

FINAL PROJECT REPORT

Project Title: Maintenance of WSU-IAREC cherry breeding plantings

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Total Project Funding: \$150,000 (\$125,144.61 actual spending)

Budget History:

Budget 1:

Organization Name: WA Tree Fruit Research Commission (WTFRC)

Contract Administrator: Kathy Coffey

Telephone: 509 665 8271

Email address: Kathy@treefruitresearch.com

WTFRC Collaborative expenses:

Item	2015	2015 actual
Wages	8,366	11,703
Benefits	3,256	8,837
Supplies	200	1,500
Travel to plots	2,160	6,240
WTFRC staff	1,500	
Total	15,482	28,280

Footnotes: Total includes full fruit sampling of WSU-Roza, Pasco, and Wenatchee of selected P1 and selected P2 genotypes; budget table does not include exempt personnel hours.

Budget 2:

Organization Name: WSU Prosser

Telephone: 509 335 4564

Contract Administrator: Carrie Johnson

Email address: carriej@wsu.edu

Item	2015	2015 actual
Salaries ¹	6,588	3,167.66
Benefits	3,030	1,372.57
Wages ²	32,000	20,549.00
Benefits	3,136	8,000.00
Supplies	809	11,998
Travel	3,000	
Plot fees ³	9,025	9,025
Plot establishment and maintenance	65,500	
Total	93,818	54,113.61

¹ Salary and benefits for Assoc in Research, Mojtaba Chavoshi (July 1 – Sept 30) to collect field data and complete labeling..

² Wages and benefits for (7) temporary employees @ \$10/hr, 40 hrs, for 6 wks, (2) temporary employees @ \$10/hr, 40 hrs, for 2 wks, and 1 hourly supervisory employee @ \$20/hr, 40 hrs, for 8 wks for remaining data collection and lab analysis.

³ Land use fee is \$475/acre.

Budget 3: Todd Einhorn**Organization Name:** OSU-MCAREC**Telephone:** 541-737-3228**Contract Administrator:** L.J. Koong**Email address:** l.j.koong@oregonstate.edu

Item	2015	2015 actual
Salaries¹	3,666	4,230
Benefits²	2,456	2,919
Wages³	6,139	12,044
Benefits⁴	347	1,004
Fees and Supplies⁵	8,284	8,284
Travel	0	0
Miscellaneous		
Total	20,892	28,481

¹ Salaries are for: 0.083 FTE (1 month) for technician to include planting, irrigation, fertilization, tree training, data collection (bloom, harvest, analyses of fruit quality attributes, vegetative growth, etc.) in selected genotypes of the P2 trial.

² Actual OPE rate is 67%.

³ Wages are for two part-time employees (\$13/hr) to assist with tree planting, harvest, data collection and analyses. In addition, 120 hours (1 week for 3 part-time employees via Certified Personnel Services [CPS] at a contracted labor rate of \$16.49/hr [\$1,979]) are factored into year 1 for installation of the bird netting structure.

⁴ Benefits for part-time employees is 8.34% - benefits only apply to the two \$13/hr employees, and not for the CPS laborers.

⁵ Supplies include materials for bird netting structure over 2 acres [factored into year 1 only]; tree guards/paint; tree training materials (bamboo, spreaders, tape); fertilizer; filters and buffers for juice analysis; lab tape; and, labels. Fees include per acre research plot fees: \$3,104/acre. Not all supplies have been purchased yet, but our estimates should be accurate.

Budget 4**Organization Name:** Willow Drive Nursery Inc. **Contract Administrator:** Hal Leedy**Telephone:** 509 787 1555**Email address:** Hal@willowdrivenursery.com

Item	2015	2016	2017
Salaries			
Benefits			
Wages			
Benefits			
Equipment			
Supplies			
Tree propagation¹:			
advanced selections	13,593	13,593	13,593
Parents	677	677	677
Miscellaneous			
Total	14,270	14,270	14,270

¹ Tree propagation fee is \$11.23 per tree, with a target of 60 trees per genotype. Purchased trees include 5 PNWSCBP selections and 5 commercial cultivars.

Graf distributed a weekly summary of ongoing and planned horticultural and crop protection activities to all participants via e-mail. The project budget as submitted did not include netting early maturing selections to avoid bird damage, thus netting activities by WTFRC employees were an additional expense. Specific horticultural accomplishments for 2015 include:

- P2 trellis system completed
- Site preparation (added 1ft of top soil for P2)
- Planting, training, drip irrigation installation of P1 and P2 at Roza
- Drought related irrigation schedule adjustments and irrigation system modifications, including maintenance and monitoring
- Frost control, pruning/brush clean-up, spray program adjustment to provide maximum plot access, soil tests, nutrient sprays, fertilizer application, weed control, mowing, rodent control, netting

Horticultural improvements were made in the WSU-Roza P2 block beginning in July, 2014. Further improvements were made during 2015. These improvements include standardization of the irrigation systems, improved weed control, improved nutrition, and an aggressive program to manage sage rats and gophers. Basic orchard health has noticeably improved and current horticultural practices will be followed in the future in order to maintain tree health and to enhance tree uniformity.

4. Fruit and foliar evaluations in selected genotypes in P1 and P2 plantings:

P1: Plantings were inspected twice a week starting in mid-May by a team of at least two participants at each time point, including: Dena Ybarra, Tom Auvil, Ines Hanrahan, Jeff Cleveringa, Dave Allan, Sue Watkins. As early maturing selections ripened, netting was erected. Field evaluations targeted market class (early, mid or late), fruit size, and firmness. Postharvest evaluation of fruit from promising selections was conducted at WTFRC (June 4-12) and at WSU-IAREC (after June 12). WTFRC evaluations used standard protocols established by Ines Hanrahan and protocols were distributed to BPAC and WSU on August, 6 and will be available on November 9, 2015 during the BPAC meeting. IAREC evaluations were conducted by WSU breeding program support personnel under the direction of Sue Watkins with input from Ines Hanrahan, Tom Auvil and BPAC.

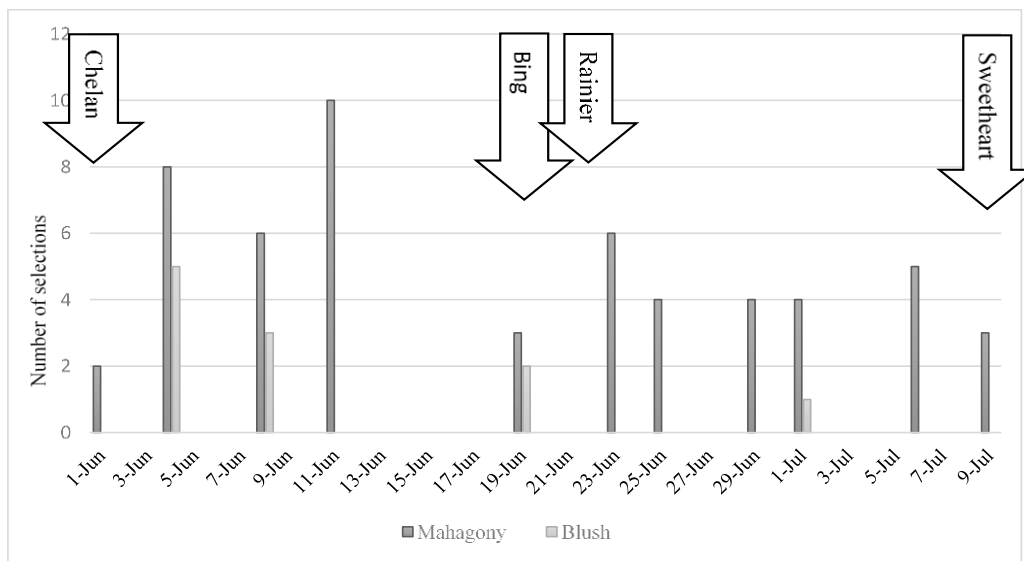


Figure 1: P1 selections selected for laboratory evaluation in 2015

A total of 66 P1 selections (55 mahogany, 11 blush) were harvested for laboratory analysis in 2015. As depicted in Fig. 1, the harvest sequence of selections included:

- Early (Chelan timing): 10 mahogany, 5 blush
- Mid-season (Bing timing): 37 mahogany, 6 blush
- Late (Sweetheart timing): 8 mahogany

No selections were harvested in 2015 that ripened before Chelan or after Sweetheart. Only ten selections met the BPAC minimum quality criteria (>10 row, 300 g/mm² firmness) (Table 2). Additional observations were recorded to aid genetic analysis of traits and to fine tune future breeding efforts. Table 2 shows some examples of selections with unusual traits that may be of interest. Data will be provided to Cameron Peace's lab. All P1 selections (1,395 individuals with 32% Sweetheart OP and 102 other parent combinations) were evaluated for mildew infection following a protocol established by Claudia Probst and Ines Hanrahan. Briefly, leaves were rated on a scale of 0-4 (0=zero, 1=mild, 2=moderate, 3=severe infection). In summary, 86 parent combinations had zero leaf infection present in late July. A selection of progeny with the highest number of individual uninfected trees is shown in Table 3. Most notable are progeny of Selah x MIM13, in which all individuals in ten families were completely free of mildew symptoms.

Table 3: Foliar powdery mildew (PM) severity of selected parentage lines in P1

Cross	# of trees	PM score ¹				PM severity (%)			
		0	1	2	3	0	1	2	3
<i>Rainier X Chelan</i>	39	28	3	7	1	71.8	7.7	17.9	2.6
<i>Sweetheart OP</i>	294	19	27	155	93	6.5	9.2	52.7	31.6
<i>12.Sweetheart.OP</i>	155	18	56	63	18	11.6	36.1	40.6	11.6
<i>FR009T033/G6</i>	18	16	1	1	0	88.9	5.6	5.6	0.0
<i>13.8011-2.OP</i>	33	15	18	0	0	45.5	54.5	0.0	0.0
<i>Selah x MIM13</i>	10	10	0	0	0	100.0	0.0	0.0	0.0

¹PM score performed on leaves in late July; 0=zero, 1=mild, 2=moderate, 3=severe leave symptoms

P2-Washington: Plantings have been established in four locations (Table 5). In addition to the significant heat stress in the 2015 season, robust evaluation was compromised by the absence of, commercial standards for comparison at all sites. All plot maps were revised by WTFRC program staff to correct significant row and tree numbering errors and to make plot interpretation easier. A map for the Roza P2 planting will be provided November 9. Adjustments in this map for 2015 include: we inverted the map to match it to the aerial view, two missing trees were added, 2015 planting was added, all selections were changed to R numbers. In general, there are 5 trees of each advanced selection in the WSU-Roza P2 planting, but some selections are present in lower or higher numbers. The experiment is arranged in a randomized incomplete block design.

All protocols and plot maps will be shared on November 9, 2015 with BPAC and WSU.

WTFRC efforts on 2015 were focused on early selections. Hence, all known early maturing phenotypes and selected industry standards were hand thinned (R2, R25, R7, R6, Chelan, Bing, Rainier, Early Robin). Standard phenotyping protocols were improved or newly developed by Ines Hanrahan and distributed to WSU, OSU and BPAC on August 6. Further modifications will be made based on input from the RosBREED team. A master flow chart for harvest activities and draft protocols to assess heat injury and internal color were developed and distributed to WSU and BPAC

on Aug. 6, 2015. 2015 phenotyping results will be distributed on November 9 (due to space constraints) but firmness and size are summarized in Table 4.

Table 4: Row size and firmness at harvest for P2 selections and selected standards from Roza in 2015.

Selection + harvest date	Row size	Firmness	Selection + harvest date	Row size	Firmness
	(8-13)	(g/mm)		(8-13)	(g/mm)
Early Robin 6/4	9.8	304	Bing 6/15	11.1	282
Early Robin 6/8	9.8	277	Bing 6/25	11.0	269
Early Robin 6/11	9.6	280	Chelan 6/1	11.3	290
Early Robin 6/15	9.7	291	Lapin 6/29	11.1	-
R9 6/8	9.7	333	R2 6/8	11.0	274
R9 6/11	9.3	299	R6 6/25	9.5	278
R9 6/15	9.5	286	R6 6/29	10.3	278
R10 6/4	10.5	334	R8 6/29	10.1	334
R10 6/8	10.5	282	R14 6/8	10.6	253
R10 6/15	10.4	228	R14 6/11	9.0	-
R10 6/18	10.3	241	R14 6/15	11.2	283
R10 6/25	10.0	255	R15 6/8	11.3	269
R10 Thinned 6/15	8.8	177	R15 6/11	11.5	242
R10 Thinned 6/25	8.4	266	R25 6/4	11.0	337
R16 6/8	10.5	312	Sweetheart 7/6	11.3	228
Rainier 6/8	10.6	271			
Rainier 6/11	10.0	270			
Rainier 6/18	10.4	252			

Weekly industry samples were distributed within Washington and Oregon BPAC members (list available upon request).

Key findings for P2 plots in 2015 include:

- Neither Pasco nor Wenatchee P2 plots have standard cultivars included for comparison
- Fruit size for fast track selection R2 was smaller than the BPAC threshold (>10mm). Further horticultural challenges include: fruit maturity one week ahead of Chelan, fruit maturity widespread within the tree, excessive preharvest fruit drop, inconsistent taste
- R25 was the only Chelan timing selection currently in P2. Its fruit was medium size, firm, no doubles, not cracking sensitive, good taste across several color grades, uneven color development, very crunchy
- All mahogany selections previously classified as late-maturing were classified as Bing-Lapins harvest timing; R6 exhibits the best fruit quality characteristics of this maturity group
- Data on three blush selections contradicted available program records. They had been identified as mid/late season or mis-labeled as mahogany. Data collection was compromised since no green fruit thinning was performed
- Wenatchee: 3 of 5 genotypes are Rainier season blush (R5, R7, R11), no late season genotype
- Prosser: inconsistent tree vigor and overset trees (no green fruit thinning performed because 2015 maturation was much earlier than previously observed); compromised fruit quality data for all but R2, R25, Chelan; all other selections evaluated had delayed harvest dates, softer

- fruit, reduced size; elevated temperatures at harvest affected consistency of fruit maturation patterns
- Budget deviations (Prosser P1 + 2):
 - o 6 additional genotypes assessed in P2 based on observed maturation pattern in 2015 (R8, R9, R10, R14, R15, R16)
 - o Bird netting (P1 and P2): 91 trees
 - o Opportunistic evaluation based on extreme heat events
 - WTFRC team assessed heat damage
 - 7 genotypes (R10, R6, R16, R8, Bing, Sweetheart, Rainier)

Table 5: P2 and P3 selection distribution and experimental design in 2015

	Location	Replication	Standards	Number of entries
P2	Hood River	YES/NO ^Y	NO	27
	Prosser ^z	YES/NO ^y	YES	27
	Pasco	YES	NO	11
	Wenatchee	YES ^Y	NO	5
P3	Pasco	NO	YES	1
	Hood River	NO	YES	1
	Orondo	NO	YES	1

^z R7 not enough fruit for evaluation in 2015

^y replication is incomplete or missing for some entries

5. Management of plan material in greenhouse:

The WSU program made multiple crosses during 2015. Seed has been scarified and germinated. Seedlings were transplanted to 7" plastic cones containing vermiculate/sunshine mix and incubated in a controlled-environment room at 60°F. When root bound, (November/December) seedlings will be transplanted and moved to the greenhouse.

2015 Outreach Activities by WTFRC team

- June 12: Program update and P2 field day
- June 21: Program update and discussion of heat damage, North Central Washington Fieldmen's Association
- August 6: Season summary by WTFRC staff to WSU and BPAC
- December 8: P2 updates and discussion of heat damage at WSTFA (upcoming)

Table 2: Fruit harvest date and fruit quality parameters for P1 selections in the Pacific Northwest Sweet Cherry Breeding Program. WSU Roza, 2015

Orchard Block	Harvest Date	Selection ID	Market class	Weight g	SSC °Brix	TA %	Firmness (g/mm)	Row size (8-13)	Color (1-7) ¹	Cracking (%) ²	Special characteristic
			Mahogany/blush								
SELECTIONS MEETING BPAC SELECTION CRITERIA IN 2015											
F	5/28	R19	Mahogany	NA	NA	NA	345	9.9	2.1	73.4	
C	6/8	3-35	Mahogany	10.8	19.3	0.73	313	9.4	4.6	NA	
F	6/18	45-76	Blush	14.0	22.9	0.90	310	8.8 ³	NA	NA	
F	6-19	Bing	Mahogany	10.6	21.6	1.11	242	NA	NA	NA	standard
F	6/22	54-19	Blush	12.3	20.6	1.12	305	9	NA	NA	
F	6/23	57-87	Mahogany	12.2	23.9	1.02	301	9.3 ³	4.0	NA	
F	6/23	61-56	Mahogany	12.9	24.6	1.06	368	NA	6.0	NA	
C	6/25	1-78	Mahogany	11.8	25.0	1.09	300	NA	5.3	NA	
F	6/25	39-117	Mahogany	16.5	20.4	0.75	309	NA	5.0	NA	
C	6/29	3-47	Mahogany	9.5	21.0	0.88	338	9.5	6.0	NA	
C	7/1	1-79	Mahogany	10.9	21.0	0.94	324	9.3 ³	4.2	NA	
F	7-9	Sweetheart	Mahogany	10.0	17.3	1.12	280	NA	5.1	NA	standard
SELECTIONS WITH ONE OR MORE NOTICABLE FEATURES											
C	6/4	04-72	Mahogany	9.1	20.4	0.81	NA	10.1	3.8	14.9	Speckled fruit
C	6/4	05-13	Mahogany	8.9	17	0.94	302	10.7	3.4	0	No cracking
C	6/4	07-46	Mahogany	10.4	17.8	0.70	252	10.0	3.3	0	No cracking
C	6/4	05-24	Mahogany	8.1	17.8	0.97	344	10.4	4.6	4.9	big, firm
C	6/4	05-100	Blush	10.2	16.3	0.45	249	9.6	NA	10.7	crunchy
C	6/4	08-48	Blush	8.9	17	0.43	270	10.5	NA	8.5	free stone
F	6/4	58-7	Mahogany	NA	NA	NA	260	9.4	6.0	2.0	big, shiny, even color
C	6/8	3-47	Blush (dark)	8.5	16.7	0.80	360	10.4	NA	NA	crunchy, short stems
C	6/8	2-50	Mahogany	15.4	20.6	0.85	218	8.7	4.0	NA	very big, pointed
C	6/8	6-06	Blush	9.0	16.6	0.73	358	10.4	1.5	NA	pointed, firm, very dark
C	6/11	7-70	Mahogany	9.4	20.4	0.78	NA	10.1	4.8	NA	speckled, shiny
C	6/11	4-22	Mahogany	9.5	21.9	0.91	NA	9.9	6.8	NA	very dark and even color
F	6/23	50-104	Mahogany	15.5	21.5	0.93	264	8.8 ³	5.0	NA	huge and attractive

Each selection was picked once (50 fruit sample) from a single tree, cooled within 2 hours and transported to WTFRC in Wenatchee or WSU-IAREC for fruit quality analysis performed on the following day, WTFRC evaluated P1 fruit until June 11, then analysis was performed by WSU staff lead by Sue Watkins (grey highlight) ¹ CTIFL color chart, ² Cracking determined in laboratory as % fruit cracked/50 fruit sample, ³estimate of row size

Oregon SIGNIFICANT FINDINGS (P2): provided by Todd Einhorn

- We successfully evaluated fruits of 19 genotypes in 2015.
- Fruit of Sweetheart were the latest to harvest (by ~8 d) implying that none of the late-season-mahogany market class selections were sufficiently ‘late’. However, 2015 provided a challenging year to base growth and development, given the environmental conditions during dormancy and spring (resulting in relatively early bloom) and the extreme, high temperature events during most of the season.
- The November 2014 freeze event (~3°F minimum temperature at MCAREC) resulted in fairly significant flower mortality, potentially limiting fruit set and tree yields. No selection presently under P2 evaluation, however, appeared to respond differently to the event. One previously discarded selection was observed to be highly sensitive to freeze.
- Fruit from several of the selections were not well-described by their suggested market class (i.e. mahogany cherries were, in fact, blush cherries). All replicates of those genotypes were the same.
- In general, fruit size was small and firmness and pedicel retention force low. Rain events near harvest provided a cracking ‘test’; the range of cracking among selections was 0% to 100%. However, the timing of the rain events relative to harvest timing needs to be considered.

Table 6. 2015 harvest dates, number of replicate trees harvested, market class, yield, and fruit quality attributes for 19 accessions. Market classes were revised to reflect whether fruits were blush or mahogany. The suggested timing (early, mid, late) was not altered. The data show limited number of trees harvested for a few selections, and, importantly, for the ‘standards’. This represents a serious issue. High variability in cherry fruit quality (especially in 2015 given the impact of environmental conditions on development) necessitates replication in order for treatment effects (selection) to be observed. Standards need to be represented by equal replication as selections. Shaded data represent values approaching acceptability. For many genotypes, 2015 represented the first fruiting year; partially explaining the low per tree yields. Rainier and 1T36 trees were received in 2 different years (hence the two rows of data for these selections).

Genotype	Harvest (date)	Trees (reps) (no. harvested)	Market class	Yield (lbs/tree)	FF (g/mm)	Fruit size (dia.) mm	Fruit size Row sz	CTIFL (1-7)	Cracking (%)	PRF (g)	SSC (%)	TA (%)
1T5	5-Jun	1	ESM	0.02	364.8	27.4	10	4.6	100	328	19.8	0.99
Early Robin	5-Jun	1	ESB	0.03	415.9	30.3	9	Blush	40	528	16.2	0.56
9T89	5-Jun	1	ESM	0.02	329.5	25.8	10.5	5.3	n.d.	365	18.2	0.68
1T7	10-Jun	1	FT-ESM	0.43	223.1	25.7	10.5	5.6	0	702	16.2	1.03
10T51	15-Jun	4	MSM	1.28	247.6	28.8	9.5	5.4	36.2	513	19.4	1.18
6T59	15-Jun	4	LSM	5.26	289.2	27.4	10	5.5	13.3	568	22.3	1.26
Rainier	15-Jun	4	MSM	26.33	236.5	28.5	9.5	Blush	n.d.	550	19	0.73
Rainier	15-Jun	3	MSM	2.58	214.9	29.9	9.5	Blush	n.d.	544	19.8	0.81
11T59	18-Jun	5	ESB	0.50	270.1	30.4	9.5	Blush	14.4	342	22.1	1.01
1T36	18-Jun	5	MSM	0.79	285.8	27.4	10	4.7	2.8	362	18.4	0.96
6T63	18-Jun	5	LSM	0.76	262	29.5	9.5	5.4	8.2	353	24.5	1.18
13T4	20-Jun	3	LSM	0.24	384.1	30.5	9	5.4	66.7	534	21	0.81
1T74	20-Jun	5	LSM	1.65	309	31.3	9	5.5	12.7	469	20.5	0.98
3T75	20-Jun	4	LSM	0.19	253.3	30.5	9	5.9	1.8	329	23.1	0.95
Bing	20-Jun	1	MSM	1.49	254.9	29.3	9.5	5.9	12.2	360	22.4	0.85
1T36	22-Jun	5	MSM	14.29	312.4	28.2	10	5	2.8	481	n.d.	n.d.
49T83	25-Jun	5	LSB	0.36	377.5	28.6	10	Blush	17.8	300	23.6	0.58
4T29	25-Jun	5	LSB	0.43	360.1	27.4	10	Blush	25.4	184	23.5	0.78
1T70	25-Jun	4	LSB	0.37	279.9	27	10	Blush	10.7	248	23.7	1.08
2T30	29-Jun	4	LSB	0.13	307.7	29.4	9.5	Blush	2.5	333	21.5	0.89
Sweetheart	7-Jul	1	LSM	0.56	218.4	24.2	11	5.3	n.d.	109	25.9	1.02

Table 7. Postharvest storage quality, and in a few cases, pitting susceptibility of those genotypes with ample fruit remaining after harvest evaluations. Fruit was held at 32°F (>95% RH) for 3 weeks prior to evaluation. The number of replicates for each genotype that were evaluated is provided. As stated above, additional replications of standards are required for statistical analyses. Average pit score was a weighted average of the number and size of pits per fruit, where 1= mild insignificant pitting and 4= severe pitting. Percent bruised fruit were characterized by compression bruising (surface of fruit visibly flattened). In many cases, trees were in their first year of production and had insufficient fruit volume to accommodate postharvest analysis and pitting.

Genotype	Trees (reps) (no. evaluated)	Market class	FF (g/mm)	Fruit size (dia.) mm	Fruit size Row sz	CTIFL (1-7)	Cracking (%)	PRF (g)	SSC (%)	TA (%)	Ttl pits/fruit (no.)	Avg. pit score (1-4)	Bruised (%)
10T51	2	MSM	318.6	28.5	9.5	5.8	46	171.1	19.2	1.07	4	3.3	43.3
6T59	4	LSM	348.3	27.6	10	5.9	8.1	175.4	22.8	0.97	3.9	3	17
Rainier	4	MSB	294.4	27.7	10	Blush	2	239.5	18.8	0.65	3.8	3	46
Rainier	1	MSB	254.5	29.8	9	Blush	0	255.7	22.2	0.67	3.2	3.3	56
1T36	5	MSM	298.5	28.3	10	5.1	0	682.8	19.1	0.85	5.4	2.5	22
6T63	2	LSM	323.1	29.8	9	5.4	2.4	670.6	24.5	1.22	5.8	3.2	65
1T74	4	LSM	359.6	31.1	9	5.6	n.d	416.5	20.6	0.92	n.d	n.d	n.d
Bing	1	MSM	288.9	28.7	9.5	5.1	n.d	205	21.6	0.76	n.d	n.d	n.d

Figure 3. Bloom timing (full bloom) for 2014 and 2015. In general, bloom time was consistent between years for a given genotype. In 2015, most genotypes bloomed 10-12 days earlier than 2014.

