Preharvest Spray Cooling for Tart Cherries

Michigan State University Agricultural Experiment Station and Cooperative Extension Service

Research Report

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Issued July 1968

4 pages

RESEARCH REPORT 69 FARM SCIENCE

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION EAST LANSING

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Preharvest spray cooling of tart cherries using an orchard air blast sprayer

Preharvest Spray Cooling for Tart Cherries

By R. G. Diener, R. T. Whittenberger and J. H. Levin[1]

About 50 percent of the 85 million pound 1967 Michigan cherry crop (1967 Federal State Market Report) was mechanically harvested (2). Nearly all tart cherries will be harvested mechanically within a few years. With proper equipment and water handling, the quality of this fruit is generally good. However, when cherry temperatures become too high, the fruit softens and quality is lowered. In some cases, growers have had to stop harvesting for part of a day because of excessive fruit softness.

Since it has been shown that cooling cherries after harvest improves quality and pitter yield (1, 3, 5) it was suggested that preharvest cooling using a cold water spray might be of further benefit by increasing firmness and reducing bruising during mechanical harvest. Even in cases where cherries were already cool, it was felt additional cooling would further increase fruit quality and pitter yield.

OBJECTIVES

In order to determine the practicability of commercial preharvest spray cooling, a research study was conducted in Michigan orchards in the summers of 1966 and 1967 with the following specific objectives:

1. To determine the magnitude of cooling possible, using an air blast sprayer with cold water;
2. To study the cooling process in the individual cherry;
3. To determine the effects of water temperature, cherry temperature, amount of water applied, humidity, and wind velocity on amount of cooling;
4. To determine effects of cooling on cherry shrinkage and pitter yield;
5. To determine the economic practicability of commercial preharvest spray cooling, and to recommend procedures for the grower to follow.

PROCEDURE

Nine orchard spray cooling tests were conducted in conjunction with mechanical harvesting operations in the southwest and northwest cherry growing regions of Michigan during the 1967 season. Entire trees (cover) were sprayed with an air blast sprayer about 20 minutes before harvest with a commercial self-propelled cherry harvester. Water was applied at a rate of about 20 gallons per minute on both sides of the tree in the row, for time periods ranging from ½ to 2 minutes per side. Water temperatures ranged from 52 to 70° F. and original cherry temperatures ranged from 69 to 83° F.

Internal cherry temperatures were averaged from thermocouples inserted in eight cherries on both the test and check trees. Two additional thermocouples were used in each tree to measure air temperature. All temperatures were recorded before, during and for 20 to 30 minutes after the spray run.

In small-scale tests individual cherries were sprayed in a manner similar to that used in commercial sprayings. The resulting internal and external temperature changes were measured with respect to time using a thermocouple inserted in the cherry near the pit and an infrared thermometer on the outside surface (Fig. 1).

Samples of 120 cherries were selected at random from the pallet tank on the cherry harvester immediately after harvesting for tests of soak loss and pitter

Fig. 1. Measurement of cherry temperature: *surface* —infrared non-contact thermometer; *internal* — thermocouple inserted in cherry (held by masking tape).

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yield. Samples were taken for both the test tree and the check tree which was usually adjacent in the same row.

Samples of 100 cherries were weighed immediately and placed in water for the 20 hour soak test. Firmness measurements were made with a PL meter (4) on an additional 20 cherries from both the check and test trees.

After soaking 20 hours, samples were weighed and pitted on a six needle hand pitter which operates on the same principle as a commercial pitter. The pitted cherries were drained for 2 minutes and weighed to obtain the pitter yield. At this time, firmness measurements were also made on the soaked 20 cherry samples from both the test and sprayed trees.

Similar studies were conducted in 1966.

RESULTS

Effectiveness of Spray for Cooling

The orchard air blast sprayer was very effective in cooling both the cherries and the air within the tree canopy. Although 1967 was a cool season, it was possible to lower temperatures of cherries by 10.3° F. when original temperatures were only 79.1° F. More cooling would have been possible with higher original temperatures in a warmer season. Average spray water temperature was 56.8° F.

Cooling Process of the Cherry

Cooling by water spray on the cherry is accomplished by (1) conduction from the cold water on the surface and (2) evaporative cooling. This process is shown in Fig. 2 where the external surface is cooled rapidly from 75° F. to 69° F. during a 20 second application of water. This is equivalent to a 60 second application over the entire tree where the spray covers about 1/3 of the tree at any given time.

Further evaporative cooling took place until a low value of 67° F. was reached at the surface in about 7 minutes.

During this time, heat was being removed from the interior of the cherry as shown by the solid line in Fig. 2. Since the heat transfer was to the exterior tissues, a low value of 68° F. was not reached in the interior of the cherry until about 9 minutes after spraying.

The dashed area between the curves of Fig. 2 gives the continuous differential between the external and internal temperatures. As the external temperature starts to rise again due to (a) the ambient temperature, (b) absence of water on the surface, and (c) heat flow from the interior of the cherry, the surface again becomes warmer than the interior of the cherry. The cross over point occurred in this case at about 11 minutes after spraying.

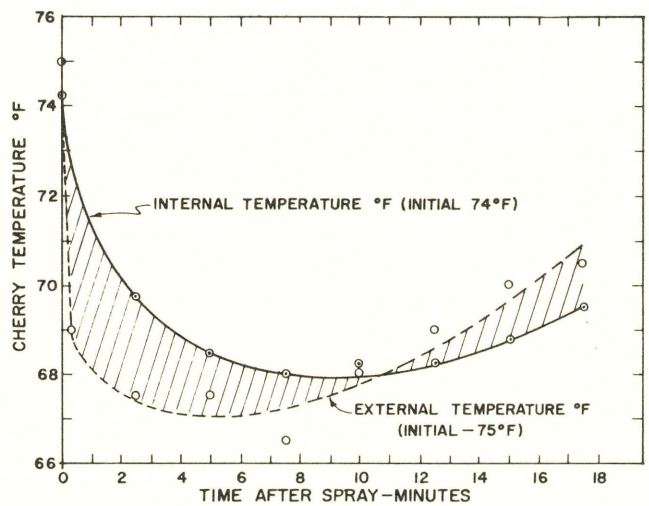

Fig. 2. Affect of spraying on internal and external cherry temperatures.

As shown in Fig. 2 the temperature rise from the lowest temperature is relatively slow. In the tests temperatures increased only about 2 degrees in 10 minutes. Thus, the most benefit from spray cooling can be derived if the fruit is harvested within 10 to 20 minutes after spraying with 50 to 55° F. water.

Effect of Water and Cherry Temperatures on Cooling

The amount of cooling possible depends on the difference between the cherry and water temperatures. Maximum cooling of 16° F. resulted in run #8 when cherries at 83° F. were sprayed with 55° F. water. This value occurred 8 minutes after spraying. With warmer cherries more cooling would be possible.

On the average, cherries in these tests reached their lowest temperature in 9.9 minutes. However, it was not physically possible to coincide exactly with the mechanical harvester and shake them at this time. Consequently, they were not harvested until an average of 18.6 minutes after spraying. Since they had warmed up only an average of 2° F. the delay was not serious.

Effect of Spray Period on Cooling

In these tests, trees were sprayed in periods of from 30 seconds to 120 seconds *per side*. The 120 second application in run #5 did not appear to have an advantage in cooling rate over the 30 second application for small to medium size trees. Longer applications would be advantageous for large trees.

The most effective cooling would be to make two 15 second applications 10 minutes apart on each side of the tree to take advantage of the full evaporative cooling capacity of the water film on the cherry. When excessive amounts of spray are used, the water film on the cherry is replaced before it has absorbed its full capacity of heat from the cherry.

Effect of Humidity, Wind Velocity, and Time of Day on Cooling

Both low relative humidity and high cherry temperatures favored maximum cooling. During spraying in the absence of wind, however, the air within the tree canopy was cooled and raised to near 100 percent humidity. At this time the natural movement of warm air through the tree canopy starts the evaporative cooling cycle.

Under commercial conditions spray cooling would be most beneficial on hot afternoons. Lowering cherry temperature at that time would be especially valuable as a scald deterrent.

EFFECTS OF COOLING

The sprayed cherries were only slightly firmer than check cherries at harvest and even less so after a 20 hour soak. Contact with the metal elevators in the catching frame would have warmed the cherries slightly before their firmness was measured. In addition, if the sprayed cherries were only 10 degrees cooler than the check cherries, they would be expected to be only 2×10^{-3} inches firmer.

Spray cooling of cherries prior to harvest decreased their weight loss during a 20 hour soak period by an average of 0.79 percent, and increased their *pitted yield* by an average of 0.97 percent. The total increase given by the *product yield* of the sprayed lots (sums of the soak increase and the pitted increase) was an average of 1.76 percent. This was significant at better than the 97.5 percent level. Scald counts were very low (0 to 5 percent) even at 20 hours. It should be pointed out that the cherries were not rehandled, or rebruised in any way, prior to pitting. Rehandling promotes scald.

The temperature of the cherry before spraying (Fig. 3), and the temperature of the spray water, were the most important factors in determining the benefit derived from preharvest spray cooling. In one test, for example, spraying warm cherries with cold water prior to harvest resulted in a 3.2 percent increase in product yield.

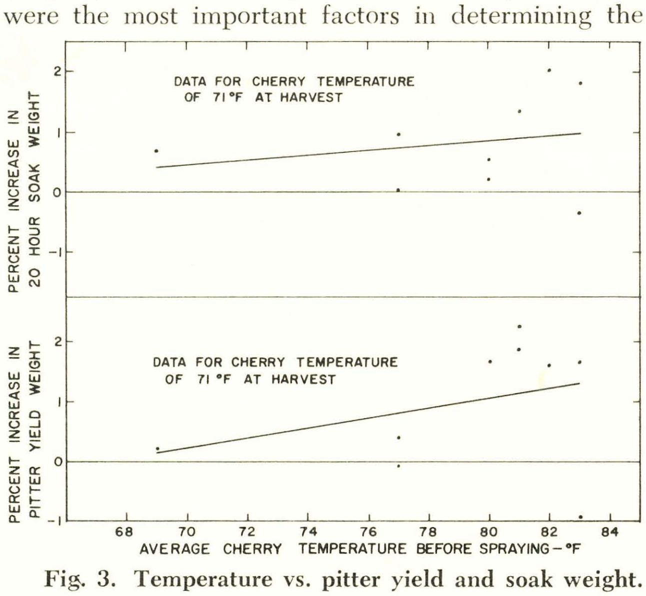

Fig. 3. Temperature vs. pitter yield and soak weight.

ECONOMIC PRACTICABILITY

Preharvest spray cooling of tart cherries gives significant benefits and appears to be practical. The savings to the grower during the 20 hour soak period would about equal the cost of additional labor and fuel required for spray cooling. In 1967, for example, the savings due to reduced cherry shrinkage would have amounted to about $400 for a 100 ton grower. The grower would also be able to continue harvest in hot weather.

The processor may pay a premium for spray cooled cherries in a short crop year, or give the grower preference in a year of a large crop. In 1967, for instance, a 5,000 ton processor would have gained about $20,000 through increased pitter yield. Moreover, spray cooled cherries can be expected to have reduced scald counts at time of processing.

RECOMMENDATIONS

To obtain maximum benefit from a preharvest spray cooling program:

1. Orchard temperature should be 83° F. or higher.
2. Trees should be sprayed 20 to 30 minutes before harvest.
3. Spray water should be 50° F. or less and should be applied at a rate of 20 gallons per minute.
4. Water should be applied a minimum of 30 seconds on both sides of the tree. Total spray water required would be about 20 gallons per tree.

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ACKNOWLEDGMENTS

The authors wish to thank Mr. R. J. Wolthuis, Mr. David Friday of Hartford and Mr. George McManus, Jr., of Traverse City, for their cooperation in these investigations.

Research was conducted under cooperative work of the Agricultural Engineering Research Division and Eastern Utilization Research Division, ARS, USDA and the Agricultural Engineering Dept., Michigan State University, on mechanical harvesting of tree fruits.

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