FINAL PROJECT REPORT

Project Title: MSU cherry rootstocks: pre-commercialization

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Total Project Request: **Year 1:** $81,012 **Year 2:** $82,532 **Year 3:** $84,963

Other funding sources - None

Budget 1 – Amy Iezzoni
Organization Name: Michigan State University **Contract Administrator:** Greta McKinney
Telephone: (517) 353-0391 **Email address:** mckin134@anr.msu.edu

Item	2017	2018	2019
Salaries (technician)[a]	$ 5,500	$ 5,775	$ 6,064
Benefits[b]	2,335	2,492	2,635
Wages			
Benefits			
Equipment			
Supplies[c]	600	600	600
Travel[d]	4,500	4,500	4,500
Trees & shipping[e]	11,721		
Plot Fees			
Total	$ 24,656	$ 13,367	13,799

Footnotes:
[a]Technician will analyze and prepare summary tables and figures of the plot data and conduct the DNA diagnostics.
[b]Benefits calculated at 42.46%,43.15% and 43.46% for 2017, 2018 and 2019, respectively.
[c]Laboratory supplies for the DNA diagnostics.
[d]Travel for A. Iezzoni to visit the test plots, liner nurseries and finished tree nurseries.
[e] The cost of the trees and tree shipping for the 2017 plantings for Obj. 1 and 2.

Budget 2 – Lynn Long
Organization Name: Oregon State University **Contract Administrator:** Russel Karow
Telephone: **Email address:** Russel.Karow@oregonstate.edu

Item	2017	2018	2019
Salaries		$ 8,400	$ 8,400
Benefits		$ 2,772	$ 2,722
Wages	$ 5,100	$ 5,600	$ 6,400
Benefits	510	560	640
Equipment			
Supplies	200	200	200
Travel	40	40	40
Plot Fees	660	660	660
Miscellaneous			
Total	$ 6,510	$ 18,232	$ 19,112

Footnotes:
[1]Previous 2018 and 2019 totals were $7,060 and $ 7,940. The increase is due to the reduction in salary support by OSU and Wasco County due to Lynn Long's retirement.

Budget 3 – Bernardita Sallato[1]
Organization Name: Washington State Univ. **Contract Administrator:** Katy Roberts
Telephone: (509) 335-2885 **Email address:** katy.roberts@wsu.edu

Item	2017	2018	2019
Salaries	$ 2,990	$ 15,450	$ 16,068
Benefits	2,270	7,547	7,849
Wages	25,472	14,400	14,976
Benefits	17,489	10,498	10,918
Equipment			
Supplies			
Travel	1,625	3,038	2,241
Plot Fees			
Miscellaneous			
Total	$ 49,846	$ 50,933	$ 52,052

Footnotes:
[1]Budget for 2017 was to the WTFRC with Tom Auvil as Co-PI. Due to changes at the WTFRC, for 2018, and moving forward, this project was transferred to B. Sallato.

OBJECTIVES:

1. Compare the performance of the MSU cherry rootstocks (labeled as the Corette™ series) to currently available sweet cherry rootstocks using intensive cherry production systems.
2. Track the MSU rootstock performance in trials with PNW grower cooperators that are experimenting with a wider range of scions and orchard systems.
3. Collaborate with cooperating nurseries and the Clean Plant Center Northwest-Fruit Trees to ensure MSU cherry rootstocks are available as virus certified and genetically verified.

SIGNIFICANT FINDINGS

- For the three 2015 plantings, trees were generally largest (TCSA) on the Krymsk® rootstocks, followed by the Gisela® rootstocks and then the Corette™ rootstocks.
- Trees on K5 and K6 were too vigorous and not sufficiently precocious for the ultra-high density systems.
- The reduced size of trees on Clinton compared to Lake at The Dalles and Mattawa may be due to increased spur fruiting on Clinton and higher heat/stress tolerance on Lake.
- For 'Early Robin' in the 2015 plantings, there was not one rootstock whose projected yields per acre consistently outperformed the others, nor were there any consistent differences in fruit size. However, in E. Wenatchee in 2019, the highest 'Early Robin' yields were on Gi5 and Clinton.
- For 'Regina' at The Dalles 2015 planting, all the Corette™ rootstocks had equivalent of higher projected yields per acre compared to K6 and Gi5. Cass and Clare exhibited the highest projected tree yields without an associated reduction in fruit size.
- Across the 2015 plantings, 'Sweetheart' yields tended to be highest on Gi5, Gi6 and Clinton: however, the mean fruit size was small across all rootstocks.
- Trees with higher crop loads tended to have smaller fruit. However, there did not appear to be a genetic tendency for the small Corette™ rootstock trees to have smaller fruit independent of crop load.
- The SSA training system resulted in the trees on the Gisela® and Corette rootstocks coming into production earlier (third leaf) than trees trained to a KGB or steep leader.
- For the 2017 plantings, in general, the tree sizes (TCSA) for 'Regina' and 'Sweetheart' on Gi5, Clinton and Crawford were similar. Promalin-scoring techniques resulted in successful lateral shoot development.
- In one plot planted in 2017, 'Chelan' on all five Corette™ rootstocks had significantly more fruit and earlier ripening fruit than trees on the K6 control. In another plot, 'Coral' trained to an SSA, will have its first crop next year.
- The MSU rootstocks were trademarked under the name Corette™ to facilitate experimental plantings and are commercially available at several nurseries.
- The Iezzoni lab provided DNA diagnostic support as needed at no cost to the collaborating nurseries to assure rootstock trueness-to-type. The genetic test developed by the Iezzoni lab is now offered as a routine service provided by the Foundation Plant Services – U.C. Davis.

RESULTS AND DISCUSSION

Obj. 1. *Performance of the MSU rootstocks*

The performance of the Corette™ rootstocks was evaluated from plots planted in 2015 and 2017 in three locations, The Dalles, Mattawa, and E. Wenatchee. Summaries of the 2015 plantings are provided in Tables 1 and 2. The 2017 plantings, also in these three locations, included an additional MSU rootstock, Crawford, that was not in the prior plantings, and a subset of the scions and rootstocks planted in 2015.

Tree growth – 2015 plantings:

Results: For the 2015 plantings, in general across the three trials, the trees were largest (trunk cross-sectional area; TCSA) on the Krymsk® (K) rootstocks, followed by the Gisela® (Gi) rootstocks and then the Corette™ rootstocks (Table 3). When considering the three trials separately, trees planted in the two Super Slender Axe (SSA) trials in Wash. were significantly smaller than the trees in The Dalles trial that were trained as Kym Green Bush (KGB) and steep leader systems. The much greater shoot and branch growth of the KGB and steep leader systems compared to the SSA, contributed to the larger tree size. In addition, in the ultra-high density double row SSA systems used at Mattawa and E. Wenatchee, tree growth was influenced by inter-tree competition contributing to a reduction in tree size. Despite these limitations, K5 and K6 were found to be too vigorous for an SSA ultra-high density system.

Across all locations and scions, there were no significant differences for TCSA between the two Gisela controls (Gi 5 and Gi 6)(Table 3). This result was unexpected as Gi 5 is known to produce smaller trees than Gi 6. In contrast, when comparing the Gisela® and Corette™ rootstocks, the following differences in TCSA were observed (Table 3).

- At The Dalles, when each scion was considered separately, all the Corette™ rootstocks either had equivalent or smaller TCSA compared to the Gi controls.
- In Mattawa, the TCSA of 'Early Robin' on the Gisela® and Corette™ rootstocks were equivalent; however, 'Sweetheart' trees on Gi6 were significantly larger than trees on Cass and Clinton.
- In E. Wenatchee, for each scion, the TCSA of Gi5 and Clinton were not significantly different, and they were significantly larger than Clare ('Early Robin') and Cass and Clare ('Sweetheart'). The mean TCSA of Lake was similar to Gi5 for 'Sweetheart', but significantly smaller than Gi5 for 'Early Robin'.

Mattawa has sandier soil with less water holding capacity and can reach higher temperatures during the summer than the other sites. The differential growth of Clinton at Mattawa and E. Wenatchee (Table 3), suggests that of the Corette™ rootstocks, Clinton could be more susceptible to one or either of those conditions. In Michigan trials that are also on very sandy soils, Clinton consistently exhibited more symptoms of water/heat stress compared to the other MSU rootstocks. This trait was also observed in The Dalles. In contrast, in Mattawa, The Dalles and Michigan trials, Lake consistently appeared to have a higher water/heat stress tolerance than the other Corette™ and Gisela® rootstocks. The MSU rootstocks also differed in the presence or absence of suckers. Of the five Corette™ rootstocks, Lake, Cass and Clare produced suckers whereas Clinton and Crawford did not.

In addition to TCSA, another indicator for vigor is the ability to create new vegetative growth. In an SSA system, this branching ability is fundamental for the sustainability of the system. In an SSA system, fruiting is targeted to basal flower buds on one-year-old shoots as opposed to fruiting spurs on older wood. At Mattawa, 'Sweetheart' trees on Cass exhibited significantly less new shoot growth than trees on Gi6 and K5, but differences among the Corette™ rootstocks were not significant (data not presented). Anecdotally, under SSA, Gi 6 appeared to have more blind wood (not measured) compared to all other rootstocks.

Tree growth – 2017 plantings

The Corette™ rootstock Crawford was not included in the 2015 plantings as it was delayed being released from the CPCNW-FT. Therefore, in 2017, three smaller plots comparing Crawford with its most similar rootstocks, Clinton and Gi5 were planted in The Dalles, Mattawa, and E. Wenatchee. The two scions were 'Regina' and 'Sweetheart'. Trees in The Dalles were trained to a steep leader for 'Regina' and KGB for 'Sweetheart', while trees in the Wash. sites were trained to an SSA. For these 2017 plantings, tree sizes (measured as TCSA) at Mattawa and E. Wenatchee were not significantly different for 'Regina' and 'Sweetheart' on Gi5, Clinton and Crawford (data not presented). However, at The Dalles, 'Regina' on Gi5 and Clinton were not significantly different but 'Regina' trees on

Crawford were significantly smaller than those on Gi5 (data not presented). Promalin-scoring techniques resulted in successful lateral shoot development.

Discussion: The MSU rootstocks were previously compare to Gi5 and Gi6 in a six year trial planted in Prosser, Wash. in 2009 with 'Bing' scion. The trees were trained to a multiple leader system with eight feet between trees within the row, and fruit were hand-thinned when pea size to prevent over-cropping. In the sixth and final year of this trial, Gi5 and all the MSU rootstocks had significantly smaller TCSA than Gi6 (Long et al. 2019). The mean TCSA of trees on Clare was significantly smaller than for trees on Gi5, Clinton and Crawford. Tree sizes on Lake and Cass were intermediate between Gi5/Clinton/Crawford and Clare. In contrast to the 2009 planting, the TCSA of trees on Clinton in the 2015 plantings tended to be smaller than those of the other rootstocks at The Dalles and Mattawa, but not at E. Wenatchee. This suggests that Clinton is better suited for a cooler climate. It is also possible that in hotter and dryer sites, Cass, Clare and Lake may benefit from increased root volume. When trees in the 2009 WSU-Prosser planting were removed in 2014, three trees per rootstock were excavated to expose the root distribution and size. Visual observations suggested that the root masses differed with Gi6 having the most roots and Gi5, Clinton and Crawford having the least roots. Cass, Clare and Lake appeared intermediate.

Yield and fruit size:

Results:

The Dalles, Ore.: For 'Early Robin' trained to a KGB, there were some differences among rootstock tree yields over the three years (2015-17). However, as the different rootstocks would be planted at different spacings, the tree yields were used to calculate projected tons/acre using the following tree numbers/acre: 519 (6×14) for Krymsk and Gi6; 622 (5×14) for Gi5, Clinton and Lake; and 778 (4×14) for Clare and Cass. For the most part, the projected tons per acre among rootstocks were not significantly different (data not presented). However, in 2017, 2018, and 2019, the lowest projected yields (tons/ac) were for Gi6 (0.1), Lake (8.7) and Clinton (8.9), respectively, and the highest projected yields (tons/ac) were for Clinton (0.3), Gi6 (13.8) and Clare (16.4), respectively. In addition, in 2019 there were no significant differences in fruit size among the rootstocks. This similarity in fruit size and shifting yield rankings among years, illustrates the difficulty in identifying one rootstock that is best suited for 'Early Robin' trained to a KGB.

For 'Regina' trained to a steep leader, the comparison with Gi5 and Gi6 was only possible at The Dalles trial as all the 'Regina' on Gi5 and Gi6 at the Wash. trials turned out not to be 'Regina'. At The Dalles there were no significant rootstock effects on yield in 2017, and minimal differences in 2018 (Table 4). However, in 2019, Cass and Clare, followed by Clinton, resulted in significantly increased annual projected per acre yields when compared with K6 and Gi6. 'Regina' fruit size on Clinton was significantly smaller than that on Gi5 and Clare in 2019 and Clare and Lake in 2018 (Table 4).

For 'Sweetheart', also trained to a KGB, Gi5 tended to have the highest tree and per acre yields across the three years (data not presented). In 2019, the 'Sweetheart' trees at The Dalles overset. Trees on Gi5 were the most overset while K6 had a light crop and lowest yield efficiency, with Lake exhibiting the best balanced crop load rating (data not presented). As the fruit where hand thinned to equalized crop loads, there were no significant differences in fruit size. As 'Sweetheart' tends to over-crop when trained to systems that promote spur fruit production, there is little benefit to putting 'Sweetheart' on an extremely dwarfing rootstock.

Mattawa and E. Wenatchee, Wash.: In contrast to The Dalles, trees at Mattawa and E. Wenatchee were trained to a trellised SSA system at ultra-high density spacings (Table 2). In Mattawa, the 'Early Robin' crop was lost to frost in 2017; however, good yields were obtained in 2018 (Table 5). In 2018, 'Early Robin' on Gi5, Cass and Clare had significantly higher extrapolated yields per acre (as high as 10 tons/acre) compared to K6 (7.4 tons/acre), but these extrapolated yields were not significantly higher than on Gi6, Clinton or Lake (Table 5). 'Early Robin' data was also taken in 2019 but the yields were

too low to provide a meaningful comparison. At E. Wenatchee, 'Early Robin' was not harvested in 2018 due to bird damage. Data was taken in 2017 and 2019, but the yields were extremely poor due to unfavorable weather conditions (Table 6); however, yields and yield efficiencies tended to be highest on Gi5 and Clinton.

'Regina' trained to an SSA, continually had low crops at E. Wenatchee and Mattawa. The highest per acre yield was obtained with Clare; extrapolated to be 4.7 tons/acre in 2017 in E. Wenatchee and 7.7 tons/acre in 2018 in Mattawa. These low yields of 'Regina' suggest that this cultivar may not result in increased per acre yields if trained to an SSA system.

'Sweetheart' rootstock performance at E. Wenatchee was similar to that in The Dalles in that the highest tree yields were obtained on Gi5/Gi6 and Clinton. However, in the E. Wenatchee trial, 'Sweetheart' exhibited high early yields in 2017 (third leaf) on all rootstocks except K6 compared to The Dalles KGB trees (Table 6). At E. Wenatchee, high extrapolated tons/acre were also obtained in 2018 and 2019 for all rootstocks except K5. However, the mean 'Sweetheart' fruit size was small across all rootstocks (generally ≥10 row) which is consistent with this productive cultivar having too high a crop load.

Unfortunately, in the Mattawa trial, poor weather in 2017 resulted in an extremely low 'Sweetheart' crop so data was not collected. In 2018, significantly lower yields were obtained on K5 which is consistent with this rootstock being less precocious compared to the Gisela® and Corette™ rootstocks (Table 6). Also in 2018, Gi5 and Clare had significantly higher extrapolated yields per acre compared to Gi6 and Clinton, while yields on Cass and Clare were intermediate. Among the rootstocks, fruit size tended to be smallest on Clinton and highest on Lake. 'Sweetheart' data was also taken in 2019 but the yields were too low to provide a meaningful comparison (Table 6).

Fruit quality: Across scions, locations and years, there were no consistent significant differences in fruit quality (soluble solids, brix, color) among the rootstocks. For example, 'Regina' fruit color was significantly lower on K5 compared to all the Corette™ rootstocks for E. Wenatchee and Mattawa in 2018 and Mattawa in 2019, but this difference was not significant in other years and locations (data not presented).

Discussion: Of the three 2015 plantings, tree yields and projected per acre yields were significantly higher at The Dalles in 2018 and 2019 where the trees were trained to a KGB or steep leader system compared to an SSA at the Wash. sites. However, the results from the E. Wenatchee trial highlight the potential of the SSA system to result in increased yields in the third leaf with precocious rootstocks. Yet, the results from Mattawa illustrated the challenges maintaining high production with an SSA system. For example, lower yields at Mattawa in 2019 compared to 2018 for 'Early Robin' and 'Sweetheart' were likely also due to difficulties in wood renewal with the SSA system. 'Early Robin' in particular exhibited more dead wood or blind wood than the other two cultivars. As 'Early Robin' and 'Regina' typically have lower fruit sets, the SSA system, with its limited number of flower buds may not be the best option for these cultivars. Cultivars with a relatively high number of flowers and good fertility of the basil portion of 1-year-old wood are more likely to benefit from an SSA system (Musacchi et al. 2015).

Previous results from the sixth leaf of the WSU-Prosser 'Bing' planting (2009-2014) illustrated the ability of the Corette™ rootstocks to maintain high tree yields without a reduction in fruit size despite their smaller tree sizes. However, key features of the WSU-Prosser plot included hand thinning of the fruit, lack of inter-tree competition and minimal heat stress compared to what is typically experienced at Mattawa. Results from the three 2015 trials illustrated the importance of matching the scion/rootstock/orchard environment and cultural practices as there was not one rootstock that performed best across all the scions and sites. At The Dalles, where more traditional training systems were used and normal to heavy crops were obtained each year, the data suggests that there may be a benefit of experimenting with 'Regina' on Clare, Cass and Clinton. These rootstocks, along with Gi5, also have potential in the SSA system; however, the weather and bird related crop losses, inter-tree

competition, lack of Gi5 and Gi6 controls for 'Regina' and the difficulty of maintaining 1-year-old fruiting wood, limited our ability to make recommendations among the rootstocks. Additional trails such as those described below in Obj. 2 will help determine what genetic/environment/cultural practices result in the most profitable plantings. These trials will also help determine if the perceived heat/drought tolerance of Lake would have value for sandy hot sites.

Obj. 2. *Track the MSU rootstock performance in trials with PNW grower cooperators that are experimenting with a wider range of scions and orchard systems*.

Project team members visited the plots planted in 2017 (Table 7) to monitor performance and provide cultural practice recommendations as requested. The goal of these plantings was to collectively provide critical comparisons of the new rootstocks with difference scions, high density orchard systems, and environments. The 'Coral', and 'Benton' plantings established in Wash. were managed to initiate an SSA system (Figure 1), while the 'Bing'/'Chelan' planting was managed to initiate a modified SSA/TSA system. All plantings are high density with trellis. In Oregon, the 'Coral' planting was trained to a KGB system and the 'Ebony Pearl'/ 'Burgundy Pearl' planting is being trained to a UFO.

In 2019, the 'Chelan' 2017 planting in Dallesport that includes all five Corette™ rootstocks and K6 control, fruited for the first time. Fruit was harvested from a subset of the trees to assess the early yields in this block (data provided by Ashley Thompson). There were no significant differences in tree yields or fruit quality measurements among the Corette™ rootstocks. However, there were virtually no fruit on the K6 control trees and the K6 fruit present on the day of harvest was just straw color. This illustrates the early yields and advance in maturity possible on dwarfing rootstocks that are precocious and have a reduced canopy size.

Figure 1. 2017 Coral Champagne trial at Denny Hayden orchard, Pasco, WA.

These 2017 plantings, along with the 2015 plantings also serve as demonstration plots. For example, In June, approximately 80 participants visited the Hayden Orchard 'Coral' rootstock plot in Pasco.

Obj 3. *Collaborate with cooperating nurseries and the Clean Plant Center Northwest-Fruit Trees to ensure MSU cherry rootstocks are available as virus certified and genetically verified.*

All five Corette™ cherry rootstocks have been virus certified by the CPCNW-FT; however, this virus certification had not included screening for Cherry Virus A (CVA). Therefore, all five Corette™ rootstocks were screened for CVA and found to be negative. To enable growers to have access to the MSU rootstocks, they were trademarked under the name Corette™ and are available from several nurseries.

The Iezzoni lab provided DNA diagnostic support as needed at no cost to the collaborating nurseries to assure rootstock trueness-to-type at various stages of liner and finished tree production. In addition, a DNA diagnostic test to distinguish cherry rootstocks that was developed by the Iezzoni lab as part of

RosBREED has been adopted by several nurseries and is a routine service provided by the Foundation Plant Services – U.C. Davis.

REFERENCES

Long LE, Iezzoni A, Seavert C, Auvil T, Kaiser C, Brewer LJ. 2019. New cherry rootstock and cultivar interactions directly affect orchard profitability. Acta Hortic. 1235. DOI 10.17660/ActaHortic.2019.1235.26

Musacchi S, Gagliardi F, Serra S. 2015. New Training systems for high-density planting of sweet cherry. HortScience 50:59-67.

Table 1. Summary of rootstock plantings made in 2015 with three scions at three locations: The Dalles, Ore., Mattawa & East Wenatchee, Wash.

	Scion		
Conditions	Regina	Early Robin	Sweetheart
Control Rootstocks	Gi5, Gi6, K6	Gi5, Gi6, K6	Gi5, Gi6, K5
Pollinizers	Sam	Chelan	
Training systems	Steep Leader[1], SSA[2]	KGB[1], SSA[2]	KGB[1], SSA[2]
Corette™ Rootstocks[3]	Clare, Cass, Lake, Clinton		

Training systems at [1]The Dalles; [2]Mattawa and Wenatchee.
[3]All locations and scions except 'Regina'/Cass was not included at East Wenatchee due to insufficient tree numbers.

Table 2. Summary of planting distances and number of trees/acre for rootstock plantings made in spring 2015 with three scions at three locations.

	Planting distance (ft) [trees/acre]		
Rootstock	The Dalles	Wenatchee[1]	Mattawa[1]
K5, K6, Gi5, Clinton	8 × 16 [340]	2 × 12 [1,815]	1.25 × 12 [2,904]
Gi6	8 × 16 [340]	2 × 12 [1,815]	1.5 × 12 [2,420]
Clare, Cass, Lake	8 × 16 [340]	1 × 12 [3,630]	1 × 12 [3,630]

[1]Orchard design consists of double rows, one on either side of a V-trellis.

Table 3. Mean comparison of trunk cross-sectional area (cm^2) in 2019 for three scions ('Early Robin', 'Regina', and 'Sweetheart') on four Corette™ rootstocks, K5, K6, Gi5, and Gi6 and planted in 2015 at three locations (The Dalles, OR; Mattawa and East Wenatchee, WA)[1].

	Trunk Cross-Sectional Area (cm^2)								
	The Dalles			Mattawa			East Wenatchee		
Rootstock	Early Robin	Regina	Sweet-heart	Early Robin	Regina	Sweet-heart	Early Robin	Regina	Sweet-heart
K5/6[2]	81 a[3]	101 a	111 a	24 a	31 a	33 a	29 a	31 a	35 a
Gi5	64 ac	102 a	76 b	20 ab	-[4]	15 bc	28 ab	-[4]	24 bc
Gi6	74 ab	76 ab	80 b	20 ab	-	18 b	27 a	-	27 b
CASS	57 ac	73 ab	48 cd	18 b	9 c	10 c	18 cd	-	17 d
CLARE	58 ac	52 b	47 cd	15 b	11 bc	11 bc	17 d	16 c	16 d
CLINTON	41 c	54 b	40 d	16 b	12 bc	11 c	23 bc	23 b	22 c
LAKE	55 bc	73 ab	64 bc	20 ab	15 b	14 bc	19 cd	16 c	21 cd

[1]KGB and steep leader systems at The Dalles produced much greater shoot and branch growth than SSA, contributing to the larger tree size.
[2]'Early Robin' and 'Regina' are on K6; 'Sweetheart' is on K5.
[3]Means that are significantly different ($P < 0.05$; Tukey) within column are denoted by different letters.
[4]Data for Gi5 and Gi6 from Mattawa and East Wenatchee were not available (-) as the trees unfortunately turned out not to be 'Regina'.

Table 4. Individual tree yields, projected per acre yields and fruit size for 'Regina' on four Corette™ rootstocks, Gi5, Gi6 and K6 for trees planted in 2015 in The Dalles, OR. The tree numbers/acre and spacings (ft) used for the projected yields were 519 (6×14) for K6 and Gi6; 622 (5×14) for Gi5, Clinton and Lake; and 778 (4×14) for Clare and Cass. Trees were trained to a steep leader. Data for three years are presented with yield efficiencies (YE) for 2019. In 2019, fruit were harvested on July 2.

Rootstock selection	Tree yield (lb)			Yield per acre (tons/ac)[1]			Row size		
	2017	2018	2019 / YE	2017	2018	2019	2017	2018	2019
Gi5	6.3 a[2]	23.8 ab	12.9 bc / 0.13 bc	2.0 a	7.4 ab	4.0 bc	9.7 a	9.8 ab	9.4 a
Gi6	5.2 a	30.1 a	16.6 abc / 0.23 ab	1.3 a	7.8 ab	4.3 c	9.8 a	10.1 ab	9.9 ab
K6	3.1 a	22.2 ab	6.5 c / 0.06 c	0.8 a	5.8 b	1.7 d	9.9 a	9.7 ab	9.8 ab
CASS	4.0 a	23.6 ab	27.5 a / 0.39 abc	1.5 a	9.2 a	10.7 a	9.9 a	9.8 ab	9.9 ab
CLARE	6.1 a	13.6 b	17.3 ab / 0.33 a	2.4 a	5.3 b	6.7 b	9.7 a	9.6 a	9.5 a
CLINTON	4.3 a	22.7 ab	19.4 ab / 0.39 a	1.3 a	7.0 ab	6.1 ab	9.8 a	10.2 b	10.1 b
LAKE	3.1 a	15.0 b	9.9 bc / 0.14 b	1.0 a	4.7 b	3.1 c	9.8 a	9.7 a	9.7 ab

[1]Ton=US short ton = 2000 lbs.
[2]Significantly different means (P < 0.05) are denoted by different letters.

Table 5. Individual tree yields, extrapolated yields per acre and fruit size for 'Early Robin' and 'Sweetheart' grown on four Corette™ rootstocks, Gi5, Gi6, K5 or K6 and trained to a Super Slender Axe (SSA) from trees planted in 2015 at Mattawa, WA. The tree numbers and spacings (ft) used for the extrapolated yields are in Table 2. Data are presented for two years with yield efficiencies (YE) presented for 2019. In 2019, fruit of 'Early Robin' and 'Sweetheart' were harvested June 14 and July 5, respectively. No fruit was harvested in 2017 due to a weather-related crop loss.

	Rootstock selection	Tree yield (lb)		Yield per acre (tons/ac)[1]		Row size	
		2018	2019 / YE	2018	2019	2018	2019
Early Robin	Gi5	6.7 ab[2]	1.0 ab / 0.05 b	9.7 a	1.5 ab	9.9 ab	9.7 ab
	Gi6	7.3 a	0.8 b / 0.04 b	8.8 ab	1.0 b	9.9 ab	9.8 ab
	K6	5.1 cd	2.0 a / 0.08 ab	7.4 b	2.8 a	9.4 a	10.0 b
	CASS	5.5 bcd	1.2 ab / 0.07 ab	10.0 a	2.1 ab	9.5 ab	9.5 a
	CLARE	5.5 bcd	1.7 ab / 0.11 a	10.0 a	3.1 a	9.6 ab	9.6 a
	CLINTON	6.0 abc	1.1 ab / 0.07 ab	8.7 ab	1.7 ab	10.7 b	9.7 ab
	LAKE	4.6 d	1.0 ab / 0.05 ab	8.3 ab	1.8 ab	9.9 ab	9.6 a
Sweetheart	Gi5	10.9 a	3.9 ab / 0.25 ab	15.8 a	5.6 ab	11.1 c	9.9 a
	Gi6	9.1 ab	5.6 a / 0.31 a	11.0 b	6.8 ab	10.4 ab	9.9 a
	K5	2.5 c	1.7 b / 0.06 b	3.6 c	2.4 b	10.5 b	10.0 a
	CASS	7.3 b	1.8 b / 0.18 ab	13.2 ab	3.2 ab	11.1 c	9.9 a
	CLARE	9.2 ab	4.1 ab / 0.38 a	16.7 a	7.5 a	10.5 b	9.7 a
	CLINTON	8.1 b	3.2 ab / 0.29 a	11.8 b	4.6 ab	11.5 d	10.0 a
	LAKE	7.7 b	2.6 ab / 0.18 ab	14.0 ab	4.7 ab	10.2 a	9.7 a

[1]Ton=US short ton = 2000 lbs.
[2]Significantly different means (P < 0.05) are denoted by different letters.

Table 6. Individual tree yields, extrapolated yields per acre and fruit size for 'Early Robin' and 'Sweetheart' grown on four Corette™ rootstocks, Gi5, Gi6 and K5 or K6 and trained using a Super Slender Axe (SSA) from trees planted in 2015 at East Wenatchee, WA. The tree numbers and spacings (ft) associated with the extrapolated yields per acre are in Table 2. Data are presented for three years with yield efficiencies (YE) presented for 2019. In 2019, 'Early Robin' was harvested on June 20 and 'Sweetheart' was harvested on July 14.

Rootstock selection	Tree yield (lb)			Yield per acre (tons/ac)[1]			Row size		
	2017	2018	2019 / YE	2017	2018	2019	2017	2018	2019
Early Robin									
Gi5	2.4a[2]	-[3]	6.6a / 0.24ab	2.2a	-	6.0a	9.6b	-	9.4a
Gi6	1.5bc	-	4.3ab / 0.16a	1.4ab	-	3.9bc	9.5ab	-	9.4a
K6	0.8d	-	2.5bc / 0.09bc	0.7b	-	2.3bc	10.1c	-	9.3a
CASS	1.0cd	-	0.9c / 0.05c	1.8a	-	1.6c	9.4a	-	9.1a
CLARE	1.2cd	-	0.7c / 0.05c	2.2a	-	1.3c	9.4a	-	9.1a
CLINTON	2.2ab	-	4.9ab / 0.22abc	2.0a	-	4.5ab	9.5ab	-	9.0a
LAKE	1.2cd	-	0.8c / 0.05c	2.2a	-	1.5c	10.0c	-	9.2a
Sweetheart									
Gi5	5.0a	11.7bc	12.0bc / 0.49bc	4.5a	10.6b	10.9bc	11.3b	10.4a	10.0ab
Gi6	3.1b	14.5ab	15.6ab / 0.56b	2.8b	13.2ab	14.2b	11.3b	10.4a	9.9a
K5	0.6d	1.1e	2.9d / 0.08d	0.5c	1.0c	2.6d	11.2ab	10.2a	10.1ab
CASS	2.0c	8.7cd	6.4d / 0.36c	3.6ab	15.8a	11.6c	11.1ab	10.0a	10.0ab
CLARE	1.9c	9.5cd	7.4cd / 0.45bc	3.4ab	17.2a	13.4c	11.0a	10.4a	10.1ab
CLINTON	4.0ab	15.6a	16.9a / 0.76a	3.6ab	14.2ab	15.4a	11.1a	10.4a	10.3b
LAKE	1.9c	6.3d	7.3cd / 0.35c	3.4ab	11.4b	13.3c	11.5c	10.4a	10.1ab

[1]Ton=US short ton = 2000 lbs.
[2]Significantly different means ($P < 0.05$) are denoted by different letters
[3]No fruit was harvested for 'Early Robin' in 2018 due to bird damage.

Table 7. PNW trials planted in 2017 testing the Corette™ cherry rootstocks.

Location	**Scion(s)**	**No. of Corette™ Rootstocks (~ rep. size[1])**	**Producer**
The Dalles, OR[2]	Ebony Pearl, Burgundy Pearl	All 5 (40)	Omeg Orchards
The Dalles, OR	Coral	All 5 (45)	Dahle Orchards
Dallesport, WA	Bing, Chelan	All 5 (30)	Orchard View
Mattawa, WA[3]	Benton	All 5 (200)	Zirkle Fruit
Mattawa, WA	Coral	All 5 (20)	Wash. Fruit & Produce
Pasco, WA	Coral	All 5 (20)	Hayden Farms

[1]The number of trees for each rootstock/scion combination.
[2]The rootstock liners were planted in the orchard in spring 2016 and budded fall 2016.
[3] The rootstock liners were budded in August 2016 and planted in place in spring 2017.
[4] Crawford was not included.

EXECUTIVE SUMMARY

Project Title: MSU Cherry Rootstocks: Pre-commercialization

KEY WORDS: Rootstock, sweet cherry, Super Slender Axe

Five MSU sweet cherry rootstocks were previously identified that induced precocious abundant flowering and significantly reduced tree size compared to Gi6. This result was from a trial at WSU-Prosser with 'Bing' scion planted in 2009 and removed after the 2014 season. All five MSU rootstocks named after Michigan counties (Cass, Clare, Clinton, Crawford and Lake) and labeled as the Corette™ series, produced trees of similar size to Gi5 or smaller. In 2014, all five of the Corette™ rootstocks had yield efficiencies (kg fruit/cm^2) that were higher than that of Gi5 and Gi6, suggesting that they would be suitable for ultra-high density orchard systems. To test the Corette™ rootstocks in wider range of scions, systems and locations, plantings were established in 2015 at three locations (The Dalles, Mattawa, and East Wenatchee), with four Corette™ rootstocks (Cass, Clare, Clinton, and Lake) plus Gisela® and Krymsk® controls, and three scion cultivars ('Regina', 'Early Robin' and 'Sweetheart'). KGB and steep leader training systems were used for The Dalles trial, while ultra-high density double rows trained to a Slender Spindle Axe (SSA) were used for the Wash. trials. Crawford was not included in the 2015 plantings as it was delayed being released from the CPCNW-FT. Three smaller plots comparing Crawford with the most similar rootstocks, Clinton and Gi5, were planting in 2017, also in The Dalles, Mattawa, and E. Wenatchee.

For the 2015 plantings, in general across the three trials, the trees were largest (trunk cross-sectional area; TCSA) on the Krymsk® (K5/K6) rootstocks, followed by the Gisela® (Gi 5/6) rootstocks and the Corette™ rootstocks. Trees on the Krymsk® rootstocks were found to be too vigorous and of insufficient precocity for an SSA system. When comparing just the Gisela® and Corette™ rootstocks, the significant differences in TCSA varied slightly with cultivar/site/training system. The reduced size of trees on Clinton compared to Lake at The Dalles may be due to increased spur fruiting on Clinton and higher heat/stress tolerance on Lake.

For 'Early Robin' in the 2015 plantings, there was not one rootstock whose projected yields per acre consistently outperformed the others, nor were there any consistent differences in fruit size. However, in E. Wenatchee in 2019, the highest 'Early Robin' yields were on Gi5 and Clinton. For 'Regina' at The Dalles 2015 planting, all the Corette™ rootstocks had equivalent of higher projected yields per acre compared to K6 and Gi5. Cass and Clare exhibited the highest projected tree yields without a reduction in fruit size. Across the 2015 plantings, 'Sweetheart' yields tended to be highest on Gi5, Gi6 and Clinton but the mean fruit size was small across all rootstocks. However, there did not appear to be a genetic tendency for the small Corette™ rootstock trees to have smaller fruit independent of crop load. The SSA training system resulted in the trees on the Gisela® and Corette rootstocks coming into production earlier (third leaf) than trees trained to a KGB or steep leader. Yet, after the third leaf there were challenges renewing the wood necessary for the SSA system. For the 2017 plantings, in general, the tree sizes for 'Regina' and 'Sweetheart' on Gi5, Clinton and Crawford were similar. Promalin-scoring techniques resulted in successful lateral shoot development. Collectively these results illustrate the importance of matching the scion/rootstock/orchard environment and cultural practices, as there was not one rootstock that performed best across all scions and sites.

Project team members visited grower plots planted in 2017 that collectively encompass six scions and four training systems. These plantings not only provided critical comparisons of the new rootstocks, but they will also illustrate how these new rootstocks perform given different scions, orchard systems and environments. In one plot, 'Chelan' on all five Corette™ rootstocks had significantly more fruit and earlier ripening fruit than trees on the K6 control. In another plot, 'Coral' trained to an SSA, will have its first crop next year.

The Iezzoni lab provided DNA diagnostic support as needed at no cost to the collaborating nurseries to assure rootstock trueness-to-type. The genetic test developed by the Iezzoni lab is now offered as a routine service provided by the Foundation Plant Services – U.C. Davis.