

# FINAL PROJECT REPORT

WTFRC Project Number: CH-07-702

**Project Title:** Prevention of cherry fruit cracking using soluble potassium silicate

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<b>Total project funding request:</b>	<b>Year 1:</b>	<b>Year 2:</b>	<b>Year 3:</b>
	\$6000	\$6500	

## Other funding Sources

**Agency Name:** NONE  
**Amount requested or awarded:**  
**Notes:**

**Organization Name:** OSU      **Contract Administrator:** Dorothy Beaton  
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Item	(2007)	(2008)	
Salaries	2000	2250	
Benefits			
Wages			
Benefits			
Equipment	1000		
Supplies	1500	1750	
Travel	1500	2000	
Miscellaneous		500	
Total	6000	6500	

**Footnotes:**

## Objectives for 2008

1 To test the effects of soluble potassium silicate on cherry fruit quality parameters

- This research project had a main objective to control fruit splitting in 2007 (Priority 4).
- The research emphasis was changed by the WTFRC to that of fruit firmness.
- This research identified the effect of silicon on postharvest fruit quality (Priority 1).

## Significant Findings and Accomplishments:

### END OF YEAR 1 (2007)

#### Hood River 2007

- There were no significant differences in % fruit cracking between treatments at Hood River of 'Bing'/'Mazzard' (mean for cracked fruit = 23.6%  $\pm$  4.47%). Throughout the growing season in Hood River, there were no significant differences in 'Bing' fruit diameter (figure 1) however on the day of harvest, fruit from untreated control trees were 0.64 mm in diameter larger than those from trees treated with soluble potassium silicate (F. pr. <0.001).
- In Hood River, 'Bing' fruit from trees on Mazzard rootstock, treated with soluble potassium silicate were significantly firmer (409.4 mm.g<sup>-1</sup>) than untreated control fruit (385.5 mm.g<sup>-1</sup>) (F pr.<0.001).
- In Hood River, the TSS levels of 'Bing' fruit treated with soluble potassium silicate were significantly lower (19.15% Brix) compared to control fruit (19.99% Brix) (F. pr. <0.001).

#### Corvallis 2007

- There were no significant differences between treatments of 'Stardust'/'Gisela 6' (mean for cracked fruit = 14.7  $\pm$  5.08) . However there was a major treatment difference for 'Stardust'/'MM14', where the application of potassium silicate (mean = 34.7%) actually resulted in more cracking than on control trees (mean = 14.7%) (Figure 5).
- 'Stardust' fruit from trees treated with soluble potassium silicate were significantly larger than control fruit (Figure 6) regardless of the rootstock cultivar.
- Furthermore, 'Stardust' fruit from trees on 'Gisela 6' rootstock were the firmest of the all the treatments (Figure 7). Those from trees on 'MM14' rootstocks were the least firm. Clearly rootstock effects are having a major impact on role of soluble potassium silicate.
- The incidence of disease in the fruit at harvest in Corvallis was such that postharvest disease assessments were not deemed necessary. It was concluded that the silicon soil applications had no effect on these diseases.

### END OF YEAR 2 (2008)

#### The Dalles 2008

- There were no significant differences in percentage fruit cracking between treatments in The Dalles for either 'Royal Rainier' on 'Citation' interstocks nor for 'Sandra Rose' on 'Gisela 6' rootstocks as result of insufficient rain to induce cracking.
- In terms of fruit size, soil-drenching with soluble potassium silicate resulted in significantly more Row 9.5 'Royal Rainier' fruit than the untreated check. Only those trees soil-drenched with soluble potassium silicate had large fruit (Row 8). The converse was true for 'Sandra Rose'.
- Fruit TSS levels were not affected by soil drenching with soluble potassium silicate.
- 'Royal Rainier' fruit were softer than 'Sandra Rose' at harvest. Fruit firmness of fruit from trees soil-drenched with soluble potassium silicate, were however, significantly firmer than fruit from untreated check trees on the day of harvest and remained significantly firmer even when stored for two weeks in regular atmosphere storage at 2°C.
- Stem pull force of 'Royal Rainier' and 'Sandra Rose' decreased most significantly for check fruit between the day of harvest and after two weeks in regular atmosphere storage at 2°C. In contrast, stem pull force of similar fruit from trees, soil-drenched with soluble potassium silicate, and stored in regular atmosphere for two weeks at 2°C decreased slightly but these differences were not significant.

### **Milton Freewater 2008**

- There were no significant differences in percentage fruit cracking between treatments in Milton–Freewater for ‘Bing’ on ‘Mazzard’ rootstocks as result of insufficient rain to induce cracking.
- In terms of fruit size, soil-drenching with soluble potassium silicate resulted in significantly larger ‘Bing’ fruit of size Row 8.5.
- Fruit TSS levels were not affected by soil drenching with soluble potassium silicate.
- ‘Bing’ fruit were firmer than ‘Royal Rainier’ and ‘Sandra Rose’ fruit.
- Fruit from ‘Bing’ trees, soil-drenched with soluble potassium silicate, were firmest after two weeks of regular atmosphere storage at 2°C when compared to untreated controls either on the day of harvest or after two weeks of regular atmosphere storage 2°C
- Stem pull force decreased significantly in untreated check fruit and those soil drenched with soluble potassium silicate, as a result of regular atmosphere storage at 2°C however, decreases in stem pull force of fruit from trees soil-drenched with soluble potassium silicate were not as marked.

### **OVERALL CONCLUSION**

- *Soil Drenching on a regular basis with soluble potassium silicate during the growing season has a marked positive effect on cherry fruit quality at harvest and after two weeks regular atmosphere storage at 2°C. Depending on the scion/ rootstock combination, increased fruit size, fruit firmness and stem pull force may be expected. Future research should aim at expanding the rootstock scion interactions.*

### **Materials and Methods:**

#### **The Dalles**

In two completely randomized block design, ten eight-year-old ‘Royal Rainier’ on ‘Citation’ interstocks and ‘Sandra Rose’ on Gisela 6’ trees in The Dalles were drenched three times on 05/9/08, 05/23/08 and 06/06/08 with soluble potassium silicate during the growing season and compared against similar untreated control trees. Fruit were harvested according to industry standards and on the day of harvest, the total number of cracked fruit per tree were counted and expressed as a percentage of the total number of fruit on each tree. A sample of 50 fruit were harvested from each tree. On the day of harvest 25 fruit were analyzed for fruit size (as a function of Row size), fruit firmness, stem pull force and TSS. The remaining 25 fruit were stored in cold storage at 2°C for two weeks, removed from the cold room and held at room temperature for 14 hr to equilibrate and then subjected to the same treatments as on the day of harvest. All results were analyzed by general analysis of variance using Genstat 11.1. In addition the covariance for each of these factors was tested for against the remaining factors.

#### **Milton-Freewater**

An identical trial was laid out in Milton-Freewater except that the trees used in this experiment were twelve-year-old ‘Bing’ on ‘Mazzard’ rootstock. Fruit were handled identically to those in The Dalles.

## Results

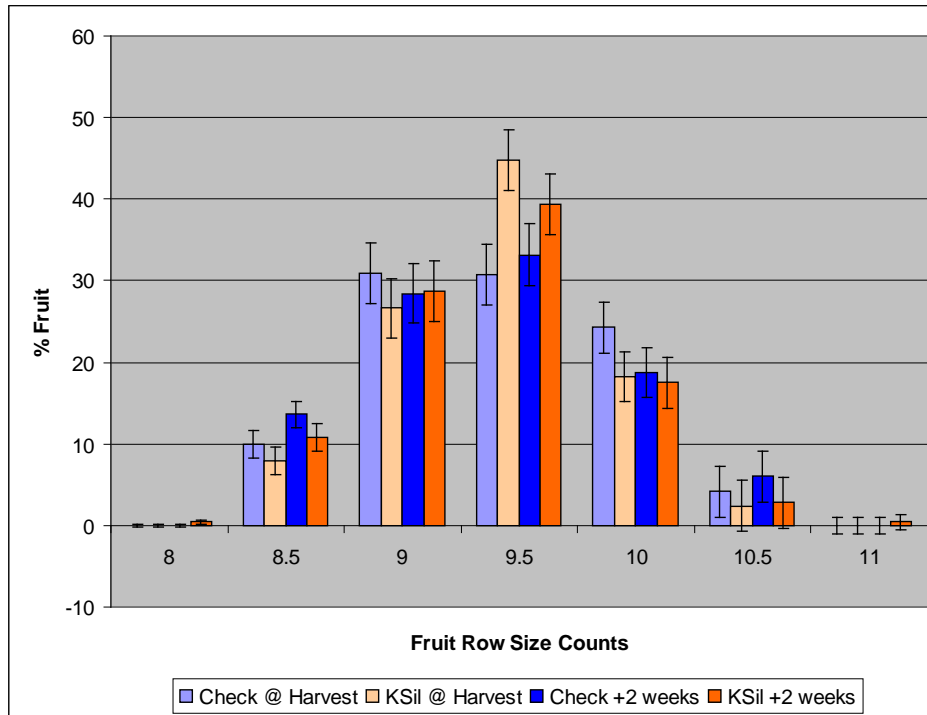


Figure 1. Average fruit size (Row counts) of ‘Royal Rainier’ fruit from trees with ‘Citation interstem’ in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

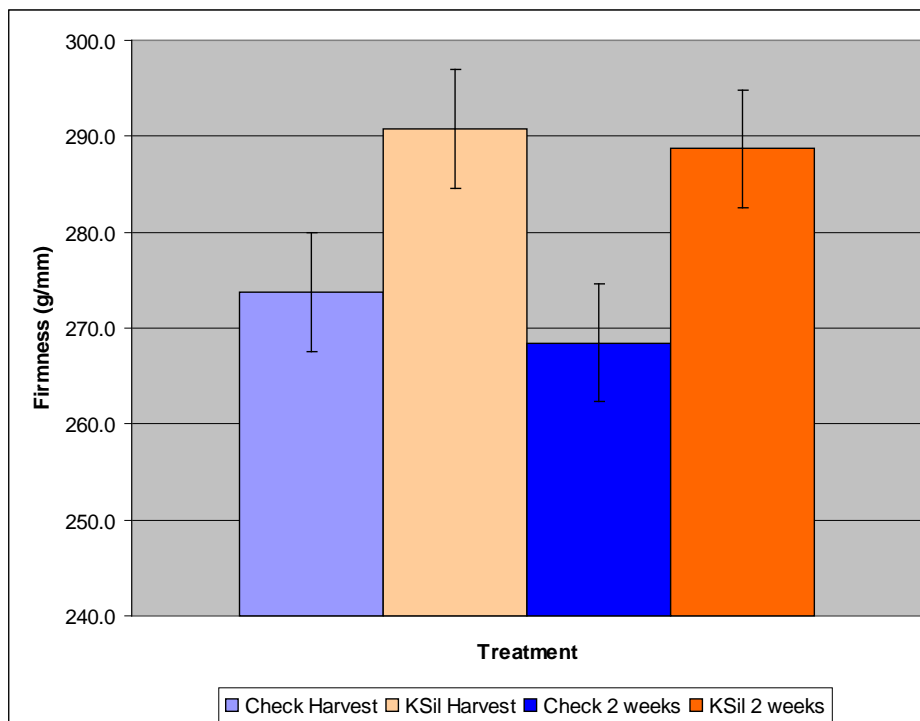


Figure 2. Average Firmness ( $\text{g}\cdot\text{mm}^{-1}$ ) of ‘Royal Rainier’ fruit from trees on ‘Citation’ interstem in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

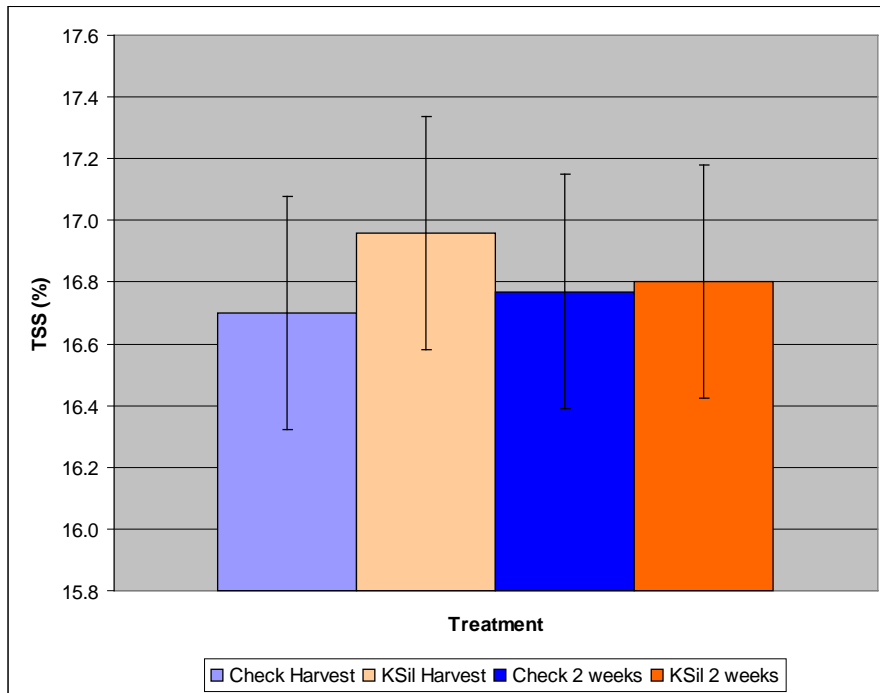


Figure 3. Average TSS (% Brix) of 'Royal Rainier' fruit from trees on 'Citation' interstem in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

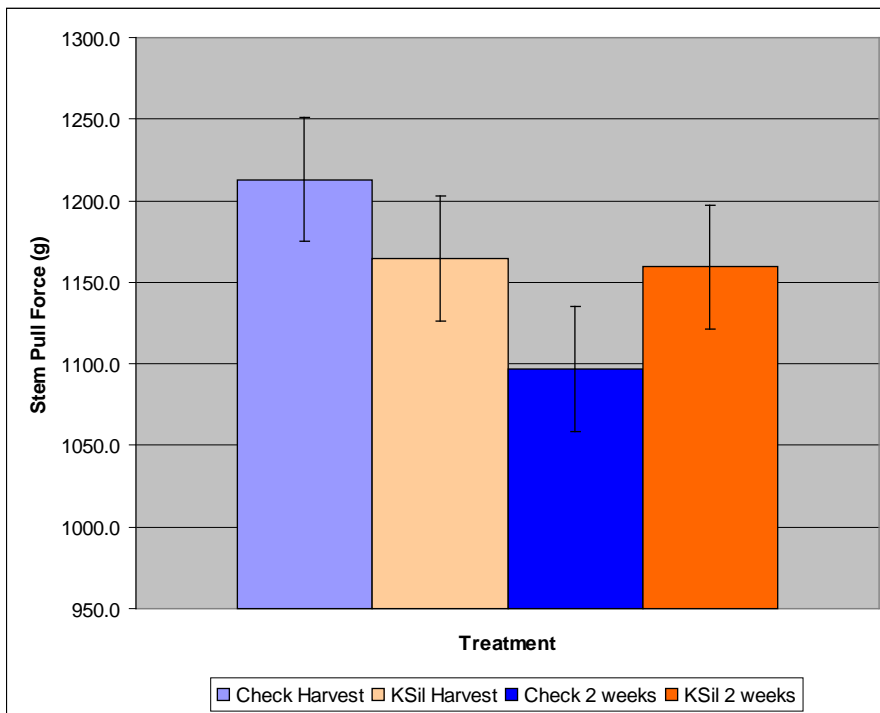


Figure 4. Average Stem Pull Force (g) of 'Royal Rainier' fruit from trees on 'Citation' interstem in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

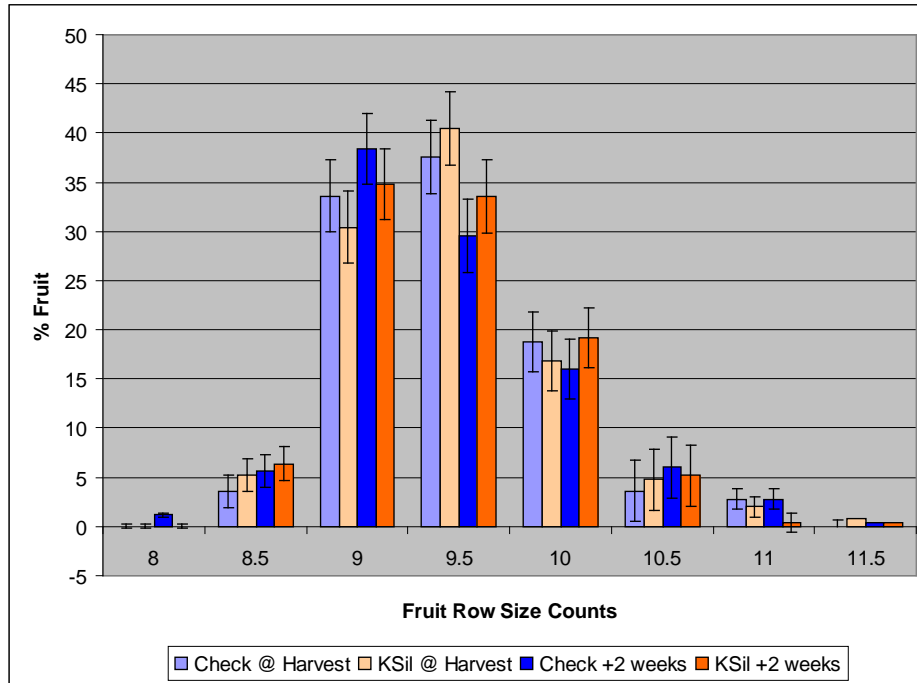


Figure 5. Average fruit size (Row counts) of ‘Sandra Rose’ fruit from trees on ‘Gisela 6’ in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

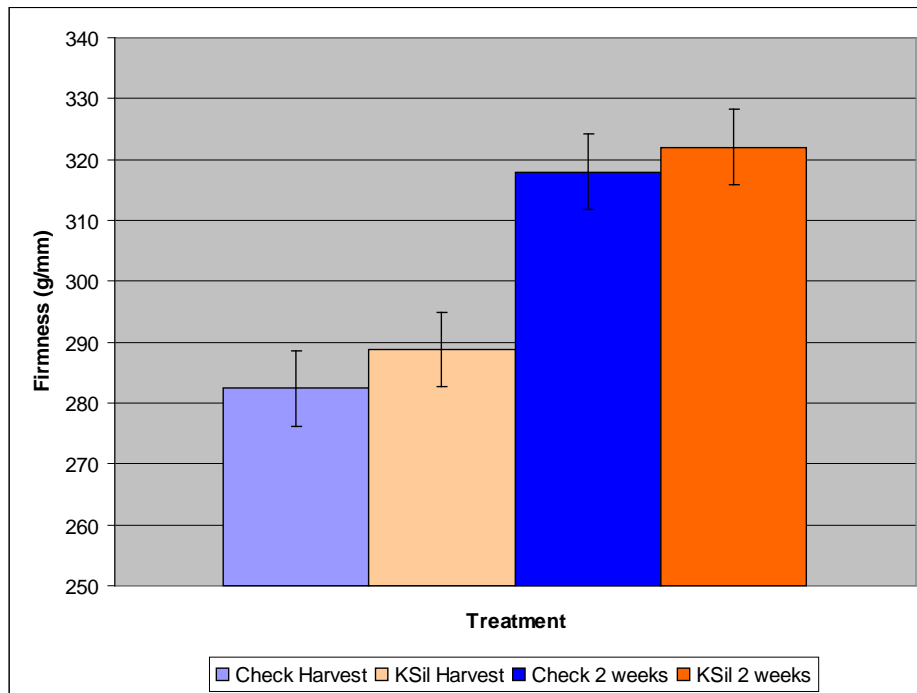


Figure 6. Average Firmness ( $\text{g}\cdot\text{mm}^{-1}$ ) of ‘Sandra Rose’ fruit from trees on ‘Gisela 6’ in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

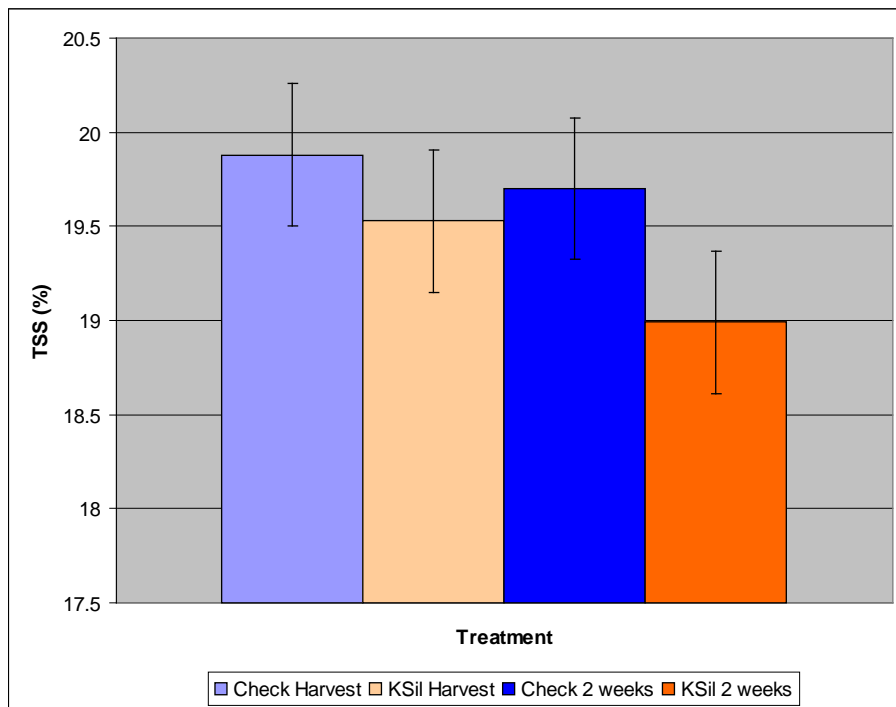


Figure 7. Average TSS (% Brix) of 'Sandra Rose' fruit from trees on 'Gisela 6' rootstocks in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

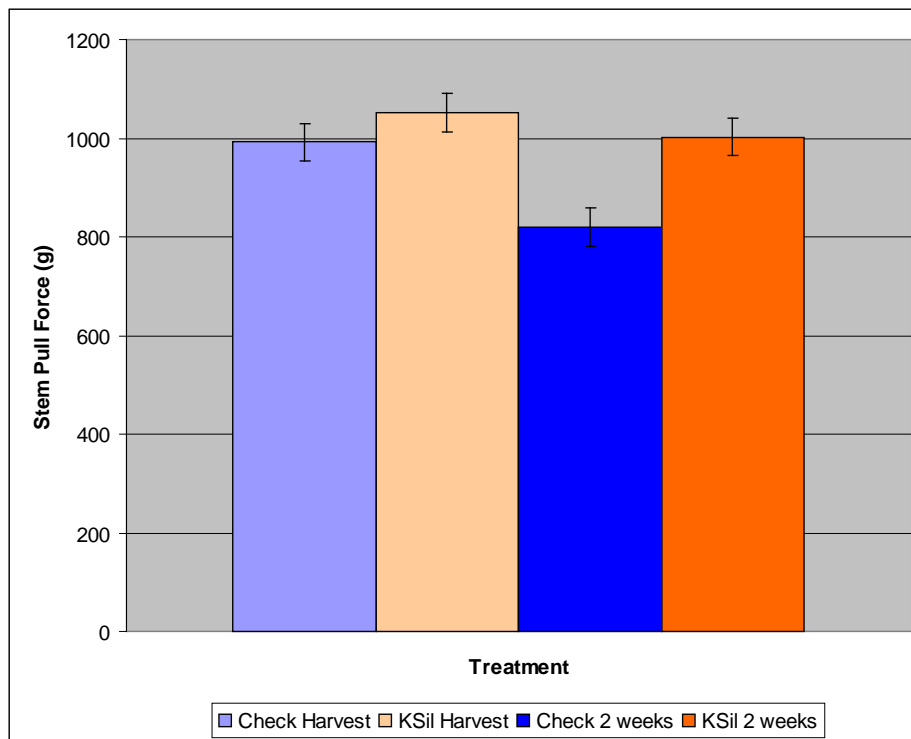


Figure 8. Average Stem Pull Force (g) of 'Sandra Rose' fruit from trees on 'Gisela 6' rootstocks in The Dalles, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

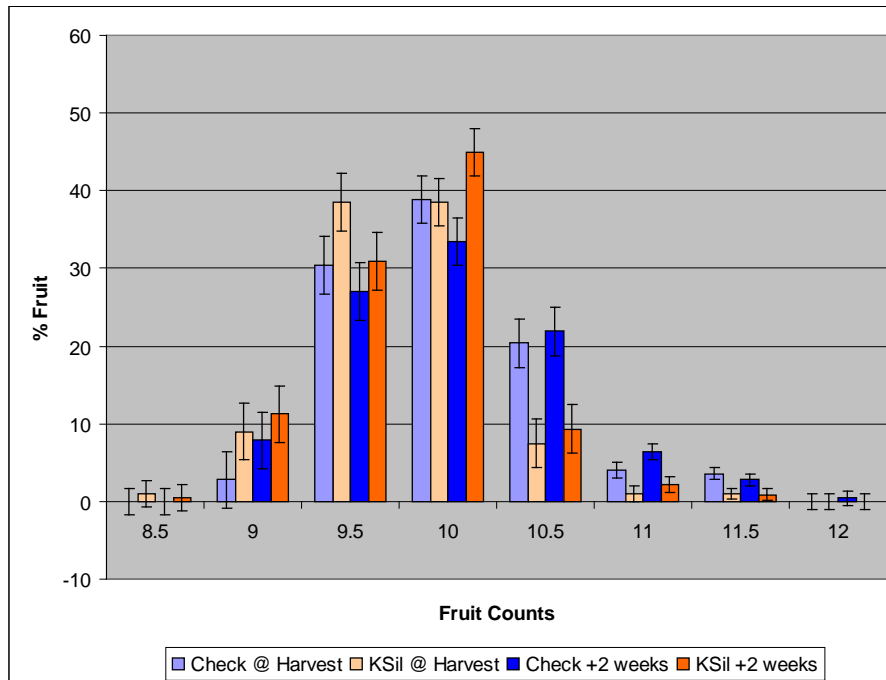


Figure 9. Average fruit size (Row counts) of 'Bing' fruit from trees on 'Mazzard' rootstocks in Milton-Freewater, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

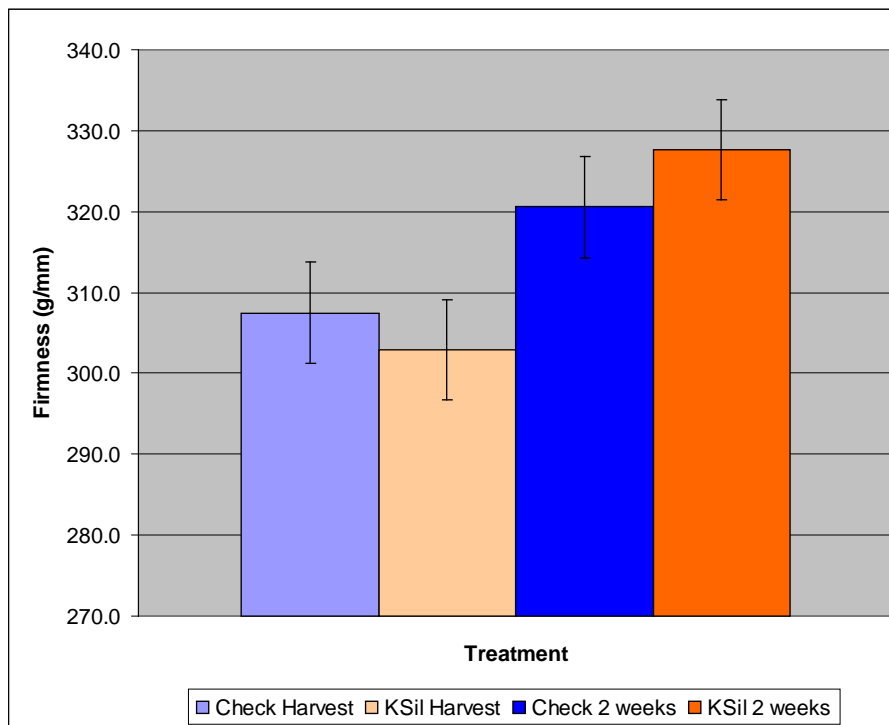


Figure 10. Average Firmness ( $\text{g}\cdot\text{mm}^{-1}$ ) of 'Bing' fruit from trees on 'Mazzard' rootstocks in Milton-Freewater, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.



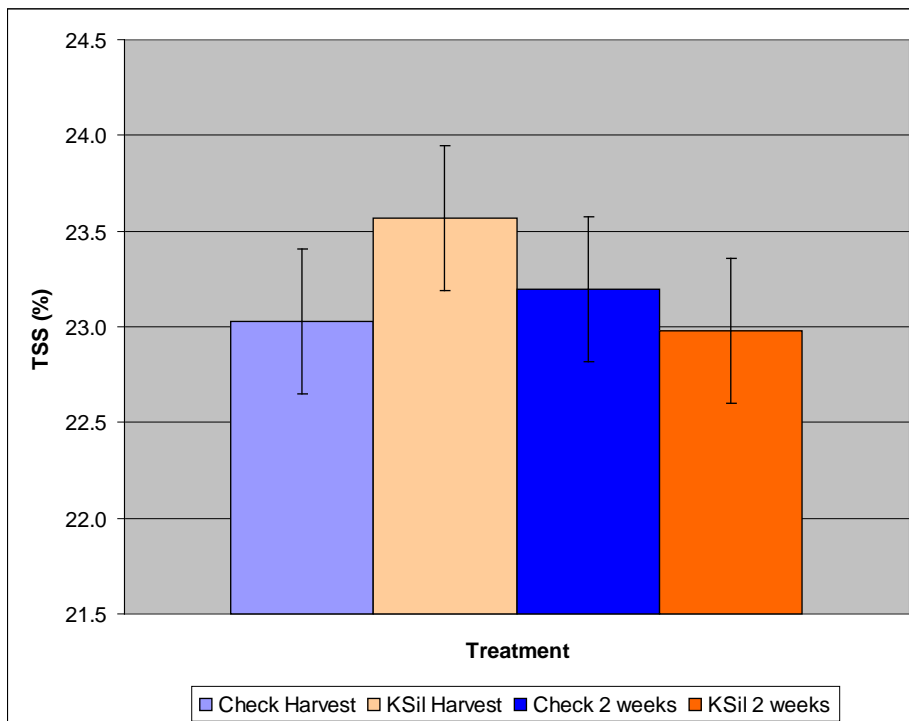


Figure 11. Average fruit TSS (%Brix) of 'Bing' fruit from trees on 'Mazzard' rootstock in Milton-Freewater, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

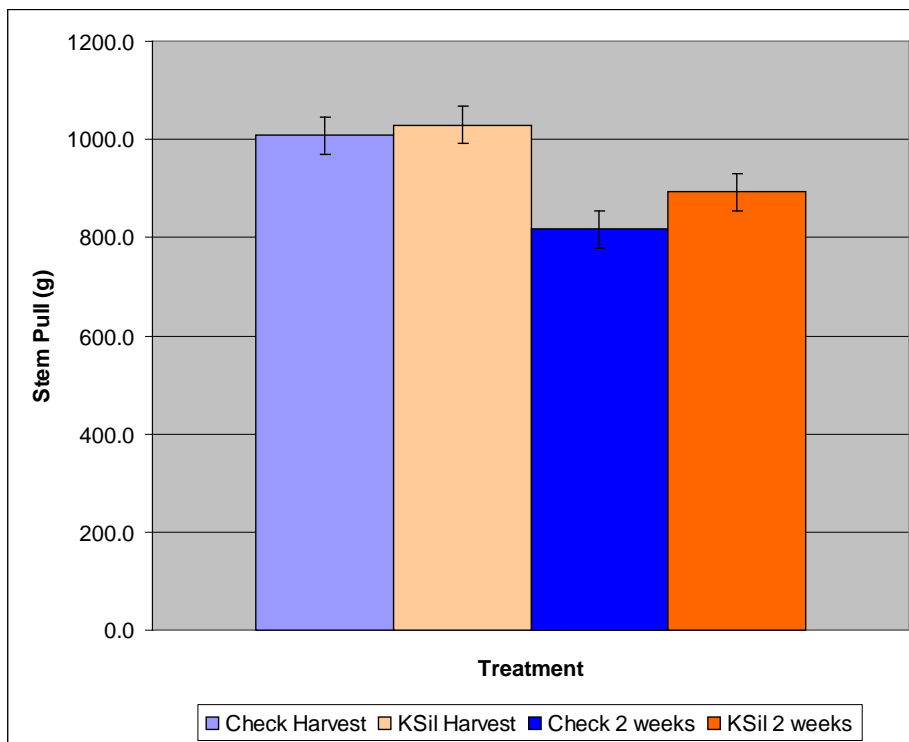


Figure 12. Average Stem Pull Force (g) of 'Bing' fruit from trees on 'Mazzard' rootstock in Milton-Freewater, treated with or without soluble potassium silicate (KSil), on the day of harvest or stored for two weeks at 2°C.

## Discussion & Conclusions

Unfortunately, there were no significant differences in rain-induced fruit cracking in the Pacific Northwest in 2008 in either Milton-Freewater or The Dalles. Indeed, the total percentage cracked fruit at harvest was less than 3% in both the untreated check trees, and those soil-drenched with soluble potassium silicate. Consequently, we are unable to make recommendations regarding the use of soluble potassium silicate for the prevention of cherry fruit cracking.

In terms of fruit size however, soil-drenching with potassium silicate in The Dalles in 2008, resulted in significantly ( $F.P.r.=0.015$ ) more 'Royal Rainier' fruit of average diameter 28.17 mm (Row 9.5) than the untreated check. Furthermore, only those trees treated with potassium silicate had some very large fruit of average diameter 33.33 mm (Row 8) (Fig. 1). A similar finding was recorded for 'Bing' fruit in Milton Freewater in 2008, where soil-drenching with potassium silicate resulted in large fruit of average diameter 31.35 mm (Row 8.5) when compared to zero fruit of this size from untreated check trees (Fig. 9). This was a positive contrast to 2007, where potassium silicate actually resulted in slightly smaller fruit (0.644 mm on average) than untreated check trees in Hood River. In contrast, in 2008, untreated 'Sandra Rose' check fruit from The Dalles were larger than those treated with potassium silicate (Fig. 5). This may have been a response to cultivar or rootstock differences but at this point, the exact cause is speculative. The most important message to take home concerning the use of soluble potassium silicate on fruit size is that it did not result in smaller 'Bing' and 'Royal Rainier' fruit than the untreated checks.

Where total soluble solids (TSS) are concerned, there were significant differences ( $F.P.r.<0.001$ ) between the different cultivars (Figs 3, 7 & 11) however, there were no significant differences between those fruit treated with potassium silicate or not, nor within any cultivar on the day of harvest v. those stored at 2°C for two weeks. Testing for the effect of fruit firmness as a covariate found that there were no significant differences either. Consequently, we conclude that silicon applications had no effect on the TSS concentrations of any of the different cultivars whether stored in regular atmosphere for two weeks at 2°C or not and that fruit firmness was not correlated with higher or lower TSS concentrations.

Where fruit firmness is concerned, there were highly significant differences between cultivars ( $F.P.r.<0.001$ ); effects of soil-drenching with soluble potassium silicate versus untreated checks ( $F.P.r.=0.049$ ); the day of harvest versus stored in regular atmosphere for two weeks at 2°C ( $F.P.r.<0.001$ ), as well as the interaction between sampling on the day of harvest v. two weeks of storage in regular atmosphere at 2°C and the different cultivars ( $F. Pr=0.002$ ) (Figs 2, 6 & 10). 'Royal Rainier' fruit were the softest of all the fruit used in this trial. However, fruit from trees soil-drenched with soluble potassium silicate, but were significantly firmer than fruit from untreated check trees on the day of harvest (291 v. 274  $g.mm^{-1}$  respectively) and remained significantly firmer even when stored for two weeks in regular atmosphere storage at 2°C (289 v. 269  $g.mm^{-1}$  respectively). Fruit from both 'Sandra Rose' and 'Bing' trees, soil-drenched with soluble potassium silicate, were firmest after two weeks of regular atmosphere storage at 2°C (322 and 329  $g.mm^{-1}$  respectively) when compared to untreated controls either on the day of harvest (283 and 308  $g.mm^{-1}$  respectively) or after two weeks of regular atmosphere storage 2°C (318 and 321  $g.mm^{-1}$  respectively). These differences were however, not significant but still bode well for soil-drenching all these cultivars with potassium silicate. Furthermore, this contrasts well with the reduced fruit firmness, observed as a result of soil-drenching 'Stardust' on 'MM14' trees, with potassium silicate in 2007. This last result does however, suggest a measure of caution with this cultivar/rootstock combination. However, based on the majority of results obtained in 2007, where soil-drenching with soluble potassium silicate resulted in a significant improvement in fruit firmness of 'Bing' fruit on 'Mazzard' rootstocks at Hood River and of 'Stardust' on 'Gisela 6' rootstock in Corvallis together with the significant increase in fruit firmness of 'Royal Rainier' on 'Citation' interstem in The Dalles 2008, we conclude that potassium silicate has a beneficial effect on most cultivar / rootstock combinations. Furthermore, this effect was further enhanced in all cultivars tested after two weeks of regular atmosphere storage at 2°C in 2008.

Where stem pull force is concerned, there were highly significant differences between cultivars (F.Pr<0.001); effects of soil-drenching with soluble potassium silicate v. untreated checks (F.Pr=0.032); and between the day of harvest v. stored in regular atmosphere for two weeks at 2°C (F.Pr<0.001). Furthermore, stem pull force was positively correlated with fruit firmness (covariate F.Pr=0.034) and was negatively correlated with TSS (F.Pr=0.046). This last correlation was most likely a function of fruit maturity. In all three cultivars tested in 2008, stem pull force decreased most significantly for check fruit between the day of harvest and after two weeks in regular atmosphere storage at 2°C (Figs 4, 7 & 11). Indeed, stem pull force of 'Bing' check fruit decreased the most after two weeks regular atmosphere storage at 2°C (from 1008 g to 816 g) compared to 'Bing' fruit from trees, soil-drenched with soluble potassium silicate (from 1026 g to 890 g). Stem pull force of 'Sandra Rose' check fruit decreased from 992 g to 815 g whereas stem pull force of similar fruit from trees, soil-drenched with soluble potassium silicate, decreased only slightly from 1052 g to 1002 g. Stem pull force of 'Royal Rainier' check fruit had the highest stem pull force at harvest 1213 g but this decreased significantly to 1097 g after two weeks of regular atmosphere storage at 2°C compared to similar fruit from trees, soil-drenched with soluble potassium silicate, where stem pull force decreased only marginally from 1165 g to 1159 g. Clearly, stem pull force decreased significantly in untreated check fruit as a result of regular atmosphere storage at 2°C. In contrast, although there were slight decreases in stem pull force of fruit from trees soil-drenched with soluble potassium silicate, these were only significant in fruit from 'Bing' trees on 'Mazzard' rootstock. Consequently, we conclude that soluble potassium silicate has a beneficial effect on stem pull force of 'Royal Rainier', 'Sandra Rose' and 'Bing' fruit and that this is especially marked after two weeks of regular atmosphere storage at 2°C.