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Field heat removed rapidly by

Forced-Air Cooling

of vine-ripe tomatoes

A one-half cooling time of 47 minutes for eight tons of vine-ripe tomatoes was achieved in a test to develop information on forced-air cooling rates.

The test, conducted in Ventura County, used a cooler commercially constructed to operate on the forced-air principle of applying a difference in pressure to the two sides of the stacked tomato boxes to force air through and between the boxes. Air is drawn from the bottom of an ice bunker by a five horsepower belt-driven radial-flow fan and may be directed to either of two rooms by means of a hinged plywood baffle.

Packed tomato boxes, stacked on pallets, are run into the cooling room on a battery-powered live-skid. When a room is completely loaded, 672 boxes—a little over eight tons net—are in two stacks, each three rows wide, eight layers high, and 14 tiers long; about 15″ out from the walls and with about 20″ of open space down the middle of the room between the two stacks. The space between each stack and the wall behind it is closed by a hinged baffle at the top and by a fixed baffle at the end. The air is forced from between the stacks through the boxes into the enclosed space next to the wall and back to the top of the ice bunker through ducts beneath the floor.

From the size of the fan discharge and measurement of the air velocity, the air flow in the cooling room was estimated to be about 0.9 cubic foot per minute per pound of tomatoes. Difference in air pressure between the two sides of the stacked boxes was measured with a sensitive gauge to be equivalent to about 0.1″ of a column of static water.

Most of the ice in the bunker was in 300- or 150-pound blocks. Air-flow was roughly 100 cubic feet per minute per square foot of ice bunker grate area. The air passing through the bunker was cooled a little more than half-way to ice temperature.

Ice consumption was measured before and after cooling each of two different room-loads of tomatoes. Cooling one lot melted 1,070 pounds of ice; cooling the other lot melted 1,330 pounds of ice. Because of considerable variations in initial and final temperatures in different parts of the loads, it was not possible to estimate accurately the actual temperature reductions. However, it was evident from data obtained that the temperature reduction approached 10°F in one lot and 12°F in the other lot and that consequently very little ice was melted by heat from other sources than the tomatoes.

During cooling, temperatures were taken with thermocouples hung in the air stream and also inserted in the tomatoes. Removing the tomatoes from the cooler and loading them in a truck presumably mixes the warmer and colder boxes so that the entire load tends to assume the average temperature. In that event the important temperature figure is the average, which, in the Ventura County test, was reduced halfway to average air-blast temperature in 47 minutes of fan operation.

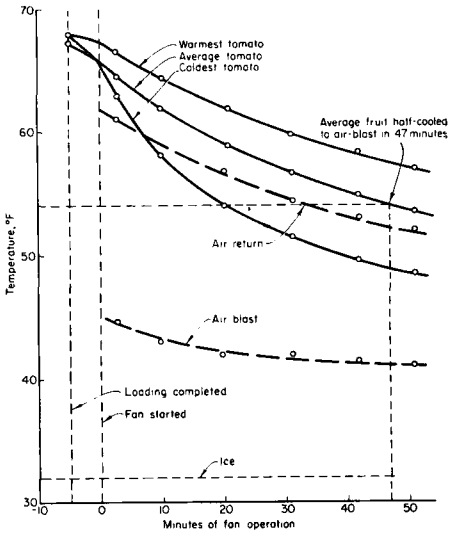
Air-blast temperatures may be expected to vary considerably depending on the initial temperature of the load. For this reason, performance predictions are more reliable if they are based on half-cooling to ice temperature. Calculations from the data obtained in this test show that the average tomato temperature would be reduced halfway to a 32°F ice temperature in about 75 minutes. Tomatoes initially at 60°F would cool to 55°F in 20 minutes while those initially at 100°F would cool to 55°F in two hours. The cooling rate is proportional to the average temperature difference between the tomatoes and the ice.

Initial average °F	100	90	80	70	60
Time to 55°F average: Hr.	2	1	1	–	–
Min.	–	40	20	55	20

The difference between the warmest and the coldest tomatoes measured reached a maximum of 9°F after 50 minutes. the coldest tomato was never more than 6°F below the average and this for only a short time, so reducing the average temperature to 55°F or even 50°F should not result in any chilling injury.

Temperatures during forced-air cooling of vine-ripe tomatoes in study made in September, 1958.

Minutes from end of loading	0	8	15	26	36	47	56
of fan operation		3	10	21	31	42	51
	(Temperatures in degrees F)						
Air blast		45	43	42	42	41	41
Air return		61	58	57	54	53	52
Tomato							
bottom layer upstream	68	65	62	58	55	53	52
bottom layer middle	66	65	64	61	59	57	55
bottom layer downstream	67	65	63	61	59	58	56
center layer upstream	68	63	58	54	52	50	48
center layer middle	67	64	61	58	56	55	54
center layer downstream	68	67	64	62	60	58	57
top layer upstream	66	62	59	56	53	52	50
top layer downstream	69	66	63	61	59	57	56
average	67	65	62	59	57	55	54



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