0	-15.0
9	-15.5	-13.0	-13.0

Test conducted Nov 29, as tree was acclimating.

SOURCE LIMITATION

- Grower dogma "starve them in the fall to get them to harden off"
- HOWELL AND STACKHOUSE 1972
  - EARLY LOSS OF LEAVES REDUCED HARDINESS, REDUCED BUD SET THE FOLLOWING SPRING CAUSED BY MID SUMMER DEFOLIATION

Effect of time and amount of defoliation on bloom date, bud survival and fruit set of tart cherry trees.

Defoliation date	Date of 1st & full Bloom (May)	Percent buds with at least 1 flower	Fruits/100 surviving buds
11-12-1970 KF	8,11	40a	22a
09-02-1970 P	8,11	37a	20a
08-15-1970 P	9,13	26b	12b
07-10-1970 P	★ 11,15	★ 14c	★ 5c
06-10-1970	13,17	10c	2c

from Howell and Stackhouse, J. Amer. Soc. Hort. Sci. 98:132-136

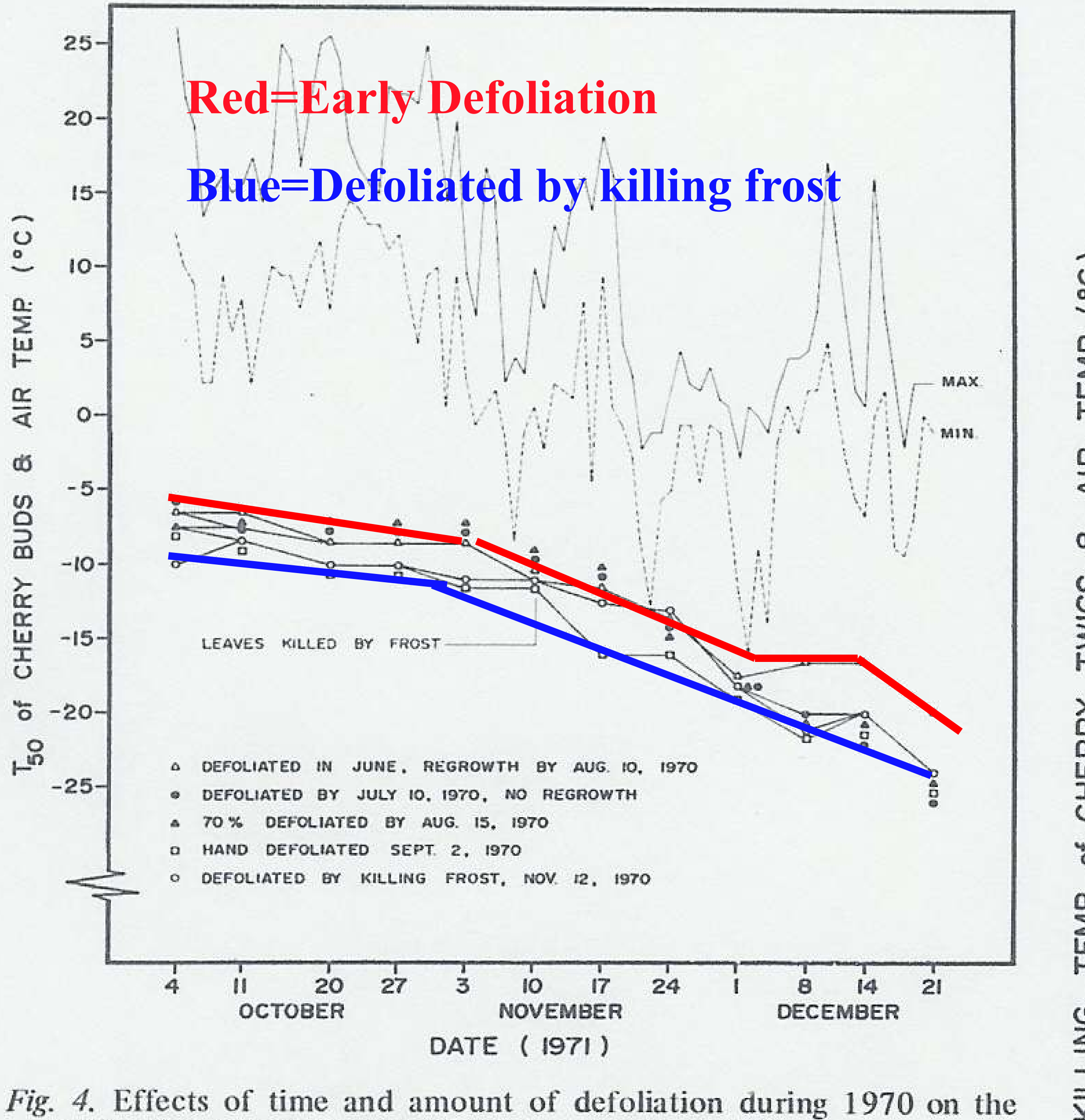


Fig. 4. Effects of time and amount of defoliation during 1970 on the acclimation of tart cherry buds in the autumn of 1971.

DATE (1972)

Fig. 7. Effects of time and amount of defoliation during 1970 on the deacclimation of tart cherry twigs in the spring of 1972.

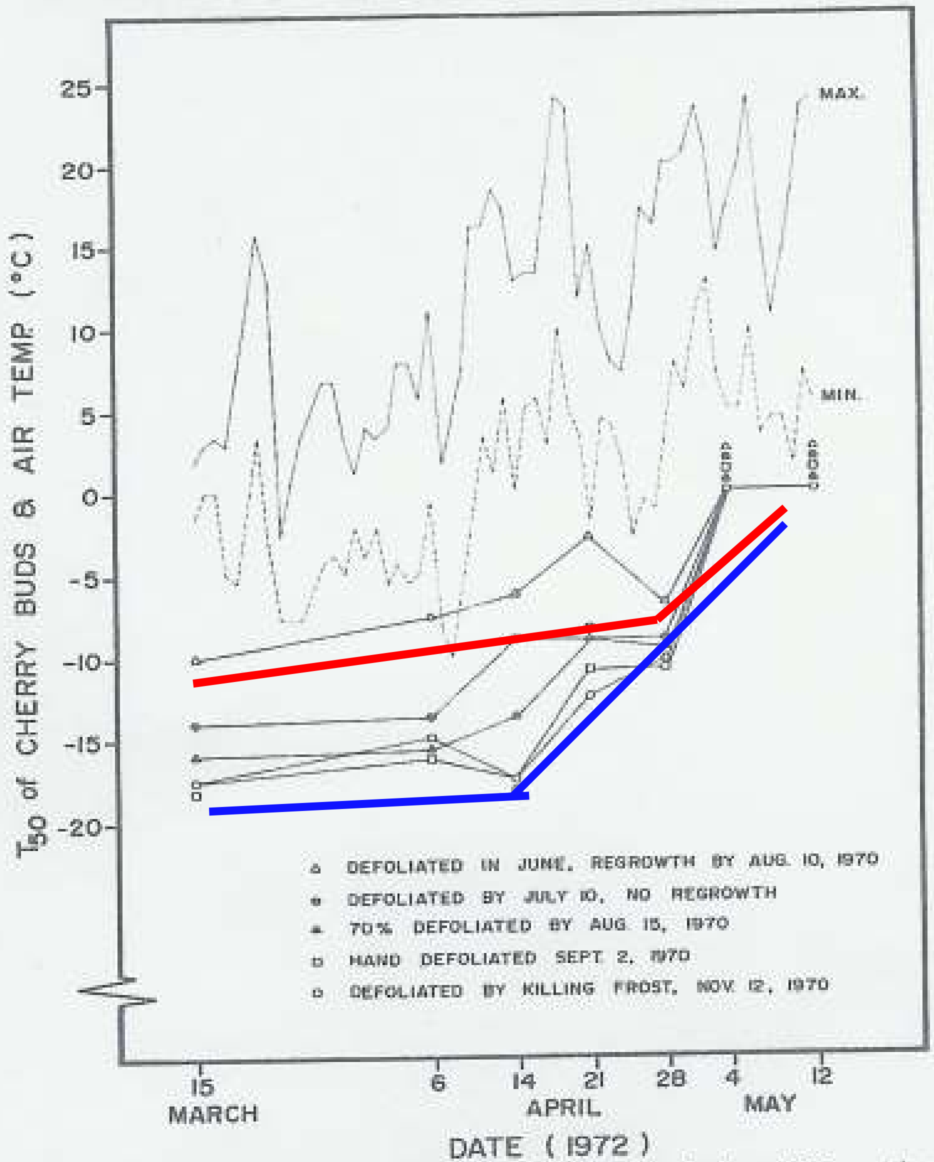


Fig. 8. Effects of time and amount of defoliation during 1970 on the deacclimation of tart cherry buds in the spring of 1972.

The Effect of Pests on Carbon Supply

During the crop year

- No effect unless the leaf-to-fruit ratio is less than 2.0
- Major concerns are
  - Mites
  - Leaf spot
- Thresholds are being developed

For the next season

- Pests reduce storage carbon for flower bud initiation and development.
- Pest damage reduces cold hardiness

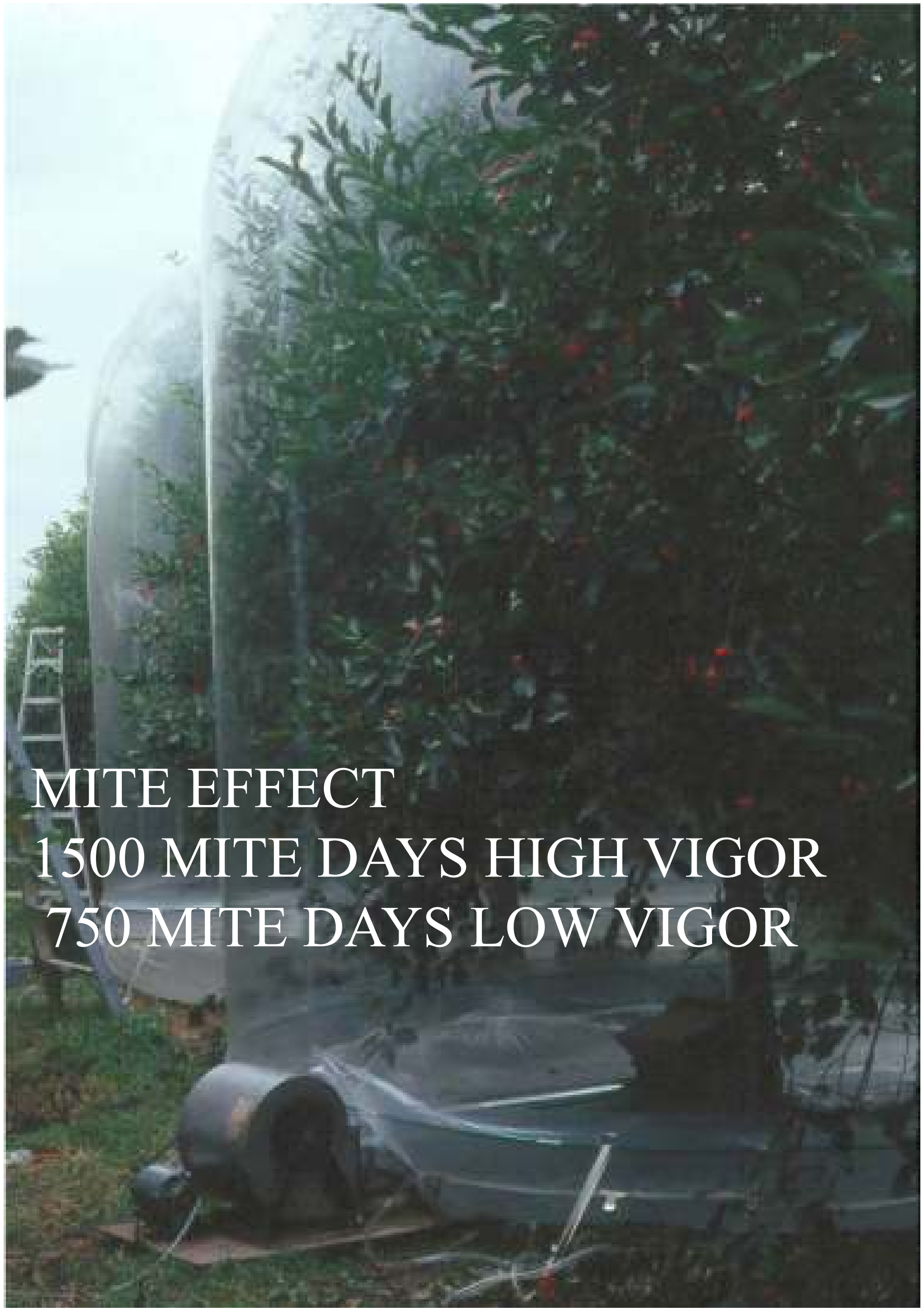
Foliage damage after harvest model development (cont’d)

- We have developed the relationship between % Good Foliage and Cold Hardiness.
- % Good Foliage is estimated by multiplying the <u>degree of defoliation</u> by <u>foliage duration</u> to get a fraction of total full potential.

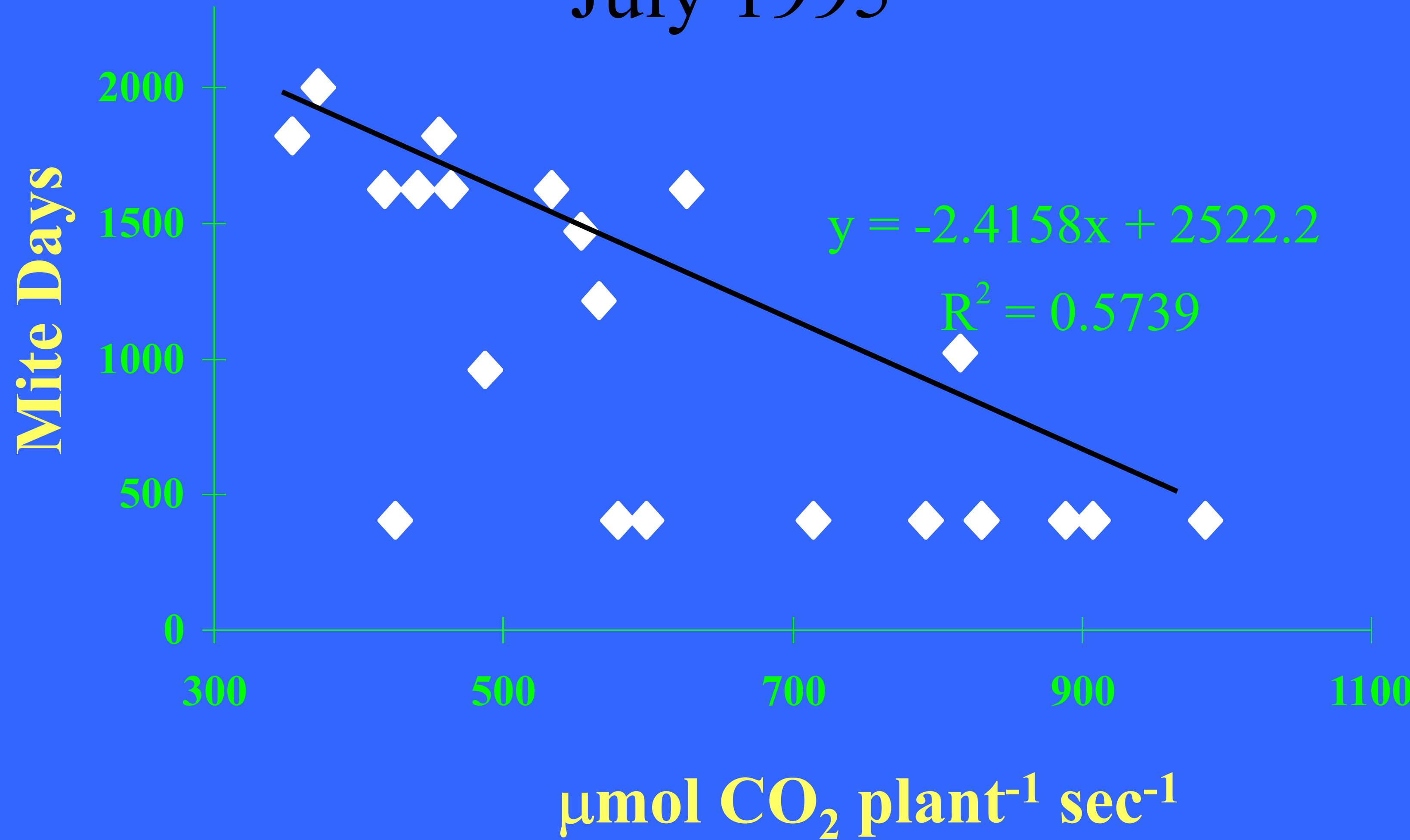
Cherry Grower	Example 1	Example 2
DD in one year	2000	2000
Shoot length	16	25
% Fruit on 2nd yr shoots	50	50
% Fruit set	50	80
# of leaves	36	18
# of Fruit	2	19
# leaves/# fruit	18	.95
Cm2/fruit	87.4	5.9

EFFECT OF LEAF LOSS ON HARDINESS

MODEL BASED FOLIAGE POTENTIAL AND HARDINESS DATA FROM MICHIGAN

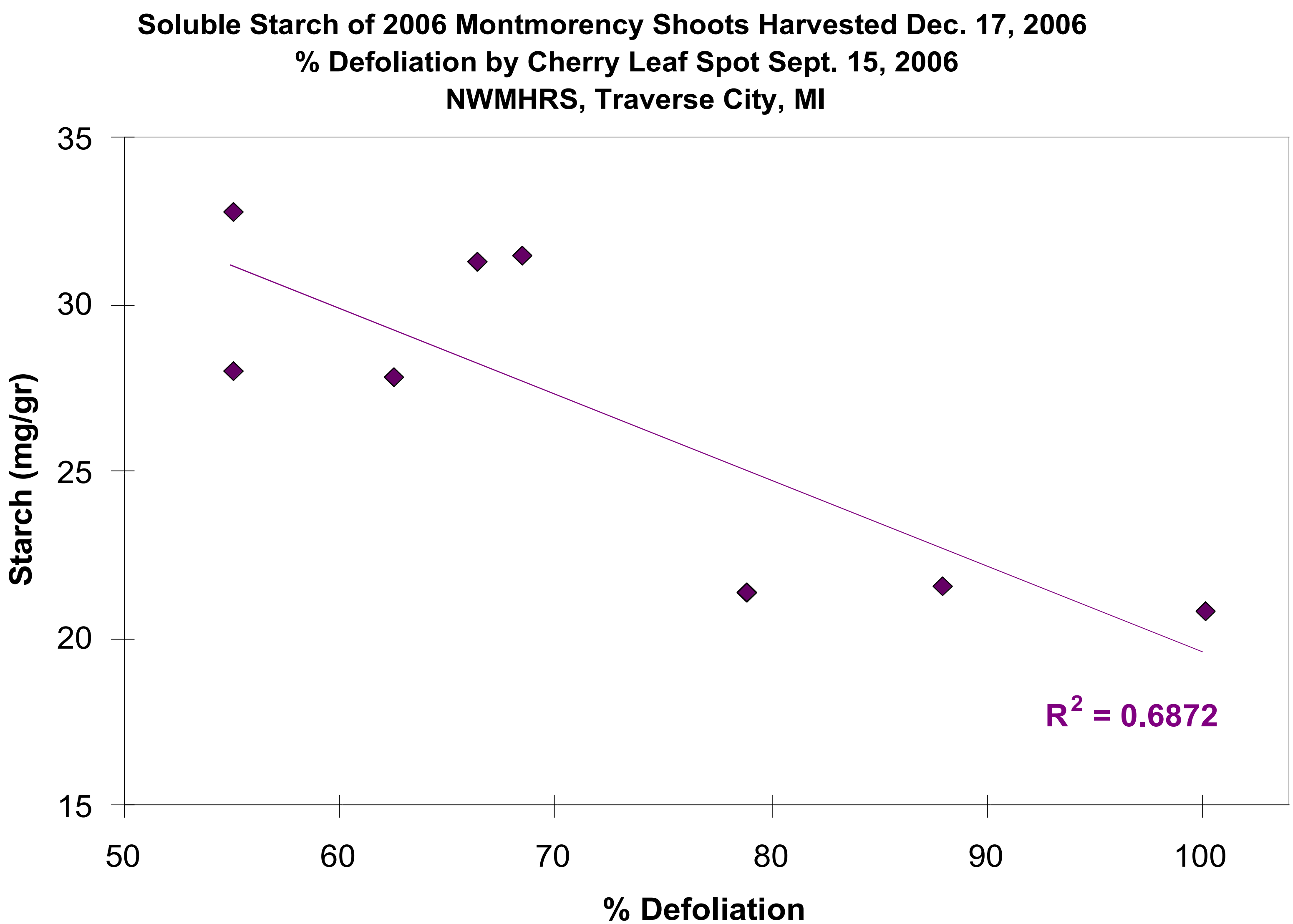

MITE EFFECT
1500 MITE DAYS HIGH VIGOR
750 MITE DAYS LOW VIGOR

Whole Plant Photosynthesis vs. Mites/Leaf
July 1995



Foliage damage after harvest model development

- Defoliation studies (Howell and Stackhouse, 1973),
- Shading studies (Flore several publications, and Sams PhD thesis)
- Photosynthetic inhibitor studies (Hubbard PhD thesis, and Flore unpublished data)
- European Red Mite studies (Hubbard PhD thesis and Flore data.

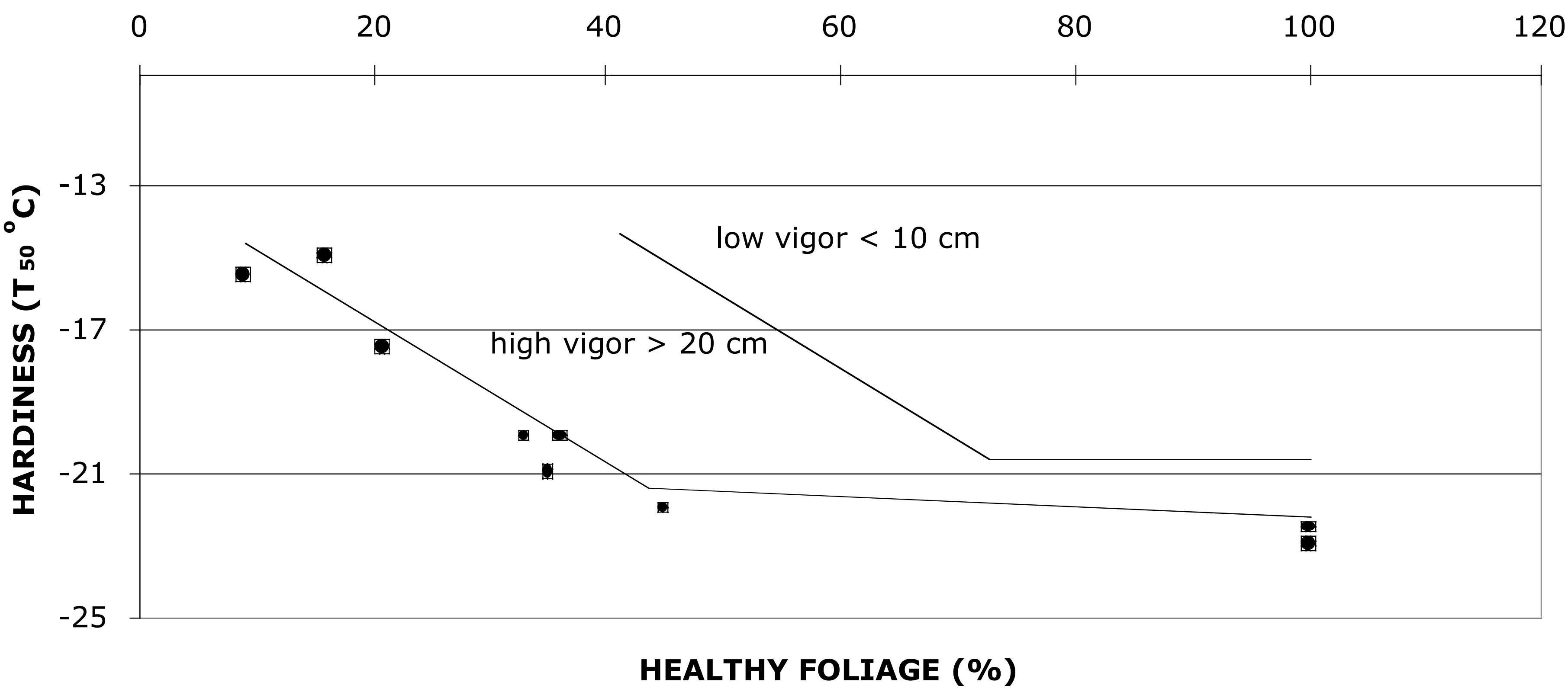


Soluble Starch of 2006 Montmorency Shoots Harvested Dec. 17, 2006
% Defoliation by Cherry Leaf Spot Sept. 15, 2006
NWMHRS, Traverse City, MI
35
30
25
20
15
Starch (mg/gr)
50
60
70
80
90
100
% Defoliation
R2 = 0.6872

FOLIAGE POTENTIAL (FP)

FP = DURATION X GROWTH - DAMAGE

THE EFFECT OF HEALTHY FLOLIAGE (%) ON COLD HARDINESS (T_{50}), Dec. 15



Conclusions

- Vigor makes a difference.
- Crop load makes a difference, less than 2 leaves per fruit stresses the tree.
- Leaf spot. Keep the foliage on until Sept 1.
  - 25% defoliation at that time can be tolerated.

Mist-cooling to delay bloom

Jim Flore, Ishara Rijal, Jeff Andresen,
and Greg Lang

Supported by: Michigan Cherry Research committee, Michjigan Apple Committee, Michigan State Horticultural Society, MSU AgBioResearch.

What Controls the time of Spring Bloom? Heat or cold of the bud!

- Early (Environment) Acclimation
- Deep (Chilling hours 32F-50F) heat no effect.
- Late (GDH) De-acclimation

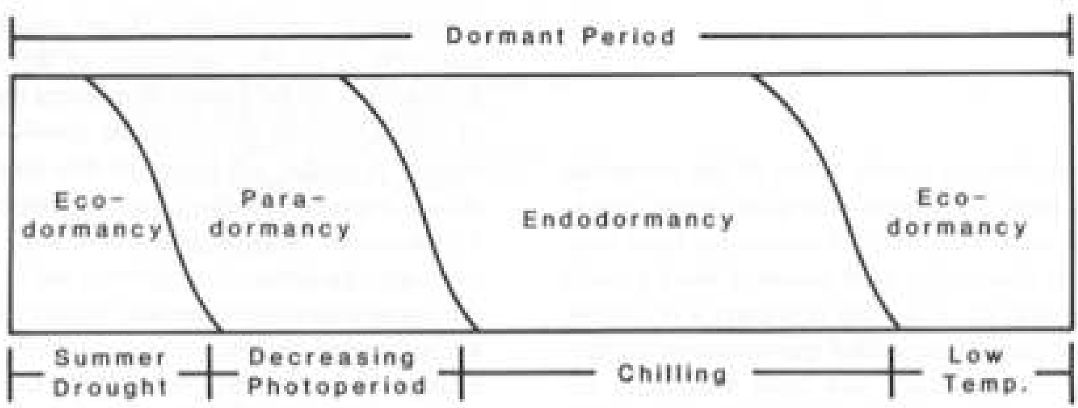


FIGURE 3.2. Relative contribution of the various types of dormancy during a hypothetical dormant period for an apical bud. From Lang *et al.* (1987). *HortScience* **22**, 371–377.

Why mist-cooling?

- Delay bloom to avoid frost! Remember 2012

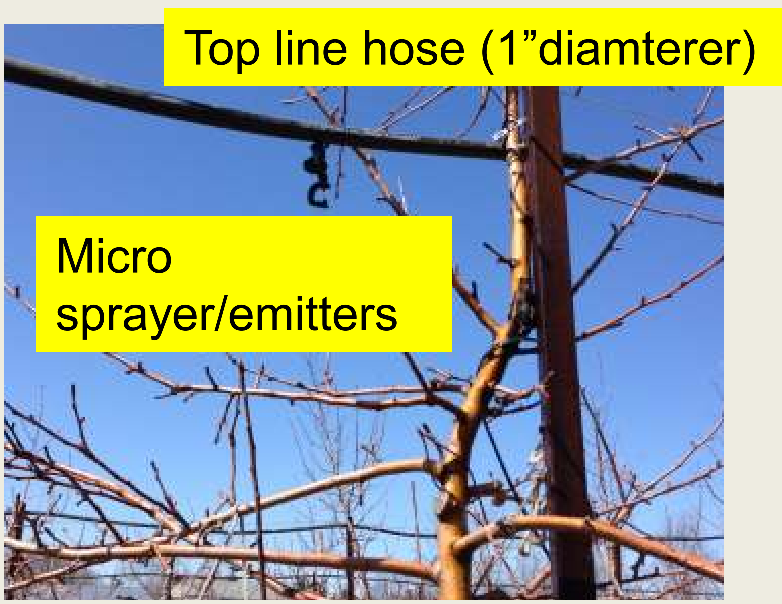
- Delay harvest by cooling in the summer.
- Avoid sun-scald (mainly in the West)
- Reduce dormancy by increasing accumulation of heat units. They only accumulate between 32 and 50 degrees F (some formulas differ slightly)

Why now, isn't this old work?

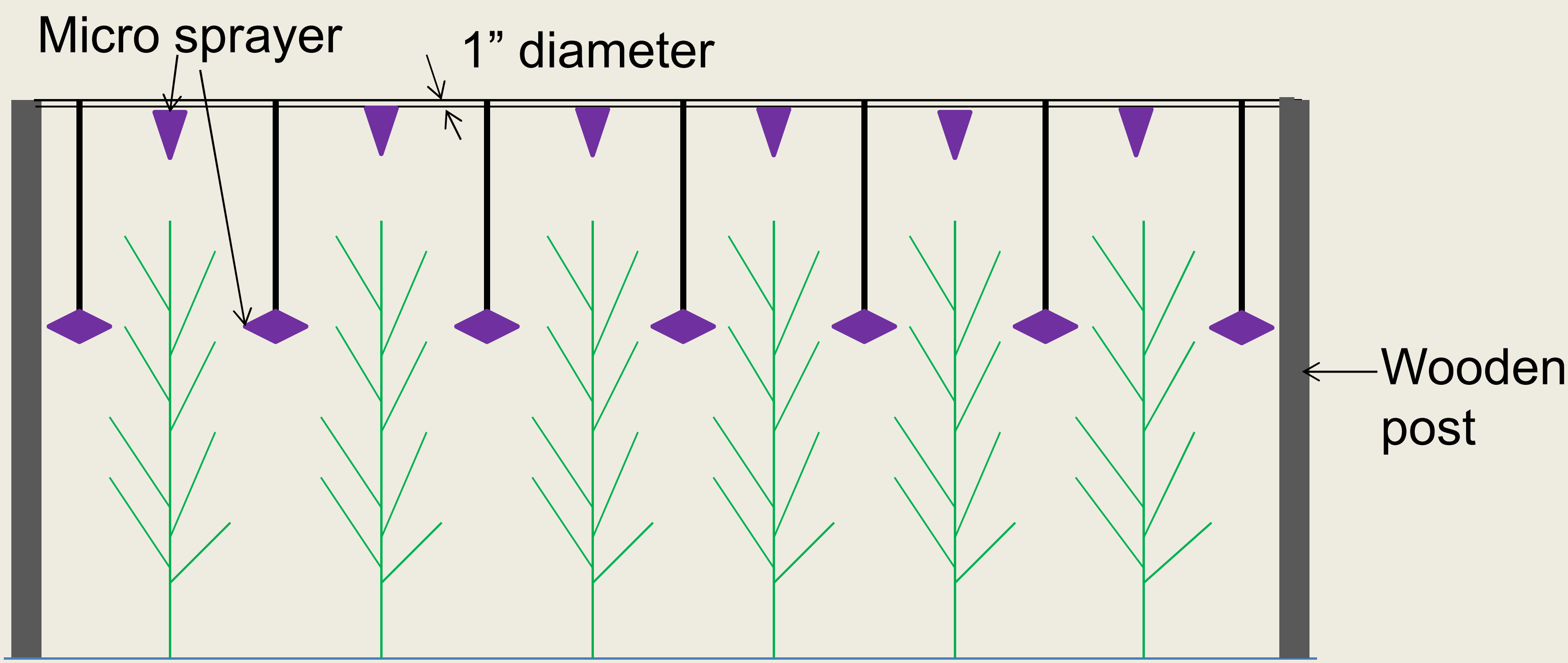
- Old systems based on sprinklers (minimum of ¼ inch per hour) and time clocks (5 min on rmon off) had disadvantages (disease, poor set, and excessive water use).
- Why now?
  - Newer delivery systems based on mist application using the SSCD (solid state canopy delivery system) to apply pesticides
  - Modern weather stations that accurately measure temperature, humidity, and wind speed (factors that effect evaporation)
  - Modern control systems based on environtmenta that gives maximum cooling from evaporation.

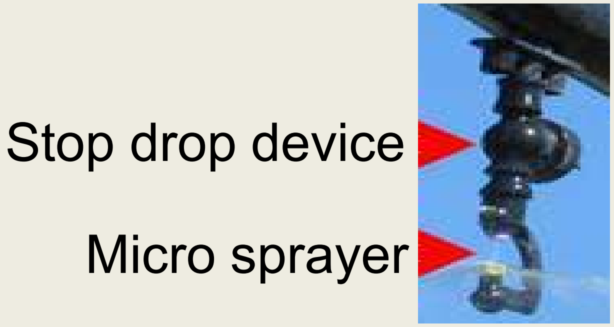
Solid Set Canopy Delivery system (SSCD)

- Increasingly being used in high density orchards for application of pesticides and growth regulators (Grieshop et al., Agnello and Landers, 2006)
- Can theoretically provide the water necessary for cooling at a tiny fraction of rates consumed by a conventional sprinkler



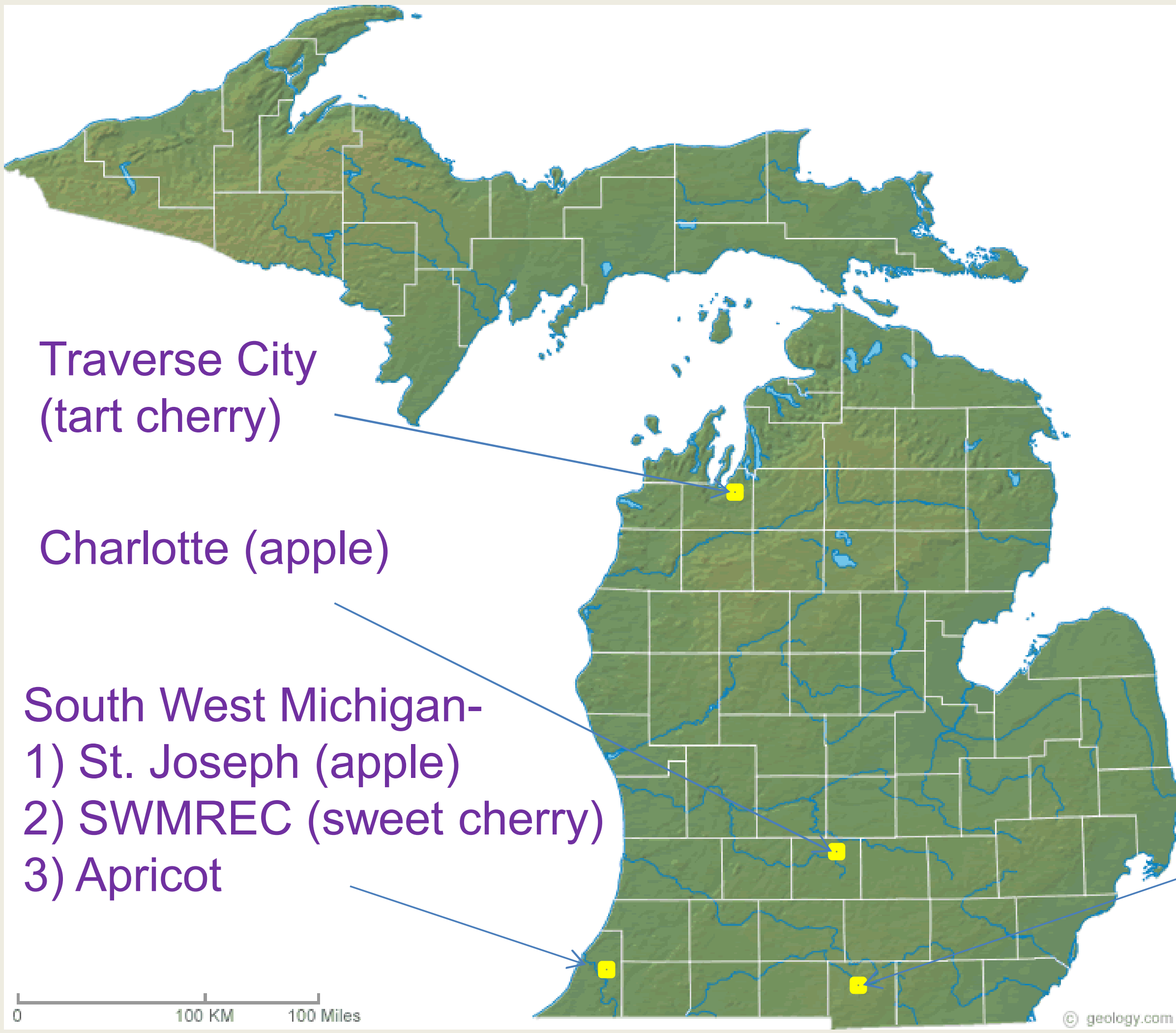
SSCD System Layout in the Field





Study areas: Left Sweet Cherries at SWMREC under high tunnels. Right ‘Montmorency’ in Elk Rapids at Ken Engle’s

The Study Area



- Cherry flowers on May 2, 2013 at SWMREC, Benton Harbor, MI
- Non misted bloomed May 2 and misted on May 13

- Cherry (Skeena), Control and treated on May 8, 2014, SWMREC, Benton Harbor, MI
- Non-misted bloomed on May 7
Treated buds bloomed on May 16

Bud and air temperature along with ON and OFF periods, SWMREC 2014.

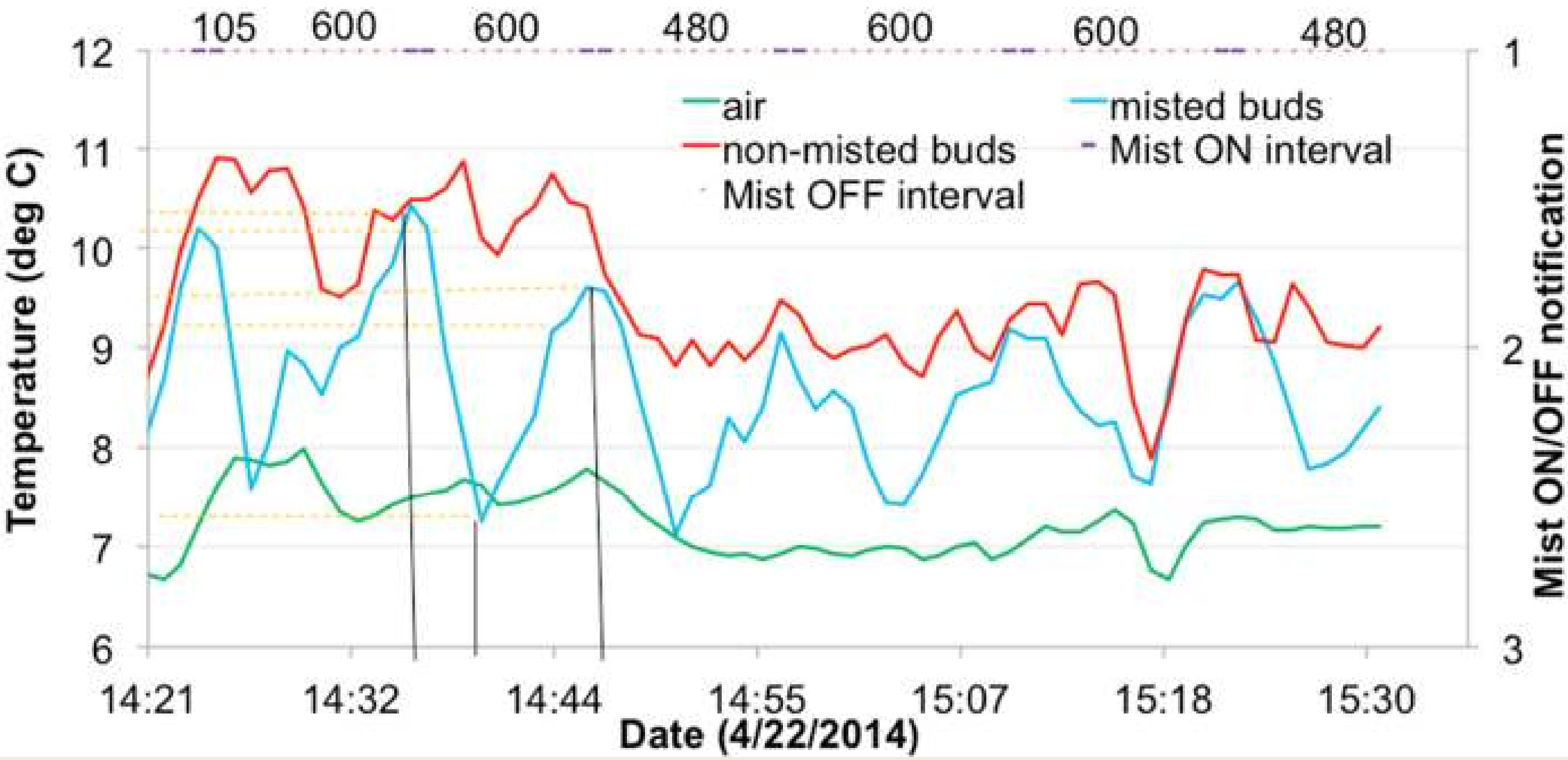


Table- Bloom date and GDD (from green tip on non-misted) of sweet cherry at SWMREC, GDD using minimum and maximum air temperature.

Year	Study	Bloom date	GDD	Mist duration (Hours)	Mist volume (ac-in)
2013	No mist	2-May	150		
	Mist	13-May	258	39	5.35
2014	No mist	7-May	134		
	Mist	16-May	238	52	10.5

- Apricot, non-misted and misted buds on April 25, 2014, Baroda, MI
- Non-misted had full bloom on May 29 and misted had full bloom on May 5
- Mist application was started from April 19, when buds were at red calyx



Pictures taken on May 16, 2014

1. No mist
2. Red Delicious, SSCD turned off on May 16 (Treatment 2)
3. SSCD system turned off on May 13 (Treatment 1)

Apple test plots in 2014

Experimental orchards in Michigan	Year	Treatment	Total duration of misting (hours)	ac-in
St. Joseph	2013	Mist turned off on May 7	58.87	13.76
		Mist turned off on May 15	46.72	10.86
	2014	Mist turned off on May 13	61	14.59
		Mist turned off on May 16	57	12.64
Charlotte	2013		45.96	8.17
	2014		62	14.88
Hillsdale	2014		81	25.48

Full Bloom Date of Apple at St. Joseph, MI

Variety	Treatment	First bloom date	
		2013	2014
Gala	control	10-May	11-May
	treatment 2	16-May	18-May
	treatment 1	18-May	20-May
Red Delicious	control	12-May	13-May
	treatment 2	16-May	20-May
	treatment 1	19-May	23-May
Honey Crisp	control	14-May	15-May
	treatment 2	19-May	23-May
	treatment 1	22-May	26-May

Bloom date of apples and fruit per flowering spur , 2013-14

Orchard Location	Variety	Study	2013		2014	
			bloom date	Fruits per flowering spur	bloom date	Fruits per flowering spur
St. Joseph	Gala	Control	10-May	69.23	15-May	44.01
		treatment 2	16-May	40.06	20-May	44.14
		treatment 1	18-May	47.73	23-May	62.27
	Red Delicious	Control	12-May	39.69	16-May	100.0
		treatment 2	16-May	28.52	22-May	46.88
		treatment 1	19-May	32.29	25-May	66.24
	Honey Crisp	Control	14-May	44.74	20-May	84.12
		treatment 2	19-May	47.42	26-May	94.44
		treatment 1	22-May	32.04	28-May	84.17
Charlotte	Honey Crisp	Control	16-May	51.00	20-May	70.00
		Treatment	22-May	52.00	26-May	75.00

Conclusions

1. SSCD mist applications delayed bloom by at least 5 – 11 days and protected cherry and apple blossoms from spring frost damage
2. The treatment resulted in less damage to the king bloom of HoneyCrisp apples than in controls
3. There were no apparent disease or fruit set problems or fruit quality issues in apple
4. Uses less water than that reported in earlier studies;
   2013:11-14 ha-cm (10.8-13.76 ac-in)
   2014: 3.9-15 ha-cm (13.59 -14.76 ac-in)

Thank You!!!!!

Mist-cooling to delay bloom

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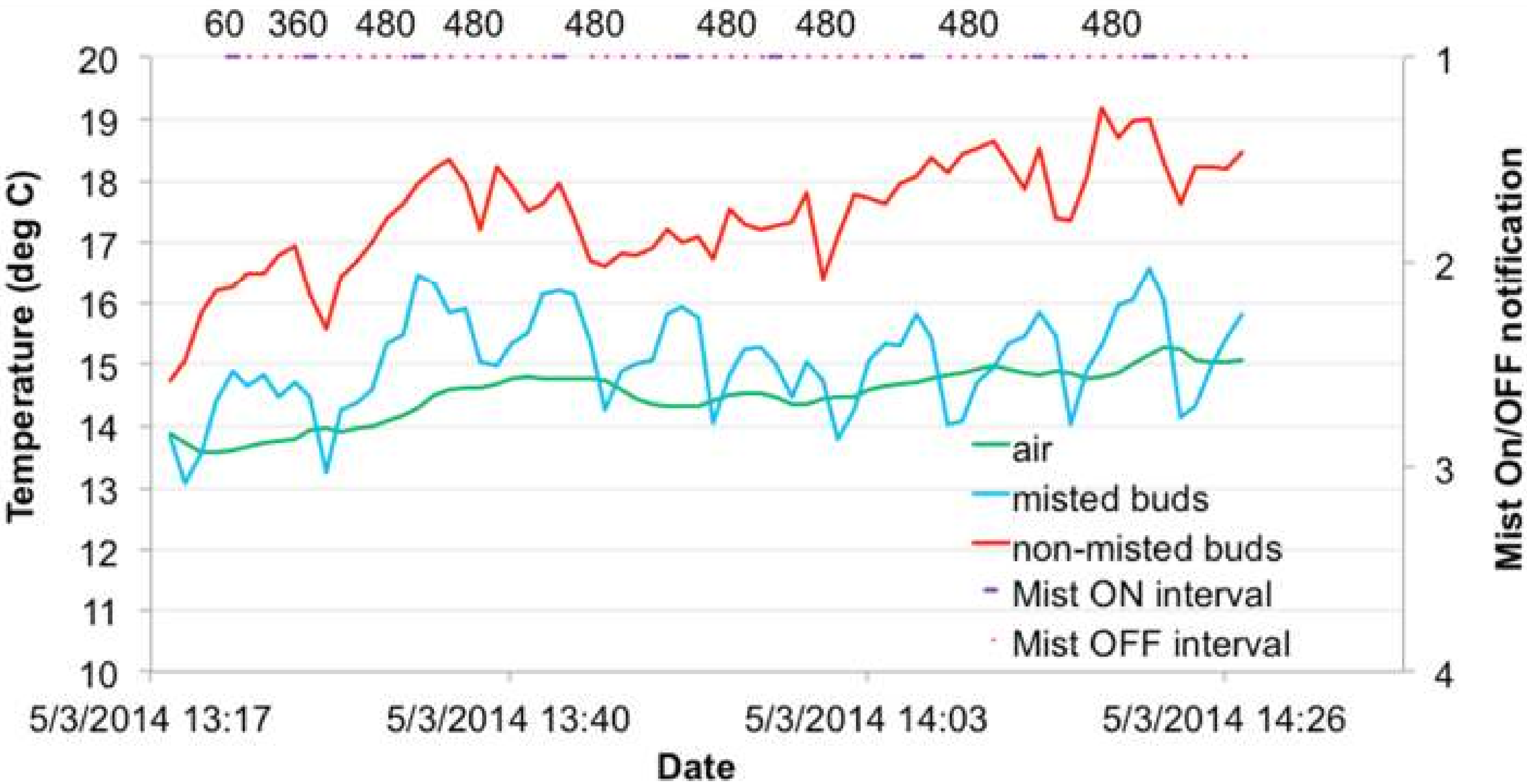
and Greg Lang

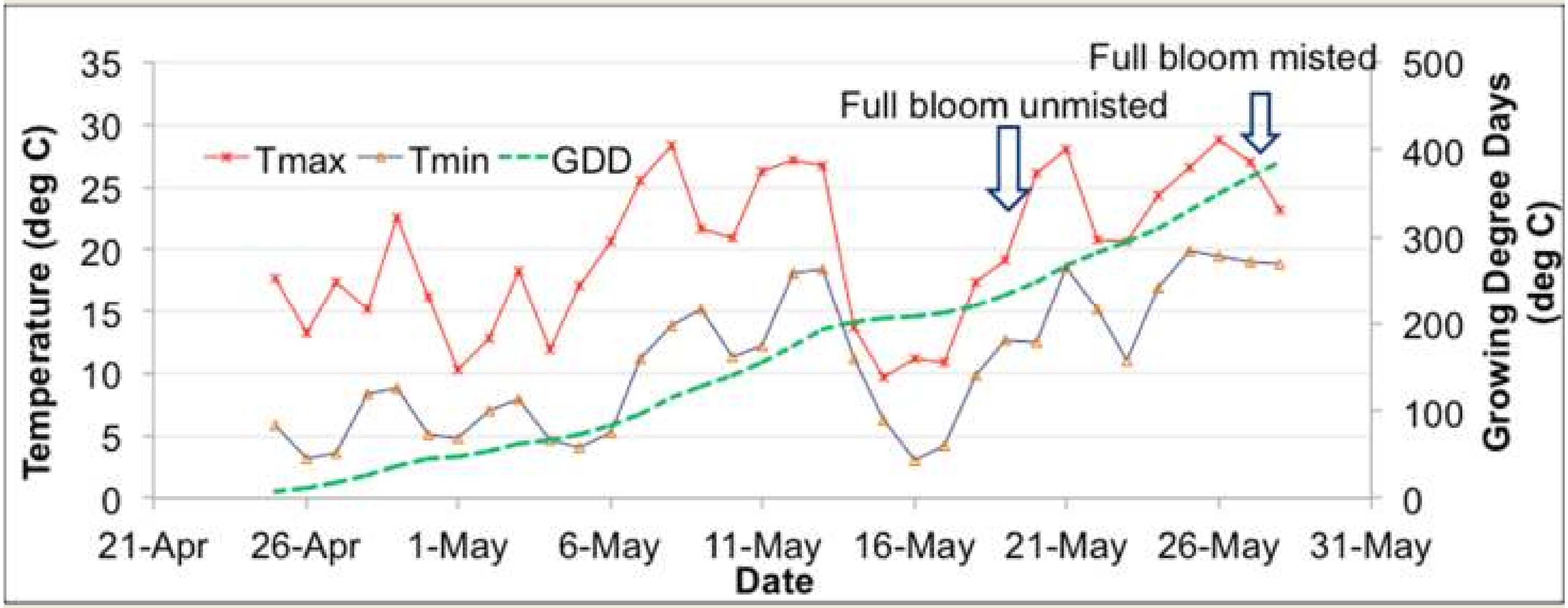
Supported by: Michigan Cherry Research committee, Michjigan Apple Committee, Michigan State Horticultural Society, MSU AgBioResearch.

Apple trials at
St. Joesph
Charlotte
Hillsdale

Air, control bud and misted bud temperature at St. Joseph MI



Minimum and Maximum air temperature and GDD, Hillsdale MI.



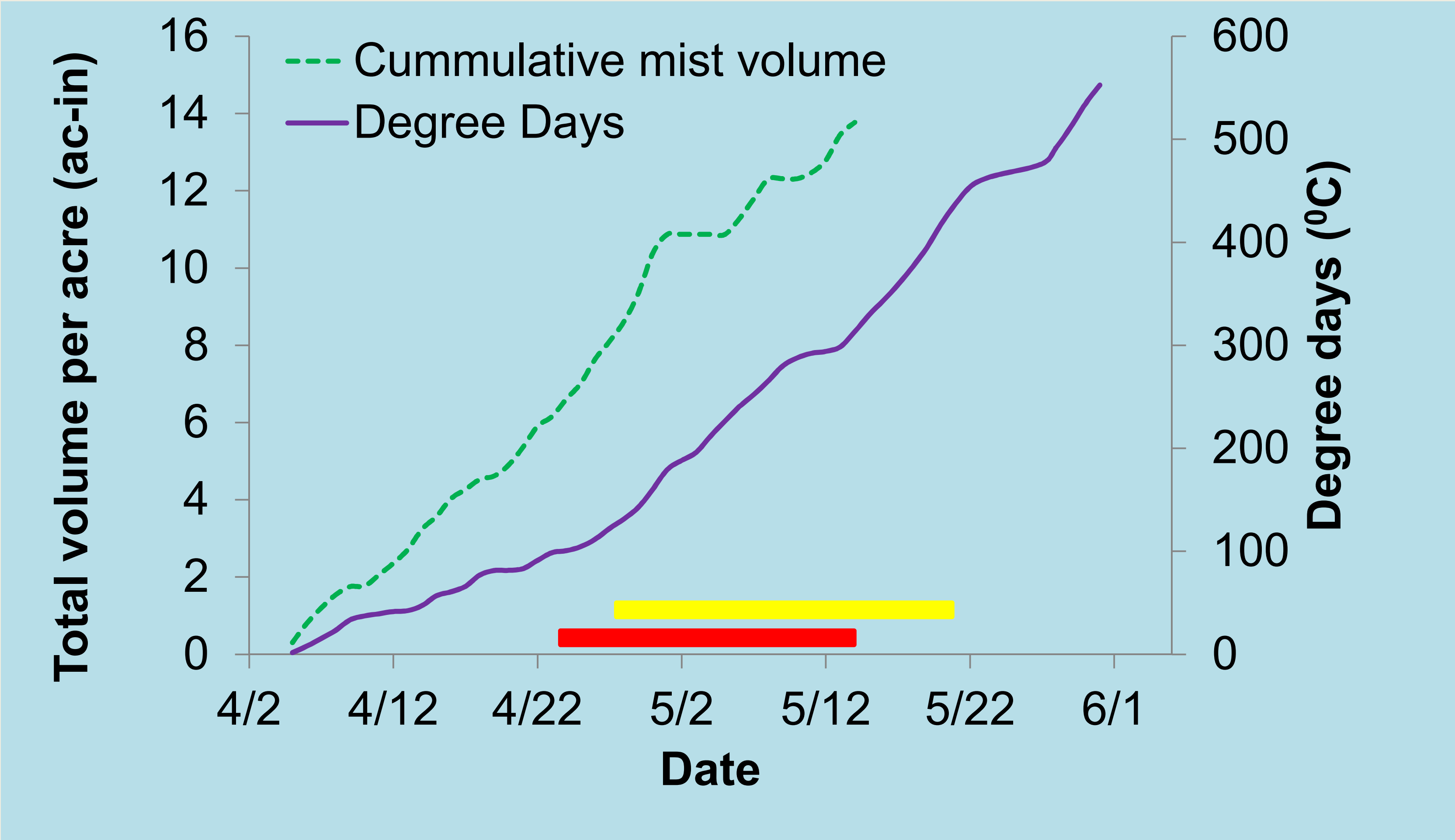
Bloom delayed by approximately 9 days, mist applied 81 hours. Coverage poor because of high winds.

Control, Treatment 2, Treatment 1 on May 16, 2014, Red Delicious variety

Cherry (Skeena), Control and treated on May 8, 2014

Control bloomed on May 7
Treated buds bloomed on May 16

Mist Volume Per Acre and Growing Degree Days (GDD base 3 ^{0}C) at St. Joseph, MI (apple) in 2013



Silver tip to full bloom in treatment 1

Silver tip to full bloom in control