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A Preliminary Report
on the
Pollination of the Sweet Cherry

By
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A PRELIMINARY REPORT ON THE POLLINATION OF THE SWEET CHERRY.

The Relative Importance of the Cherry Industry in Oregon.

According to the United States Census Report for 1910 the cherry ranks fourth in importance among orchard fruits in Oregon (*). The apple, prune, and pear, in the order named, rank ahead of it. The value of the 1909 crop is given as $269,934. That the industry is increasing very rapidly in size is indicated by the fact that in 1909 there were only 223,456 bearing trees, while there were 313,770 that had not yet reached bearing age. These figures convey some idea of the size of the industry as a whole, but do not indicate the relative importance that it has assumed in some sections.

Though cherries are grown in commercial quantities in almost all of the fruit growing sections of the state, only in a few places do they dominate the horticulture of the section. Among the places where both an extensive and intensive cherry industry has developed, may be mentioned Cove, in the Grande Ronde Valley of eastern Oregon, and The Dalles, in the Columbia River Basin. Many parts of the Willamette Valley produce cherries in large quantities, Salem and Eugene being especially important producing centers. The Hood River, Umpqua, and Walla Walla valleys are also important cherry raising sections. Comparatively few growers, however, are engaged exclusively in the production of this fruit. In most cases its culture is combined with that of some other fruit crop in order that labor may be employed and utilized to better advantage. Frequently the cherry orchard constitutes only a relatively small part of the producing acreage of the farm; consequently, while the fortunes of only a small number are entirely made or broken by the cherry crop, its size, and the profits or losses incident to it, affect the incomes of a great many. It not only fills an important place in the economic management of many fruit farms, but also serves to make the by-product industry more profitable through keeping the canneries running at a period when otherwise they would be idle. From many viewpoints cherry growing must be regarded as one of our most important horticultural industries.

Many varieties of cherries have been tried in the state at one time or another. As their ability or inability to meet the conditions of soil, climate, and market has been determined, the list of those found in the commercial orchards has gradually narrowed down to only a small percentage of the kinds that have been introduced. Three varieties, in fact,—Napoleon (Syn. Royal Ann) Lambert and Bing—have come to constitute probably more than 90 per cent of the commercial plantings. Napoleon is the leading canning variety; Lambert and Bing are the leaders for the fresh fruit trade.

(*). 13th Census of the U. S.; 1910.—Bulletin—Abstract—Farm Crops, by States.

The Importance of the Cherry Pollination Problem.

The increase in the size of the cherry industry, or perhaps more accurately, the increasing tendency to specialize in cherry growing, has naturally occasioned the introduction of certain new problems. Old-time problems of the cherry grower have become more acute. Some of these are problems common to the apple, pear, or prune grower, and have been met in much the same way; others seem to be more or less peculiar to the cherry grower, and demand special attention.

One of the most serious problems that has recently arisen has been that of securing a proper set of fruit. There is seldom any complaint about cherry trees refusing to bloom or about their not blooming heavily enough. The flowering habit of the sweet cherry, coupled with the methods of pruning usually employed, is such as practically to insure an abundance of flowers each year, at least if the trees are in reasonably good condition. Yet in spite of a heavy bloom, it frequently happens that not enough cherries set to make a profitable crop. This complaint is not peculiar to any one part of the state, for the Division of Horticulture of the Experiment Station has on file letters from many places indicating the trouble and asking about causes and remedies. For reasons that will be mentioned later, it seems to be most common in The Dalles section. There, a number of orchards that have long since reached bearing age have failed to produce profitable crops. Others that formerly bore well are becoming less productive. The fact that still others have been bearing very profitable crops when soil and other environmental conditions are practically the same, has apparently made the problem more puzzling.

It is a well established and commonly recognized fact that the setting of fruit is dependent upon many factors. The influence of weather conditions at the time of blossoming is at least partially understood. Rain, fog, frost, a low mean temperature, cloudiness, high winds, are all known to be limiting factors to the setting of fruit. When one or more of these unfavorable weather conditions are present during all or a greater part of the blooming season, the grower has a very obvious cause to which to attribute his poor set of fruit. On the other hand, when weather conditions are favorable at the blossoming season and still the fruit does not set, as has been repeatedly the case in many orchards in the state, something besides weather conditions must be at fault. Age and condition of the tree are known to have some influence upon the ability of some kinds of fruit trees to set fruit, those that are young and very vigorous being less fertile than older ones of the same varieties. Trees on heavy rich soils, and consequently making a rapid growth, are generally considered less fertile than those on lighter soils, growing more normally. These facts, however, explain but few of the frequent failures of the cherry to set in this state. Some growers are aware that certain of our varieties of orchard fruits are self-sterile, and, though no data on the sub

ject of self-sterility and self-fertility in the sweet cherry have been available, they have thought it best policy to plant two or more varieties together in the orchard to secure any possible advantage that might arise from cross-pollination. The percentage of cherry growers who have been careful to do this, however, is relatively small. Either the growers as a class are unaware that self-sterility of orchard fruits is a common problem with which the horticulturist must deal, or, knowing that it is a problem, simply neglect to give any attention to its solution. Probably both are contributing factors to the general difficulty that has suddenly become acute.

Why has the Cherry Pollination Problem become Acute Within the Last Two or Three Seasons?

Many cherry growers are slow to believe that a lack of proper cross-pollination is the main cause of the failure of their trees to set fruit. If such is the cause, they do not see why the trouble should all at once have become acute, for certainly cross-pollination must have been as important 10 or 20 years ago as now, and there used to be no general complaint about the failure of the cherry to set fruit. There is an explanation of these facts, however, that lends support to the theory that it is the lack of proper cross-pollination that now causes such a poor set of fruit in some orchards.

The bearing cherry orchards of a decade ago were of relatively small size and of mixed varieties. It is true that the three leading commercial varieties of to-day,—Napoleon (Syn.—Royal Ann), Lambert and Bing—dominated them; but they nearly all contained a few scattering trees of many other varieties—Yellow Spanish, Knight, Wood, Black Eagle, Black Tartarian, and Elton. In addition to these standard varieties there were few orchards that did not have in them, or near them along the roads or fencerows, seedlings of many kinds. That these mixed plantings were made for purposes other than to secure cross-pollination did not render them any less efficient in that respect.

The recent commercial plantings of the sweet cherry, however, have been on a much larger scale. Orchards of 10 to 100 acres have been established, and these have been almost exclusively of one or more of the three dominant commercial varieties just mentioned. Occasionally large solid blocks of a single one of these varieties have been planted, thus making no provision for cross-pollination but providing conditions for almost certain failure in the setting of the fruit if the variety planted happened to be self-sterile. Though the orchards containing trees of two or more of these varieties apparently provide for cross-pollination, the observations and experiments here reported tend to show that they are inter-sterile and consequently little better off from the viewpoint of securing a set of fruit than large solid blocks of a single variety.

The investigations that are here reported in detail were begun by

the Horticultural Division of the Oregon Agricultural Experiment Station with an entirely different object in view than that of obtaining data on the self-fertility and inter-fertility of cherry varieties. From the start the end in view has been the working out of certain breeding problems. As the data obtained, however, seem to throw considerable light upon some of the questions regarding cherry pollination, this preliminary report of progress is made in the hope that it will be of some immediate use to cherry growers.

Investigations of 1911.

In the spring of 1911 the cherry breeding investigation, above referred to, was limited to an attempt to secure pure bred seeds of a number of varieties of the sweet cherry. Unopened flowers on trees at Corvallis and at Salem were covered with 2-pound paper bags between March 31 and April 5. The trees at Corvallis were moderately healthy, about 20 years old, and growing in the Station orchard. The soil is a heavy clay, too heavy to be considered satisfactory for the sweet cherry and none too well drained. The orchard has been under clean cultivation for many years and cover crops are grown annually. The elevation is about 250 feet. The trees at Salem were 15 to 20 years old, large for their age, healthy, and in good condition in every way. They are on the rolling and well-drained red hill land typical of the section, at an elevation of about 400 feet. The orchard has been under clean cultivation for a long time.

A few days after bagging, when the trees were in full bloom, the bags were removed and the flowers that had opened in the meantime were pollinated with their own pollen, with the aid of a camel's hair brush. The bags were then replaced to prevent insects or the wind bringing in any foreign pollen. About two weeks later the paper bags were replaced with muslin sacks to allow any cherries that might have set to develop under more normal conditions. Weather conditions during the blooming season were only fairly favorable for the setting of fruit. There was much cloudy and rainy weather, though there were some bright sunny days. Consequently the blooming season of most varieties was prolonged for three weeks or more. At the ripening season the amount of fruit set was determined, and the fruit developing on the bagged clusters gathered.

The following table presents the results of this season's work.

Table I. Results of Self-Pollination in 1911.

Variety	Location	No. flowers self-pollinated	No. cherries developed	Set
				%
Black Republican	Corvallis	732	0	0
Bing	Salem	124	0	0
Coe	Corvallis	364	0	0
Elton	Corvallis	271	1	0+
Elton	Salem	189	0	0
Knight	Corvallis	429	2	0+

Lambert	Salem	804	17	2
Napoleon	Salem	348	0	0
Rockport	Corvallis	204	1	0
Willamette	Corvallis	290	0	0
Windsor	Corvallis	964	1	0
Wood	Corvallis	229	1	0

From this table, coupled with the fact that the portions of all the trees worked upon and open to cross-pollination by insects had a good set of fruit, it would seem that all of the varieties of the sweet cherry tested are practically self-sterile. At least they failed to set fruit with their own pollen in 1911 at Salem and Corvallis. One variety, Elton, failed to set fruit at either place. In the case of Elton, Rockport, Windsor, and Wood, one cherry developed from 271, 204, 964, and 229 self-pollinated flowers, respectively; in the case of Knight, 2 cherries developed from 429 self-pollinated flowers; and 17 cherries developed from 804 self-pollinated Lambert flowers. The percentage setting in each case, however, is extremely small, so small as to be almost negligible from a practical viewpoint. It should also be stated that it was not without some hesitation that these few cherries were counted. All were undersized, as compared with the fruits that developed on other parts of the same trees, probably as the result of cross-fertilization. Furthermore, all of these cherries developed on clusters that at the time of flowering or immediately after were infested with cherry aphids. (See Plate XII. Fig. 2.) It is believed that these few fruits hung on and underwent partial development because of some stimulus given them by the aphids rather than because of any secondary effect of the pollen. Additional color is lent to this view by the fact that the seeds (or rather stones, for the stones were not cracked to see if they contained seeds) refused to germinate when placed under conditions favorable for germination. It was realized at the time that the numbers employed were rather small and that possibly the seasonal conditions were such that one would not be warranted in drawing a hard and fast conclusion regarding the self-sterility of the varieties under consideration. At the same time, the evidence presented no exceptions, other than the aphised cherries, that needed special explanation, and was, to say the least, very suggestive.

Experiments of 1912.

As the main object of the Experiment Station in this investigation has been to obtain seeds for breeding studies, it was decided to limit the work during 1912 to an effort to obtain seeds that might result from intercrossing Napoleon, Lambert, and Bing, the three varieties apparently affording the best foundation material for the breeding work. Consequently a large number of flowers of Napoleon and Lambert at both Salem and Corvallis were emasculated just before opening, covered with paper bags, and then a few days later artificially pollinated with pollen of one of the two other varieties. The pollen was collected and preserved in the ordinary manner. Though no ger-

mination tests were made, it is believed that the pollen used was representative of that produced by these varieties. Immediately after the pollen was applied, the paper bags were again tied in place; two or three weeks later they were removed and the developing cherries enclosed in muslin sacks. A large number of flowers of Lambert and Napoleon at both Salem and Corvallis were covered with sacks and later pollinated with their own pollen to test these varieties again for self-fertility. The work was carried on in the same orchards as that done the preceding season. Weather conditions were rather unfavorable for the setting of fruit, cold and rain prevailing during a part of the blooming season. There was a fair set of fruit, however, on those portions of all the trees used in the experiment where the flowers were open to cross-pollination by insects.

The following table presents the results of the pollination work of 1912.

Table II. Results of Self- and Cross-Pollinations in 1912.

Cross	Location	No. flowers self-pollinated	No. cherries developed	Set
				%
Lambert x Lambert	Corvallis	(a) 500	0	0
x Lambert	Salem	(a) 500	0	0
x Bing	Salem	(a) 500	3	1--
x Napoleon	Salem	(a) 500	0	0
Napoleon x Napoleon	Salem	(a) 500	0	0
x Napoleon	Corvallis	(a)1000	0	0
x Bing	Salem	(a) 500	1	0+
x Lambert	Salem	(a) 500	0	0

(NOTE)—(a)—approximately.

As in 1911, Lambert and Napoleon refused to set fruit when self-pollinated. Early in the season it appeared as though a few cherries would develop from self-pollinated flowers, especially on several spurs that were attacked by aphids, but they dropped off before ripening.

The results seemed to show that certain varieties of the sweet cherry are not only self-sterile, but that they are **inter-sterile.** Napoleon and Bing pollen gave no set of fruit, or practically no set of fruit, on Lambert; and Lambert and Bing pollen gave practically no set of fruit when applied to Napoleon. It is true that there were three Lambert cherries harvested from about 500 flowers and one Napoleon cherry from about 500 flowers pollinated with Bing. These, however, were undersized and were from clusters that had been infested with aphids. The question may well be raised as to whether the partial development of these three cherries was due to the Bing pollen that was used or to some kind of a stimulus given by the aphids. It may be added that the seeds (or rather stones, for the stones were not cracked to see if they enclosed seeds) of these fruits failed to germinate when planted later.

Observations of 1912.

Between June 28 and July 2, 1912, a trip was made to The Dalles to study the cherry pollination problem as it presented itself there and if possible make field observations to check on the pollinating experiments conducted at Corvallis and Salem. Mention has already been made of the kind of cherry orchards found in the state, from the viewpoint of solid or mixed plantings. In this regard the orchards at The Dalles are no exception to the general rule. Napoleon is the dominant variety of that section. Some Bings and a few Lamberts are grown in commercial quantities. Then there are smaller numbers of Black Republican, Black Tartarian, Elton, Wood, Major Francis, and a few other varieties, together with a few seedlings. The seedlings were not planted intentionally, but were mixed with the other trees as they came from the nurseries and, not being recognized, were planted with them.

The following observations were made:

(1). Napoleon, where planted in solid blocks, had a very light set of fruit, in some cases hardly enough of a set to make picking worth while.

(2). Where Napoleon and Black Republican were interplanted and both outside the radius of any appreciable influence of other varieties, both were bearing full crops.

(3). Where Napoleon and Lambert trees were interplanted and both were outside the radius of any appreciable influence of other varieties, neither was bearing a satisfactory crop.

(4). Where Napoleon and Bing were interplanted and both were outside the radius of any appreciable influence of other varieties, neither was bearing a satisfactory crop.

(5). Where Lambert or Bing trees were interplanted with Black Republican they were heavily loaded. Opportunity was not afforded, however, to see either Lambert or Bing where influenced by the pollen of Black Republican only, for there were always Napoleon trees near by; but from the fact that either Napoleon and Bing or Napoleon and Lambert when interplanted gave unsatisfactory crops, it seemed reasonable to conclude that Black Republican is a good pollenizer for both Bing and Lambert.

(6). Where Napoleon and seedling trees happened to be interplanted, and both were outside the radius of influence of other varieties, Napoleon generally had a good set of fruit, though sometimes not. No data were available as to whether or not the seedling trees that apparently did not fertilize Napoleon, bloomed at the same time.

(7). Elton was observed to be heavily loaded in all cases. Napoleon trees in the vicinity of Elton trees were heavily loaded. It was impossible, however, to form any correct estimate of the reciprocal influences of these two varieties, as Black Republican or seedling trees were invariably near them.

Conversation with Mr. Andrew Vercler, one of the commercial

cherry growers near Salem, brought out the following observations regarding the setting of fruit in his orchard: Napoleon, Bing, and Lambert trees that are standing near Black Republican trees have been especially productive. His heaviest bearing Napoleon trees are in a row of Black Republican top-grafted to Napoleon, but each tree still having one or two limbs of the stock that were either accidentally or intentionally left. Napoleon, Bing and Lambert trees standing by themselves in a part of his orchard have never borne as satisfactorily as other trees of the same varieties in other parts of the orchard, though Mr. Vercler keeps a number of swarms of bees.

Mr. M. H. Harlow, one of the cherry growers of Eugene, tells the writer that he has observed that Napoleon does not set heavily when planted in solid blocks. He has had a chance to see the relative efficiency of Black Republican, Centennial, and Waterhouse as pollenizers for Napoleon and is of the opinion that Waterhouse is the most satisfactory of the three.

The experiments and observations of this and the preceding season seem to point conclusively to two general facts: (1). Some varieties of the sweet cherry are practically self-sterile. (2). Some varieties of the cherry are much better pollenizers than others for Napoleon, Lambert, and Bing.

WORK OF THE SEASON OF 1913.

Object.

In view of the results of the cherry breeding work of 1911 and 1912, the observations on the setting of fruit in 1912, and the increasing number of inquiries from many parts of the state about causes of the failure of cherry trees to set fruit, it was decided to make as comprehensive an investigation of the subject as possible during the spring and early summer of 1913,—to obtain, if possible, a definite answer to the question: Is there Physiological Selection between Sweet Cherry Varieties? In other words are certain sweet cherry varieties **inter-sterile** as well as **self-sterile**? From a practical viewpoint it was deemed desirable to pay special attention to Napoleon, Bing and Lambert,—to determine as far as possible which varieties are inter-sterile and which are inter-fertile with them.

Plan and General Methods.

The general plan of the work of the season was to pollinate as many varieties of the sweet cherry with as many other varieties as possible. Since many of the complaints about the failure of fruit to set had come from The Dalles, it was decided to do part of the work in that vicinity, where environmental conditions are somewhat different from those in the Willamette Valley where most of the previous work had been done.

The methods of procedure were essentially the same as those employed in cross-pollination work in general. Flowers were emasculated before opening and covered with 2-pound paper bags; pollen was

applied to these emasculated flowers when the tree as a whole was in full bloom; the pollinated flowers were again covered with paper bags; about three weeks later the bags were removed and the developing fruits counted; and finally at the time of maturity the fruits were gathered and counted. Percentages of "set" are determined from those flowers that developed and ripened normal fruits, as compared with the numbers pollinated.

The Materials Employed.

The work at Corvallis was done in the Station orchard. A statement has already been made regarding the soil, and the age and condition of the trees. It may be added that weather conditions at Corvallis during the blooming season were fairly favorable for the setting of fruit. There were some cloudy and rainy days, but also a number that were warm and sunny. Twice during the blooming season the thermometer registered below 32° F. between midnight and six o'clock in the morning; but each time the orchard was smudged and the temperature about the trees kept up to or above the freezing point.

The work at The Dalles was done in the orchards of Dr. G. E. Sanders and Mr. X. M. Morgan. The soil of both orchards is a light sandy loam and in an excellent state of cultivation. The Napoleon, Bing, and Lambert trees in these orchards are about 10 years old and as nearly perfect specimens of the particular varieties as are often seen. The Black Republican and Black Tartarian trees are 15 to 20 years old. The elevation of these orchards is approximately 500 feet; the land, rolling. Weather conditions at The Dalles during blooming season were favorable. There was some cool cloudy weather, and considerable wind, but enough warm sunny days to provide for cross pollination.

Pollen of Waterhouse and Centennial that was used in this investigation was obtained from the orchards of Messrs. M. H. Harlow and F. L. Waite of Eugene.

The Germinability of the Pollen.

The pollen used in these experiments was collected in the following manner. Branches were cut from the trees just before the flowers opened; brought indoors and placed in buckets of water to force the flowers out; the stamens removed when just beginning to discharge their pollen; placed on trays in a warm bright place; when dry, the pollen was kept in a dry place in glass vials loosely stoppered with cotton. Throughout the whole course of the work there was no evidence of its fermenting or becoming moldy. Germination tests of several samples were made after all the artificial pollination in the orchard was completed, and three weeks after it was collected. Its percentage of germinability was, in each case, as high then as immediately after collecting and drying, when the first tests were made. There is no reason to believe that the pollen was not in good condition throughout the period it was being used.

The pollen was from flowers opening rather early during the blooming periods of the varieties used. The pollen tested for germinability was likewise from among the earlier flowers to open. It is possible that pollen from later opening flowers might test a little higher, or a little lower; but it is believed that the tests represent fairly closely the average germinability of the pollen of the varieties used for the season of 1913. The medium used for the germination test was a 12% solution of cane sugar.

Following is a table presenting the results of the germination tests:

Table III. Germinability of Pollen Used in 1913 Experiments.

Date	Variety	Source	No. Grains counted	No. Grains germinated	Per cent Grains germinated
					%
4-21	Bing	The Dalles	1142	373	32.66
4-21	Black Republican	The Dalles	1046	382	36.64
4-22	Black Republican	Corvallis	1158	426	37.65
4-21	Black Tartarian	The Dalles	1278	482	37.16
4-17	Centennial	Eugene	1248	483	37.94
4-14	Coe	Corvallis	939	211	22.47
4-8	Early Purple	Corvallis	796	155	19.51
4-14	Elton	Corvallis	1025	404	25.29
4-21	Gros Gobet (?)	Corvallis	1340	661	49.32
4-14	Knight	Corvallis	898	276	30.72
4-22	Lambert	Corvallis	1325	548	41.28
4-22	Lambert	The Dalles	1209	431	35.65
4-14	Lincoln	Corvallis	1534	522	34.02
4-22	Major Francis	Corvallis	1130	430	38.05
4-22	May Duke	Corvallis	1043	460	44.10
4-22	Napoleon	Corvallis	1107	369	35.14
4-21	Napoleon	The Dalles	1294	449	42.43
4-14	Rockport	Corvallis	990	325	30.45
4-15	Waterhouse	Eugene	1235	490	39.64
4-14	Willamette	Corvallis	1046	300	28.68
4-22	Windsor	Corvallis	1183	497	42.71
4-14	Wood	Corvallis	1395	386	27.60

It will be noted from this table that the germinability of the pollen varied from 19% to 50% in the different varieties, for the most part ranging between 25% and 45%. It is evident that the failure of the pollen of certain varieties to give a satisfactory set of fruit when applied to the stigmas of those varieties or of certain other varieties cannot be entirely attributed to a lack of germinability of the pollen itself. Attention is called to the fact that the tests show little difference in the germinability of pollen of Napoleon, Lambert, and Black Republican obtained from Corvallis and that of the same varieties obtained from The Dalles. The differences that appear are such as might be due to experimental error.

What Constitutes a Normal Set of Fruit for the Sweet Cherry.

It is a fact well known to every fruit grower that all the flowers

that fruit trees produce in the spring will not set fruit. A certain percentage of the flowers, and usually of the young developing fruits, are expected to "drop." This dropping of flowers and young fruits is apparently one of the normal processes of the tree. From a practical point of view it is very desirable; for did it not occur a large amount of artificial thinning would be required to prevent trees that bloom heavily from overbearing, and from all the evils incident to overbearing. The problem of securing a **proper** set of fruit, then, is not to get all the flowers to develop fruits, but to get a certain correct percentage to do so. What is this correct percentage? Manifestly, this depends upon a number of factors. The age, vigor, and general condition of the tree; the available food and moisture supply in the soil; the relative lightness or heaviness of bloom; the purpose for which the fruit is being grown—size or number of fruits—are all important considerations. Fletcher (*) makes the statement that from 4,725 flowers counted in the spring of 1899 at Ithaca, N. Y., only 617 fruits developed and these made what would be considered a good crop. This is approximately a 13% set, or one out of every eight flowers. The counts included apples, pears, plums, and apricots, and may presumably be taken as averages for those fruits.

As the fruiting habit of the cherry is somewhat different from that of the fruits just mentioned, it seems reasonable to suppose that its normal drop may also be different. To determine approximately what percentage of the flowers constitutes a normal set of fruit in several of our varieties of the sweet cherry, counts were made of the flowers on certain limbs at blooming time and later counts made of the fruits that set from them. These counts of the "fruits set" were made from three to four weeks after the flowers were counted. (See Plate III. Figs. 1 and 2.) Unfortunately, the labels were removed from the limbs at that time, it being assumed that most of the cherries counted as "set" then would reach full maturity. A little later, however, it became evident that a number of fruits previously considered as "set" would soon drop off. They were turning yellow, shriveling a little and their attachment with the fruit spur was becoming weakened. (See Plates IV and V.) Consequently between June 1 and 13 counts were made of the cherries that had **apparently** set on certain limbs. At picking time counts were again made of the number of fruits on these limbs that had reached full maturity. From these two figures the per cent of this **later drop** is readily determined. The percentage of the **apparently** set fruit surviving this later drop multiplied by the per cent first counted as **apparently** set gives the percentage of flowers that actually matured fruits, or in other words the **normal** set for this season. Opportunity was not afforded to determine exactly the amount of this **later drop** of the several varieties at The Dalles, nor of its amount in the case of Early Purple, Gros Gobet (?), and Major Francis at Corvallis. It may be stated, however, that at The Dalles the amount

(*). Fletcher, Pollination in Orchards, Bul. No. 181 Cornell Exp. Sta. p. 241. (1900).

of this drop on Bing, Lambert, and Napoleon was so small as to be practically negligible; on Black Republican it very appreciably thinned the fruit. On Early Purple, Gros Gobet (?), and Major Francis at Corvallis it was relatively slight. These statements explain the significance of the words "nearly" and the question mark (?) in Table IV.

No attempt is here made to explain the cause or causes of this late drop or "June drop"; for apparently it corresponds with the so-called "June drop" of apples and pears. It is simply recorded as one of the apparent characteristics of certain varieties of cherries. Plates II and III show a portion of a branch of Black Republican, most of whose fruits are about to fall off from this "June drop." In fact there is only one fruit that is not affected by it. Plate III shows that the seeds, before the fruit falls, shrivel up within the stone. That the "June drop" is an important factor in determining the relative size of the crop harvested in the case of certain varieties is clearly brought out by Table IV.

Table IV. Normal Set of Fruit Among Sweet Cherry Varieties in 1913.

Variety	Location	Flowers counted.	Cherries apparently set three weeks after blooming.	Per cent apparently set three weeks after blooming.	Developing cherries counted June 1-13.	Number of developing cherries that matured.	Per cent of developing cherries that matured	Calculated per cent of flowers that matured cherries.	Estimated per cent of full crop borne by the tree.
				%			%	%	%
Bing	The Dalles	913	171	19	.....	.....	.....	(n)19	70
Blk. Rep.	The Dalles	520	397	76	.....	.....	.....	(?)76	90
Blk. Rep.	Corvallis	778	252	32	169	73	43	14	50
Blk. Tar.	The Dalles	646	454	70	.....	.....	.....	(?)70	100
Coe	Corvallis	999	409	41	160	41	26	11	50
Early Purple	Corvallis	1035	383	37	.....	.....	.....	(n)37	30
Elton	Corvallis	782	347	44	276	244	88	39	60
Gros Gobet (?)	Corvallis	1224	238	19	.....	.....	.....	(n)19	50
Knight	Corvallis	943	274	29	184	131	71	21	60
Lambert	Corvallis	873	162	19	207	189	91	17	50
Lambert	The Dalles	672	179	27	.....	.....	.....	(n)27	75
Lincoln	Corvallis	652	124	19	160	72	45	8	20
Maj. Francis	Corvallis	978	169	17	.....	.....	.....	(n)17	30
Maye Duke	Corvallis	1082	88	8	103	90	87	7	60
Napoleon	Corvallis	893	205	23	308	168	54	13	60
Napoleon	The Dalles	1125	278	25	.....	.....	.....	(n)25	60
Rockport	Corvallis	1008	376	37	190	143	75	28	100
Willamette	Corvallis	1022	556	54	177	160	90	49	90
Windsor	Corvallis	1074	193	18	64	43	69	12	25
Wood	Corvallis	387	139	36	170	134	79	28	100

NOTE:—n—nearly.

The figures in the tenth column of the preceding table give the writer's estimates of the percentage of a full crop borne by the trees of the varieties involved in the test. Estimates are given in round numbers purposely. What constitutes a full crop is always a matter of judgment, consequently the figures are to be regarded only as approximate. As the computations made in later tables with these figures taken as a basis would not be materially changed if they all ranged a little higher or a little lower, closer estimates would be of no particular value. It should be stated in passing that the counts were made on average limbs whose flowers were open to cross pollination by insects.

It appears from this table that in 1913 the normal set of fruit among sweet cherry varieties varied from 7 to 49 per cent of the flowers. (The figures for Black Republican and Black Tartarian are not taken into account here because no estimate of their "June drop" is available.) The size of the crop varied from what was estimated as 20 per cent of a full crop to a full crop. Wood and Rockport, which each bore full crops had a 28 per cent set. It would have taken a nearly 60 per cent set on the Elton to give a full crop. On the other hand it would have taken only about a 12 per cent set on the May Duke to afford a full crop. To the extent that these figures represent average conditions, they indicate that while it is sometimes necessary for about every other flower to "set," one out of every four to eight will usually give satisfactory crops.

RESULTS OF THE EXPERIMENTS CONDUCTED IN 1913.

To What Extent are our Varieties of the Sweet Cherry Self-Sterile?

Though the investigations and observations of the two preceding seasons seemed to indicate clearly that many of our sweet cherry varieties are self-sterile, it was considered desirable to test again as many varieties as possible for self-fertility. Consequently two-pound paper sacks were tied over unopened and unemasculated flower clusters on trees at Corvallis, Eugene, and The Dalles. Large muslin sacks about three feet wide and six feet long were also placed over limbs on each of the varieties worked with at Corvallis and at The Dalles just before the flowers started to open. These sacks, both paper and muslin, were left in place until after the flowering season was past, when they were removed and the branches or spurs properly labeled. Counts were then made of the number of flowers that had been enclosed, (estimates in the case of limbs enclosed in muslin sacks), the number of developing fruits regarded as "set" and of others regarded as doubtful. At the ripening season the matured cherries were gathered and counted. The following table (No. V) presents the results of these self-fertility tests. (See also Plate II. Figs. 1 and 2.)

Table No. V. Self-Sterility in Sweet Cherry Varieties.

Variety	Location	No.sks	No.flowers	Cherries apparently set May 7-17.	Additional cherries counted as doubtful May 7-17.	Cherries gathered.	Per cent set.
							%
Bing	The Dalles	(m) 1	(est.) 800	7	.....	9	1
Black Republican	The Dalles	(m) 1	(est.) 800	33	.....	21	3
Black Republican	Corvallis	(m) 1	(est.) 1000	2	16	0	0
Black Republican	Corvallis	9	545	0	5	0	0
Black Republican	The Dalles	8	200	0	.....	0	0
Black Tartarian	The Dalles	8	174	0	7	0	0
Black Tartarian	The Dalles	(m) 1	(est.) 1500	27	.....	11	1
Coe	Corvallis	12	501	5	6	0	0
Coe	Corvallis	(m) 1	(est.) 1500	0	16	2	0
Early Purple	Corvallis	30	1398	81	.....	0	0
Early Purple	Corvallis	(m) 1	(est.) 1250	3	.....	0	0
Elton	Corvallis	(m) 1	(est.) 500	0	(a) 2	0	0
Elton	Corvallis	6	209	0	2	0	0
Knight	Corvallis	21	581	2	2	0	0
Knight	Corvallis	(m) 1	(est.) 800	0	(a) 14	0	0
Lambert	The Dalles	8	322	17	.....	(a)1	0
Lambert	The Dalles	(m) 1	(est.) 1000	6	.....	1	0
Lambert	Corvallis	4	53	0	3	0	0
Lambert	Corvallis	(m) 1	(est.) 1000	0	15	5	0
Lincoln	Corvallis	(m) 1	(est.) 1500	0	106	1	0
Lincoln	Corvallis	8	452	167	.....	0	0
Major Francis	Corvallis	(m) 1	(est.) 1000	0	(a) 5	0	0
May Duke	Corvallis	(m) 1	(est.) 1000	6	.....	6	1
May Duke	Corvallis	2	81	0	.....	0	0
Napoleon	Corvallis	10	386	0	(a) 5	0	0
Napoleon	Corvallis	(m) 1	(est.) 1000	0	.....	0	0
Napoleon	The Dalles	8	501	1	.....	0	0
Napoleon	The Dalles	(m) 1	(est.) 2000	0	11	24	1
Rockport	Corvallis	(m) 1	(est.) 1000	1	4	1	0
Rockport	Corvallis	9	308	8	.....	0	0
Waterhouse	Eugene	5	(est.) 250	.....	.....	0	0
Willamette	Corvallis	(m) 1	(est.) 1500	0	6	0	0
Willamette	Corvallis	9	845	0	(a) 8	0	0
Windsor	Corvallis	(m) 1	(est.) 1000	0	(a) 3	0	0
Wood	The Dalles	(m) 1	(est.) 500	11	.....	11	2
Wood	Corvallis	(m) 1	(est.) 500	1	.....	0	0
Wood	Corvallis	13	286	137	.....	0	0

(NOTE)—(m)—Muslin; (est.)—Estimated; (a)—Aphis present.

A glance at the last column of this table giving the per cent of flowers setting fruit when self-pollinated, shows that all of the varieties considered are practically self-sterile. Three per cent was the highest "set" obtained, and this was in one of the large muslin sacks. It will be noted that all of the cherries obtained in this test (with the

exception of a single Lambert at The Dalles) were from the muslin sacks. The number of flowers enclosed within paper sacks was certainly large enough and the conditions within these sacks near enough normal to insure the setting of some fruit if any of the varieties considered are self-fertile. Yet fruit did not set within the paper sacks. Pollen of some other variety was probably deposited on all of the large muslin sacks sometime during the course of the blooming season by wind, insects, or some other agent; and though the muslin was of a rather fine weave it would be easily possible for a few grains to get through and fall on some of the exposed stigmas within the sacks. It is believed that accidental cross-pollination of this sort is one of the probable explanations of the very light set of fruit secured within some of the large muslin sacks. If such an assumption is correct, the evidence presented by the table to show self-sterility becomes still stronger. Even without such an assumption to explain the apparent setting of a few fruits without cross-pollination, seven of the 17 varieties tried give evidence of being completely self-sterile and the other ten are so nearly so as to be placed in the self-sterile list for the commercial grower. Certainly the experiments of this season coupled with the experiments and observations of the two preceding seasons warrant the conclusion, first, that the sweet cherry varieties commonly grown in the northwest are self-sterile; and, second, that if there be any exception to this consideration such an exception is negligible from a practical point of view.

It should be noted in passing that this self-sterility is not due to any inherent weakness of either ovaries or pollen grains; for tables already presented show that each of the varieties considered produces a certain percentage of ovaries that are capable of developing into fruits when conditions are favorable and that each of them produces germinable pollen. Not only is the pollen of each of these varieties germinable, but it is capable of causing a set of fruit when used on the right variety. (See Table No. VI.)

To What Extent Are Our Varieties of the Sweet Cherry Inter-Sterile?

The work of 1911 and 1912 suggested that our sweet cherry varieties are **self-sterile**; the work of 1912 seemed to indicate also that at least certain of them are **inter-sterile**. So far as the writer is aware, no one has called attention to cases of the inter-sterility of cherry varieties. Consequently it seemed desirable to put a number of varieties of the sweet cherry to the test in order to determine definitely whether or not inter-sterility is a factor in cherry growing.

The following table (No. VI) presents the results of the cross-pollination work of the season.

Table No. VI. Showing Results of Cross-Pollination of Cherries, 1913.

Cross	Location	No. sacks.	No. Flowers Pollinated.	Cherries apparently set May 7-17.	Additional Cherries counted as doubtful	Cherries gathered.	Per cent set.
							%
Bing x Wood	The Dalles	5	198	17	.....	14	7
Bing x Knight	The Dalles	7	193	15	.....	16	8
Bing x Waterhouse	The Dalles	5	157	28	.....	26	17
Bing x Coe	The Dalles	5	181	51	.....	51	28
Bing x Napoleon	The Dalles	5	163	0	1	0	0
Bing x Black Republican (Corvallis)1	The Dalles	5	216	53	.....	54	25
Bing x Black Republican (The Dalles)1	The Dalles	5	156	39	.....	38	24
Bing x Lambert	The Dalles	5	250	1	.....	1	0
Bing x May Duke	The Dalles	5	275	6	.....	6	2
Bing x Windsor	The Dalles	4	148	18	.....	17	11
Bing x Willamette	The Dalles	5	225	33	.....	30	13
Bing x Black Tartarian	The Dalles	5	138	54	.....	59	43
Bing x Elton	The Dalles	6	196	24	.....	22	11
Bing x Rockport	The Dalles	6	227	52	.....	52	23
Bing x Lincoln	The Dalles	5	151	14	.....	12	8
Black Republican x Lambert	The Dalles	5	145	0	.....	0	0
Black Republican x Lambert	Corvallis	10	140	44	.....	22	16
Black Repub. x Napoleon	Corvallis	10	389	38	(a) 16	29	7
Black Repub. x Napoleon	The Dalles	13	569	230	.....	199	33
Black Repub. x Royal Ann	The Dalles	2	62	9	.....	14	23
Black Repub. x Elton	The Dalles	4	200	68	.....	69	34
Black Repub. x Elton	Corvallis	7	147	0	(a) 3	1	1
Black Repub. x Rockport	Corvallis	6	177	0	1	0	0
Black Repub. x Early Purple	Corvallis	5	74	0	(a) 3	0	0
Black Repub. x Lincoln	Corvallis	7	200	9	(a) 10	2	1
Black Repub. x Knight	Corvallis	6	61	0	.....	0	0
Black Repub. x Knight	The Dalles	6	233	71	.....	68	29
Black Repub. x Windsor	The Dalles	5	150	67	.....	68	45
Black Tartarian x Bing	The Dalles	8	112	15	.....	6	5
Black Tartar. x Lambert	The Dalles	8	122	43	.....	36	30
Black Tartar. x Napoleon	The Dalles	9	180	48	.....	37	21
Coe x Black Republican	Corvallis	6	181	3	(a) 1	2	1
Coe x Lambert	Corvallis	7	173	2	(a) 2	2	1
Coe x Napoleon	Corvallis	7	228	2	(a) 2	2	1
Early Purple x Blk. Repub.	Corvallis	28	372	48	.....	17	5
Early Purple x Lambert	Corvallis	18	192	22	.....	9	5
Early Purple x Napoleon	Corvallis	36	424	65	.....	32	8
Early Purple x Lincoln	Corvallis	24	624	32	.....	14	2

1. Indicating the source of the pollen.
(a). Aphids present.

Table No. VI Continued.

Elton x Lambert	Corvallis	7	226	0	1	0	0
Elton x Black Republican	Corvallis	13	423	38	.....	34	8
Elton x Napoleon	Corvallis	9	181	8	(a) 5	6	3
Lambert x Early Purple	Corvallis	4	108	19	3	23	21
Lambert x Early Purple	The Dalles	7	166	33	.....	25	15
Lambert x Bing	The Dalles	7	258	3	.....	2	1
Lambert x Knight	The Dalles	6	109	28	.....	22	20
Lambert x Knight	Corvallis	4	116	0	.....	0	0
Lambert x Major Francis	Corvallis	4	84	5	1	5	6
Lambert x Major Francis	The Dalles	6	193	59	.....	59	31
Lambert x Coe	The Dalles	6	210	92	.....	96	46
Lambert x Coe	Corvallis	5	214	17	1	23	11
Lambert x Elton	Corvallis	3	126	18	4	21	17
Lambert x Elton	The Dalles	6	81	45	.....	45	55
Lambert x Windsor	The Dalles	4	48	17	.....	17	35
Lambert x Napoleon	The Dalles	11	224	2	2	0	0
Lambert x Napoleon	Corvallis	4	149	0	.....	0	0
Lambert x Black Republican	Corvallis	5	149	28	1	28	19
Lambert x Black Republican	The Dalles	6	183	41	.....	36	20
Lambert x Rockport	The Dalles	8	223	51	(a) 6	45	20
Lambert x Rockport	Corvallis	3	85	7	1	10	12
Lambert x Lincoln	Corvallis	3	123	3	1	2	2
Lambert x Lincoln	The Dalles	8	161	52	.....	44	27
Lambert x Willamette	The Dalles	6	94	30	.....	22	23
Lambert x Willamette	Corvallis	4	110	17	.....	12	11
Lambert x May Duke	Corvallis	4	124	14	1	17	14
Lambert x May Duke	The Dalles	5	134	5	.....	5	4
Lambert x Black Tartarian	The Dalles	5	156	78	.....	74	47
Lambert x Waterhouse	The Dalles	7	188	112	.....	107	57
Lambert x Napoleon	The Dalles	2	75	1	.....	1	1
Lambert x Waterhouse	Corvallis	5	218	37	4	39	18
Lambert x Gros Gobet (?)	Corvallis	4	74	1	(a) 6	4	6
Lambert x Centennial	Corvallis	3	129	18	.....	15	12
Knight x Napoleon	Corvallis	8	180	1	.....	1	1
Knight x Black Republican	Corvallis	6	254	15	(a) 7	15	6
Kuight x Lincoln	Corvallis	13	206	31	(a) 8	31	15
Knight x Elton	Corvallis	5	113	0	(a) 2	0	0
Knight x May Duke	Corvallis	8	105	0	1	0	0
Knight x Lambert	Corvallis	11	147	0	(a) 23	1	1
Lincolu x Wood	Corvallis	7	186	4	2	3	2
Lincoln x Black Republicau	Corvallis	5	151	0	3	2	1
Lincoln x Napoleon	Corvallis	11	297	3	(a) 10	2	1
May Duke x Lambert	Corvallis	3	169	2	(a) 2	3	2
May Duke x Napoleon	Corvallis	2	69	0	.....	0	0
Napoleon x Black Tartarian	The Dalles	5	200	24	.....	22	11
Napoleon x Black Republican	The Dalles	3	122	10	.....	8	7
Napoleon x Black Republican	The Dalles	8	231	27	.....	24	10
Napoleon x Black Republican	Corvallis	7	75	7	1	7	10
Napoleon x Elton	Corvallis	5	98	2	.....	3	3
Napoleon x Elton	The Dalles	6	205	29	.....	25	12

(a). Aphids present,

Table No. VI Continued.

Napoleon x Coe	The Dalles	7	246	28		25	10
Napoleon x Coe	Corvallis	5	79	6		5	6
Napoleon x Knight	Corvallis	5	124	0		0	0
Napoleon x Knight	The Dalles	5	186	4		4	2
Napoleon x Bing	The Dalles	6	277	0		0	0
Napoleon x Windsor	The Dalles	6	240	15		8	3
Napoleon x Windsor	Corvallis	4	78	6		6	8
Napoleon x Lambert	Corvallis	4	77	0		0	0
Napoleon x Lambert	The Dalles	7	214	0		0	0
Napoleon x Early Purple	The Dalles	6	196	52		51	26
Napoleon x Early Purple	Corvallis	4	99	6		5	5
Napoleon x Major Francis	Corvallis	5	110	1		1	1
Napoleon x Wood	Corvallis	5	97	14		11	11
Napoleon x Wood	The Dalles	7	261	44		48	16
Napoleon x May Duke	The Dalles	7	291	7		5	2
Napoleon x May Duke	Corvallis	4	31	0		0	0
Napoleon x Willamette	Corvallis	5	76	9		6	8
Napoleon x Willamette	The Dalles	5	262	29		29	11
Napoleon x Rockport	The Dalles	5	156	47		46	29
Napoleon x Rockport	Corvallis	4	72	1		1	1
Napoleon x Lincoln	Corvallis	5	66	2		0	0
Napoleon x Gros Gobet (?)	Corvallis	6	157	6		5	3
Napoleon x Centennial	Corvallis	6	83	5		4	5
Napoleon x Waterhouse	Corvallis	5	141	18		15	11
Napoleon x Waterhouse	The Dalles	6	239	31		28	12
Napoleon x Mazzard (?)	The Dalles	5	178	32		30	17
Rockport x Black Republican	Corvallis	12	314	110		66	21
Rockport x Napoleon	Corvallis	10	299	62		25	8
Rockport x Lambert	Corvallis	7	197	85		69	35
Rockport x Willamette	Corvallis	9	222	54		38	17
Willamette x Lambert	Corvallis	6	171	10		5	3
Willamette x May Duke	Corvallis	1	25	0	(a) 3	0	0
Willamette x Napoleon	Corvallis	7	157	9	(a) 1	9	6
Willamette x Wood	Corvallis	6	189	31		23	12
Willamette x Blk. Republican	Corvallis	7	169	0	(a) 5	0	0
Wood x Black Republican	Corvallis	13	236	82		27	11
Wood x Lambert	Corvallis	11	276	65		29	10
Wood x Lincoln	Corvallis	6	120	37		18	15
Wood x Napoleon	Corvallis	12	211	55		28	13

(a). Aphids present.

After it has been suggested that the purpose of the preceding table is to afford at least a partial answer to the question of the existence or non-existence of inter-sterility among sweet cherry varieties, probably the first impression gained from a mere glance at it is that of its incompleteness, of the fragmentary nature of the data presented It is freely acknowledged that it is far from being as complete as might be wished. Crosses were made on but 15 varieties; but 19 kinds of pollen were used; and only a small part of the possible combinations between these 15 kinds of female and 19 kinds of male parents were

made. Furthermore, the numbers of each particular cross are smaller, some of them much smaller, than might be desired. In such work it is only from the averages of large numbers that error is eliminated and accurate conclusions may be drawn. Particular crosses numbered by the thousands would be far more satisfactory than the same crosses numbered by the hundreds. The fact that a cross of one particular kind numbers much higher than that of another kind (for instance at The Dalles Lambert x Elton numbered 81, Lambert x Bing 258) renders the percentages of "set" obtained of an unequal degree of reliability. With 11 of the varieties, only a few combinations were made; a much larger number were made with the other four—Bing, Black Republican, Lambert and Napoleon. The larger number made with these four—58 out of a total of 95—was because of their commercial importance. In spite of these and other limitations and shortcomings of the table, however, it is believed that results sufficiently definite and clear-cut are presented to be worthy of careful consideration.

Bing.

Attention is first directed to the per cent set of fruit obtained on Bing. Lambert and Napoleon pollen failed to give any fruit at all. (See Plate X. Fig. 1.) The pollen of the other varieties tried gave some fruit, the percentages varying from two in the case of May Duke to 43 in the case of Black Tartarian. Between these two extremes many different percentages were obtained. Probably little or no significance is to be attached to the minor differences shown in this table. For instance, while Willamette pollen is shown as giving a slightly better set of fruit than Windsor, the difference is so small as to be negligible. Had a much larger number of flowers been pollinated with these two kinds of pollen, the figures might be reversed. In other words the figures should be considered as affording a qualitative rather than a quantitative indication of the value of the several varieties as pollenizers for Bing. Viewing them in that manner, Black Tartarian, Coe, Black Republican, and Rockport may be placed together in a group as strong pollenizers for Bing. (See Plate IX. Fig. 2 and Plate XI. Fig. 1.) May Duke, Wood, Knight, and Lincoln constitute a group that proved weak pollenizers. (See Plate XI. Fig. 2.) Waterhouse, Willamette, Elton, and Windsor form a third group that are fair or medium. (See Plate X. Fig. 2.) Further trial might shift one of the varieties thus classed to an adjacent group; but it would not be likely to place one of the poor in the class of good pollenizers, or conversely place one of the good in the group of poor pollenizers. Attention is here called to the fact that these differences in per cents of "set" obtained cannot be attributed to differences in the apparent viability of pollen used. As has already been shown, all of the varieties investigated produce a moderately high percentage of germinable pollen. (See Plate XII. Fig. 1.) Enough pollen was applied to each stigma to insure its receiving some germinable grains. Furthermore, pollen of the same kinds and from the same vials was applied to the stigmas

of other varieties on the same or on following or preceding days and on certain varieties gave a good "set" of fruit.

Lambert.

In the case of Lambert we again have a certain variety of pollen, Napoleon, good in itself, failing to give any set of fruit. Bing pollen is next to useless for Lambert, giving less than a one per cent set of fruit. The varieties that proved strong pollenizers for Lambert at both The Dalles and Corvallis are Black Republican, Waterhouse and Elton. Black Tartarian or Windsor pollen was not tried on Lambert at Corvallis, but both gave excellent results at The Dalles. Coe, Major Francis, Lincoln, Willamette, Rockport, Early Purple, and Knight are varieties that gave good results at The Dalles but less satisfactory results at Corvallis. From the viewpoint of the Willamette Valley grower, at least, it would seem that they must be regarded as only fairly satisfactory, and several of them rather poor.

The Gros Gobet (Syn. Short Stemmed Montmorency) gave a small set of fruit on Lambert at Corvallis. The writer is not certain of the identification of the variety; but it is included here because, whether Gros Gobet or one of the several very closely related varieties, or one of their unnamed seedlings, it shows that at least some of the sweet cherry varieties will set fruit when pollinated by the sour cherry (P. cerasus).

Napoleon.

The table shows that Napoleon refused to set fruit with Bing, Lambert, or Lincoln pollen, Lambert being tried on it at both Corvallis and The Dalles. (See Plate VI. Figs. 1 and 2.) It averaged a lower set at both places than Lambert and some of the other varieties, suggesting that possibly a lower percentage of its ovaries are capable of being stimulated into further growth and subsequent development into fruits. Black Republican, Waterhouse, and Wood gave the best results as pollenizers, considering the average of both places. (See Plate VII. Figs. 1 and 2.) Elton, Coe, Rockport, Early Purple, and Willamette also proved very satisfactory at The Dalles, but probably are to be regarded as less satisfactory for the Willamette Valley. (See Plate VIII. Figs. 1 and 2.) May Duke, Major Francis, Windsor, and Knight constitute the varieties that appear to be poor pollenizers for Napoleon. Black Tartarian was tried on Napoleon at The Dalles and gave fairly good results there, but opportunity was not afforded to try it at Corvallis. (See Plate IX. Fig. 1.)

Attention is also called to the small set of fruit obtained on Napoleon from the use of Gros Gobet (?) pollen. Evidently the sour cherry is capable of pollinating a number of the varieties of the sweet cherry.

At The Dalles nearly 200 emasculated flowers of the Napoleon

were pollinated with Mazzard (?). (*). It will be noted that this pollen gave a good set of fruit, showing that in all probability many of the seedling trees found in and about cherry orchards are efficient pollenizers for the varieties in these orchards and that such seedlings may afford the explanation of why the orchards have been productive.

Other Varieties.

The other 12 varieties that were each pollinated with several kinds of pollen show the same general results as Bing, Lambert, and Napoleon. For instance, Black Republican at Corvallis gave no set of fruit with Rockport, Early Purple, or Knight pollen, and at The Dalles no set of fruit with Lambert pollen; Elton gave no set of fruit at Corvallis with Lambert pollen; Knight gave none with Elton or May Duke pollen; and Willamette gave none with Black Republican. At the same time these same varieties gave a good set of fruit with certain other varieties of pollen and a medium or fair set with pollen of still other kinds.

When all of the data presented are carefully considered, there seems to be very little occasion for doubting the conclusion that certain of our sweet cherry varieties are inter-sterile. Of those which are commonly grown, however, those that are completely inter-sterile are very few. That the list of completely inter-sterile varieties should include the three that probably constitute 90 per cent of our commercial plantings (and practically stop there) is as extraordinary as it is unfortunate.

Influence of the Kind of Pollen Used Upon Size of Crop.

Inspection of Table No. VI presenting the results of the cross-pollinations, shows that the set of fruit is greatly influenced by the kind of pollen available for pollinating purposes, and it is but a short step to conclude from this that the size of the crop is correspondingly influenced. That table, however, does not give a correct idea of how great this influence upon the crop is. It has already been shown (Table IV) that a full crop may often be produced by a set of 10 to 50 per cent—sometimes by a set of less than 10 per cent. A difference of 10 to 15 in per cent of set, then, between two kinds of pollen may often mean the difference in yield between a half crop and a full crop, or even between a quarter crop and full crop. To illustrate: Bing at The Dalles when pollinated with Windsor gave a 13 per cent set. The normal set for the season was 19 per cent; but 19 per cent gave 70 per cent of a full crop. Consequently the 13 per cent set given by Windsor furnished only 13/19 of a 70 per cent crop or 41 per cent of a full crop. On the other hand Black Republican pollen giving a 25 per cent set provided for 25/19 of a 70 per cent crop, or 92 per cent of a full crop. Thus a difference in per cent set of 14 in

(*). What the true Mazzard is, it is very difficult to say. Many seedlings of our ordinary varieties of the sweet cherry are called Mazzards. To distinguish many of these from seedlings of the wild Mazzard is practically impossible. The tree from which the pollen above referred to was taken, bears small, black, slightly sweet, slightly bitter, astringent cherries and is evidently the stock upon which it was thought the graft or bud had "taken."

this case meant the difference between less than half a crop and nearly a full crop.

The following table, No. VII, showing computations made from the figures given in Tables IV and VI, gives a better idea of what the per cent set obtained in this investigation with different kinds of pollen, means in terms of yield.

Table No. VII. Showing Per Cent of a Full Crop Given by Different Kinds of Pollen When Used on Different Varieties.

Cross	Location	Per cent pollicherries.	nated developing Normal set for season.	Estimated per cent of full crop borne	Per cent of estimated full crop given by the cross
		%		%	%
Bing x Wood	The Dalles	7	19	70	25
Bing x Knight	The Dalles	8	19	70	29+
Bing x Waterhouse	The Dalles	17	19	70	63
Bing x Coe	The Dalles	28	19	70	103
Bing x Napoleon	The Dalles	0	19	70	0
Bing x Black Republican (Corvallis)1	The Dalles	25	19	70	92
Bing x Black Republican (The Dalles)1	The Dalles	24	19	70	89
Bing x Lambert	The Dalles	0+	19	70	0+
Bing x May Duke	The Dalles	2	19	70	7
Bing x Windsor	The Dalles	11	19	70	41
Biug x Willamette	The Dalles	13	19	70	48
Bing x Black Tartarian	The Dalles	43	19	70	158
Bing x Elton	The Dalles	11	19	70	41
Bing x Rockport	The Dalles	23	19	70	85
Bing x Lincoln	The Dalles	8	19	70	29
Black Repub. x Lambert	The Dalles	0	76 (?)	90	0
Black Repub. x Lambert	Corvallis	16	14	50	57
Black Repub. x Napoleon	Corvallis	7	14	50	25
Black Repub. x Napoleon (Corvallis)1	The Dalles	33	76 (?)	90	39(?)
Black Repub. x Napoleon (The Dalles)1	The Dalles	23	76 (?)	90	27(?)
Black Repub. x Elton	The Dalles	34	76 (?)	90	40(?)
Black Repub. x Elton	Corvallis	1	14	50	4
Black Repub. x Rockport	Corvallis	0	14	50	0
Black Repub. x Early Purple	Corvallis	0	14	50	0
Black Repub. x Lincoln	Corvallis	1	14	50	4
Black Repub. x Knight	Corvallis	0	14	50	0
Black Repub. x Knight	The Dalles	29	76 (?)	90	34(?)
Black Repub. x Windsor	The Dalles	45	76 (?)	90	53(?)
Black Tartarian x Bing	The Dalles	5	70 (?)	100	7(?)
Black Tartarian x Lambert	The Dalles	30	70 (?)	100	43(?)
Black Tartarian x Napoleon	The Dalles	21	70 (?)	100	30(?)

Table No. VII Continued.

Coe x Black Republican	Corvallis	1	11	50	5
Coe x Lambert	Corvallis	1	11	50	5
Coe x Napoleon	Corvallis	1	11	50	5
Early Purple x Black Republican	Corvallis	5	37 (?)	30	4(?)
Early Purple x Lambert	Corvallis	5	37 (?)	30	4(?)
Early Purple x Napoleon	Corvallis	8	37 (?)	30	6(?)
Early Purple x Lincoln	Corvallis	2	37 (?)	30	2(?)
Elton x Lambert	Corvallis	0	39	60	0
Elton x Black Republican	Corvallis	8	39	60	12
Elton x Napoleon	Corvallis	3	39	60	5
Lambert x Early Purple	Corvallis	21	17	50	62
Lambert x Early Purple	The Dalles	15	27	75	42
Lambert x Bing	The Dalles	1	27	75	3
Lambert x Knight	The Dalles	20	27	75	56
Lambert x Knight	Corvallis	0	17	50	0
Lambert x Major Francis	Corvallis	6	17	50	18
Lambert x Major Francis	The Dalles	31	27	75	86
Lambert x Coe	The Dalles	46	27	75	128
Lambert x Coe	Corvallis	11	17	50	32
Lambert x Elton	Corvallis	17	17	50	50
Lambert x Elton	The Dalles	55	27	75	153
Lambert x Windsor	The Dalles	35	27	75	97
Lambert x Napoleon	The Dalles	0	27	75	0
Lambert x Napoleon	Corvallis	0	17	50	0
Lambert x Black Republican	Corvallis	19	17	50	56
Lambert x Black Republican	The Dalles	20	27	75	56
Lambert x Rockport	The Dalles	20	27	75	56
Lambert x Rockport	Corvallis	12	17	50	35
Lambert x Lincoln	Corvallis	2	17	50	6
Lambert x Lincoln	The Dalles	27	27	75	75
Lambert x Willamette	The Dalles	23	27	75	64
Lambert x Willamette	Corvallis	11	17	50	32
Lambert x May Duke	Corvallis	14	17	50	41
Lambert x May Duke	The Dalles	4	27	75	11
Lambert x Black Tartarian	The Dalles	47	27	75	131
Lambert x Napoleon (The Dalles)	The Dalles	1	27	75	3
Lambert x Waterhouse	The Dalles	57	27	75	158
Lambert x Waterhouse	Corvallis	18	17	50	52
Lambert x Gros Gobet (?)	Corvallis	6	17	50	18
Lambert x Centennial	Corvallis	12	17	50	35
Knight x Napoleon	Corvallis	1	21	60	3
Knight x Black Republican	Corvallis	6	21	60	17
Knight x Lincoln	Corvallis	15	21	60	43
Knight x Elton	Corvallis	0	21	60	0
Knight x May Duke	Corvallis	0	21	60	0
Knight x Lambert	Corvallis	1	21	60	3
Lincoln x Wood	Corvallis	2	8	20	5
Lincoln x Black Republican	Corvallis	1+	8	20	3
Lincoln x Napoleon	Corvallis	1—	8	20	2

1. Indicating the source of the pollen.

Table No. VII Continued.

May Duke x Lambert	Corvallis	2	7	60	17
May Duke x Napoleon	Corvallis	0	7	60	0
Napoleon x Black Tartarian	The Dalles	11	25	60	26
Napoleon x Black Republican (The Dalles)1	The Dalles	7	25	60	15
Napoleon x Black Republican (Corvallis)1	The Dalles	10	25	60	24
Napoleon x Black Republican	Corvallis	10	13	60	46
Napoleon x Elton	Corvallis	3	13	60	13
Napoleon x Elton	The Dalles	12	25	60	29
Napoleon x Coe	The Dalles	10	25	60	24
Napoleon x Coe	Corvallis	6	13	60	28
Napoleon x Knight	Corvallis	0	13	60	0
Napoleon x Knight	The Dalles	2	25	60	5
Napoleon x Bing	The Dalles	0	25	60	0
Napoleon x Windsor	The Dalles	3	25	60	7
Napoleon x Windsor	Corvallis	3	13	60	13
Napoleon x Lambert	Corvallis	0	13	60	0
Napoleon x Lambert	The Dalles	0	25	60	0
Napoleon x Early Purple	The Dalles	26	25	60	62
Napoleon x Early Purple	Corvallis	5	13	60	23
Napoleon x Major Francis	Corvallis	1	13	60	5
Napoleon x Wood	Corvallis	11	13	60	51
Napoleon x Wood	The Dalles	16	25	60	38
Napoleon x May Duke	The Dalles	2	25	60	5
Napoleon x May Duke	Corvallis	0	13	60	0
Napoleon x Willamette	Corvallis	8	13	60	32
Napoleon x Willamette	The Dalles	11	25	60	26
Napoleon x Rockport	The Dalles	29	25	60	70
Napoleon x Rockport	Corvallis	1	13	60	5
Napoleon x Lincoln	Corvallis	0	13	60	0
Napoleon x Gros Gobet (?)	Corvallis	3	13	60	13
Napoleon x Centennial	Corvallis	5	13	60	23
Napoleon x Waterhouse	Corvallis	11	13	60	51
Napoleon x Waterhouse	The Dalles	12	25	60	29
Napoleon x Mazzard (?)	The Dalles	17	25	60	41
Rockport x Black Republican	Corvallis	21	28	100	75
Rockport x Napoleon	Corvallis	8	28	100	29
Rockport x Lambert	Corvallis	35	28	100	125
Rockport x Willamette	Corvallis	17	28	100	61
Willamette x Lambert	Corvallis	3	49	90	6
Willamette x May Duke	Corvallis	0	49	90	0
Willamette x Napoleon	Corvallis	6	49	90	11
Willamette x Wood	Corvallis	12	49	90	22
Willamette x Black Republican	Corvallis	0	49	90	0
Wood x Black Republican	Corvallis	11	28	100	39
Wood x Lambert	Corvallis	10	28	100	36
Wood x Lincoln	Corvallis	15	28	100	54
Wood x Napoleon	Corvallis	13	28	100	46

1. Indicating the source of the pollen.

This table shows that in the case of Bing, pollination with Coe and Black Tartarian gave more than an estimated full crop; and at The Dalles Lambert pollinated with Coe, Elton, Black Tartarian, and Waterhouse gave more than an estimated full crop. In other words, if all the flowers on trees of these two varieities were to be pollinated exclusively with these kinds of pollen, the trees would be overloaded. That the set of fruit given by Black Tartarian on Bing really would overload the tree is shown by Plate IX. Fig. 2, a typical spur of that variety pollinated in the way indicated. The danger of such a thing happening in the orchard, however, is slight; for it is doubtful if all the flowers on trees with a heavy bloom are cross-pollinated, even when conditions are very favorable.

It may seem that the results from many of the cross-pollinations were unsatisfactory,—that in many cases even the apparently strong pollenizers gave too low a per cent "set,"—a "set" that would provide for only 50 to 75 per cent of an estimated full crop. It is probably true that most, if not all, of these figures given are really too low. There are a number of reasons for this. Naturally those spurs were selected for enclosing in paper bags that had the largest number of flowers. This meant less time spent in tying on and removing bags. On many of these spurs the flowers were undoubtedly so numerous that there was simply not room, even though there might be enough food material, for them to develop. Probably a larger percentage of these flowers were weak or physiologically imperfect and thus incapable of developing into fruits, even though properly pollinated, than was true of the tree as a whole. If such were the case, this factor alone would tend to make all the figures giving per cents of set range too low. All the flowers on a fruit spur do not open at the same time. Yet in this work all had to be emasculated at the same time and pollinated on the same day. Some were pollinated prematurely; i. e., before the stigmas were in a receptive state; others were over-mature at the time of pollination, their stigmas having begun to turn brown. Just what the effects are in the case of the cherry of too late or too early pollination, is not known; but without doubt these were factors that reduced to some extent the set of fruit obtained. At Corvallis especially it was noted that quite a good many stigmas had apparently gone beyond the receptive stage at the time of pollination. In experimental work of this kind where emasculation and pollination of large numbers of flowers must be done within a few days, if done at all, the ovaries, styles, and stigmas of many flowers are very apt to be injured mechanically even though all the care consistent with rapid work is exercised. Many times the ovary is scratched or cut in the process of emasculation. In tying the paper sacks over the emasculated flowers, removing them later for pollination, and then replacing them, as well as in the work with the camel's hair brush about the stigmas, some styles are almost sure to be broken. Of course some of the mechanical injuries that are very slight do not interfere with the later development of the fruit; but

the more severe injuries prevent it. Without doubt this factor materially reduced the per cent "set" obtained; how much, it is impossible to say. There is the further possibility that a few of the stigmas in some of the large flower clusters did not receive any pollen. Where a fruit spur six or eight inches long has 40 to 50 emasculated flowers it is often very difficult to tell when all have been pollinated. When all these factors are taken into consideration, it becomes evident that the set obtained within the paper sacks from the use of different kinds of pollen represents something distinctly less than what may reasonably be expected from cross-pollination of the same kind taking place in the orchard under normal orchard conditions. Consequently, it is believed that any of those pollenizers which according to the above table afford 60 or more per cent of what has been estimated as a full crop, are to be regarded as satisfactory for the variety under consideration.

The photographs of typical clusters of cross-pollinated cherries shown in Plates VII and VIII afford further evidence on the point that has just been made. According to Table No. VII these clusters represent something less than a full crop, yet they would all be regarded as excellent clusters in the commercial cherry orchard; and trees with all their bearing surface fruiting as well would be yielding heavily. Too heavy setting of fruit is as undesirable with the sweet cherry as with other fruits. Even for fruit going to the canneries higher prices are paid for the larger than for the smaller sizes.

Does Environment Influence the Setting of Cherries?

It has already been shown that the setting of cherries is greatly influenced by the kind of pollen available for pollination purposes. Study of Table No. VI reveals the further fact that the same kind of pollen often gives markedly different results when used for a certain variety at The Dalles than when used on the same variety at Corvallis. The differences in general climatic conditions are well known to those who are at all acquainted with Oregon climatology. Perhaps the most marked difference is that in humidity. The region about The Dalles averages 15 to 20 inches rainfall; the Willamette Valley 30 to 40 inches. The differences in soil, elevation, and conditions at the time of flowering between the two places have already been mentioned.

The following table, No. VIII, shows the set of fruit obtained on Black Republican, Lambert, and Napoleon at the two places when pollen of the same varieties was used.

Table No. VIII. Showing Influence of Climate on Set of Cherries.

Cross	No. Pollinated at Corvallis	No. Pollinated at The Dalles	Per cent set at Corvallis	Per cen set at The Dalles
Black Repub. x Black Repub.	545	200	0	0
Black Repub. x Lambert	140	145	16	0

Black Repub. x Napoleon	389	569	7	33
Black Repub. x Elton	147	200	1	34
Black Repub. x Knight	61	233	0	29
Average			5	19
Lambert x Lambert	53	322	0	0
Lambert x Early Purple	108	166	21	15
Lambert x Knight	116	109	0	20
Lambert x Major Francis	84	193	6	31
Lambert x Coe	214	210	11	46
Lambert x Elton	126	81	17	55
Lambert x Napoleon	149	224	0	6
Lambert x Black Republican	149	183	19	20
Lambert x Rockport	85	223	12	20
Lambert x Lincoln	123	161	2	27
Lambert x Willamette	110	94	11	23
Lambert x May Duke	124	134	14	1
Lambert x Waterhouse	218	188	18	57
Average			10	24
Napoleon x Napoleon	386	501	0	0
Napoleon x Black Republican	75	231	10	10
Napoleon x Elton	98	205	3	12
Napoleon x Coe	79	246	6	10
Napoleon x Knight	124	186	0	2
Napoleon x Windsor	78	240	3	3
Napoleon x Lambert	77	214	0	0
Napoleon x Early Purple	99	196	5	36
Napoleon x Wood	97	261	11	16
Napoleon x May Duke	31	291	0	2
Napoleon x Willamette	76	262	8	11
Napoleon x Rockport	72	156	1	29
Napoleon x Waterhouse	141	239	11	12
Average			6	10

The first thing to be noted is that the average set of fruit is higher at The Dalles than at Corvallis. It is not only higher, but much higher; and this is true of all three varieties. Attention has already been called to the fact that on the average the pistils, at the time of pollination, were not in as good condition at Corvallis as at The Dalles. So far as these three varieties are concerned, however, that statement only applies to the Black Republican. Most of the pistils of the Napoleon and Lambert were in good condition at both places at the time of pollination and with them the average set of fruit when the same kind of pollen was used was roughly estimated as two to one. It would seem that the number of flowers pollinated (of Lambert 1660 at Corvallis and 2288 at The Dalles; of Napoleon 1433 at Corvallis and 3228 at The Dalles) was large enough to make the results obtained suggestive. This difference in the set of fruit cannot be attributed

to any differences in the pollen, for pollen collected at Corvallis was used at both places. There is no other interpretation to be placed upon these facts than to conclude that the environmental conditions at The Dalles were more favorable this last season (1913) than those at Corvallis for the "setting" of cherries. Another season the figures might be reversed; but then the season would be different.

Comparison of the set of fruit obtained with particular kinds of pollen tends to verify the conclusion reached from comparison of the averages. In every case but three out of the 31 given, the per cent set at The Dalles was as high as that at Corvallis, or higher. One of these three exceptions, however, is interesting. Lambert pollen gave no set of fruit on Black Republican at The Dalles but gave a 16 per cent set at Corvallis. Conversely, Knight pollen gave no set of fruit on Lambert at Corvallis, but gave a 20 per cent set at The Dalles. Does this mean that two varieties may be inter-sterile under one set of conditions and inter-fertile under entirely different conditions? The figures suggest that such may possibly be the case; but the numbers employed are too small and the number of instances too few to warrant arriving at any definite answer to the question. It may not be out of place in this connection, however, to call attention to two facts; first, Prof. E. J. Kraus has found at this Experiment Station that varieties of pomaceous fruits that are considered self-sterile in some of the eastern states are at least partially self-fertile in Oregon; and second, that differences between environmental conditions at The Dalles, and Corvallis, Oregon, though less than 200 miles apart, are greater than those between many of the eastern states and western Oregon.

May a Particular Cross be a Failure and its Reciprocal Prove Successful?

Since it has been shown that certain varieties refuse to set fruit when pollinated with certain other varieties, the question naturally arises as to whether or not the flowers of these poor pollenizers (poor for the variety or varieties considered) will in turn refuse to set fruit when pollinated by the varieties that they themselves cannot cause to develop fruits. At first thought, it might seem that if any particular cross showed the existence of variety inter-sterility the reciprocal of the same cross would show the same condition. The following table, No. IX, arranges certain of the figures given in Table No. VI in such a way as to bring out the evidence that is available on this question.

As might be expected, this table shows that but few of the crosses gave exactly the same per cent "set" of fruit as their reciprocals. Seventeen of the 31 reciprocal crosses agreed closely enough in their per cent "set" to attribute any differences between them to chance or experimental error. With the other pairs of crosses, however, the differences seem to be too large to be explained in that way. For instance, if Rockport is actually as good a pollenizer for Black Republican as Black Republican is for Rockport, it is difficult to see why none of the 177 flowers thus pollinated should set fruit while the 314 Rock-

port flowers pollinated with Black Republican should yield 66 cherries or a set of 21 per cent. It is realized that only limited data are available and that definite conclusions should not be drawn from a single season's work; but the facts here presented at least suggest that two cherry varieties may be quite inter-sterile when crossed one way and more or less inter-fertile when the reciprocal cross is made.

Table No. IX. Showing Results from Reciprocal Crosses.

Cross	Location	No. flowers pollinated	No. flowers of the reciprocal cross-pollinated.	Per cent set.	Per cent set of reciprocal cross
				%	%
Bing x Napoleon	The Dalles	163	277	0	0
Bing x Lambert	The Dalles	250	258	0	1
Blk. Repub. x Lambert	The Dalles	145	183	0	36
Blk. Repub. x Lambert	Corvallis	140	149	16	19
Blk. Repub. x Napoleon	Corvallis	389	75	7	10
Blk. Repub. x Napoleon	The Dalles	569	231	33	10
Blk. Repub. x Elton	Corvallis	147	423	1	8
Blk. Repub. x Rockport	Corvallis	177	314	0	21
Blk. Repub. x Early Purple	Corvallis	74	372	0	5
Blk. Repub. x Lincoln	Corvallis	200	151	1	1
Blk. Repub. x Knight	Corvallis	61	254	0	6
Blk. Tartarian x Lambert	The Dalles	122	156	30	47
Blk. Tartarian x Napoleon	The Dalles	180	200	21	11
Coe x Lambert	Corvallis	173	214	1	11
Coe x Napoleon	Corvallis	228	79	1	6
Early Purple x Lambert	Corvallis	192	108	5	21
Early Purple x Napoleon	Corvallis	424	99	8	5
Elton x Lambert	Corvallis	226	126	0	17
Elton x Napoleon	Corvallis	181	98	3	3
Knight x Lambert	Corvallis	147	116	1	0
Knight x Napoleon	Corvallis	180	124	1	0
Lambert x Napoleon	Corvallis	149	77	0	0
Lambert x Napoleon	The Dalles	224	214	0	0
Lambert x Rockport	Corvallis	85	197	12	55
Lambert x Willamette	Corvallis	110	171	11	3
Lambert x May Duke	Corvallis	124	169	14	2
Lincoln x Napoleon	Corvallis	297	66	1	0
May Duke x Napoleon	Corvallis	69	31	0	0
Napoleon x Wood	Corvallis	97	211	11	13
Napoleon x Willamette	Corvallis	76	157	8	6
Napoleon x Rockport	Corvallis	72	299	1	8

Is Inter-Sterility Limited to Closely Related Varieties?

Self-sterility in orchard fruits is usually attributed to nature's supposed abhorrence of inbreeding, self-fertilization resulting in the closest kind of inbreeding. If this is the true explanation of self-sterility (the writer is not stating that it is) closeness of lines of descent, blood relationship, at once suggests itself as a possible explanation of cases of variety inter-sterility. Unfortunately the pedigree is not known of any of our varieties of the sweet cherry. The immediate pa-

rentage on both sides is known of but a very few varieties and the parentage on a single side of but comparatively few more. Parentage of the second preceding generation is known in but extremely few cases. Consequently a complete answer cannot be given to the question, "Is inter-sterility of cherry varieties limited to those closely related by lines of descent?"

The following statements may be made, however, concerning the varieties discussed in this paper. Bing is a seedling of Black Republican which in turn is a seedling of Black Eagle. Lincoln is likewise supposed to be a seedling of Black Eagle. Bing and Black Republican are inter-fertile—at least Bing gives a good set of fruit when pollinated with Black Republican. Here is a case of a variety and its parent being inter-fertile. Black Republican and Lincoln are inter-fertile to a slight degree, though both are seedlings of Black Eagle. Willamette and Centennial are known seedlings of Napoleon and there is good reason for believing that Waterhouse is also a Napoleon seedling. All these varieties are capable of pollinating Napoleon and giving a fair set of fruit, Waterhouse being a very good pollenizer for it. Reciprocally Napoleon pollen is capable of giving a moderate set of fruit on Willamette, and field observations lead the writer to believe that it is an excellent pollenizer for Waterhouse. Napoleon and Bing are inter-sterile; yet the two seedlings of Napoleon, Waterhouse and Willamette, are good pollenizers for that variety. Black Republican, belonging to the same line of descent as Bing, is quite different from that variety in its relationship with Napoleon. Lambert probably belongs to still another line of descent, though its parentage is unknown. Lambert and Napoleon are inter-sterile; but Willamette is a fair and Centennial and Waterhouse are very good pollenizers for Lambert. Other illustrations of these peculiarities of physiological selection might be given. There is only one conclusion that can be reached in answer to the question that has been raised, and that is negative. Inter-sterility among the sweet cherry varieties studied is not correlated with the closeness of their relationship.

May the Royal Ann Type Ever be Self-Sterile?

This question may seem superfluous. It is, however, an entirely different question from those that have been thus far discussed. Throughout this paper the name "Napoleon" has been used to designate the variety almost universally called Royal Ann in this State. This is in accordance with the generally accepted rules of pomological nomenclature, although it may be questioned if the correct name of the variety, under a strict application of the rules, is not "Lauermann." But Napoleon alone is not grown here under the name Royal Ann. There is good reason to believe that there are really a number of other varieties or sub-varieties being cultivated here under that name. Thus Royal Ann, as the term is really used in the northwest, sometimes denotes a type rather than a variety. This condition has probably come about through propagation of Napoleon by means of seeds in the early

history of horticulture in Oregon. Many of these Napoleon seedlings were inferior and were destroyed or grafted over to better varieties. Others were distinctly different from their parent, and being considered valuable were given new variety names and were propagated under them, sometimes only locally, sometimes quite widely. (Waterhouse is probably one of these seedling varieties that was propagated in a very limited way for a time, but not gaining more than a local reputation ceased to be propagated at all.) Still others were very much like their parent and consequently worthy of keeping as orchard (generally home-orchard) trees. Sometimes these seedlings were known as Royal Ann seedlings (for Royal Ann is also a synonym of Napoleon) and sometimes simply as Royal Ann trees. The trees in not a few of the older cherry orchards of the state were grafted by the owners, the cions often coming from different sources. That some of these Napoleon seedlings have been propagated and disseminated in this way there can hardly be any question. Nurserymen have probably at times unknowingly propagated some of these Napoleon-like seedlings for the true Napoleon. There seems to be no other way to explain the existence of so many types of Napoleon that are found about the state. The differences between them certainly cannot all be attributed to differences in age, in condition of tree, or in environment, for often several apparently distinct types may be found growing side by side in the same orchard. Thus certain cherry orchards appear to be of the Royal Ann type rather than of the Napoleon variety. To what extent these different types of the Royal Ann may be inter-sterile or inter-fertile is not known, for if the Royal Ann as grown in some orchards must be looked upon as a type rather than as a variety the question becomes one of inter-sterility and inter-fertility rather than of self-sterility and self-fertility. That at least some of them may be inter-fertile is suggested by the inter-fertility of Napoleon and Waterhouse, and Napoleon and Willamette. This may serve to explain why some Royal Ann cherry orchards have borne good crops where there has been no apparent cross-pollination possible. It should be stated here, however, that no commercial cherry grower should rely upon obtaining several of the different Royal Ann types to secure proper cross-pollination and a proper setting of fruit. The inter-relationships of these different types are at present unknown and the only safe thing to do is to plant varieties that are known to be efficient pollenizers for the variety selected.

The Relation of Aphid Injury to the Setting of Fruit.

In discussing the results obtained from the pollination experiments of 1911 and 1912 mention was made of the fact that self-pollinated flowers will sometimes "set" fruit even though the variety is self-sterile if aphids happen to attack the leaves and pedicels in the flower cluster. (See Plate XII. Fig. 2.) That the irritation caused by aphids will in some way cause the fruit to develop, though abnormally, was illustrated a number of times in the course of the season's

work in 1913. The effect of aphids is the same upon cross-pollinated flowers of inter-sterile varieties and in fact upon properly pollinated flowers of inter-fertile varieties. The fruit that is developed is very much undersized, though the stone is nearly normal. Because of their undersize and poor quality, the fruits that set as a result of aphid stimulation are not salable. Not infrequently this aphid-injured fruit falls off before reaching full maturity. Only a part of these abnormal fruits contain seeds. The question is raised here as to whether or not this development of fruit as a result of aphid stimulation is akin to the development of parthenocarpic fruits.

A Few Practical Suggestions.

When the facts of self-sterility and inter-fertility of sweet cherry varieties are once understood and appreciated, the wisdom of not only making mixed plantings but of making certain particular mixed plantings is apparent. Whoever sets out an orchard of Bing, Lambert, or Napoleon should plant with them one or more of the several varieties that are known to be efficient pollenizers for them. One tree of the pollen producer to every six or eight of the main variety is sufficient to provide thorough pollination.

Those who have young orchards of a single variety not yet in bearing, or mixed orchards of two or more of the varieties that have been shown to be inter-sterile, should graft over one tree out of every 6 or 8 to some other variety that would otherwise be planted for the same purpose. This, of course, should also be done in older orchards that are of bearing age but that are not bearing satisfactory crops through a failure of the fruit to set.

It need hardly be pointed out that fruit growers having orchards consisting mainly of Bing, Lambert, or Napoleon but who have a few scattering trees of Black Republican, Black Tartarian or some other good pollenizer, or even scattering seedling trees in the orchard, should carefully preserve them. They are probably among the most valuable trees in the orchard.

There is still another temporary measure that may and should be resorted to in the case of orchards that are of bearing age but are not provided with inter-fertile varieties that will effect efficient cross-pollination. At blossoming time large branches may be cut from seedling trees and placed upright in buckets of water here and there throughout the orchard, so that the agents of cross-pollination, bees and other insects, may carry their pollen to the flowers of the orchard trees. The efficiency of this procedure may be illustrated by the results obtained from it in one particular instance this year. The plan was recommended to a grower at The Dalles, Oregon, who last year (1912) had a very poor set of fruit, harvesting only 13 tons of cherries. This year 39.5 tons were harvested from the same trees, though weather conditions at the blooming season were no more favorable. This tripling of the crop was not entirely due, of course, to the better cross-pollination secured this year. The trees were older and would natur-

ally have produced a few more tons of fruit. It is reasonably certain, however, that no small part of the increase in yield was due to the practice indicated.

Finally, the importance of bees as agents of cross-pollination cannot be over-emphasized. In the case just mentioned, a number of swarms of bees were obtained and distributed through the orchard along with the seedling branches at blooming season. It makes little difference how thorough the provision for cross-pollination through the mixed planting of inter-fertile varieties; cross-pollination will not be effected unless insects are present to carry the pollen from tree to tree. Fortunately many fruit growers realize the importance of pollen-carrying insects and keep bees. Many, however, do not. There is little question but that many cherry orchards now having a light sprinkling of trees that are good pollenizers would be rendered much more productive if their owners would give proper recognition to the known facts regarding the importance of bees in the orchard.

Conclusions.

The results obtained from the cherry pollination work during the seasons of 1911-13 seem to warrant the following conclusions:

1. All the varieties of the sweet cherry tested are self-sterile. This self-sterility is in no case due to a lack of germinability of the pollen produced. On the other hand, the pollen of each of the varieties studied is capable of producing a set of fruit on the variety or varieties with which it is inter-fertile. The list includes Bing, Black Republican, Black Tartarian, Coe, Early Purple, Elton, Knight, Lambert, Major Francis, May Duke, Napoleon, Rockport, Waterhouse, Willamette, Windsor, Wood.

2. Certain of these varieties—Bing, Lambert, and Napoleon are mentioned especially—are inter-sterile. Mixed plantings of these three varieties cannot be expected to set fruit unless the trees are within the range of influence of some other variety or varieties that are inter-fertile with them.

3. Among those studied, Black Republican, Black Tartarian, and Waterhouse seem to be the most efficient pollenizers for this group of varieties.

4. Other good pollenizers that may be mentioned are: Elton, Wood, Coe, Major Francis, Early Purple. These, however, proved somewhat variable in their pollenizing abilities.

5. Some of the seedling trees found in and about cherry orchards are efficient pollenizers for the three varieties—Bing, Lambert, Napoleon. Probably many of these seedling trees are efficient pollenizers, though the value of any particular seedling can be determined only by experiment or very careful observation.

6. At least some members of the Duke group of cherries are capable of pollinating some of the Bigarreaus.

7. At least some of the varieties of the sour cherry (P. cerasus) are capable of pollinating some of the Bigarreaus.

8. Inter-sterility of sweet cherry varieties is apparently not correlated with their closeness of relationship.

9. The ability of a variety of cherry to set fruit is not entirely dependent upon the kind of pollen available. Environmental factors are important.

Acknowledgments.

The writer wishes to express his appreciation for the assistance that he has received in conducting the work on which this is a preliminary report. His thanks are especially due to the Head of the Division of Horticulture, Prof. C. I. Lewis, for many suggestions; and to his associates in the Division, Prof. E. J. Kraus and Mr. F. C. Bradford, for both suggestions and help in the orchard and laboratory. Without the aid of Messrs. H. C. Hetzel, R. A. Blanchard, F. M. Harrington, A. F. Barss, and H. D. Foster, students in Advanced Plant Breeding, the work would have had to be done on a much smaller scale. Much of the emasculation, collecting of pollen, and artificial pollination was done by these students. Mrs. Alice Hill-Applewhite, another student in Advanced Plant Breeding, made the germination tests of the pollen. Thanks are also due to Dr. G. E. Sanders of The Dalles, Oregon, for permitting the use of a number of trees in his orchard for experimental work and for many courtesies extended. Mr. X. M. Morgan of The Dalles, Oregon, Messrs. M. H. Harlow and F. L. Waite of Eugene, and Mr. A. Vercler of Salem also kindly furnished materials for both the orchard and laboratory work.

Explanation of Plates.

Plate I.

Fig. 1. Napoleon tree at The Dalles, Ore., with flower clusters bagged for pollination work. Photo taken April 20, 1913.

Fig. 2. Bing tree at The Dalles, Ore., with flower clusters bagged for pollination work. Photo taken April 20, 1913.

Plate II.

Fig. 1. Cluster of Napoleon that was enclosed in paper bag at time of flowering. No fruit has set, showing self-sterility. Photo taken at Corvallis, May 20, 1913.

Fig. 2. Cluster of Lambert that was enclosed in paper bag at time of flowering. No fruit has set, showing self-sterility. Photo taken at Corvallis, May 20, 1913.

Plate III.

Fig. 1. Average cluster of Napoleon that was open to cross-pollination by insects. Five cherries have set. Photo taken at Corvallis, May 20, 1913.

Fig. 2. Average cluster of Lambert that was open to cross-pollination by insects. One cherry has set; two more are doubtful. Photo taken at Corvallis, May 20, 1913.

Plate IV.

Average cluster of Black Republican. Eleven cherries have apparently set. Only one, however, the one with decided lustre, will mature. The others are about to fall from "June drop." Photo taken at Corvallis, June 17, 1913.

Plate V.

The same cluster shown in Plate IV with the developing fruits cut open. It will be noted that the seeds of all but the one cherry that would normally mature have shrivelled. Photo taken at Corvallis, June 17, 1913.

Plate VI.

Fig. 1. Average cluster of Napoleon x Bing. No fruit has set. showing inter-sterility. Photo at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Napoleon x Lambert. No fruit has set, showing inter-sterility. Photo taken at The Dalles, June 20, 1913.

Plate VII.

Fig. 1. Average cluster of Napoleon x Black Republican. Photo taken at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Napoleon x Waterhouse. Photo taken at The Dalles, June 20, 1913.

Plate VIII.

Fig. 1. Average cluster of Napoleon x Elton. Photo taken at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Napoleon x Willamette. Photo taken at The Dalles, June 20, 1913.

Plate IX.

Fig. 1. Average cluster of Napoleon x Black Tartarian. Photo taken at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Bing x Black Tartarian. Photo taken at The Dalles, June 20, 1913.

Plate X.

Fig. 1. Average cluster of Bing x Napoleon. Photo taken at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Bing x Willamette. Photo taken at The Dalles, June 20, 1913.

Plate XI.

Fig. 1. Average cluster of Bing x Black Republican. Photo taken at The Dalles, June 20, 1913.

Fig. 2. Average cluster of Bing x Knight. Photo taken at The Dalles, June 20, 1913.

Plate XII.

Fig. 1. Average cluster of Rockport x Napoleon. It shows that Napoleon is efficient as a pollenizer for certain varieties. Photo taken at Corvallis, June 16, 1913.

Fig. 2. A cluster of Rockport x Napoleon that was infested with aphids. Three cherries have set; one will mature. All are undersized (Compare with average specimens shown in Plate XII, Fig. 1.) Photo taken at Corvallis, June 16, 1913.

PLATE I

Fig. 1. Napoleon Tree Bagged for Pollination Work.

Fig. 2. Bing Tree Bagged for Pollination Work.

PLATE II

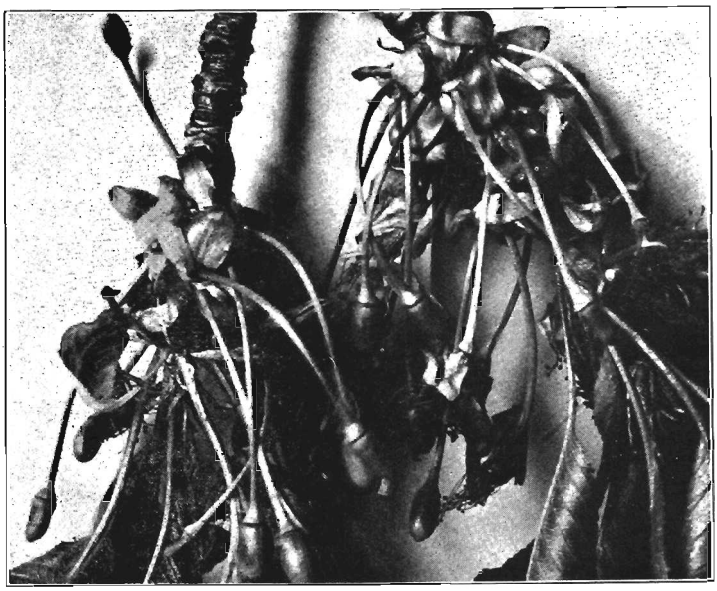

Fig. 1. Average Cluster of Self-pollinated Napoleon.

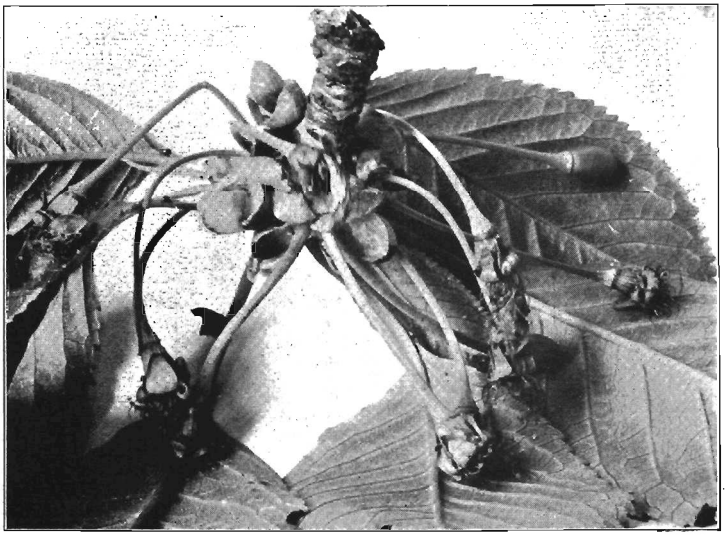

Fig. 2, Average Cluster of Self-pollinated Lambert.

PLATE III

Fig. 1. Average Cluster of Napoleon Open to Cross-pollination by Insects.

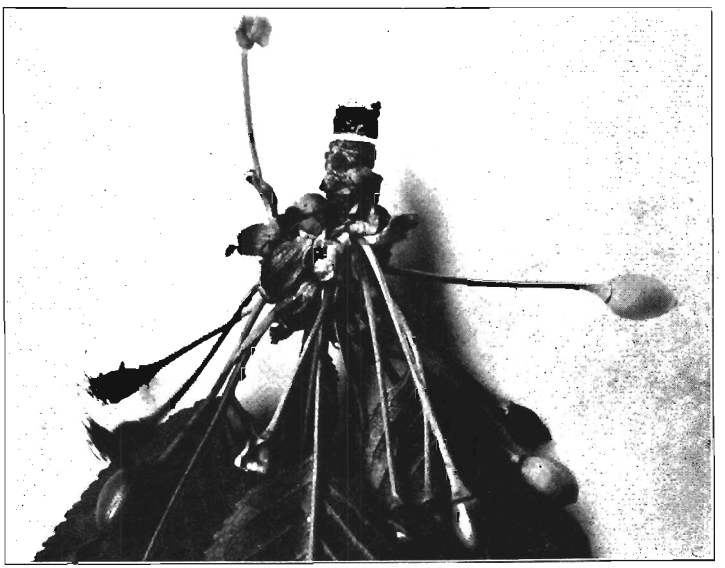

Fig. 2. Average Cluster of Lambert Open to Cross-pollination by Insects.

PLATE IV

Average Cluster of Black Republican Before the "June Drop."

PLATE V

Average Cluster of Black Republican Before the "June Drop," Showing Withered Seeds.

PLATE VI

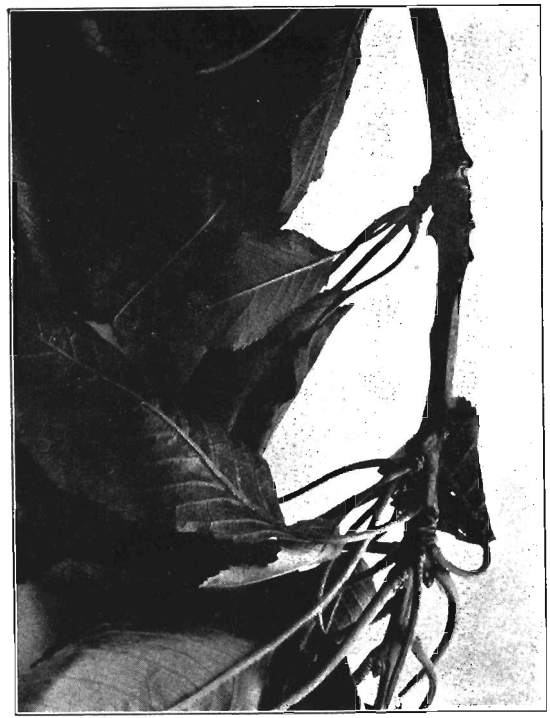

Fig. 1. Average Cluster of Napoleon x Bing.

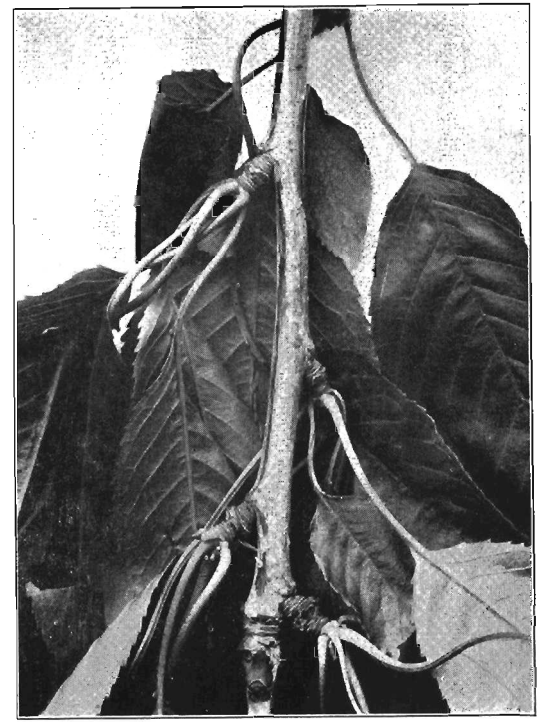

Fig. 2. Average Cluster of Napoleon x Lambert.

PLATE VII

Fig. 1. Average Cluster of Napoleon x Black Republican.

Fig. 2. Average Cluster of Napoleon x Waterhouse.

PLATE VIII

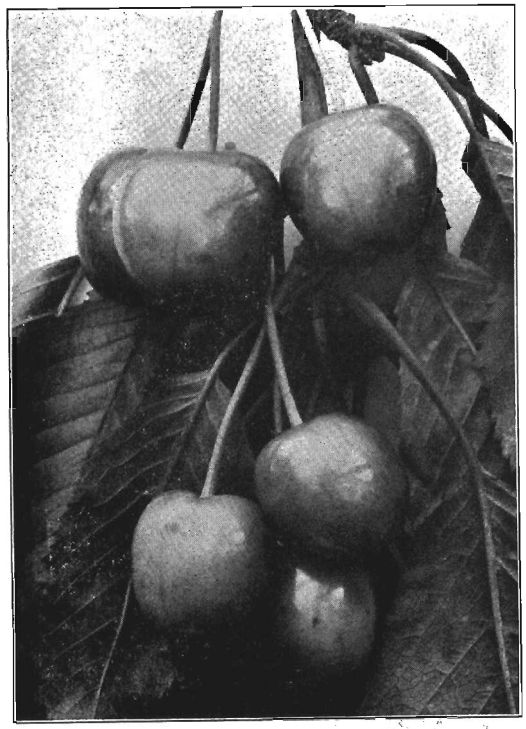

Fig. 1. Average Cluster of Napoleon x Elton.

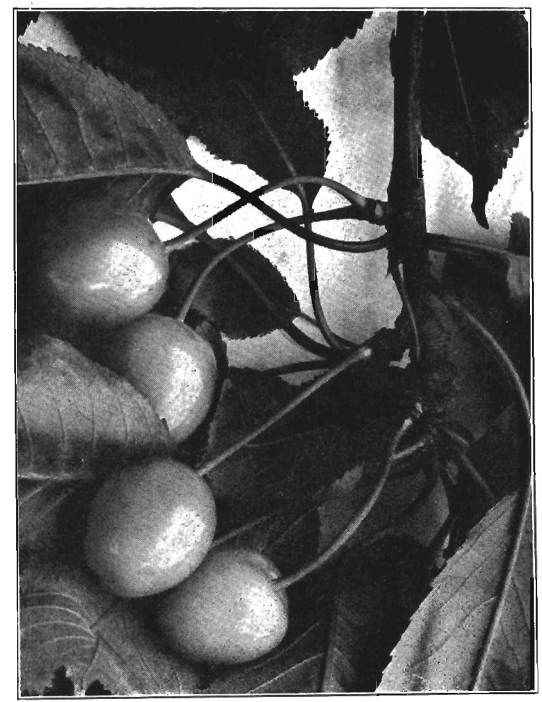

Fig. 2. Average Cluster of Napoleon x Willamette.

PLATE IX

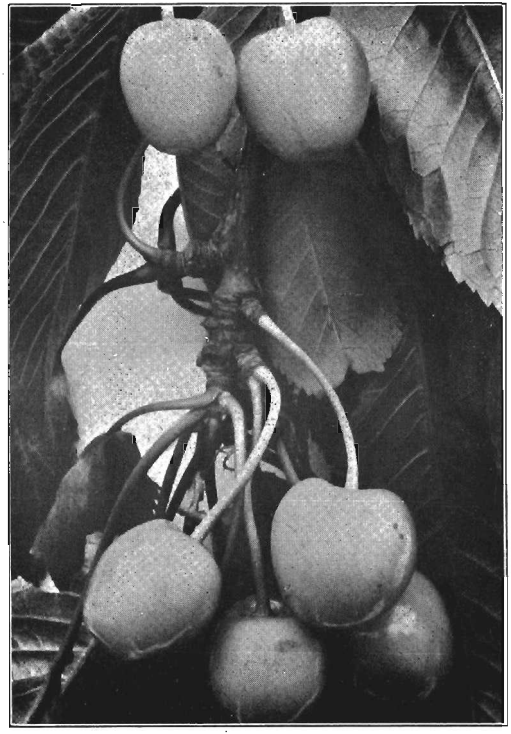

Fig. 1. Average Cluster of Napoleon x Black Tartarian.

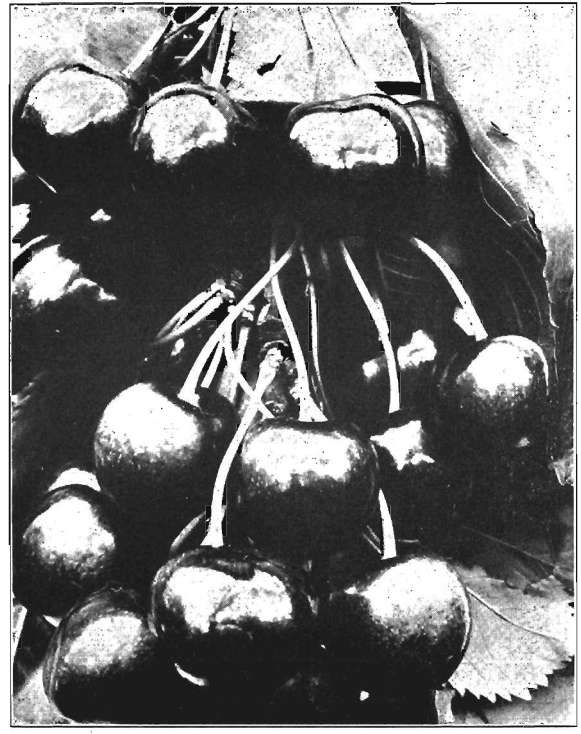

Fig. 2. Average Cluster of Bing x Black Tartarian.

PLATE X

Fig. 1. Average Cluster of Bing x Napoleon.

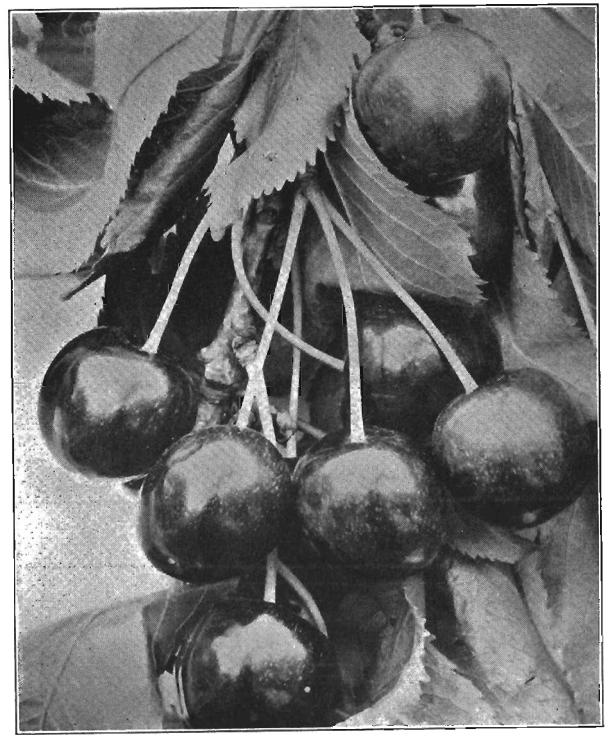

Fig. 2. Average Cluster of Bing x Willamette.

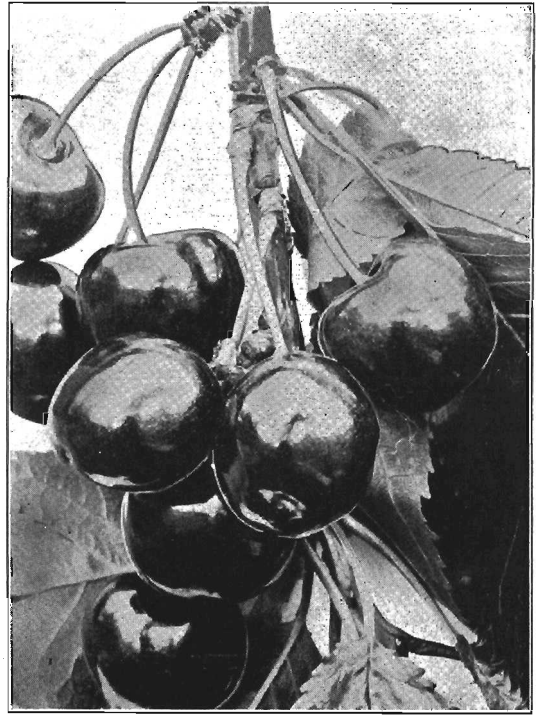

Fig. 1. Average Cluster of Bing x Black Republican.

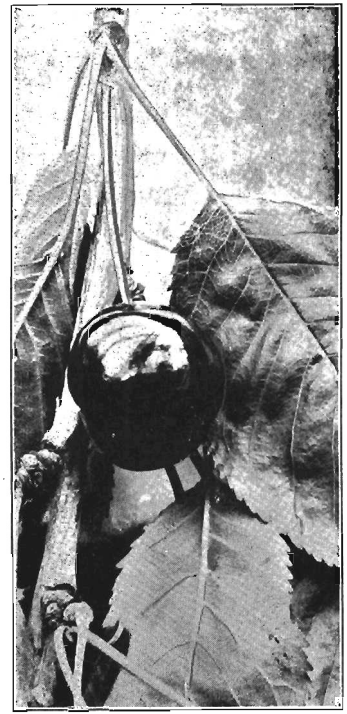

Fig. 2. Average Cluster of Bing x Knight.

PLATE XII

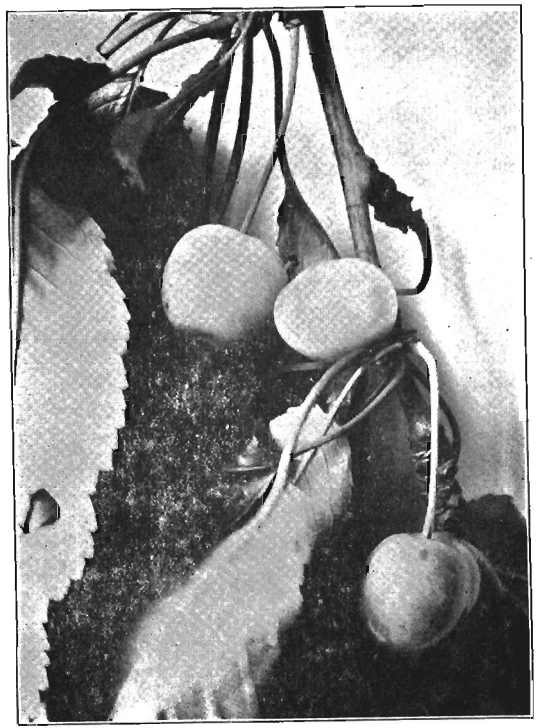

Fig. 1. Average Cluster of Rockport x Napoleon.

Fig. 2. An Aphid-infested Cluster of Rockport x Napoleon.