Experiments on Late Season RDI-
Early Irrigation Termination Trials

- Site 1 (2014 & 2015). Drip irrigated, 10-year-old Skeena/Gi6 (10 ft. x 17 ft., 256 trees per acre) Commercial site, Dufur, OR

<u>Irrigation treatments</u>

1. Control

2. 5 dbh cutoff

3. 10 dbh cutoff

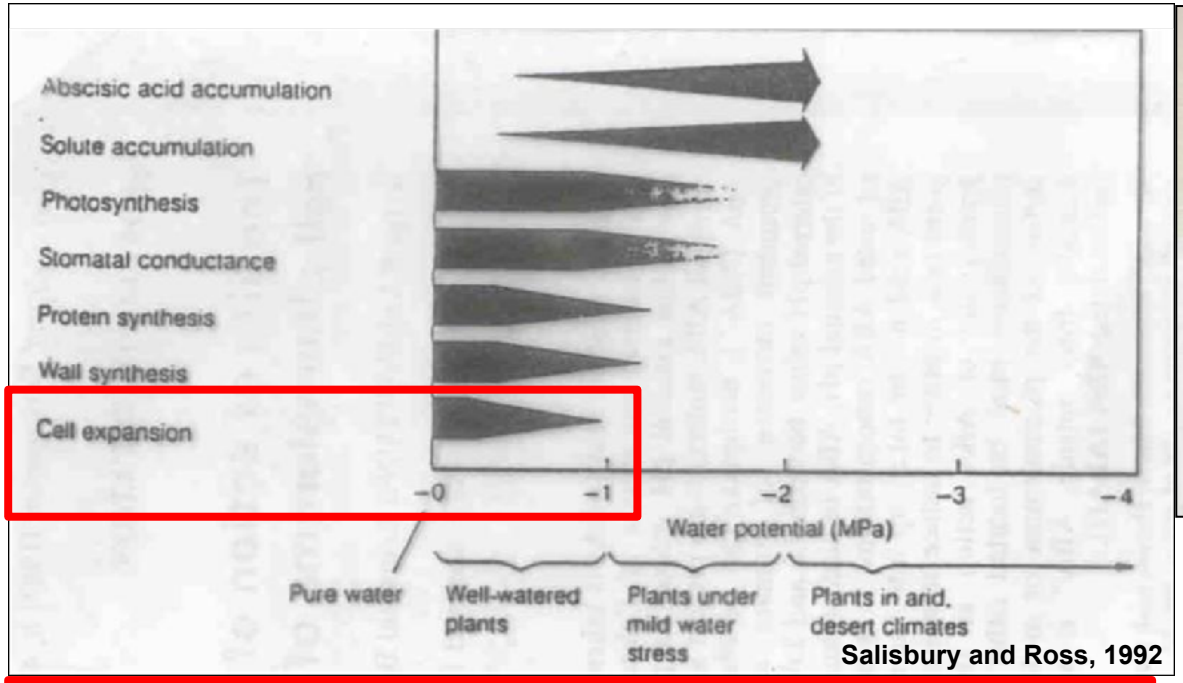
4. 15 dbh cutoff

<u>Experimental design</u>

RCBD; Four, 4-tree reps

Plant Water Potential

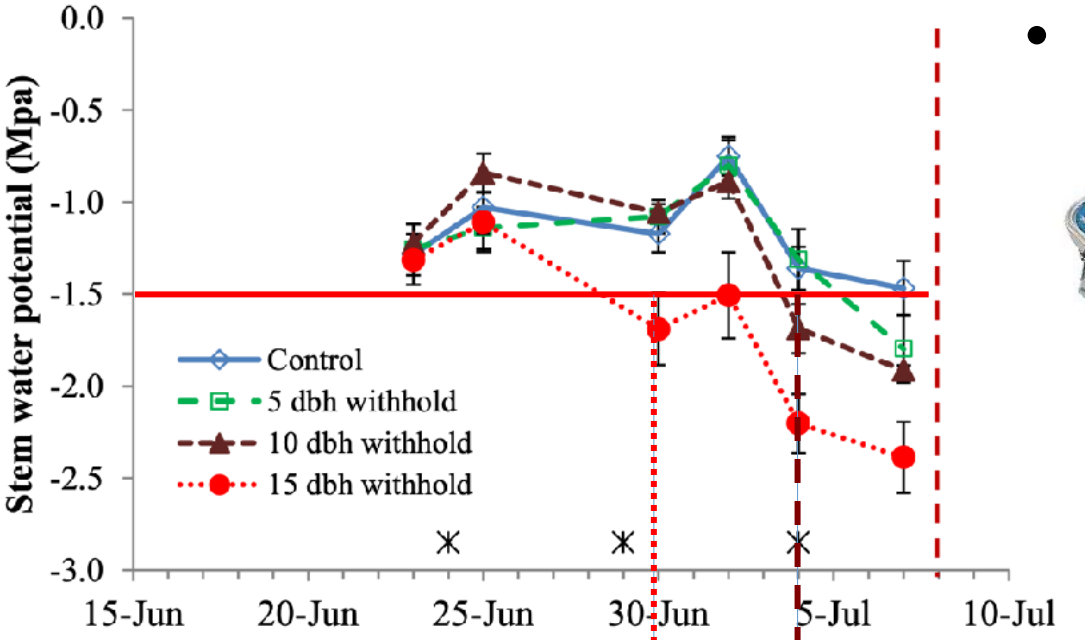
- A direct measure of plant water status
- Water potential determines the direction of water flow within plants
- Water potential measurement is simple but manual
- Based on the plant process (for example, fruit or shoot growth) one determines a threshold value not be exceeded

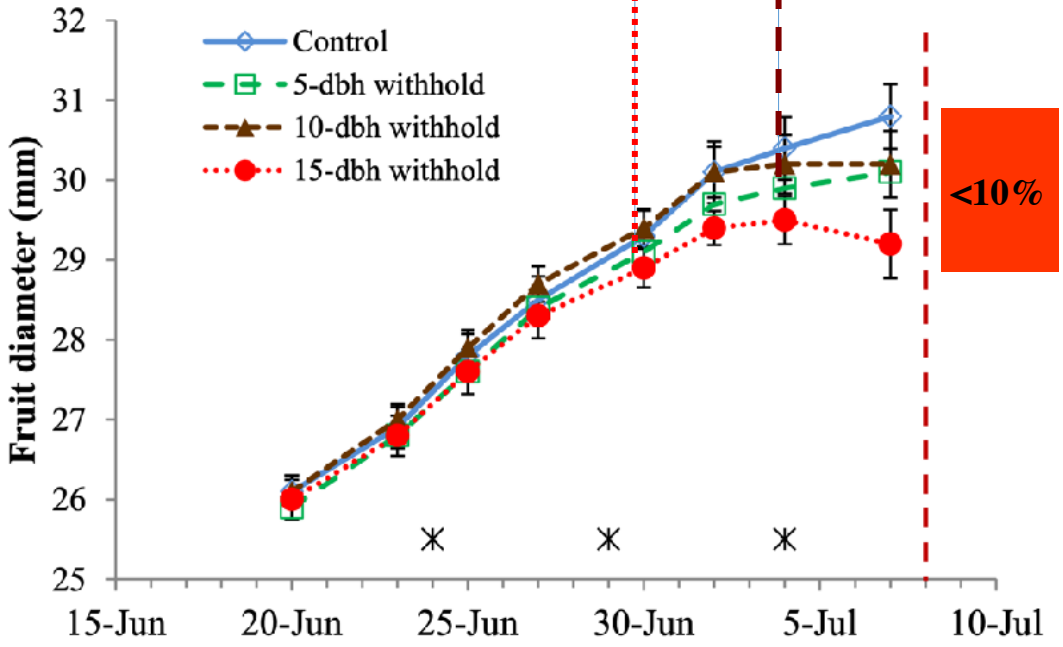


Salisbury and Ross, 1992

Cell growth is very sensitive to water stress

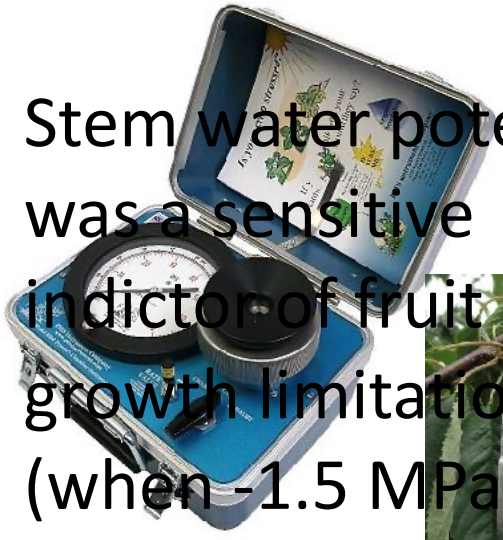
2014 ‘Skeena’ Water Relations



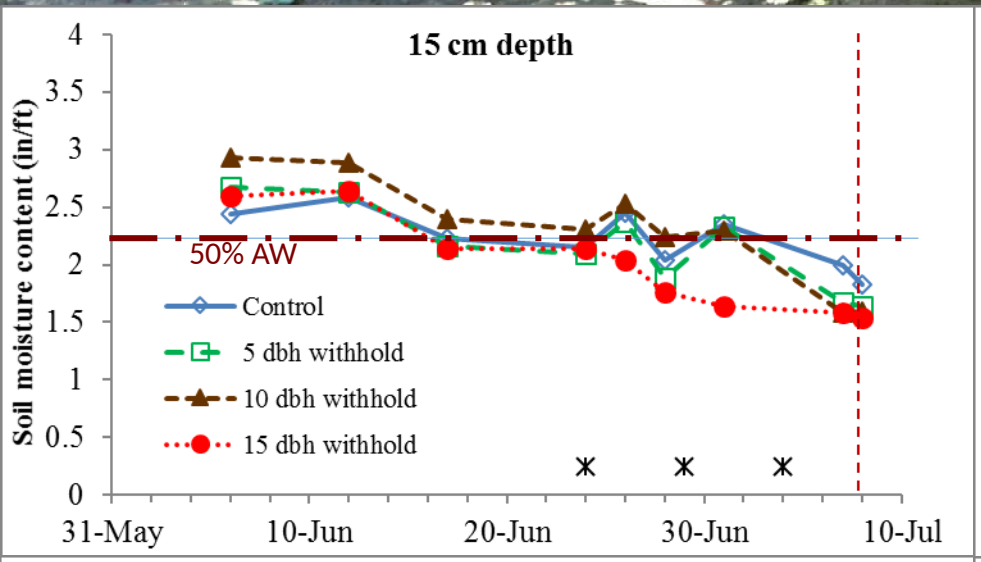


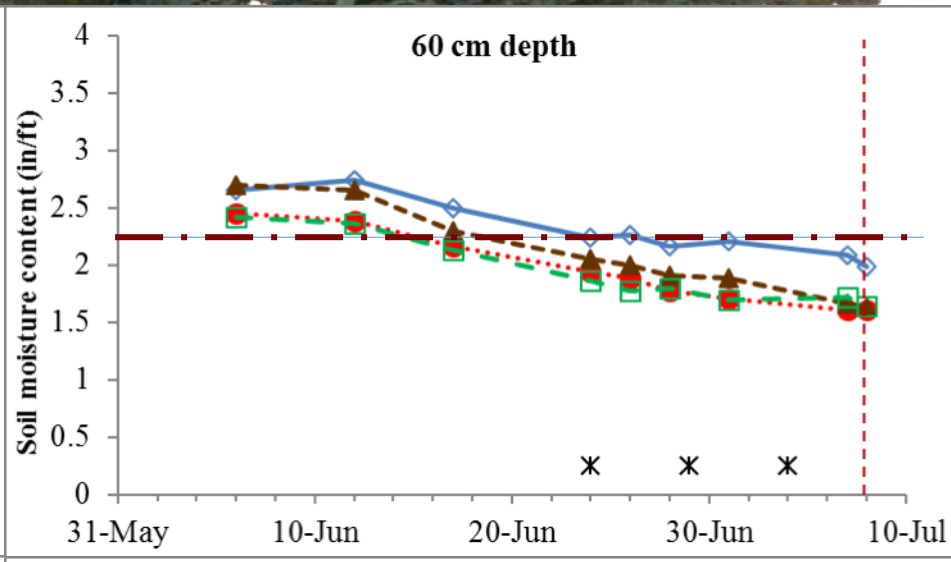
<10%

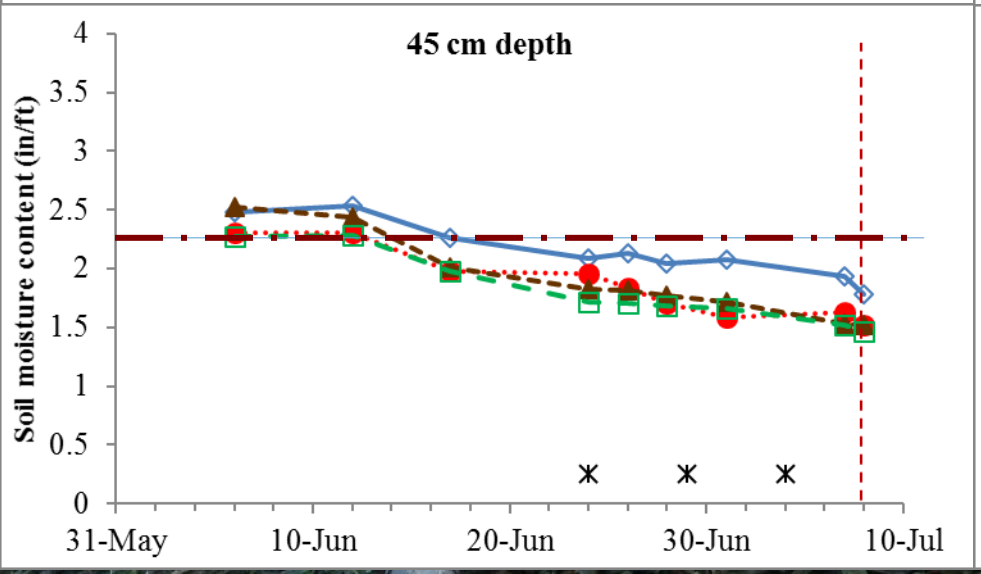
- Stem water potential was a sensitive indictor of fruit growth limitation (when -1.5 MPa was reached ~1 week from harvest)

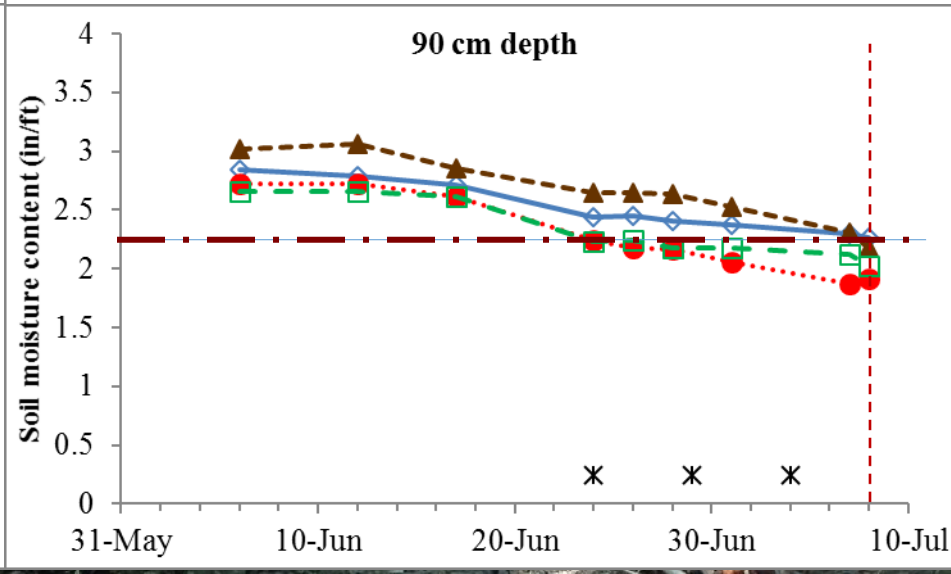


Skeena- 2014 Soil moisture





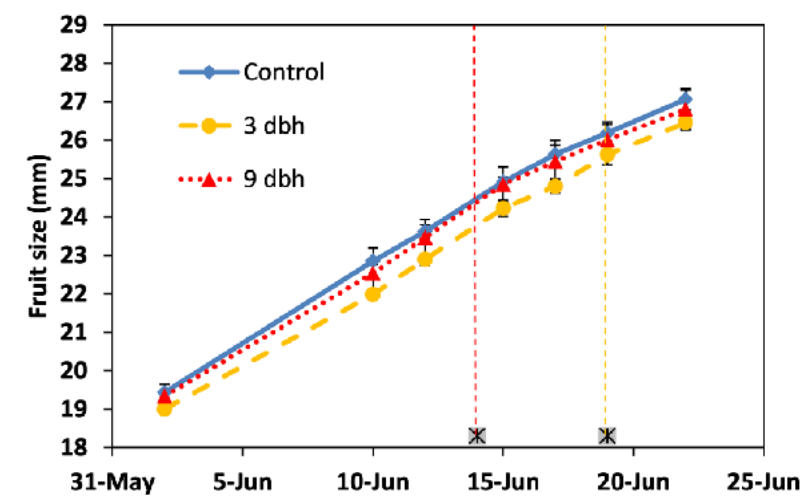




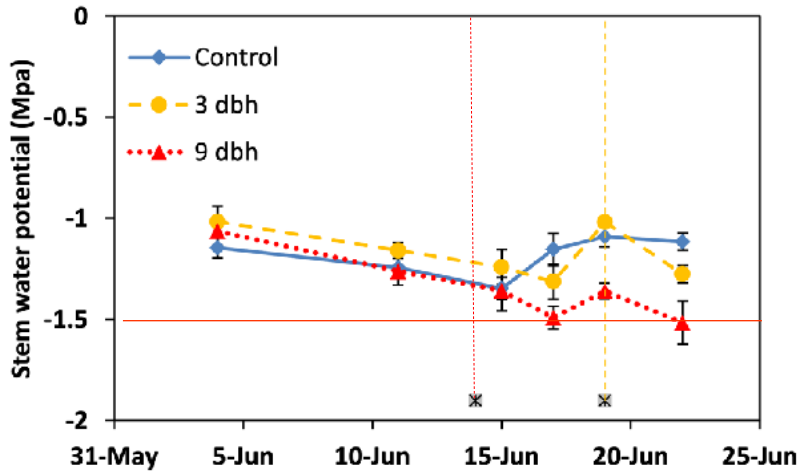
2014 –’Skeena’ Yield and Fruit Quality

Treatment	Tree yield (Kg)	Fruit wt. (g)	FF (+21dPH) (g/mm)
Control	35.1	12.2 a	403 a
5 dbh	36.6	11.7 a	385 ab
10 dbh	37.9	11.5 ab	379 ab
15 dbh	32.7	10.8 b	363 b

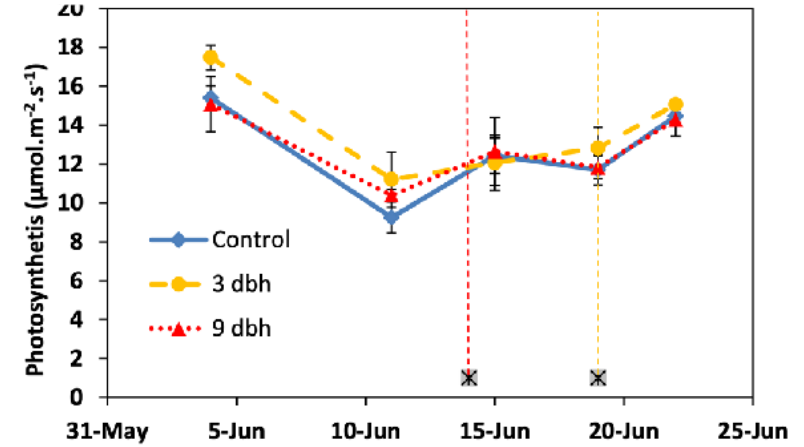
2015 ‘Skeena’ Trial



- Fruit growth not affected by water withholding up to 9 dbh

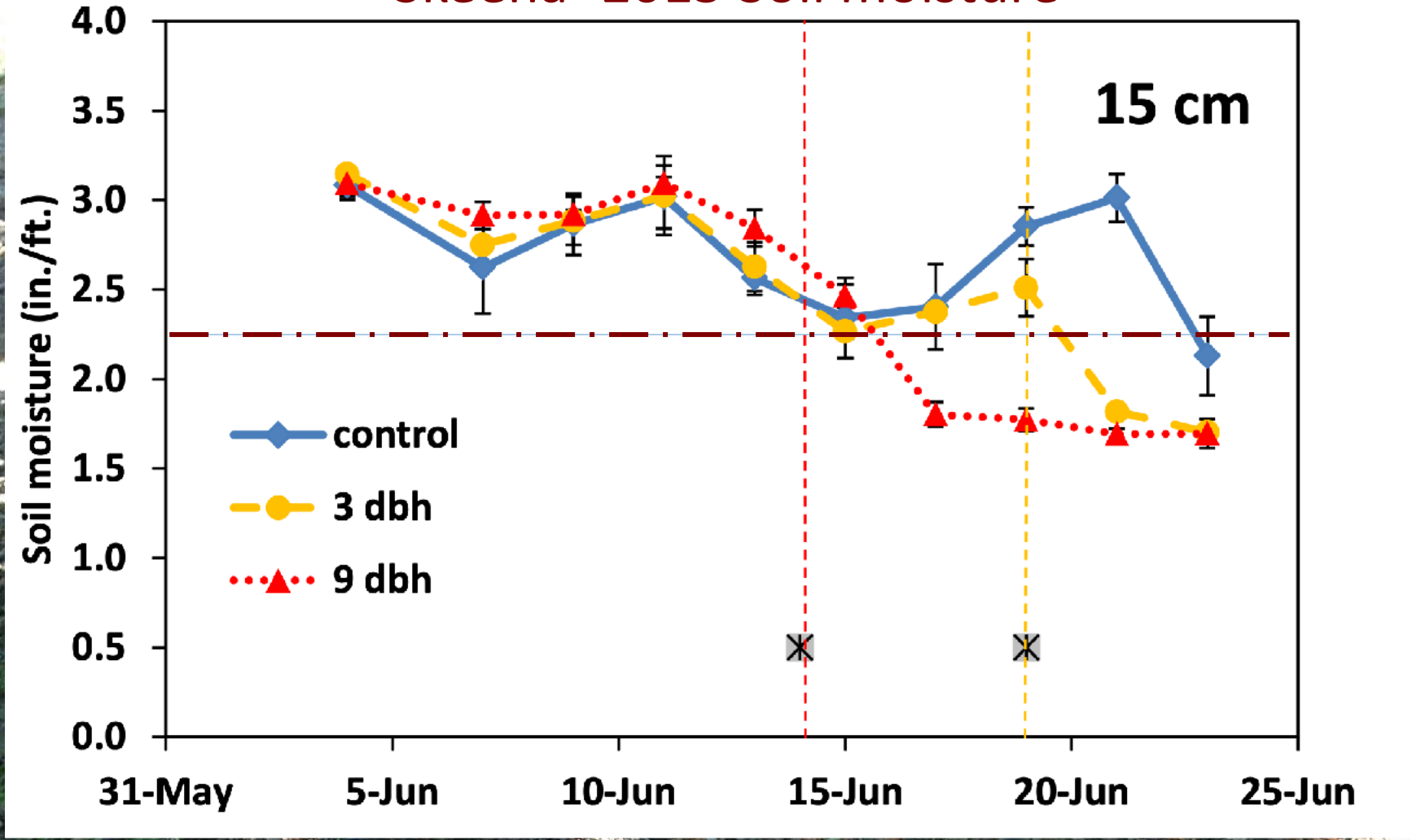


- Stem water potential above critical level of -1.5 MPa

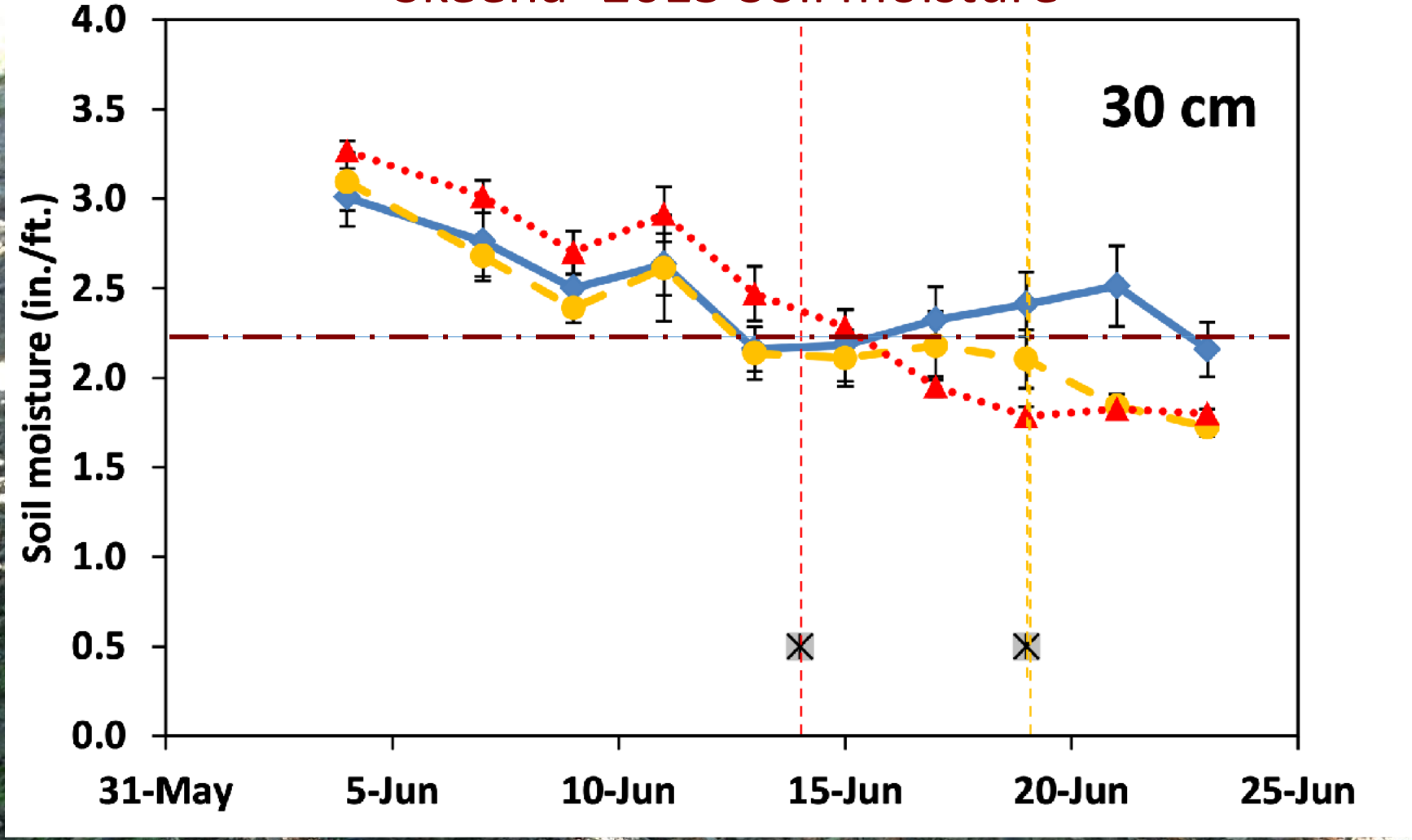


- Pn was not reduced at lower water potential values of 9 dbh treatment

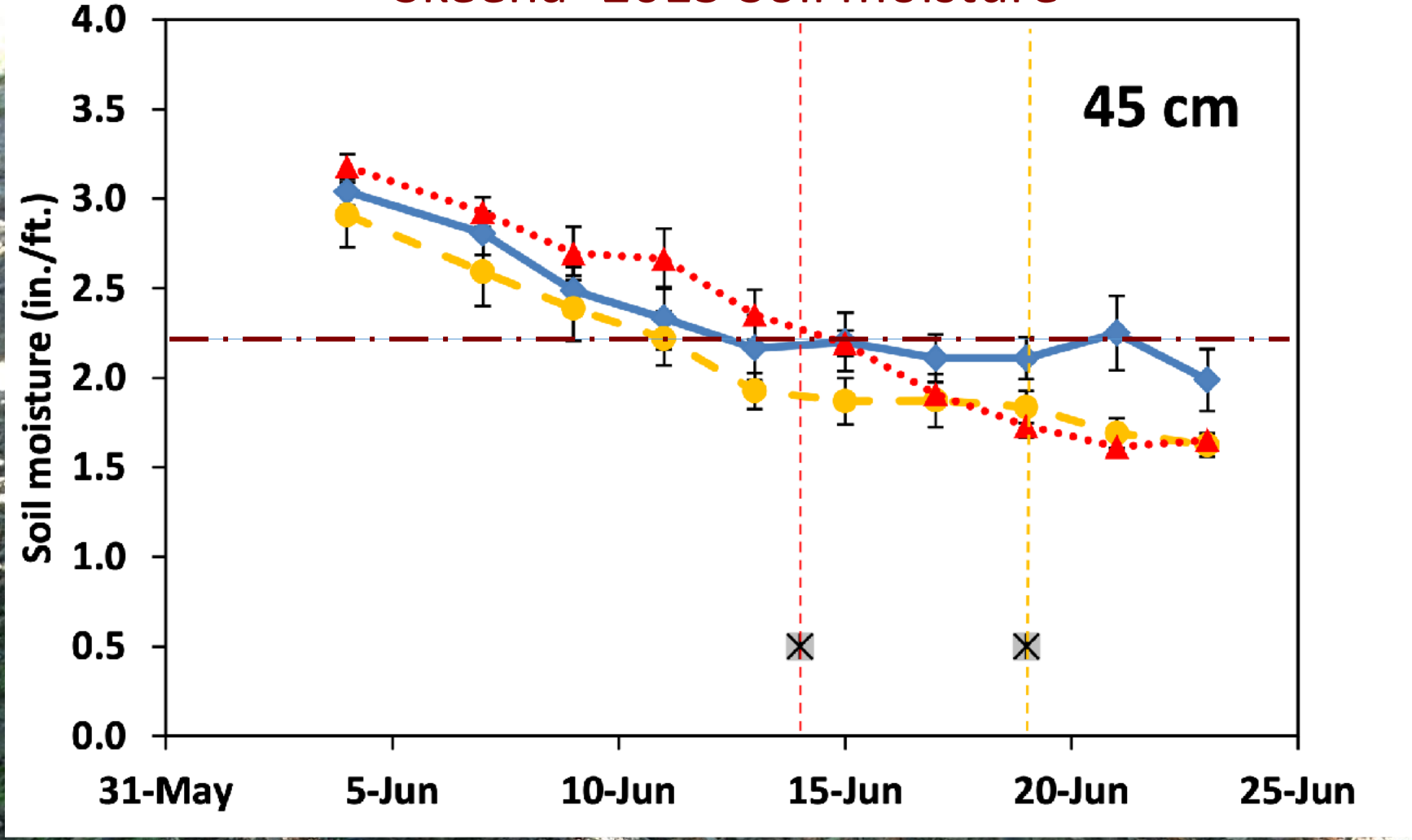
Skeena- 2015 Soil moisture



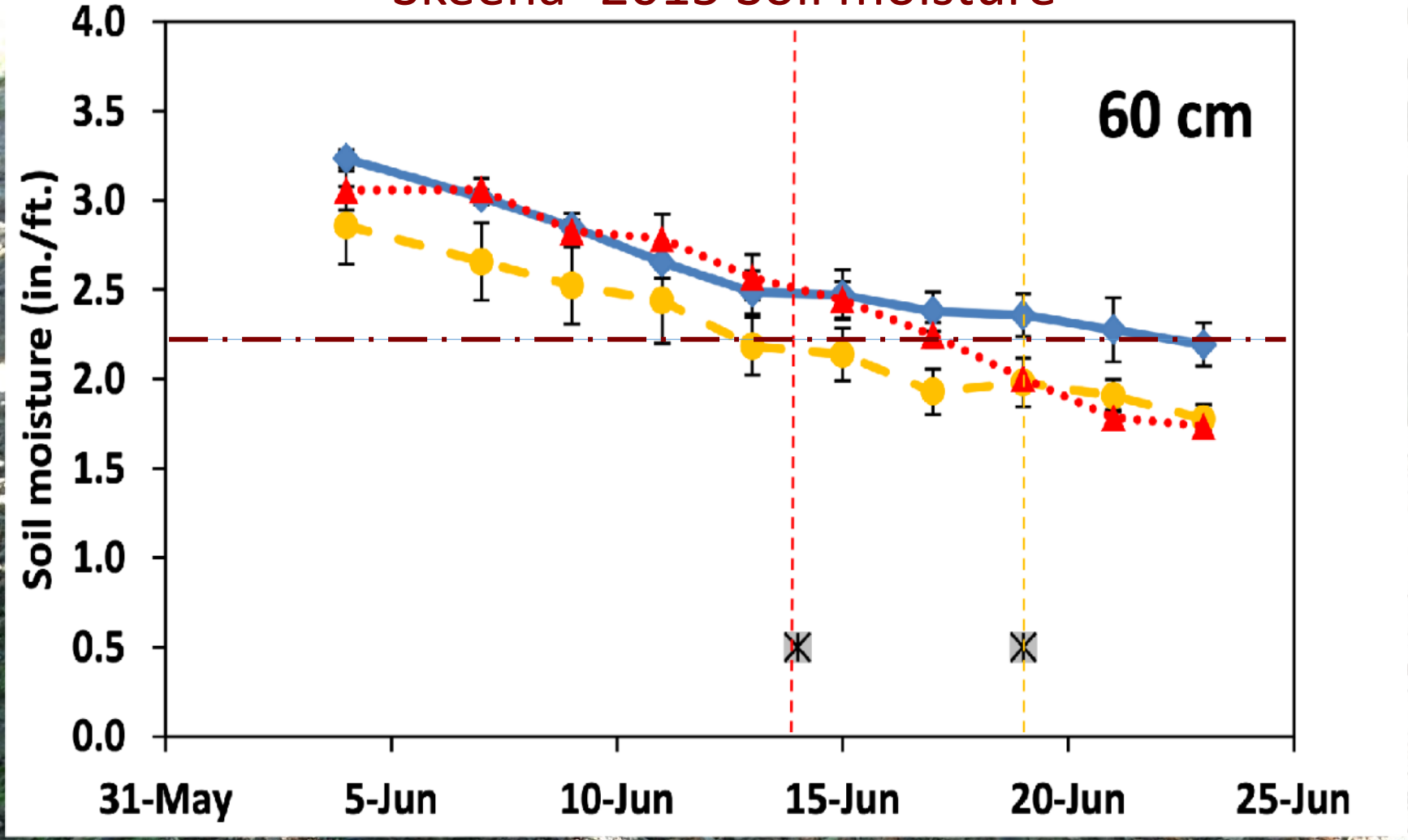
Skeena- 2015 Soil moisture



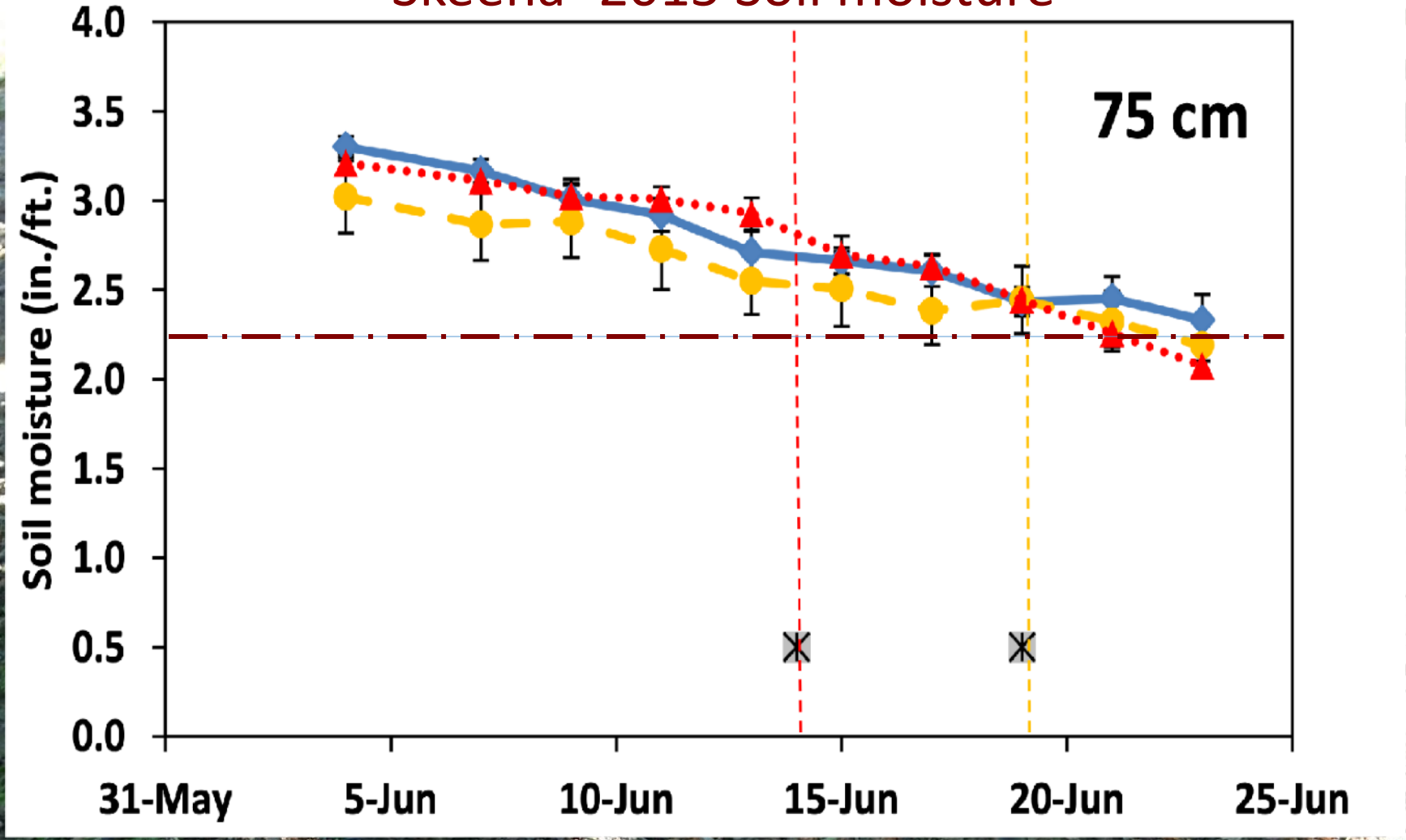
Skeena- 2015 Soil moisture



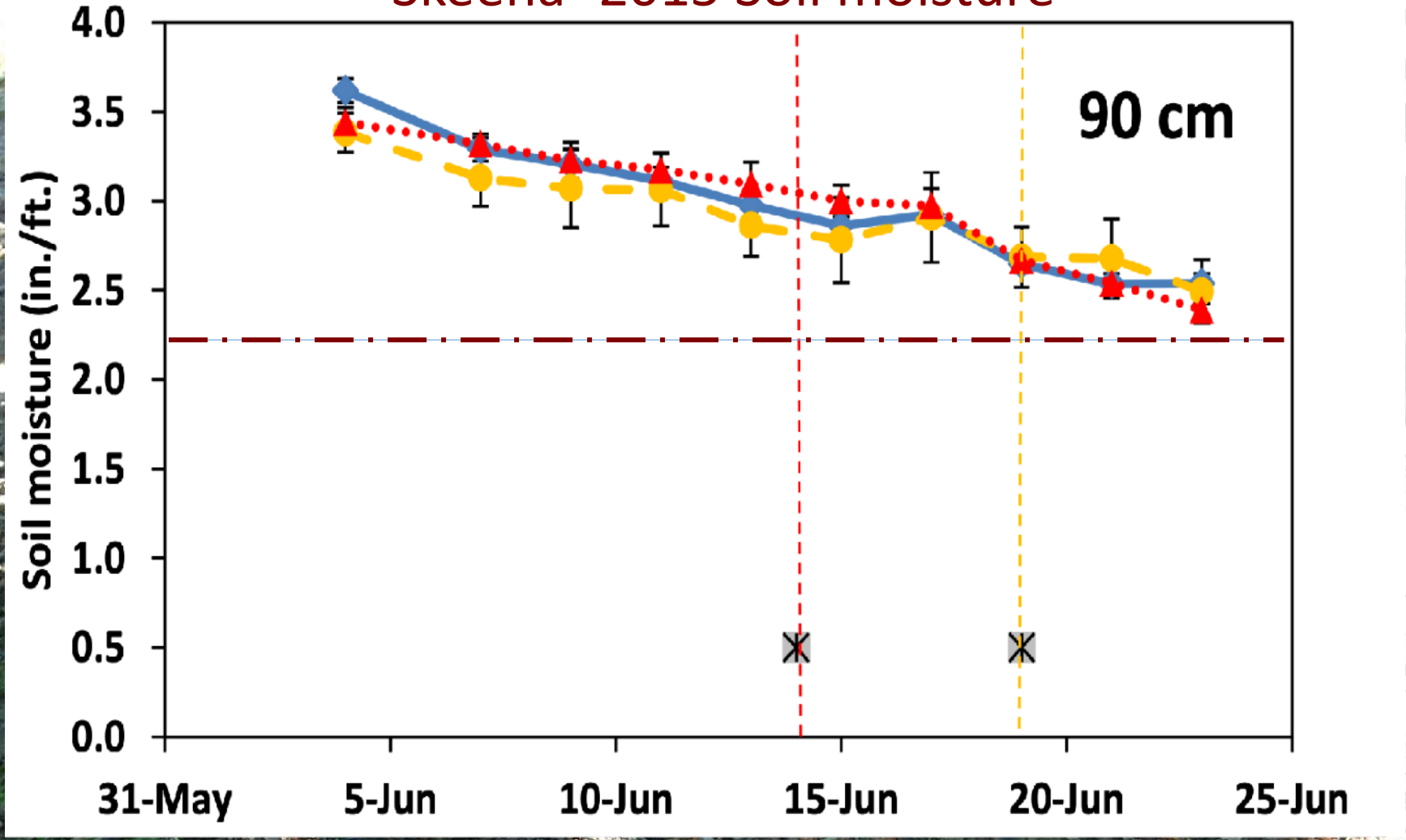
Skeena- 2015 Soil moisture



Skeena- 2015 Soil moisture



Skeena- 2015 Soil moisture



- Markedly higher water content at 75- 90 cm depth compared to 2014

2015 'Skeena' Production and Fruit Quality

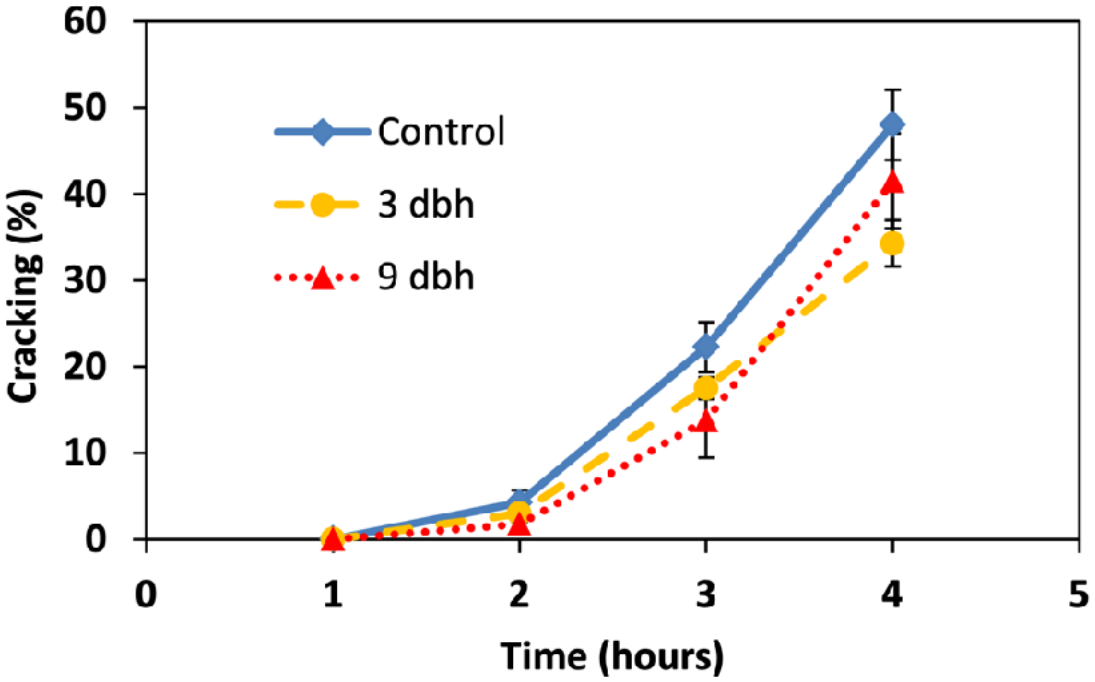
Treatment	Yield kg/tree	Fruit diameter mm	Fruit wt. g	FF g/mm	Skin color ctifl	PRF g	SSC %	TA %
Control	34.85	28.35	10.01	339.6	5.7	276 b	18.6	0.88
3-dbh	38.06	27.75	9.45	340.4	5.5	422 a	18.1	0.91
9-dbh	34.76	28.25	9.94	343.4	5.5	356 ab	18.7	0.91
Pr>F	*0.659*	*0.469*	*0.496*	*0.834*	*0.083*	*0.016*	*0.533*	*0.241*

Yield (n=2); fruit diameter and weight (n=400);
fruit firmness (FF) (n=400); skin color (n=100); pedicel retention force (PRF) (n=25);
titratable acidity (TA) and soluble solids content (SSC) (n=2).

Significant Finding

Withholding irrigation water for up to 10 dbh in 2014 and 9 days dbh in 2015 ***did not significantly alter*** *yield, fruit size or quality, yet significant water savings were achieved*

Effect of irrig. treatments on ‘Skeena’ cracking



Cherries from 3 and 9 dbh withholding treatments had similar cracking susceptibility to Controls

2015 Sweetheart Early Termination Trial

- Site 2 (2015). Drip irrigated, 10-year-old Sweetheart/Mazzard (10 ft. x 17 ft., 256 trees per acre), Dufur

Irrigation treatments

1. Control

2. 5 dbh cutoff

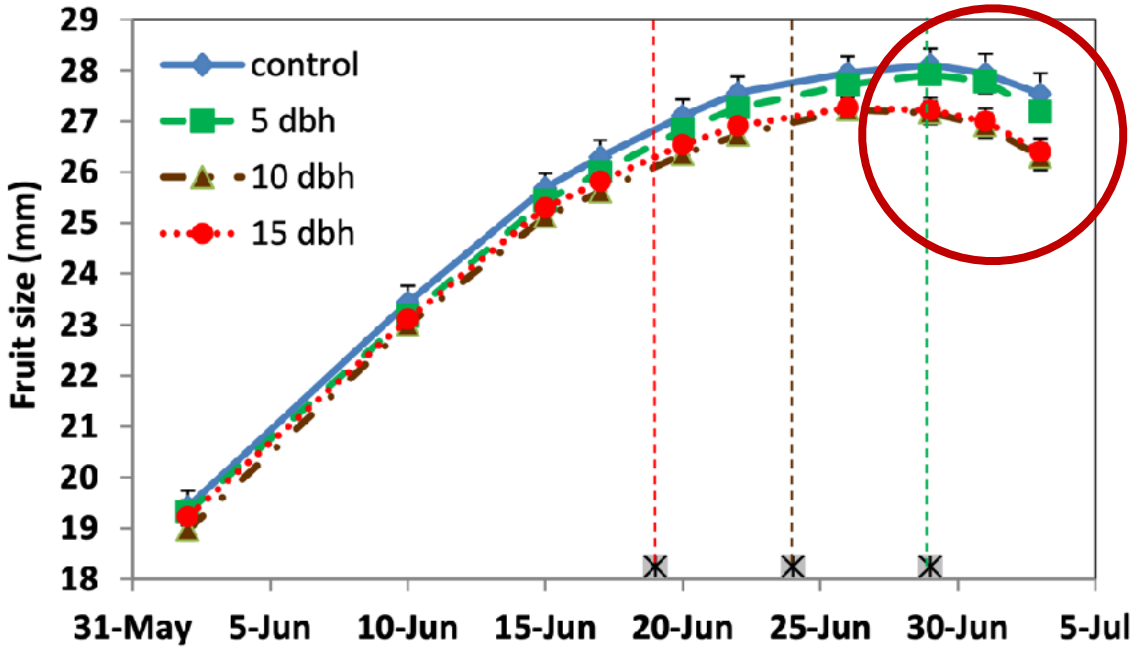
3. 10 dbh cutoff

4. 15 dbh cutoff

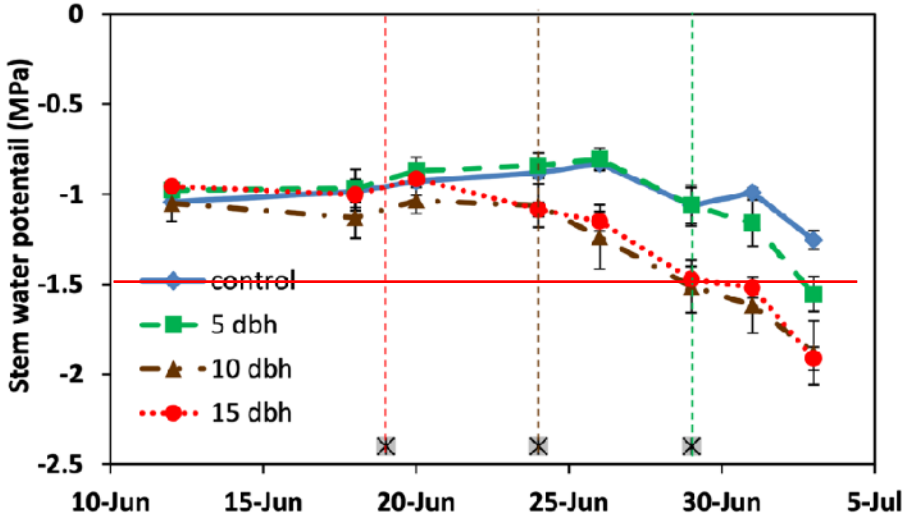
Experimental design

RCBD; Four, 4-tree reps

‘Sweetheart’ 2015 Fruit Growth and Water potent.

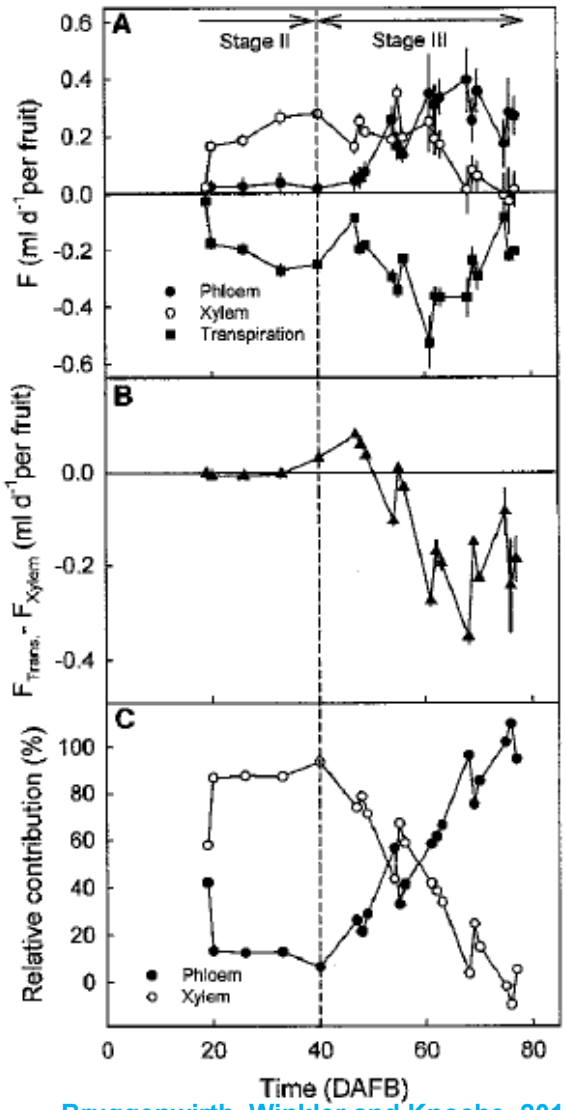


Fruit growth was similarly reduced in the 10 and 15 dbh treatments



Stem water potential indicated stress development in both trts ~ 1 week from harvest

Water delivery to Sweet Cherry Fruit

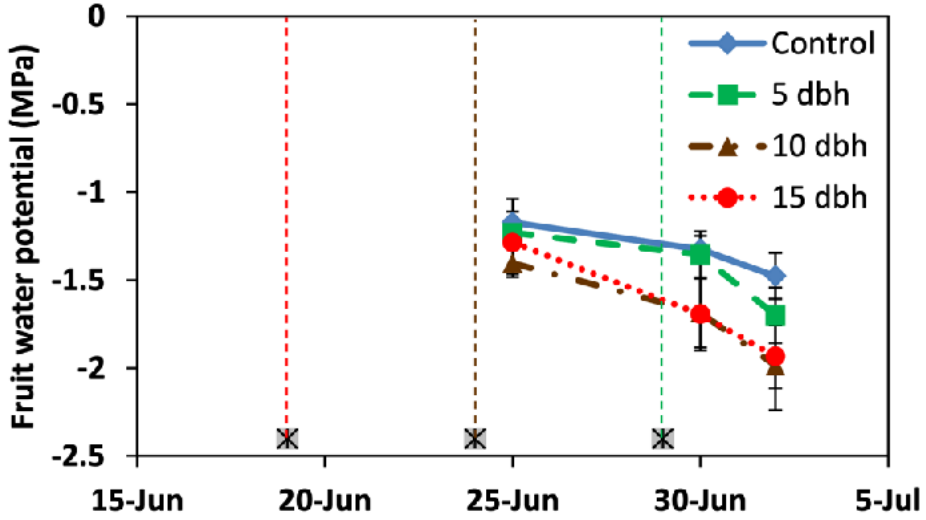


Bruggenwirth, Winkler and Knoche, 2016

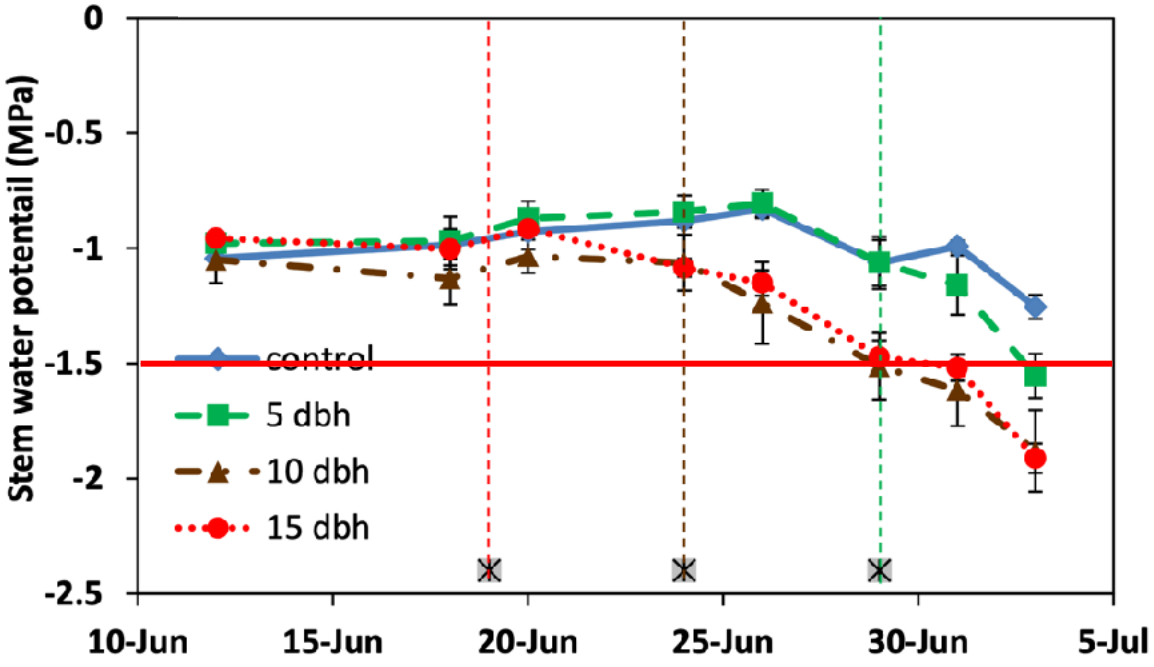
Fig. 4 Time course of flows (F) in developing sweet cherry fruit. **a** Xylem, phloem and transpirations flows. **b** Difference between transpiration flows ($F_{Trans.}$) and xylem flows (F_{Xylem}). Horizontal line indicates the absence of net flow. **c** Relative contributions of xylem flow and phloem flow. The sum of the xylem flow and the phloem flow represents 100 % of the inflow to the fruit. *X* axis scale in days after full bloom (DAFB). Xylem, phloem, and transpiration flows were calculated from flows determined for steam-girdled, detached, or non-treated control fruit. Data represent mean ± SE of eight fruit. For details, see materials and methods

- The Xylem flow to fruit decreases steadily during development, approaching 0 at maturity
- Phloem increases to ~100% of the total sap flow into a mature fruit
- Thus, sweet cherry fruit ***becomes increasingly more isolated*** from the hydraulic system of the plant throughout the season
- At maturation, fruit water can be lost via fruit transpiration, a process that concentrates solutes and limits phloem unloading to the fruit

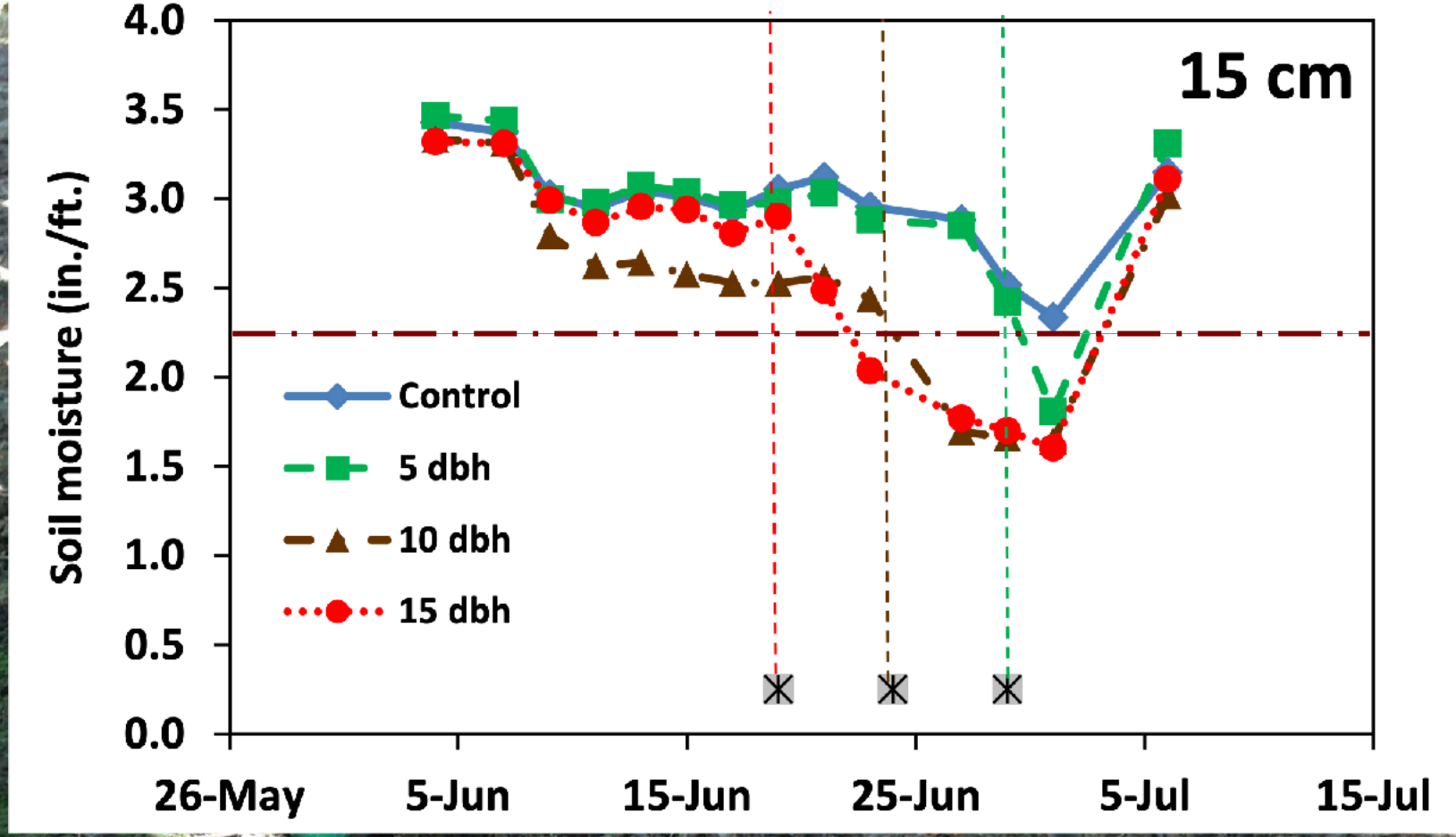
‘Sweetheart’ 2015 Fruit & Stem Water potential



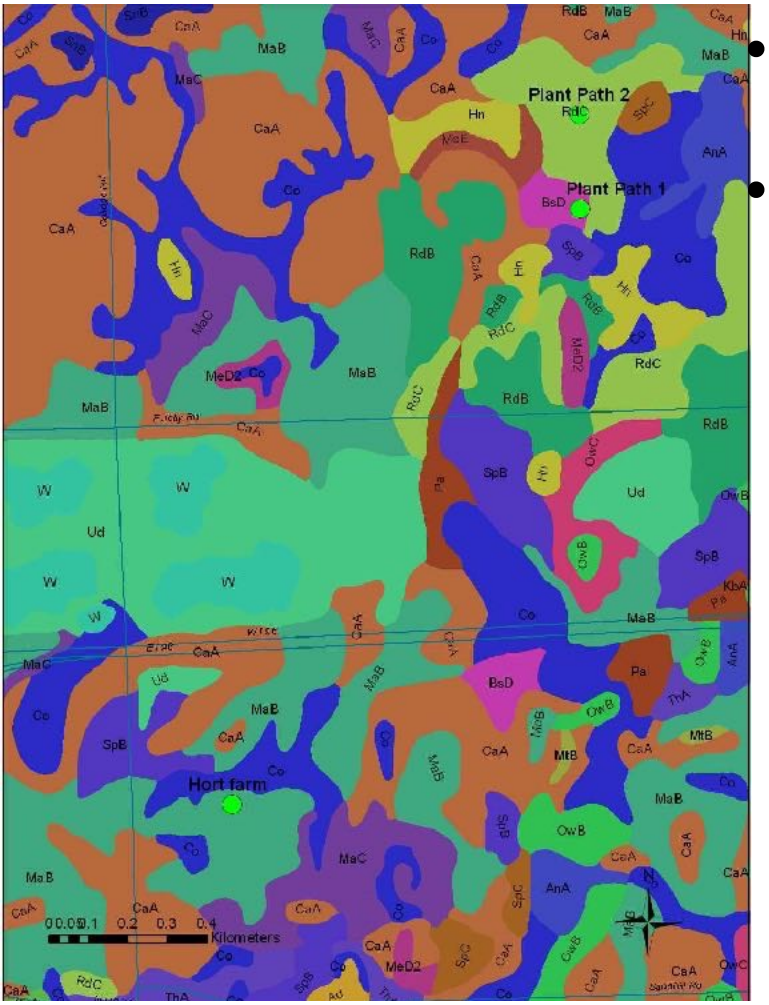
Fruit water potential similar to slightly lower than stem water potential



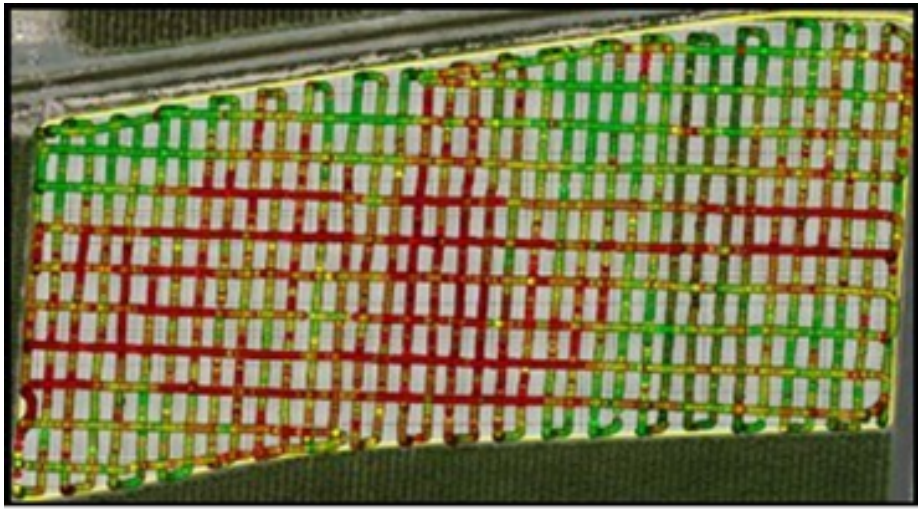
Sweetheart- 2015 Soil moisture



Heterogeneous soils?



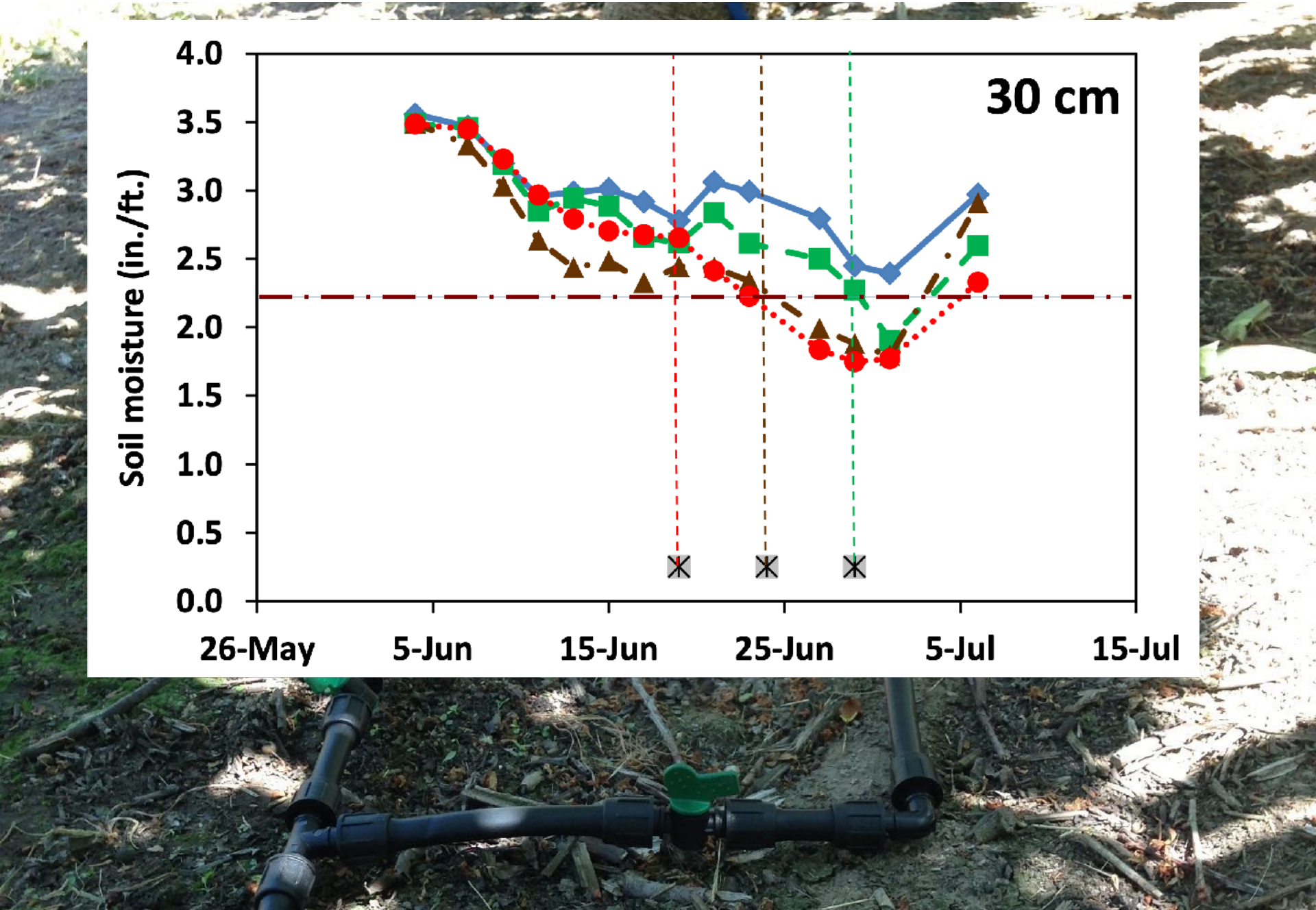
- Soils are extremely diverse. Each of the colored areas to the left (Polygons) is a different soil series
- Irrigation systems and scheduling must account for soil types and non uniformity; INCREASED PRECISION via variable rate technology is needed



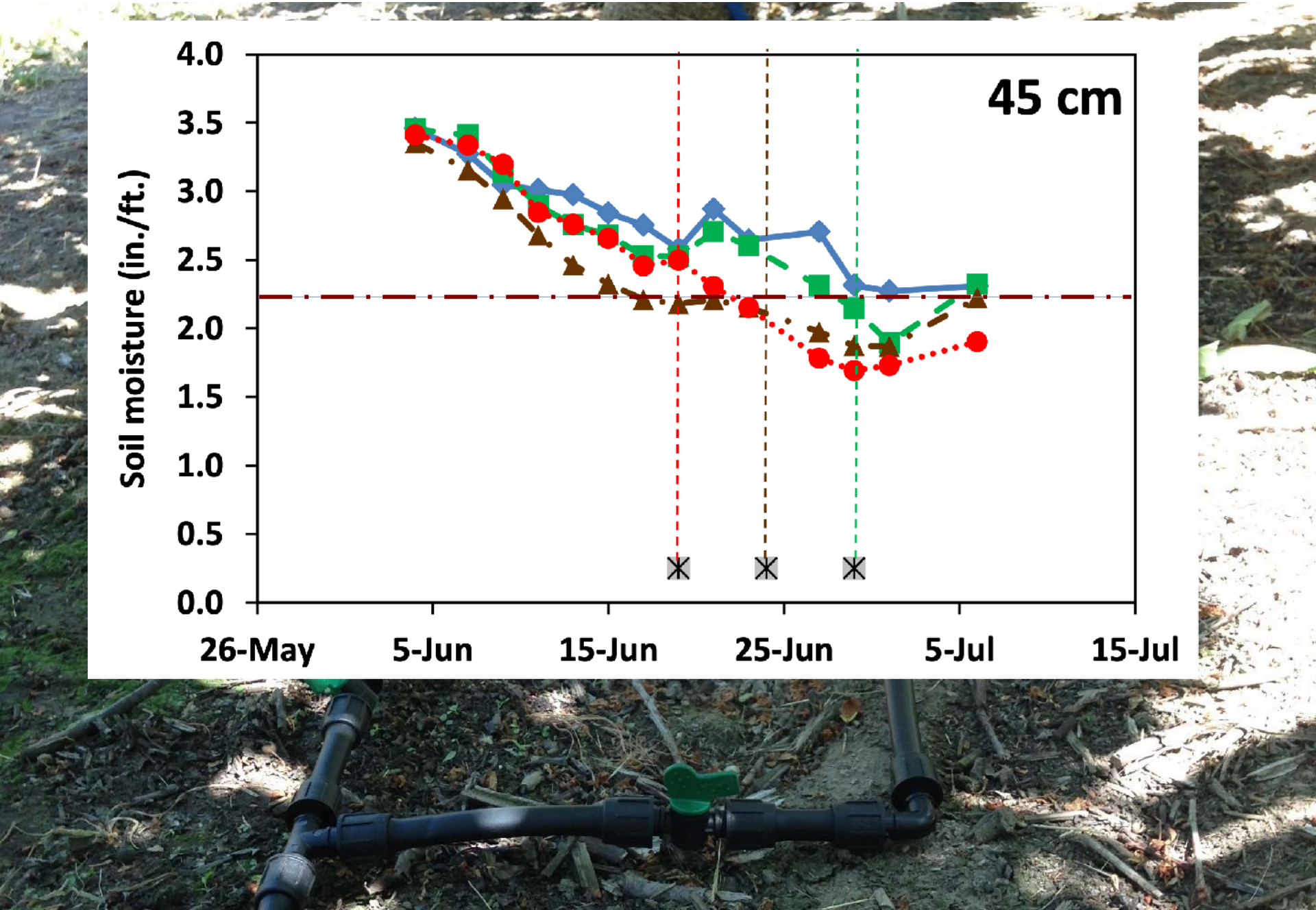
ECa preplanting soil map from EMI survey of Othello, WA orchard

Soil Mapping with Electromagnetic Induction (EMI). EMI sensors measure apparent electrical conductivity (ECa), which is strongly correlated with soil moisture and secondarily correlated with clay content, mineralogy, organic matter and salinity. By comparing measurements of fields when wet and dry, static (e.g. clay content) and dynamic (e.g. soil moisture) components of ECa can be separated statistically (text and photo to right, Dr. David Brown, WSU)

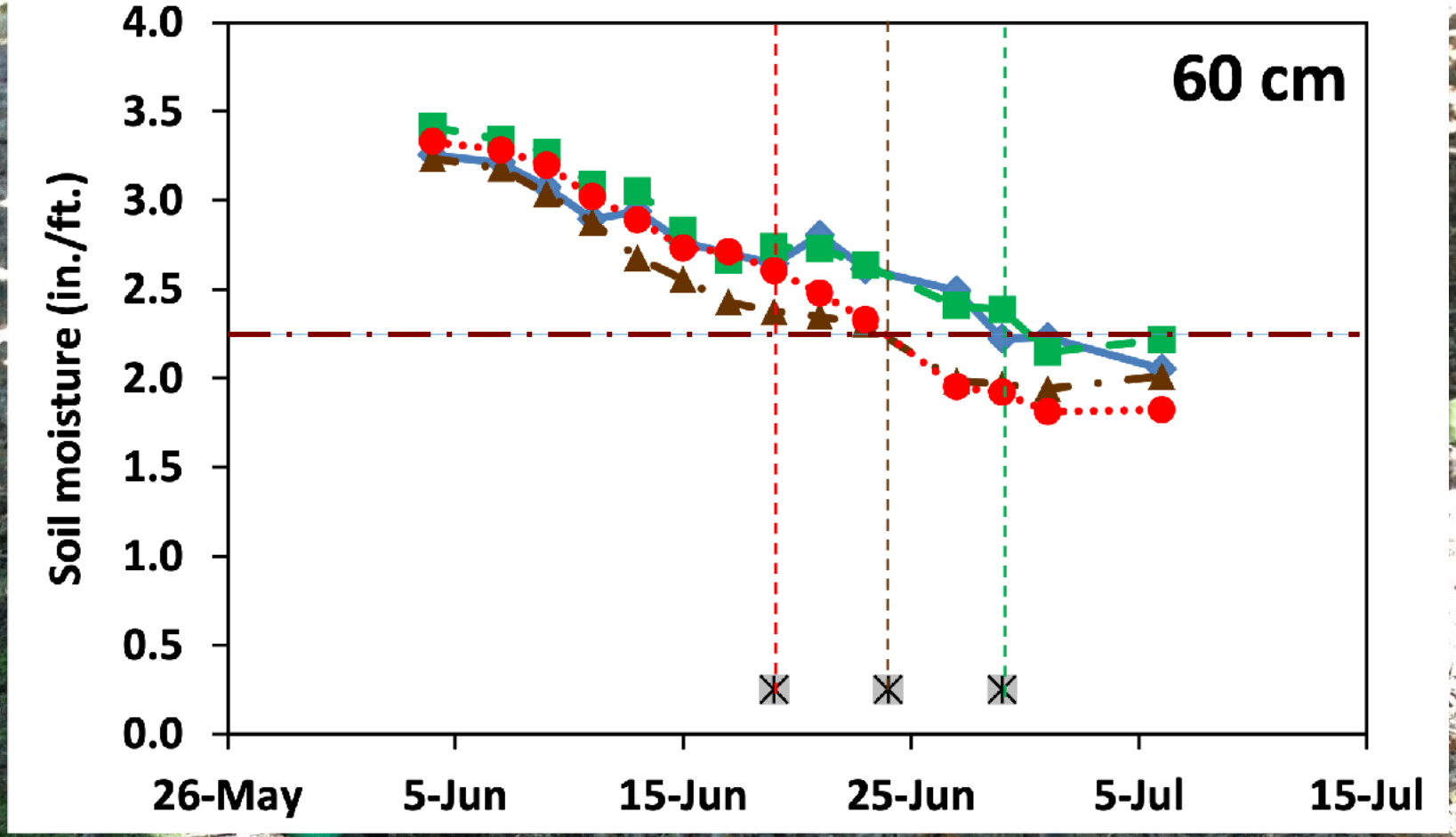
Sweetheart- 2015 Soil moisture



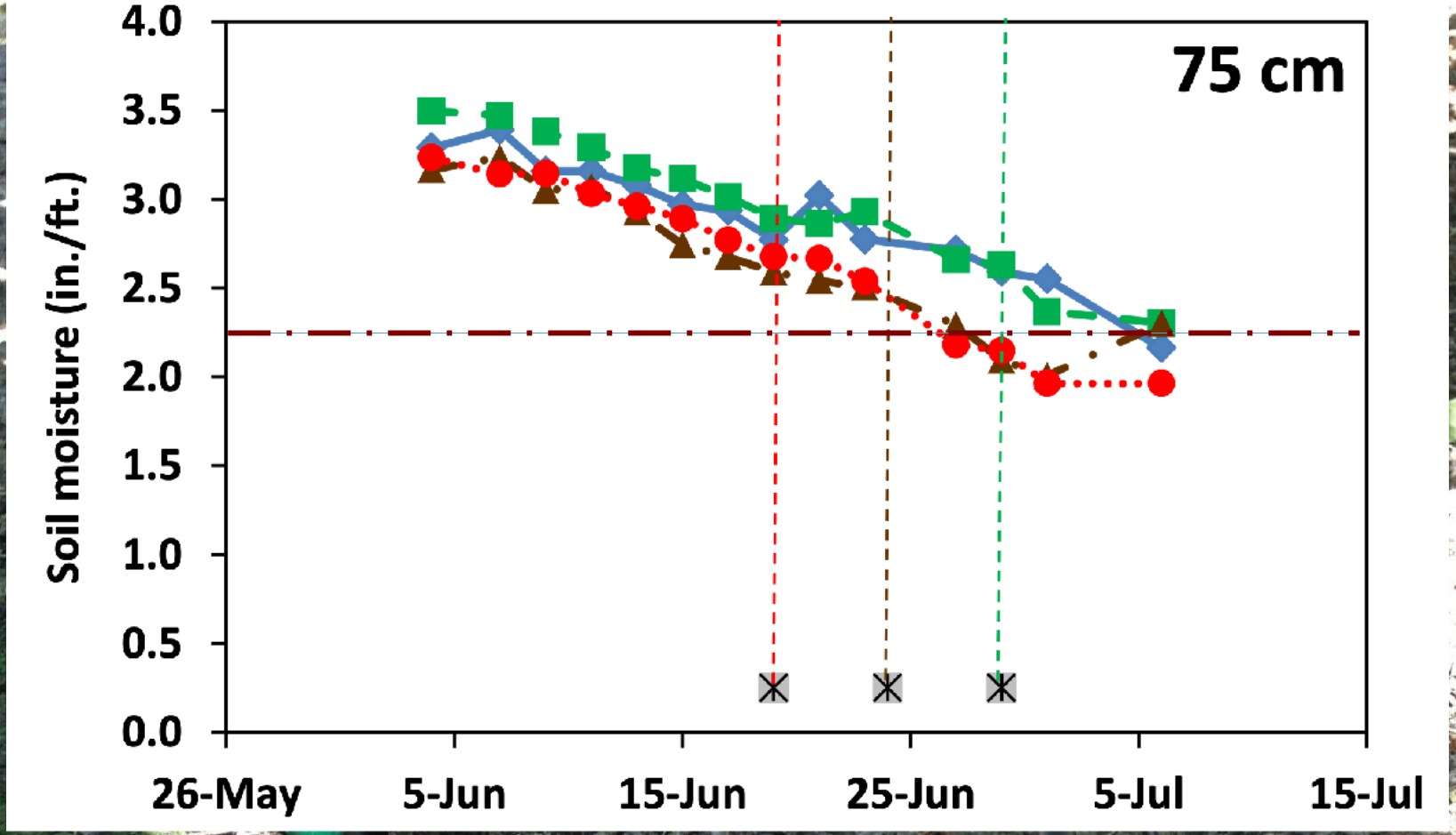
Sweetheart- 2015 Soil moisture



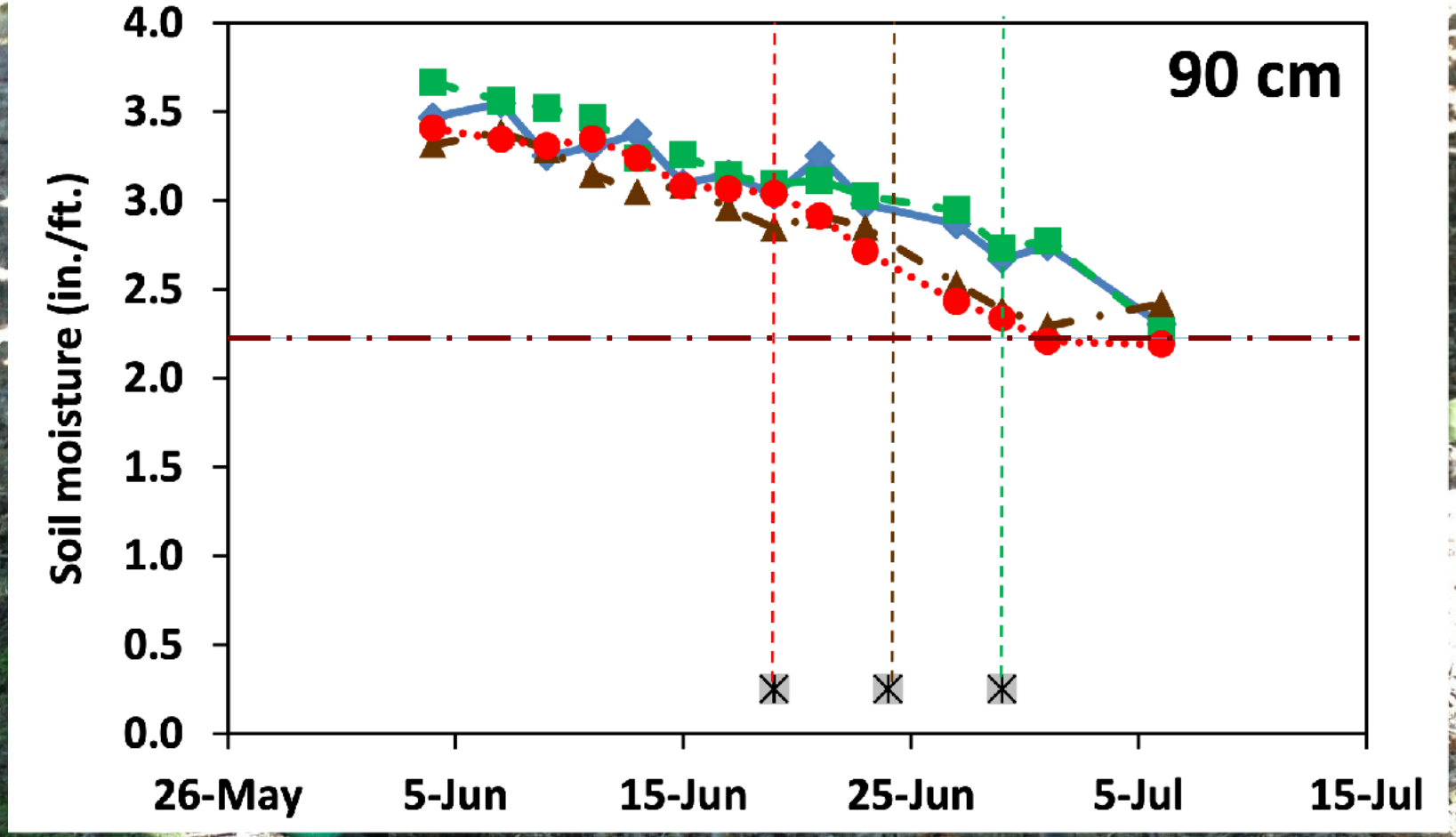
Sweetheart- 2015 Soil moisture



Sweetheart- 2015 Soil moisture



Sweetheart- 2015 Soil moisture



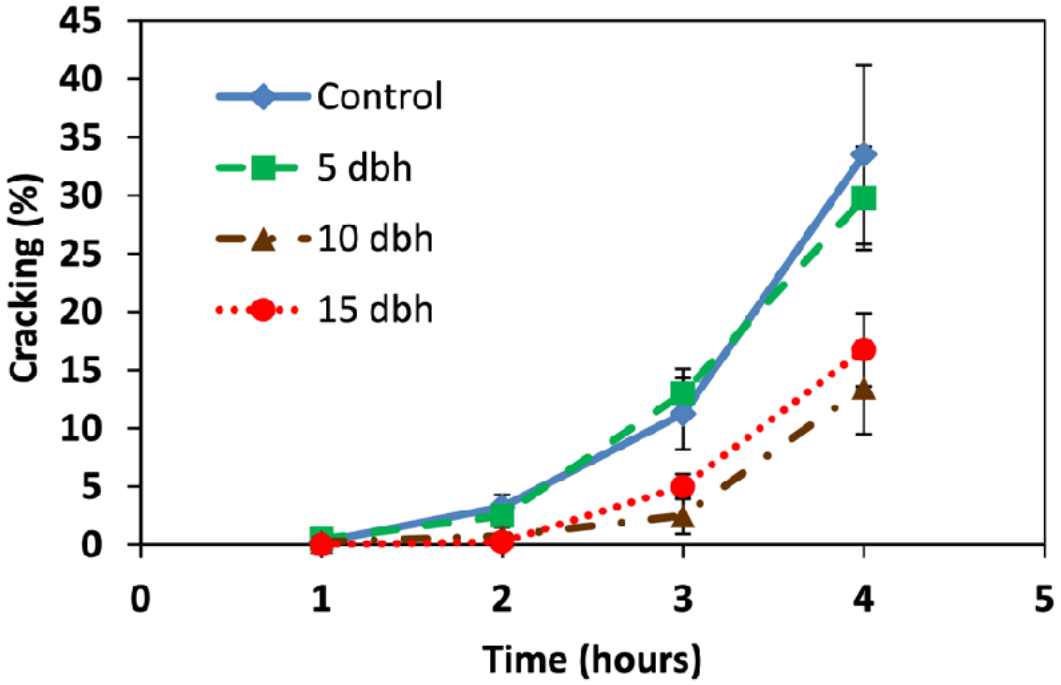
- Mazzard roots extracting water at 90 cm depth

‘Sweetheart’ 2015 Production and Fruit Quality

Treatment	Yield kg/tree	Fruit diameter mm	Fruit wt. g	DMC g/fruit	RWC %	FF g/mm	Skin color ctifl	PRF g	SSC %	TA %
Control	19.4	27.7 a	9.8 a	2.29	76.98 a	341.8	4.7 a	277	22.1	1.07
5-dbh	20.7	27.4 a	9.5 ab	2.23	77.3 a	343.2	4.4 b	277	21.1	1.08
10-dbh	19.9	26.5 b	9.0 b	2.3	75.03 b	329.6	4.8 a	205	23.6	1.01
15-dbh	19.3	26.9 ab	9.2 b	2.28	75.92 ab	328.3	4.6 a	212	22.4	1.05
Pr>F	*0.948*	*0.042*	*0.024*	*0.851*	*0.031*	*0.587*	*0.008*	*0.109*	*0.098*	*0.19*

- Withholding irrigation for 5 dbh had no effect on fruit growth or quality of ‘Sweetheart’
- Withholding irrigation water for 10 and 15 days reduced fruit weight (~6% to 8% loss)
- Fruit size was reduced by water loss/stress (dehydration/shrinkage) ***not*** via limitations in carbon

Effect of water stress on 'Sweetheart' cracking



Cherries from 10 and 15 dbh treatments had significantly greater cracking resistance (i.e., ~50% less cracking), compared to fruits of control and 5 dbh treatments

Water Savings…

2015 Experiments	Treatment	Sets saved (no.)	Water savings (gal/acre)
Skeena	3 dbh	1	7,200
	9 dbh	3	21,600
Sweetheart	5 dbh	1	7,200
	10 dbh	3	21,600
	15 dbh	5	36,000

typical irrigation set was 12 hrs, every third day

27,154 gallons = 1 acre inch

On a 100-acre farm, savings is 3.6 million gallons

Cherry Orchard Establishment

Treatments: Same volume of water applied to trees at different frequencies

I1= 25% daily water applied 4 x per d
I2= 100% water applied every 2 d

+

Mulch= 10 cm thick wood waste mulch covering 2 m wide strip centered on tree row
P= annual fertigated P at 20g P/tree via ammonium polyphosphate

Multiple, small daily irrigations improved plant growth and nutrient acquisition (both P and K leaf [ ] were higher in I1 treatment)

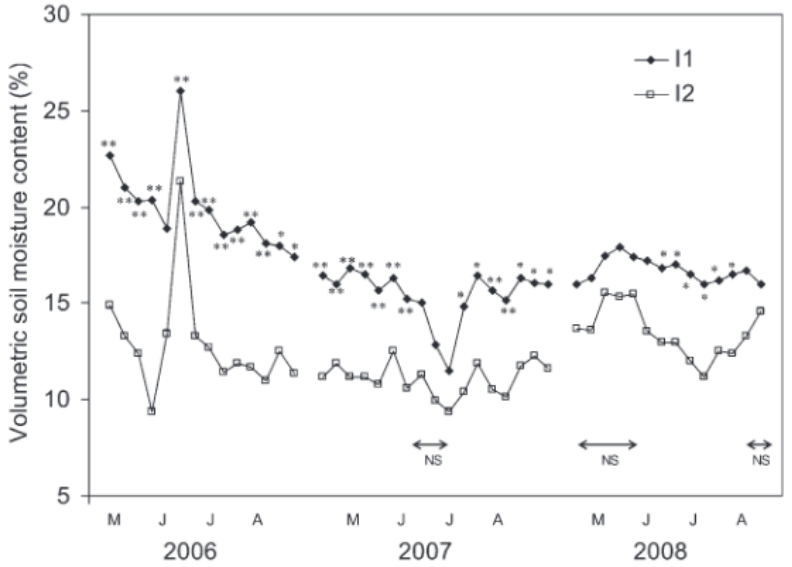


Fig. 1. Average volumetric soil moisture content, 0- to 20-cm depth, for I1 (4× daily) and I2 (every second day) irrigation treatments applying the same quantities of water, 2006 to 2008 growing seasons. Significance level at $P \leq 0.05$ (*) or $P \leq 0.01$ (**) indicated above (or below) I1 values or not significantly different (NS).

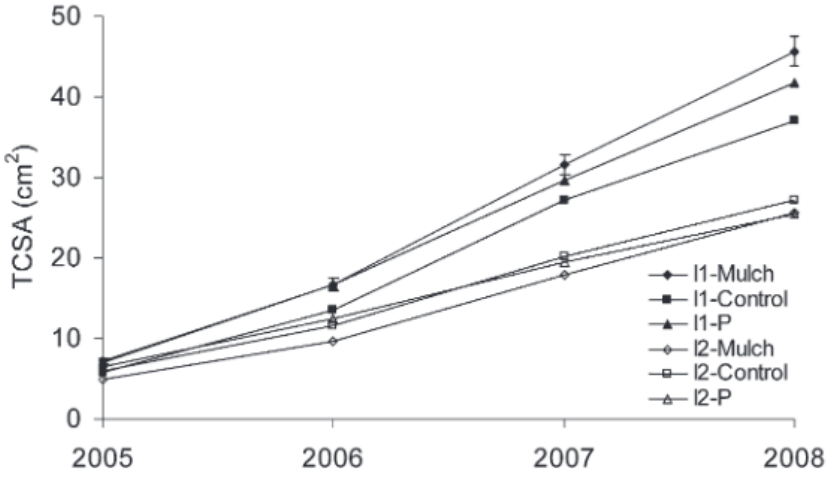
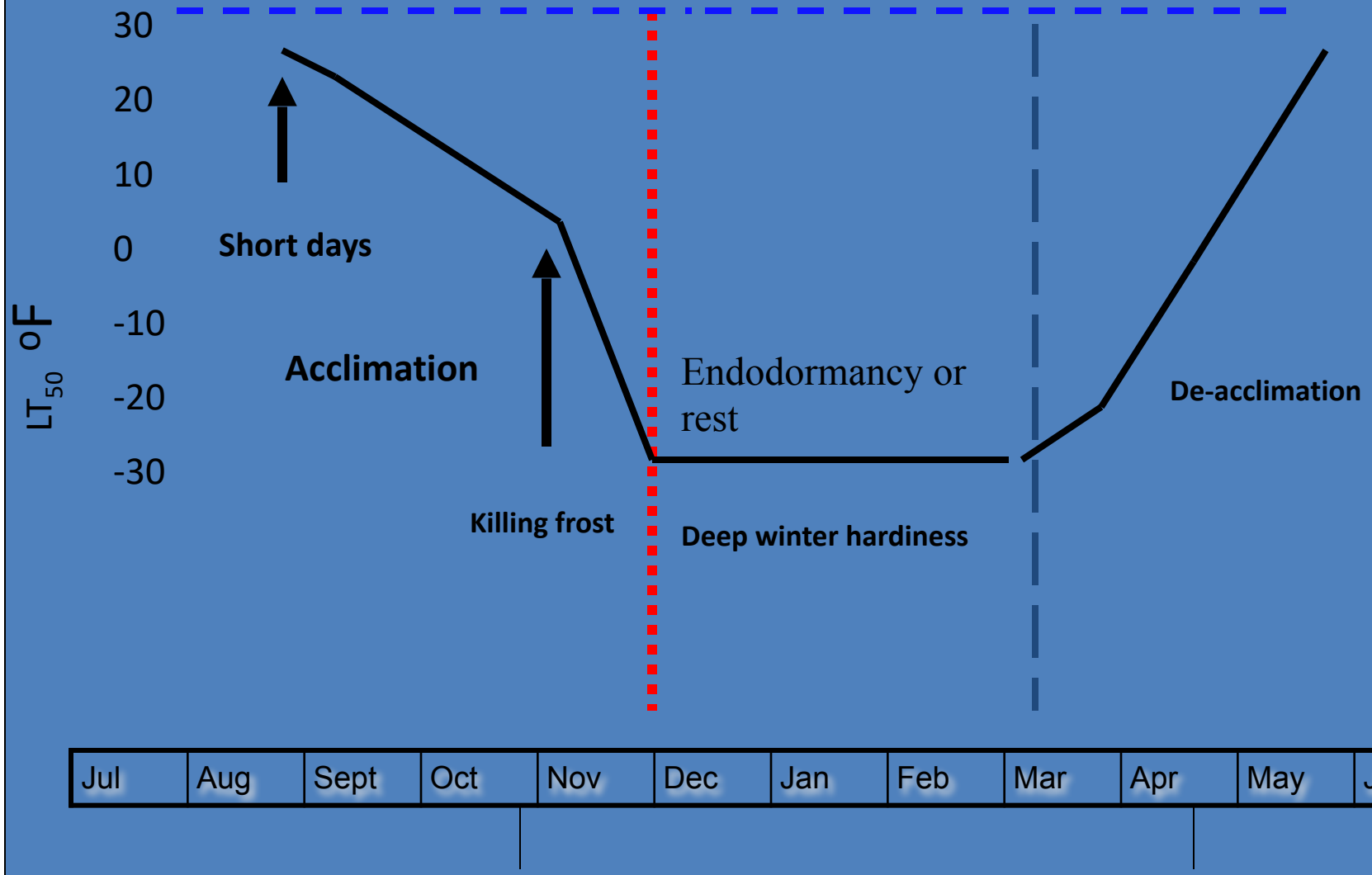


Fig. 2. Average trunk cross-sectional area (TCSA) as affected by irrigation and soil management treatment at the end of each growing season, 2005 to 2008. Irrigation treatments include I1 (4× daily) or I2 (every second day) applying the same quantities of water. Interaction SE was the same for all treatments and indicated on the top curve unless smaller than symbols.

Neilsen et al., 2010, HortScience


Cold Hardiness of Sweet Cherry

Cold Hardiness in Fruit Trees



Frost protection of tart cherry orchards during spring

- Site selection is the most critical factor…
- Episodic spring frost events likely to occur later
- Concomitantly, GDH accumulation is likely to occur earlier
- Resulting in earlier bloom and greater risk of crop loss