Introduction

Washington State has the largest production of sweet cherry in the United States. Currently, most fresh-market sweet cherries are harvested by hand (Fig. 1) which is time consuming, unsafe and contributes to a high proportion of product cost. There are preliminary studies on mechanical cherry harvesting with the methods of vibration, but none are successfully commercialized due to damage of the fruit and tree, as well as low harvest efficiency.

Methods

A hydraulically powered limb shaker (Fig. 2), which shakes tree limbs with reciprocating impacts, was developed and tested. It was used as an actuator for performing mechanical harvest of sweet cherries in the 2011 harvest season.

To obtain maximum fruit removal efficiency, field tests were conducted to find optimal combination of impact frequency and duration.

Two previously identified optimal impact frequencies of 14 and 18 Hz were used to combine with two intermittent impact durations of 2 and 5 s. The procedure of harvest test was shown as Fig. 4 – Fig. 6. The parameter of overall fruit removal efficiency, the weight ratio of the mechanically harvested fruits to the total fruits of the tree, were measured and treated as an indicator of the performance of shaker. Images of a tested tree were taken before and after mechanical harvest.

Results

Fish removal efficiency

The overall fruit removal efficiency showed the highest value under the condition of 5 s impact duration and 18 Hz shaking frequency, which was treated as the optimal working condition. The result also showed that most of the fruit could be removed within 10 s by the shaker in any tested condition.

Results (continued)

- **Percentage of fruits with stem**

  The average overall percentage of stem-on fruits (Fig. 8) ranged from 7.4% to 28.7%. The combination of 18Hz-5s harvested the highest average percentage (21.5%) of stem-on fruits, while the lowest value showed in the situation of 14Hz-2s, which is a little less than that of 14Hz-5s. However, in general, there was no significant difference in the percentage of stem-on fruits among these four combinations.

  ![Fig. 8. Overall percentage of fruits with stem](image)

- **Analysis of remained fruits**

  Visually analyzing the images of trees mechanically harvested showed that about 61% of the remaining fruit were on slim and long branches, which suggested that better pruning could benefit the mechanical harvesting.

  ![Fig. 9. Distribution of remained fruits](image)

Conclusion

a. It is possible to harvest sweet cherry with the vibratory method;

b. The optimal operation condition was 18 Hz shaking frequency with 5-second impact duration;

c. Percentage of fruit with stem was in the range of 7.4% to 28.7%;

d. A careful pruning would improve the mechanical harvest efficiency.

This research is part of the SCRI (Specialty Crop Research Initiative) sweet cherry research project of developing a sustainable, stem-free sweet cherry production, processing, and marketing system. The main goal of this research is to develop a mechanical or mechanical-assist system to harvest fresh market sweet cherries to improve labor efficiency and safety. In the past two years, a novel vibratory harvest system was developed and tested. Tests showed that vibratory harvest is a potential method to harvest sweet cherry. Future work plans include developing various shake and catch systems that can be utilized in a variety of sweet cherry orchard architectures.