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A Varietal Study of the Susceptibility of Sweet Cherries to Cracking

By

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Summary

1. Comparative susceptibilities to cracking were determined for eight varieties of sweet cherries. Varieties listed in order of susceptibility starting with least resistant are: Bing, Tartarian, Napoleon, Lambert, Republican, Oregon, Waterhouse, and Eagle.

2. Large-fruited varieties were more susceptible to cracking than small-fruited varieties.

3. Varieties having a small amount of skin per gram of soluble solids were more susceptible to cracking than those with large amounts of skin. Fruit size, skin thickness, and concentration of soluble solids all affect the amount of skin per gram of soluble solids. Of these factors skin thickness might be varied with least change in market quality of the fruit. This could be accomplished by a program of breeding and selection.

4. A study of a 30-year rainfall record for June and July in the Lewiston district showed that late varieties are exposed to appreciably less rainfall than midseason varieties.

Acknowledgments

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Introduction

SWEET cherries crack when the fruit absorbs so much moisture that the skin will not retain the contents. Rainfall about harvest time is often heavy enough to cause serious damage due to cracking. In the Lewiston cherry district of Idaho, for instance, the loss in 1931 was about 30 to 60 per cent of the crop, and in 1934 it ranged from 50 to 90 per cent in various orchards.

The present report deals with inherent varietal differences in tendency to crack, and gives a summary of June and July rainfall conditions for the region in which these studies were conducted.

Hartman and Bullis (1), and others state that the excess water responsible for cracking may be taken up either through the roots or through the fruit. Verner and Blodgett (4, p. 2) state:

"The type of cracking common to the Lewiston district [of Idaho] is due to an osmotic absorption of water through the skin of the fruit. This type of cracking is directly affected by [a] the osmotic concentration of the fruit juice; [b] turgor of the fruit; [c] temperature of the water; and [d] by skin permeability.

"Factors affecting cracking indirectly through their effects on one or more of the direct factors above are: [a] soil moisture below the wilting point; [b] an excessive transpiration rate; [c] inherent varietal characteristics; and [d] local climatic conditions."

Sawada (2, p. 891) found that "the moisture content of soils, however extreme it may be, seems to bear no definite relation to the cracking of cherries"; "the cause of the cracking lies in the direct influence of rain water upon the fruits," and also, "the effect of water upon the cracking of the cherries is localized to the part of the skin directly touched by the water." And, when the fruit was placed under a saturated moisture condition—"the humidity of the air is not enough to cause cracking."

Methods of Procedure

The methods of procedure established by Verner and Blodgett (4), in as far as they were applicable to varietal comparisons, were followed in this study.

Varieties. The varieties studied were limited to those growing in commercial orchards of the Lewiston district. These were Bing, Lambert, Napoleon (Royal Ann), Republican, Tartarian, Oregon, Eagle, and Waterhouse.

Sampling of Fruit. In the mornings of the days on which tests were made, 100 or more fruits were picked at random from one representative tree of each variety. The stems were cut at the base of the fruits from one lot of 50 cherries, which were used for the volume and tendency-to-crack determinations. A comparable lot of 50 cherries was used for firmness and soluble solids tests.

Susceptibility to Cracking. Susceptibility to cracking was determined by the method introduced by Verner and Blodgett (4). Fifty cherries were placed in tap water for 10 hours. The number that cracked during each 2-hour interval was counted. This number was multiplied by the mean time remaining between this period and the end of the 10 hours. This expression, in terms of cherries cracked times hours remaining, has been designated as *cracking index*. As shown by Verner and Blodgett, this is a much more accurate figure than the percentage cracked during the 10-hour period. For this varietal study the cracking index was determined at about the period of greatest susceptibility.

Volume Determinations. The volume of 50 fruits was measured by placing them in a 1000 ml. graduated cylinder containing a known amount of water, the volume of which was then subtracted from the total volume of fruit and water.

Firmness Determinations. Firmness was determined by the Idaho pressure tester, designed by Verner (3) to determine the firmness of the flesh of the fruit by measuring resistance of the fruit to pressure between two flat surfaces. This tester was not entirely satisfactory for this varietal study since variations in fruit size affected the readings. It was, however, the most effective method available for these determinations.

Soluble Solids in the Juice. The fruits that were used for the firmness determinations (together with the remainder of the sample if needed), were placed in a canvas cloth and the juice extracted, using a small lard press. The juice was tested for soluble solids in 1931 by the use of the Balling scale hydrometer, and in 1932 and 1933 with the Zeiss refractometer. The readings on cherry juice by these two methods were found to be almost identical. Although the hydrometer had been used by Hartman and Bullis (1), by Verner and Blodgett (4), and others, the refractometer was used in the present work because it was found to furnish a more convenient and rapid method for obtaining readings comparable to those secured with the hydrometer.

Measurements of Fruit Structure. Structural measurements were made during the 1932 season by using an eyepiece micrometer in a binocular

TABLE I
Cherry Cracking Data—1931

Variety	Date Tested	Firmness Pounds	Soluble Solids in juice, %	Volume of 50 Cherries in ml.	Cracking Index	Calculated Grams Soluble Solids per Fruit
Bing	6-15	6.76	19.4	375	354	1.45
Tartarian	6-20	2.20	15.4	220	130	.68
Napoleon	6-14	6.31	16.9	269	222	.91
Lambert	6-16	7.94	17.6	334	260	1.18
Oregon	6-19	5.34	16.8	303	84	1.02
Waterhouse	6-20	5.01	17.9	310	70	1.11
Eagle	6-18	4.65	16.4	215	1	.71

microscope. Four fruits of each variety, usually from equidistant points around one tree, were examined. By means of a razor blade a thin free-hand section perpendicular to the fruit axis was made from the cheek of the fruit to the seed. Thickness of cuticle and thickness of the heavily pigmented layer of the hypodermal cells were measured separately and compared with susceptibility to cracking. As no positive correlation was established by these comparisons the cuticle and pigmented layer combined were used as a single measure of skin thickness.

Skin thickness varied considerably along the section, some points being twice as thick as others. Several measurements were taken and an approximate average obtained for each fruit. These measurements again were averaged for the four fruits of the variety. This gave an approximate figure that seemed to be accurate enough for preliminary varietal comparisons.

Rainfall Summary. A 30-year record (1901-30) of the rainfall at Lewiston during June and July was obtained from the United States Weather Bureau and summarized as to frequency of occurrence, duration, and amount.

TABLE II
Cherry Cracking Data—1932

Variety	Date Tested	Firmness Pounds	Soluble Solids in Juice, %	Volume of 50 Cherries in ml.	Cracking Index	Calculated Grams Soluble Solids per Fruit
Bing	6-23	6.29	16.7	339	163	1.12
	6-28	5.44	18.3	375	264	1.37
	7-2	5.19	20.7	405	324	1.68
	Av.	*5.64*	*18.6*	*373*	*250*	*1.39*
Tartarian	6-22	2.58	12.8	212	184	.55
	6-27	2.77	15.8	228	264	.72
	Av.	*2.68*	*14.3*	*220*	*224*	*.64*
Napoleon	6-23	5.86	17.7	340	196	1.20
	6-28	5.74	20.3	353	162	1.43
	7-2	5.94	23.8	359	66	1.71
	Av.	*5.85*	*20.6*	*351*	*141*	*1.45*
Lambert	7-1	5.26	17.9	236	53	.84
	7-6	5.30	18.8	267	52	1.04
	7-11	4.83	19.4	293	64	1.14
	Av.	*5.13*	*18.7*	*265*	*56*	*1.01*
Republican	7-1	6.70	24.0	175	59	.84
	7-6	6.60	24.6	188	15	.93
	7-11	6.56	26.4	188	26	.99
	Av.	*6.62*	*25.0*	*184*	*33*	*.92*
Oregon	6-22	4.59	15.8	247	39	.78
	6-27	4.10	17.4	245	30	.85
	7-5	5.22	22.4	255	35	1.14
	Av.	*4.64*	*18.5*	*249*	*35*	*.92*
Waterhouse	6-25	5.08	17.9	253	26	.93
Eagle	6-22	3.79	15.1	178	28	.54
	6-27	3.75	16.1	170	18	.55
	Av.	*3.77*	*15.6*	*174*	*23*	*.54*

Results and Discussion

Varietal Tendency of Cherry Fruits to Crack. While there was a tendency for all varieties to crack more one season than another, there were large differences among varieties under similar conditions. Tables I, II and III show the results of tests made during the three years, 1931-1933. The approximate order of varietal susceptibility to cracking as summarized in Table IV, starting with the least susceptible variety, is as follows: Eagle, Waterhouse, Oregon, Republican, Lambert, Napoleon, Tartarian, and Bing. As measured by the cracking index these varieties vary from 29 to 298, Eagle being only one-tenth as susceptible as Bing.

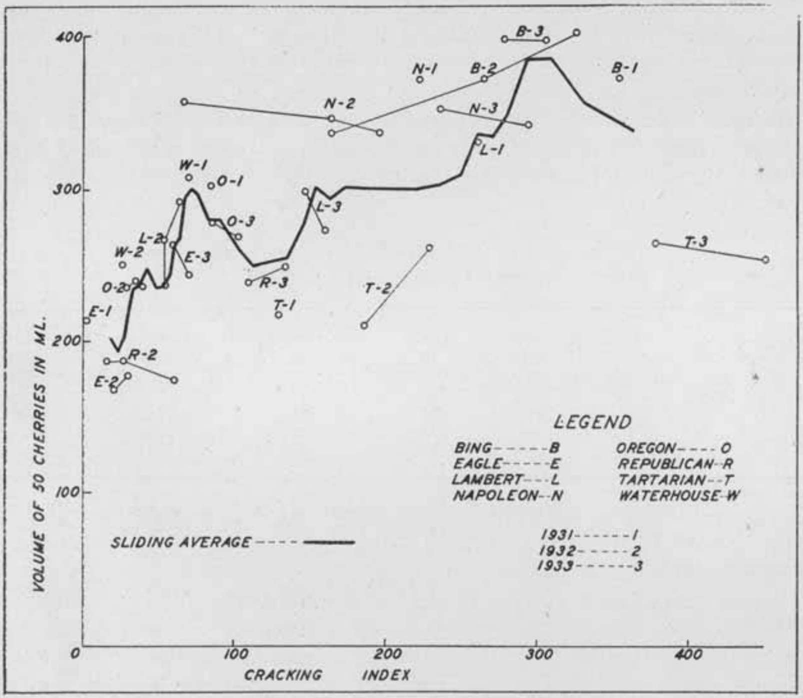

Fig. 1.—Relationship between volume and cracking index. (Sliding average was obtained by plotting the average cracking index and average volume of each five consecutive cracking index readings. This shows the volume trend accompanying the increases in susceptibility to cracking when all varieties and seasons in which tests were made were combined).

Fruit Size and Tendency to Crack. The volumes and cracking indices of the eight varieties are plotted in Figure 1. The trend shown by the heavy line was established as a sliding average, all varieties being included in the computation. The lowest five of the cracking-index readings were averaged for the starting point, and the line continued by dropping the lowest of these readings and annexing the next higher reading.

Large-fruited varieties like Bing and Napoleon tend to crack more readily than small-fruited varieties as Eagle and Republican (Fig. 1). The surface area as compared with the volume of a cherry is similar to that of a sphere, that is, the area increases proportionately as the radius *squared* increases, while the volume increases proportionately as the radius *cubed* increases. The result is that a large cherry has less skin surface per unit

TABLE III

Cherry Cracking Data—1933

Variety	Date Tested	Firmness Pounds	Soluble Solids in Juice, %	Volume of 50 Cherries in ml.	Cracking Index	Calculated Grams Soluble Solids per Fruit
Bing	6-28	7.13	18.8	402	276	1.51
	7-7	6.41	20.0	402	304	1.61
	Av.	*6.77*	*19.4*	*402*	*290*	*1.56*
Tartarian	6-29	2.93	15.4	255	450	.79
	7-4	2.24	16.2	267	377	.87
	Av.	*2.58*	*15.8*	*261*	*414*	*.83*
Napoleon	6-28	5.91	17.4	344	292	1.20
	7-7	5.90	19.7	355	234	1.40
	Av.	*5.90*	*18.6*	*350*	*263*	*1.30*
Lambert	7-7	5.01	16.3	275	158	.90
	7-12	3.79	15.4	300	147	.92
	Av.	*4.40*	*15.8*	*288*	*152*	*.91*
Republican	7-7	6.80	23.2	240	108	1.11
	7-12	6.35	24.9	252	133	1.25
	Av.	*6.58*	*24.0*	*246*	*120*	*1.18*
Oregon	6-28	5.39	17.5	270	102	.94
	7-4	4.95	18.3	280	86	1.02
	Av.	*5.17*	*17.9*	*275*	*94*	*.98*
Eagle	6-29	5.82	21.8	245	70	1.07
	7-4	5.45	21.8	266	59	1.16
	Av.	*5.64*	*21.8*	*2[illegible]6*	*64*	*1.12*

of volume than a smaller cherry, and other factors being equal, the large cherry would be expected to more readily absorb water in excess of the expansive capacity of its skin.

Some fruits crack more rapidly for their size than others, as indicated by the fact that the small-fruited variety Tartarian cracked more readily than the larger-fruited variety Napoleon. A correlation between volume and cracking index of $+.55 \pm .074$ together with Figure 2 shows that size was one, but not the only, factor influencing tendency to crack. Also the relationship between volume and cracking index was greater within a variety between seasons than between varieties (Fig. 2). This indicates that other influences are active among varieties that are not obvious within a variety.

Fruit Firmness and Tendency to Crack. When fruit firmness and tendency-to-crack tests were plotted, no relationship was apparent. Since cracking susceptibility seemed to be correlated with volume, fruits of each size were plotted with relation to firmness and cracking index. This is shown in Figure 2.

Figure 2 is a three-dimensional graph giving volume as depth, cracking index as height, and firmness as width. Each column represents one test of one variety. The tall columns are those having the high cracking indices. These are found toward the back, showing that in general they are also cherries of large volume. Firmness determines their position from left to right and in this respect the tall and short columns are scattered. In the group of medium size there appears to be some tendency for those of medium firmness to be slightly less susceptible to cracking than either the firm or soft fruits. This, however, probably is not significant, since the results are quite variable. Besides this possible exception, it can be seen that fruits of any one size show no consistent relationship between firmness and cracking index.

It is, therefore, concluded that fruit firmness, as determined by the Idaho pressure tester, does not, so far as varieties are concerned, give a measure of cracking resistance. In other words, varietal differences make it impossible to give a definite pressure beyond which a cherry would not be expected to crack.

TABLE IV

Three-Year Summary of Maturity Tests

Variety	Year	Dates Tested	Average Firmness in lbs.	Average Soluble Solids in Juice, %	Average Vol. 50 Cherries in ml.	Average Cracking Index
Bing	1931	June 15	6.76	19.4	375	354
	1932	June 23, 28, July 2	5.64	18.6	373	250
	1933	June 28, July 7	6.77	19.4	402	290
	Av.		*6.39*	*19.1*	*383*	*298*
Tartarian	1931	June 20	2.20	15.4	220	130
	1932	June 22, 27	2.68	14.3	220	224
	1933	June 29, July 4	2.58	15.8	261	414
	Av.		*2.49*	*15.2*	*234*	*284*
Napoleon	1931	June 14	6.31	16.9	269	222
	1932	June 23, 28, July 2	5.85	20.6	351	141
	1933	June 28, July 7	5.90	18.6	350	263
	Av.		*6.02*	*18.7*	*323*	*209*
Lambert	1931	June 16	7.94	17.6	334	260
	1932	July 1, 6, 11	5.13	18.7	265	56
	1933	July 7, 12	4.40	15.8	288	152
	Av.		*5.82*	*17.4*	*296*	*156*
Republican	1932	July 1, 6, 11	6.62	25.0	184	33
	1933	July 7, 12	6.58	24.0	246	120
	Av.		*6.60*	*24.5*	*215*	*76*
Oregon	1931	June 19	5.34	16.8	303	84
	1932	June 22, 27, July 5	4.64	18.5	249	35
	1933	June 28, July 4	5.17	17.9	275	94
	Av.		*5.05*	*17.7*	*276*	*71*
Waterhouse	1931	June 20	5.01	17.9	310	70
	1932	June 25	5.08	17.9	253	26
	Av.		*5.04*	*17.9*	*282*	*48*
Eagle	1931	June 18	4.65	16.4	215	1
	1932	June 22, 27	3.77	15.6	174	23
	1933	June 29, July 4, 12	5.64	21.8	256	64
	Av.		*4.69*	*17.9*	*215*	*29*

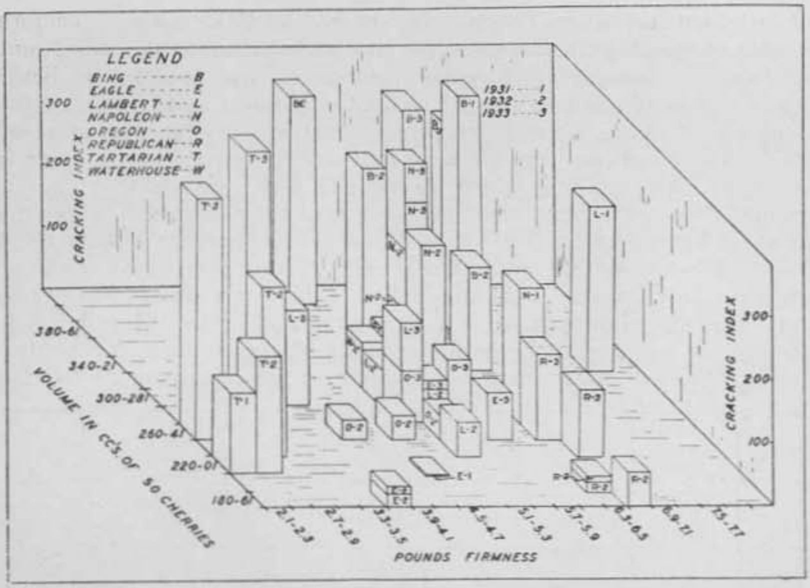

Fig. 2.—Relationship between volume, firmness and cracking of sweet cherries.

Soluble Solids in the Juice and Tendency of Fruit to Crack. Verner and Blodgett (4) and Sawada (2) found that, within a variety, the fruits with higher soluble solids content tend to crack more rapidly than those with lower soluble solids content. Some of the varieties here studied contained only about two-thirds as much soluble solids in the juice as others and it was expected that there would be some relationship among varieties in this respect. This, however, was not the case in this study as is shown in Figure 3. It was found that Republican with its high soluble solids content cracked no more than Oregon and much less than Tartarian, both of which had a much lower percentage of soluble solids in their juices. The concentration of juice, so far as varietal differences were concerned, seemed to have no measurable direct effect upon susceptibility to cracking. It may be, however, that one or several other factors influence resistance to cracking to such an extent that a factor such as variation in soluble solids, so important within a variety, is completely masked when varieties are compared. Unpublished three-dimensional graphs of the data in Tables I, II and III showed, however, that neither firmness nor volume so masked any relationship between percentage of soluble solids and resistance to cracking.

Volume of fruit and percentage soluble solids both affect the total amount of soluble solids. The correlation between amount of soluble solids and cracking index was $+.34 \pm .094$. Since concentration of juice showed no relationship, and volume of fruit a higher relationship to cracking ($+.55 \pm .074$) than amount of soluble solids, it seems that the corelation between amount of soluble solids and tendency to crack ($+.34 \pm .094$) is due to the volume relationship.

Fruit Structure and Tendency to Crack. In 1932 microscopic measurements of skin thickness were made and summarized as described under "Methods." A low-power binocular miscroscope was used in the field in order to rapidly obtain an enlarged view of conditions and changes. Each section was made as needed but protection from drying was necessary. For protection sections were first covered with a few drops of water but this caused rapid swelling which visibly changed their shape. The cells were not observed to burst but thickened until they formed a wider mass than the adhering skin. This caused the skin to cup and the cuticular surface (not cut surface but former fruit surface) assumed a rounded trough-like appearance. This shows how rapidly the fruit cells take up water when directly exposed. This swelling was prevented and the sections kept in approximately normal condition long enough for study by covering them with a few drops of juice from the remainder of the fruit.

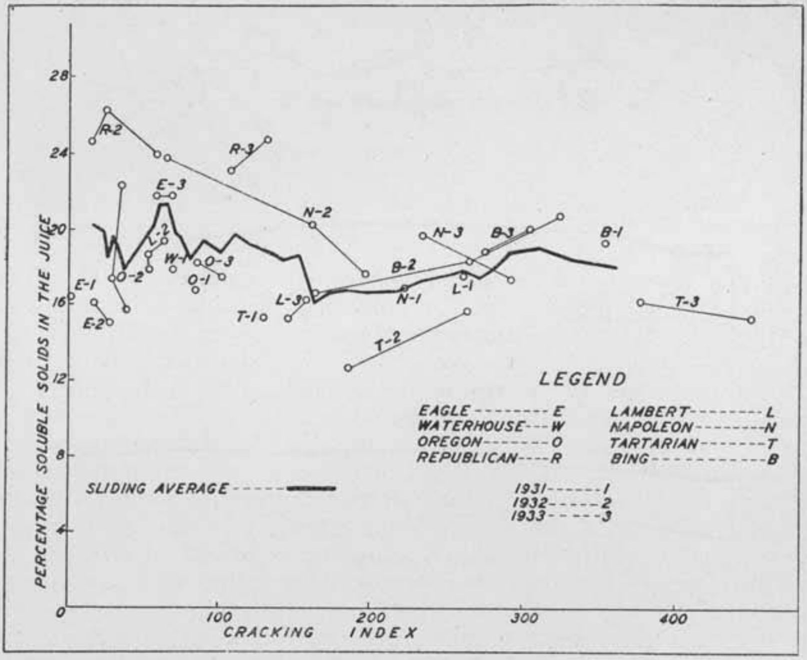

Fig. 3.—Relationship between concentration of soluble solids in the juice of various varieties and cracking index. (Sliding average was obtained by plotting the average cracking index and average soluble solid content of each five consecutive cracking index readings. This shows the soluble solid trend accompanying the increases in susceptibility to cracking).

A few photomicrographs were taken in 1933 through a wide field binocular microscope with a 120 Eastman kodak. Drawings from these showing the combined thickness of the cuticle and heavily pigmented cells underneath for five different varieties are shown in Figure 4.

Figure 4 shows the irregularities in thickness of this area within one fruit as well as varietal variability in this respect. Field observations showed the cuticle to extend into spaces between many of the pigmented cells making its thickness very hard to measure. Approximately one-third of the total thickness consisted of cuticle. The thickness of both cuticle and heavily pigmented cells was considered as skin thickness. Skin

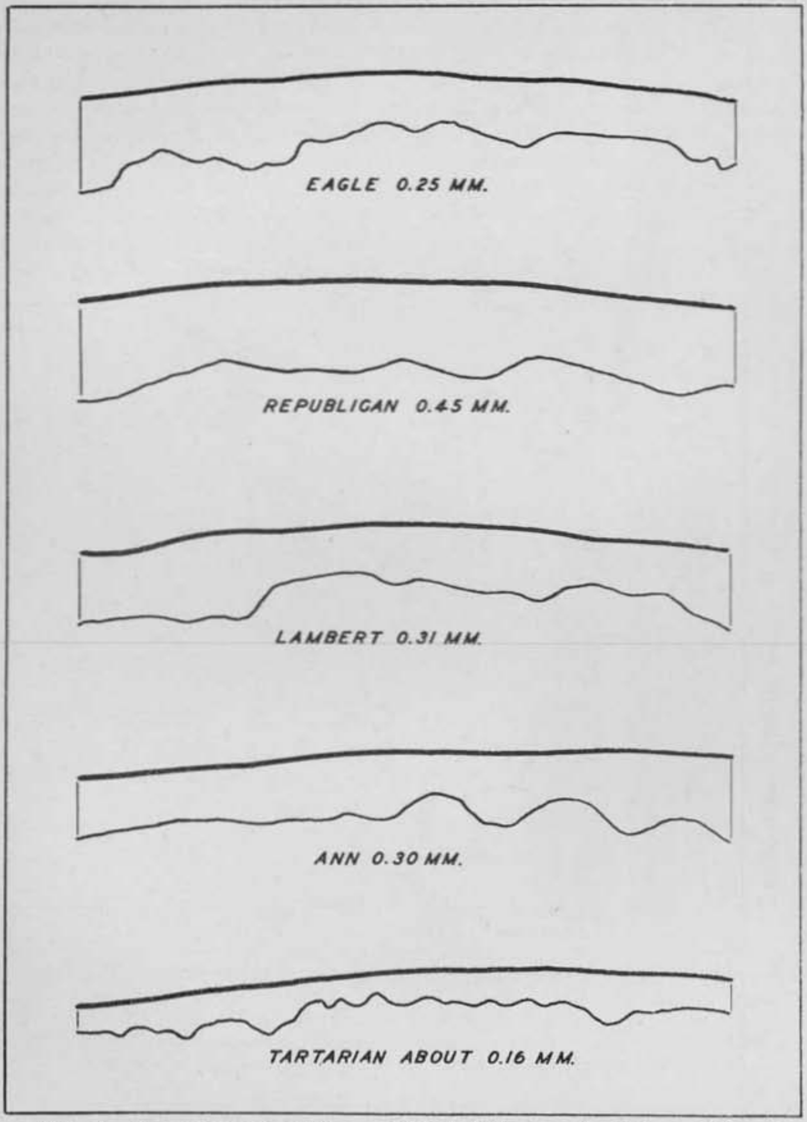

Fig. 4.—A comparison of the combined thickness of cuticle and heavily pigmented cells among the Eagle, Republican, Lambert, Napoleon, and Tartarian sweet cherry varieties.

thickness at first appeared to be *not* definitely and directly correlated with cracking tendencies. This might constitute the principal difference between some varieties (as Eagle and Republican), while there was little

TABLE V

Miscroscopic Measurements of Cherry Structure—1932

Variety	Date	Skin Thickness (cuticular and epidermal layers) in mm.	Cracking Index	Volume of 50 Cherries in ml.	Soluble Solids in per cent	Soluble Solids per cherry, grams	Approximate skin volume per cherry cc.	Skin Volume per gram of soluble solids in fruit, cc.
Bing	6-29	0.297	279	382	18.9	1.44	1.188	.82
Napoleon	6-30	0.304	114	356	22.0	1.56	1.167	.75
Lambert	7-8	0.314	57	277	19.0	1.05	1.017	.97
Republican	7-8	0.446	19	188	25.3	.95	1.128	1.19
Oregon	6-25	0.342	34	246	16.7	.83	1.019	1.23
Eagle	6-27	0.247	18	170	16.1	.55	.593	1.08
Waterhouse	6-25 6-30	0.297	48	260	17.9	.97	.927	.95
Unknown 1 (Black)	6-14	0.162	194	190	17.0	.65	.410	.63
Unknown 2 (Black)	6-14	0.152	107	200	18.1	.72	.397	.55
Unkown 3 (White)	7-2	0.152	214	110	22.6	.51	.268	.53
Tartarian	6-22		184	212	12.8	.55		

difference in this characteristic among other varieties. However, other wide differences existed among varieties, as fruit size between Eagle and Bing. Size of fruit affects the area of skin produced. When skin area was considered along with thickness and these compared with soluble solid production, these factors seemed to be related to cracking tendencies.

The only structural relationship measured that seemed to be generally related to cracking susceptibility throughout the varieties studied was that of the calculated cubic centimeters of skin per gram of soluble solids in the fruit. The number of cubic centimeters of skin per fruit was calculated by multiplying average skin thickness by approximate skin surface, the cherry being considered, for this purpose, a sphere. Approximate number of grams of soluble solids was calculated from the percentage figures of soluble solids in the juice applied to entire cherry volume.

Some varieties are less productive of juice than others, indicating that some produce more insoluble solids than others and that this method of calculation can at best be only an approximation. But the cherry, unlike the apple and some other fruits, is heavier than water, indicating that very little of the volumetric content consists of air spaces, and that the volume measurements of the fruit represent essentially liquids and solids. The specific gravity of the fruit, and the seed volume and weight in the different varieties were not measured. The seed was disregarded, and the specific gravity of all fruits considered as 1.00 in the calculations. While these calculations are not entirely accurate they are considered accurate enough for practical approximations.

The amount of soluble solids in the fruit is markedly affected by the two factors, juice concentration and fruit volume. Fruit volume so affects skin surface. Volume change, however, alters at different rates the amount of soluble solids and the amount of skin surface (see *Fruit Size and Tendency to Crack*). These two factors were balanced with skin thickness by calculating the cubic centimeters of skin per gram of soluble solids in the fruit (Table V). In Figure 5 the varieties are distributed according to cubic centimeters of skin per gram of soluble solids and cracking index.

These calculations indicated that the more skin the fruit produced per gram of soluble solids the less tendency there was toward cracking. This relationship seems to be definite enough to justify the selection of thick skin as one factor in breeding work for varietal cracking resistance.

This study was made in the orchard and consists only of notes that could be readily recorded there. A detailed study of the anatomical structure of the cherry in relation to cracking is needed.

Seasonal Tendency of Cherry Fruits to Crack. In order to compare the effects of different seasons on the tendency of sweet cherries to crack, the results obtained on six varieties, Bing, Napoleon, Lambert, Eagle, Oregon, and Tartarian, were averaged for each of three seasons, 1931, 1932 and 1933. An attempt was made to test each variety at least twice at about its maximum period of cracking. The first test was made on most of these varieties in 1931 at a period thought to be just previous to that of maximum cracking. This was immediately followed by a rainy period which caused many of the fruits to crack so that other accurate

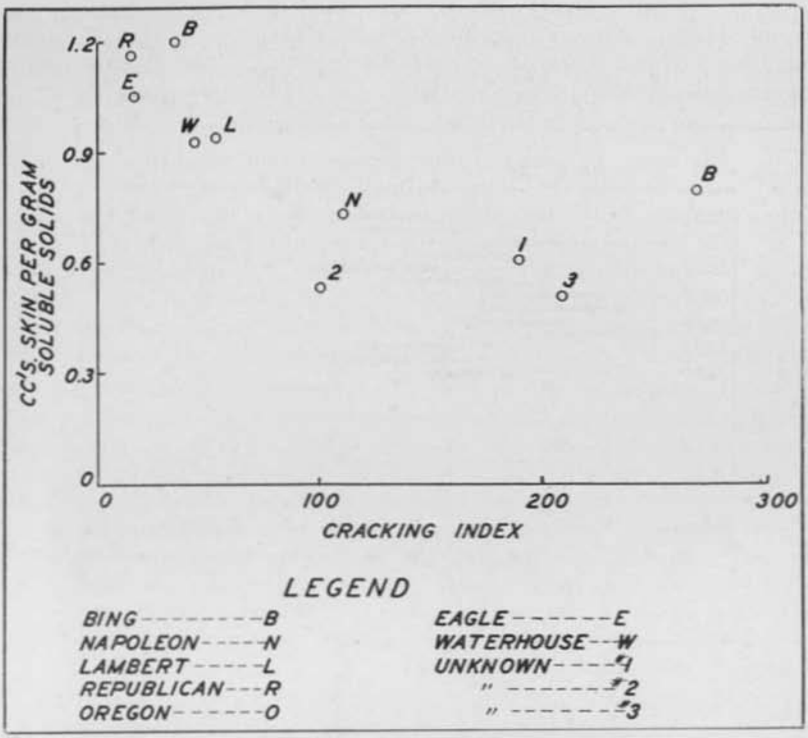

Fig. 5.—Relationship between cracking index and approximate skin volume per gram of soluble solids in sweet cherries, 1932 (Table V).

tests could not be obtained that season. This made only one test for each variety in 1931 and the figures are somewhat lower than would be expected had more tests been made. Taking this into consideration, the summary in Table VI indicates that the fruit in 1932 was smaller and softer, and less susceptible to cracking than either the 1931 or 1933 fruit.

TABLE VI

Averages of Six Varieties—Bing, Napoleon, Lambert, Eagle, Oregon, Tartarian

	1931	1932	1933
Cracking Index	177	122	213
Soluble solids, per cent	17.1	17.7	18.2
Firmness in pounds	5.53	4.62	5.08
Volume of 50 fruits in ml.	286	272	305

Probability of Rain on the Lewiston Cherry Crop. The Lewiston cherry crop consists mostly of Bing, Napoleon, and Lambert varieties. Napoleon and Bing mature about the same time and Lambert later. The crop does not mature on the same date each year, as shown in Figure 6. Here are plotted the periods of harvest for each year from 1920 to 1933 in the Gano orchard, containing Napoleon and Lambert varieties. The extreme range in harvest seasons over this period of years extended from June 8 to July 13, but in the majority of these years harvest occurred between June 16 and July 7.

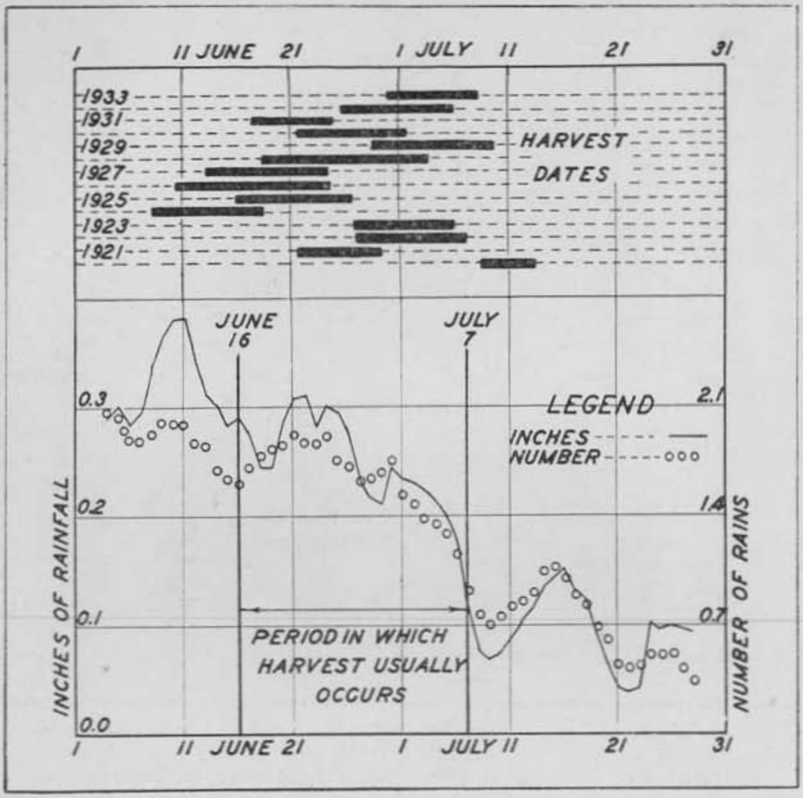

Fig. 6.—Sliding 7-day average showing amount and number of rains expected each week at Lewiston, Idaho (from U.S.D.A. 1901-1930 rainfall records) and the yearly harvest periods in Gano orchard (1920-1933) containing Napoleon and Lambert varieties).

The rainfall as recorded by the United States Weather Bureau at Lewiston (1901-1930) is summarized in Tables VII and VIII. Table VII indicates that the amount of rain per day decreases somewhat about the middle of the usual harvest season, but that the frequency of rain does not decrease much until after July 4, when the amount per day also declines. Judging from these records, growers may expect some rain during the 24-hour period about one day out of four between June 8 and July 4. During the period of July 5 to 31 they should expect only one rainy day out of 10. The average rainfall per rainy day in the earlier period was 0.17 inch, in the later period 0.13 inch. Also, in Figure 6 are shown the total amount and the number of rains that may be expected each week during the months of June and July. The points are located on the middle day of each week. Lines connecting these points, representing sliding averages, show how rapidly the normal rainfall decreases during this period.

As shown in Table VIII, rains during these months come in periods ranging from a single day to seven days in succession. The prolonged rains are the ones that do most damage by cracking. In the earlier period (June 8 to July 4) (Table VIII) there are long rains of five to seven days duration and also more rains, both of medium and of short duration, than in the later period (July 5 to 31). It is obvious, therefore, that in order to minimize damage by rain, the varieties grown in this district should either mature after July 4 or be varieties not especially susceptible to damage by the amounts of rain ordinarily experienced earlier in the season.

TABLE VII
Rainfall, Lewiston, Idaho, 1901-1930

Date	Total no. days	Days of rain	Inches of rain	Inches per Rainy Day	Ratio Rainy days to total days
June 1-6	180	53	9.27	0.13	1:3.4
June 7-12	180	52	13.19	0.19	1:3.5
June 13-18	180	40	9.32	0.18	1:4.5
June 19-24	180	51	9.76	0.16	1:3.5
June 25-30	180	43	6.53	0.13	1:4.2
July 1-6	180	38	6.23	0.16	1:4.7
July 7-12	180	19	1.70	0.09	1:9.5
July 13-18	180	30	4.16	0.14	1:6.0
July 19-24	180	11	1.01	0.09	1:16.4
July 25-30	180	11	2.83	0.26	1:16.4
June 8 to July 4	810	207	34.42	0.17	1:3.9
July 5-31	810	79	10.49	0.13	1:10.3

TABLE VIII
Rainy Periods Distributed According to Frequency of Occurrence

Length of Rainy Periods in Days	Number of Periods	
	June 8 to July 4	July 5 to July 31
1	71	28
2	27	12
3	10	5
4	6	3
5	3	0
6	1	0
7	1	0

TABLE IX

Summary of Varietal Characteristics for Consideration in Breeding Work

Variety	Index of Cracking Susceptibility		Firmness in lbs. at Early Maturity		Concentration of Soluble Solids in Juice, per cent		Season
	Approx. Range	Av.	Approx. Range	Av.	Approx. Range	Av.	
Bing (Black)	163-354	*298*	5.2-7.1	*6.39*	16.3-20.7	*19.1*	Medium
Tartarian (Black)	130-450	*284*	2.2-2.9	*2.49*	12.8-16.2	*15.2*	Early
Napoleon (White)	66-292	*209*	5.7-6.3	*6.06*	16.9-23.8	*18.7*	Medium
Lambert (Black)	52-260	*156*	3.8-7.9	*5.82*	15.4-19.4	*17.4*	Medium late
Republican (Black)	15-133	*76*	6.3-6.8	*6.60*	23.2-26.4	*24.5*	Late
Oregon (Black)	30-102	*71*	4.1-5.4	*5.05*	15.8-22.4	*17.7*	Late medium
Waterhouse* (White)		*48*		*5.04*		*17.9*	Late medium
Eagle (Black)	1-70	*23*	3.7-5.8	*4.69*	15.1-21.8	*17.9*	Med. to late

*Only two samples were tested, therefore the ranges obtained (Tables I, II, and III) are not summarized here.

TABLE IX Cont.

Summary of Varietal Characteristics for Consideration in Breeding Work

Variety	Volume of 50 Cherries in ml.		Approximate average Skin Thickness in 1932 Season	Tree Vigor and Hardiness	Remarks
	Approx. Range	Av.	mm.**		
Bing	339-405	*383*	0.30	Not strong, medium hardy	Fruits set more nearly singly than most varieties.
Tartarian	212-267	*234*	***	Vigorous, hardy	Widely used as a pollenizer.
Napoleon	269-359	*323*	0.30	Medium vigor, not hardy	About the only white variety grown commercially at Lewiston.
Lambert	236-334	*296*	0.31	Vigorous, hardy	Fruits set heavily.
Republican	175-252	*215*	0.45	Medium vigor, hardy	Widely used as a pollenizer.
Oregon	245-303	*276*	0.34	Vigorous, hardy	One season, some fruits were small, poorly colored, shriveled heavily, and had no kernel in pit.
Waterhouse		*282*	0.30		Seeds large.
Eagle	170-266	*234*	0.25	Vigorous, very hardy	Fruit quality varies more in Lewiston section than most varieties.

**Skin measurements (cuticular and epidermal layers) were extremely variable both on the surface of one fruit and between fruits. Skin thickness in relation to fruit size should be kept in mind.

***Measurements were not made in 1932 but photomicrographs in 1933 showed this variety to have a very thin skin.

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