Irrigation of High Density Orchards

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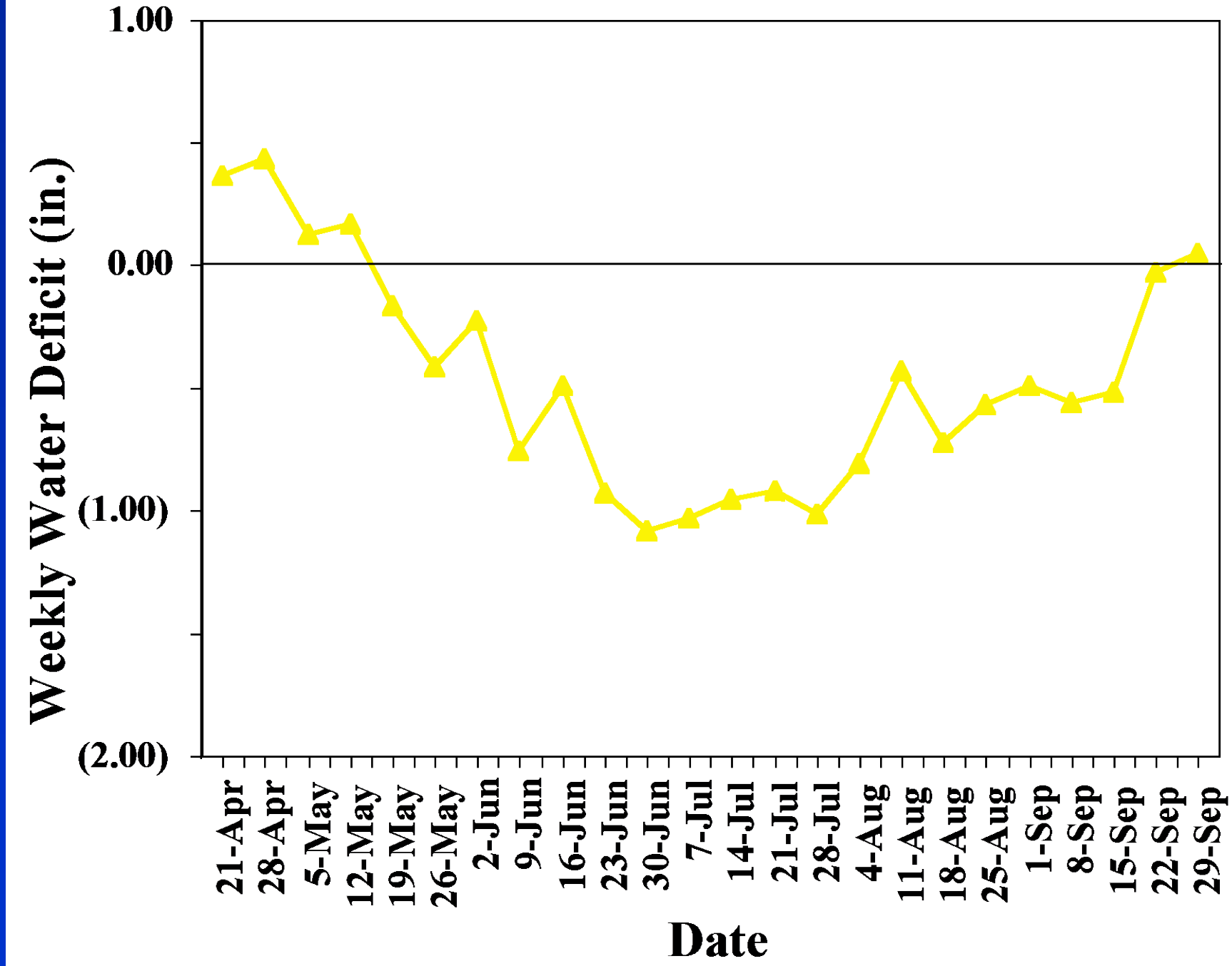
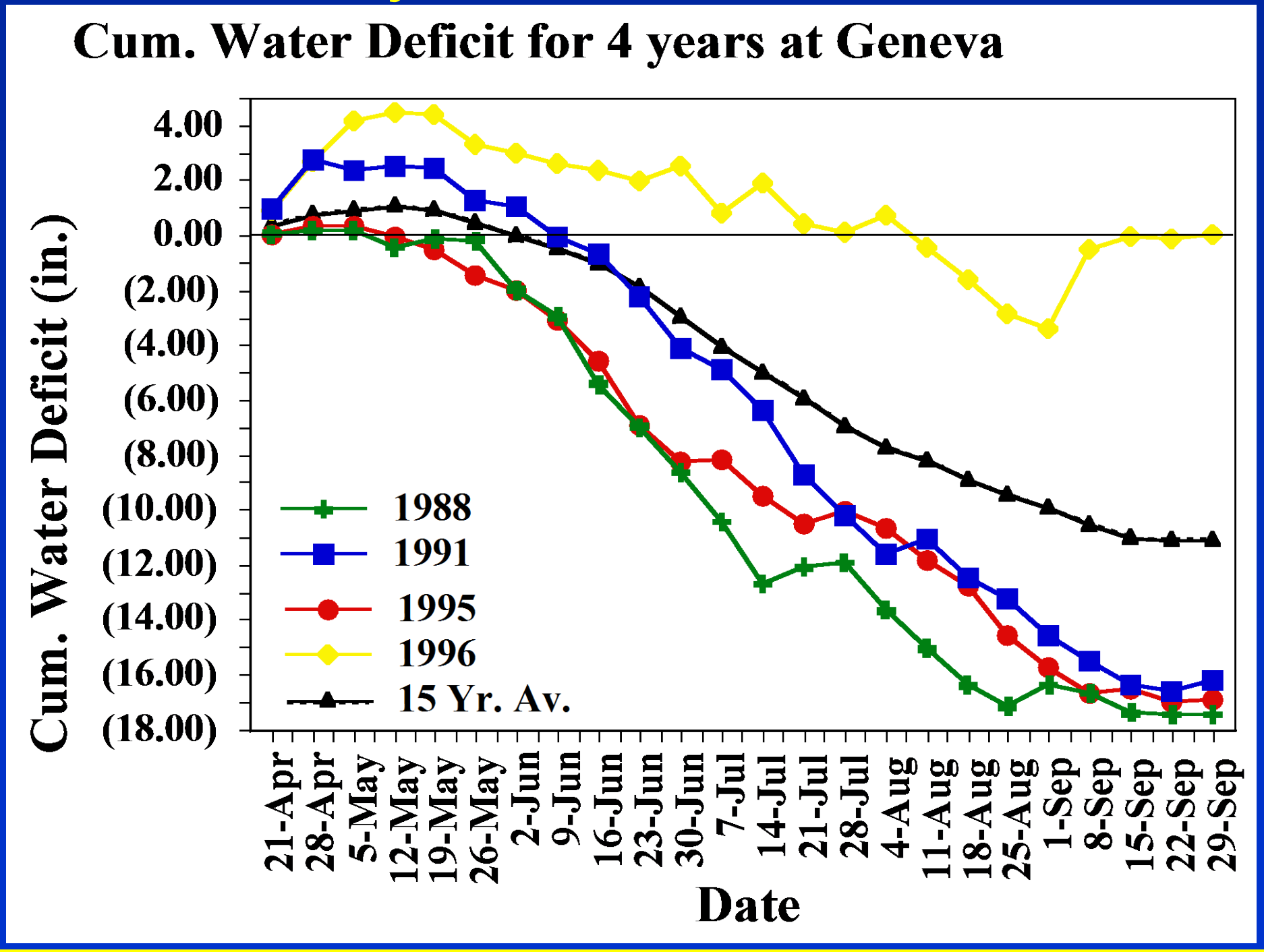
The Need for Irrigation in Apple:

- In the average season (May-September), rainfall is 125-150 mm less than pan evaporation.
- In 3 years out of 5, significant water shortages occur in June, July and August.
- In the worst situations, the shortfall can be 35-50mm per week.

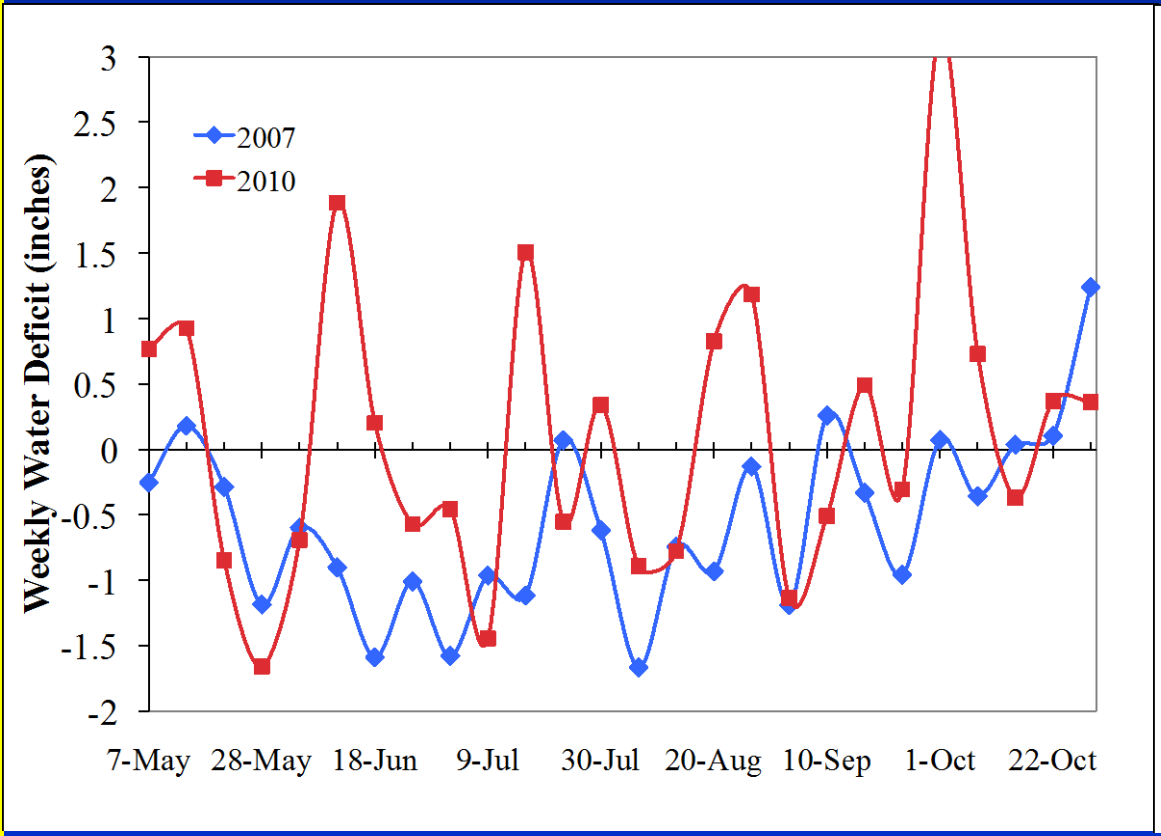
15 Yr. Average Water Deficits at Geneva, NY

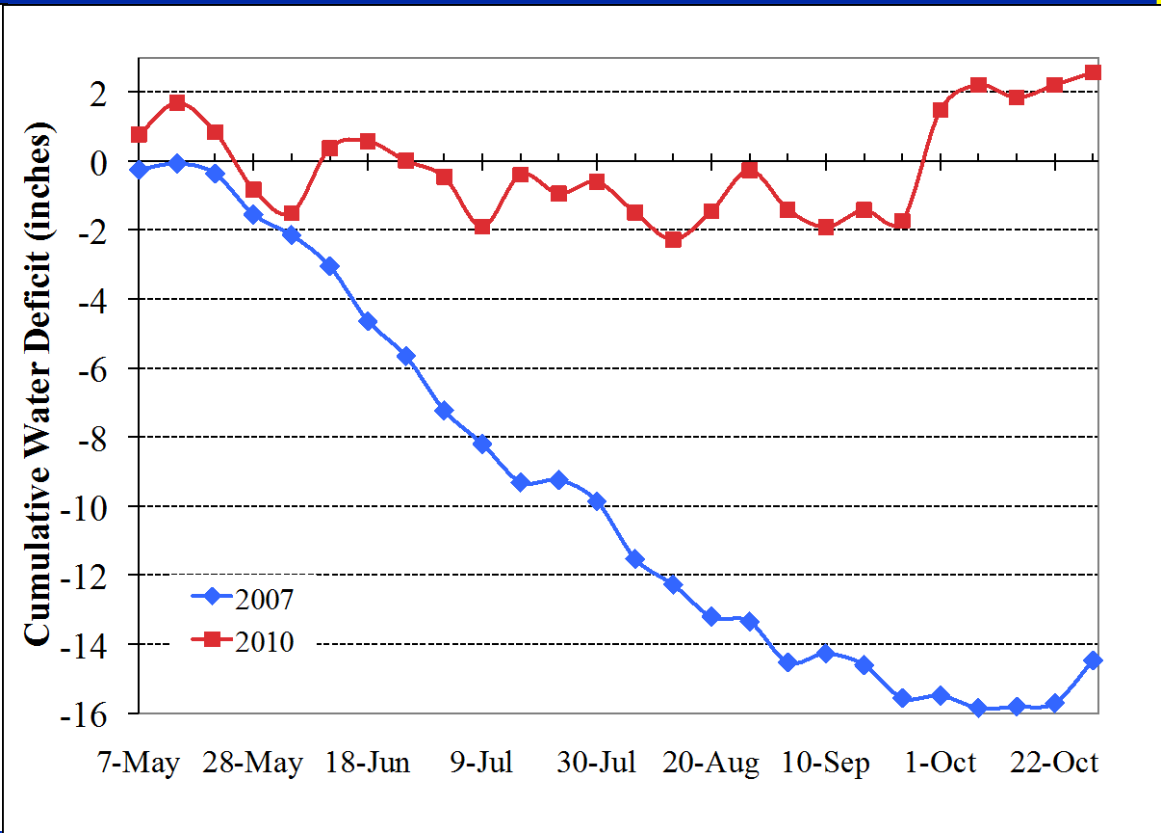


Water Deficits vary Each Year in Humid Climates

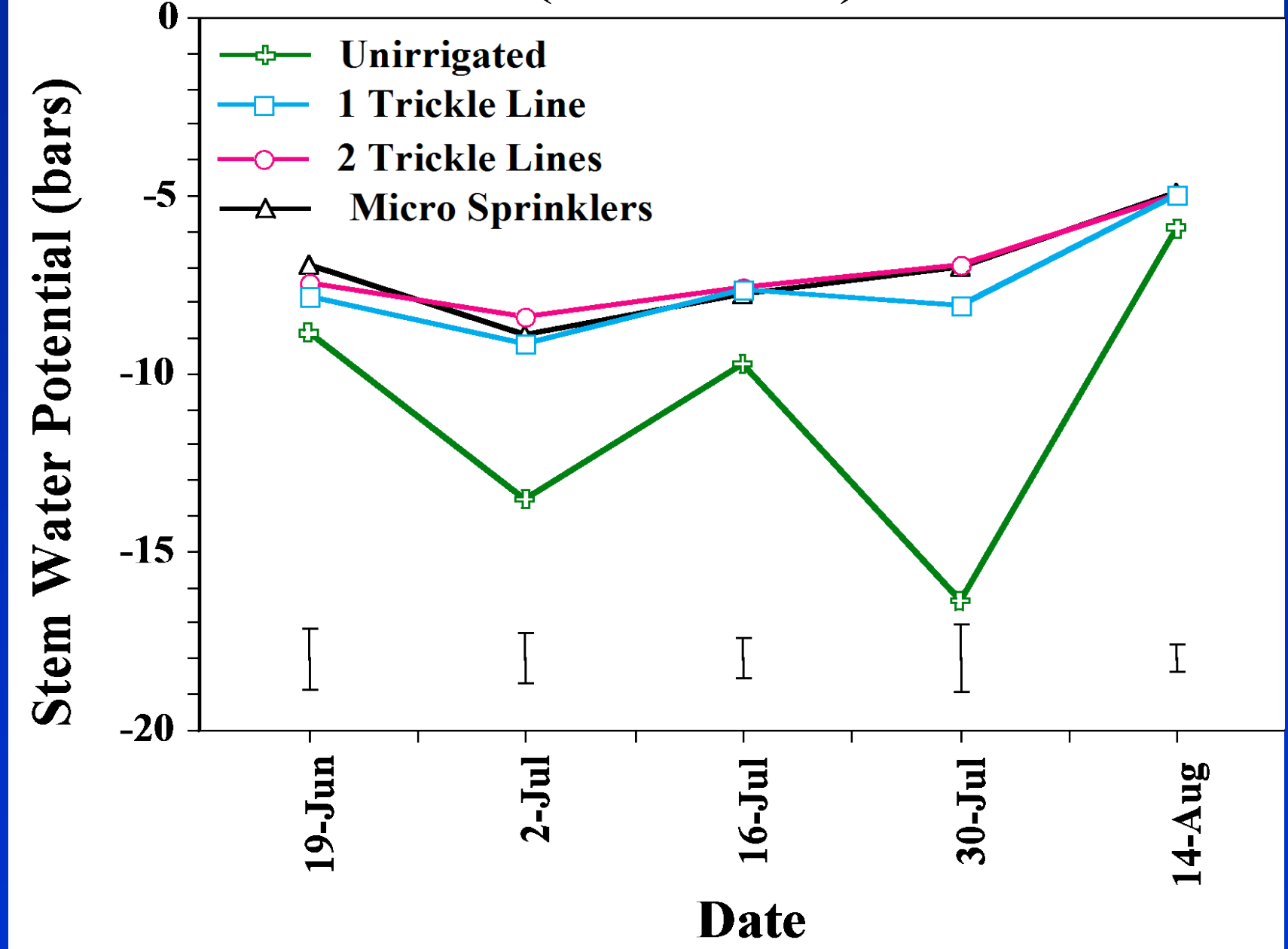


Water Deficits in a Dry Year (2007) and a Wet Year(2010)

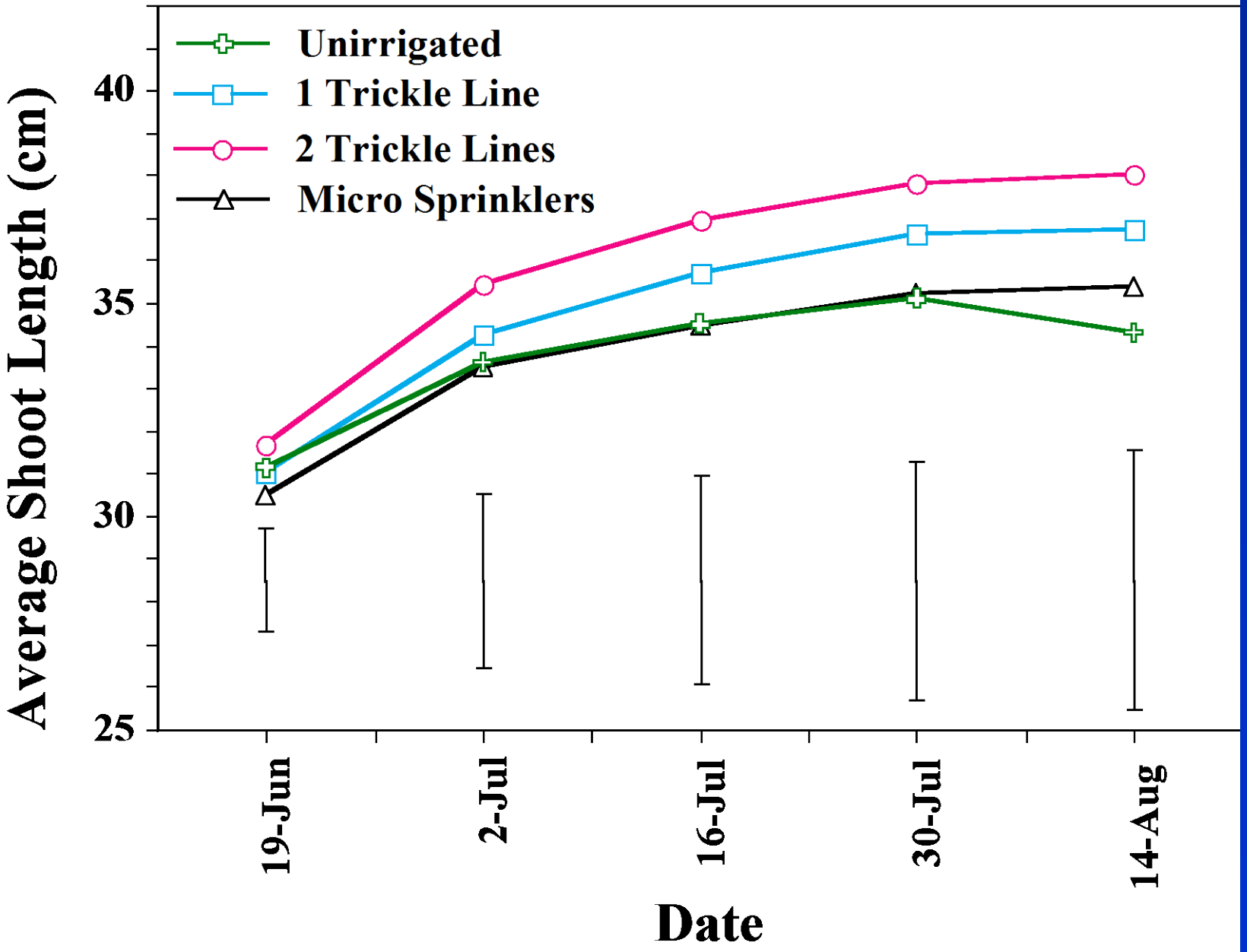




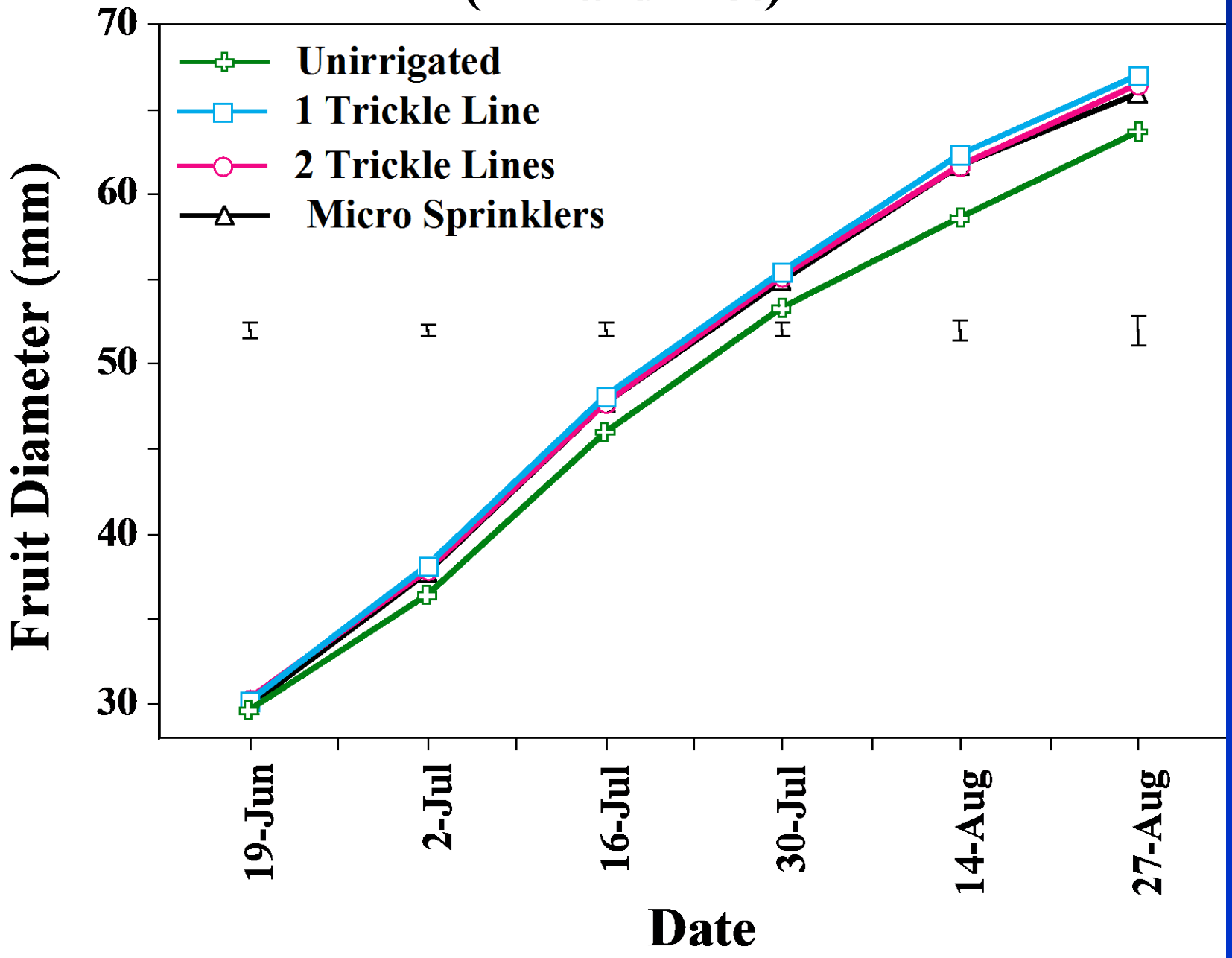
Effect of Irrigation on Stem Water Potential (Minard Plot)



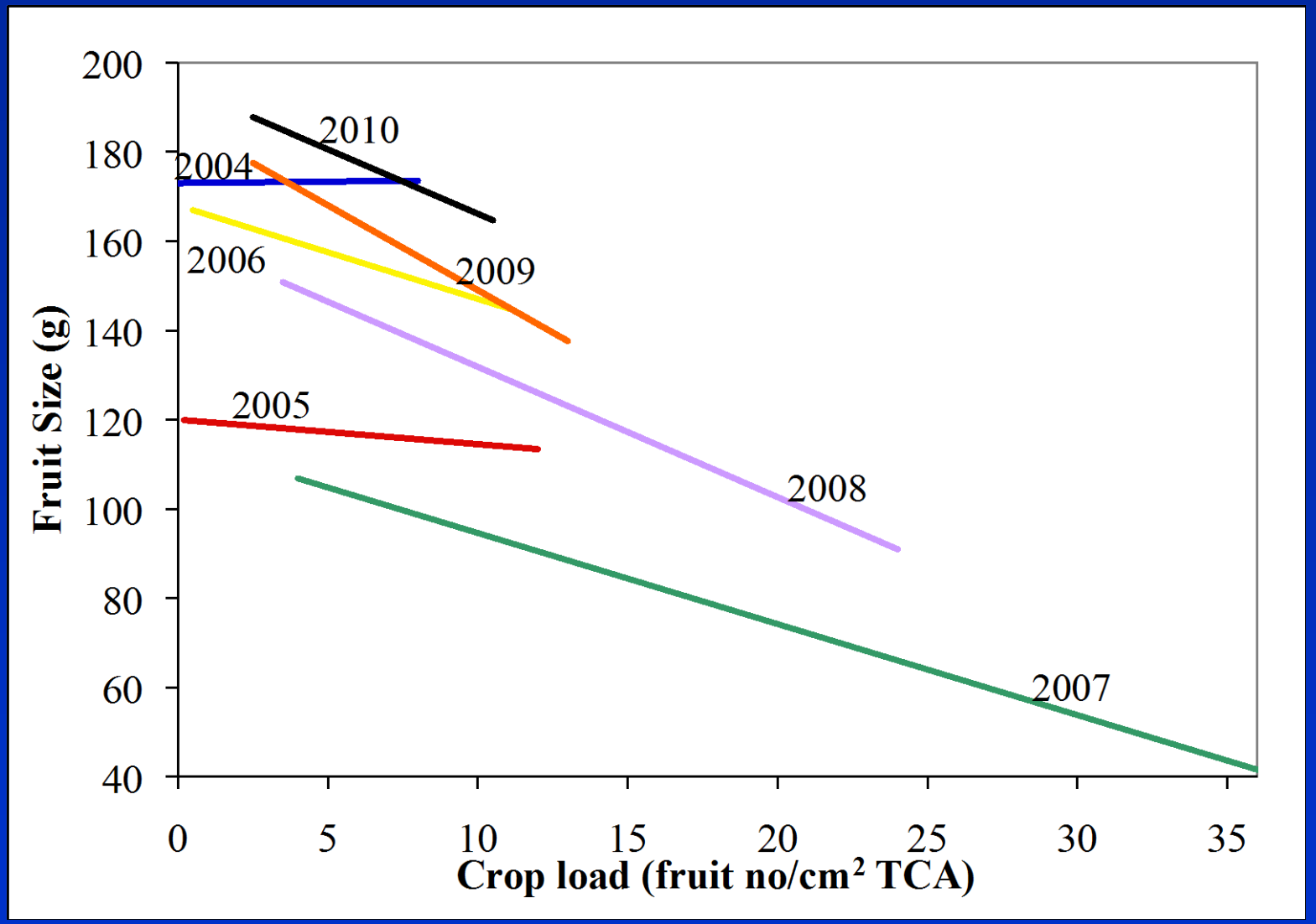
Effect of Irrigation on Shoot Growth (Minard Plot)



Effect of Irrigation on Fruit Growth (Minard Plot)



Fruit Size in the Severe Drought of 2007



Fruit size of Gala in 2007 was 70g less than in 2010 (2 inch vs. 3 inch Gala

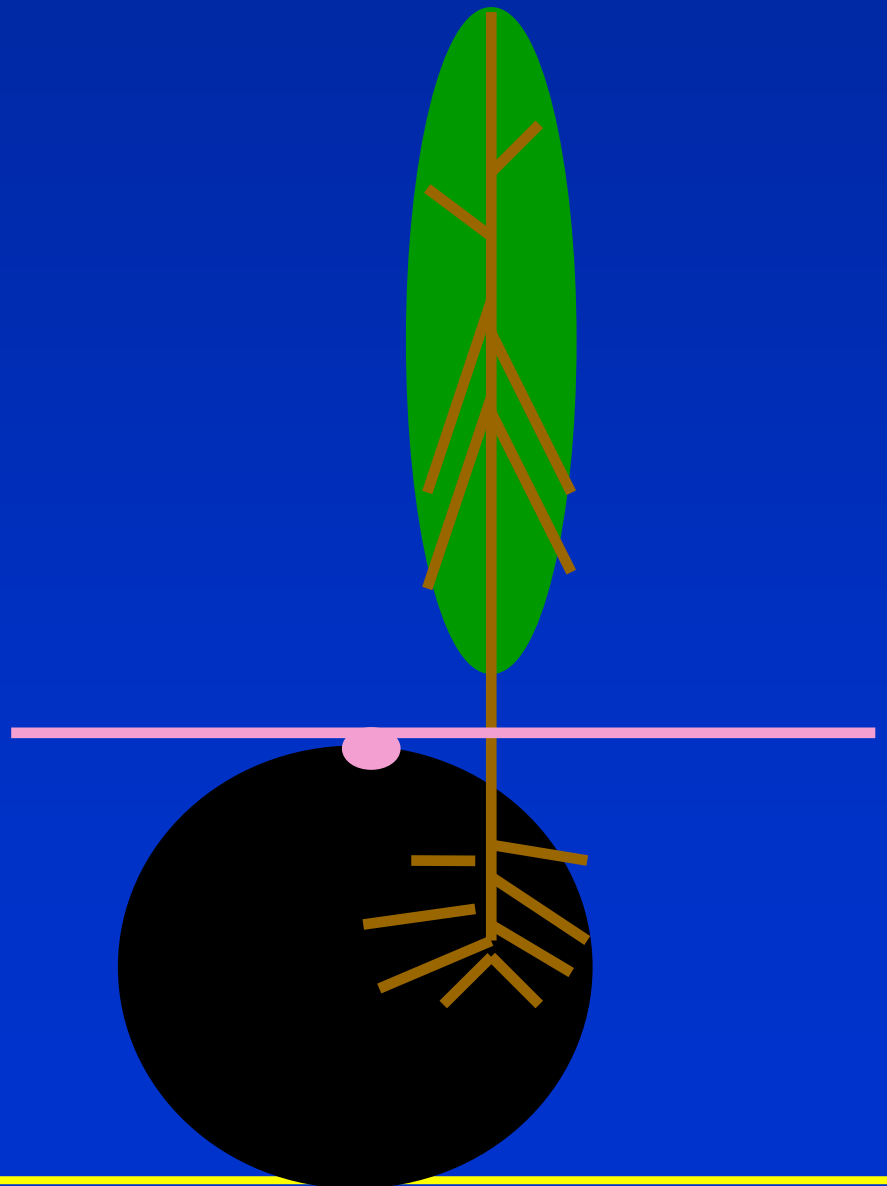
Water Stress with Young Trees

Limited root system due to digging in nursery.
Transplant shock
Rapid Leaf area development with branched trees

Highly feathered trees experience water stress in late May and June due to limited root systems and extensive leaf area

Water must be applied frequently to limit water stress on newly planted trees. Trickle irrigation must be installed within 2 weeks of planting

Newly planted trees have limited nutrient uptake due to damaged root systems.



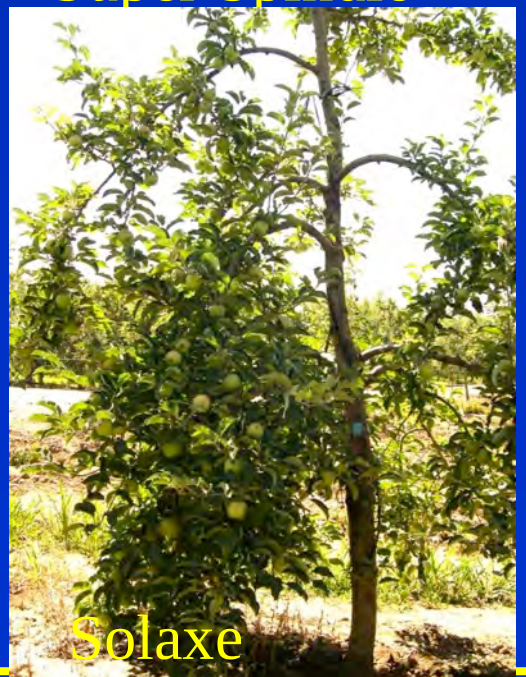
Modern High-Density Orchards Have High Early Production on Small Trees Which Have Small Root Systems

Tall Spindle

Super Spindle

Precision V-Trellis

Bi-Axis



Solaxe

Mur Frutiere (Fruiting Wall)

Water and Nutrient stress with different tree types

Little stress → More stress

Drought Affects Root System Characteristics

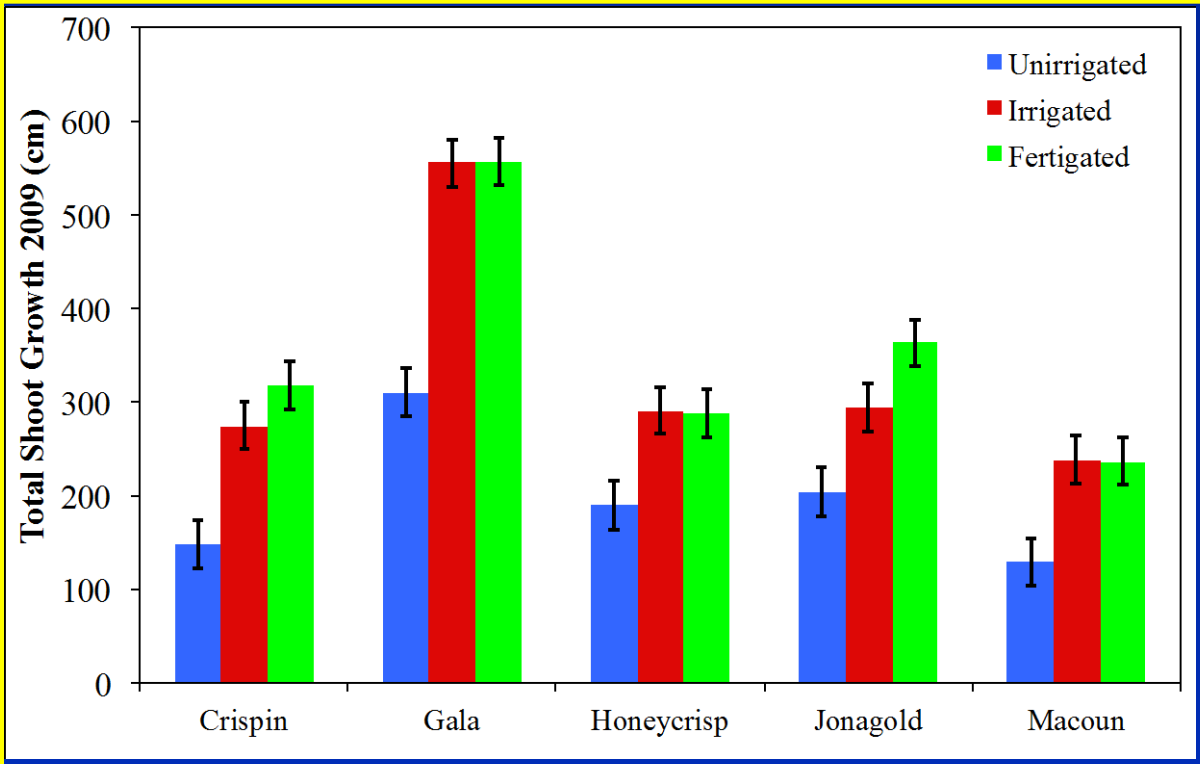
With Irrigation the Early Cropping Potential of Young Apple Orchards is High

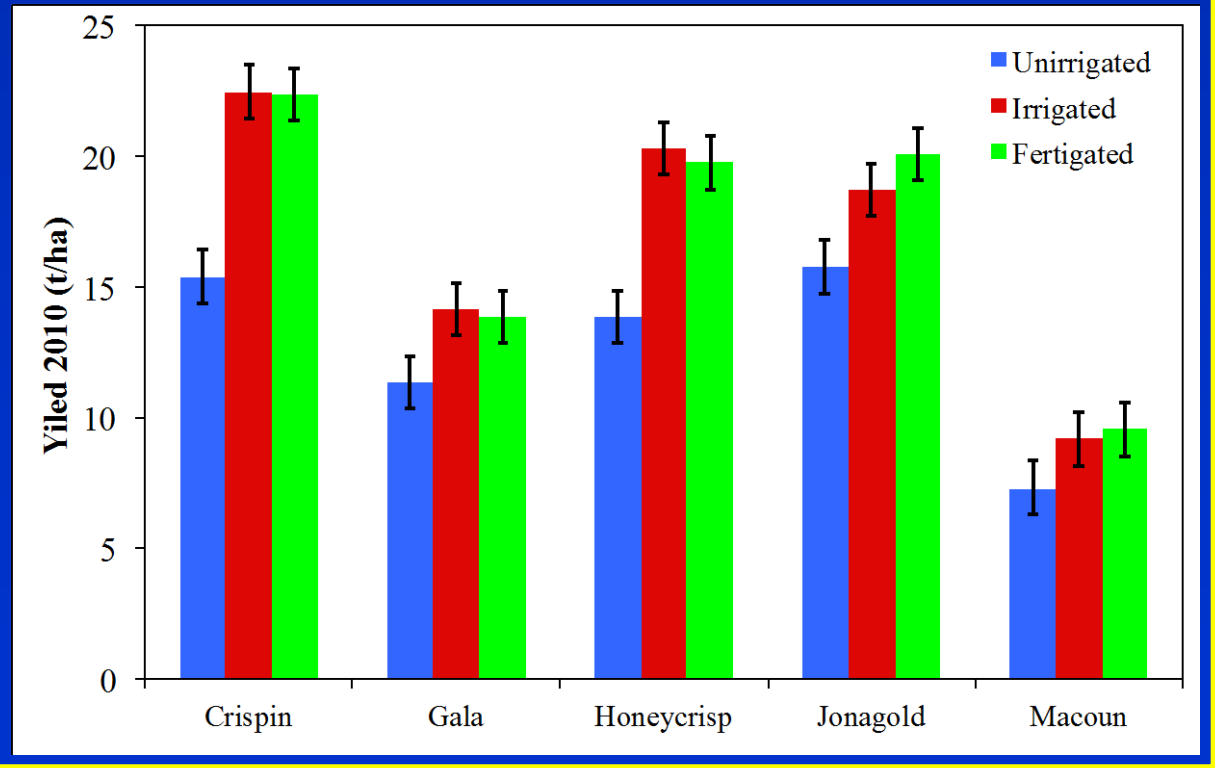
Fuji/CG.007

85 fruits/tree in the second year

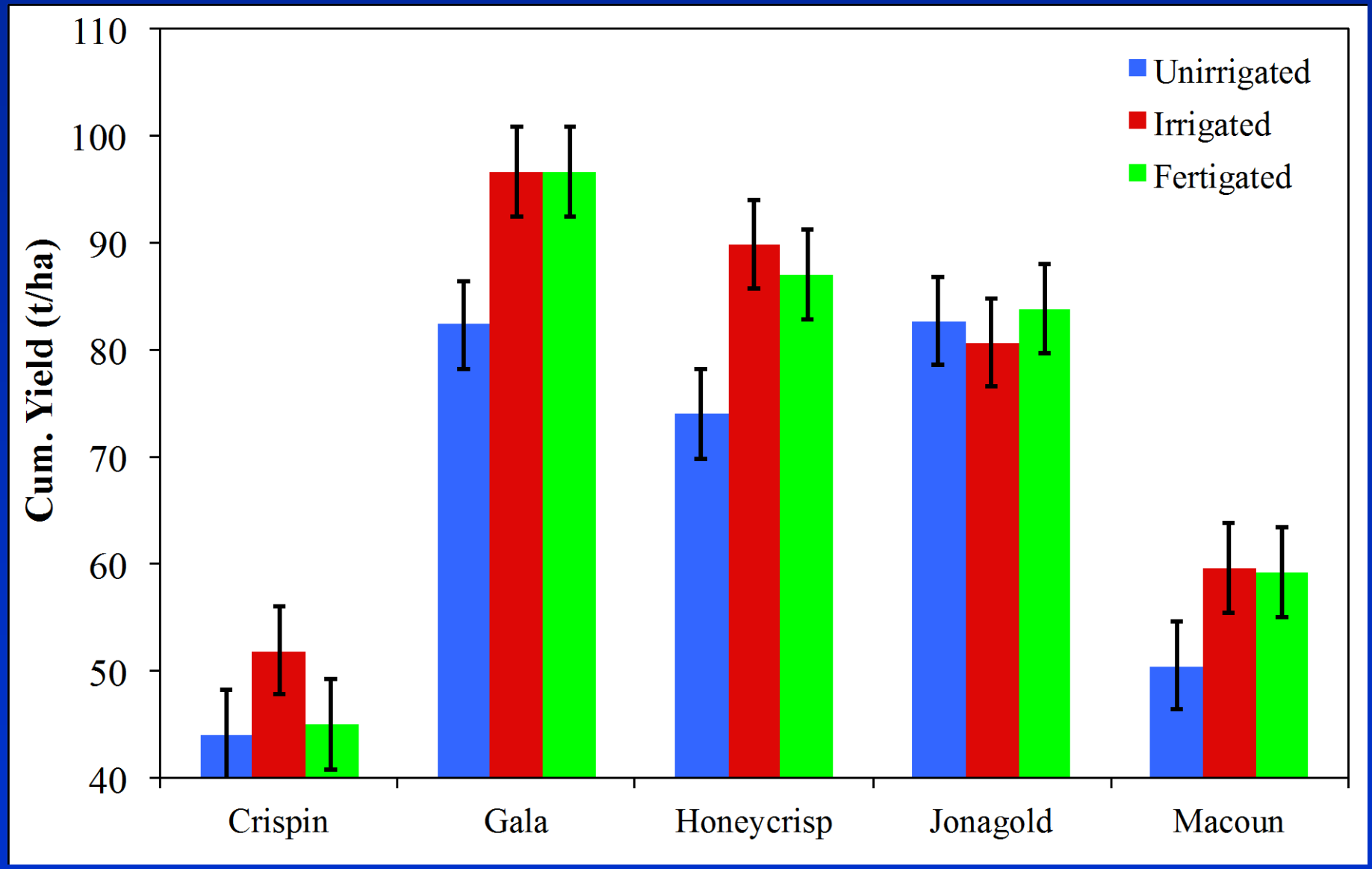
X 3300 trees/ha= 50 t/ha

Effect of Irrigation on Young Trees





Effect of Irrigation on Young Trees



Gala: 770 box increase X $15/box = $11,550 increase in crop value

Honeycrisp: 880 box increase X $30/box= $26,400 increase in crop value

Effect of Trickle Irrigation on Growth and Yield of Empire, Mutsu and Delicious Trees

Treatment	Shoot Growth yr. 1-3 (m)	Shoot Growth yrs4-5 (m)	Yield/ tree yr. 2-4 (kg)	Yield/ tree yr. 5-6 (kg)	Av. Fruit Size (g)
	(% of Control)				
Unirrigated	100 b	100 b	100 b	100 b	100 b
Trickle Irrigation	160 a	139 a	145 a	160 a	107 a

Estimating Tree Water Requirements:

- Modified Kenworthy Rule
  - 4 liter water/tree/day/year of tree age.
- Soil suction tensiometers
  - Apply irrigation when tensiometers read -20 centibars.
- Pan Evaporation
  - Open surface evaporation adjusted with a crop coefficient (K_c).
- Evapotranspiration models
  - Penman-Monteith model developed for grass adapted to orchards with a crop coefficient (K_c)
  - New Cornell evapotranspiration model for apples.

Using the New Cornell Irrigation Model

Grower chooses weather station

Cornell Web Server (NEWA)

Evapotranspiration Model (scales output for orchard age and for leaf area development)

<u>Grower inputs:</u>
Green tip date
Tree spacing (inrow x between row)
Orchard age

<u>Model Provides:</u>
Water balance daily since budbreak
Forecasts water balance for 7 days

Output page of Cornell Irrigation Model

NEWA Apple ET Model

Weather Station: Williamson (Demarree)

Select Date: 07/08/2012

Continue

Map | Results | Help

Apple ET Model for Williamson (Demarree)

Change green tip date or tree density and click "Calculate" to recalculate results. Changing "Age of Orchard" will automatically recalculate table.

Green tip date	In row spacing	Between row spacing	Trees per acre	Age of orchard	Water balance
3/18/2012	3 feet	12 feet	1210	Mature	

Apple Evapotranspiration Model Results

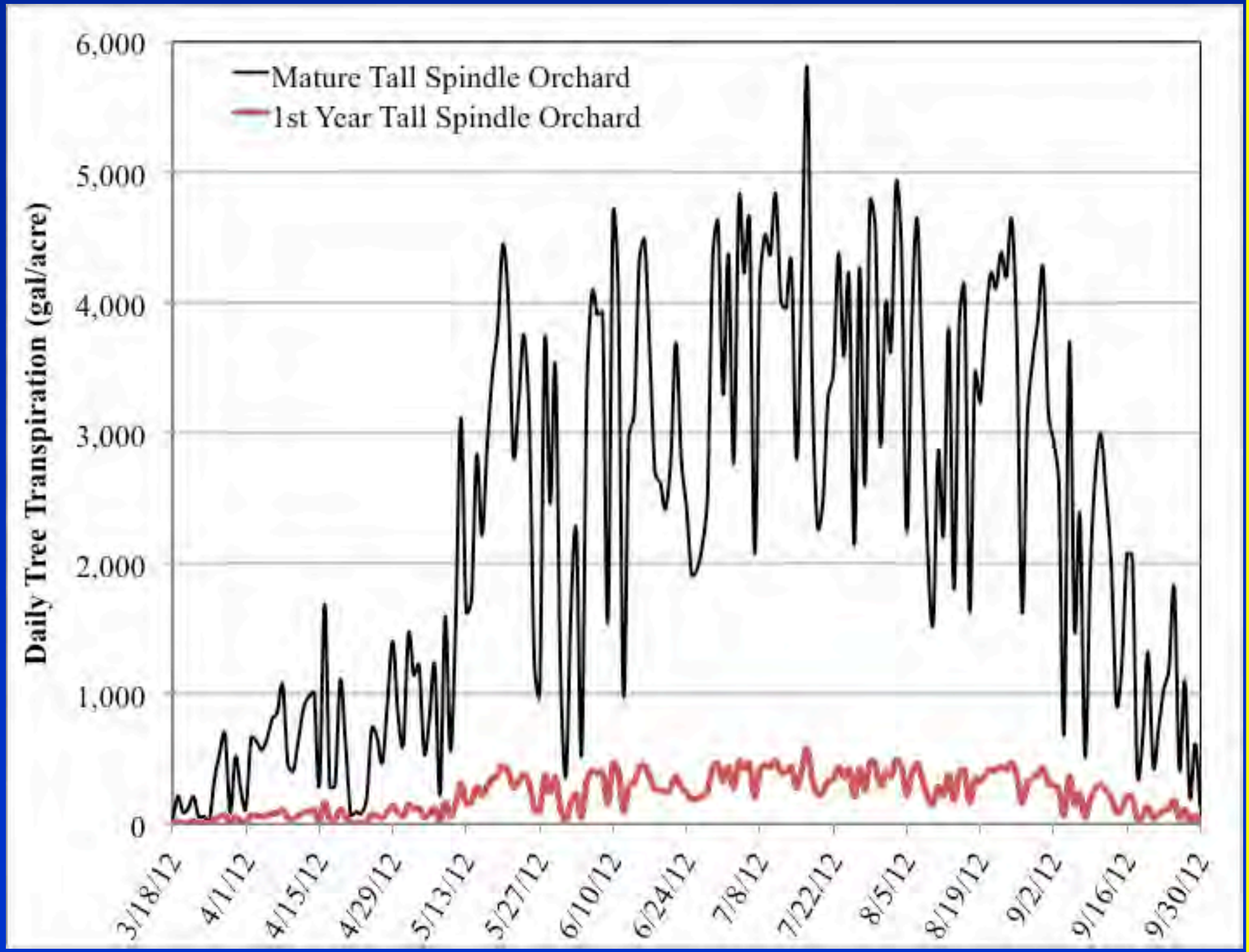
Date	Model ET (liters/tree)	Orchard ET (liters/tree)	Orchard ET (gallons/acre)	Rainfall (inches)	Available Rainfall (gallons/acre)	Water Balance (gallons/acre)
Jul 1	24.07	10.3	3294	0.00	0	-3294
Jul 2	31.92	13.66	4368	0.00	0	-4368
Jul 3	20.25	8.67	2771	0.00	0	-2771
Jul 4	34.99	14.98	4788	0.00	0	-4788
Jul 5	30.88	13.22	4226	0.00	0	-4226
Jul 6	33.82	14.48	4628	0.00	0	-4628
Jul 7	15.19	6.5	2079	0.20	3802	1723
Jul 8	30.33	12.98	4150	0.00	0	-4150
Jul 9	33.01	14.13	4517	0.00	0	-4517
Jul 10	31.96	13.68	4373	0.02	380	-3993
Jul 11	35.32	15.12	4833	0.00	0	-4833
Jul 12	29.31	12.55	4011	0.00	0	-4011
Jul 13	28.90	12.37	3955	0.00	0	-3955
Jul 14	31.48	13.48	4308	0.00	0	-4308

You can enter your own rainfall amounts and click "Calculate" to recalculate the water balance.

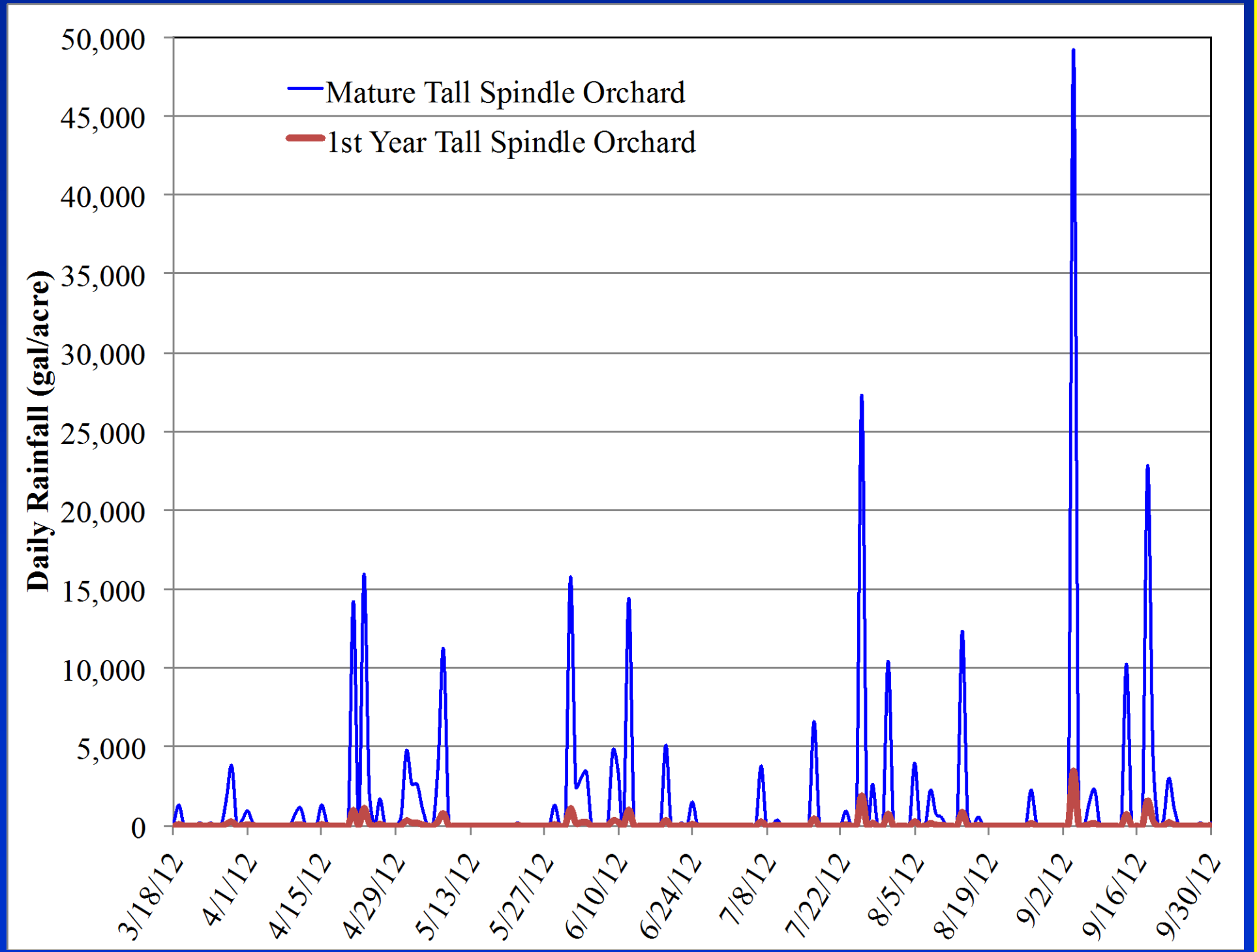
NEWA

Powered by ACIS Northeast Regional Climate Center

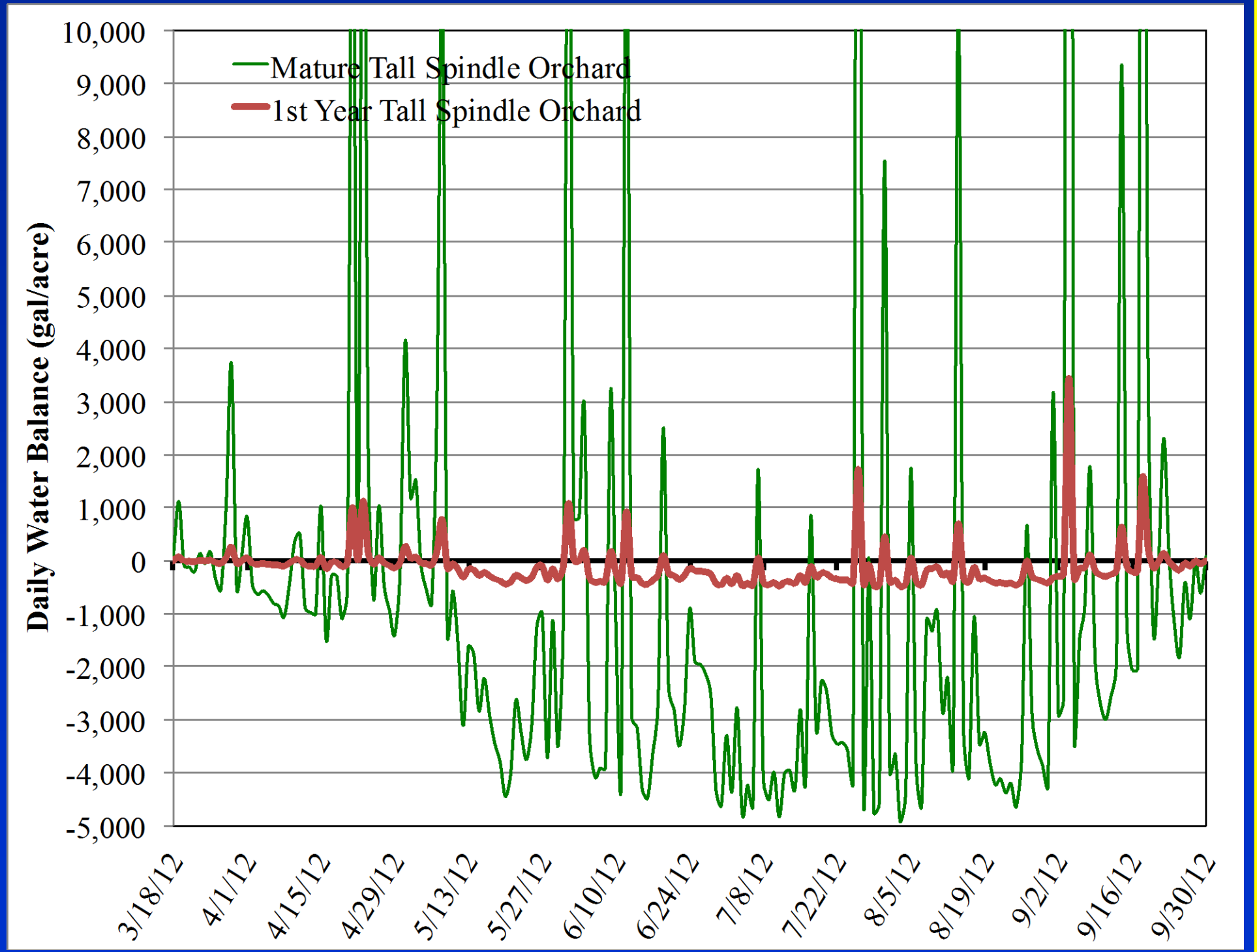
2012 Tree ET Data for Western New York State



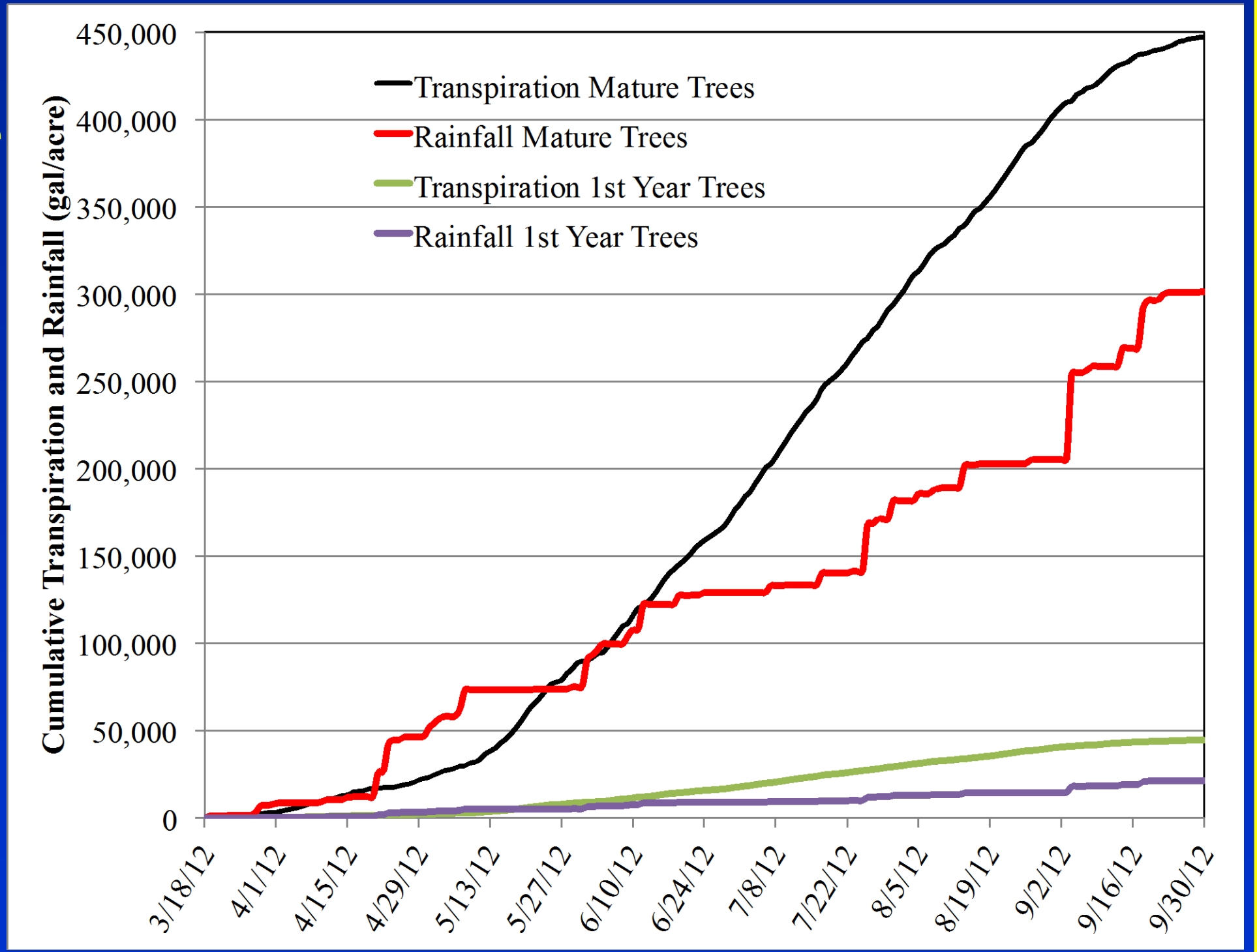
2012 Rainfall Data for Western New York State



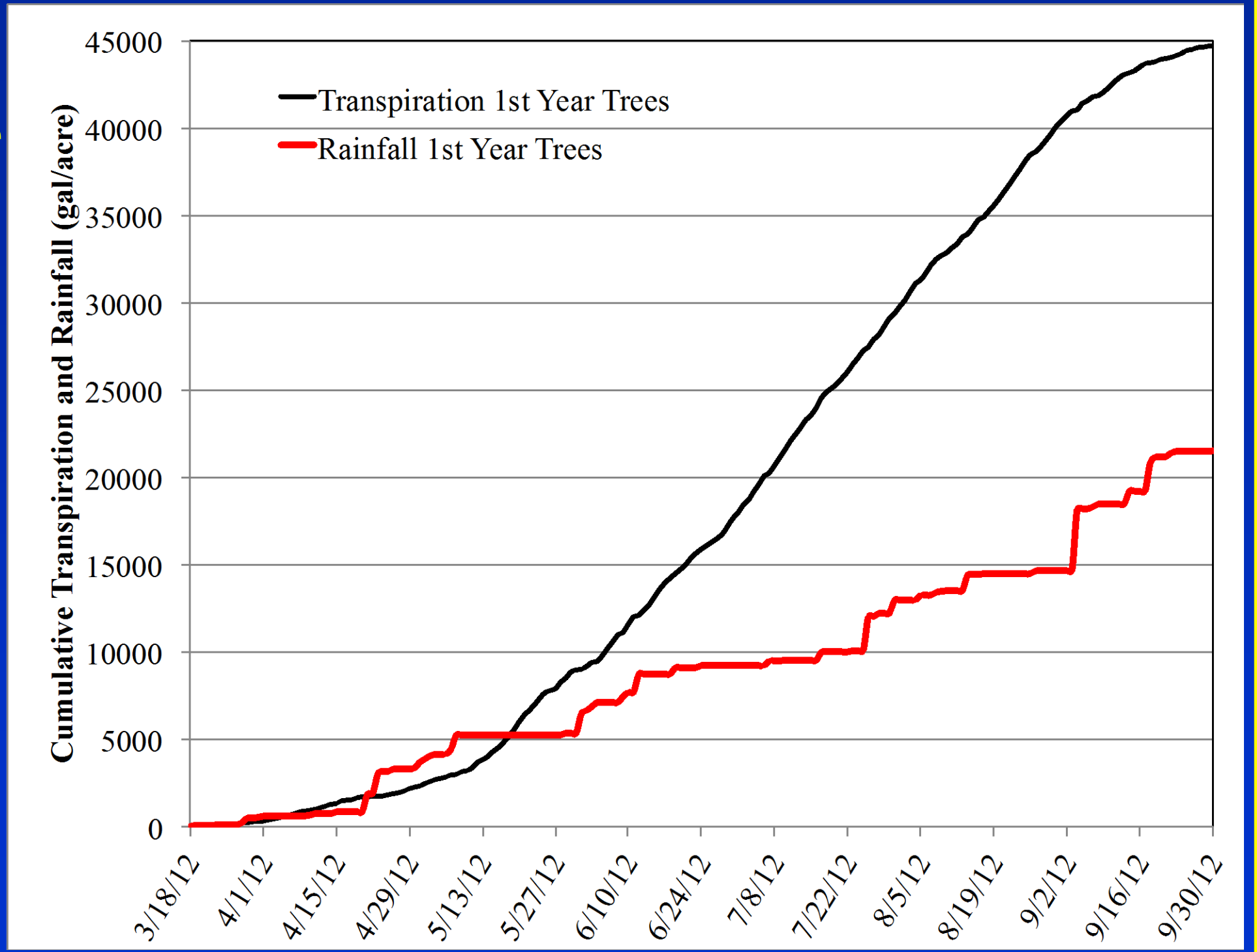
2012 Water Balance Data for Western New York State



2012 Cumulative Water Balance Data for Western New York State



2012 Cumulative Water Balance Data for Young Trees in Western New York State



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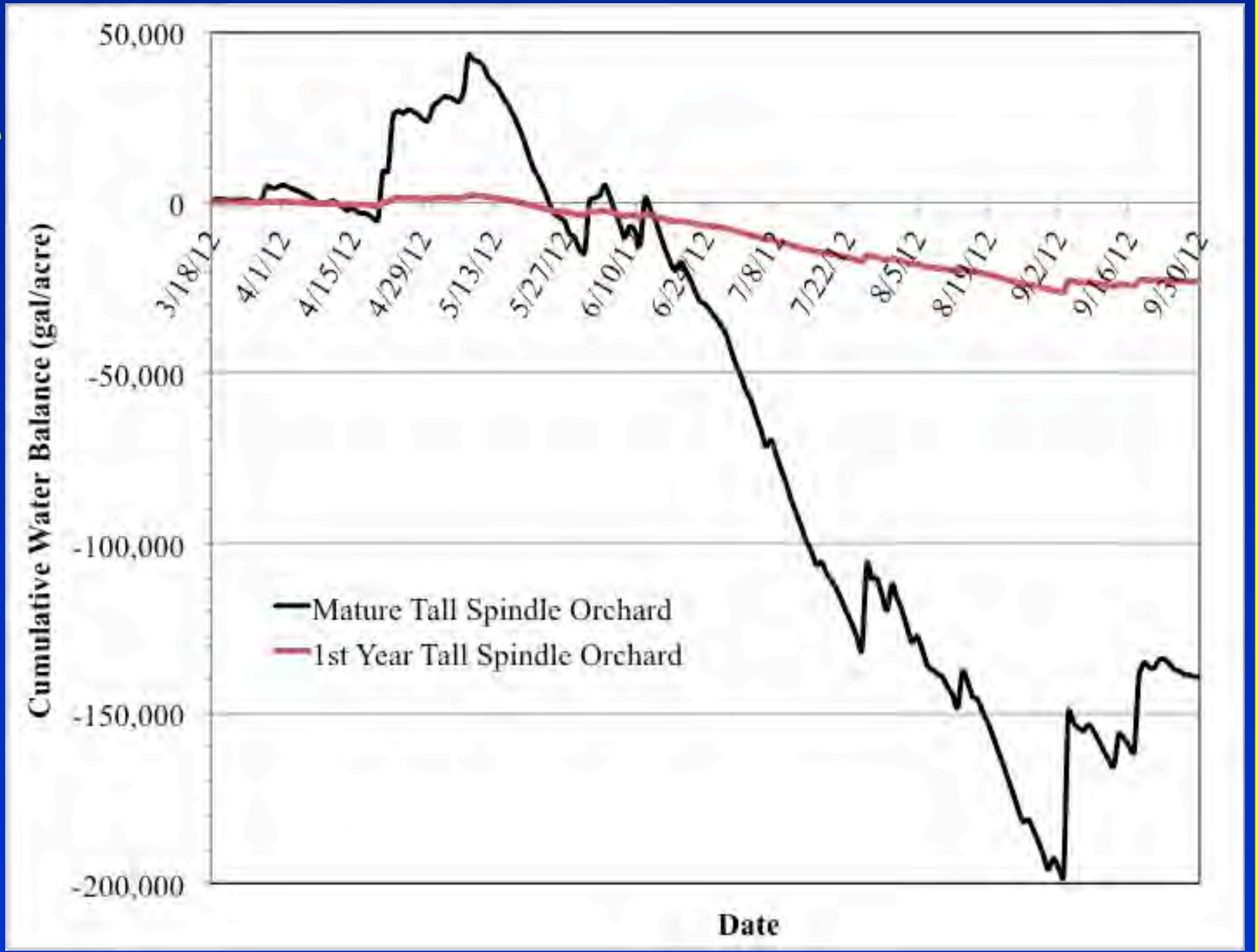


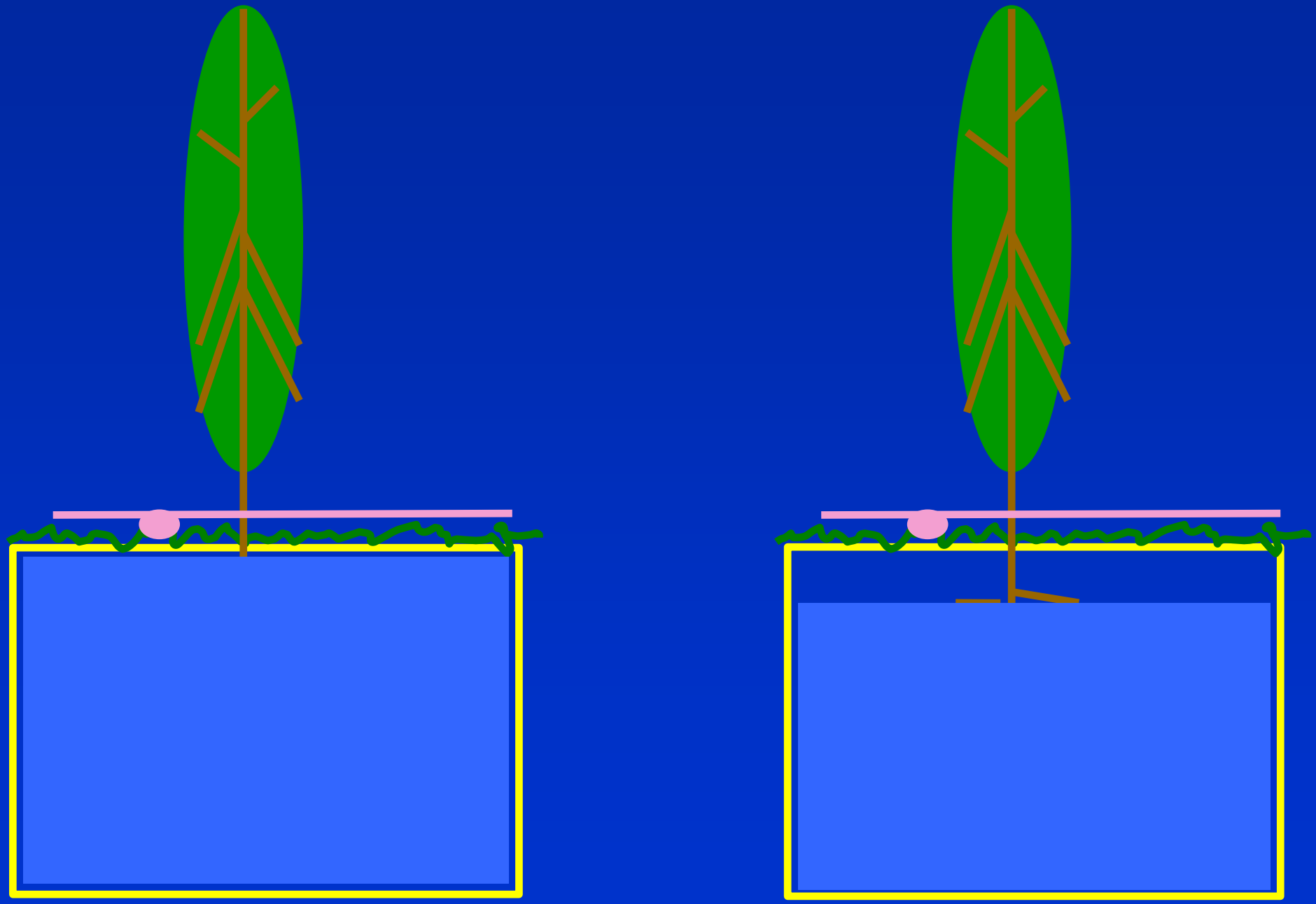
Precision Irrigation

1. Even if growers properly control fruit crop load through precision thinning, drought can cause a reduction in fruit size and reduce crop value.
2. Irrigation quantity and frequency in NY is done by “experience”.
3. Irrigation quantity and frequency can be done more precisely using the Cornell irrigation model for apple orchards.

Practical Application of Precision Irrigation

1. Twice weekly calculate ET for orchard using the Cornell ET model
2. Apply proper amount of irrigation on a twice weekly basis from Mid-May until Mid-June.
3. Apply proper amount of irrigation on a three times per week basis from Mid-June to end of August.

Using the Model: Keep the Tank 90% Full



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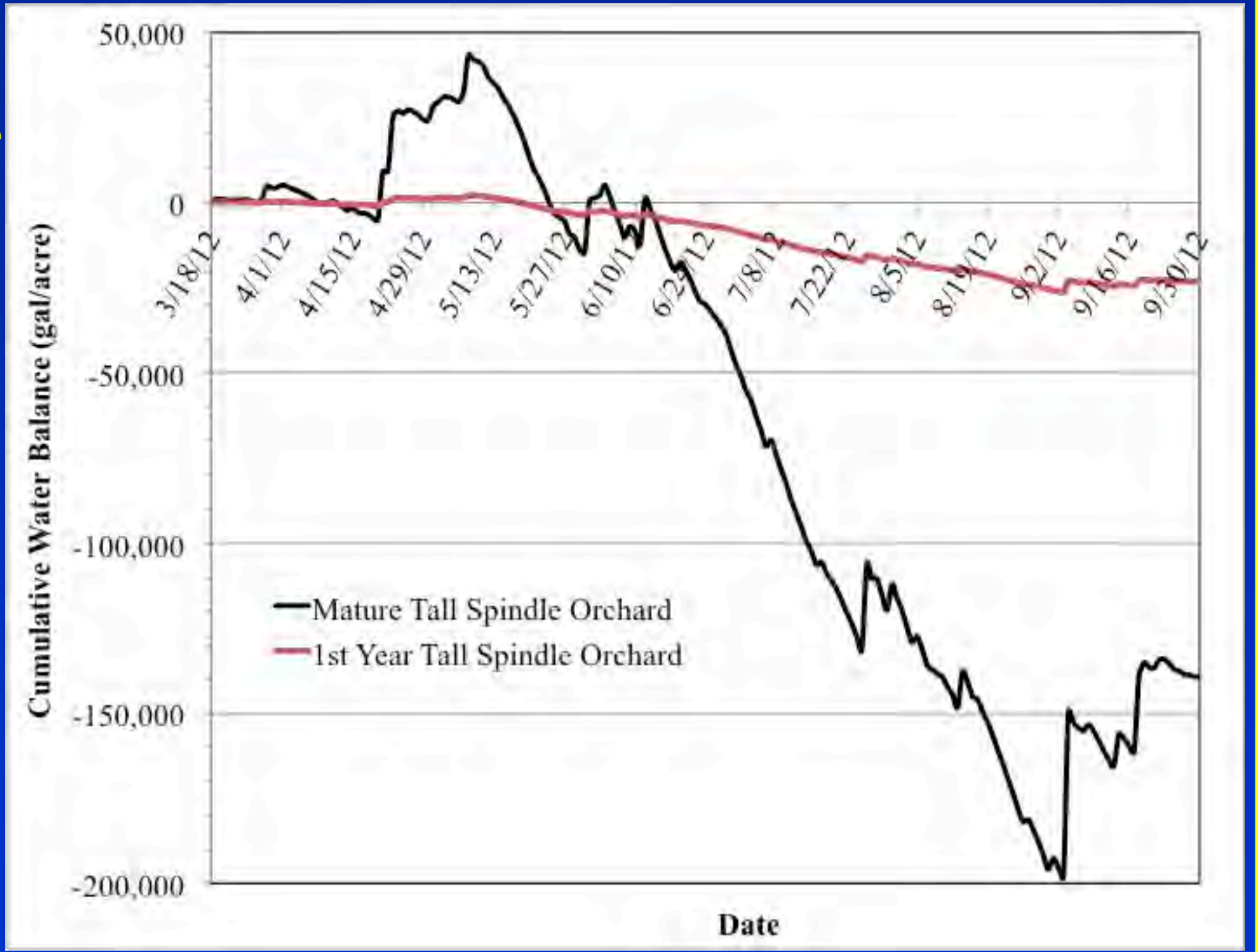

What you can take to the farmers?

- Newly planted apple trees can undergo water stress soon after growth starts limiting first year growth.
- Trickle irrigation has its largest impact in the first few years and so should be installed early in the first year.
- In dry years, the application of water should begin in mid-May. In other years, the application of water can be delayed until early June.
- Using the ET model to precisely apply the proper amount of water will help ensure that proper fruit size is achieved each year.