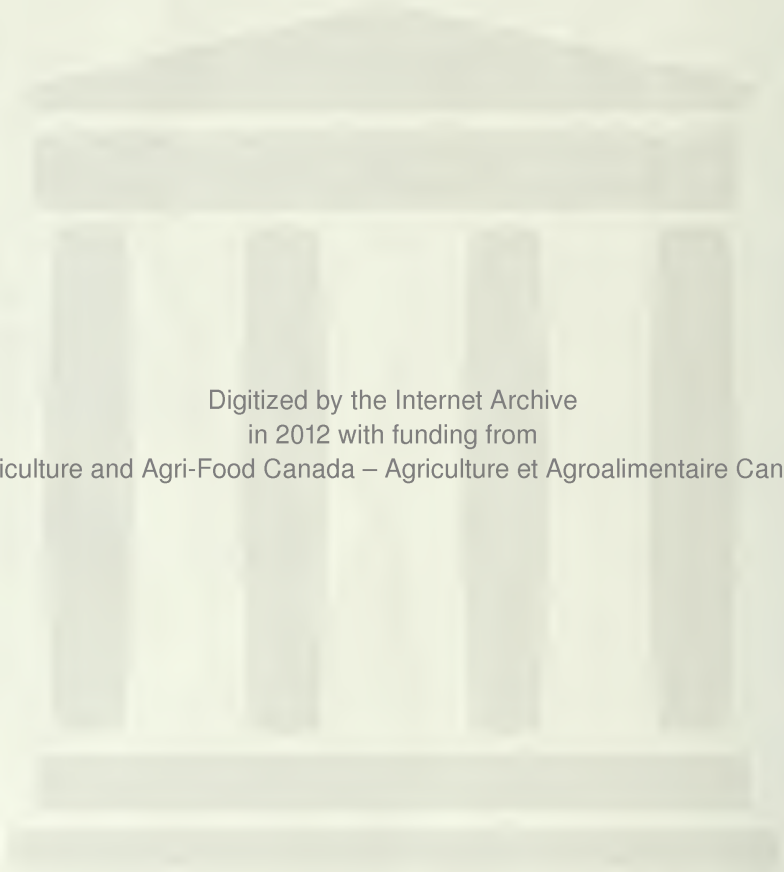


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DEPARTMENT OF AGRICULTURE
DAIRY AND COLD STORAGE BRANCH
OTTAWA - - - CANADA

PRECOOLING, SHIPMENT AND COLD STORAGE OF TENDER FRUIT

With Notes on Packing and Packages

BY EDWIN SMITH, B.Sc.

ASSISTED BY J. M. CREELMAN, B.S.A.



The Grimsby Precooling and Experimental Fruit Storage Warehouse.

BULLETIN 48---DAIRY AND COLD STORAGE SERIES

LETTER OF TRANSMITTAL.

OTTAWA, February 21, 1916.

To the Honourable,
The Minister of Agriculture.

SIR,—I beg to submit for your approval the manuscript for a bulletin giving the results of two years' work at the Grimsby Precooling and Experimental Fruit Storage Warehouse, which has been prepared under my direction by Edwin Smith, B.Sc., who is in charge, assisted by J. M. Creelman, B.S.A.

Mr. Smith has, by his devotion to the work, his excellent training and keen grasp of essentials, collected a large amount of data during the past two years, which must prove to be useful information to fruit growers, shippers and dealers. He has been ably assisted since the beginning of the season of 1915 by Mr. Creelman, who had previously gained valuable experience, in British Columbia and in California, along similar lines of investigation.

Mention should also be made of those fruit growers and shippers in the Niagara district whose hearty co-operation has been a great help in extending the scope of the work.

I have the honour to recommend that the manuscript be printed for circulation as Bulletin 48 of the Dairy and Cold Storage Series.

I have the honour to be, sir,
Your obedient servant,

J. A. RUDDICK,
Dairy and Cold Storage Commissioner.

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PRECOOLING SHIPMENT AND COLD STORAGE OF TENDER FRUITS WITH NOTES ON PACKING AND PACKAGES.

BY

EDWIN SMITH, B.Sc.

ASSISTED BY

J. M. CREELMAN, B.S.A.

SCOPE OF WORK.

The work at the Grimsby Precooling and Experimental Fruit Storage Warehouse has been divided into:—

- (1) Commercial cold storage and the precooling of fruit for the general public;
- (2) Demonstrations in fruit handling, packing, precooling and transportation, and
- (3) Experimental refrigeration tests.

Under the first division, the work is strictly commercial; and fixed rates are charged for services rendered. Precooling of carlots is usually done for the fruit marketing organizations or dealers, although occasionally a grower makes up carloads of his own products. There are occasions when certain new practices need to be demonstrated to the growers and shippers to show the advantage or disadvantage of certain manners of picking, packing, loading or refrigeration of fruit. In these cases demonstrations are carried on in such a manner as to secure reliable information for commercial practice. Under the third division, experimental tests are made with the refrigeration of fruit-testing varieties for cold storage (32° F.) and refrigerator car temperatures (40° F.), maturity of fruits for cold storage, and the effect of different rates of cooling on the keeping quality of fruits.

While all projects have not been carried to completion there has been secured much information of importance especially in connection with the precooling, cold storage and shipment of tender fruits. The object of this bulletin is to present such information as seems reliable gathered from observations of our commercial work, together with the results of experimental work during the seasons of 1914 and 1915, so that it may be available for the use of fruit growers and shippers at once.

PRECOOLING INVESTIGATIONS.

STRAWBERRIES.

Work with this fruit has been limited to one commercial carload shipment to Winnipeg by refrigerated express in 1915, to precooling tests for ordinary express shipments and to tests made in the experimental storage rooms. The commercial trial was made for the Vineland Growers Co-operative. The berries were picked after heavy rains during the latter part of the season, and they were possibly a little ripe with a tendency towards softness, and were packed in the Ontario 24-quart crates. They were picked June 28, shipped by refrigerated express on the 29th, and were sold July 2 on a slow and overcrowded market. The berries arrived in Winnipeg without decay, but owing to the unsuitability of the crate and their condition when picked,

they were unattractive and sold at a low price. From an economic standpoint the shipment was a failure, although the physical condition of the berries makes it a success as far as precooling is concerned, so that further trials are to be made.

PRECOOLING STRAWBERRIES FOR ORDINARY EXPRESS SHIPMENTS—SEASON OF 1915.

While it is known that low temperatures effectively check the ripening process of fruit, and that precooling is of distinct advantage when shipping in refrigerator cars, the problem of precooling for ordinary express shipments is still open for further investigation. Although precooling retards the ripening of fruit, injury is also liable to follow excessive condensation which causes the germination of mould spores and decay when cold fruit is removed from the cooling room to the warm atmosphere of the express car.

The experience of some commercial shippers indicates that precooling for ordinary express shipments is of some advantage. A series of tests conducted by the senior author in 1913 for the British Columbia Department of Agriculture showed that strawberries cooled 5 degrees below the average temperature of the express car carried better than those shipped direct from the field. This work also showed that cooling more than five degrees was of no advantage, and further cooling resulted in greater loss than no cooling at all.

To secure more information on this point a series of tests was started at Grimsby in 1915, shipping strawberries from Vineland to Ottawa, Ont. Five tests were made using the Williams variety. The fruit was picked at Vineland, packed in the twenty-four $\frac{1}{4}$ -quart Ontario crate and shipped by express in the afternoon. One crate each day was shipped direct to Ottawa without cooling. Three other crates picked at the same time from the same field were sent to the precooling warehouse at Grimsby. One crate was cooled to approximately 60° F.; one to 50° F, and one to 40° F. These were shipped the following day. It will be seen that in order to cool the fruit it took twenty-four hours longer to reach the market than when shipment was made without cooling.

The fruit was received at the warehouse of C. E. Plain, Ltd., Ottawa, Ont., and was inspected by Mr. C. W. Baxter, Chief Fruit Inspector for eastern Ontario.

A summary of the results is given below and it indicates that no benefit was derived by precooling the strawberries and shipping the following day:—

RESULTS.

Test No.	Treatment.	Temp.	Condition on arrival.		
			Mouldy.	Total waste.	Market Value.
			Per cent.	Per cent.	
1	Not precooled	65° F.	0·8	1·1	Fair.
2	Precooled.	57° F.	1·3	7·6	Fair to poor.
3	"	49° F.	0·6	6·1	Fair.
4	"	40° F.	1·7	7·7	Fair to poor.

The results given are averages of all shipments.

The temperatures of the express cars, which ranged from 60° F. to 70° F. were secured by placing thermographs in the cars.

Conclusion.

There was no apparent benefit derived from precooling in these shipments.

RED AND BLACK RASPBERRIES.

As yet no successful shipments of precooled red raspberries have been made by refrigerated freight to western points, although several attempts have been under observation. When promptly cooled and held under refrigerator car temperatures in the experimental room, observations show that about three days is the limit of the life of the red raspberry at 40° F. Successful shipments have been made to Winnipeg by precooling the black raspberry and shipping by refrigerated freight. Being more firm than the red raspberry it remains at 40° F. for five days without serious mould growth.

Raspberries grown in the Pacific Coast districts have better carrying qualities than those grown in the East, so that from those districts successful shipments are being made requiring more than three days. Such shipments of Ontario berries would not be practicable according to information thus far obtained.

CHERRIES.

Sour cherries have responded most favourably to precooling. During 1914 a carload of Montmorencies was purchased, precooled and shipped to Winnipeg as a demonstration shipment. The excellent condition of the precooled cherries upon arrival in Winnipeg sold them for 60 cents per 6-quart basket, whereas ordinary shipments were selling in the same market for 38 to 42 cents.

While the experimental shipment in 1914 showed clearly what might be done by precooling and shipping the Montmorency cherry to the northwest, there were still some misgivings about the Early Richmond, which is reputed to have poorer carrying qualities than the Montmorency. It was decided therefore to make a test shipment with this variety, similar to that made with the Montmorency in 1914. The department purchased half a carload, the other half being made up by the Grimsby Fruit Growers, Ltd., and the Winona Fruit Growers, Ltd.

One phase of the test related to packages best adapted to sour cherries. Those used were the British Columbia 4-basket crate (warehouse pack), and the 6-quart basket (warehouse pack) and the 6-quart basket, orchard pack. In order to teach green packers how to pack the British Columbia 4-basket crate, it was necessary to use fruit picked on two days, July 2 and 3. The fruit was cooled over Sunday and despatched by refrigerator freight on the morning of July 6. The bunkers received but four tons of ice in transit. The car arrived in Winnipeg during the night of Sunday, July 11, and was not opened for distribution until Monday, July 12. It will be seen that the Early Richmond cherries were given a transportation test of ten days from time of picking.

The junior author was in Winnipeg to make an accurate inspection, and he reported the shipment to be in prime market condition upon arrival. The fruit sold readily at 60 cents for the 6-quart basket and \$1.50 for the 4-basket crates. (The British Columbia 4-basket crate holds about 20 pounds of cherries as against about 8 pounds in a 6-quart basket.) No difference was found between the two pickings on different days. The fruit was in as good a market condition as were the Montmorencies in 1914.

There is much doubt among fruit growers as to the "holding quality" of precooled fruit after removal from the refrigerator car. Especially has the inquiry come to us as to whether precooled cherries would stand reshipment by express after the refrigerator car had been opened at the larger distributing points in the prairie provinces. To test this out in a practical manner Mr. Creelman reshipped by express from Winnipeg to Brandon a half-dozen 6-quart baskets and four 4-basket crates, and inspected them in Brandon, Tuesday, July 13. The fruit was found to arrive in splendid market condition, and sold in Brandon for 75 cents per 6-quart basket and \$1.25 per 4-basket crate. A minute inspection after reshipment showed considerable

more actual waste in the fruit than there was upon withdrawal from the refrigerator car in Winnipeg, but this was not great enough to detract much from the market condition.

Conclusions.

In emphasizing the importance of the length of time elapsing in this test between the picking and the distribution of the cherries (ten days), it must be borne in mind that the actual time of the car between Grimsby, Ont., and Winnipeg, Man., was only five and one-half days, the rest of the time being required for repacking, precooling, and holding over two Sundays.

The test shows that Ontario sour cherries may be successfully marketed by refrigerator freight in Edmonton, Alta., since transportation companies have promised a nine-day despatch to that city. Furthermore, the Brandon reshipment test shows the possibility of distributing Ontario Early Richmond cherries to points in Alberta as remote as Athabaska Landing.

Cherries that have been picked for ten days, even though they have been under refrigeration will not stand up as well as freshly-picked fruit. Ripening processes take place slowly under refrigeration and thus the vitality of the fruit is gradually lowered day by day. However, cherries will not perish immediately upon withdrawal from refrigeration, and if they have not been under refrigeration for more than eight or ten days most varieties will stand up long enough for marketing. Upon first withdrawal from the refrigerator car there is a rapid condensation of moisture upon the surface of the fruit (not so heavy on the prairies as in the east on account of the low relative humidity of the air in the west). This gradually disappears, but the moisture has promoted the germination of mould spores. During the day of unloading and distribution, the cherries remain in good condition without much sign of change. After twenty-four hours from the car, or on the following morning the fruit will appear in as good a condition, but upon careful examination will show discoloured spots, especially where it has been bruised. After thirty-six hours the discoloured spots start to show decay which begins to be serious after two days from the car unless kept in cold storage.

It has been shown that sweet cherries may also be precooled and shipped by refrigerated freight to western markets. Included in the experimental car in 1915 were the following packages containing Black Tartarian cherries:

- Two 24 $\frac{3}{4}$ -quart hallock strawberry crates,
- Two 24 full-pint hallock strawberry crates, and
- Two 4-basket crates.

The cherries arrived in excellent condition and sold well. The twenty-four $\frac{3}{4}$ -quart hallock crates sold for \$4 each, and the twenty-four full-pint hallock crates sold for \$3.50 each.

Splendid prices are realized in prairie markets for sweet cherries, and by precooling and shipping in refrigerator cars by freight, transportation costs are more than cut in half.

While practically all of the commercial varieties of sour cherries may be shipped long distances by precooling, this is not true with sweet cherries. The Black Tartarian, Windsor, and Napoleon Bigarreau (Royal Arm) are adapted to this purpose.

PLUMS.

No fruit has responded to precooling more satisfactorily than the plum. Successful precooling shipments of plums were made as far west as Prince Albert, Sask., and to Glasgow, Scotland. The plums retained their flavour and texture under refrigera-

tion better than any other tender fruits. When removed from the refrigerator car most varieties remained in good condition for four or five days if the shipment had not extended over ten days. Such tender varieties as the Burbank were precooled and shipped by refrigerator freight to Brandon, Man., and again carried back by hand to Grimsby in good condition.

Conclusions.

All varieties of plums are not adapted to long distance shipments. The following have proven most satisfactory: Bradshaw, Monarch, Grand Duke, Reine Claude, Damson, Abundance and Burbank. The Washington, General Hand, Imperial Gage and Lombard should not be used for distant shipments.

PEACHES.

Precooling investigations with peaches have been limited to the season of 1915. The first shipment was made to Boissevain, Man., by refrigerated freight and consisted of the Yellow St. John variety, which is one of the more tender shippers of the yellow-fleshed peaches. The fruit was packed in the northwest standard box and was precooled to 40° F. The car was eight days in transit, and the fruit arrived at its destination in splendid condition and was sold profitably without the loss of a peach.

Other shipments followed to Winnipeg and Brandon. The farthest western shipment was made to Prince Albert, Sask. On all shipments where peaches were brought to the warehouse in a satisfactory condition, the best results followed, the peaches arriving in very good condition.

Eastern shipments were made to Montreal, Que., St. John, N.B., and Halifax, N.S., with equally satisfactory results. Through the courtesy of the Grimsby Fruit Growers, Ltd., one lot of fifteen northwest standard boxes of Elbertas, packed in the ordinary commercial manner, was shipped to Glasgow, Scotland. The shipment arrived in good condition after being in transit fourteen days, and sold at retail for 4d. to 6d. each.

Two cars of fruit, including peaches, were purchased to demonstrate packages and precooling. One car included 855 boxes of Early Crawford peaches, some of which were becoming well advanced toward ripeness at the time of picking, and in order to make up the carload a portion was held under refrigeration eight days before shipping, it was five days in transit to Winnipeg. This extreme test gave satisfactory results as reported by Mr. A. H. Flack, Chief Fruit Inspector for the prairie provinces. The other experimental car shipped to Winnipeg contained Elberta peaches packed in the Michigan bushel basket, the Woolverton crate, the Hunter crate and the northwest box. The test showed conclusively that if peaches are picked, packed, and precooled properly, they may be shipped in any of these packages, although other shipments have shown that unless the fruit is properly handled and packed the results will not be satisfactory.

Conclusions.

Peaches should not be held under refrigeration longer than is absolutely necessary, since they lose flavour under a low temperature more quickly than any other fruit.

Tests have shown that all varieties of peaches are not adapted to precooled shipments of long duration. Thus far, it appears that the Belle of Georgia, Yellow St. John, Early Crawford and Elberta, if properly picked and packed, may be precooled and shipped to nearly any part of the Dominion.

PEARS.

For long-distance shipments of varieties of pears like the Bartlett that ripen quickly, precooling acts as a preventive of loss. Universal satisfaction has been given in domestic shipments. United Kingdom shipments of Bartlett pears that have been held in local cold storage over two weeks have proved a failure.

TOMATOES.

The ripening of the tomato is checked by precooling, hence it requires to be handled with caution. All shipments of precooled tomatoes have not met with satisfactory results owing either to immaturity, over-ripeness or over-storage at the time of shipment. Demonstrations in 1915 show that for a precooled shipment the tomato must have colour, but must still be firm enough to withstand the necessary package pressure.

GOOSEBERRIES.

Gooseberries stand up well under refrigeration, and if precooled will stand a shipment of three weeks at 40° F.

BLACK CURRANTS.

Black currants ship well when precooled but have a tendency to develop a fine mould growth throughout the package if held longer than two weeks at 40° F.

RED CURRANTS.

Red currants are more tender, but if packed in proper packages (berry crates) and precooled, will stand up for ten days at 40° F. and may readily be shipped to Manitoba and Saskatchewan points.

CUCUMBERS.

Observations on the precooling of cucumbers as well as other cucurbits indicate that they also must be handled with caution. Bad results have followed lowering the temperature of cucumbers to 32° F. Temperatures as low as this break down the cell structure, the cucumber becomes watery, discoloured and is worthless. However, by reducing the temperature of cucumbers to 40° F. only, they have been held satisfactorily for from seven to ten days.

SWEET CORN.

By precooling to 40° F. sweet corn has stood a refrigerated shipment of eight days. While it is always advisable to ship this commodity in crates, these shipments were partly made in bags.

CELERY.

It has been found beneficial to precool celery promptly, especially if it is to be placed in storage. Celery is apt to wilt badly if exposed to high temperatures between the time of pulling and storage. It will stand low temperatures.

APPLES.

While it is essential to place all apples in low temperatures immediately after picking, the early apples ripening during August and September or earlier respond favourably to precooling. Early varieties soon lose their crispness and flavour if not placed immediately under low temperatures.



FIG. 1. CORRECT DEGREE OF MATURITY FOR A PRECOOLED REFRIGERATED SHIPMENT OF FROM FOUR TO SIX DAYS



FIG. 2 STAGES OF RIPENESS, GLENMARY STRAWBERRIES



FIG. 3. THREE DEGREES OF MATURITY FOR STORAGE



FIG. 4. THREE DEGREES OF MATURITY, MONTMORENCY CHERRIES

MATURITY OF FRUITS FOR PRECOOLED SHIPMENTS

MATURITY OF FRUITS FOR PRECOOLED SHIPMENTS.

The proper degree of maturity or ripeness of fruit at the time of picking is one of the most important factors governing the condition of its arrival at market destination. Great loss is incurred each year by fruit growers through their ignorance of the proper degree of maturity at which fruit should be picked. Mistakes are made both in leaving the fruit too long before picking, and in picking it before maturity. The success of a great many fruit growers may be attributed to their ability to consider how their fruit is to appear on the market, which leads to their using good judgment in timing their pickings. It follows that growers who are careful about maturity are careful about packing.

In connection with our experiments in fruit precooling, maturity tests have been made to determine the proper degree of maturity at which fruits should be picked for precooled shipments. In illustrating the different degrees of maturity, colour photography was used to show the exact colour of the different stages tested. Mr. F. P. Macklem, of Toronto, carried out the photographic work from which the accompanying coloured plates were reproduced. (See coloured plate opposite page 12.)

The distinction between maturity and ripeness cannot be closely drawn, as some fruits are not fully mature until ripe; while others, such as the pear and apple, may be mature and ready for picking weeks or months before they are ripe. In this discussion "mature" fruit will be referred to as being ready for picking; "ripe" fruit as that being fit for eating; immature fruit will be referred to as "green"; whereas "medium ripe" will indicate that the fruit is undergoing the last of the ripening processes, but is not yet fit for eating on account of its firmness.

STRAWBERRIES.

Strawberries will colour under ordinary ventilated shipment. They may be picked with little colour and yet advance in colour sufficiently before reaching the market. Under refrigeration (40° F. or less) the colour of strawberries advances very slowly, so that when they are to be precooled before shipment they should be allowed to develop more colour than for ventilated or ordinary refrigerated shipment without precooling, in which case the fruit is at a comparatively high temperature for from twenty-four to forty-eight hours after loading in the cars.

Tests have shown that the "medium ripe stage" shown in fig. 1, see coloured plate, or in the central clusters in fig. 2, coloured plate, is the proper degree of maturity for a precooled refrigerated shipment of from four to six days. For a four-day shipment without precooling, the berries should have a colour similar to that of the berries in the clusters at the left of fig. 2, coloured plate. Strawberries may be picked at very nearly the ripe stage for nearby local markets, but when this stage is allowed to advance too far, pickers are apt to include soft fruit, which will not stand package pressure. The riper the berries at the time of picking, the better will be the quality of the fruit.

Strawberries should not be picked for refrigeration at the green stage, as upon removal they will deteriorate before advancing in colour. It is also noticeable that when green-picked strawberries are held under refrigeration, they discolour wherever they are bruised or are touching. This discolouration is evident in the bottom box in fig. 3, coloured plate.

In determining the maturity of a strawberry for a precooled shipment, much depends upon the texture and solidity of the fruit. Berries which are very firm and have that rubbery touch and bright sheen that are always indicative of good carrying quality, may be picked at a ripe stage, and still stand a precooled shipment of three days. Since pickers are not able to discriminate carefully as to texture and firmness, it is always safest to use colour as a standard, and have them picked at the medium stage for distance shipments.

When using colour as the chief indication of the proper degree of maturity, a great deal depends upon the variety of strawberries. The colour shown in the medium ripe Glen Mary in fig. 2 will not be attained by the Williams. Good judgment and a knowledge of the manner of ripening of the variety in question are always necessary to determine the proper degree of ripeness for any particular shipment.

CHERRIES.

For precooled shipment, sour cherries should remain on the tree till well coloured, but should be picked while firm. Successful shipments of ripe Montmorencies have been made to Winnipeg by refrigerated freight. When allowed to reach the deep red colour at the left of fig. 4, coloured plate, the cherries are apt to be soft and easily crushed. Sour cherries should never be picked as green as is shown in the right of fig. 4, as they never attain a good colour, are under-developed, and are always lacking in quality.

The ripe stage of maturity shows discolouration and decay much sooner than either of the other stages, hence should not be used in precooled shipments of over four days. The medium degree of maturity (centre basket in fig. 4) will stand a precooled shipment of ten days. In selecting this medium degree of ripeness, a good rich colour and good size are to be desired while the fruit is still firm.

PLUMS.

The colour of plums does not advance greatly under refrigeration. Such a tender variety as the Burbank has stood a refrigerated freight shipment from Grimsby to Brandon, Man., and remained in good market condition for four or five days after removal. Consequently, this variety, which has to be picked before coloured in order to get firmness, had ample time to advance to a rich wine colour upon withdrawal from the refrigerator car. The Abundance and Burbank must be picked when just starting to show a reddish cast in order to get firmness. With the exception of the Washington, Imperial and Lombard, which varieties should be used with caution in long-distance shipments, the more common varieties of plums grown in the Niagara district should be allowed to become medium ripe before picking.

A great mistake is made by some growers in picking plums too green. The popularity of some of our best varieties such as the Reine Claude, is being lost by picking them before they have ripened sufficiently to acquire their normal high quality and good flavour.

PEACHES.

If peaches are allowed to become ripe before picking for precooling, the flesh is apt to become mealy before shipment. A medium ripeness wherein the green ground colour is starting to turn to a yellow tinge is best. In the case of a white fleshed peach, picking should take place when the ground colour is losing its deep green shade. Peaches advance in colour but slowly while under refrigeration. Upon removal from storage they continue to advance in colour, this being more evident with the ground colour of the skin than it is with the red blush.

TOMATOES.

It is essential to the successful shipment of precooled tomatoes that the proper degree of maturity be secured at the time of picking. If picked too green, the tomatoes have a pale unattractive appearance on the market; if left until too ripe the fruit becomes soft, will not withstand the package pressure, starts to decay, and will be "leaking" through the package before the market is reached. Our experience thus far has shown that for a precooled shipment of seven days the tomato should be allowed

to ripen till nearly a full red, but must be picked while very firm. Tomatoes showing soft spots or cracks should not be included.

With the shipment of any fruit, the degree of maturity at which it is to be picked must be determined according to the manner and distance of shipment, paying special attention to whether it is to be precooled, shipped under refrigeration without pre-cooling, or under ventilation only. Other conditions being the same, more advanced maturity may be allowed when fruits are precooled before shipment.

EFFECT OF USING LOW TEMPERATURES FOR PRECOOLING.

In making variety tests of fruits under refrigeration a quantity of fruit has usually been divided into four lots, two of which were tested at 40° F. (a refrigerator car temperature) and two at 32° F. One lot in each temperature was cooled rapidly in an air temperature lower than 25° F, while the other lot was cooled gradually, using a temperature of 40° F. for several hours. In the cases of the low cooling temperatures the interior of the package was cooled to a temperature between 32° F. and 40° F.

In some cases hourly readings of the temperatures were taken for a period of from 12 to 18 hours, in order that the rate of cooling could be determined for a certain package of fruit when surrounded by a given air temperature. The cooling temperatures commonly used were 42° F., 32° F., and from 10° F. to 15° F.

By these methods it was possible to determine the effect of using temperatures below the freezing point of fruit for precooling either for refrigerator car shipments or for cold storage; and it was also possible to determine the approximate length of time required for precooling when using air temperatures of 42° F., 32° F., and 15° F. to 17° F. Owing to the size and type of the equipment used to obtain the low temperatures, it was not possible to secure constant temperatures for the different tests.

RESULTS.

In giving the results the length of the test will be chosen that will show wastage.

Strawberries.

With four varieties, Glen Mary, Joe, Wm. Belt, and Pocomoke, no striking difference was to be noticed between those cooled rapidly and those cooled slowly. However, all strawberries tested were too ripe to base positive conclusions upon.

Sweet Cherries.

An air temperature of 20° F. was used for rapid cooling.

	Average percentage of waste.	
	Cooled rapidly.	Cooled slowly.
Held ten days at 32° F.	11.52 per cent.	10.71 per cent.
Held ten days at 40° F.	16.19 " "	21.08 " "

No injury was found to result from rapid cooling.

Sour Cherries.

Air temperatures from 17° F. to 20° F. were used for rapid cooling.

	Average percentage of waste.	
	Cooled rapidly.	Cooled slowly.
Held ten days at 32° F.	6·67 per cent.	5·41 per cent.
Held ten days at 40° F.	10·01 "	12·73 "

No injury was found to result from the rapid cooling.

Plums.

Air temperatures from 10° F. to 20° F. were used for rapid cooling with the larger part at 16° F.

	Average percentage of waste.	
	Cooled rapidly.	Cooled slowly.
Held ten days at 32° F.	6·60 per cent.	5·98 per cent.
Held ten days at 40° F.	27·89 "	24·70 "

No marked injury was found to result from the rapid cooling.

Peaches.

Air temperatures from 12° F. to 20° F. were used for rapid cooling.

	Average percentage of waste.	
	Cooled rapidly.	Cooled slowly.
Held ten days at 32° F.	7·64 per cent.	6·06 per cent.
Held ten days at 40° F.	44·36 "	43·50 "

With the exception of the Triumph variety no injury was to be observed from rapid cooling. With the variety mentioned, a slight pitting took place on the surface of the fruit.

Tomatoes.

Air temperatures from 12° F. to 20° F. were used for rapid cooling.

	Average percentage of waste.	
	Cooled rapidly.	Cooled slowly.
Held ten days at 32° F.	4.52 per cent.	5.95 per cent.
Held ten days at 40° F.	7.80 " "	9.55 " "

When held in storage at low temperatures (32° F.-30° F.) the tomato has a tendency to shrink and to become soft. It is possible that under extremely low cooling temperatures the same effect would tend to result, although from these observations no marked injury was observed from cooling tomatoes rapidly and it would not seem a dangerous practice if moderately low temperatures were used.

RATE OF COOLING.

To cool cherries in 6-quart baskets from 65° F. to 42° F. with an air temperature of 40° F., required twenty hours; with an air temperature of 32° F. required six hours; and with an air temperature of 14° F. it required 4½ hours.

To cool raspberries in 24-quart crates from 73° F. to 42° F., using an air temperature of 40° F., required approximately twenty-four hours; using an air temperature of 32° F. required 6½ hours; and using an air temperature of from 17° F. to 20° F. required 4½ hours.

To cool plums in 6-quart baskets from 73° F. to 42° F. using an air temperature of 40° F. required ten hours; using an air temperature of 32° F. required seven hours; using an air temperature of 16° F. required 4½ hours.

To cool wrapped peaches, in boxes, from 67° F. to 42° F., using an air temperature of 12° F., required five hours; in 11-quart baskets, 4½ hours; and in 6-quart baskets, 3¾ hours.

Conclusions.

From observations over two seasons it is evident that moderately low temperatures (12° F.-20° F.) may be used with most of the tender fruits grown in Canada without apparent injury to them either for storage at 32° F. or for refrigerated shipments at 40° F. At the same time it is to be noted that no marked benefits in regard to the storage or the carriage of the fruit were apparent when it was chilled rapidly during a period of five or six hours, compared with the more gradual cooling required from eighteen to twenty-four hours.

The two great advantages of rapid cooling are:—

- (a) To facilitate receiving and shipping at the precooling plant, and
- (b) To start the cars rolling earlier, thus giving a longer period and greater radius for shipping.

Basket fruit when surrounded with an air temperature of from 38° F. to 40° F. requires from eighteen to twenty-six hours for cooling from 70° F. to 40° F., when surrounded with an air temperature of 12° F. to 15° F. requires from four to five hours for cooling.

FRUIT PACKAGE TESTS.

STRAWBERRY PACKAGE TEST.

This test was made to determine the relative carrying and selling merits of several strawberry packages now in use in Canada, working along the following lines: to compare the merits of the British Columbia twenty-four $\frac{3}{4}$ -quart crates with the twenty-four full-pint crates; to compare the British Columbia and Ontario strawberry packages; to demonstrate careful packing in Ontario, and to find means of improving the Ontario crate. The difference of opinion in British Columbia regarding the adoption of the full-pint package, and the universal dissatisfaction in Ontario with their present crate, were the immediate motives that prompted the work.

At the present time the British Columbia twenty-four $\frac{3}{4}$ -quart crate that has been in use for a number of years, faces competition with the full-pint crate from the United States. The $\frac{3}{4}$ -quart hallock contains 55.5 cubic inches. The two packages sell for nearly the same price on the market.

The present strawberry crate in use in the Niagara district is so constructed that the separators holding the tiers of hallocks apart rest on the fruit instead of on the crate so that the fruit in the bottom tiers supports the weight of the top tiers. It is impossible to pack the hallocks full without injury to the two lower tiers.

In making the test, fruit was secured at Vineland, Ontario. Ordinary express shipments were made to Ottawa, and refrigerated express shipments to Winnipeg.

The Williams variety was used and the following packages were tested:—

Ontario twenty-four $\frac{3}{4}$ -quart crate, field packed.

British Columbia twenty-four $\frac{3}{4}$ -quart crate, field packed.

British Columbia twenty-four full-pint crate, field packed.

British Columbia twenty-four $\frac{3}{4}$ -quart crate, carefully packed.

British Columbia twenty-four full-pint crate, carefully packed.

The term "field packed" indicates that the crate was commercially picked and that no packing was done after leaving the pickers other than to level off the tops of the hallocks, this being the customary manner of harvesting strawberries in the Niagara district.

The "carefully packed" lots were taken to the packing shed and carefully gone over to remove cull berries, packing the prime fruit with the top faced. This is the customary manner of packing strawberries in the Mission-Hatzic district of British Columbia.

OTTAWA SHIPMENTS.

Five shipments on different days of each lot (excepting the British Columbia twenty-four $\frac{3}{4}$ -quart crate, carefully packed, which was given four shipments) were made by ordinary express to Ottawa. Thermograph records were taken of the express cars. Inspections were made in the fruit warehouse of C. E. Plain, Limited, by Mr. C. W. Baxter, Chief Fruit Inspector for Eastern Canada.

The inspections took into account the percentage bruised, mouldy, total waste, and market condition. Owing to shipments going astray or being sold before inspection could be made, averages could not be taken from five shipments. Averages for summaries were taken only on shipments of the same day for each comparative test.

STRAWBERRY CRATE TEST.

Crate.	Condition on arrival at Ottawa.			
	Mouldy.	Injured.	Total waste.	Market Value.
	Per cent.	Per cent.	Per cent.	
Ontario twenty-four $\frac{1}{2}$ -quart	0·8	29·5	1·1	Fair.
British Columbia twenty-four $\frac{1}{2}$ -quart.....	0·0	12·5	0·0	Fair to good.
British Columbia twenty-four full-pint....	0·0	8·5	0·0	Good to very good.

The British Columbia twenty-four full-pint crate carried the best in every case. This package always had the hallocks well filled and in good condition.

STRAWBERRY PACKING TEST—OTTAWA SHIPMENTS.

Crate.	Packing.	Condition on arrival at Ottawa.			
		Mouldy.	Injured.	Total waste.	Market Condition.
		Per cent.	Per cent.	Per cent.	
British Columbia $\frac{1}{2}$ -quart ..	Field pack....	0·0	12·49	0·7	Fair.
British Columbia $\frac{1}{2}$ -quart ..	Careful pack..	0·4	25·44	2·1	Fair to good.
British Columbia full-pint ..	Field pack....	0·0	22·10	0·4	Good to very good.
British Columbia full-pint ..	Careful pack..	0·0	10·89	0·2	Very good.

The berries that were carefully packed had the best appearance, but it is doubtful if it would pay to repack for eastern markets.

The British Columbia packages went into a market not accustomed to their use and sold at the same rate as the Ontario packages. After making the inspections Mr. Baxter made the following statement:—

“In almost every case where the 24-quart crate (Ontario crate) is used, the top layers of boxes are more or less damaged when they reach destination.

“Practically 60 per cent of the 24-quart crates are more or less damaged when they reach destination.

“The British Columbia hallock with the raised bottom is viewed with suspicion by consumers who term it a ‘false bottom’ intended to deceive—they are unacquainted with the package.

“The very thin veneer and whitewood used in the British Columbia hallocks appears to be very easily stained—the colour spreads quickly and spoils the appearance.

“Cement-coated nails in covers are not desirable—the wood breaks when the cover is being removed.

“What is known as the ‘27’ and ‘36’ crate with movable cover and fastener seems to give general satisfaction.”

From the past season’s investigations it would not seem advisable to advocate the adoption of the British Columbia package for eastern markets. However, the present Ontario crate is not suitable and should be modified at once so as to give some of the safe carrying advantages of the British Columbia crate.

Further tests will be made using other packages.

WINNIPEG SHIPMENT.

Ten British Columbia crates of strawberries were included in a private shipment by refrigerated express, the object being to test the $\frac{3}{4}$ -quart and the full-pint crate as to carrying qualities on long-distance shipments, and to compare careful packing with field packing at time of picking.

The summary of results is the average taken from two of each type of package when carefully packed and from three of each type when field packed.

STRAWBERRY PACKING TEST—WINNIPEG SHIPMENT.

Package.	Packing.	Condition on arrival at Winnipeg.		
		Mouldy.	Total waste.	Market value.
		Per cent.	Per cent.	
British Columbia $\frac{3}{4}$ -quart.	Field pack.	0.44	0.44	Good.
British Columbia full-pint.	Field pack.	2.67	6.02	Fair.
British Columbia $\frac{3}{4}$ -quart.	Careful pack.	0.79	4.55	Fair.
British Columbia full-pint.	Careful pack.	0.32	0.32	Good.

Remarks.—Careful packing gave the best market appearance. Pint hallocks were filled better than the $\frac{3}{4}$ -quarts. "Waste" did not figure so conspicuously as did the appearance.

No great difference was to be seen in the condition of the fruit shipped in the different packages. The carefully packed strawberries had a very superior appearance to the field packed and it is advisable to pack carefully for this market so as to have shipments compare favourably with competing fruit from Hood River, Oregon.

The outstanding feature of the shipment and with all other shipments made this season using the $\frac{3}{4}$ -quart and full-pint crates was that the pint hallock arrives at destination full. There is no chance for the fruit to settle.

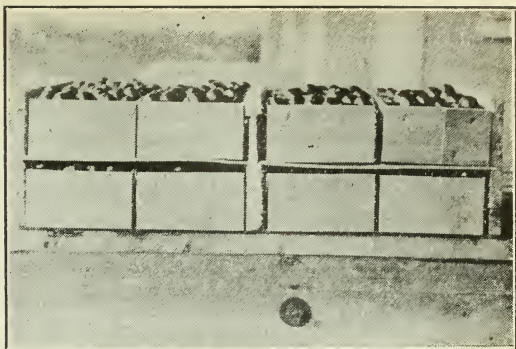
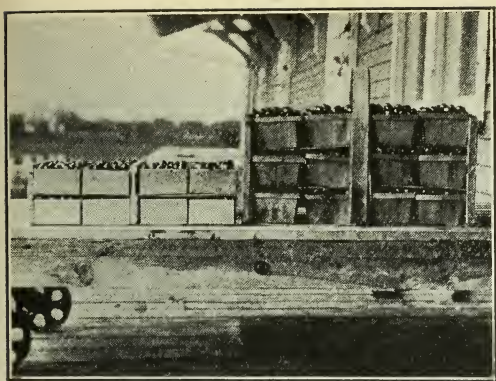
In Winnipeg and other western markets the 24 full-pint is the best seller. In this shipment the average selling prices were as follows: twenty-four full-pint, \$2.60; twenty-four $\frac{3}{4}$ -quart (British Columbia), \$2.80; twenty-four $\frac{3}{4}$ -quart (Ontario), \$2.50. Owing to market conditions, these prices were very low for Winnipeg, but show the relative values of the different packages.

Conclusions.

Twenty-four full-pint:—This package has greater carrying possibilities than any package tested. It shows less injury to fruit, carries full and in western markets sells more readily at higher prices than do other packages. It loads well in a refrigerator car, and is adapted to long-distance shipments.

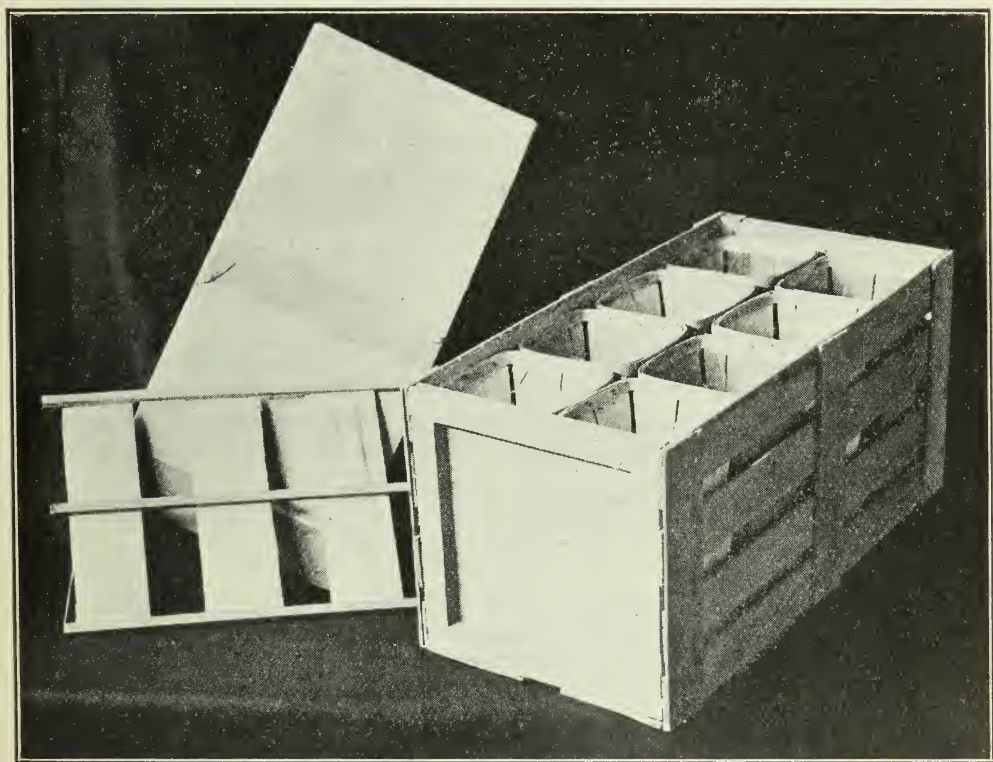
Twenty-four $\frac{3}{4}$ -quart (British Columbia):—As a carrier it is superior to the Ontario $\frac{3}{4}$ -quart crate because of the raised-bottom hallocks, raised separator and has but two tiers of hallocks. It loads as well in a refrigerator car as the twenty-four full-pint crate. Its greatest disadvantage is the depth of the hallocks, which causes a great amount of settling of the berries during long shipments.

Twenty-four $\frac{3}{4}$ -quart (Ontario):—No special merits may be attributed to this package unless they lie in its cheapness to manufacture, which does not profit the growers or consumer since its cost to them is as high as that of the British Columbia packages. The features which work against the Ontario crate are its separators resting on the fruit instead of on the crate; three tiers of hallocks; deep hallocks; bad design on account of its handle for car loading; and its unattractiveness.

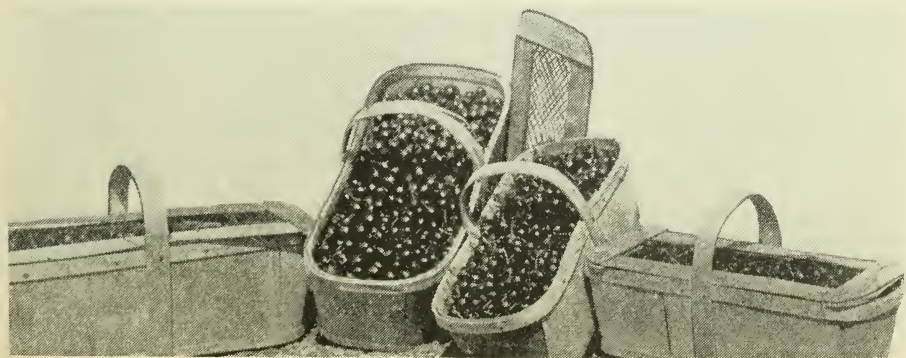


Cross section of the Ontario 24-quart and the Western 24-pint Hallock crate.

Cross section 24-pint Hallock crate.



American Strawberry crate.



Climax baskets, with Cherries.

CHERRY PACKAGE TEST.

The object of these tests was to secure information that would lead to a more standard package for Canadian sweet and sour cherries.

To make comparative tests of some of the packages in vogue, both as to carrying features and selling merits, demonstrations were made, shipping as follows:—

1. Sour cherries, warehouse pack, 6-quart climax basket.
2. Sour cherries, warehouse pack, 4-basket plum crate.
3. Sour cherries, orchard pack, 6-quart climax basket.
4. Sweet cherries, warehouse pack, 4-basket crate.
5. Sweet cherries, warehouse pack, twenty-four $\frac{4}{8}$ -quart British Columbia strawberry crate.
6. Sweet cherries, warehouse pack, twenty-four full-pint British Columbia strawberry crate.
7. Sweet cherries, orchard pack, Woolverton, three 6-quart basket crate.

The cherries having the warehouse pack were brought to the precooling plant and packed in the demonstration room, using western methods (facing the tops). The field-packed lots were commercially packed and placed in the baskets by pickers, this being the customary manner of harvesting cherries in the east.

DESCRIPTION OF PACKAGES TESTED.

The 6-quart climax basket is $4\frac{1}{2}$ inches deep, $15\frac{3}{8}$ by 7 inches at the top, and $13\frac{1}{2}$ by $5\frac{5}{8}$ inches at the bottom; it has a leno netting in the panel of the top, and holds 8 pounds of cherries.

The 4-basket crate is made up of four tin-bound baskets, each $3\frac{3}{4}$ inches deep, $7\frac{5}{8}$ by $7\frac{5}{8}$ inches at the top, and $6\frac{1}{2}$ by $6\frac{1}{2}$ inches at the bottom. The crate holds 20 pounds of cherries.

The twenty-four $\frac{4}{8}$ -quart British Columbia strawberry crate is a hallock crate, using twenty-four boxes each $4\frac{1}{2}$ by $4\frac{1}{4}$ by 3 inches deep, and containing approximately 55 cubic inches.

The twenty-four full-pint British Columbia strawberry crate is a hallock crate, using twenty-four boxes each $4\frac{1}{4}$ by $4\frac{1}{4}$ by $1\frac{7}{8}$ inches deep, and measuring approximately 33.6 cubic inches.

The Woolverton crate is a carrier, $20\frac{1}{2}$ by $16\frac{1}{4}$ by $8\frac{1}{2}$ inches deep, and carries three 6-quart climax baskets.

SOUR CHERRIES.

The tests with sour cherries were made in Winnipeg and Brandon markets. The cherries used were Early Richmonds, picked and packed July 2 and 3, pre-cooled over Sunday and shipped the following Monday by refrigerated freight. The refrigerator car was opened in Winnipeg and inspections made by Mr. Creelman, scientific assistant, July 12.

Results of Carrying.

Type of Package.	Average Waste.	Market Condition.
	Per cent.	
4-basket crate, warehouse pack.....	12.5	Good.
6-quart basket, warehouse pack.....	12.9	Good.
6-quart basket, orchard pack.....	4.8	Very good.

This shows that the 4-basket crate and the 6-quart basket (warehouse pack) carry about equally well, but the 6-quart basket, orchard pack, carried better than either of the warehouse pack, undoubtedly being due to less handling.

Results of Sales.

Package.	Net Weight.	Cost of Packing and Package.		Average Sale Price.	Average Net Returns to Growers.	
		Total.	Per Lb.		Per Package	Per Lb.
	Lb.	Cts.	Cts.	\$ Cts.	Cts.	Cts.
4-basket crate, warehouse pack. . .	20	21·3	1·06	1 46	35·1	4·24
6-quart basket, warehouse pack. . .	8	6·5	0·81	0 59	35·7	4·46
6-quart basket, orchard pack. . . .	8	4·0	0·5	0 59	38·2	4·78

The orchard-packed 6-quart baskets gave the greatest net returns to the grower. They sold at the same price as the warehouse packed and cost 2½ cents less per package to pack.

Winnipeg markets preferred sour cherries packed in 6-quart baskets. The 4-basket crate is an unpopular package for this fruit.

SWEET CHERRIES.

Test shipments with sweet cherries were made to Winnipeg, using the Black Tartarian variety, packed in twenty-four full-pint strawberry crate, twenty-four ½-quart strawberry crates (British Columbia), and the 4-basket crate. The Woolverton crates were filled with Smith's Bigarreau. This shipment was made by express with transportation costs based upon the carload freight and icing rates.

Inspections showed that the fruit carried best in the twenty-four ½-quart crate, although not much difference was to be seen in the general appearance of the fruit.

Results of Sales.

Package.	Net Weight.	Cost of Package and Packing.		Average Sale Price.	Average Net Returns to Grower.	
		Total.	Per Lb.		Per Package	Per Lb.
	Lb.	Cts.	Cts.	\$ Cts.	\$ Cts.	Cts.
24 full-pint crate.	17	32	1·8	3 50	2 43	14 3
24 ½-quart crate.	24	35	1·4	4 00	2 75	11 5
4-basket crate.	20	21·3	1·6	*2 00	1 31	6·5
Woolverton crate.	24	24·0	1·0	3 50	2 48	10·3

* Estimated.

The full-pint strawberry crate gave by far the best net returns. For shipping without repacking, the 6-quart basket in the Woolverton crate is a desirable package.

CHERRY PACKAGES ADAPTED TO CAR-LOADING.

The box or crate type of package is undoubtedly the most satisfactory for loading in cars. Baskets may be loaded without breakage if care is taken, but should be raised on false floors to aid refrigeration; they should be loaded in tiers, commencing at one side of the car, and should have a space of 2 feet or more in the centre of the car. In order to get the centre space, the load must be "squared off" and braced with bulkheads and at least six 2- by 4-inch braces. These must be pounded into place so as to squeeze the load and make it rigid to prevent shifting. If loaded in this way, there will be no more breakage than in boxes. Boxes or crates require more secure bracing and stripping every third layer, since these packages do not have the solidifying features of the basket handles.

Conclusions.

1. The 6-quart climax basket is the most satisfactory package for sour cherries in prairie markets. The 4-basket crate is unpopular in Manitoba markets. The 6-quart basket carried the fruit equally well, sold more readily, and the fruit netted the grower 0.54 cents more per pound than that packed in the 4-basket crate.

2. It is not desirable or profitable to repack sour cherries in 6-quart baskets. The orchard-packed fruit commanded as high prices as the warehouse packed, showed less waste, and at the same time saved the packing charge of 2½ cents per basket.

3. The twenty-four full-pint hallock strawberry crate is the most desirable package for fancy, sweet cherries in prairie markets. It carries the fruit well, is the most popular seller, and netted the Ontario grower 14.3 cents per pound as against 11.5 cents per pound in the twenty-four ¾-quart, and 6.5 cents per pound in the 4-basket crate.

4. The twenty-four full-pint hallock strawberry crate has possibilities of being a popular package in eastern markets. Trial shipments sold for \$2.40 in Montreal.

5. In packing sweet cherries in the strawberry crates, the boxes should be faced with stems underneath.

PEACH PACKAGE TEST.

In order to show returns from peaches shipped in various packages, and also determine the waste in the various packages, two carload shipments were made to Winnipeg, Man. The following packages were tried:—

1. Northwest standard box.
2. Woolverton crate (three 6-quart heaped baskets).
3. Hunter crate (six 6-quart heaped baskets or four 11-quart heaped baskets).
4. Michigan bushel basket.

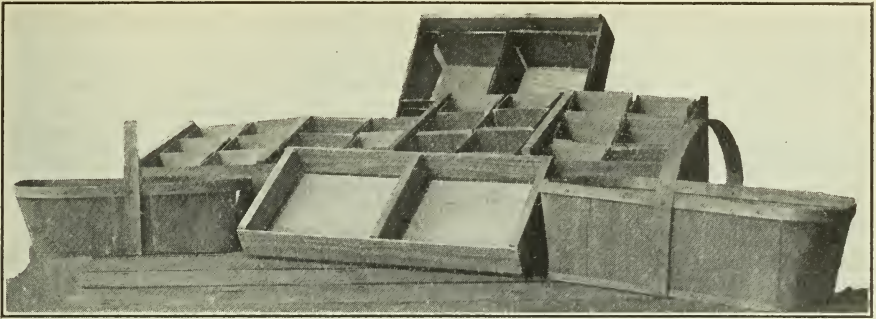
The northwest standard box for peaches has the following inside dimensions: 18 by 11 by 4½ inches. The depth varies from 4 to 5 inches, depending upon the size and shape of the peaches to be packed. The sides of the box are slightly narrower than its depth, and the tops and bottoms are made of thin material, narrower than the box, thus giving quarter-inch cracks for ventilation and sufficient spring for bulge. The tops and bottoms are put on with cleats, to protect the bulge, for ventilation and security. Cleats are very essential on the peach box.

The Woolverton crate is designed to carry three 6-quart heaped climax baskets, these being covered with leno.

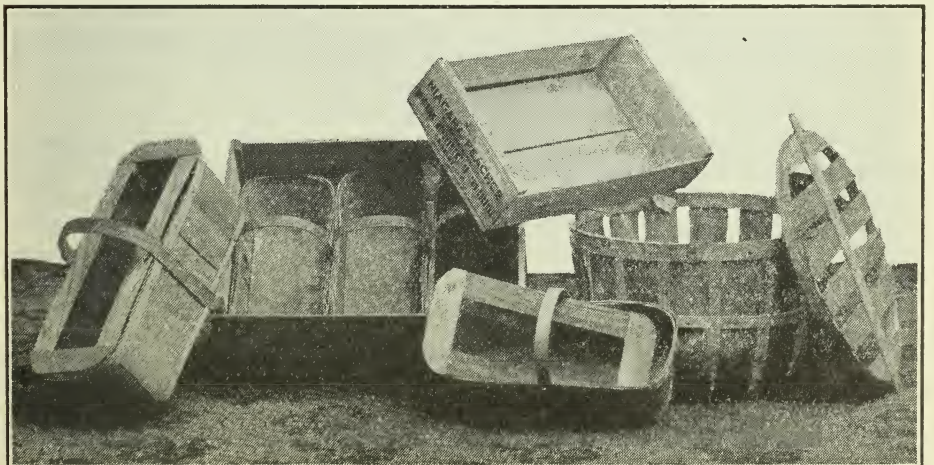
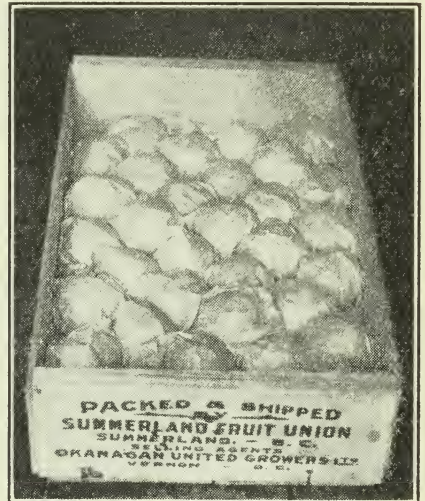
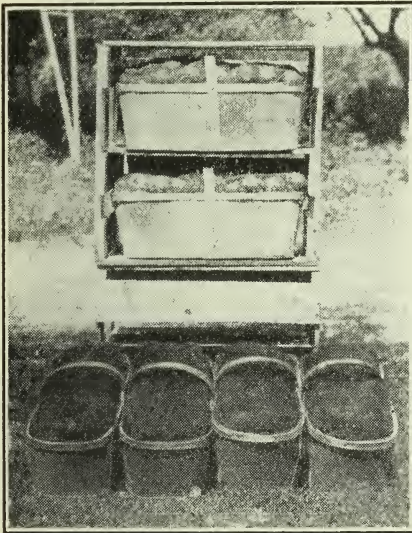
The Hunter crate is designed to carry six 6-quart baskets or four 11-quart baskets, packed in the same manner as the Woolverton crate.

The Michigan bushel basket is a splint bushel basket with lid and centre post, commonly used in Michigan, western Ontario, and New York.

Mr. A. H. Flack, Chief Fruit Inspector for the prairie provinces, inspected the cars and packages. The time elapsing between shipping and opening the cars in Winnipeg was seven and five days. All lots of peaches were in good condition, showing no waste. This is undoubtedly due to the fact that the fruit was picked at the proper degree of maturity and was precooled directly after packing.



Cherry packages.



Peach packages.

Results of Sales.

Package.	Net Weight of Fruit.	Cost of Package and Packing.		Average Sale Price.	Average Net Returns to Grower.	
		Total.	Per lb.		Per Package	Per lb.
		Lb.	Cts.		Cts.	\$ cts.
Northwest standard box, Early Crawford lot	20	15	0.75	0.87½	0.392	1.96
Northwest standard box, Elberta lot	20	15	0.75	0.53½	0.113	0.56
Woolverton crate, three 6-quart baskets	27	26	0.96	2.03½	1.146	4.23
Woolverton crate, three 6-quart baskets, 2nd lot	27	26	0.96	1.174	0.425	1.58
Hunter crate, six 6-quart baskets	54	51	0.94	4.003	2.83	4.14
Michigan bushel basket	56	17 2/3	0.31	0.716	*0.053	0.94

* Loss.

Crates occupy so much space that 20,000 pounds cannot be put in a car when they are shipped alone, so that in straight carloads of crates the freight charges would be more and the net returns less than those shown above. From 480 to 560 Woolverton crates may be loaded in a car, making their weight for freight expenses range from 36 to 41.6 pounds. About 240 Hunter crates may be loaded in a car, which, divided into the minimum weight for carload shipment, gives 83.3 pounds for which freight has to be paid on each crate.

The Northwest Standard Box.

For western markets and select trade in eastern markets the 20-pound box is the most satisfactory peach package. As a carrier of fruit when well packed it has no equal. For long distance shipments it is rivalled only by the Georgia carrier. The latter is slightly cheaper in original cost and cost of packing (0.5 cents per pound), but the wrapping of the fruit in the box means days to the life of the peaches by preventing bruising, and isolating fruits that start to decay prematurely. Western wholesale houses are very reluctant to make f.o.b. purchases of any other type of peach package.

New packers may be taught in a short time to pack in boxes and with a few days' practice most packers become proficient. Packers will pack from 70 to 120 boxes per day. The cost of package, packing, and mailing is 0.75 cents per pound of fruit.

The Woolverton Crate.

The Woolverton crate is a new package designed to protect peaches marketed in baskets and to allow the marketing of the popular "leno" or heaped baskets. For local express shipments it is an ideal package as it carries peaches well, is not easily pilfered and is a good display package. For long-distance shipments it carries peaches well, but on account of the space it requires is not adapted to carload shipments, since sufficient packages cannot be loaded to make up the minimum weight. The package is to be criticised for long-distance shipments on account of the liability of the fruit to bruise by its jarring about in the baskets.

It is a package that can easily be adopted by the growers since they are accustomed to marketing in the climax baskets. Its initial cost and cost of packing are slightly more than that of the box, being 0.96 cents per pound. From general observations during the season it is evident that this package will readily wholesale for from \$1.25 to \$1.75 in the prairie markets, netting the grower from 1½ to 3 cents per pound for his fruit.

The Hunter Crate.

What has been said about the Woolverton crate also applies to the Hunter crate. Its chief advantage over the Woolverton crate is its lower cost, although it is less attractive, does not load so well in cars, nor is it as easily handled.

While the net returns in the 1915 tests were 4.14 cents per pound, this would be more than the average. The freight was also figured on the actual weight of the package rather than on the straight carload basis.

The Michigan Bushel Basket.

This package was used to determine how western markets would accept a large-sized package in purchasing peaches for preserving. Its chief advantages to the grower would be its cheapness and the quickness with which it may be handled.

The bushel basket was found very difficult to sell in Winnipeg, the net returns being less than the cost of the package, the grower having to pay, besides his fruit, 0.9 cents per pound. The bushel holds too great a bulk to make an ideal peach package and it is not advisable to educate markets to accept it.

PEACH PACKAGES ADAPTED TO CAR-LOADING.

The northwest standard box is undoubtedly the most satisfactory package for car-loading. It is the most economical in the use of space. Spaces between packages may be readily left for ventilating and refrigerating purposes. The minimum weight may be loaded in the car without piling to the roof. The load can be securely "squeezed" and braced without injuring the packages or fruit.

The Woolverton crate and Hunter crate may be loaded in cars securely without danger of injury to the fruit as is the case with baskets alone. They are especially well adapted to refrigeration and ventilation. Their great disadvantage in car-loading is the large amount of space they require. In order to load 560 Woolverton crates in a car it is necessary to stack them to the roof, whereas the Hunter crate is even less economical in space. Unless very good prices are to be secured it would be advisable to ship these packages in mixed cars when the minimum weight could be made up with other less bulky packages.

The bushel basket is readily loaded in a car, securing the minimum weight with four tiers high. Centre posts in the basket prevent excessive bruising of the fruit. The bushel basket is not advantageously loaded in cars of mixed packages.

Conclusions.

1. Peaches may be shipped without waste to prairie markets in packages other than the box if properly picked, packed and precooled.

2. Competitors in western markets use the box, a package which wholesalers and retailers prefer over every other package. In shipping Ontario peaches it is essential to meet this competition with a package that is as good or better.

3. Packages costing the least do not always mean a saving since the more expensive packages made the greatest net returns. The Woolverton crate, costing the most, made the greatest net returns. The more expensive packages are to be advised for long distance shipments if they are such that carry the fruit without waste.

4. The Northwest standard box is the most satisfactory package for carloads of peaches shipped long distances. Returns will average as much or more as with other packages and there is a greater assurance against waste.

5. The Woolverton and Hunter crates are well equipped for shipping the heaped leno basket. As safe carriers of fruit they are more easily adapted to Ontario conditions than the western box, and, although costing more, will undoubtedly make greater net returns in eastern markets. This would not prove true with western shipments if based on a large number of trials.

6. The bushel basket for marketing peaches is not adapted to western markets.

THE USE OF LOW PERCENTAGE OF SALT WITH CRUSHED ICE IN BRINE TANK CARS.

Through the general criticism of the brine tank refrigerator cars by the growers and shippers of perishable products, the attention of the Department of Agriculture was called to the subject in 1913. During that season the transportation companies furnished the fruit growers of British Columbia with approximately 50 per cent of that type of car. While the brine tank refrigerator has been found admirable for the shipment of such perishable produce as poultry, meats and dairy products that require very low shipping temperatures, it has not been found satisfactory for fruits. Many shippers have refused to ship in them altogether, and consignees or prospective purchasers who have had experience with brine tank cars rule against them in ordering carloads of fruit.

It is generally understood that for dressed meat or poultry shipments from 10 per cent to 20 per cent of rock salt should be mixed with crushed ice in the brine tanks. In this way the ice is melted and removes heat from the interior of the car so rapidly that temperatures below freezing are maintained even in hot weather. However, through the supposed danger of freezing, the salt has been omitted in making fruit shipments in brine tank refrigerators, and the ice has been placed in the tanks in block form, after the same manner that the bunker or block-ice type of refrigerator is iced.

By having the ice shut off in the tanks, melting takes place more slowly and high temperatures are resultant. By placing thermographs in brine tank cars iced in this way, it has been found that the temperature seldom goes below 50 degrees F. The thermograph record shown herewith is a fair sample of such shipments. This shipment was made July 19, 1915, with cherries, currants, etc., precooled to 46 degrees F., and shipped to Winnipeg in car No. 284492 C.P. It will be seen that the temperature actually rose during the shipment and a portion of the cherries showed a waste of 10 per cent upon arrival at Winnipeg.

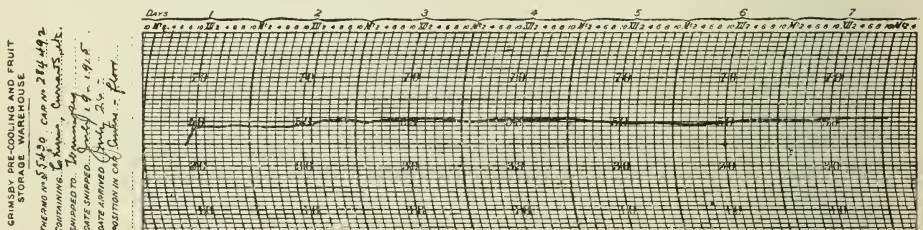


FIG. 1.—Thermograph record. Temperature in a brine tank car, in which no salt was used. Car No. 284,492 C.P.

THE USE OF SALT AND ICE FOR FRUIT SHIPMENTS IN BRINE TANK CARS.

Co-operating with the Canadian Pacific Railway during the spring of 1914, tests were made in Vancouver by the senior author using low percentages of salt, i.e., 2 per cent and 5 per cent of salt with crushed ice in empty brine tank cars. By using 2 per cent of salt the temperature near the tanks reached 32 degrees F., and in the centre

of the car, 38 degrees F. By using the 5 per cent of salt mixture a temperature of 25 degrees F. was secured near the tanks, and 32 degrees F. in the centre of the car. While the 5 per cent mixture seemed to give a temperature too low for fruit, it should be kept in mind that the tests were made in the middle of April when the outside temperature ranges from 40 degrees F. to 65 degrees F. With ten tons of warm fruit in the car and an outside temperature of from 60 degrees F. to 90 degrees F. this low temperature would not be obtained (fig. 1).

Following up this work in the summer of 1914 with a shipment of fruit from Summerland to Vancouver, B.C., a brine tank car was used with slatted floors and with 5 per cent of salt incorporated with crushed ice in the tanks. The shipment arrived in Vancouver in good condition. The temperatures were low and there was no evidence of freezing.

DEMONSTRATIONS WITH BRINE TANK CARS IN 1915.

With the co-operation of the Canadian Pacific and the Grand Trunk railways, arrangements were made to use brine tank refrigerators for two cars of fruit that were purchased for experimental shipment from Grimsby to Winnipeg during the past season, in order to carry the work further, using the salt mixture with precooled fruit.

Crushed ice with 5 per cent of salt was placed in the tanks of the cars. The fruit was precooled to 40° F. and 45° F. As is the customary practice at the precooling plant with all shipments of precooled fruits slatted false floors were placed in the cars. A thermograph was placed on the floor against the ice tanks to record the lowest temperatures during transit and one was placed on top of the load of fruit in the centre of the car to record the highest temperature to which the fruit would be exposed while in the car. The fruit was loaded and braced in the usual manner and the doors sealed with sulphite paper. On September 20, car No. 284024 C.P. (fig. 2) was shipped to Winnipeg, requiring four and one-half days to reach its destination. On September 23, car No. 340053 G.T.P. (fig. 3) was shipped to the same point requiring approximately five days to reach its destination. Block ice without salt was used for re-icing during transit.

Mr. A. H. Flack, Chief Fruit Inspector for the prairie provinces, inspected the shipments and reported that they arrived there in perfect condition. No injury whatever was to be seen from low temperatures and the highest temperature was as low as is ordinarily secured in refrigerator shipments. Copies of the thermograph records are herewith shown, with the exception of that from the instrument on the floor near the bunkers of the car No. 284024 C.P. which failed to record.

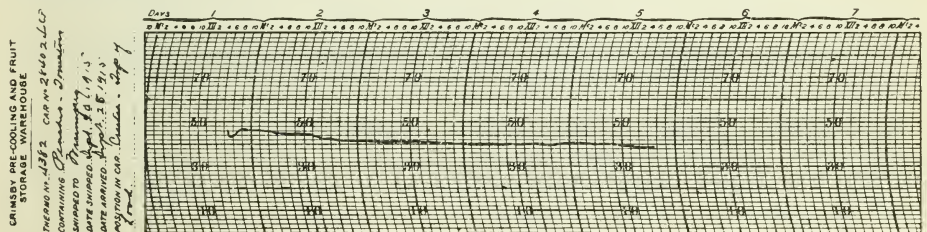


FIG. 2.—Thermograph record. Temperature record, top of load of fruit, centre of car No. C.P. 284,024.

Conclusions.

When using block ice without salt in brine tank cars, the fruit growers have just cause for complaint on account of high temperatures.

The use of 5 per cent of salt with crushed ice for the initial icing in conjunction with slatted false floors improved the temperature conditions in brine tank cars.

Freezing did not take place in the fruit when using 5 per cent of salt with the initial icing, neither was injury apparent from too low temperatures.

A small amount of ice without salt was used in transit with these shipments. The importance of the use of slatted false floors is to be emphasized. This allows ample space for the circulation of cold air to the centre of the car and obviates

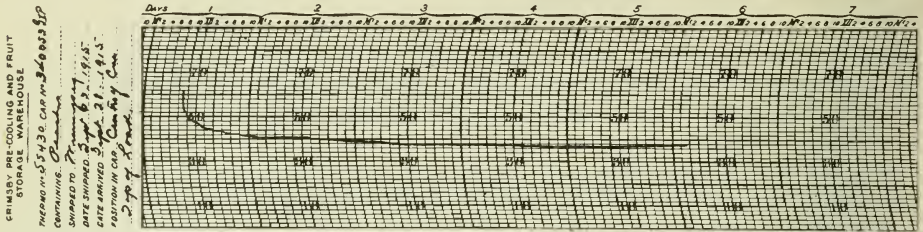


FIG. 3.—Thermograph record. Temperature record, top of load of fruit, centre of car G.T.P. No. 340,533

the pocketing of cold air near the bottom of the tanks, which would cause freezing of the fruit in that region and a high temperature in the centre of the car.

The writer would not recommend the widespread use of 5 per cent of salt with ice in tank cars for fruit till further trials have been made. However, if care is taken it may be used in the initial icing with much benefit, and the trials so far

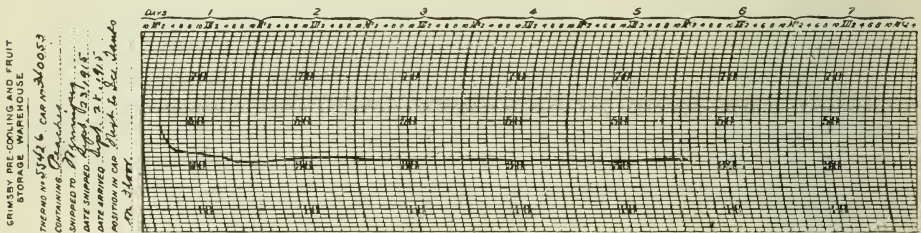


FIG. 4.—Thermograph record. Temperature record, against brine tanks, floor of car, G.T.P. No. 340,533

made warrant further investigation, covering the use of 5 per cent of salt with crushed ice both in the initial icing and in re-icings in transit with fruit that has not been precooled.

COLD STORAGE INVESTIGATIONS.

During 1914 and 1915 variety tests have been made with the principal tender fruits grown in the Niagara district at temperatures of 31° F. to 32° F., and 40° F. to 42° F. The objects of the tests have been to determine the effect of rapid and gradual precooling (the results of which have already been shown), the behaviours of the varieties under low temperatures, and the length of their life under refrigerator car temperature (40° F.). The records will be supplemented as future work brings forth added information.

STRAWBERRIES.

Our tests indicate that strawberries may be held from two to five days at 40° F. and from four to seven days at 32° F. Tests were made with the following varieties: Joe, Pocomoke, Glen Mary, Wm. Belt, and Wilson. Tests with strawberries and raspberries have not gone far enough to publish further details.

BLACK CURRANTS.

At 32° F. the Black Champion variety remains in good condition for two weeks
 At 40° F. this variety remains in good condition from one week to ten days.

RED CURRANTS.

At 32° F. the Red Dutch variety remains in good condition for ten days.
 At 40° F. this variety remains in good condition for one week.

GOOSEBERRIES.

At 32° F. the European and American gooseberries remain in good condition for four weeks.

At 40° F. these gooseberries remain in good condition for two weeks. Gooseberries do not decay rapidly in storage, but at the end of their storage season begin to change colour, during which time they are in condition fit for use.

CHERRIES.

In picking cherries to go under refrigeration, extreme care must be exerted in picking before the fruit is too ripe; in preserving all stems intact on the fruit; in securing fruit that is free from cracks; and in eliminating fruit that is infested with worms. The following tabular statement gives in brief some of the results obtained so far:—

Life of Cherries in Storage.

Variety.	Temperature.	
	32° F.	40° F.
	Days.	Days.
Early Richmond.....	12	7-10
Montmorency.....	14	10
Black Tartarian.....	10	6- 8
Elkhorn.....	6	4
Windsor.....	10	6

All sweet cherries without stems and those showing bruises or cracks deteriorated quickly.

Life of Plums in Storage.

Variety.	Temperature.	
	32° F.	40° F.
	Days.	Days.
Burbank.....	16	10
Abundance.....	14	10
Bradshaw.....	21	10
Grand Duke.....	21	14
Lombard.....	7	3- 5
Imperial Gage.....	12	7-10
Washington.....	10	7
General Hand.....	10	5- 8
Yellow Egg.....	14	10
Reine Claude.....	21-28	15
Monarch.....	21	14
Damson (Shropshire).....	28	21

Notes on Plums in Storage.

Burbank and Abundance.—Should be well coloured. Do not colour much in storage.

Grand Duke.—Will keep longer than time given, but with a tendency to become “mealy.” A good variety for long-distance shipment.

Lombard, Imperial Gage, Washington, and General Hand.—Not suitable varieties for long-distance shipment. Lombard has a tendency to show discoloured spots.

Reine Claude, Monarch and Damson.—Good varieties for long-distance shipment. Monarch has a tendency to become “mealy.” Damson (Shropshire) may be stored longer than time given but is apt to shrivel.

PEACHES.

The peach is not truly a cold-storage fruit and, when subjected to low temperatures for any length of time, rapidly loses flavour. In our investigations with several varieties, the loss of flavour at 32 degrees F. was not greater than at 40 degrees F. when held in storage for the same length of time. When picked fully ripe or after the flesh had started to soften before being placed under refrigeration, all varieties soon became mealy and dry. In view of these facts peaches should not be held under refrigeration longer than is actually necessary to comply with marketing conditions.

Life of Peaches in Storage.

Variety.	Temperature.	
	32° F.	40° F.
	Days.	Days.
Triumph.....	10	3
Arp's Beauty.....	18	10
Admiral Dewey.....	10-14	7
Graves.....	7	4-6
Belle of Georgia.....	18	10
Early Rivers.....	14	7-10
Mountain Rose.....	3-6	Very short
Champion.....	10-14	6
Early Crawford.....	12-14	7-10
Elberta.....	14-21	10

PEARS.

The life of the pear in cold storage varies widely with different varieties. It may be kept under refrigeration with but little loss in flavour and texture if the storage season is not unduly extended. Caution should be observed in picking the pear for storage as it should not be over-ripe. It is very necessary to place the pear in cold storage immediately after picking.

Our test indicates that pears may be stored as follows if proper care as to maturity is exercised.

Life of the Pear in Storage.

Variety.	Temperature.	
	32° F.	40° F.
	Weeks.	Weeks.
Bartlett	6	3
Clarigan	8	6
Buerre d'Anjou	8	6
Howell	8	5
Duchess	8	6

All the above varieties required about ten days to ripen under fruit stand conditions after being removed from storage.

GRAPES.

Storage tests have been under way with seven of the principal commercial varieties of grapes grown in Ontario to determine the length of their storage season, the best manner of preparing and packing and the best temperature for holding in storage. Examinations took into account the flavour and texture of the berries, the condition of the stem, the decay or mouldiness of the fruit and the amount of fruit shelling off. All loose and deteriorated berries were taken as total deterioration.

The results as given will be brief, only giving general conclusions drawn from the work carried on thus far. The results in detail will be published after the work has been carried on more fully.

Temperatures.

The grapes were stored at 40° F. and 32° F. No injury was apparent at the low temperature and the length of the storage season for the different varieties was increased several weeks as compared with storage at 40 degrees.

Results with Different Varieties.

Niagara.—The berries shelled very badly with this variety so that it is not desirable for storage. Its season was not later than November 15. After this time not only did shelling take place very badly, but the pulp lost its texture and took on an inferior flavour.

Concord.—This variety has possibilities of being stored until early December and with extreme care may be held for the Christmas trade. It showed slight shrivelling in the latter part of the season and a tendency to become mouldy where the least injured.

Lindley or Rogers No. 9.—This variety showed a small amount of shelling but tended to develop mould on the stems. The berries had a tendency to shrivel. Its storage season lasted until the first of December.

Agawam or Rogers No. 15.—The fleshy stem promoted mould growth and the berries shrivelled considerably. However, there was a small amount of shelling and if properly handled may be stored till the 15th of December.

Wilder or Rogers No. 44.—Like other Rogers varieties the fleshy stem developed mould growth. They are also subject to mildew previous to picking and should not be placed in storage. The Wilder did not shell badly and kept until after December 1.

Vergennes.—One of the best storage varieties. It is slow to shrivel and develop mould and does not shell. It may be stored till January 1.

Catawba.—One of the best storage varieties but not equalling the *Vergennes*. It showed a small amount of stem mould and shrivelling, with a tendency to shell. Its storage season lasts from December 25 to January 1.

Conclusions.

Packages.—Hermetically sealed packages did not give satisfactory results. Packages in which a filler such as wood wool or mill shavings was used gave better results than packages having the grapes exposed. With the filler the fruit kept fresher and stem mould was less apparent.

Treatment of Fruit.—The waxing of the ends of the stems so as to stop evaporation did not show beneficial results. In fact less mould on the stems was apparent when the stems were not waxed and allowed to shrivel up as quickly as possible.

The trimming off of all injured or decaying berries from the cluster previous to shipment is of the greatest importance to the good keeping quality of the fruit. All grapes for storage purposes must be handled as carefully as possible for the above reason.

By special preparation and much care during storage the better storage varieties of grapes may be stored for the greater part of the winter. However, considerable waste will be apparent and some trimming will be necessary, consequently the storage seasons for the various varieties as given above were based upon commercial conditions of storage and marketing, thus making the seasons much shorter than they would be in the case of family lots where extra care would be exerted at the time of storage and where mouldy clusters could be trimmed and brightened up before using.

TOMATOES.

Like the peach, the tomato is a product adapted to only short periods of refrigeration. Investigations have only begun with the tomato under refrigeration, but up to the present time indications are that the tomato softens under temperatures as low as 30° F., and when held at this point for any length of time develops a slightly insipid flavour. Tomatoes for cold storage should have a very firm flesh and should be free from cracks or injuries. For this reason it is advisable to pick tomatoes without leaving any stems on the fruit to puncture.

Life of Tomatoes in Storage.

Variety.	Temperature.	Remarks.
	32° F.	
	Days.	
Earliana.....	14	
Earliest of All.....	10	Fairly good shipper.
Chalks Jewell.....	14	A good shipper.
Livingstons Favourite.....	12	Tendency to mould.
Dominion Day.....	12	Does not store well.
Bruce's First and Best.....	14-18	A good shipper.
Ignotum.....	14	Medium to good shipper.
June Pink.....	10	Poor shipper.
Danish Export.....	18	One of the best shippers.
Dwarf Champion.....	10	Not a good shipper.
Alacrity.....	12	Medium shipper.
Success.....	12	Does not store well.
Bonnie Best.....	14	Good shipper but does not store well.

CUCUMBERS.

The cucumber will not store well at low temperatures. After a few days' storage at 32° F. the cucumber begins to show a slight darkening; this increases with the length of the storage season. Upon removing from storage the cucumber turns very dark and breaks down completely. The action seems to be one that breaks down the cell walls, allowing water to permeate the intercellular spaces, making the fruit a watery mass.

At 40° F. the cucumber remains intact, with no darkening or breaking down and may be successfully stored or shipped for a period of from one week to ten days. At the higher temperature the first signs of deterioration are shrivelling followed by a slight mould growth. The lowest and best temperatures to which cucumbers may be subjected has not yet been determined.

