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Pollination Study of the Anjou Pear in Hood River Valley

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Pollination Study of the Anjou Pear in Hood River Valley

By

GORDON G. BROWN and LEROY CHILDS

INTRODUCTION

The Anjou pear, because of the excellence of its dessert quality and long storage life, lends itself well to satisfactory commercial production. In suitable soils the tree is a vigorous grower, reaching a good size in a very few years. There have been many disappointments, however, associated with the culture of this variety. Generally speaking, production has been extremely irregular, so much so that this pear is classified in most horticultural literature as being a shy bearer.[1, 2] Unfruitfulness is the rule rather than the exception during the first ten years in the tree's growth, though occasionally young trees set a heavy crop before this age is reached. Extensive production irregularities in certain mature orchards and the occurrence of regular fruitfulness in other orchards, or on occasional trees in a few orchards, led the writers to consider, experimentally, factors relative to the pollination of the variety. This report deals with cross-pollination of the Anjou pear in the Hood River Valley and is intended for application to Hood River Valley conditions.

It has not been definitely proved that the variety is entirely self-sterile. In California Tufts and Philp[3] place it in the doubtful-sterile class. The writers' observations, covering a period of ten years, indicate that the sort will occasionally set fruit without apparent crossing—as indicated by the production of seedless fruit—during years of extremely favorable weather conditions. Where behavior of this character has been noted excellent growing conditions have prevailed following the bloom period. On the other hand, in the absence of other varieties, during seasons of little or no sunshine, there is a decided tendency for the variety to fail to set a crop. Many years' observations concerning the behavior of this variety have pointed to the definite relationship of good weather conditions and fruitfulness, the degree of fruitfulness for the most part varying with the number of other varieties associated with the Anjou.

The pollination studies were begun in the spring of 1924, continuing in three typical Anjou orchards until 1928. The location and character of these orchards are designated and summarized as follows:

SCOPE AND LOCATION OF INVESTIGATIONS

Location	Elevation (feet)	Age of trees	Soil	Years of observation
Lower Valley	400	20	Silt loam	1927-1928
Middle Valley	1100	18	Parkdale loam	1924-25-27-28
Upper Valley	1700	15	Parkdale loam	1925-1928

From tests in 1924 and 1925 little information of a positive nature was obtained even though more than forty varieties were tested. A minimum temperature of 24° F. occurred shortly after the blossoms had been emasculated in 1924; in 1925, owing probably to faulty technique in the collection of pollen, results were negative. Germination tests in all cases showed extremely low or no viability of the pollen.

During these years, the influence of both Easter and Bartlett, as a factor in cross-pollination, was again observed in numerous orchards. These varieties were found to bloom at the correct time, producing an abundance of flowers throughout the period of florescence of the Anjou. The commercial possibilities of both make these sorts worthy of serious consideration as agencies in bringing about the fruitfulness of the Anjou. In 1927 Easter and Bartlett were the only varieties tested; to these was added Fall Butter in 1928, owing to some promising field observations made during the preceding year.

MATERIALS AND METHODS USED

The method of procedure in obtaining pollen was that commonly employed in work of this character. For convenience, and to insure having an ample supply of pollen when needed, limbs well supplied with blossom buds of the variety required were placed in sufficient water in the laboratory to permit development. Generally, the majority of buds on these limbs were in the "pink" or "advanced pink" stage when collected. Full bloom was usually brought about in four or five days. For instance, from one series of Bartlett, Anjou, Easter, and Fall Butter, collected on April 10, 1928, ripe or nearly ripe pollen was gathered on April 14. This material was held in open petri dishes in a cool open building until April 21, when germination tests were made. The pollen was used only in Lower Valley tests at the Experiment Station. Table I shows the behavior of the pollen.

TABLE I. GERMINATION OF POLLEN USED IN TESTS AT THE EXPERIMENT STATION 1928

Variety	Buds gathered	Pollen ripe	Germination at 7 days, April 21	Germination at 12 days, April 26	Germination at 17 days* May 1
			%	%	%
Bartlett	Apr. 10	Apr. 14	61.4	49.1	.....
Easter	Apr. 10	Apr. 14	33.1	32.8	20.4
Fall Butter	Apr. 10	Apr. 14	44.9	.....	4.5
Anjou	Apr. 10	Apr. 14	34.8	34.1	10.0

*Growth very weak in all cases.

New material was gathered for the Upper Valley tests, which showed the following percentage of germination before it was applied: Bartlett, 37.5 percent; Easter 38.1 percent; Fall Butter, 43.5 percent; Anjou 49.5 percent.

A 12-percent sugar solution was employed in making the germination tests. Pollen was thinly distributed on a drop of this solution suspended in a Van Tieghum cell. A small amount of water was placed

in the cell for the purpose of preventing the evaporation of water in the sugar solution.

At ordinary laboratory temperature pollen often showed extensions of the germ tubes within a half hour. The percentage of germination was usually determined within eight or ten hours after the exposure. Further exposure failed to increase the percentage of germination but complicated the determinations owing to extensive growth of the hypha-like tubes.

In the germination study noticeable variations in responses both as to quickness of germination and vigor of growth of the tubes were observed. Fall Butter pollen was found to be much more active in these respects than Easter, Bartlett, and Anjou. In percentage of actual germination, on the other hand, the variety showed no superiority over the others mentioned. That there is a possible value in this vigor is indicated in the final results. In every comparative test the set resulting from Fall Butter was superior to the other varieties tested; in several instances the difference was quite pronounced. See Table II.

Shortly before the petals opened, the blossoms were emasculated by hand by means of well-sharpened thumb and finger nails; the receptacle was cut through immediately below the point of attachment of stamens, thus leaving the fully exposed style and stigma (Fig. 2). It was necessary to go over many of the clusters twice in order to obtain the proper stage of development. Experience has shown that from a practical standpoint pear blossoms so treated are not subject to cross-pollination by natural agencies. Pollen, in most of the tests, was applied to the stigmas by means of a small camel's-hair brush. In all these tests applications were made early in the full bloom period. At this time stigmas became sticky, probably indicating a receptive condition.

Some preliminary tests were made by applying the pollen to the flower parts with an atomizer as a means of determining possible practical methods from a commercial standpoint. The results obtained are for the most part inconclusive and negative. Difficulty was encountered in satisfactorily mixing the pollen in a solution. Pear pollen and water will not mix; even with agitation the particles continued to float. Pollen in water and in 5- and 7-percent sugar solutions appeared to collapse the grains with no germination though a fairly good mixture of pollen and solution was obtainable, especially as the percentage of sugar increased. After vigorous agitation, a fairly good mixture of pollen was obtained in a 12-percent sugar solution. Growth responses of submerged pollen were found to be very slight; a very small percentage of the pollen grains germinated and in a short time ceased to grow altogether. In the spraying tests the pollen was mixed up in the field and applied immediately.

Throughout the series of pollination tests crosses were also made directly with unemasculated Anjou blossoms. It is recognized that this method is somewhat open to objection because of the probability of natural cross-pollination. The set of fruit in these tests in many instances so closely parallels that obtained with emasculated blossoms as to warrant the use of the resulting data for comparative purposes (Fig. 1).

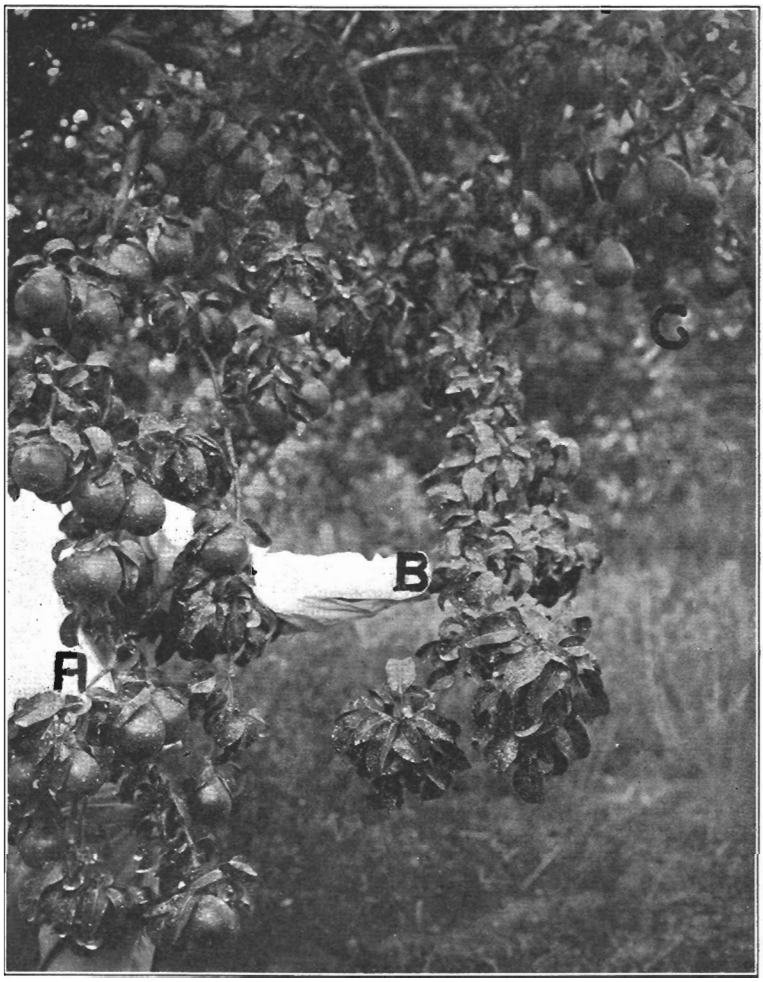

Fig. 1. A. Unemasculated Anjou blossoms x Bartlett—29.0 percent spurs produced fruit. B. Unemasculated flowers allowed to develop normally—1.0 percent spurs produced fruit. C. Emasculated blossoms x Bartlett—20.0 percent spurs produced fruit. Few fruits were produced on this large tree except on the pollinated branches.

WEATHER CONDITIONS 1927 AND 1928

The chart (Fig. 3) indicates the character of the weather before and after the period of full bloom during the years 1927 and 1928 in locations where pollination tests were made. The data presented indicate that weather conditions of the character recorded have, in a direct way, little to do with the complete development of a fertilized Anjou flower. Where

pollen reached the stigmas highly satisfactory results have been obtained in every test made. Two sets of experiments were conducted during rainy, cold weather, and two sets of tests when the weather was bright and warm. Weather conditions therefore appear to affect the dissemination of pollen and indirectly fruitfulness of the Anjou pear.

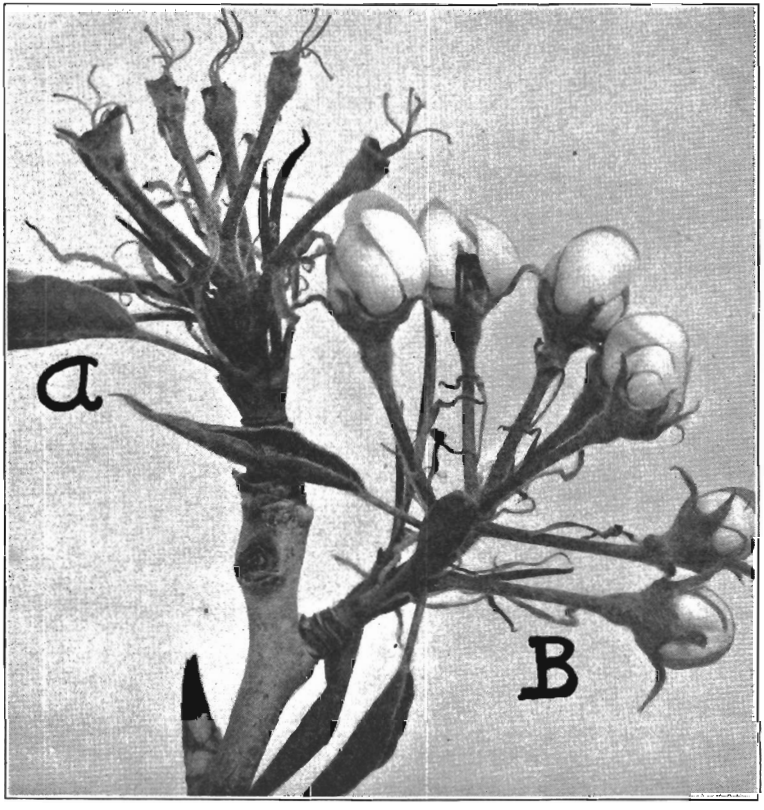

Fig. 2. A. Emasculated blossoms. B. Stage of development at which time male parts of the flower were removed. The string-like anthers can be seen in A. To these the pollen was applied with a brush.

In the 1927 tests, beginning with April 18, the maximum daily temperature shows a uniform rise until April 24, when it began to recede. The total rise was from 48° to 84° F., or an average of six degrees daily. Full bloom occurred in the Lower Valley when temperatures were nearly at their maximum. Clear weather was unbroken from April 19 to 26 inclusive. The minimum temperatures between April 22 and 27 did not fall below 40° F. In the Middle Valley, weather conditions immediately before and after full bloom were distinctly unfavorable. From April 28 (the date of full bloom) until May 3, maximum temperatures were about 60° F. On April 28 the minimum temperature reached 37° F. Cloudy or partly cloudy weather with showers prevailed from April

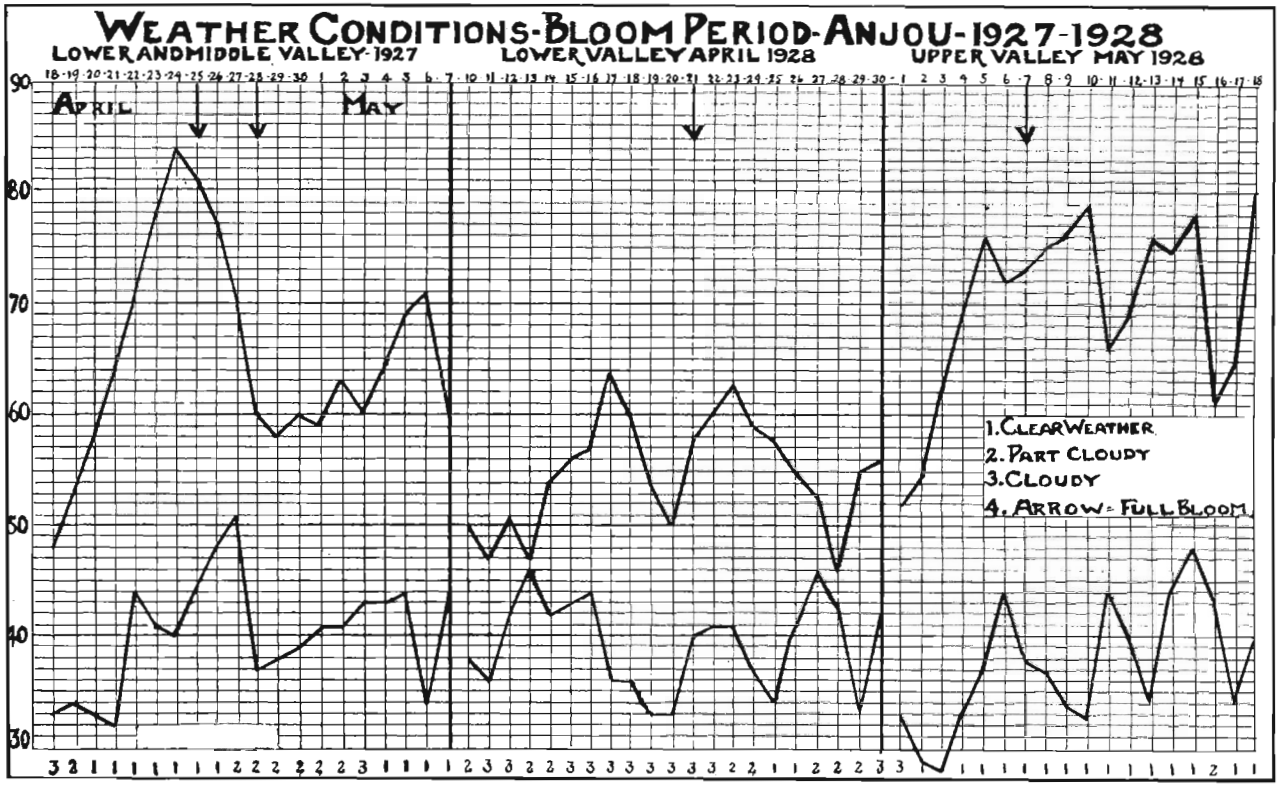
WEATHER CONDITIONS-BLOOM PERIOD-ANJOU-1927-1928
LOWER AND MIDDLE VALLEY-1927
LOWER VALLEY APRIL 1928
UPPER VALLEY MAY 1928
APRIL
MAY
90
80
70
60
50
40
30
1. CLEAR WEATHER
2. PART CLOUDY
3. CLOUDY
4. ARROW = FULL BLOOM

Fig. 3.

27 until May 3. In 1928, the character of weather just before and after full bloom in some respects was a reversal of that obtaining the previous year. In the Lower Valley the maximum temperature declined to 50° F. on April 20, the day preceding full bloom. During the following three days the daily rise was gradual but reached only 63° F., after which there was an unbroken decline for five days when the temperature was 46° F. The minimum temperature was low during this critical period and on April 20 was 33° F. Cloudy weather, intermittent rain, and wind prevailed. During the 1928 tests in the Upper Valley clear, sunshiny weather without rain prevailed from May 2 until May 15. Before and after full bloom, which occurred on May 7, maximum temperatures were high. The average maximum from May 5 to 10 inclusive was 74° F.

RESULTS OF CROSSING TESTS, 1927 AND 1928

Following the June drop, counts were made on June 24, 1927, to determine the percentage of Anjou blossoms setting fruit. The percentages are based on the number of spurs bearing fruit. These data are summarized in Table II. The outstanding fact in connection with both tests is that a high percentage of fruit set—in all cases more than 30 percent—resulted from the use of Bartlett and Easter pollen under two nearly opposing sets of climatic conditions; namely, clear, warm weather in the Lower Valley and cloudy, cold weather in the Middle Valley. Emasculated blossoms in the Lower Valley tests crossed by Anjou set 3.3 percent fruit. Non-pollinated emasculated blossoms failed to set a single fruit, while the natural set in the Lower Valley tests, with conditions favorable, was 20.0 percent and in the Middle Valley with poor weather a set of but 1.5 percent occurred. (See Fig. 1.)

The results obtained in 1928 closely follow those of 1927. The Fall Butter variety was added to Easter and Bartlett in these tests. Weather was similar to that occurring during the preceding year except that the unfavorable conditions occurred in the Lower Valley rather than in the

TABLE II. RESULTS OF POLLINATION TEST, ANJOU VARIETY. HOOD RIVER, OREGON, 1927-1928.

Anjou crossed by	Blossom treatment	Method of pollen application	Spurs fruiting — in percentages — 1927 Lower Valley	1927 Middle Valley	1928 Lower Valley	1928 Upper Valley
			%	%	%	%
Easter	Emasculated	Sprayed on	.....	.....	2.0	.....
		Brush	38.3	.....	16.8	12.5
	No emasculation	Sprayed on	.....	.....	3.6	.....
		Brush	34.0	44.0	18.7	8.7
Bartlett	Emasculated	Brush	32.4	.....	16.5	14.3
	No emasculation	Brush	37.0	30.0	26.2	23.9
Fall Butter	Emasculated	Brush	.....	.....	24.8	38.4
	No emasculation		.....	.....	29.1	34.7
Anjou	Emasculated	Brush	3.3	.....	.00	.00
	No emasculation	Brush	15.0	.....	.64	5.7
12-percent sugar	Emasculated	Sprayed on	.....	.....	.....	.00
No pollen	No emasculation	Sprayed on	.....	.....	1.1	1.51
No pollen (Check)	Emasculated		.00	.00	.00	.00
	No emasculation		20.2	1.5	1.0	3.6

Upper Valley orchard. Under both sets of conditions positive results of a significant character were again obtained on both emasculated and open blossoms under both sets of weather conditions. This information is summarized in Table II. Emasculated blossoms crossed by Anjou again failed to set a single fruit as was the case with uncrossed emasculated flowers. The results point definitely to self-sterility of the variety under Hood River Valley conditions.

DISCUSSION OF RESULTS

Practical significance. The practical value of the influence of these three varieties on Anjou is significant in that the fruitfulness produced as a result of crossing is far in excess of that needed in ordinary orchard performance. What constitutes a "normal set" of fruit is open to differences of opinion. Data gathered indicate that a relatively small percentage will insure a good crop. Estimates made by the authors show that a full bearing Anjou tree at fifteen years of age may have as many as 8,000 fruit buds, each of which contains at least seven perfect flowers in each cluster. A single tree may therefore produce as many as 56,000 flowers, all of which, potentially at least, may produce fruit. Assuming a production of 1,100 pears per tree—this would give a yield of about 12 packed boxes of size 90—it is apparent that a 13.75-percent set would be necessary where 8,000 blossom clusters were carried by the tree. This computation is based on the set of one fruit per cluster. Owing to the fact that some blossom clusters bear two or more pears to full maturity, a smaller percentage set may actually produce an equivalent yield. On the basis of total flowers the required set is only 1.96 percent. In California, Tufts and Philp have estimated the yield of Anjou pears at 12,851 pounds per acre where 7.1 percent set was recorded over a number of years. For the Anjou variety, they considered this a normal set. The length of time during which a normal set of fruit for the Anjou variety may be obtained varies from season to season. With temperatures high, the time elapsing between the opening of the first and last blossoms is relatively short. Fully 90 percent of the blossoms open within three days, the remainder opening a short time thereafter. During cold, rainy weather the blossoms open slowly and the petals often hang on for two weeks or more. Observations indicate that the shorter period is to be favored because it is generally associated with a greater degree of sunshine and the activity of bees, which promote cross-pollination.

Bees as agents. The most perplexing problem associated with the fertilization of the Anjou blossoms, particularly during unfavorable weather conditions, is that of reaching them with the necessary crossing pollen. Pear pollen for the most part is scattered from flower to flower through the agency of insects. Native insects, as a rule, are rather scarce owing to the fact that the pear is such an early bloomer. During the past year behavior of honey-bees in the pear orchards was noted. The pear at best is not very attractive to these insects. Easter produces more nectar than Bartlett. Both have more than Anjou, the flowers of which are practically devoid of nectar. Bees, however, are apparently interested only in the collection of pollen from the pear. As soon as this has been discharged, no more interest in the blossom is shown even though

the petals persist for some time. During warm weather this period of attractiveness is at best not longer than a day or two for the individual blossom. For the variety, owing to the fact that most of the blossoms open at about the same time, favorable action by the insects is decidedly limited. Pollen lasts somewhat longer during cold weather. Since cold weather is not favorable to them, however, the bees will either not work or do so only to a very limited extent. The practical interpretation of this information indicates that there must be present in the Anjou orchard adequate crossing varieties and numerous bees. This is of extreme importance during seasons accompanied by cold, wet weather.

Orchard performance. Since the pollination work was started close observation has been made relative to the performance of a number of Anjou orchards. Regularly producing trees have invariably been associated with crossing varieties. The planting plan in the heaviest and most consistently producing Anjou orchard in the district is planted in the following manner: two rows of Bartletts and two rows of Anjous throughout. Such a planting arrangement apparently assures pollen exchange even when conditions for insect activity are reduced to a few hours, as is often the case during the pear blossoming season. Good yields have been obtained in another orchard under observation where the planting is one row of Bartlett and six rows of Anjous throughout the orchard. Although the yields have not been as heavy as in the other orchard cited, satisfactory crops have been obtained. Where there occurs only an occasional Bartlett or Easter in an Anjou orchard production is usually much heavier near these trees than is the case a few rows away. (See Figs. 4 and 5.)

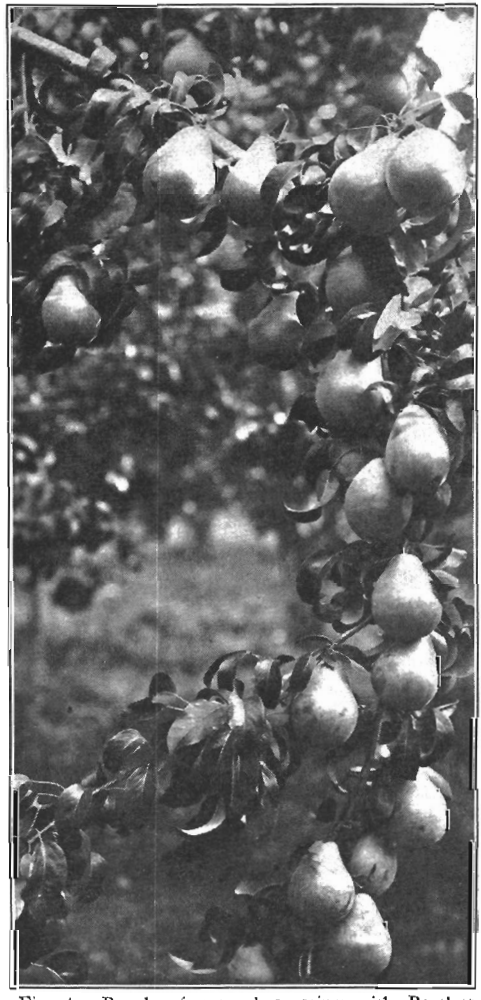

Fig. 4. Result of natural crossing with Bartlett. An abundance of suitable crossing pollen makes Anjou fruitful.

Establishment of pollinators. An effective distribution of pollinators in an orchard set on the square system is shown in Fig. 6. Every fifth row is composed of a planting arranged as follows: Bartlett two thirds and Easter one third. Assuming the trees to be thirty feet apart, the greatest distance separating an Anjou from a pollinating variety would be sixty feet.

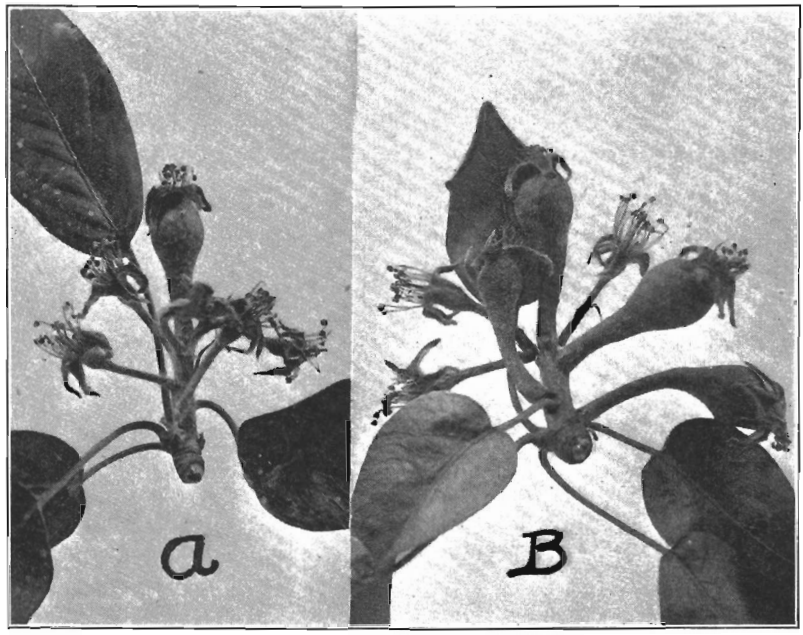

Fig. 5. A. Typical initial set on Anjou tree 10 rows from pollinating variety. B. Typical initial set adjacent to Bartlett. The June drop takes many of these young pears. The chances of a tree surviving with a good crop are much better when the spurs appear as in B following the bloom period.

Two or more varieties are preferred for pollination purposes because insurance is thus afforded against light bloom on the part of one variety following heavy cropping. Bartlett especially has shown a tendency toward alternate bearing. The use of a larger number of pollinating trees than commonly employed is also considered an effective means of overcoming the disadvantages of light bloom. This arrangement presents no disadvantages, however, since both Easter and Bartlett have pronounced commercial value, which is not always true of pollinators. Greater ease in harvesting is also possible where pollinators are set in single rows.

Approximately 11 percent of trees shown in Fig. 7 are Easter and Bartlett pollinators equally represented. Every fourth tree in every fourth row is alternately set with these two varieties. Where few pollenizers are desired this arrangement has advantages since a uniform

distribution is effected. The plan has some disadvantages, however, in the event of partial or total blossom failure with one pollinator, the trees of the other variety being too far apart to insure effective results. The loss of a pollinator from any cause makes the possibility of crossing less certain since there are no trees of similar character close by. Har-

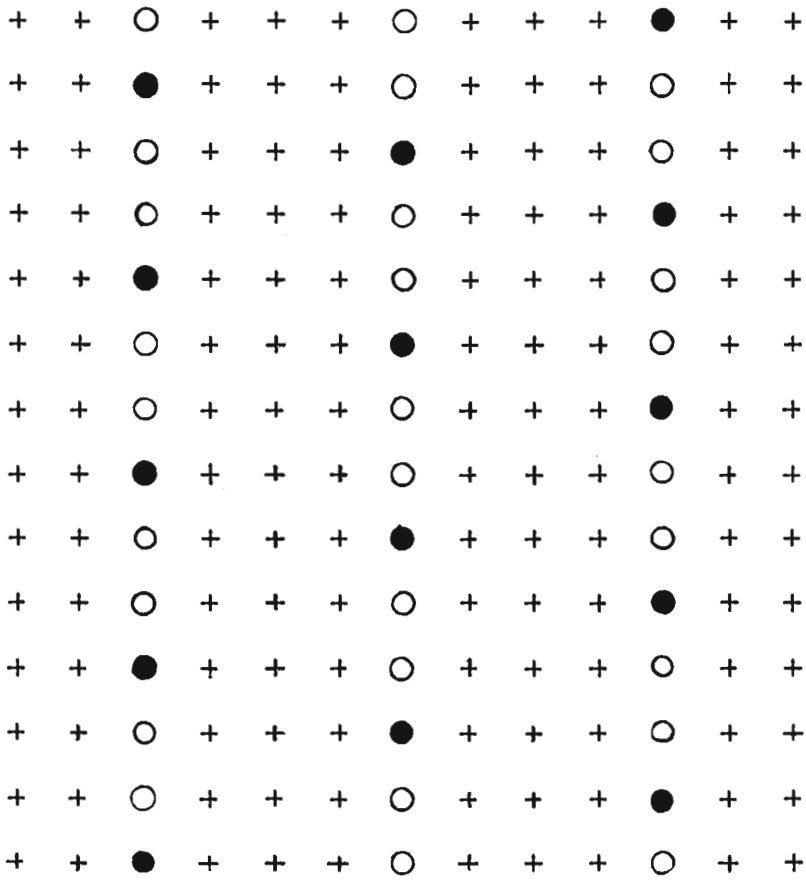

Fig. 6. Suggested planting arrangement of Bartlett and Easter in Anjou orchard for pollination purposes. Light circle, Bartlett; Dark circle, Easter; Cross, Anjou.

vesting of fruit from pollinators as set in Fig. 7 is more difficult than as set in Fig. 6 because of the scattered planting. In established orchards solidly planted to Anjou, top-working to pollinating varieties should be undertaken.

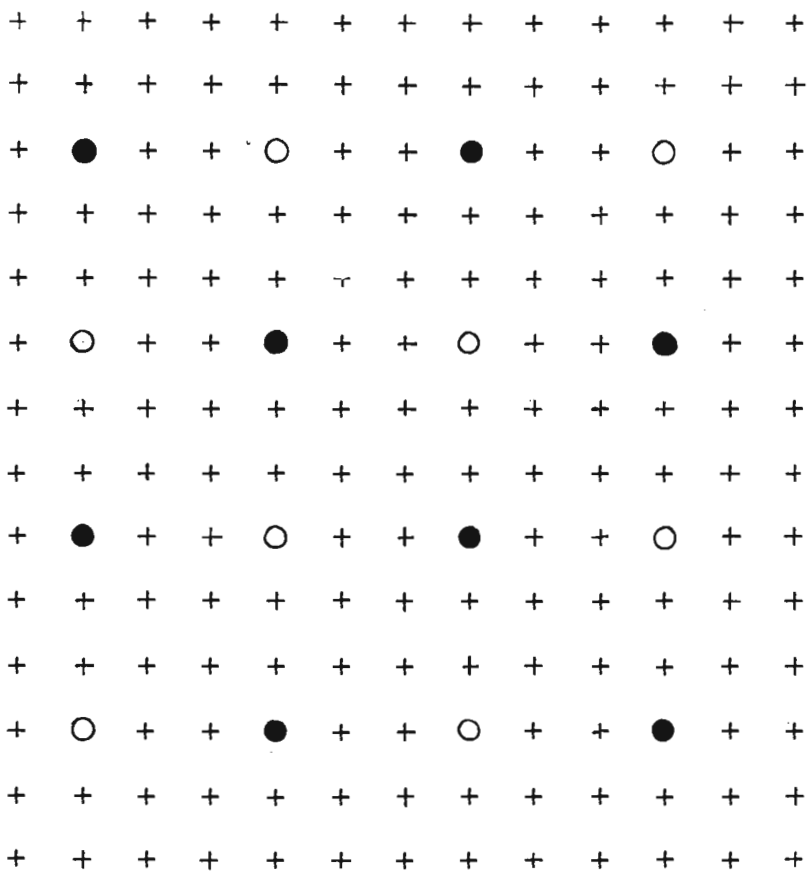

Fig. 7. Usual arrangement of pollinators in orchard. This plan perhaps not as practical as that shown in Fig. 5. Bartlett and Easter equally distributed.

CONCLUSIONS

Under conditions of tests made in 1927 and 1928 in Hood River Valley self-sterility of Anjou is demonstrated.

Bartlett, Easter, and Fall Butter were found to pollinate Anjou effectively. All three bloom satisfactorily with Anjou. The first two are recommended because of their commercial value.

Fertilization of Anjou was accomplished both in warm favorable weather and during cold rainy weather when pollen was artificially applied. It is apparent that failure of the variety to set in mature commercial plantings is due to the absence of pollen or because the pollen of crossing varieties is unable, owing to inclement weather, to reach the Anjou blossoms.

Native insects as a rule are not abundant in pear orchards during the blossoming period. Bees, though not particularly fond of pear blossoms, will work over them to a certain degree for the purpose of gathering pollen. Very little nectar is present in the Anjou bloom. Pollen is dissipated within a day or two, after which bees are no longer attracted to the flowers. For best results, bees must be present in relatively large numbers at the time the blossoms open. At least one strong stand of bees to the acre is recommended.

Pollen of Easter mixed in a 12-percent sugar solution and sprayed upon emasculated and unemasculated blossoms produced negative results.

Two or more varieties for cross-fertilization are recommended.

Top-working to pollinators should be undertaken in all orchards solidly planted to the Anjou variety.

LITERATURE CITED

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