Cooling Fruit in Fibreboard

new containers for plums and pears tested for their suitability to present packing and shipping methods

Rene Guillou

Concern that customary handling and cooling methods—developed for wooden containers—might result in unsatisfactory cooling when applied to fibreboard containers led to studies of cooling measurements with plums and pears at Davis.

Warm fruit packed in openly constructed wooden containers can be adequately cooled in a refrigerator car. A modern refrigerator car is provided with air-circulating fans which are driven from the car wheels or by electricity from the packing shed in the time between loading of the car and the start of its journey. Cold air from the fans finds its way through and between the stacked containers and cools the fruit at a satisfactory rate. The cooling rates for packed wooden containers in refrigerated cooling rooms are known from experience when this type of cooling is used.

Fibreboard containers must be quite well enclosed in order to be of adequate strength, and the fibreboard tends to insulate the fruit inside from the air outside. However, the Davis studies indicate the cooling times that can be expected with the new containers and with some special methods of cooling.

Fruits used in the cooling measurement studies were first warmed to a uniform temperature in an 85F room and then packed in a fibreboard box to be studied. Thermocouples were inserted in fruits in different locations in the box, and the box was placed in a 40F room. Top, bottom, and two sides of the box were insulated and two sides were left exposed to simulate one way of stacking in a cold-storage room or refrigerator car. The room air was in random movement estimated at one mile per hour or less. An air blast when used was turned directly on one end of the box.

The accompanying table shows the approximate time required for the temperature difference—between the most protected fruit and the room air—to reach one half its initial value. For example, if pears at 70F are wrapped, packed in a standard wooden box, and placed in comparatively still air at 30F, the pears in the center of the box will cool to 50F in about 26 hours, to 40F in 52 hours, to 35F in 78 hours, to 32.5F in 104 hours, and so on, the temperature difference being halved in each 26 hours. Again, if plums that have been cooled to 40F are spread on a sorting belt in a 100F packing shed, they will warm to 70F in about 30 minutes, to 85F in 60 minutes, to 92.5F in 90 minutes, and so on.

Wrapped pears in the center of a fibreboard box cooled at almost the same rate as wrapped pears in the center of a wooden box. Temperatures measured in different parts of these boxes showed that most of the resistance to heat flow was in the wrapped pears and at the outer surface of the box. The additional resistance introduced by the fibreboard box as compared with the wooden one was not very important in the total resistance. Experimental containers in which the pears were not wrapped cooled faster than the standard wooden-box

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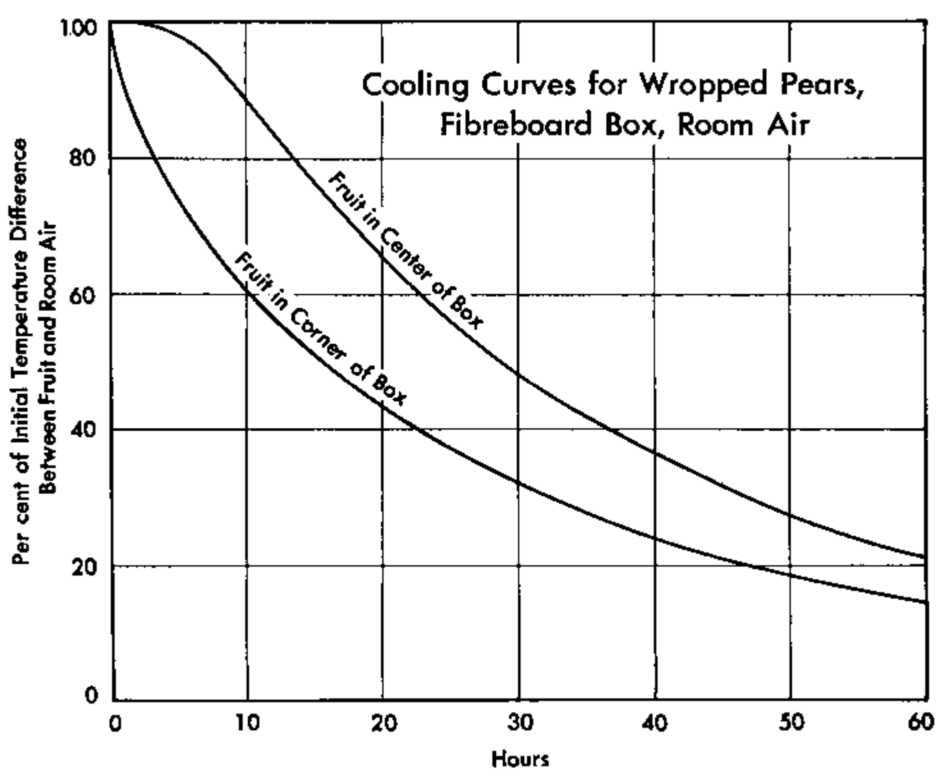
Pear and Plum Cooling Measurements at Davis, 1954.

Time required for the initial temperature difference between the most protected fruit and the surrounding air to be reduced by one half.

	Hours
Wrapped pears in 38-pound fibreboard telescope box with hand-holes in ends, room air	28
Wrapped pears in standard wooden pear box, room air	26
Naked pears in 38-pound fibreboard telescope box with hand-holes in ends	
Room air	23
10-mile air blast or 4 cubic feet per minute circulated through box	8
Naked pears in 2-pound cardboard boxes packed 20 in a cubical fibreboard box, no ventilation openings, room air	21
Naked pears in 38-poued wire-bound box, room air	13
Naked pears in field lug, room air	9
Plums in 25-pound fibreboard box with polyethylene liner, top layer in fibreboard tray	
Room air	24
10-mile air blast	15
Plums in 25-pound fibreboard box with open hand holes, top layer in fibreboard tray	
Room air	16
10-mile air blast or 3 cubic feet per minute circulated through box	4
Plums in 4-basket crate or field lug, room air	10
	Minutes
Plums on belt or table	
Room air	30
20-mile air blast	8
Plums immersed in water	4



FIBREBOARD

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pack. It appears that any cooling practices that have been satisfactory for standard wooden pear boxes will be satisfactory for any of these experimental packs.

Fibreboard boxes of plums required about half again as long to cool as did the standard four-basket crate. When a polyethylene liner was used, as is done with some other fruits to control ripening, the cooling time was over twice that for a four-basket crate. These differences might be greater in a storage room or refrigerator car because of the tendency of fibreboard containers to settle together and lose their original spacing.

Plums could be cooled rapidly in an air-blast cooler or in a hydrocooler. Either of these devices is expensive, however, and the plums would warm again rather quickly if exposed in a warm packing shed. To cool plums in field lugs before packing would take two thirds as long as to cool them after packing in fibreboard boxes with open handholes, and again a part of the cooling would be lost if packing were done in a warm shed. An air blast cools packed boxes quickly if they can be stacked in such a way that each one is exposed to it.

Circulation of air through fibreboard boxes appears to be a promising means of speeding up the cooling. An air pressure of less than one-sixteenth inch of water sufficed to circulate three cubic feet of air per minute through a 25-pound plum box. The air entered and left the box through one-inch by three-inch handholes in the ends. Calculations indicate that the pressure required to force the air through the handholes themselves was insignificant and there would be no advantage in making the holes larger.

To attain this air flow through each of 1,000 boxes in a carload would require 3,000 cubic feet of air per minute at a pressure of one-sixteenth inch of water. The fans in a standard refrigerator car are rated to deliver 8,000 cubic feet of air per minute at a pressure of one-eighth inch of water when the car is moving 50 miles an hour or when the car is standing and the fans are being operated by electric power from the packing house. Circulation of even one half of this air through the boxes would be ample for quick cooling.

Plans have been developed for stacking the load in such a way as to accomplish this. Cooling tests are to be checked and extended in 1955.

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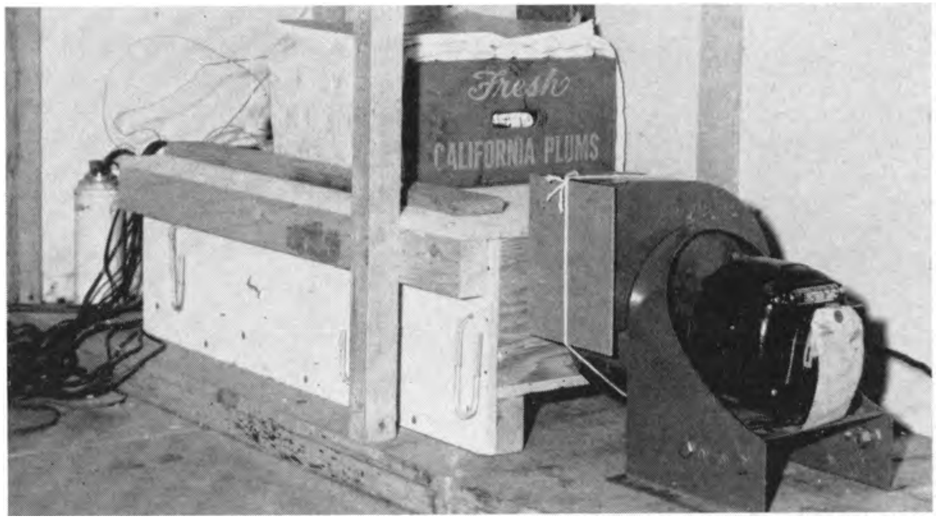
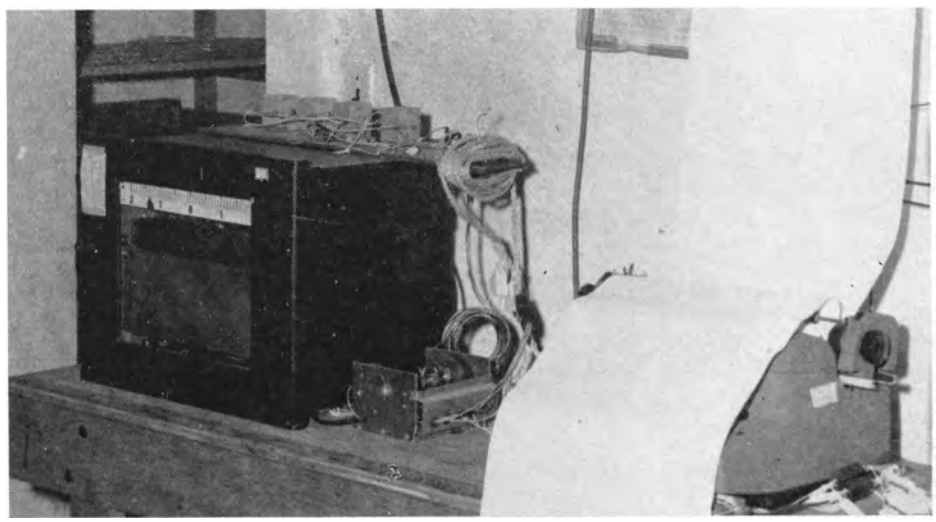
The above progress report is based on Research Project No. 1579.



Air being drawn through a box of plums in a small wind tunnel. Manometers measure pressure and orifices in the tunnel measure flow. The box with one end exposed is being cooled in still air.



An electric typewriter arranged to record temperatures at each of sixteen points every four minutes.

Experimental spacing of a new type of plum container tested by the California Grape and Tree Fruit League and the U.S.D.A.