FRUIT THINNING TO INCREASE FRUIT SIZE OF LESS VIGOROUS ROOTSTOCKS IN THE 2005 NC-140 REGIONAL ROOTSTOCK PROJECT; 2015-2016 Progress Report

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ABSTRACT

The Multi-State Research Project NC-140, "Improving Economic and Environmental Sustainability in Tree Fruit Production through Changes in Rootstock Use", was established in the late 1980s. The first 10-year, multi-state pear trial was established in 1987 and subsequent ones in 2004-2006. Three trials were planted in California in April 2005: Bartlett in Mendocino (loam) and Sacramento (clay) Counties and 'Golden Russet' Bosc in Mendocino County (loam). Trial design was the standard NC-140 configuration of randomized complete block (RCB) with 10 single tree replicates. Rootstocks included 708-36 (United Kingdom), BM 2000 (Australia), Fox 11 (Italy), Horner 4 (Oregon), OHxF 69 (Oregon, Mendocino Bartlett only), OHxF 87 (Oregon), Pyro-233 and Pyrodwarf (both Germany). The Sacramento trial was abandoned after 2009, and the final trial data reported (Elkins 2011; Elkins et al. 2011; Elkins and Ingels 2010). Survival rate for both Mendocino County trials combined ranged from 60-100%, with Fox 11 having the most losses. After 10 years (2005-2014), there were very strong positive correlations between yield components, but not yield efficiency, and TCSA for Bartlett. For Bosc, yield efficiency was positively correlated with fruit number and negatively correlated with TCSA; while fruit size was positively correlated only with TCSA. Water stress status appears most positively correlated with vigor and soluble solids and fruit size (Bosc). 2014 was the tenth season of the 10 year trial and the final year of formal data collection and reporting (Elkins 2012, 2013, 2014). 2015 and 2016 focused on crop load management, specifically post-June drop fruit thinning, to increase fruit size of low vigor rootstocks. Mid-day stem water potential (MSWP) was used as a means to evaluate water relations of individual rootstocks in order to determine relative vigor and ability to withstand water stress. After two years, 27-31% post-June drop thinning significantly increased fruit size overall, with a lesser effect on yield and yield efficiency, but had limited effect on mid-day stem water potential (MSWP), an indicator plant stress, which is more related to canopy size. Thinning will be repeated in 2017.

INTRODUCTION AND OBJECTIVES

There are very few commercially viable size controlling rootstocks for pear. Quince rootstock is widely used in Europe interstemmed with Old Home or Beurre Hardy, but is only being employed in the U.S. as a rootstock for Comice due to its incompatibility with other cultivars. The Old Home x Farmingdale (OHxF) (Brooks®)[1] series offers several potential options that are more widely being planted. The two OHxF selections currently most offered by major wholesale

nurseries are 97 and 87 (333 is generally sold to homeowners) (Elkins, R., 2006). 97 is a relatively large tree similar to Winter Nelis, though more precocious than the more vigorous *P. betulaefolia*. 87 is a smaller tree, but has tended to produce smaller fruit in some locations. Data from California, and more recently Washington, has suggested OHxF 69, which has limited commercial availability, as also promising, particularly for Bosc, but difficult to propagate by hardwood cuttings (Elkins and DeJong 2002; Elkins et al. 2008; Elkins and DeJong 2011; Reed 2011; Elkins, Bell and Einhorn 2012).

The North Central Regional Research Project NC-140 (*www.NC140.org*) is a federally (NIFA)-supported, multi-state rootstock project focused on perennial tree fruit crops. The goal of NC-140 is to disseminate information generated from long-term (generally 10 year) trials throughout the U.S. Each participating state (as well as Canada and Mexico) establishes and evaluates similar ("uniform") trials using the same rootstocks and similar plot design so that regional differences can be determined. Researchers share progress and results at the annual meeting and via the NC-140 website. Each state representative submits an annual report which is distributed at the meeting and then compiled into a national report for USDA and posted on the NC-140 website for public use. Data is also shared with growers and nurseries who can then select rootstocks suitable to their location and customer base.

All Regional projects must be re-authorized every five years; the NC-140 2012-2017 continuing 5-year proposal was submitted and accepted by the North Central Regional Association (NCRA) of State Agricultural Experiment Station Directors (NC-140 2012). California began participating in NC-140 for apples in 1995 and peaches in 2001 and began participating actively in pears in 2005.

In coordination with Chuck Ingels (UCCE Sacramento Co.), Oregon (the late Eugene Mielke, succeeded by Todd Einhorn, now with Michigan State University, East Lansing), Washington (Tim Smith), Chihuahua (Mexico) (Rafael Parra), and New York (Terence Robinson), three new NC140 trials were established in California in spring 2005, two in Talmage, Mendocino County (Bartlett and Bosc, 5' x 10' spacing), and one in Courtland (Bartlett, 9' x 15' spacing, abandoned after 2009). Rootstock liners were grown by Meadow Lake Nursery, McMinnville, Oregon, then budded and finished by Fowler Nurseries, Inc. in Newcastle. These trials completed their 10th and final formal year of data collection in 2014 as the **only bearing *replicated*** pear rootstock trials in California. Information provided by the 2005 trials has already informed the pear industry of benefits and challenges related to alternative rootstocks under high-density planting conditions (the Talmage trial is planted at 871 trees per acre and is on very fertile soil) and have elucidated or confirmed several promising rootstocks, depending on cultivar and site conditions, most notably, Horner 4. Based on data from the 2005 trial, four replicated demonstration trials comparing Horner 4 to OHxF 87 and OHxF 97 were established in Lake County in Spring 2016 to evaluate it under a wider range of soil and management (conventional, organic) conditions. It is being propagated by at least two major pear nurseries using hardwood cuttings and micropropagation (tissue culture) methods and is also being trialed commercially.

Although the 10-year period of formal data collection ended in 2014, there remained great opportunity to utilize the still-existing test trees to evaluate cultural manipulations to increase fruit size on some of the weaker rootstocks, as well as monitor the effects of controlling crop load on water relations and tree vigor.

[1]The male parent of this series has now been shown to be Bartlett (Postman et al. 2013).

PROCEDURES

Trial Design: Rootstocks (and origin) evaluated in California from 2005-2014 and again from 2015-2016 were 708-36 (United Kingdom), BM 2000 (Australia), Fox 11 (Italy), Horner 4 (Oregon), OHxF 69 (Oregon), OHxF 87 (Oregon), Pyro 2-33 (Germany), and Pyrodwarf (Germany). Design was randomized complete block, with 10 single tree replicates per rootstock. Data collection and calculation included % survival (reason for decline or death noted), number of flower clusters (2005-2010), number of fruit, tree height, trunk cross sectional area (TCSA, 10 cm. above graft union), yield (kg/tree), and number of root suckers. 2010-2016 data also included fruit firmness (kg) and soluble solids (°Brix). Average fruit size and yield efficiency (kg/cm^2) were calculated.

From 2013 to 2016, weekly mid-day stem water potential (MSWP, bars) was measured using a pressure chamber (either PMS Model 610 Pressure Chamber, PMS Instrument Company, Albany, OR or Model 3000 Plant Water Status Console,
Soil Moisture Equipment Corp., Goleta, CA) from May through early October to assess whether and how much water stress might affect vigor and yield (crop load and fruit size), and vise versa. Data was collected from each replicate tree, as well from a set of five` established Bartlett trees on Winter Nelis rootstock as an unreplicated comparison. Data was analyzed using ANOVA (including means separation using Tukey's HSD) and simple regression analysis run to obtain correlation coefficients (r values) among variables for each trial year and for cumulative (2008-2014; 2015-2016) cropping years (Statgraphics Centurion XVII, Statpoint Technologies, Warrenton, VA).

Post-June drop thinning - In 2015 and 2016 the existing 10 trees per rootstock were divided into treated and untreated groups (5 trees per treatment). Half of the trees were thinned by hand after June drop (May) to a reduced number of fruit based on initial assessment of fruit number after final set. Trees with similar initial numbers of fruit were then paired and data collection proceeded as in previous years. Thinning versus non-thinning results were analyzed (Statgraphic, Centurion XVI, Statpoint Technologies, Inc., Warrenton, VA) using the t-test procedure and significant means separated using Tukey's HSD ($p<.05$).

2015-2016 RESULTS AND DISCUSSION

Results from previous years are available (Elkins 2014, 2013, 2012, 2011; Elkins 2010, Elkins and Ingels, 2010 and 2009).

Tree growth and productivity (Tables 1 - 8): 2015 Bartlett results showed that an average of only 27% crop thinning after June drop 1) very significantly increased fruit size overall, with a lesser effect on yield and yield efficiency, and 2) had limited effect on mid-day stem water potential (MSWP), an indicator plant stress. Effect was less in 2016, despite only slightly more severe thinning (31%). This may be explained by overall higher initial crop load and yield (24% and 31% higher, respectively, which translated into 25% smaller fruit size (166 vs. 219 gm. unthinned and thinned combined average). In comparison, Bosc failed to respond in either 2015 or 2016, although fruit size was larger in 2016 despite heavier crop load and yield. Varying

cultivar response may suggest inherent differences in vigor and susceptibility to stress.

Among Bartlett rootstocks, only 708-36 response was significantly related to thinning. Interestingly, due to variability among trees, absolute fruit numbers were actually *higher* on thinned 708-36 trees, but fruit size increased over the entire set of 10 trees. There was also a trend (p = 0.11) toward response by Pyrodwarf (44% thinning, 11% increased fruit size). For each of the above there was also a trend toward reduced yield, suggesting a fine line between optimal and over thinning.

Mid-day stem water potential (MSWP)(Tables 9-14 and Figures 1-18): From 2013 through 2016 there was a trend toward declining seasonal MSWP for both Bartlett and Bosc as trees grew larger, although 2016 average was slightly better than 2016 as canopy size stabilized. For Bartlett, Horner 4 was consistently least and Pyro 2-33 consistently most stressed. Rootstocks, including (non-replicated) standard sized mature Bartlett trees on Winter Nelis, seldom attained the values of -6 - -8 bars, the suggested baseline for fully-watered trees (Shackel 2007). In 2015, overall monthly Bartlett MSWP trajectory declined after June 25, achieving baseline on June 4 and 25, July 23, and September 3. Horner 4 was least and Pyro 2-33 most stressed but all rootstocks equalized on September 24. In 2016, Horner 4 achieved baseline on June 29, July 20, and September 14 (established trees on September 7). Bosc 2015 MSWP held steady until July 31, then fell behind until recovering somewhat when weather cooled. 2016, MSWP held steady May 31 to August 3, than declined. Horner 4 (followed by Fox 11), was least and OHxF 87 most stressed in 2016.

For thinned and unthinned trees combined, MSWP was lowest from mid- to late-August both years: Bartlett (2015 range 11.6 to 15.6, 2016 range 9.0 to 16.0) and Bosc (2015 range 12.5 to 21.9, 2016 range 12.8 to 19.7). This contrasts with established trees with a low of 15.4 in 2015 and 12.9 in 2016. Bartlett and Bosc trees on Horner 4, followed by Fox 11, were least stressed. Bartlett on 708-36 and Pyro 2-33 were most stressed, with no differences among rootstocks in either year for Bosc. Unthinned Bartlett MSWP averaged 13.9 bars in 2015 and 11.4 bars in 2016, with no differences among rootstocks. Trees were driest on August 27 (15.6 bars). Unthinned Bosc averaged 15.1 bars, also driest on August 27 (21.8 bars) in 2015; Horner 4 performed best and BM2000, OHxF 87 and Pyro 2-33 worst. Average MSWP was 14.8 in 2016 (driest on August 17, 18.3 bars) with no differences among rootstocks. For thinned Bartletts, MSWP averaged 13.8 overall with 708-36 averaged significantly higher and Fox 11 lower. MSWP was lowest (15.5) on September 24, one month later than average. BM2000 seasonal MSWP was highest (11.5) and Pyro 2-33 lowest (15.9) in 2015, with no differences in 2016. For thinned Bosc, 708-36 2015 MSWP was lowest (15.4), with no differences in 2016. 2015 MSWP was lowest (21.4) on August 27 and on August 17 (18.3) in 2016. Horner 4 was least stressed and 708-36, OHxF 87, and Pyro 2-33 in 2015 with no differences among rootstocks in 2016 (similar to Bartlett).

MSWP was (very) significantly and positively correlated with fruit size and TCSA in both years for both unthinned and thinned Bartlett and Bosc, as well as Bartlett yield in 2015. It was significantly negatively correlated with unthinned Bosc fruit number in 2016, and both thinned and unthinned (2015 only) Bosc yield efficiency in 2015 and 2016. MSWP was also consistently negatively correlated with fruit firmness and soluble solids (except thinned Bartlett in 2016) in both years.

Two years comparing fruit thinned to unthinned trees have produced very few significant differences related to water status. Water stress pattern is largely similar regardless of treatment

and is mostly positively and negatively related to the same factors regardless of thinning treatment. These results corroborate past results demonstrating canopy size rather than crop load as the key factor related to seasonal water stress. As in past years, Horner 4 maintained the best water status through the season, despite its relatively larger canopy size. Better water status is likely a key factor related to larger yield and fruit size of trees on Horner 4, as well as smaller fruit and less yield on Pyro 2-33, OHxF 87, and 708-36 trees.

2017 PLANS

Thinning treatments will be repeated in 2017 to evaluate 1) response of the existing group of rootstocks to a regime of crop load management consisting of reducing the number of fruit proportionately to tree size and vigor (initial number of fruit per tree, fruit per cm^2 trunk circumference), and 2) differences in mid-day stem water potential (MSWP) among rootstocks appear to correlate with vigor, yield, and fruit size. Data for all years will be summarized and reported following the 2017 season.

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Table 1a: Effect of post-June drop fruit thinning on tree vigor, fruiting characteristics, fruit quality, and root suckers of 11-year-old (12th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2016.

Treatment[1]	No. Fruit (no./tree) 8/3/16	Fruit Size (g) 8/3/16	Yield (kg/tree) 8/3/16	TCSA (cm^2) 10/18/16	Yield Efficiency (kg/cm^2)	Tree Height (cm) 10/18/16	Average Box Size (44 lb.) 8/3/16	Average No. Boxes (per tree) 8/3/16	Firmness (kg force) 8/3/16	Soluble Solids (°Brix) 8/3/16	Root Suckers (no./tree) 10/18/16
Unthinned	131	161	21.3	52.9	0.42	320	120	1.06	7.7	13.5	0.18
Thinned	90 (31%)	171	15.4	56.5	0.29	312	120	0.77	7.8	13.6	0.24
P -Value[2]	*** (<0.001)	NS (0.11)	** (0.01)	NS (0.49)	*** (<0.001)	NS (0.64)	NS (0.06)	** (0.01)	NS (0.11)	NS (0.96)	NS (0.65)

[1] Means comparison by t-test, $P \leq 0.05$. Root sucker data normalized using SQRT(root suckers+1).

[2] **, *** Indicates significance at $P \leq 0.01$ and 0.001, respectively. NS indicates not significant, n=33.
Fruit thinned 6/8/16. Harvested 8/3/16.

Table 1b: Effect of post-June drop fruit thinning on tree vigor, fruiting characteristics, fruit quality, and root suckers of 10-year-old (11th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

Treatment[1]	No. Fruit (no./tree) 8/10/15	Fruit Size (g) 8/10/15	Yield (kg/tree) 8/10/15	TCSA (cm^2) 10/9/15	Yield Efficiency (kg/cm^2)	Average Box Size (44 lb.) 8/10/15	Average No. Boxes (per tree) 8/10/15	Firmness (kg force) 8/18-19/15	Soluble Solids (°Brix) 8/18-19/15	Root Suckers (no./tree) 10/9/15
Unthinned (n=34)	73	210	15.7	48.3	0.32	100	0.78	7.7	13.6	0.22
Thinned (n=36)	53 (27%)	229	12.4	48.3	0.26	90	0.62	7.6	12.7	0.11
P -Value[2]	** (0.01)	** (0.01)	NS (0.10)	NS (0.99)	NS (0.07)	** (0.002)	NS (0.10)	NS (0.53)	NS (0.08)	NS (0.33)

[1] Means comparison by t-test, $P \leq 0.05$. Root sucker data normalized using SQRT(root suckers+1).

[2] ** Indicates significance at $P \leq 0.01$. NS indicates not significant.
Fruit thinned 6/18-19/15. Harvested 8/10/15.

Table 1c: Effect of post-June drop fruit thinning on tree vigor, fruiting characteristics, fruit quality, and root suckers of 11-year-old (12th leaf) "Golden Russett" 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

Treatment[1]	No. Fruit (no./tree) 8/24/16	Fruit Size (g) 8/24/16	Yield (kg/tree) 8/24/16	TCSA (cm^2) 10/18/16	Yield Efficiency (kg/cm^2)	Tree Height (cm) 10/18/16	Average Box Size (44 lb.) 8/24/16	Average No. Boxes (per tree) 8/24/16	Firmness (kg force) 8/24/16	Soluble Solids (°Brix) 8/24/16	Root Suckers (no./tree) 10/18/16
Unthinned	104	221	22.0	80.7	0.29	353	90	1.10	8.2	14.3	0.04
Thinned	75	232	16.9	84.9	0.21	358	90	0.85	8.2	15.0	0.16
P -Value[2]	** (0.01)	NS (0.42)	** (0.02)	NS (0.60)	** (0.003)	NS (0.81)	NS (0.37)	* (0.02)	NS (0.69)	NS (0.01)	NS (0.39)

[1] Means comparison by t-test, $P \leq 0.05$. Root sucker data normalized using SQRT(root suckers+1).

[2] *, ** Indicates significance at $P \leq 0.05$ and 0.01, respectively. NS indicates not significant, n=25.
Fruit thinned 6/8/16. Harvested 8/24/16.

Table 1d: Effect of post-June drop fruit thinning on tree vigor, fruiting characteristics, fruit quality, and root suckers of 10-year-old (11th leaf) "Golden Russett" 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

Treatment[1]	No. Fruit (no./tree) 8/25/15	Fruit Size (g) 8/25/15	Yield (kg/tree) 8/25/15	TCSA (cm^2) 10/9/15	Yield Efficiency (kg/cm^2)	Average Box Size (44 lb.) 8/25/15	Average No. Boxes (per tree) 8/25/15	Firmness (kg force) 08/25/15	Soluble Solids (°Brix) 08/25/15	Root Suckers (no./tree) 10/9/15
Unthinned (n=28)	74	201	14.6	73.3	0.21	100	0.73	6.8	14.6	0.11
Thinned (n=26)	60	209	12.2	76.6	0.17	100	0.61	6.7	15.1	0.23
P -Value[2]	NS (0.19)	NS (0.42)	NS (0.23)	NS (0.64)	NS (0.21)	NS (0.078)	NS (0.23)	NS (0.46)	* (0.05)	NS (0.43)

[1] Means comparison by t-test, $P \leq 0.05$. Root sucker data normalized using SQRT(root suckers+1).

[2] * Indicates significance at $P \leq 0.05$. NS indicates not significant.
Fruit thinned 6/8/16-19/15. Harvested 8/25/15.

Table 2a: Effect of post-June fruit drop thinning on tree vigor, fruiting characteristics, and root suckers of "Bartlett" pear trees, Talmage, Mendocino County, California, 2016.

	Fruit No. (per tree) 8/3/16		Fruit Size (g) 8/3/16		Yield (kg/tree) 8/3/16		TCSA (cm^2) 10/18/16		Yield Efficiency (kg/cm^2)		Tree Height (cm) 10/18/16		Average Box Size (44 lb.box) 8/3/16		Average No. of Boxes (per tree) 8/3/16		Root Suckers (no./tree)[3] 10/18/16	
	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned
Rootstock[1]																		
708-36	71	91	129 b	143 c	8.6	13.6	23.5 d	29.5 c	.43	.37	234 d	266 c	165 b	135 c	0.4 b	0.68	.0	0.0 b
BM 2000	129	97	169 ab	181 ab	21.8	17.5	57.6 b	67.6 b	.37	.26	367 ab	378 ab	120 ab	110 ab	1.1 ab	0.88	.4	0.2 b
Horner-4	161	102	201 ab	209 ab	31.3	21.1	94.6 a	92.5 a	.32	.24	412 a	410 a	100 a	100 a	1.6 a	1.05	.3	1.2 a
Fox 11	134	101	156 b	155 bc	20.6	16.4	54.5 bc	52.1 bc	.37	.29	328 bc	311 abc	135 ab	135 bc	1.0 ab	0.82	.4	0.3 b
OHxF 69	115	80	143 b	149 bc	17.0	12.1	46.0 bc	52.5 bc	.36	.22	290 cd	286 bc	135 ab	135 c	0.9 ab	0.61	.0	0.0 b
OHxF 87	120	81	148 b	174 abc	18.0	13.9	36.8 cd	44.0 bc	.43	.31	243 d	285 bc	135 ab	120 abc	0.9 ab	0.70	.0	0.0 b
Pyrodwarf	172	96	149 b	166 bc	26.6	15.9	42.2 bcd	43.2 c	.59	.36	298 bcd	289 bc	135 ab	120 abc	1.3 ab	0.80	.3	0.0 b
Pyro 2-33	164	82	173 ab	161 bc	27.5	13.3	49.5 bc	48.2 bc	.56	.28	317 bcd	300 abc	120 ab	120 abc	1.4 ab	0.67	.0	0.0 b
ANOVA (*P* -value)[2]																		
Rootstock	NS (0.30)	NS (0.98)	***(0.001)	***(0.001)	NS (0.09)	NS (0.70)	***(0.001)	***(0.001)	NS (0.11)	NS (0.73)	***(<0.001)	** (0.003)	** (0.01)	***(0.001)	NS (0.09)	NS (0.70)	NS (0.73)	**(0.002)
Block	NS (0.60)	NS (0.46)	NS (0.16)	NS (0.10)	NS (0.70)	NS (0.56)	NS (0.31)	NS (0.44)	NS (0.26)	NS (0.61)	**(0.01)	NS (0.32)	NS (0.17)	*(0.05)	NS (0.70)	NS (0.57)	~	~

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$); Average box no., unthinned, means by $P \leq 0.10$.

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1), P<0.05. One-way ANOVA due to variance of sampled trees in reps.

Fruit thinned 6/8/16. Harvested 8/3/16.

Table 2b: Effect of post-June drop thinning on tree vigor, fruit characteristics and root suckers of 10-year-old (11th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

	No. Fruit (no./tree) 8/10/15		Fruit Size (g) 8/10/15		Yield (kg/tree) 8/10/15		TCSA (cm^2) 10/9/15		Yield Efficiency (kg/cm^2)		Average Box Size (44 lb.) 8/10/15		Average No. Boxes (per tree) 8/10/15		Root Suckers (no./tree)[3] 10/9/15	
	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned
Rootstock[1]																
708-36	62 ab	54 ab	167 b	220 b	10.3 b	11.6 b	21.9 c	29.4 c	.39	.38 a	120 b	90 ab	.52 b	.58 b	.0	.0
BM 2000	63 ab	48 ab	220 ab	228 b	14.3 b	11.3 b	50.0 b	57.5 b	.26	.20 b	90 ab	90 ab	.72 b	.56 b	.4	.2
Horner-4	124 ab	83 a	249 a	273 a	30.9 a	23.4 a	87.8 a	88.3 a	.37	.24 ab	80 a	70 a	1.5 a	1.17 a	.6	.2
Fox 11	41 b	45 ab	228 ab	230 b	9.4 b	10.5 b	47.7 b	42.8 bc	.19	.24 ab	90 ab	90 ab	.47 b	.53 b	.5	.3
OHxF 69	63 ab	37 b	197 ab	219 b	11.6 b	8.5 b	44.2 b	42.3 bc	.24	.19 b	100 ab	90 b	.58 b	.43 b	.0	.0
OHxF 87	67 ab	43 ab	190 b	234 b	12.6 b	9.9 b	34.8 bc	35.9 c	.36	.27 ab	110 ab	90 ab	.63 b	.50 b	.2	.2
Pyrodwarf	65 ab	62 ab	215 ab	229 b	14.1 b	14.4 ab	41.2 bc	39.0 bc	.34	.34 ab	90 ab	90 ab	.70 b	.72 ab	.0	.0
Pyro 2-33	87 ab	73 ab	212 ab	214 b	18.5 ab	15.9 ab	44.7 b	45.0 bc	.38	.37 ab	90 ab	90 ab	.93 ab	.80 ab	.0	.0
ANOVA (P -value)[2]																
Rootstock	NS (0.06)	* (0.05)	** (0.01)	***(0.001)	**(0.003)	** (0.01)	***(0.001)	***(0.001)	NS (0.57)	* (0.03)	* (0.02)	* (0.03)	**(0.003)	** (0.01)	NS (0.63)	NS (0.79)
Block	NS (0.15)	NS (0.16)	NS (0.54)	* (0.05)	NS (0.13)	NS (0.16)	NS (0.08)	NS (0.81)	NS (0.24)	NS (0.09)	NS (0.62)	NS (0.16)	NS (0.13)	NS (0.16)	~	~

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$). Root sucker means by (Duncan Multiple Range Test $P \leq 0.05$).

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1), $P \leq 0.05$. One-way ANOVA due to variance of sampled trees in reps.

Fruit thinned 6/18-19/15. Harvested 8/10/15.

Table 3a: Effect of post-June drop fruit thinning on firmness and soluble solids of 11-year-old (12th leaf) "Bartlettt" pear trees, Talmage, Mendocino County, California, 2016.

	Firmness (kg. force)			Soluble Solids (°Brix)		
	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]						
708-36	7.7	7.7	.83	13.8	14.0	.10
BM 2000	8.1	7.9	.70	13.3	13.5	1.00
Horner-4	7.5	7.8	* .01	12.6	12.7	.30
Fox 11	7.9	8.3	.17	13.3	13.7	.90
OHxF 69	7.6	7.7	.77	13.7	14.0	.65
OHxF 87	7.6	7.7	.78	13.9	14.2	.37
Pyrodwarf	7.6	7.8	.61	13.9	14.3	.72
Pyro 2-33	7.3	8.1	.89	13.3	13.4	.49
ANOVA *P* -value[2]						
Rootstock	NS (0.34)	NS (0.34)		NS (0.77)	NS (0.63)	
Block	** (0.01)	NS (0.57)		NS (0.18)	NS (0.61)	
Average All Rootstocks[3]	7.7	7.8		13.5	13.6	
P -value	NS (0.11)			NS (0.96)		

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, P≤0.05).

[2] *, ** Indicate significance at *P* ≤0.05 and 0.01 respectively. NS indicates not significant.

Fruit-thinned 6/8/16. Harvested 8/3/16. Measured: 8/4 & 5/16.

Table 3b: Effect of post-June drop fruit thinning on fruit firmness and soluble solids of 10-year-old (11th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

	Firmness (kg. force)			Soluble Solids (˚Brix)		
	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]						
708-36	8.2	7.4	.07	12.2	13.1	.54
BM 2000	7.5	7.3	.46	13.6	12.3	** .01
Horner-4	7.1	7.1	.92	13.0	11.9	.27
Fox 11	7.5	8.0	** .00	13.5	12.7	.54
OHxF 69	7.9	8.0	.60	13.5	13.5	.98
OHxF 87	8.2	7.5	* .05	14.0	12.5	.06
Pyrodwarf	7.4	7.7	.46	13.2	13.6	* .02
Pyro 2-33	7.8	8.2	.42	13.2	11.8	.34
ANOVA (*P* -value)[2]						
Rootstock	NS (0.29)	* (0.04)		NS (0.62)	NS (0.92)	
Block	* (0.04)	** (0.002)		NS (0.81)	NS (0.66)	
Average All Rootstocks[3]	7.7	7.6		13.6	12.7	
P -value	NS (0.53)			NS (0.96)		

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, P≤0.05).

[2] *, ** Indicate significance at *P* ≤0.05 and 0.01 respectively. NS indicates not significant.

Fruit thinned 6/18-19/15. Harvested 8/10/15. Measured 9/3/15.

Table 4a: Effect of post-June fruit thinning on number and size of vigor tree, fruiting characteristics, and root suckers of 11-year-old (12th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	Fruit No. (per tree) 8/24/16		Fruit Size (g) 8/24/16		Yield (kg/tree) 8/24/16		TCSA (cm^2) 10/18/16		Yield Efficiency (kg/cm^2) 10/18/16		Tree Height (cm) 10/18/16		Average Box Size (44lb.) 8/24/16		Average No.Boxes (per tree) 8/24/16		Root Suckers (no./tree)[3] 10/18/16	
	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned
Rootstock[1]																		
708-36	118	96	155 b	180 b	20.1	18.5	52.0 b	75.00 ab	0.35	0.28 a	255 c	333 ab	135 b	110 b	1.00	0.92	0.0	0.3
BM 2000	69	69	254 ab	281 a	15.5	18.4	83.9 ab	101.5 ab	0.22	0.18 ab	412 abc	367 ab	80 ab	70 ab	0.77	0.92	0.0	0.0
Horner-4	103	91	258 a	276 a	26.4	23.7	112.4 a	138.9 a	0.23	0.19 ab	398 abc	443 a	80 a	70 a	1.32	1.18	0.2	0.8
Fox 11	97	59	233 ab	234 ab	22.7	12.5	92.1 ab	103.3 ab	0.26	0.13 b	422 a	403 ab	90 ab	90 ab	1.13	0.62	0.0	0.0
OHxF 87	97	79	194 ab	205 ab	17.5	16.1	58.6 b	47.7 b	0.30	0.30 a	289 bc	253 b	100 ab	100 ab	0.87	0.81	0.0	0.0
Pyrodwarf	126	79	203 ab	210 ab	26.1	16.3	67.4 ab	67.7 b	0.37	0.25 ab	314 abc	343 ab	100 ab	100 ab	1.31	0.82	0.0	0.0
Pyro 2-33	129	82	210 ab	219 ab	27.1	17.4	81.1 ab	88.1 b	0.35	0.22 ab	333 abc	364 ab	100 ab	100 abc	1.36	0.87	0.0	0.0
ANOVA[2] (*P* -value)																		
Rootstock	NS (0.92)	NS (0.42)	* (0.03)	**(0.01)	NS (0.89)	NS (0.50)	* (0.02)	** (0.01)	NS (0.55)	* (0.05)	** (0.01)	NS (0.09)	* (0.05)	* (0.04)	NS (0.89)	NS (0.50)	NS (0.56)	NS (0.59)
Block	NS (0.84)	* (0.03)	* (0.03)	NS (0.18)	NS (0.94)	NS (0.24)	* (0.05)	NS (0.10)	NS (0.43)	NS (0.40)	* (0.04)	NS (0.37)	* (0.05)	NS (0.27)	NS (0.94)	NS (0.24)	~	~

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$).,

[2] *, ** Indicate significance at $P \leq 0.05$ and 0.01 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1), $P \leq 0.05$ for *P* -value. (One-way ANOVA due to variance)

Fruit-thinned 6/8/16. Harvested 8/24/16.

Table 4b: Effect of post-June drop fruit thinning on tree vigor, fruiting characteristics, and root suckers of 10-year-old (11th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	No. Fruit (no./tree) 8/25/15		Fruit Size (g) 8/25/15		Yield (kg/tree) 8/25/15		TCSA (cm^2) 10/8/15		Yield Efficiency (kg/cm^2)		Average Box Size (44 lb.) 8/25/15		Average No. Boxes (per tree) 8/25/15		Root Suckers (no./tree)[3] 8/25/15	
	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned	Unthinned	Thinned
Rootstock[1]																
708-36	113 a	54 ab	181 b	190 ab	20.8 a	10.8 ab	65.7 b	61.0 b	.30 a	.16 b	110 c	110 bc	1.00 a	.54 ab	.00	.00 b
BM 2000	30 c	51 ab	207 ab	235 a	5.6 b	12.1 ab	60.0 b	95.0 b	.10 b	.13 b	100 bc	90 ab	.28 b	.60 ab	.00	1.70 a
Horner-4	56 abc	39 b	249 a	235 a	14.9 ab	9.5 b	111.4 a	103.0 a	.13 b	.09 b	80 a	90 a	.74 ab	.48 b	.20	.00 b
Fox 11	34 c	58 ab	225 ab	228 ab	9.2 ab	12.3 ab	81.7 ab	77.0 ab	.12 b	.19 ab	90 ab	90 ab	.46 ab	.62 ab	.00	.30 ab
OHxF 87	70 abc	107 a	186 b	169 b	13.1 ab	20.0 a	53.9 b	60.0 b	.24 ab	.30 a	110 c	120 c	.66 ab	1.00 a	.00	.00 b
Pyrodwarf	110 ab	50 ab	190 b	190 ab	20.2 a	8.7 b	75.0 ab	57.0 b	.29 a	.18 ab	110 c	110 abc	1.01 a	.44 b	.00	.00 b
Pyro 2-33	43 bc	75 ab	196 ab	208 ab	8.0 ab	15.6 ab	75.0 b	82.0 ab	.10 b	.21 ab	100 bc	100 abc	.40 ab	.78 ab	.50	.00 b
ANOVA (*P* -value)[2]																
Rootstock	NS (0.13)	* (0.02)	** (0.01)	**(0.004)	NS (0.24)	* (0.03)	**(0.003)	NS (0.29)	* (0.04)	NS (0.11)	** (0.01)	* (0.02)	NS (0.24)	* (0.03)	NS (0.59)	**(0.01)
Block	NS (0.48)	* (0.04)	NS (0.10)	**(0.003)	NS (0.62)	** (0.01)	NS (0.12)	* (0.05)	NS (0.19)	NS (0.40)	* (0.04)	**(0.002)	NS (0.62)	** (0.01)	~	~

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$). No. fruit, Yield, Box Size, No.Boxes, Yield Efficiency means by (Duncan Multiple Range Test), $P<0.05$.

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1), $P \leq 0.05$. One-way ANOVA due to variance.

Fruit thinned 6/18-19/15. Harvested 8/25/15.

Table 5a: Effect of post-June fruit thinning on firmness and soluble solids of 11-year-old (12th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	Firmness (kg. force)			Soluble Solids (˚Brix)		
	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]						
708-36	8.9	8.2 abc	.83	13.0	15.1	*.03
BM 2000	7.9	7.1 c	.16	14.1	15.2	.40
Horner-4	7.2	7.5 bc	.21	14.8	13.9	.41
Fox 11	7.8	8.6 ab	.33	13.7	14.4	.11
OHxF 87	9.0	8.7 abc	.70	14.8	15.6	.28
Pyrodwarf	8.7	8.9 a	.61	14.1	15.1	.19
Pyro 2-33	8.0	8.1 abc	.83	15.1	15.9	.31
ANOVA (*P* -value)[2]						
Rootstock	NS (0.13)	* (0.03)		NS (0.08)	NS (0.13)	
Block	NS (0.48)	NS (0.06)		NS (0.37)	NS (0.20)	

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$).

[2] * Indicates significance at $P \leq 0.05$. NS indicates not significant.

Fruit-thinned 6/8/16. Harvested 8/24/16 Measured 8/25-26/16.

Table 5b: Effect of post-June drop fruit thinning on fruit firmness and soluble solids of 10-year-old (11th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	Firmness (kg. force)			Soluble Solids (˚Brix)		
	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]						
708-36	6.5	7.4 a	.08	14.7	15.6	.13
BM 2000	6.6	6.0 b	.32	15.3	15.4	.72
Horner-4	6.4	6.7 ab	.85	14.3	14.7	.35
Fox 11	6.2	6.8 ab	.92	14.1	15.3	.04
OHxF 87	6.9	6.6 ab	.43	15.0	15.0	.91
Pyrodwarf	7.0	6.7 ab	.52	14.2	15.3	.18
Pyro 2-33	7.0	6.5 ab	.18	15.3	15.0	.39
ANOVA (*P* -value)[2]						
Rootstock	NS (0.29)	* (0.04)		NS (0.62)	NS (0.92)	
Block	* (0.04)	** (0.002)		NS (0.81)	NS (0.66)	

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$).

[2] *, ** Indicate significance at $P \leq 0.05$ and 0.01 respectively. NS indicates not significant.

Fruit thinned 6/18-19/15. Harvested 8/25/15. Measured 9/3/15.

Table 6a: Significance (*P* -value) of the effect of post-June drop thinning on fruit number and size, tree yield and growth, and root suckers of 11-year-old (12th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2016.

	No. Fruit (no./tree) 8/3/16	Fruit Size (g) 8/3/16	Yield (kg/tree) 8/3/16	TCSA (cm^2) 10/18/16	Yield Efficiency (kg/cm^2)	Tree Heights (cm) 10/18/16	Average Box Size (44 lb.box) 8/3/16	Average No.Boxes (per tree) 8/3/16	Root Suckers (no./tree)[3] 10/18/16
Rootstock[1]									
708-36	.89	* .02	.79	.11	.55	.18	* .04	.80	~
BM 2000	.24	.39	.28	* .05	.11	.75	.54	.28	.72
Horner-4	.24	.65	.20	.65	.18	.99	.69	.20	.12
Fox 11	.18	.59	.25	.88	.23	.30	.66	.25	1.00
OHxF 69	* .02	.32	.08	.32	** .01	.92	.48	.08	~
OHxF 87	.34	.44	.47	.52	.28	.57	.46	.47	~
Pyrodwarf	* .02	.11	.08	.98	* .04	.42	* .05	.08	.36
Pyro 2-33	.10	.64	.06	.64	.14	.39	.90	.06	~

[1] Means comparison by t-test, $P \leq 0.05$.

[2] *, ** Indicate significance at $P \leq 0.05$ and 0.01 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1).

Table 6b: Significance (*P* -value) of the effect of post-June drop thinning on fruit number and size, tree yield and growth, and root suckers of 10-year-old (11th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

	No. Fruit (no./tree) 8/10/15	Fruit Size (g) 8/10/15	Yield (kg/tree) 8/10/15	TCSA (cm^2) 10/9/15	Yield Efficiency (kg/cm^2)	Average Box Size (44 lb.box) 8/10/15	Average No. Boxes (per tree) 8/10/15	Root Suckers (no./tree)[3] 10/9/15
Rootstock[1]								
708-36	.77	.77	.24	** .01	.79	*** .01	.24	~
BM 2000	.19	.76	.22	.52	.17	.45	.22	.72
Horner-4	.11	* .03	.35	.68	.20	.14	.36	.42
Fox 11	.38	.97	.39	.23	.55	~	.39	.72
OHxF 69	.06	.39	* .05	.15	.09	.44	* .05	~
OHxF 87	.88	* .02	.68	.61	.94	* .04	.68	1.00
Pyrodwarf	.32	.07	.47	.63	.40	* .02	.47	~
Pyro 2-33	.66	.91	.69	.86	.87	.88	.68	~

[1] Means comparison by t-test, $P \leq 0.05$.

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Root sucker data normalized using SQRT (root suckers+1).

Table 7a: Significance (*P* -value) of the effect of post-June drop thinning on tree vigor, fruit characteristics, and root suckers of 11-year-old (12th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	Fruit No. (no/tree) 8/24 16	Fruit Size (g) 8/24/16	Yield (kg/tree) 8/24/16	TCSA (cm^2) 10/18/16	Yield Efficiency (kg/cm^2)	Tree Height (cm) 10/18/16	Average Box Size (44 lb. box) 8/24/16	Average No. Boxes (per tree) 8/24/16	Root Suckers (no./tree)[3] 10/18/16
Rootstock[1,2]									
708-36	.24	.80	.46	.57	.35	.55	.94	.46	.73
BM 2000	.57	.27	.96	.28	.29	.55	.28	.97	~
Horner-4	.57	.69	.64	.24	.46	.35	.73	.65	.61
Fox 11	.16	.76	.14	.96	.10	.62	.35	.13	~
OHxF 87	.83	.46	.76	.65	.73	.21	.55	.76	~
Pyrodwarf	.20	.70	.19	.90	* .02	.98	.72	.20	~
Pyro 2-33	.11	.60	.11	.92	.10	.91	.51	.11	~

[1] Means comparison by T-test, $P \leq 0.05$. Root sucker data normalized using SQRT(root suckers+1) for *P* -value.

[2] * Indicates significance at $P \leq 0.05$.

[3] Root sucker data normalized using SQRT(root suckers+1).

Table 7b: Significance (*P* -value) of the effect of post-June drop thinning on tree vigor, fruit characteristics, and root suckers of 10-year-old (11th leaf) 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	No. Fruit (no./tree) 8/25/15	Fruit Size (g) 8/25/15	Yield (kg/tree) 8/25/15	TCSA (cm^2) 10/8/15	Yield Efficiency (kg/cm^2)	Average Box Size (44 lb.box) 8/25/15	Average No. Boxes (per tree) 8/25/15	Root Suckers (no./tree)[3] 10/8/15
Rootstock[1]								
708-36	.16	.81	.18	.31	.24	.48	.18	1.00
BM 2000	.21	.15	.12	** .01	.93	.33	.12	.13
Horner-4	.22	.93	.18	.85	.20	.87	.18	.41
Fox 11	.70	.78	.59	.90	.52	.85	.59	.37
OHxF 87	.12	.60	.15	.29	.35	.62	.15	1.00
Pyrodwarf	.12	.95	.08	.64	.10	.99	.08	~
Pyro 2-33	.64	.30	.53	.47	.53	.37	.52	.36

[1] Means comparison by t-test, $P \leq 0.05$.

[2] ** Indicates significance at $P \leq 0.01$. NS indicates not significant.

[3] Root sucker data normalized using SQRT(root suckers+1).

Table 8: Correlation coefficiants relating post-June drop fruit thinning to tree vigor and fruit characteristics of 10- to 11-year-old (11-12th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015-2016.

	2015				2016			
	Bartlett[3]		Bosc[4]		Bartlett		Bosc	
Correlation Model [1,2]	Unthinned (n=34)	Thinned (n=36)	Unthinned (n=27)	Thinned (n=25)	Unthinned (n=33)	Thinned (n=33)	Unthinned (n=25)	Thinned (n=25)
Yield Efficiency vs.								
No. Fruit	.81 ***	.75 ***	.91 ***	.84 ***	.67 ***	.74 ***	.89 ***	.77 ***
Yield	.68 ***	.65 ***	-.34	-.42 *	-.24	-.21	-.77 ***	-.61 **
Fruit Size	-.02	.12	.85 ***	.75 ***	.55 ***	.61 ***	.70 ***	.54 **
TCSA	.09	-.08	-.23	-.47 *	-.29	-.29	-.56 **	-.42 *
Yield vs.								
Fruit No.	.95 ***	.97 ***	.96 ***	.94 ***	.95 ***	.95 ***	.90 ***	.87 ***
Fruit Size	.51 **	.61 ***	.02	-.04	.37 *	.38 *	-.23	.11
TCSA	.76 ***	.67 ***	.25	.13	.59 ***	.53 ***	.15	.49 **
TCSA vs.								
Fruit No.	.61 ***	.56 ***	.08	-.08	.40 *	.33	-.21	.14
Fruit Size	.69 ***	.63 ***	.73 ***	.80 ***	.74 ***	.76 **	.82 ***	.71 ***
Fruit Size vs.								
Fruit No.	.26	.44 **	-.23	-.31	.08	.10	-.58	-.34

[1] **, *** Indicate a significant relationship at $P \leq 0.01$ and 0.001 respectively; absence of "*" indicates not significant.

[2] Correlation: Relatively Weak: 0.01-0.50; Moderately Strong: 0.51-0.89; Relatively Strong: 0.90-1.00.

[3] Bartlett 2015: Fruit thinned 6/18-19/15. Harvested 8/10/15; 2016: Fruit thinned 6/8/16. Harvested 8/3/16.

[4] Bosc 2015: Fruit thinned 6/18-19/15. Harvested 8/25/15; 2016: Fruit thinned 6/8/16. Harvested 8/24/16.

Table 9a: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of 11-year-old (12th leaf) 'Bartlett' and 'Bosc' pear trees, unthinned and thinned combined, Talmage, Mendocino County, California, 2016.

	6/22		7/20		8/17		9/14		10/4&5/2016		Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]												
708-36	15.2 cd	15.7 ab	9.9 b	12.7 ab	12.1 ab	18.3 ab	8.8 ab	13.1	11.0	16.0 b	11.4 bc	15.2 b
BM 2000	11.5 b	16.0 ab	8.6 ab	12.3 ab	13.6 bc	17.1 ab	8.6 ab	14.1	10.6	14.0 ab	10.6 bc	14.7 b
Horner 4	9.1 a	13.2 ab	7.4 ab	9.9 a	11.0 a	16.1 a	8.0 a	12.0	9.7	12.5 a	9.0 a	12.8 a
Fox 11	13.3 bc	13.6 ab	9.6 ab	12.1 ab	13.3 abc	17.2 ab	8.8 ab	13.5	10.2	14.2 ab	11.0 bc	14.2 ab
OHxF 69	14.1 cd	~	10.2 b	~	12.0 ab	~	7.9 a	~	10.5	~	11.0 b	~
OHxF 87	15.8 d	16.5 ab	9.5 ab	13.0 b	11.7 ab	19.8 b	7.9 a	13.8	9.6	15.1 ab	10.9 b	15.7 b
Pyrodwarf	13.7 cd	17.3 b	9.7 ab	12.4 ab	14.2 bc	19.2 ab	8.6 ab	14.2	8.7	14.4 ab	11.0 bc	15.5 b
Pyro 2-33	14.7 cd	16.2 ab	10.9 b	13.0 b	16.0 c	19.7 b	10.5 b	14.1	11.2	15.5 ab	12.7 c	15.7 b
Average	13.5	15.5	9.5	12.2	13.0	18.2	8.6	13.6	10.2	14.5	10.9	14.8
Established trees[3]	11.4	~	12.6	~	12.9	~	12.3	~	13.8	~	12.6	~
Baseline	7.8	7.8	7.3	7.7	8.1	8.5	7.0	7.4	6.7	6.7	7.4	7.6
ANOVA (*P* -value)[2]												
Rootstock	*** (<0.001)	** (0.01)	** (0.004)	** (0.01)	*** (<0.001)	** (0.01)	** (0.01)	NS (0.15)	NS (0.12)	* (0.04)	*** (<0.001)	*** (<0.001)
Block	*** (<0.001)	*** (<0.001)	** (0.01)	NS (0.09)	NS (0.95)	NS (0.10)	NS (0.59)	NS (0.14)	NS (0.38)	* (0.02)	* (0.02)	*** (<0.001)

[1] Within columns, means significantly different (Tukey HSD, $P \leq 0.05$).

[2] *, **, *** indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison

Fruit thinned 6/8/16. Harvested: Bartlett 8/3/16, Bosc 8/24/16.

Table 9b: Effect of rootstock on mid-day stem water potential (MSWP) (¯bars) of 10-year-old (11th leaf) 'Bartlett' and "Golden Russet" 'Bosc' pear trees, unthinned and thinned combined, Talmage, Mendocino County, California, 2015.

	6/25		7/30-31		8/27		9/24		Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]										
708-36	11.1 b	12.2 ab	15.4 b	13.2 bc	16.5 bc	24.3 b	16.7	14.9 b	15.0 c	16.2 b
BM 2000	9.8 ab	12.5 ab	12.6 ab	11.9 abc	14.2 ab	21.8 ab	15.1	15.5 b	12.9 ab	15.4 b
Horner 4	8.0 a	10.6 a	10.3 a	09.3 a	13.0 a	17.7 a	15.2	12.6 a	11.6 a	12.5 a
Fox 11	11.0 b	13.1 ab	14.3 b	10.5 ab	15.0 ab	22.2 b	15.9	12.5 a	14.1 bc	14.6 ab
OHxF 69	11.0 b	~	15.0 b	~	16.8 bc	~	14.2	~	14.3 bc	~
OHxF 87	9.9 ab	14.0 b	15.7 b	14.5 c	15.9 abc	24.1 b	16.2	15.3 b	14.4 bc	17.0 b
Pyrodwarf	11.3 b	13.4 b	14.6 b	12.9 bc	14.3 ab	22.1 b	15.0	15.1 b	13.8 bc	15.9 b
Pyro 2-33	11.6 b	12.7 ab	14.8 b	13.2 bc	18.9 c	21.3 ab	17.2	15.1 b	15.6 c	15.6 b
Average	10.5	12.6	14.1	12.2	15.6	21.9	15.7	14.4	14.0	15.3
Established Trees[3]	8.1	~	15.1	~	15.4	~	14.3	~	13.2	~
Baseline	7.5	8.1	7.4	7.3	8.1	9.2	7.7	7.8	7.7	8.1
ANOVA(*P*-value)[2]										
Rootstock	*** (<0.001)	**(0.01)	*** (<0.001)	***(<0.001)	*** (<0.001)	***(<0.001)	NS(0.51)	**(0.01)	*** (<0.001)	***(<0.001)
Block	NS (0.08)	NS (0.25)	NS (0.19)	**(0.002)	* (0.02)	**(0.01)	NS (0.46)	*** (<0.001)	** (0.003)	**(0.003)

[1] Within columns, means significantly different (Tukey HSD, $P \leq 0.05$).

[2] *, **, *** indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison

Fruit thinned 6/19/15. Harvested: Bartlett 8/10/15, Bosc 8/25/15.

Table 10a: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of unthinned 11-year-old (12th leaf) 'Bartlett' and "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	6/22		7/20		8/24	8/17	9/14		10/4		Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]												
708-36	16.1 d	15.4	9.8	14.3	14.0	18.7	7.8	12.3	9.7	16.0	11.5 ab	15.3
BM 2000	11.6 ab	17.6	8.3	10.5	15.8	15.7	8.7	15.7	11.2	15.0	11.1 ab	14.9
Horner 4	9.7 a	12.1	8.4	11.0	13.0	16.8	8.3	11.6	9.9	12.0	9.9 a	12.7
Fox 11	13.0 bc	13.5	10.3	10.7	16.7	17.9	9.4	13.3	11.6	14.5	12.2 b	14.1
OHxF 69	14.0 bcd	~	11.8	~	14.9	~	7.8	~	10.1	~	11.7 ab	~
OHxF 87	15.4 cd	16.9	9.4	13.3	16.9	20.5	7.8	13.9	9.1	15.2	11.7 ab	16.0
Pyrodwarf	13.0 bc	18.4	9.2	14.1	15.8	18.1	8.2	12.5	8.3	13.6	10.9 ab	15.2
Pyro 2-33	13.5 bcd	14.7	9.9	13.4	16.4	20.9	10.4	12.7	11.4	14.3	23.3 ab	15.2
Average	13.3	15.5	9.6	12.5	15.4	18.3	8.6	13.1	10.2	14.4	11.4	14.8
Established Trees[3]	11.4	~	12.6	~	12.9	~	12.3	~	13.8	~	12.6	~
Baseline	7.8	7.8	7.3	7.7	8.1	8.5	7.0	7.4	6.7	6.7	7.4	7.6
ANOVA (*P* -value)[2]												
Rootstock	*** (<0.001)	NS (0.23)	NS (0.44)	NS (0.14)	NS (0.21)	NS (0.20)	NS (0.12)	NS (0.57)	NS (0.15)	NS (0.54)	NS (0.11)	NS (0.18)
Block	** (0.002)	NS (0.10)	NS (0.26)	NS (0.42)	NS (0.07)	NS (0.36)	NS (0.21)	NS (0.26)	NS (0.79)	NS (0.85)	* (0.02)	NS (0.39)

[1] Within columns, means significantly different (Tukey HSD, $P \leq 0.05$).

[2] *, **, *** indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison.

Fruit thinned 6/8/16. Harvested: Bartlett 8/3/16, Bosc 8/24/16.

Table 10b: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of unthinned 10-year-old (11th leaf) 'Bartlett' and "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	6/25		7/30 & 31		8/27		9/24		Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]										
708-36	11.2	10.2	13.3 ab	10.7 ab	17.3	22.8 ab	14.9	16.2	14.9	14.3 ab
BM 2000	9.9	13.1	12.8 ab	13.8 ab	15.6	21.7 ab	13.2	16.2	13.2	16.2 b
Horner-4	9.0	10.2	11.9 a	8.7 a	11.6	16.6 ab	12.2	12.2	12.2	11.9 a
Fox 11	10.2	13.8	13.4 ab	9.7 ab	14.7	22.9 ab	13.0	12.5	13.0	14.7 ab
OHxF 87	9.9	12.9	17.0 b	14.6 b	15.4	25.1 b	14.4	15.5	14.4	17.1 b
Pyrodwarf	11.5	11.0	15.0 ab	12.2 ab	14.6	22.3 ab	14.5	14.4	14.5	15.4 ab
Pyro 2-33	10.6	12.1	11.3 a	14.0 b	19.5	21.3 ab	14.7	16.5	14.7	16.2 b
Average	10.5	12.4	13.7	11.9	15.6	21.8	13.8	14.4	13.9	15.1
Established Trees[3]	8.1	~	15.1	~	15.4		14.3		13.2	
Baseline	7.5	8.1	7.4	7.3	8.1	9.2	7.7	7.8	7.7	8.1
ANOVA (*P* -value)[2]										
Rootstock	NS (0.57)	NS (0.09)	* (0.05)	*(0.02)	NS (0.07)	*(0.04)	NS (0.55)	(0.07)	NS (0.07)	**(0.01)
Block	NS (0.25)	NS (0.19)	NS (0.07)	NS (0.22)	NS (0.47)	NS (0.17)	NS (0.98)	*(0.04)	NS (0.07)	NS (0.8)

[1] Within columns, means significantly different (Tukey HSD test, $P \leq 0.05$)

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison.

Fruit thinned 6/18-19/15. Harvested 8/10/15.

Table 11a: Effect of rootstock on mid-day stem water potential (MSWP) (¯bars) of thinned 11-year-old (12th leaf) 'Bartlett' and "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	6/22		7/20		8/24		8/17		9/14		10/5	10/4	Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]														
708-36	15.4 b	17.3	10.2	12.1	17.1	18.0	8.1	12.9	11.3	16.7	12.4	15.4		
BM 2000	11.7 ab	15.3	8.8	12.0	13.4	17.7	8.2	13.9	9.2	14.5	10.3	14.7		
Horner 4	8.9 a	13.5	7.0	9.4	13.0	16.9	8.3	10.5	10.0	12.8	9.4	12.6		
Fox 11	13.7 b	13.1	9.8	13.1	15.0	16.3	8.3	13.5	9.1	14.6	11.2	14.1		
OHxF 69	14.7 b	~	9.4	~	17.3	~	7.6	~	10.0	~	11.8	~		
OHxF 87	15.4 b	15.3	9.7	14.0	14.4	19.3	8.1	13.7	9.0	13.5	11.3	15.2		
Pyrodwarf	13.3 b	17.6	9.8	11.3	13.8	20.9	8.5	15.2	8.2	15.7	10.7	16.2		
Pyro 2-33	14.3 b	16.6	10.0	12.6	18.3	19.0	10.1	14.1	10.8	17.1	12.7	16.0		
Average	13.4	15.5	9.3	12.1	15.3	18.3	8.4	13.4	9.7	15.0	11.2	14.9		
Established Trees[3]	11.4	~	12.6	~	12.9	~	12.3	~	13.8	~	12.6	~		
Baseline	7.8	7.8	7.3	7.7	8.1	8.5	7.0	7.4	6.7	6.7	7.4	7.6		
ANOVA (*P* -value)[2]														
Rootstock	*** (0.001)	NS (0.10)	NS (0.19)	NS (0.11)	NS (0.21)	NS (0.63)	NS (0.63)	NS (0.11)	NS (0.58)	NS (0.41)	NS (0.16)	* (0.02)		
Block	NS (0.12)	** (0.01)	NS (0.15)	NS (0.23)	NS (0.23)	NS (0.84)	NS (0.97)	NS (0.29)	NS (0.72)	NS (0.21)	NS (0.37)	* (0.03)		

[1] Within columns, means significantly different (Tukey HSD test, $P \leq 0.05$)

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison.

Fruit thinned 6/8/16. Harvested: Bartlett 8/3/16, Bosc 8/24/16.

Table 11b: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of thinned 10-year-old (11th leaf) 'Bartlett' and "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	6/25		7/30 & 31		8/27		9/24		Average	
	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc	Bartlett	Bosc
Rootstock[1]										
708-36	10.5 ab	11.8 ab	15.6 bc	14.6	15.3	24.8	15.9	16.2	14.3 ab	16.9 b
BM 2000	9.6 ab	11.9 ab	11.0 ab	11.0	12.4	20.5	14.8	14.4	12.0 a	14.5 ab
Horner-4	7.9 a	11.7 a	9.6 ab	9.9	14.1	16.7	14.4	12.3	11.5 a	12.7 a
Fox 11	11.4 b	13.6 ab	15.7 bc	11.5	14.9	24.0	17.6	13.2	14.9 ab	15.6 ab
OHxF 87	9.5 ab	14.8 b	13.5 abc	14.2	15.5	23.6	17.1	15.8	13.9 ab	17.1 b
Pyrodwarf	11.0 b	14.9 b	15.3 bc	14.0	14.2	20.6	13.9	15.2	13.6 ab	16.2 b
Pyro 2-33	12.1 b	12.1 ab	16.9 c	13.0	17.5	19.7	17.0	14.1	15.9 b	14.7 ab
Average	10.4	13.0	14.0	12.6	15.1	21.4	15.5	14.4	13.8	15.4
Established Trees[3]	8.1	-	15.1	~	15.4		14.3		13.2	
Baseline	7.5	8.1	7.4	7.3	8.1	9.2	7.7	7.8	7.7	8.1
ANOVA (*P* -value)[2]										
Rootstock	**(0.002)	*(0.03)	**(0.004)	NS (0.17)	NS (0.13)	NS (0.06)	NS (0.66)	NS (0.22)	**(0.01)	**(0.01)
Block	NS (0.91)	NS (0.33)	NS (0.90)	NS (0.20)	NS (0.71)	NS (0.27)	NS (0.90)	NS (0.21)	NS (0.83)	NS (0.08)

[1] Within columns, means significantly different (Tukey HSD test, $P < 0.05$); Root sucker means by (Duncan Multiple Range Test $P \leq 0.05$).

[2] *, **, *** Indicate significance at $P < 0.05$, 0.01 and 0.001 respectively. NS indicates not significant.

[3] Unreplicated comparison.

Fruit thinned 6/18-19/15; Harvested 8/10/2015.

Table 12a: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of unthinned versus thinned 11-year-old (12th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2016.

	6/22			7/20			8/24			9/14			10/5			Average		
	Unthinned	Thinned	t-test[3]	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]																		
708-36	16.1 d	15.4 b	.19	9.8	10.2	.39	14.0	17.1	.83	7.8	8.1	.70	9.7	11.3	.34	11.5 ab	12.4	.73
BM 2000	11.6 ab	11.7 ab	.55	8.3	8.8	.25	15.8	13.4	.35	8.7	8.2	.54	11.2	9.2	.08	11.1 ab	10.3	.51
Horner 4	9.7 a	8.9 a	.82	8.4	7.0	.94	13.0	13.0	.37	8.3	8.3	.06	9.9	10.0	.31	9.9 a	9.4	.33
Fox 11	13.0 bc	13.7 b	.79	10.3	9.8	.75	16.7	15.0	.39	9.4	8.3	.78	11.6	9.1	.28	12.2 b	11.2	.44
OHxF 69	14.0 bcd	14.7 b	.96	11.8	9.4	.28	14.9	17.3	.36	7.8	7.6	.78	10.1	10.0	.95	11.7 ab	11.8	.76
OHxF 87	15.4 cd	15.4 b	.28	9.4	9.7	.25	16.9	14.4	.67	7.8	8.1	.77	9.1	9.0	.96	11.7 ab	11.3	.57
Pyrodwarf	13.0 bc	13.3 b	.78	9.2	9.8	.16	15.8	13.8	.23	8.2	8.5	.88	8.3	8.2	1.00	10.9 ab	10.7	.83
Pyro 2-33	13.5 bcd	14.3 b	.18	9.9	10.0	.68	16.4	18.3	.59	10.4	10.1	.30	11.4	10.8	.59	12.3 ab	12.7	1.00
Average	13.3	13.4		9.6	9.3		15.4	15.3		8.6	8.4		10.2	9.7		11.4	11.2	
Established trees[4]	11.4			12.6			12.9			12.3			13.8			12.6		
Baseline	7.8			7.3			8.1			7.0			6.7			7.4		
ANOVA (*P* -value)[2]																		
Rootstock	*** (<0.001)	*** (0.001)		NS (0.44)	NS (0.19)		NS (0.21)	NS (0.21)		NS (0.12)	NS (0.63)		NS (0.15)	NS (0.58)		NS (0.11)	NS (0.16)	
Block	** (0.002)	NS (0.12)		NS (0.26)	NS (0.15)		NS (0.07)	NS (0.23)		NS (0.21)	NS (0.97)		NS (0.79)	NS (0.72)		* (0.02)	NS (0.37)	

[1] Within columns, means significantly different (Tukey HSD test, $P \leq 0.05$, $P < 0.01$ for unthinned average.

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Means comparison by t-test, $P < 0.05$.

[4] Unreplicated comparison.

Fruit thinned 6/8/16. Harvested 8/3/16.

Table 12b: Effect of roostock on mid-day stem water potential (MSWP) (¯bars) of unthinned versus thinned 10-year-old (11th leaf) 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

	6/25			7/30			8/27			9/24			Average		
	Unthinned	Thinned	t-test[3]	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
Rootstock[1]															
708-36	11.2	10.5 ab	.56	13.3 ab	15.6 bc	.84	17.3 ab	15.3 ab	.12	14.9	15.9	.06	14.9 b	14.3 ab	*.03
BM 2000	9.9	9.6 ab	.43	12.8 ab	11.0 ab	*.03	15.6 ab	12.4 a	*.03	13.2	14.8	.97	13.2 ab	12.0 a	.08
Horner-4	9.0	7.9 a	.64	11.9 a	9.6 ab	.40	11.6 a	14.1 ab	.11	12.2	14.4	.51	12.2 a	11.5 a	.83
Fox 11	10.2	11.4 b	.11	13.4 ab	15.7 bc	*.03	14.7 ab	14.9 ab	.14	13.0	17.6	.16	13.0 ab	14.9 ab	*.01
OHxF 69	11.4	10.9 b	.83	14.5 ab	14.6 abc	.69	16.4 ab	16.9 b	.92	14.5	13.1	.17	14.5 b	13.9 ab	.42
OHxF 87	9.9	9.5 ab	.41	17.0 b	13.5 abc	.07	15.4 ab	15.5 ab	.57	14.4	17.1	.52	14.4 b	13.9 ab	.31
Pyrodwarf	11.5	11.0 b	.48	15.0 ab	15.3 bc	.82	14.6 ab	14.2 ab	.92	14.5	13.9	.13	14.5 b	13.6 ab	.62
Pyro 2-33	10.6	12.1 b	.65	11.3 a	16.9 c	.07	19.5 b	17.5 b	.33	14.7	17.0	.60	14.7 b	15.9 b	.37
Average	10.5	10.4		13.7	14.0		15.6	15.1		13.8	15.5		13.9	13.8	
Established Trees[4]	8.1			15.1			15.4			14.3			13.2		
Baseline	7.5			7.4			8.1			7.7			7.7		
ANOVA (P -value)[2]															
Rootstock	NS (0.57)	**(0.002)		* (0.05)	**(0.004)		NS (0.07)	NS (0.13)		NS (0.55)	NS (0.66)		NS (0.07)	**(0.01)	
Block	NS (0.25)	NS (0.91)		NS (0.07)	*NS (0.90)		NS (0.47)	NS (0.71)		NS (0.98)	NS (0.90)		NS (0.07)	NS (0.83)	

[1] Within columns, means significantly different (Tukey HSD test, $P \leq 0.05$)

[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant.

[3] Unthinned versus thinned means comparison by t-test, P<0.05).

[4] Unreplicated comparison.

Fruit thinned 6/19/15. Harvested 8/25/15.

Note: Unthinned, n=5, Thinned, n=4; Horner 4, and Pyrodwarf Unthinned, n=4, Thinned, n=4; 708-36, OHxF 87, Pyro 2-33 Unthinned, n=3, Thinned, n=3; BM 2000, Fox 11

Table 13a: Effect of rootstock on mid-day stem water potential (MSWP) (¯bars) of unthinned versus thinned 11-year-old (12th leaf) "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

	6/22			7/20			8/17			9/14			10/4			Average		
	Unthinned	Thinned	t-test[3]	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
ROOTSTOCK[1]																		
708-36	15.4	17.3	.53	14.3	12.1	.26	18.7	18.0	.66	12.3	12.9	.88	16.0	16.7	.87	15.3	15.4	.91
BM 2000	17.6	15.3	.06	10.5	12.0	.54	15.7	17.7	.74	15.7	13.9	.28	15.0	14.5	.82	14.9	14.7	.69
Horner 4	12.1	13.5	.08	11.0	9.4	.26	16.8	16.9	.82	11.6	10.5	.36	12.0	12.8	.69	12.7	12.6	.29
Fox 11	13.5	13.1	.78	10.7	13.1	.14	17.9	16.3	.55	13.3	13.5	.54	14.5	14.6	.62	14.1	14.1	.92
OHxF 87	16.9	15.3	.80	13.3	14.0	.51	20.5	19.3	.78	13.9	13.7	.91	15.2	13.5	.55	16.0	15.2	.84
Pyrodwarf	18.4	17.6	.87	14.1	11.3	.55	18.1	20.9	*.02	12.5	15.2	.13	13.6	15.7	.99	15.2	16.2	.40
Pyro 2-33	14.7	16.6	.96	13.4	12.6	.78	20.9	19.0	.28	12.7	14.1	.51	14.3	17.1	.92	15.2	16.0	.80
Average	15.5	15.5		12.5	12.1		18.3	18.3		13.1	13.4		14.4	15.0		11.4	14.9	
ANOVA (*P* -value)[2]																		
Rootstock	NS (0.23)	NS (0.10)		NS (0.14)	NS (0.11)		NS (0.20)	NS (0.63)		NS (0.57)	NS (0.11)		NS (0.54)	NS (0.41)		NS (0.18)	* (0.02)	
Block	NS (0.10)	** (0.01)		NS (0.42)	NS (0.23)		NS (0.36)	NS (0.84)		NS (0.26)	NS (0.29)		NS (0.85)	NS (0.21)		NS (0.39)	* (0.03)	

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$)

[2] *, ** Indicate significance at $P \leq 0.05$, and 0.01 respectively. NS indicates not significant.

[3] Unthinned versus thinned means comparison by t-test, P<0.05).

Fruit thinned 6/8/16. Harvested 8/24/16.

Table 13b : Effect of rootstock on mid-day stem water potential (MSWP) (-bars) of unthinned versus thinned 10-year-old (11th leaf) "Golden Russet" 'Bosc' pear trees, Talmage, Mendocino County, California, 2015.

	6/25			7/31			8/27			9/24			Average		
	Unthinned	Thinned	t-test[3]	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test	Unthinned	Thinned	t-test
ROOTSTOCK[1]															
708-36	10.2	11.8 ab	.49	10.7 ab	14.6	*.05	22.8 ab	24.8	.14	16.2	16.2	.13	14.3 ab	16.9 b	*.02
BM 2000	13.1	11.9 ab	.08	13.8 ab	11.0	.08	21.7 ab	20.5	**.01	16.2	14.4	.34	16.2 b	14.5 ab	.24
Horner 4	10.2	11.7 a	.40	8.7 a	9.9	.87	16.6 a	16.7	.50	12.2	12.3	.63	11.9 a	12.7 a	.06
Fox 11	13.8	13.6 ab	.69	9.7 ab	11.5	.37	22.9 ab	24.0	.79	12.5	13.2	.49	14.7 ab	15.6 ab	.71
OHxF 87	13.5	14.8 b	.32	14.6 b	14.2	.44	25.1 b	23.6	.66	15.5	15.8	.77	17.1 b	17.1 b	.80
Pyrodwarf	12.9	14.9 b	.15	12.2 ab	14.0	.55	22.3 ab	20.6	.33	14.4	15.2	.80	15.4 ab	16.2 b	.40
Pyro 2-33	13.2	12.1 ab	.36	14.0 b	13.0	.31	21.3 ab	19.7	.41	16.5	14.1	*.05	16.2 b	14.7 ab	.43
Average	12.4	13.0		11.9	12.6		21.8	21.4		14.4	14.4		15.1	15.4	
Baseline	8.1			7.3			9.2			7.8			8.1		
ANOVA (*P*-value)[2]															
Rootstock	NS (0.09)	*(0.03)		*(0.02)	NS (0.17)		*(0.04)	NS (0.06)		NS (0.07)	NS (0.22)		**(0.01)	**(0.01)	
Block	NS (0.19)	NS (0.33)		NS (0.22)	NS (0.20)		NS (0.17)	NS (0.27)		*(0.04)	NS (0.21)		NS (0.08)	NS (0.08)	

[1] Within columns *, ** indicate significance at P ≤ 0.05 and 0.01 respectively; NS = not significant (Tukey HSD test P ≤ 0.05).

[2] *, ** Indicate significance at *P* ≤0.05, and 0.01 respectively. NS indicates not significant.

[3] Unthinned versus thinned means comparison by t-test, *P* <0.05).

Fruit thinned 6/19/15. Harvested 9/19/15.

Unthinned, n=5, Thinned, n=4; Horner 4, and Pyrodwarf

Unthinned, n=4, Thinned, n=4; 708-36, OHxF 87, Pyro 2-33

Unthinned, n=3, Thinned, n=3; BM 2000, Fox 11

Table 14: Correlation coefficients relating mid-day stem water potential (MSWP) (¯bars) to tree vigor and fruiting characteristics of 10- to 11-year-old (11-12th leaf) 'Bartlett' and "Golden Russet"'Bosc' pear trees, Talmage, Mendocino County, California, 2015-2016.

	2015				2016			
	Bartlett[3]		Bosc[4]		Bartlett		Bosc	
MSWP vs.[1,2]	Unthinned (n=34)	Thinned[3] (n=36)	Unthinned (n=8)	Thinned (n=8)	Unthinned (n=33)	Thinned (n=33)	Unthinned (n=25)	Thinned (n=25)
No. Fruit (per tree)	.31	.27	.02	-.13	-.02	.03	-.46 *	-.02
Fruit Size (g)	.71 ***	.42 **	.69 ***	.82 ***	.66 ***	.68 ***	.61 ***	.50 **
Yield (kg/tree)	.46 **	.36 *	.19	.08	.19	.24	-.24	.15
TCSA (cm^2)	.59 ***	.48 ***	.75 ***	.89 ***	.46 **	.52 **	.58 **	.54 **
Yield efficiency (kg/cm^2)	.07	-.03	-.19	-.40 *	-.14	-.22	-.62 ***	-.39 *
Firmness (kg of force)	-.57 ***	-.66 ***	-.62 ***	-.48 **	-.41 *	.19	-.42 *	-.46 *
Soluble Solids (degrees brix)	-.02	.02	-.51 **	-.53 **	-.75 ***	-.39 *	-.15	-.61 ***

[1] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. a absence of "*" indicates not significant.

[2] Correlation: Relatively weak: + or - 0.01-0.50; Moderately strong: 0.51-0.89; Relatively strong: 0.90-1.00.

[3] Bartlett 2015: Fruit thinned 6/18-19/15. Harvested 8/10/15; 2016: Fruit thinned 6/8/16. Harvested 8/3/16.

[4] Bosc 2015: Fruit thinned 6/18-19/15. Harvested 8/25/15; 2016: Fruit thinned 6/8/16. Harvested 8/24/16.

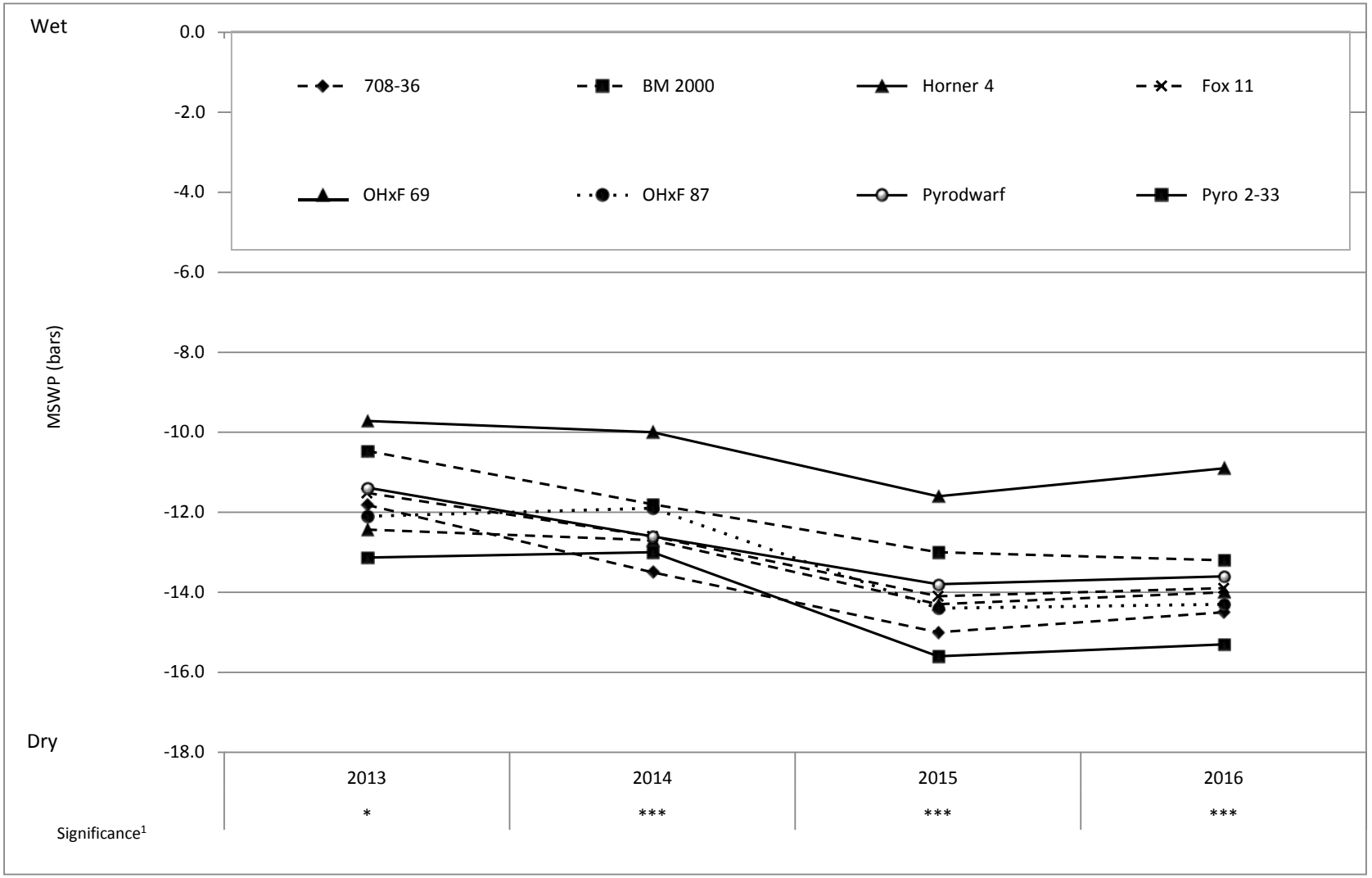


Figure 1: Effect of rootstock on average mid-day stem water potential (MSWP) (bars), 8-11-year-old 'Bartlett' pear trees, unthinned and thinned combined, Talmage, Mendocino County, California, 2013-2016

[1] *, *** Indicate significance at $P \leq 0.05$ and 0.001 respectively.

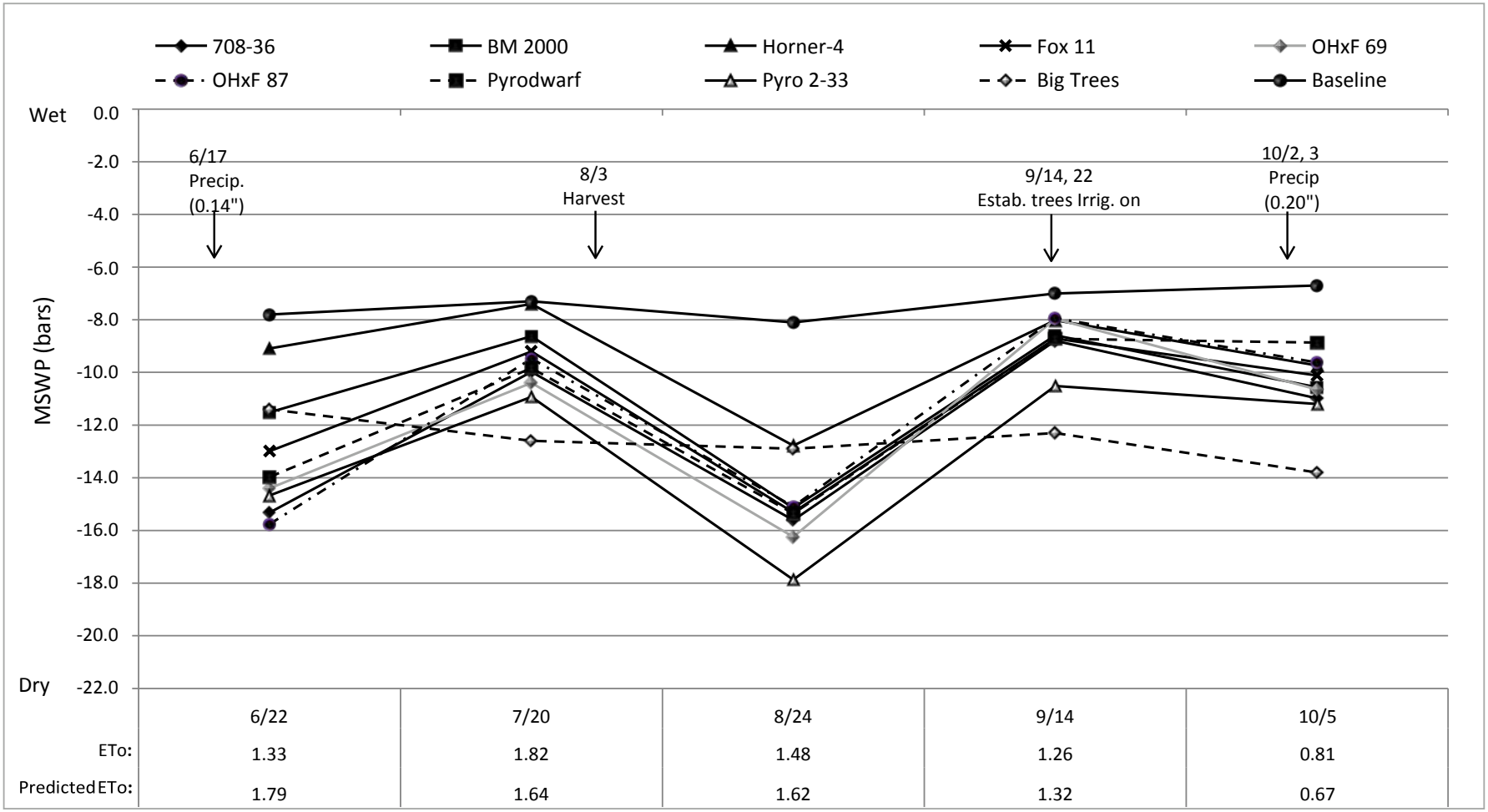
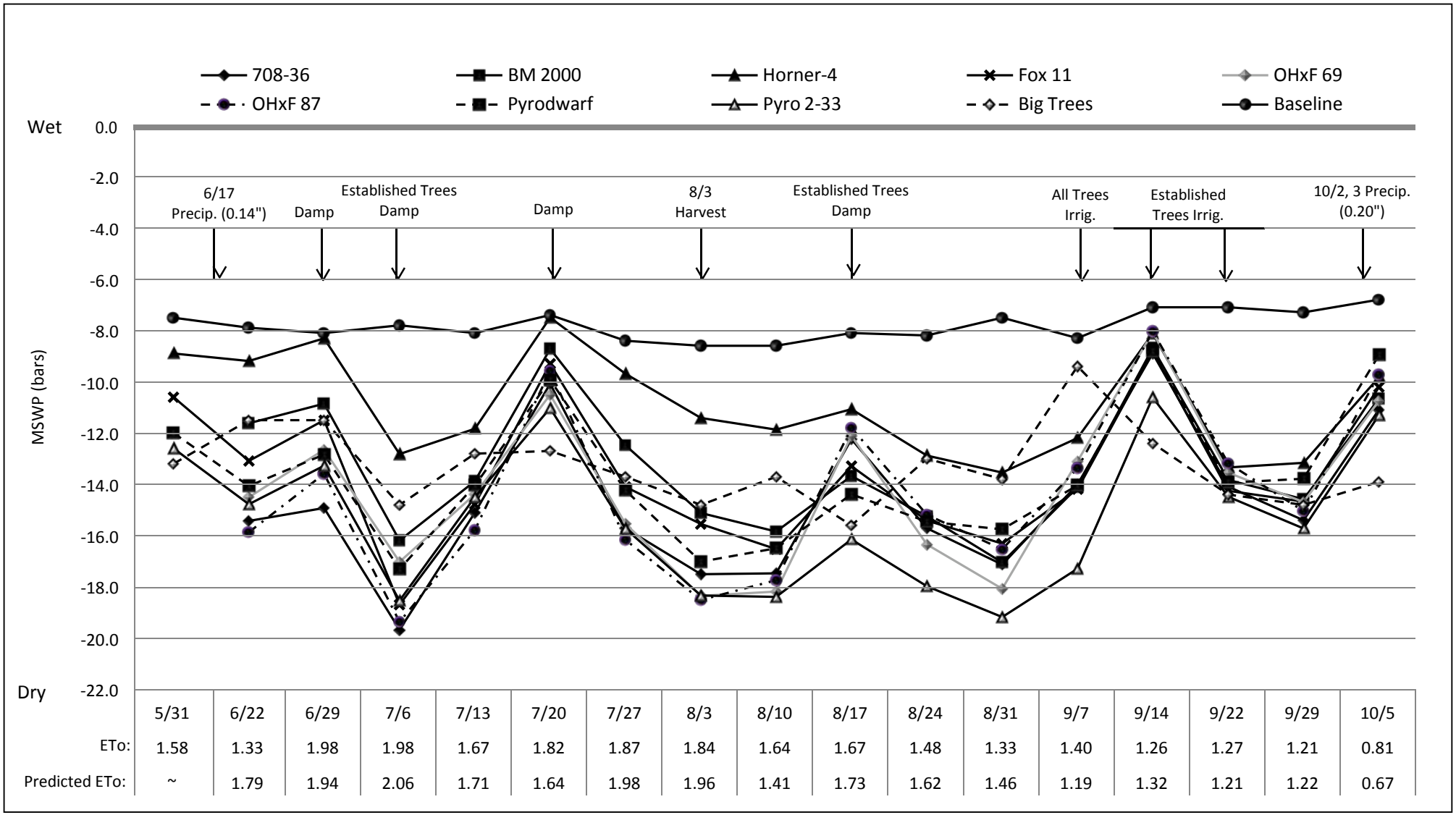


Figure 2: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) "Bartlett" pear trees, unthinned and thinned (June 8) combined, Talmage, Mendocino County, California, 2016.



	5/31	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/22	9/29	10/5
ETo:	1.58	1.33	1.98	1.98	1.67	1.82	1.87	1.84	1.64	1.67	1.48	1.33	1.40	1.26	1.27	1.21	0.81
Predicted ETo:	~	1.79	1.94	2.06	1.71	1.64	1.98	1.96	1.41	1.73	1.62	1.46	1.19	1.32	1.21	1.22	0.67

Figure 3: Effect of rootstock on average weekly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) 'Bartlett' pear trees, unthinned and thinned (June 8) combined, Talmage, Mendocino County, California, 2016.

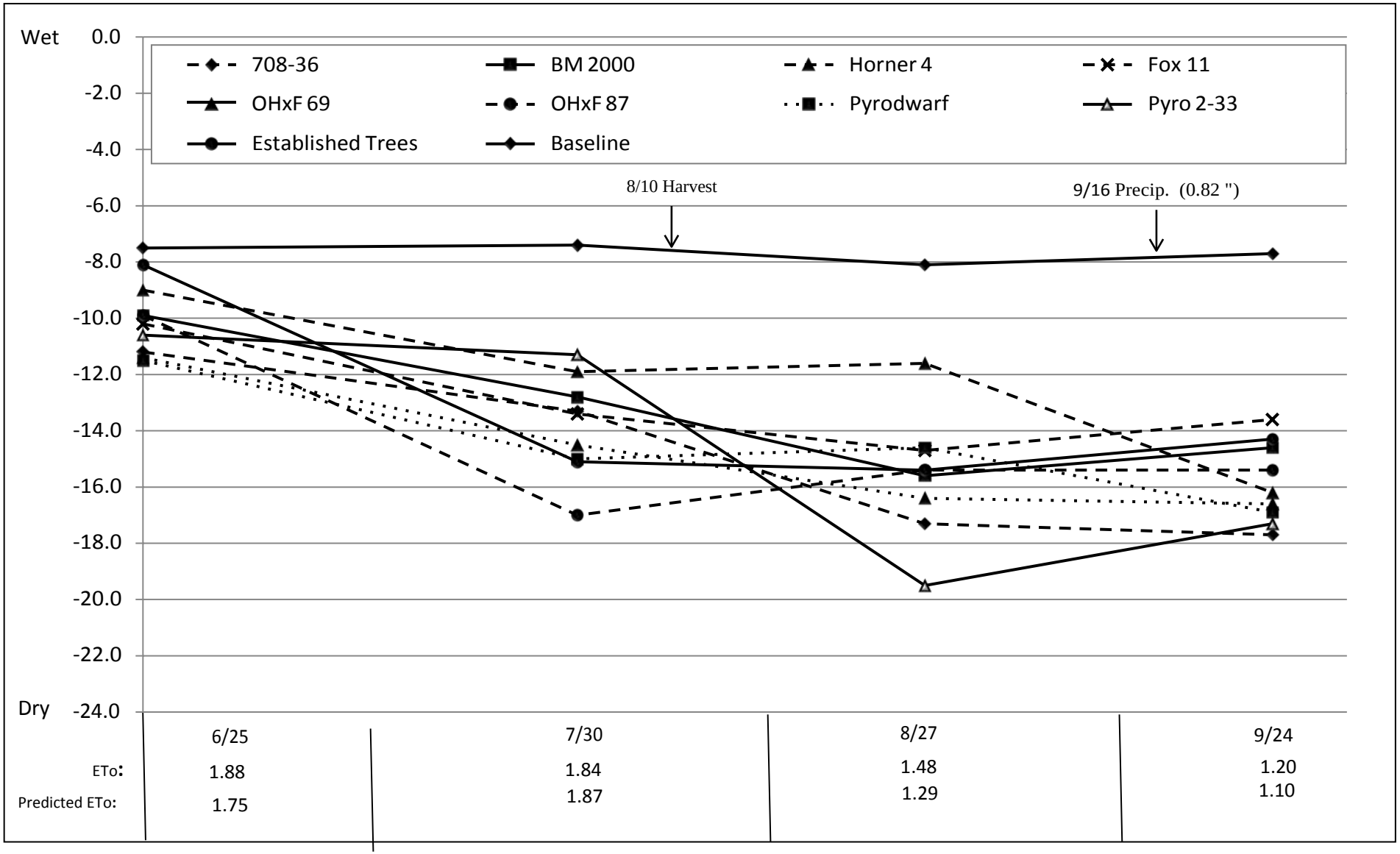


Figure 4: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf) 'Bartlett' pear trees, unthinned and thinned (June 19) combined, Talmage, Mendocino County, California, 2015.

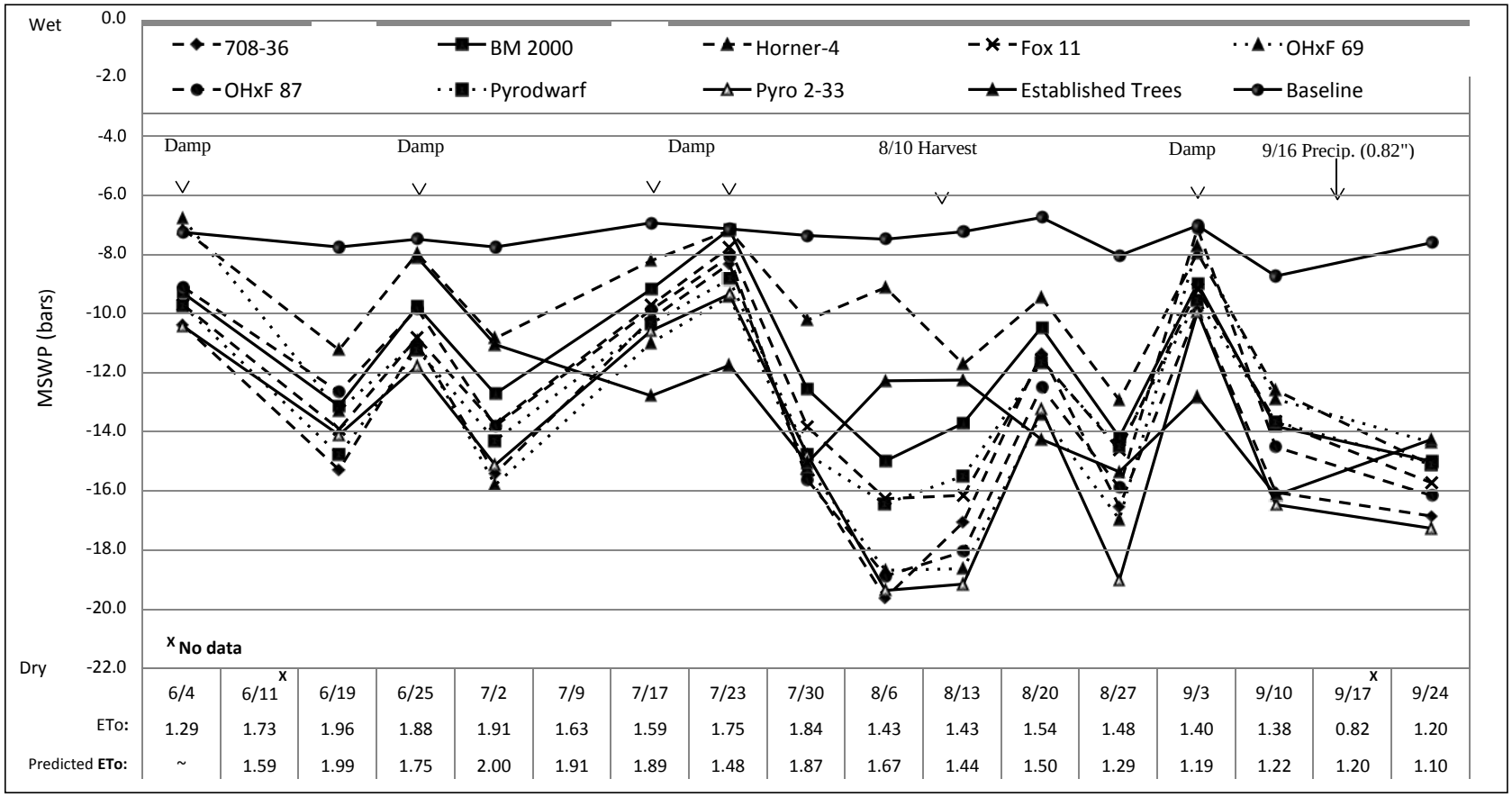


Figure 5: Effect of rootstock on average weekly mid-day stem water potential (MSWP) (bars), 11-year-old (10th leaf) 'Bartlett' pear trees, unthinned and thinned (June 19) combined, Talmage, Mendocino County, California, 2015.

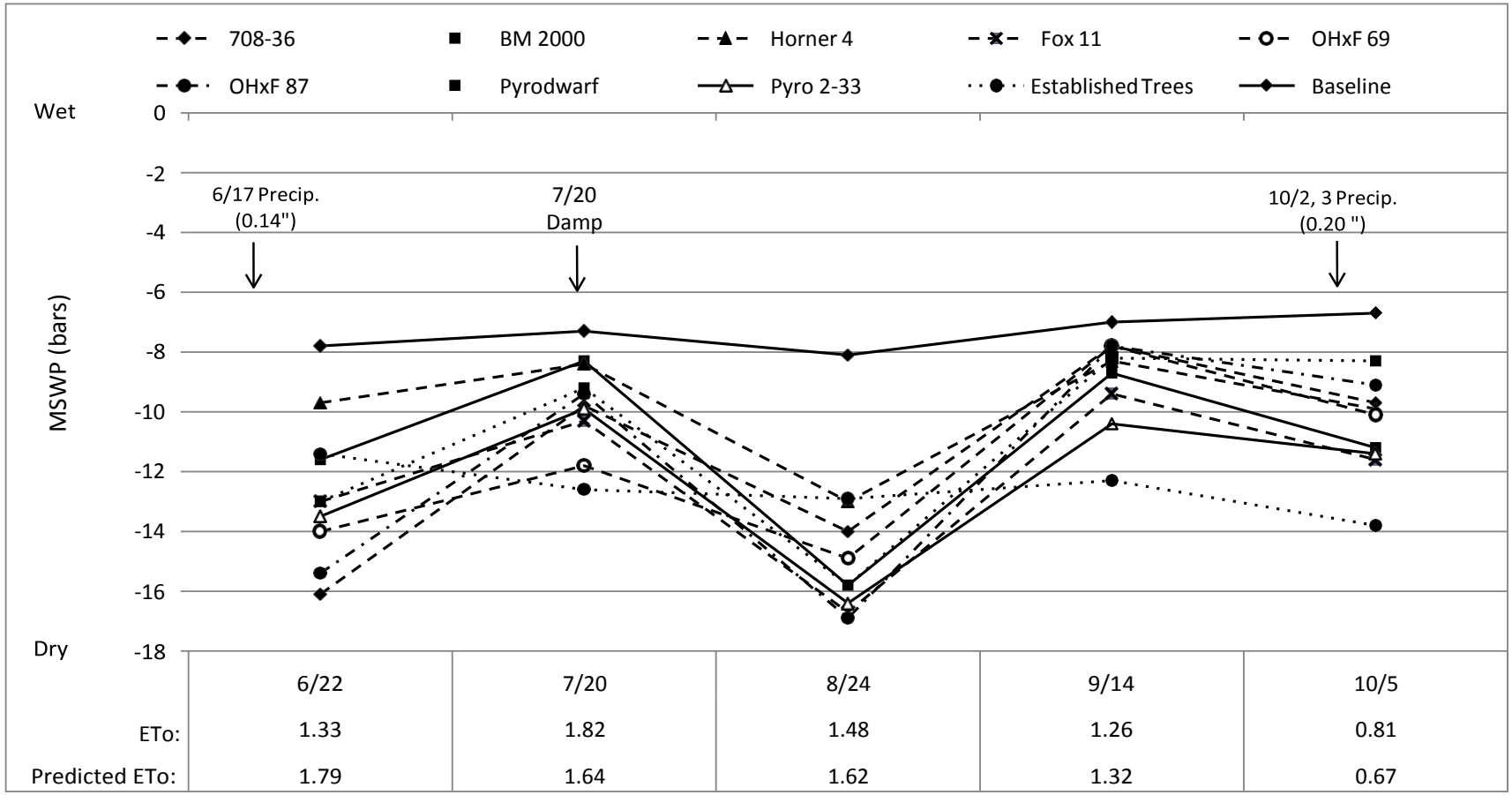


Figure 6: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) unthinned 'Bartlett' pear trees. Talmage, Mendocino County, California, 2016.

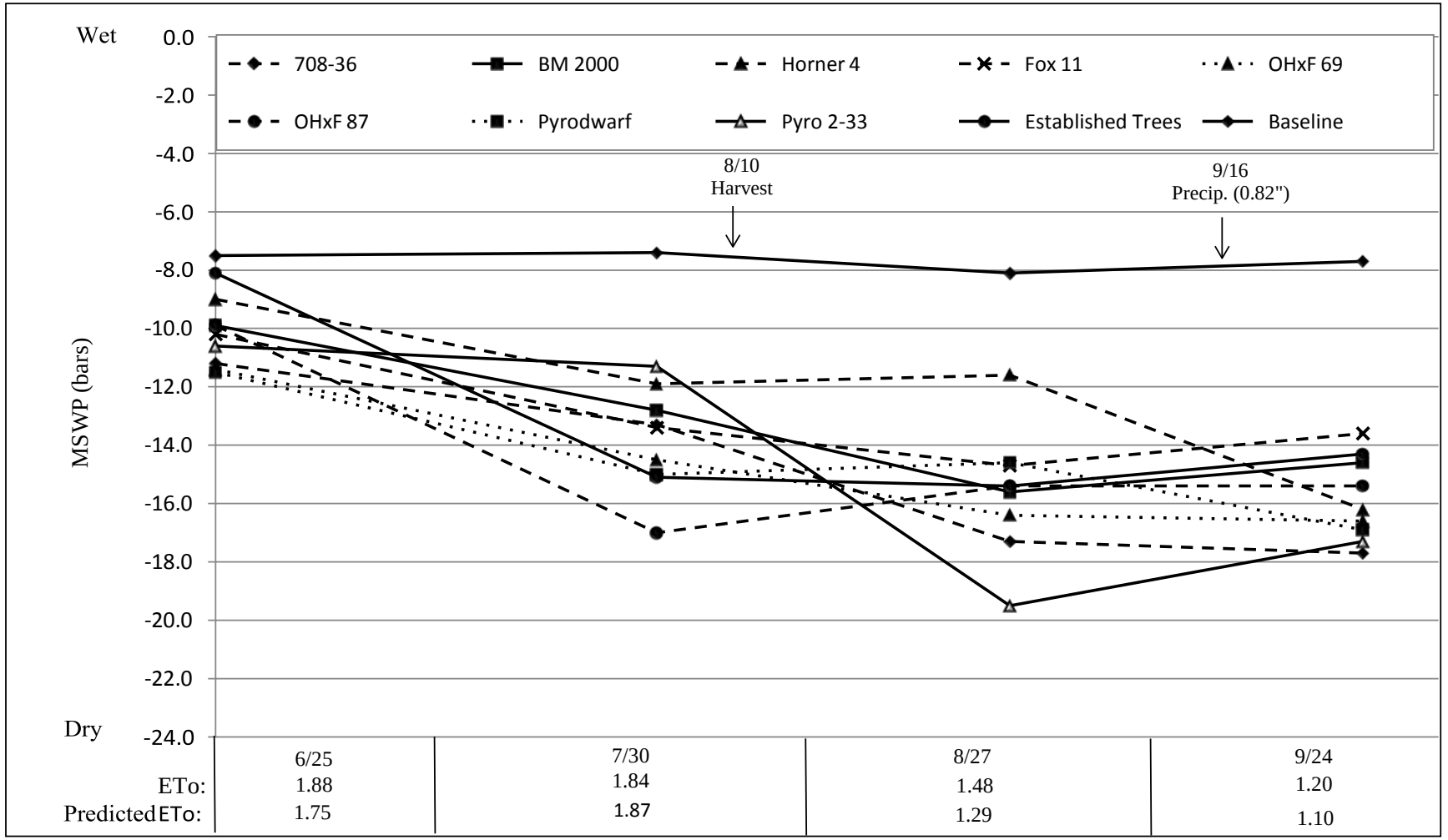


Figure 7: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf) unthinned "Bartlett" pear trees. Talmage, Mendocino County, California, 2015.

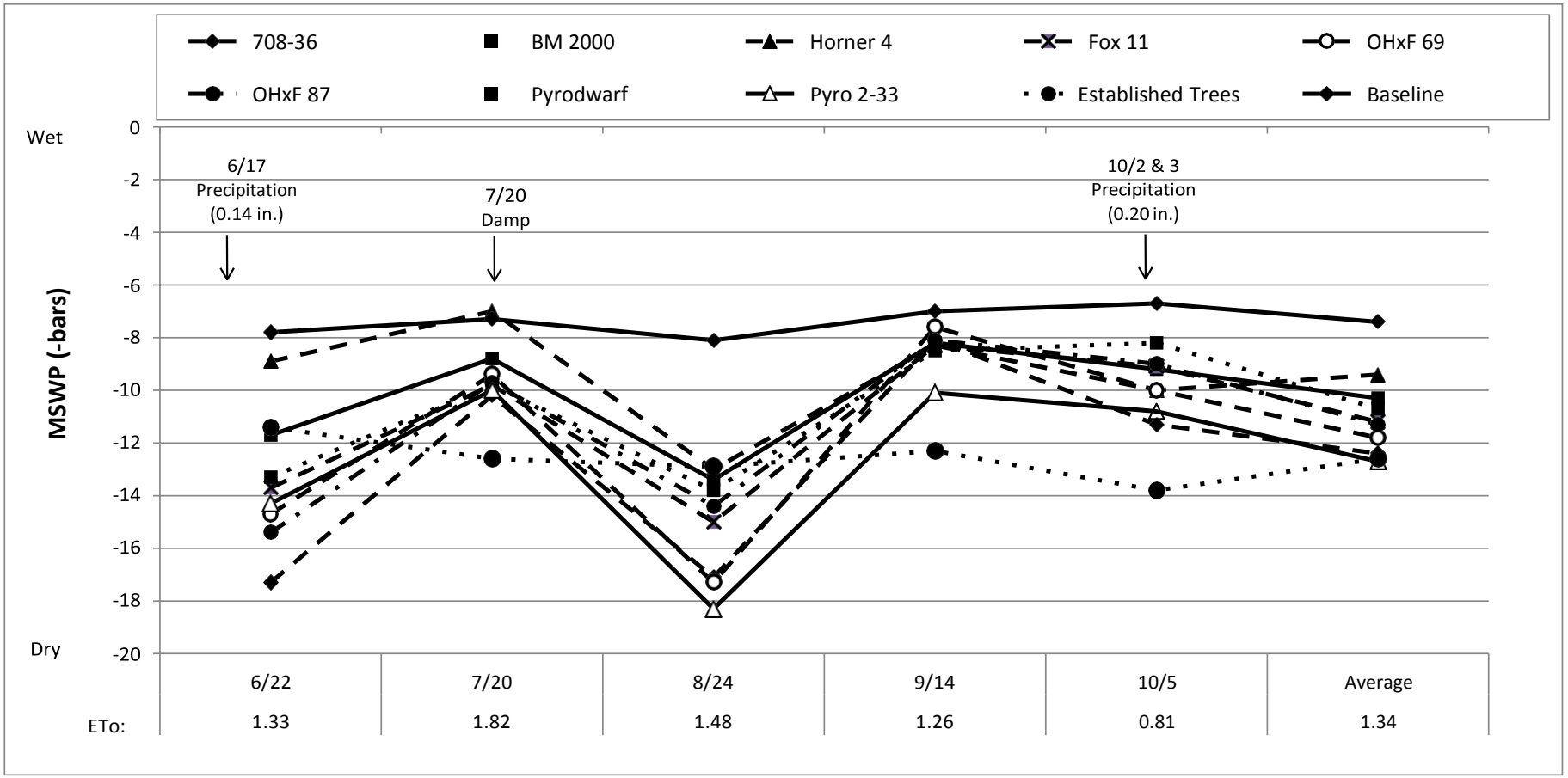


Figure 8: Average monthly mid-day stem water potential (MSWP) (-bars) following post-June drop fruit thinning (June 9), 11-year-old (12th leaf) thinned "Bartlett" pear trees, Talmage, Mendocino County, California, 2016.

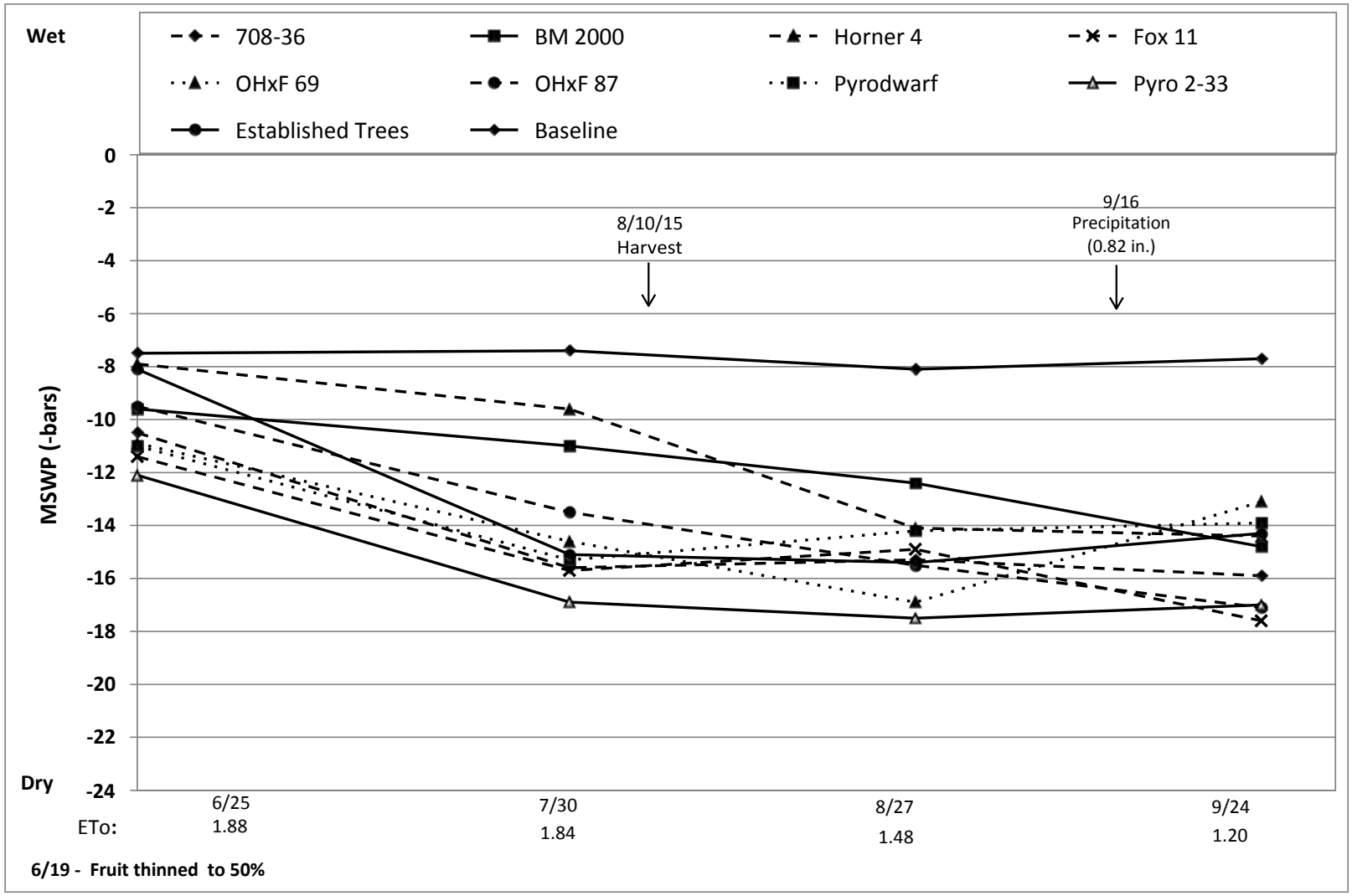


Figure 9: Average monthly mid-day stem water potential (MSWP) (-bars), 10-year-old (11th leaf) thinned 'Bartlett' pear trees, Talmage, Mendocino County, California, 2015.

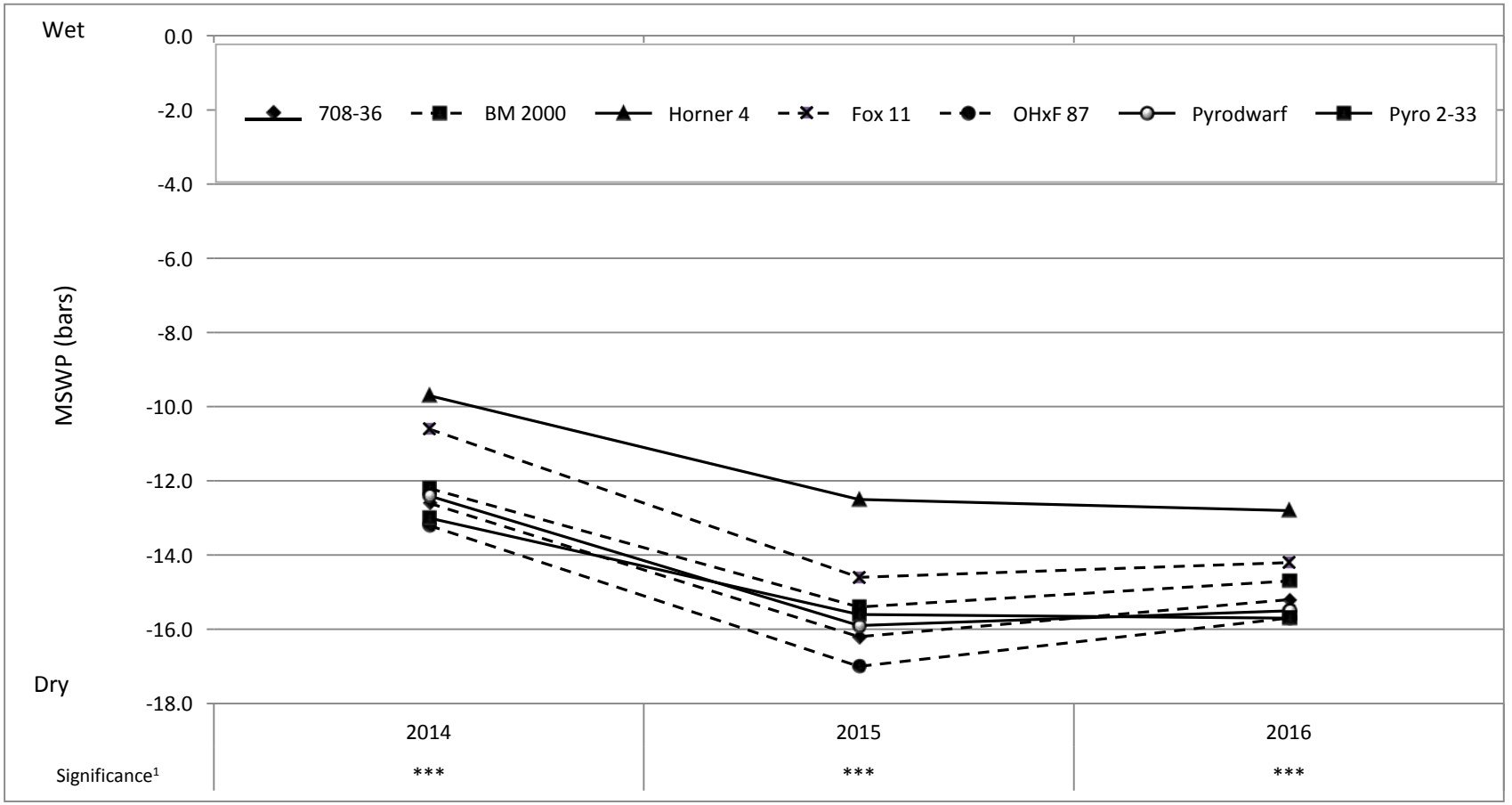


Figure 10: Effect of rootstock on mid-day stem potential (MSWP) (bars), 9 to 11-year-old (10-12th leaf) "Golden Russet" 'Bosc' pear trees, unthinned and thinned combined, Mendocino County, California, 2014-2016.

[1] *** Indicates significance at $P \leq 0.001$.

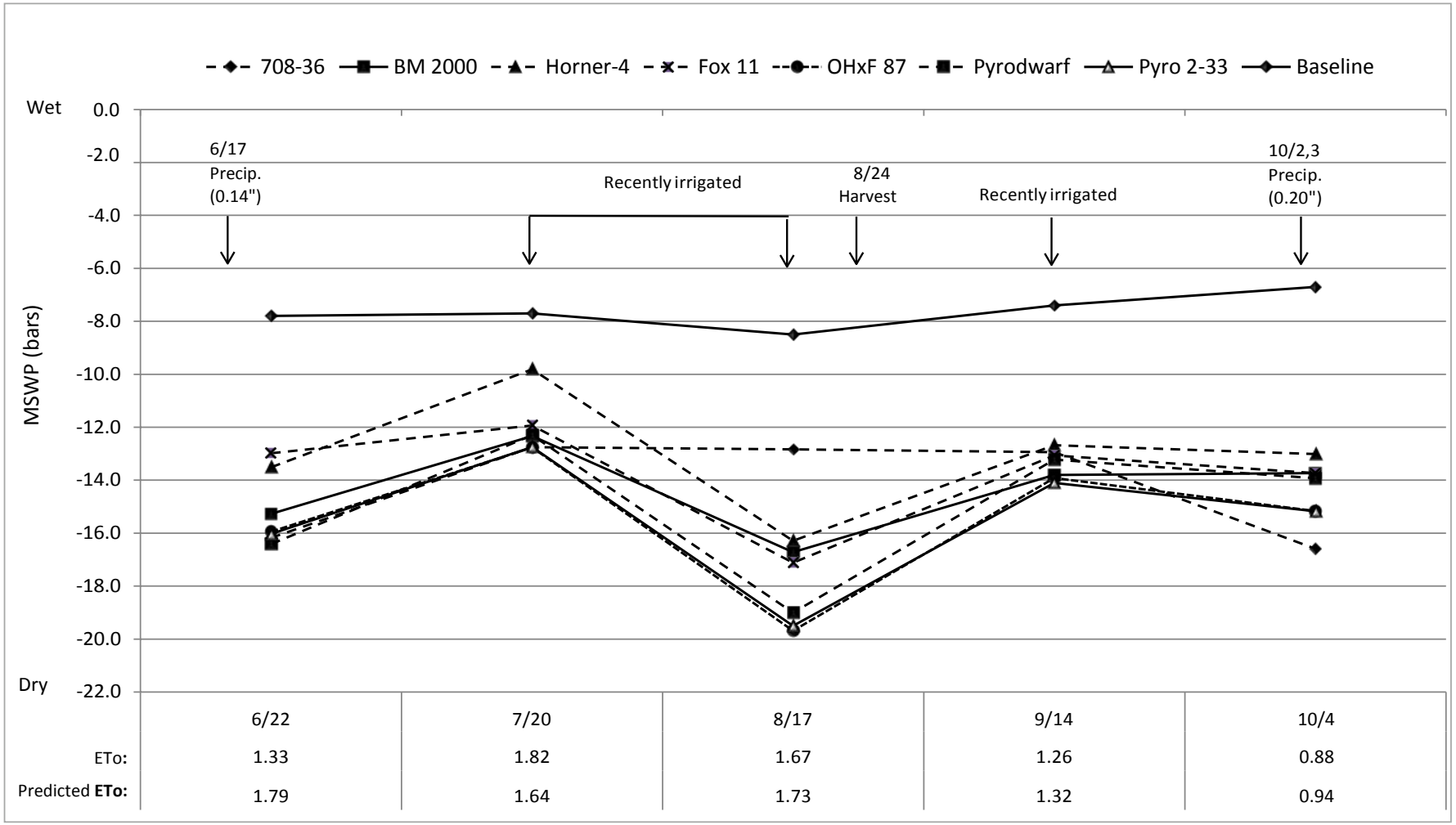


Figure 11: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) 'Golden Russet' 'Bosc' pear trees, unthinned and thinned (June 8) combined, Talmage, Mendocino County, California, 2016.

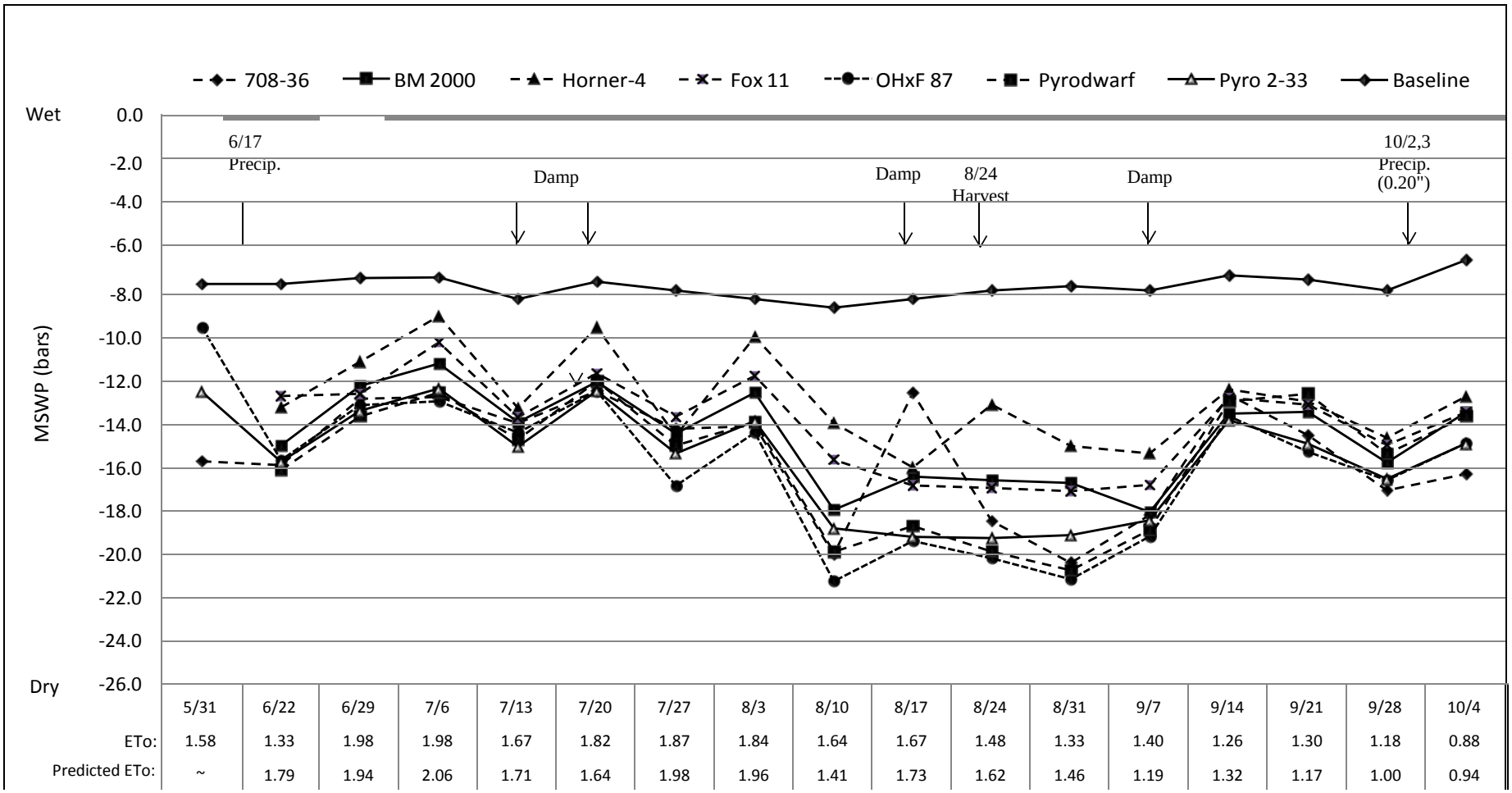


Figure 12: Effect of rootstock on average weekly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) 'Golden Russet' 'Bosc' pear trees, unthinned and thinned (June 8) combined, Talmage, Mendocino County, California, 2016.

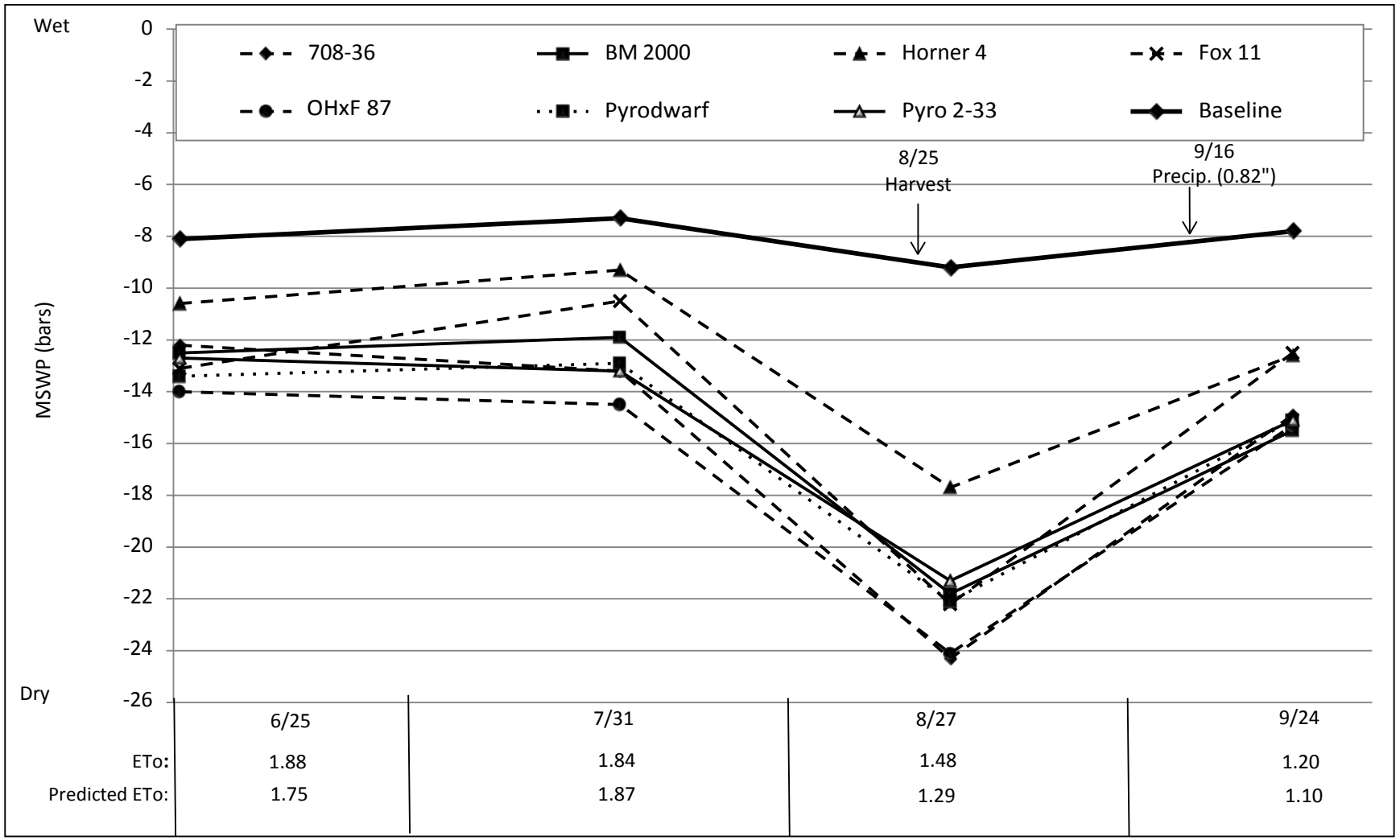
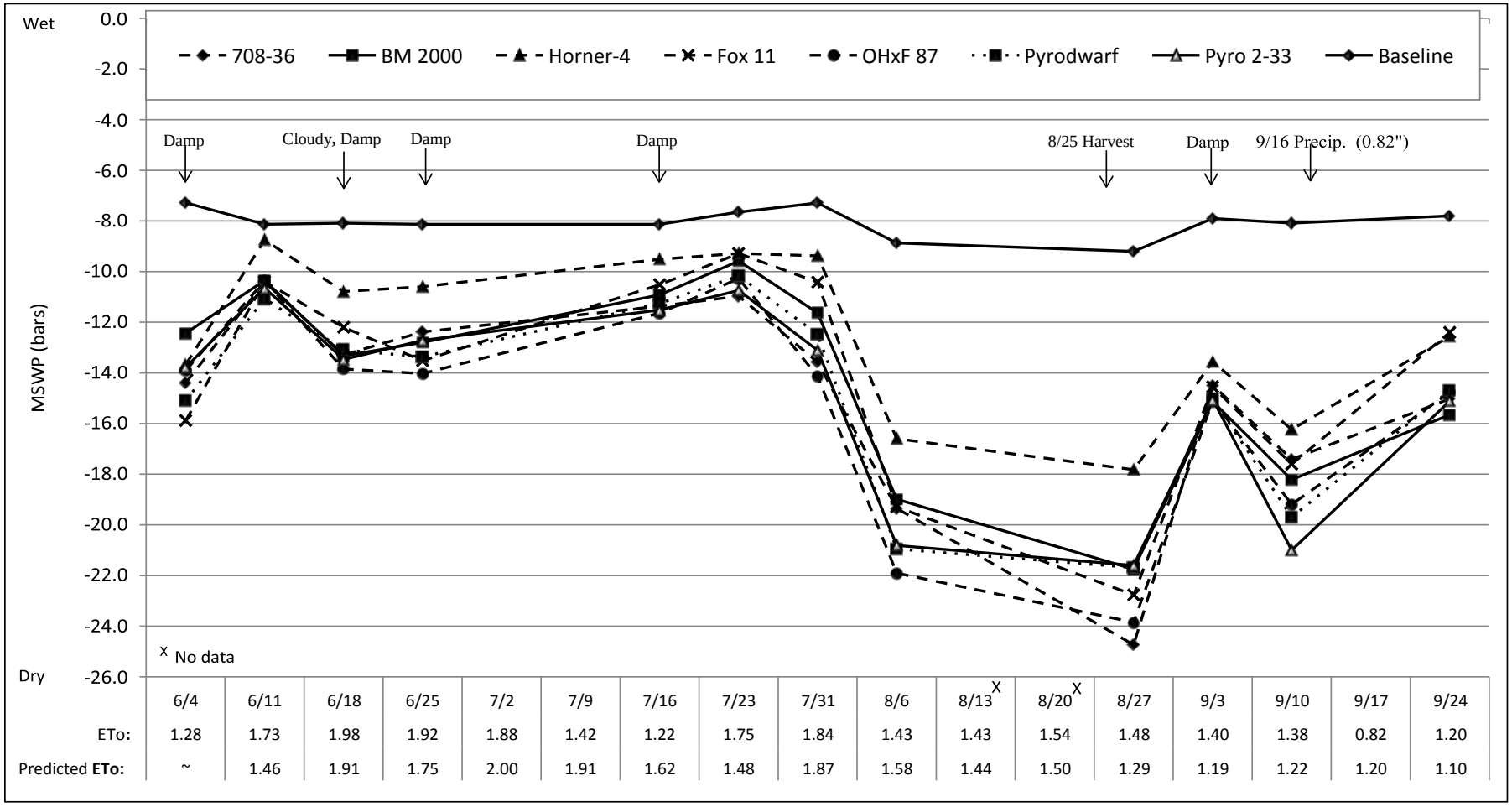


Figure 13: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf), 'Golden Russet' 'Bosc' pear trees, unthinned and thinned (June 18) combined, Talmage, Mendocino County, California, 2015.



	6/4	6/11	6/18	6/25	7/2	7/9	7/16	7/23	7/31	8/6	8/13 X	8/20 X	8/27	9/3	9/10	9/17	9/24
ETo:	1.28	1.73	1.98	1.92	1.88	1.42	1.22	1.75	1.84	1.43	1.43	1.54	1.48	1.40	1.38	0.82	1.20
Predicted **ETo:**	~	1.46	1.91	1.75	2.00	1.91	1.62	1.48	1.87	1.58	1.44	1.50	1.29	1.19	1.22	1.20	1.10

Figure 14: Effect of rootstock on average weekly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf) ‘Golden Russet’ 'Bosc' pear trees, unthinned and thinned combined, Talmage, Mendocino County, California, 2015.

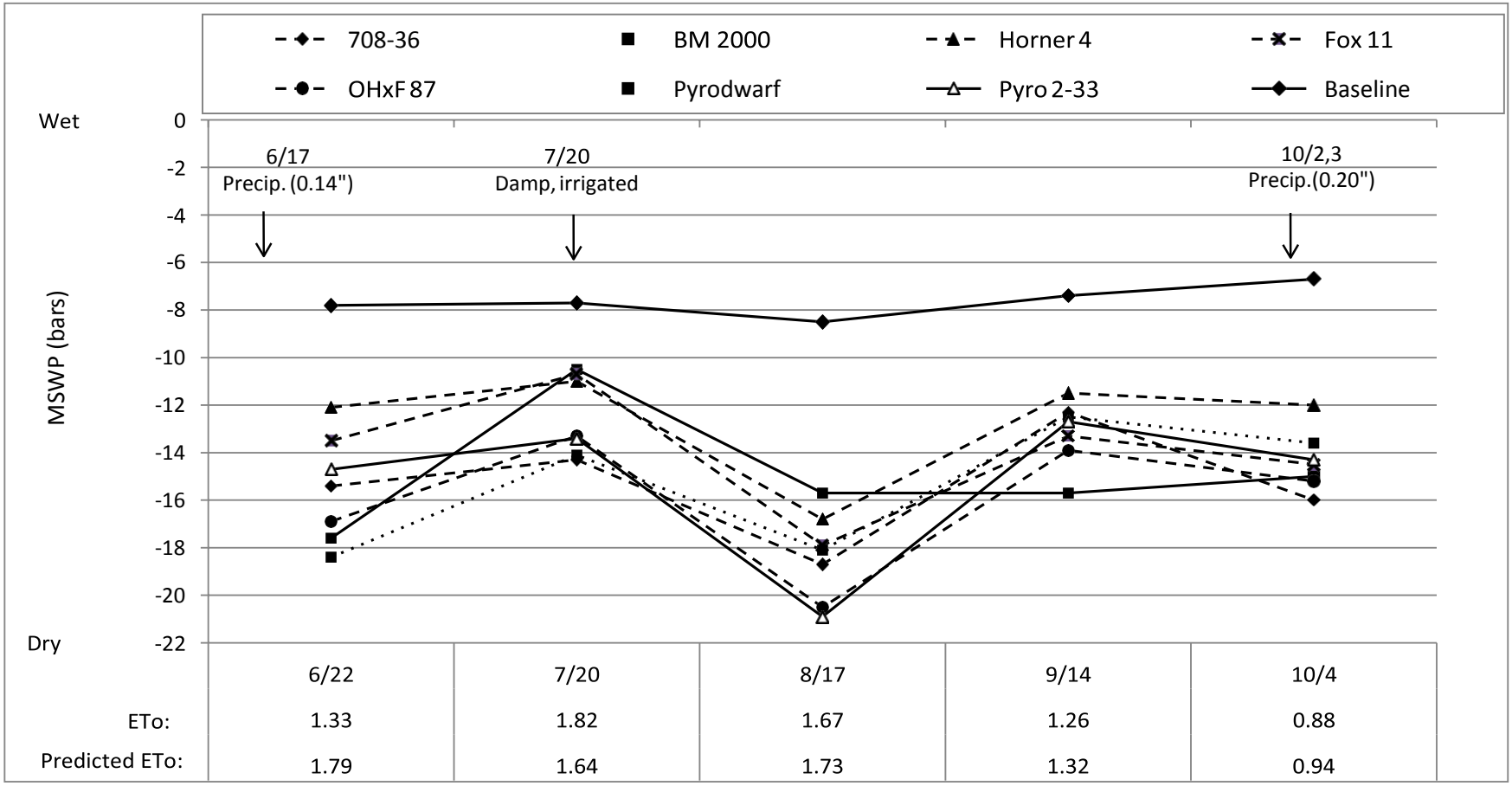


Figure 15: Effect of rootstock on average monthly mid-day stem water potential (MSWP) (bars), unthinned 'Golden Russet' 'Bosc' pear trees, Talmage, Mendocino County, California, 2016.

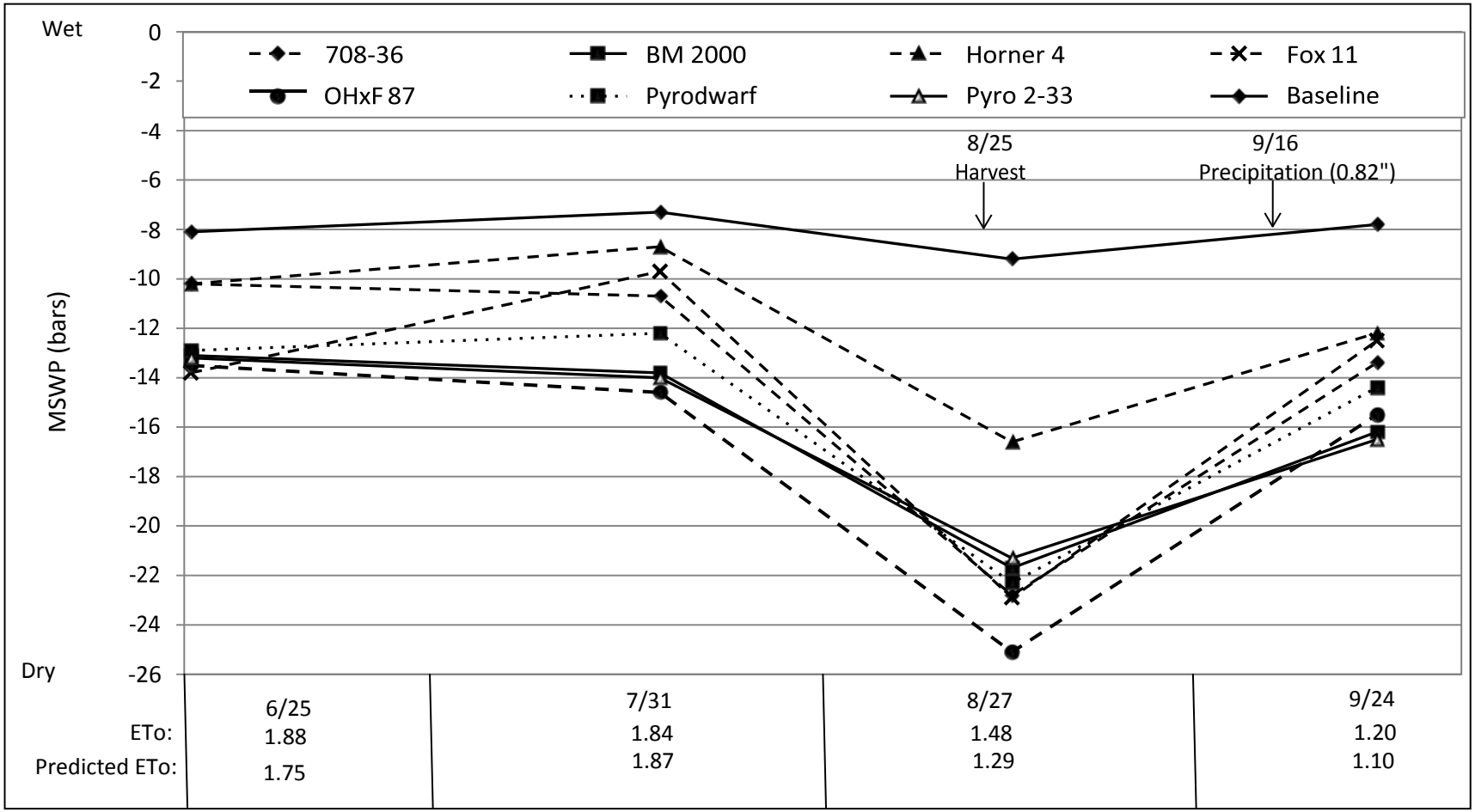


Figure 16: Average monthly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf) unthinned ‘Golden Russet’ 'Bosc' pear trees,Talmage, Mendocino County, California, 2015.

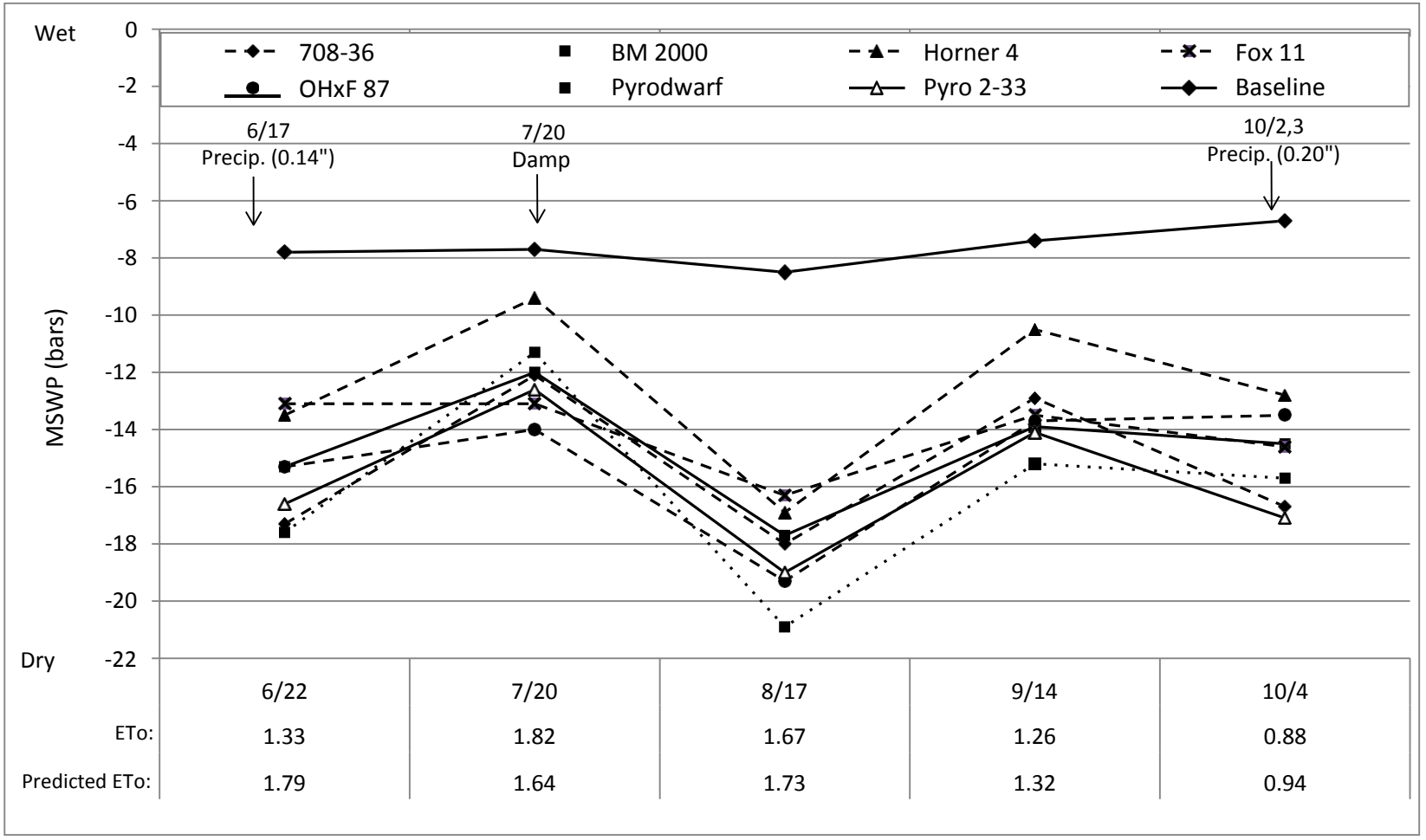


Figure 17: Average monthly mid-day stem water potential (MSWP) (bars), 11-year-old (12th leaf) thinned (June 8) ‘Golden Russet’ 'Bosc' pear trees,Talmage, Mendocino County, California, 2016.

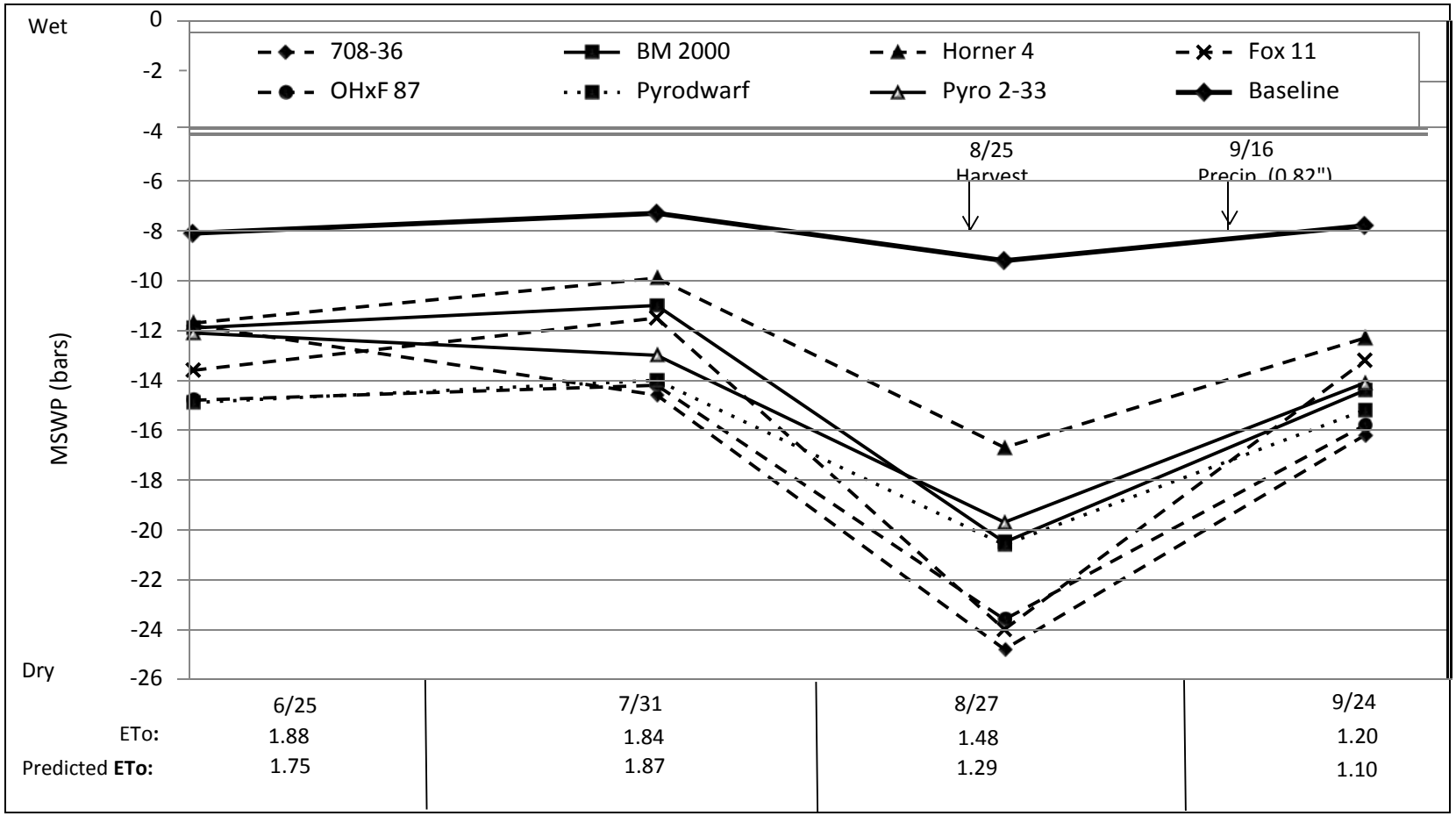


Figure 18: Average monthly mid-day stem water potential (MSWP) (bars), 10-year-old (11th leaf) thinned (June 18) 'Golden Russet' 'Bosc' pear trees,Talmage, Mendocino County, California, 2015.