A STERILITY STUDY OF THE GRIMES, JONATHAN, ROME AND WAGENER APPLES.

A THESIS

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

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BY

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PREFACE.

It has been the intention of the writer to select, for his subject, a phase of the fruit growing industry that is of great importance from both a practical and scientific standpoint. Leading commercial varieties of the apple for this section have been chosen for this test. This subject should be of vital interest to every orchardist growing these varieties.

The trees used were, for the most part, in the orchard of the Idaho Agricultural Experiment Station. Orchard No. III was used as far as possible as all the trees were practically the same age (seven years) and the conditions practically uniform. This orchard was the nearest one available and, being in the Experiment Station, should receive uniform care. All of the cages used were built around trees in this orchard. All of the pollination work was done here. Practically all the photographs were taken in this orchard. A few of the Jonathans in the Dwarf orchard nearby were used because of the scarcity of blossoms on the available trees in orchard No. III. Ten trees in each row were in the Summer and Winter Pruning Experiment now being conducted by the Horticultural Department. Five trees in each row were pruned in the winter at the same time as the trees used in the thesis and they have been used as a check.

Most of the necessary pollen was secured from orchard No. III, but some of the Wagener pollen was secured from a single Wagener tree in the Yard of Mr. W.E.Heard, 232 S.Van Buren St. The Rome pollen was taken exclusively from the

Fred. Veatch orchard about two miles south of town.

Quite a large part of the bagging was done in the orchards of Mr. Geo. Knapp and Mr. L.F.Henderson,who kindly gave me permission to use their orchards about seven miles northeast of Moscow. These orchards adjoin each other and most of the trees are near the dividing line of the two orchards. Mr. Knapp also offered the use of his small block of Wageners on the north-east corner of his orchard.

Because of the fact that the value of a work of this kind is determined largely by its extent,and the amount of work done,it was necessary for me to secure additional help during the blossoming period. This help devoted most of the time to bagging and tying, and was directly under the writer'ssupervision at all times.

The season was fully two weeks later than usual and most of the blossoming period was accompanied by warm weather and bright sunshine which greatly hastened the development of the blossoms and made it necessary to do a large part of the outdoor work within a space of about nine days.

Early writers such as Sprengel,Knight, Knuth and Darwin have thrown much light on pollination problems,but,according to Waite and Fairchilds,(Hort. Rule Book, Bailey)the origin of the investigationsalong this line was due to the experienees of a Virginian who ordered several varieties of pears for a home orchard. They did exceptionallywell,especially the Bartlett variety. His results led him to order a shipment,entirely of Bartletts,for a commercialorchard . This orchard never bore satiafactory crops except on trees near the mixed varieties.

This fact led to investigations by such men as Bailey, Close, Fletcher, Lewis, Powell, Vincent, Waite and Waugh.

The writer was attracted to this subject because of a natural interest in plant breeding andbecause of past experience in **Apple Breeding** work at this station. The writer regrets that he will be unable to carry on the work for several years with other varieties.

Acknowledgements.

I wish here to express my appreciation to Prof. W.H.Wicks of the Horticultural Department, for the use of the Department negatives No. 252," A Scene in the Orchard of Mr. B.C.Dowdy Showing the Pollination of a Wagener Tree by Mr. C.H.Heard", Negative No. 254 " Maturing of Pollen Under Cages in the University Greenhouse" and negative No. 259 " The Proper Stage to Emasculate Blossoms" . These negatives are to be used in a forthcoming bulletin on "Apple Breeding" by the Department of Horticulture. Under these circumstances, the writer is exceptionally fortunate in securing them for this work.

The writer has quoted freely from several publications. Due credit has been given where material has been used.

Some of the publications that have been especially helpful in this work are :
"Cross and Self-Fertilization in the Vegetable Kingdom" by Darwin, "Handbook of Flower Pollination" By Knuth(Translated by J.R.A.Davis), "How to Make a Fruit Garden" by Fletcher, "Pollination of Pomaceous Fruits" by Waite(U.S.D.A.Yearbook for 1898), "Notes on the Comparative Dates of Blooming and Pollen Production of Varieties of Apples ,Pears, Plums and Cherries" Oregon Agr. Exp. Sta. Bull. No. 34, "Pollination of the Apple"

Oregon Agr. Exp. Sta. Bull. No. 104, "Pollination in Orchards" Cornell Agr. Exp. Sta. Bull. No. 181, "Pollination of Bartlett and Kieffer Pears" Annual Report of the Virginia Agr. Exp. Sta. for 1909 and 1910, and Farmers Bull. No. 65 of the U.S.D.A.

INTRODUCTION.

By the term "Self-Sterility",as applied to plants,the writer means the inability to produce fruit without the introduction of foreign pollne(pollen from some other variety).

By the term "Self-Fertility" the writer means the abiliy to produce fruit without the introduction of foreign pollen. Darwin in his "Cross and Self-fertilization in the Vegetable Kingdom" (pp 328-9) recognizestwo kinds of self-fertilization. First, Fertilization of a blossom with its own pollen. Second. Fertilization with pollen from other flowers on the same plant. There isvery little difference in the fertility according to the two methods.

All plants are either self-fertile,self-sterile or belong to one of the innumerable intermediate stages.

The dropping of fruit from young trees is not true self-sterility as the fruit may have been fertilizad and the dropping may be due to mechanical ~~xxxxxxxxx~~ or physiological agencies.

Self-sterility seems to be largely an evidence of the evolution from the bi-sexual to the monoecious forms. From the present indications it seems that this"barrenness" is likely to increase than to diminish in the future. It may be considered as an attempt at specialization and separation of the sexesas we have in the higher animals.

There are numerous instances where fruit growers have planted large blocks of orchards to a single variety. In a large percentage of these cases,these orchards have failed to set fruit successfully, or at least have failed to set fruit as abundantly as the orchards of their neighborswho have planted several varieties,even though they have blossomed profusely.

It has often been observed that the outer rows of trees in these solid blocks of a single variety often set a noticeably larger amount of fruit than similar trees in the interior, especially if they are near trees of different varieties. This naturally leads us to the conclusion that the fruitfulness of some of these varieties is materially improved by their securing pollen from without.

Several causes of this "Barrenness" or self-sterility have been advances during recent years. It varies with different fruits and is a characteristic of certain varieties, some being highly self-fertile and others entirely or practically self-sterile. Prof. Fletcher says that sixty species of plants are more or less self-sterile(Bull. No. 181, Cornell Agr. Exp. Sta).

From what has been said, one can readily see the importance of the question of sterility in orchard planting. Every locality is able to produce one or two varieties of apples better than all others. Localities thus become famous for these varieties and the names on the boxes are sufficiently potent to readily sell the product. I have indicated below the names of some of the principal districts and the varieties for which they are famous.

Massachusetts,	McIntosh.
Virginia,	Russet and Pippin.
California(Sebastopol),	Gravenstein.
California (Watsonville),	Yellow Newtown.
Montana (Flathead Valley),	McIntosh.
Hood River, Oregon,	Spitzenburg and Yellow Newtown.
Yakima Valley, Washington,	Jonathan and Rome.
Wenatchee Valley, Washington,	Jonathan and Rome.
Rogue River Valley, Oregon,	Winesap and Yellow Newtown.

Boise Valley, Idaho,	Winesap, Jonathan and Rome.
Latah County, Idaho,	Wagener and Jonathan.

That Moscow can produce a very high grade wagener has been proven by the fact that the carload entry of Mr. Geo. Knapp of Moscow, Idahowon first on Wageners and also the sweepstakes at the Spokane National Apple Show in November, 1911.

The best Spitzenburgs that can b e grown here would hardly be taken into consideration in competition with Spitzenburgs from Hood River, Oregon. Our apples of this variety do ns not compare with theirs in size, color or flavor. A glance at a score card for judging apples will convince anyone at all famil-
our
iar with Spitzenburgs that the Spitzenburg is not adapted to our conditions in the Palouse.

The trophy won last year shows the importance of growing Wageners. The importance of xxxxxxxxxx winning the prizes on Mr. Knapps Wageners is practically limited to Wageners alone. It will not materially help us to sell our inferior Spitzenburgs and other apples.

If we concede that the Wagener is the best apple for this region, a very logical question to ask is "Why not plant Wageners alone ?or, in some other locality, "Why not plant Jonathans or Spitzenburgs"?

The Jonathan apples of Mr. Julius Koch, of Moscow, exhibited in Spokane by Mr. J.H. Forney, won notable recognition for their keeping qualities at the Spokane National Apple Show in 1909. With the reputation already gained for the Wagener and Jonathan varietiesit is especially important to know whether or not it is possible to grow a successful orchard of Wageners or Jonathans alone, a question that can only be settled by careful experimentation.

Several lists of self-sterile and self-fertile varieties have been given but again we are confronted with the fact that a variety may be self-fertile in one locality and self-sterile in another, or the reverse. This will be shown more clearly by the lists of self-sterile and self-fertile varieties given below.

Farmers Bulletin Number 65 gives a list of self-sterile and self-fertile varieties as follows:

Self-Sterile Varieties:

Yellow Bellflower, Chenango, Gravenstein, Tompkins King, Melon, Northern Spy, Primate, Rambo, Red Astrachan, Roxbury Russet, Spitzenburg, Talman Sweet, and Newtown Pippin (the latter based on the report of growers).

Self-Fertile Varieties:

Baldwin, Codlin and Greening.

The Oregon Agr. Exp. Sta. Bull. No. 104 contains a test of eighty-seven varieties of apples. Of these, fifty-nine were self sterile, fifteen self-fertile and thirteen partially self-fertile The Self-sterile varieties were:

Autumn Sweet, Arkansas Black, Bietigheimer, Bellflower (Yellow), Bottle Greening, Canada Sweet, Canada Reinette, Delaware, Domine, Dutch Mignonne, Ewalt, Early Strawberry, Fallawater, Great Bearer, Gravenstein, Golden Sweet, Gano, Green Sweet, Hoover's Red, Haas, Holland Pippin, Holland Beauty, Hyde's Keeper, Hanwell's Souring, Jonathan, King (of Tompkins Co.), Limbertwig, May, Melon, McMahon White, Mammouth Black Twig, Melon Sweet, Munson Sweet, Montreal Beauty, Maiden Blush, Missouri Pippin, Ortley, Paradise Sweet, Peewaukee, Red Golden Pippin, Red Cheek Pippin, (Mammouth Pippin), Romanite, Rome, Ralls, Rhode Island Greening, Sweet Bough, ST. Lawrence, Salome, Summer Queen, Summer Pearmain, Steeles Red, Talman Sweet, Transcendent Crab. Twenty Ounce, Western Beauty, Wealthy, Winesap, and York Imperial.

The Self-fertile varieties were:

Baldwin, Bailey Sweet, Bethlehemite, Colvert, Fallwine, Grimes, Keswick Codlin, Longfellow, Oldenburg(Duchess of), Pumpkin Russet, Scott's Winter, Shiawassee, Washington, White Pippin, and Yellow Newtown.

Those Partially self-fertile were:

Ben Davis, Canadian Red, Fall Jenneting, Jewett's Red, Mann, Pryor's Red, Rambo, Stark, Spitzenburg, Wagener, Willow Twig, Whitney's Crab and Yellow Transparent.

In an article in the Gem State Rural (Mar.1912, p 13), written by Mr. E.F.Stephens of Nampa, Idaho, the following varieties were considered self-sterile:

Ben Davis, Fameuse, Gravenstein, King(Tompkins Co.)Mammouth Black Twig, Rhode Island Greening, Spitzenburg, Stark and Stayman Winesap.

The Floolwing Varieties were given as self-fertile:

Alexander, Astrachan(red), Baldwin, Ben Davis, Chenango, Early Harvest, Esopus(Spitzenburg), Jonathan, Twenty Ounce, White Winter Pearmain, Winesap and Yellow Transparent.

In his Text-book entitled "Popular Fruit Growing" Prof. S.B.Green gives the following varieties of apples as self-sterile:

Winesap, Gravenstein and Northern Spy.

He names the Baldwin, Ben Davis Duchess and Red Astrachan as being self-fertile.

Prof. L.H.Bailey, in his book " The Principles of Fruit Growing" pp 229, lists the most common varieties of apples according to their fertility and sterility.

The following are classified as "More or Less Self-sterile" : Bellfleur,Chenango,Gravenstein, King, Northern Spy, Norton Melon, Primate, Rambo, Red Astrachan, Roxbury Russet, Spitzenburg Talman Sweet, Willow Twig and Winesap.

The Followingare "Mostly Self-fertile" :

Baldwin, Ben Davis, Codlin, Fallawater, Greening, Oldenburg, Rall's Genet and Smith Cider.

Prof. S.W.Fletcher, in his book " How to Make a Fruit Garden" classifies sterility in apples as follows:

Self-sterile Varieties.

Chenango, Gilpin, Gravenstein, Grimes, Tompkin's King, Northern Spy, Paragon, Rambo, Red Astrachan, Roxbury Russet, Esopus Spitzenburg, Stayman Winesap, Talman Sweet, Williams, Winesap, Bellflower and York Imperial.

Self-fertile varieties:

Baldwin, Ben Davis, Early Harvest, Fallawater, Genet, Oldenburg, Red Astrachan, Rhode Island Greening, Smith Cider and Yellow Transparent.

A comparison of the above lists will show several discrepancies. For example, the Yellow Newtown(or Newtown Pippin,as it is sometimes called),is given as self-sterile (Farmers Bulletin No. 65) and as self-fertile in Oregon Bulletin No. 104. Inasmuch as the Yellow Newtown is not mentioned in but two of the lists given,and in one it is considered self-fertile and in the other self-sterile,further experimentation is necessary. Another equally good example is in the case of the Greenings. The Greening is given as self-fertile in Farmers Bull. No. 65, and in Bailey's "Principles of Fruit Growing"and the Rhode Island Greening is given as self-fertile in Fletcher's " How to Make a Fruit Garden". Oregon Agr. Exp. Sta. Bull. No.104 and

and Mr. E.F.Stephens article in the Gem State Rural both class the Rhode Island Greening as self-sterile.
I found the Wagener variety mentioned in but one instance(Oregon Bull. No. 104). It was here considered as partially self-fertile. In the Same Bulletin,the Rome variety is given as self-sterile. In Prof. Fletcher's "How to Make a Fruit Garden" he classifies the Grimes as self-sterile Oregon Bull. No. 104 lists it as self-fertile., Again, Mr. Stephens classes the Jonathan as self-fertile and Oregon Bull. No. 104 gives it as self-sterile.

If the present data is all that is available, (and it is all that I have been able to find),I consider it little short ogf guess work to apply any of the results to this locality. With information from only two sources available,and that information conflicting, I feel that the information upon the Grimes and Jonathan varieties will be especially valuable.
Information as to the self-sterility of self-fertility of the Rome and Wagener varieties are available from one place only. If we may judge from the other results,it is safe to say that both these varieties should be tried out under our conditions before we draw any conclusions in regard to their self-fertility or sterility.

The reason for the differences in the results as given in the above instances is no doubt due largely,if not entirely, to the fact that a variety may be self-sterile in one locality and self-fertile in another.

Darwin, in his " Cross and Self-Fertilization" writes of a plant that was self-sterile in Brazil but when introduced into England,became self-fertile in one or two generations. Seed from this variety was later taken back to Brazil when the plant again became self-sterile after being subjected totheir conditions. Another example that is especially good was found on the R.S.Wallace fruit farm near Portland,Oregon. A block of Bartlett pears containing 72100 trees large enough to carry 50 # each hardly averaged six specimens per tree. Mr. Geo. W.Wescott, of Concord, California,however, has a block of 1000 Bartlett pears which gives good returns. Bartletts planted in this manner are commonly defective and,as a rule, do not give good results.

The same thing that is tnue of the Rhode Island Greening and the plant from Brazil, is true of many other self-sterile varieties and is doubtless the causeof the discrepancies in the lists of self-sterile and self-fertile varieties of apples. This peculiar phenomena makes it allthe more necessary to test the commercial varieties in each locality. Varieties of apples , for example,as the Gravenstein or Northern Spy and other self-sterile varieties are, as a rule, perfectly cross fertile. Examples of this are abundant. Most of the self-sterile varieties will set an occasional fruit under self-pollination.

It is claimed that the self-sterility of the Winesap appls can be correlated with the soil and elevation of the orchard. This variety gives good returns on rich bottom lands but upon uplands with thin soil the fruit drops badly. The soil requirements are, to a certain extent, just the opposite with the Jonathan variety.

Immense blocks of Ben Davis apples are frequent in the middle west. This demonstrates that the BenDavis is completely self-fertile in that section. The Janet is often necessarily self-fertile as it blossoms exceptionally late.

Baldwins areprobably as nearly self-fertile as any variety of aples but the percentage of fruit set under self-fertilization is only about one-fourth that of cross-fertilized trees.

Pollination of pears has been extensively studied in New York and Virginiaby the Division of Vegetable Physiology and Pathology,(Farmers Bull. No. 65). Of the thirty-eight varieties tested,the majority were entirely self-sterilebut set fruit well when pollinated with other varieties. Prof. S.W.Fletcher has perhaps done more work along this line than any other investigator.His bulletin "Pollination of Bartlett and Kieffer Pears" (Rpt. of the Va. Agr. Exp. Sta.,1909-10) and "Pollination in Orchards" (Cornell Agr. Exp. Sta. Bull. No. 181) are especially valuable. Pollen from another tree of the same variety proved to be no more effective that that from another branch of the same treeor from the same flower. Even in the varieties found to be self-sterile,cross-pollination appeared to be more certain and more satisfactory under adverse conditions.
According to M.B.Waite,in U.S.D.A. Yearbook for 1898,the seeds of self-pollinated Bartletts were much smaller thancross-fertilized ones.

Work with plums also indicate that cross-fertilization is advantageous with a large number of plums and it is necessary at least in a few cases. At the Vermont Station (Farmers Bull. No. 65) it was found that one variety out of fourteen tested set fruit normally by self-pollination. Other experiments have given similar results. European and Japanese plums have not been shown as yet to need cross-pollination. Self-sterility seems to be confined to the native Americana plums and to the prunes of the Pacific coast,notably those of California. As a rule the Lombard and Bradshaw varieties cause little or no trouble along this line.

It is probable that in some cases of apparent self-sterilityin plums, the causes are really due to defective pistils rather than to any impossibility of self-fecundation. Studies made at the Iowa, Wisconsin and Vermont stations (Farmers Bull No 65) all show that often a high percentage of the pistils of some varieties are defective. This tendency in some cases seems to be an individual rather than a varietal character. Perhaps a large part of the sterility of apples may be due to the same cause.

There is no very well proven case on record of the self-sterility of peaches. The Delaware station however, gives a few varieties that are more or less self-sterile.

There is no definite case of self-sterility in quinces. It is further stated that cross-pollination in quinces makes very little, if any, difference in their productivity.

At the California station a sterility test of olives showed that the smaller varietiesfailed to set fruit when the blossoms were confined in bags. The larger varieties were self-fertile and the medium sized ones showed variable tendencies (Farmers Bull. No. 65).

The New York station has studied the sterility of grapes for several years. They found that , out of 145 varieties tested, 86 were practically self-fertile and 49 entirely self-sterileor producing imperfect clusters when self-pollinated. The Georgia station tested 116 varieties and found 90 mostly self-fertile and 26 self-sterile. The Minnesota station gives a similar report and attaches alist of self-fertile and self-sterile varieties.

Other fruits that have given evidences of self-sterility are raspberries, blackberries,dewberries and gooseberries.

Pistillate varieties of strawberries go only a step further and make cross-fertilization absolutely necessary. Here, the stamens are usually absent, or, if present at all, they are rudimentary and functionless.

Since many of the self-sterile fruits are among the most desirable, discarding them is out of the question. Who would consider for a minute, discarding the Jonathan or Gravenstein apple, the Bartlett pear, the Mark Hanna or Buback strawberry. Discarding these varieties would often be necessary were it not for our knowledge of the question of self-sterility.

Most standard texts on fruit growing give lists of self-fertile and self-sterile varieties of the different commercial fruits. There are a number of excellent bulletins also containing this material, however, there is much to be done before these lists will be at all complete.

The causes and remedies of self-sterility are given later under separate headings.

HISTORY.

The first information concerning gender in plants was given out by the discoverer, Joachim Camerarius, a German, in 1691.

Dr. Joseph Gottlieb Kolreuter was perhaps the first to make observations concerning the pollination of flowers and the relation of insects to pollination. In about the year 1763, he made observations concerning the pollination of the fig tree and also in regard to the necessity for pollination of the families Iridaceae and Cucurbitaceae by means of insects.

Christian Konrad Sprengel closely followed Kolreuter and, in his work " Das Entdeckte Geheimnis der Nature in Bau und in der Befruchtung der Blumen" (The Disclosed Mysteries of Nature in the Structure and Blossoming of Flowers), he treats of the floral adaptations in nearly 500 species of plants. In writing of the pollen of wind-fertilized flowers, he describes it as being very buoyant and readily carried away by the slightest breath of wind. He also says " It seems that nature is unwilling that any flower should be fertilized by its own pollen" (Knuth's Handbook of Flower Pollination, Trans. by J.R.A. Davis).

Thomas Fairchild, in 1791, made one of the first hybrids by crossing a carnation and sweet William.

Thomas Andrew Knight, as aerly as 1799, through his results on cross-fertilization, formed the conclusion that no plant fertilized itself for many generations. He also discovered that varieties could be improved by introducing new pollen.

Van Mons, a Belgian, furthered the work somewhat by his " Doctrine of Continuous Selection" .

It remained for Charles Darwin to bring forth the most startling revelations. In his "Origin of Species", he informs us in no uncertain terms, that nature tells us in the most emphatic manner that " She abhors perpetual self-fertilization". He also says " No organic being can fertilize itself through an unlimited number of generations;but a cross with other individuals is occasionally,perhaps at very long intervals, indispensible".He amends in a measure the above statement by saying in his "Cross and Self-Fertilization in the Vegetable Kingdom" that there is a large class in which flowers present no apparent obstacle,of any kind, to self-fertilization. Nevertheless these plants are frequently inter-crossed owing to the propotency of the pollen from another individual or variety above the plant's own pollen". He further says," We should always keep in mind the obvious fact that the production of seed is the chief act of fertilization and that this end can be caused by hermaphrodite plants with incomparably greater certainty by self-fertilization than by the union of the sexual elements belonging to two distinct flowers or plants". In his "Cross and Self-Fertilization" Darwin showed that in the fifty-seven varieties tested,practically all of the cross-fertilized plants were the tallest,heavist and most fertile. The crossed plants also possessed greater constitutional vigor,especially as they approached maturity. Crossed plants generally flowered before the self-fertilized ones,as was shown by his experiments with Brassica Oleracea and Mimulus lutens. He says " Self-sterility differs much in degree in different plants".

Fritz Muller,in South America, followed Darwin by publishing numerous works on flower pollination,adaptationsfor securing pollination,the poison like action of pollen in self-fertilization,and the parts played by humming birds in fertilizing Abutilons. He showed, in his experiments with hybrid Abutilons,that the union of brothers and sisters,parents and children,and other near relations was highly injurious to the

the fertility of the offspring.

These investigations have since been carried on largely by our Agricultural Colleges and Experiment Stations.

Especially important recent investigators along this line are: M.B.Waite, S.W.Fletcher, F.A.Waugh, S.A.Beach, C.P.Close, W.M.Munson, U.P.Hedrick, C.I.Lewis and C.C.Vincent, and several others.

CAUSES OF SELF-STERILITY.

There has been several causes of self-sterility advanced. Some of these causes are :

1. Winter killing of buds or blossoms by late frosts. This is evidenced by a blackened condition of the pistils. The stamens are rarely injured.

2. Effect of rainy weather on the vitality of the pollen.

3. Proterogyny , or premature development of the pistils.

4. Proterandry , or premature development of the stamens.

5. Deficiency of the pollen supply.

Our common potatoes generally fail to set bolls because their anthers are usually deficient in pollen.

6. Defective pistils.

A moderate number of defective pistils will greatly in fluence the fruitfulness and percentage of fruit set.

7.Changes of environment due to domestication may affect the fecundity of the reproductive organs.

8. Asexual propagation such as cuttings and buds, tends to reduce the importance of seed selection and favors degeneration of the sexes. Propagation by seeds is seldom practiced in orcharding except in the development of new varieties.

9. Breeding and selecting for other qualities than seed production favor these new qualities at the expense of seed production.

10. Promiscuous crossing and re-crossing tends to degenerate the sexual organs and to reduce fruitfulness.

A large percent of our hybrids in nature are sterile. A good example of this is the mule. Nature emphatically objects to too sudden changes.

11. Over-vigorous wood growth.

This may often take place at the expense of fruitfulness.

13. Lack of mutual affinity between the pollen and the pistils.

This question is disputed by some authorities.

Is there a similar force manifested to correspond with the likes and dislikes as in the case of animals?

13. Poor culture.

Poor culture is responsible for most of the barrenness in fruit trees (Fletcher in " How to make a Fruit Garden").

14. Excessive feeding and possibly over cultivation.

Nitrogenous fertilizers.

This may cause an excessively vigorous wood growth at the expense of seed production. A stallion or bull can be overfed sufficiently to seriously impair, if not entirely destroy, his breeding powers.

15. Season of pruning.

Pruning during the dormant season favors wood growth while pruning during the growing season enhances fruitfulness.

16. Insects or fungous diseases may kill the blossoms.

Apple scab and brown rot may blast the blossoms, (Fletcher, in Bull. No. 181, Cornell Agr. Exp. Sta.). Pear blight often kills the blossoms. This however, is generally apparent.

17. Protracted cold rains.

Little damage is done from rain except for retarding the development of the blossoms unless they last for a week or more, (Fletcher, in " How to Make a Fruit Garden").

18. The effect of self-sterility may be similar to the effect of in and in breeding in animals.

Degeneracy and loss of breeding powers often follows the use of this practice in breeding animals.

There are numerous opportunities in the plant kingdom for this to take place. Will this explain why varieties of peas and potatoes "run out" after a certain munber of years?

Elevation.

Certain varieties are adapted to certain elevations. Anexample is given as follows: The Winesap apple is not adapted to the higher regions while the Jonathan is fairly well suited to such conditions.

20. Exposure.

This is closely correlated with No. 19. The exposure influences, to a certain extent, the time of blossoming.

21. Inability of the pollen tubes to penetrate the stigma to a sufficient depth and the inability of the proper sperm nucleus to unite with the corresponding egg cell.

22. The pistil may be longer than the stamens.

This may be regarded as an evidence nature intended the plant to be fertilized by other means than with its own pollen.

23. The pollen and stigma may be mature at different times.

24. Condition and general environment.

Conditions of light, temperature, moisture etc. must unavoidably act on the delicate and sensitive sexual elements.

E.S.Goff, in the Wisconsin State Report for 1901, said " As long as the trees are envelbped with dew or enveloped in a fog practically no anthers burst" . This was proven by saturating the atmosphere under a bell jarfor 56 hours. Apple,cherryand plum pollen was placed under the bell jar and a duplicate sample was placed in dry air. Nearly all the anthers in the dry air had burst while few of theose under the bell jarhad changed materially. A temperature of -- 1 ° C.)Goff) caused permanent injury to the stigma of the apple,pear,peach,plum and cherry.

Examination of the stigmatic surface shows that it is extremely tender and delicate. The surface is composed of a soft cushion-like layer or covering with a thin,delicate epidermal layer that offers little resistance to unfavorable conditions.

25. Lack of viability of the pollen.

According to,an experiment conducted in one of theeastern states, the pollen from a highly cultivated orchard was more viable than that from a poorly cultivated orchard. In the first case the percent of viable pollen ranged from 49 to 60 percent while in the second case it ranged from 28 to 55 percent.
The pollen from the neglected orchard was also lacking in size, plumpness and regularity. It took a longer time for it to germinate. From the same source the writer read that pollen could be kept for six months or longer if placed in a dry place with a temperature of 7 to 26°C In Bull. No. 104 of the Oregon station the writers state that pollen can be kept for about three weeks.

METHODS OF CONTROLLING SELF-STERILITY.

Fortunately self-sterility,in a large number of cases, may be easily controlled by the use of proper pollenizers.

By a "Pollenizer", the writer means "A plant that will pro - duce pollencapable of fertilizing the pistils of the self-sterile variety.". The pollenizer is usually alternated with the variety to be pollinated. This is done in several waysdepending upon: First, the market value of the pollenizer,Second,The amount of pollen it producesand Third, The Mutual Affinity or avidity of the pistils of the variety to be pollinated forthe pollen of the pollenizer. Other things being equal, the writer prefers having two rows of the pollenizer alternated with two rows of the variety to be pollinated. Where a solid block of one variety has been planted , some of the trees may be top-worked with the pollenizer. There are several conditions to be considered in the selection of a pollenizer.

The following things should be considered in the selection of a pollenizer:

1. It must blossom at the same time as the variety to be pollinated. The blossoming period must at least overlap so that cross pollination by means of insects and wind can take place. This must be determined for each locality. Varieties that bloom a day or two apart in the north may bloom a week or more apart in the south.

2. There must be an affinity between the varieties so that the pistils of the variety to be pollinated will readily accept the pollen from the pollenizer. This avidity for a particular pollen may be one of the reasons why cross-pollination often causes an increased size in the fruit. This affinity can be discovered only by experimenting with the given varieties.

Fletcher gives an example of a Seckel pear that was pollinated by both the **Kieffer** and Lawrence varieties.. He found that much larger pears were produced when Kieffer pollen was used.

3. Arrangement of rows in planting.

There must be a sufficient number of rows of the pollenizer to furnish an abundance of pollen.

4. Determine the commercial varieties that can be planted together with the best results.

5. Market value of the pollenizer.

6. Varieties should be so located that each shall assist in the pollination of the other.

7. Habit of growth.

These should not be too different. One apple ~~will~~ not start to bear as early as another. In that case there will be a lack of bearing of both varieties till the pollenizer becomes old enough to perform its proper functions.

8. Quantity of pollen produced by the pollenizer.

It is necessary to plant shy and heavy pollen producers together. Most of our common varieties howveer, produce an abundance of pollen. A few of our commercial apples are here classified according to their pollen producing ability. The data here used is taken from Oregon Agr. Exp. Sta. Bull. No. 34.

Abundant Pollen Producers.	Medium Pollen Producers.	Scant Pollen Producers.
Baldwin.	Early Harvest.	Rambo.
Fall Pippin.	Grimes.	Winesap.
Pumpkin Russet.	Romanite.	
Oregon Crab.	Missouri Pippin.	
Tetofsky.	Oldenburg.	
Whitney No. 20.	Rome.	
Hyslop Crab.	Transcendent Crab.	
Yellow Siberian Crab.	Martha Crab.	

9. If affinities exist, indiscriminate mixing of varieties may do more harm than good. Avoid mixing very distinct species. To properly arrange the trees in an orchard, it is necessary to know both the blossoming data and the pollen producing ability of each variety planted. In planting a mixed orchard however, there will be relatively little trouble in securing pollination

10. Self-fertile varieties may produce better if they are cross-pollinated. As has been said before, this is especially noticeable in the case of the Baldwins.

11. There may be a pronounced increase in size. The tendency of hybrids of the first generation is usually larger than either of the parents. As an example the F_1 generation of a cross of Barkshire on Poland China hogs is generally larger in size than either of the parents. Subsequent crosses will not often give satisfactory results but nature does not ordinarily carry these crosses in orchard work past the F_1 generation.

BLOSSOMING PERIOD OF APPLES.

One of the best methods of controllong self-sterility is to alternate the varieties. To secure the best results, as has been said before, one must select varieties that blossom at the same time or varieties whose blossoming period interlaps. The blossoming period varies graetly from year to year. The relative blossoming period however, varies but little. In order to plant successfully, then, one should know at least the comparative dates of blossoming of the more important varieties of apples. Prof. L.B.Judson, formerly of the Horticutural Department of this station, compiled such a list and included it in his report to the director for 1905. This table, as well as the one compiled from notes taken by the author in 1912, were taken in the college orchards. Both extend from the beginning of the blossoming period until the trees were in full bloom. Consequently the total blossoming period is a few days longer than it would seem from the above tables.

Blossoming Data of Apples at the Idaho Agricultural Experiment Station, by L.B.Judson, Report for 1905.

Variety.	Year 1904.	Year 1905.
Ben Davis	May 11-20	May 2-9
Blue Pearmain	" 11-16	" 3-9
Early Harvest	" 6-16	" 3-8
Gano	" 11-20	" 4-11
Gravenstein	" 5-14	April 30- May 8
Jonathan	" 13-22	May 3-10
King	" 12-19	April 27--May 7
MaidennBlush	" 6-16	" 30- " 6

Missouri Pippin	May 10-18	April 29- May 7
Red Astrachan	" 5-14	" 25- " 4
Red June	" 14-19	May 4-11
Rhode Island Greening	" 13-20	" 2-9
Rome	" 16-22	" 7-14
Spitzenburg	" 5-18	" 1-9
Twenty Ounce	" 11-18	" 2-9
Walbridge	" 10-16	" 2-9
White Winter Pearmain	" 10-19	" 3-12
Whitney No. 20.	" 12-18	" 2-10
Winesap	" 13-20	" 6-12
Wolf River	" 13-20	" 3-8
Yellow Transparent	" 11-19	" 4-10

Apple Blossoming Data for 1912, Idaho Agr. Exp. Sta. Orchard,

By C.H.Heard.

Variety.	Date.	Variety.	Date.
Alexander	May 14-23	Grimes	May 13-17
Arkansas Black	" 14-22	Haas	" 12-16
Bailey Sweet	" 13-19	Hitt	" 14-19
Baldwin	" 13-19	Hyde's King of the West	" 14-19
Ben Davis	" 14-23	Jeffries	"" 15-24
Ben Hur	" 14-19	Jonathan	" 13-19
Bismark	" 13-19	King	" 13-18
Blue Pearmain	" 13-18	King David	" 14-19
Cox's Orange	" 13-23	Maiden Blush	" 13-18
Duchess	" 11-14	Mann	" 14-22
Early Harvest	" 12-17	McIntosh	" 13-16
Elkhorn	" 15-22	McMahon White	" 14-18
Gano	" 14-23	Minkler	" 12-18
Gravenstein	" 12-17	Missouri Pippin	" 14-20

Variety.	Date.	Variety.	Date.
Northern Spy	May 17-22	Wagener	May 12-16
N.W.Greening	" 15-19	Walbridge	" 14-18
Primate	" 13-18	Wealthy	" 13-18
Red Astrachan	" 12-16	White Winter Pearmain	" 15-25
Red June	" 15-23	Whitney No. 20.	" 14-17
Rhode Island Greening	" 14-22	Winesap	" 18-24
Rome	" 16-24	Winter Banana	" 14-23
Spitzenburg	" 13-19	Wismer	" 15-18
Talman Sweet	" 16-24	Yellow Bellflower	" 14-19
Tetofsky	" 12 14	Yellow Newtown	" 15-23
Transcendent Crab.	" 12-16	Yellow Transparent	" 14-18
Twenty Ounce	" 14-18		

POLLINATION OF FLOWERS.

Flowers may be classified in regard to pollination under two main heads.

I. Self-fertilized flowers. Flowers in which no foreign agency is needed to insure proper fertilization of the ovule and where cross-fertilization is often impossible.

II. Cross-fertilized flowers. Flowers which demand pollen from another plant to insure proper fertilization.

Some of the agencies that are usefùl in cross-pollination are:

I. The Wind.

Flowers pollinated by this agency areusually small and inconspicuous, contain an abundance of very light pollen and are usually odorless. Examples are corn,wheat, rye, beeches,oaks and birches.

Nature uses an abundance of pollen in wind-pollinated plants. Mr. Blackley found 1200 pollen grains adhering to a sticky glass slide that had been sent up on the tail of a kiteto a heighth of about 1000 feet.

II. Insects.

Flowers pollinated by insects are usually highly colored,often accompanied by an odor and usually containing nectar. The pollen is usually more or less sticky and is not easily blown about. Examples noted for their scent are mignonette and honeysuckle. This scent proceeds from their nectar glands. The iris is especially noted for its color. There are distinct (guide) lines ,the purpose of which is to conduct the insect to the nectar glands and, incidentally, to conduct it past the stigma which may need fertilizing. White flowers are more odoriforous than other flowers. The majoritynof these are probably fertilized at night by moths. These need the assistance of both the odor and the conspicuous color. Often, in plants of this character, the fragrance is scarsely perceptible during the day but is very strong at night. The insects particularly important in flower pollination are Hymenoptera(bees and wasps), Lepidoptera (butterflies and moths),and Diptera (flies).

Certain flowers as the petunia can only become pollinated through the agency of specialized moths which have an exceptionally long proboscis.

The insects, on entering the flower in search of nectar, become dusted with pollen. This pollen becomes rubbed off as the insect enters other flowersand other pollen is added to tkae its place. Thus the insect in coming in contact with the stigma of the flower deposits some of its pollen and insures the pollination of the flower. The plant, in return for the pollen it has received from other plants, allows the insects to deprive it of its nectar.

Insects cover more ground than is commonly supposed. Bumblebees have been found to fly at the rate of ten miles per hour. Darwin tells us of an instance where one is said to have visited twentyfour flowers of linaria in one minute.

III. Humming Birds.

These aid somewhat in the pollination of flowers. They are enabled, with the aid of their long beaks, to pollinate certain plants while in search of nectar. Muller tells of their importance in pollinating abutilions.

Bats,snailsand slugs also aid in the pollination of some plants.

IV. Water.

In the case of some aquatic plants. Darwin, in his "Origin of Species" says, " The beauty of fruits,serves merely as a guide to birds and beasts , in order that the fruit may be devoured and the seeds disseminated.

OBJECT.

The purpose of this thesis,as is stated in the title, is to determine whether the Grimes,Jonathan, Rome and Wagener apples are self-sterile or self-fertile.

The Problems to be Worked out are as follows:

I. Are the Grimes, Jonathan, Rome and Wagener apples self-fertile or self-sterile?

II. Is a single flower on a cluster capable of fertilizing itself.

III. Are the flowers on a single cluster capable of fertilizing each other?

IV. Will the pollen from a given tree fertilize the pistils of another tree of the same variety?

V. Is there any difference in the action of pollen matured in the flower and pollen of the same variety maturred elsewhere?

VI.Compare the flowers of the above varieties as to color of petals,odor and character of pistils and stamens.

VII. Is there a variation in the sterility and fertility of fruit trees? If so, why can we not select for reproductive ability as in the case of different animals? Shropshire sheep as a breed, are noted for their fecundity, yet there is a very great variation in their breeding powers.

VIII. Compare the results of the cages where several flowers were hand pollinated and those left as a check.

IX. Can a tree be sterile to its own pollen and fertile to pollen from other trees of the same variety?

X.Compare the results from enclosing the trees with cages and from bagging the single clusters.

METHODS USED.

I. Enclose three trees of each of the Grimes, Jonathan, Rome and Wagener varieties of apples in cloth cages before any of the blossoms open.

A. Enter one cage of each variety when the trees are in blossom and hand pollinate at random several clusters with pollen from clusters on the same tree. This will insure cross-pollination of the flowers on the same tree. If one cluster is unable to fertilize itself, perhaps other clusters may be able to do so.

II. Trim away several clusters of each variety to one blossom each and enclose in a two pound paper bag until the blossoming period is over and the trees have been fertilized. This experiment should determine whether a single fower in a cl cluster is capable of fertilizing itself.

III. Bag several entire clusters of each variety before the blossoms have opened. If an individual blossom in a cluster is unable to fertilize itself, other blossoms from the same cluster may be able to do so.

IV. Emasculate and bag several clusters of each vareity.

A. When the pistils are receptive, fertilize them with pollen of the same variety but from different trees. Enclose in paper bags till danger of fertilization from without is past. Label as follows:

	Jonathan No.		Jonathan No.
I.	Location.	II.	Location.
	Emas.(Date).		Sterile Test.
	Poll.(Date).		

No. I. on front of tag. No.II on back.

The front of the tag (No. I.) shows the location of the female and the date it was emasculated and pollinated. The back (No. II) shows the location of the male and indicates thatthe object is a sterile test.

The preceding problems will, in a general way, have determined whether the pollen from the same tree, the same cluster, or the same flower is capable of fertilizing the corresponding pistils. This problem should establish whether foreign pollen (meaning here, pollen from another tree of the same variety) will be able to fertilize the pistils on a different tree.

V. Determine if possible, from comparing results, whether a tree can be sterile to its own pollen and fertile to pollen from trees of the same variety.

Fig. I. Tree No. 267. Station Orchard No. III,

Typical Wagener used in this Thesis.

Fig. 2. Tree No. 360. Station Orchard No. III.
Typical Jonathan Tree.

Fig. 3. Tree No. 291. Grimes. Station Orchard No. III. Typical Specimen.

Fig. 4. Tree No. 332. Station Orchard No.III.

A Typical Rome.

Fig. 5. Wagener Tree in the Knapp Orchard Showing Bagging . Grape Vineyard with Peach Fillers at the Right.

Fig. 6. General View of Thesis Showing the Twelve Cages. The Varieties Reading from Left to Right are Jonathan, Rome, Grimes and Wagener.

Fig. 7. General View of Thesis .Taken Later than Fig. 6. The White Spots on the Trees Are Paper Bags.

Fig. 8. One of the 6'X6'X10' cages before being covered with the cloth. Wagener tree No. 265. The projecting limbs were either pruned back or tied in to scaffold limbs in the center of the tree.

Fig. 9. One of the 9'X9'X10' frames used in caging the Jonathans and Grimes varieties. This picture shows one of the Jonathans.

Fig. 10. Another view showing the cages.
Note the outline of the trees within the cages.
This method allows more ventilation and sunlight than the blossoms are enclosed in paper bags.

Fig. 11. One of the 9'X9'X10' cages after being covered with house-lining (grade C).
These cages eliminated practically all of the pollen.

Fig. 12. One of the cages after the cloth has been removed. Note the luxuriant growth of weeds (larger than those outside the cage). This picture was taken to show the favorable growing condition within the cages. There being more shade and less direct sunlight ,the moisture supply was greater than without. This fact was largely responsible for the excessive growth of weeds.

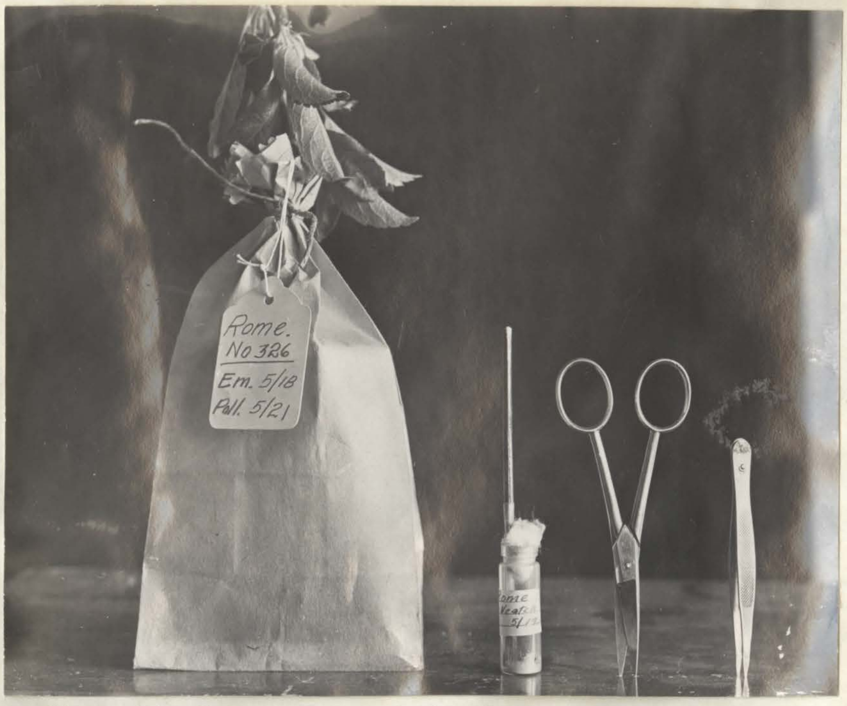

Fig. 13. Equipment used in Emasculation and Pollination. Scissors, forceps, glass vials, camels hair brushes, tags and 2# paper bags.

Fig. 14. Ripening of pollen under cloth covered cages in the greenhouse. Limbs of the desired variety are gathered and place under these cages. It is gathered whenripe and placed in the glassvials. Hort. Dept. Neg. No. 254. Courtesy of W.H.Wicks.

Fig. 15. Blossoms at the correct stage for Emasculating. No. 1 shows the proper time for Emasculating. It is desirable to choose the ends of limbs or spurs such as the one marked (X) as they are stronger and afford a good place to tie the bag.

Hort. Dept. Negatvie No. 259. Courtesy of W.H.Wicks.

Fig. 16. Removing the Petals preparatory to Emasculating.

Fig. 17. Emasculation. This consists of the removal of the anthers. Be sure to remove all of the anthers. Forceps and scissors are both used. The author prefers forceps.

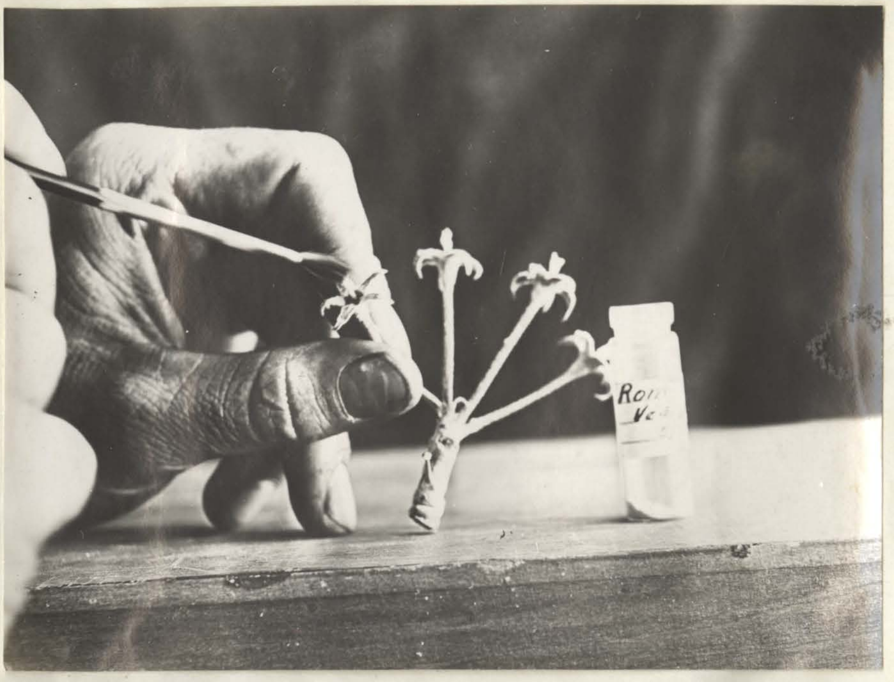

Fig.18. Pollinating. Applying the ripened pollen in the vial to the stigma of the flower by means of a camels hair brush.

Fig. 19. Stages of Emasculation.

No. I shows petalsready to be removed.

No. II Petals removed and stamens exposed.

No. III Petals and stament removed showing the exposed pistils.

Fig. 20. The author and P.W.Gray pollinating Wageners. The author applying the pollen and taking notes. P.W.Gray re-bagging.

Fig. 21. Same as above .Pollinating,taking notes, re-tying and labeling.

Fig.22. A heavily bagged tree in the Sterility Test.
P.W.Gray bagging the unopened blossoms.

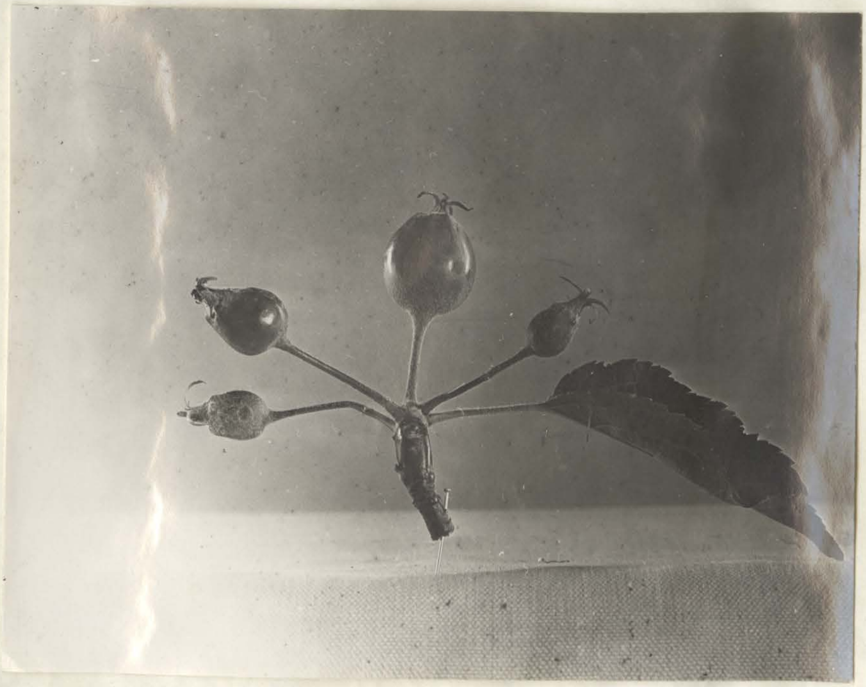

Fig. 23. Size of fruit when final notes were
taken on the setting of the fruit.

TEMPERATURE AND GROWING CONDITIONS WITHIN THE CAGES.

Some of the cages were entered through small openings made at the corner opposite the prevailing wind. This opening was immediatelt closed and tacked down as soon as the cage was entered. The table given below compares the temperature within and without the cages.

Size of cage.	Position of Thermometer.	Tree caged.	Temp. Cent.	Tree uncaged. Check.	Temp. Cent.
9'X9'X 10'	Tied to under bbranches.	No. 359.	21 1/2°.	No. 358.	21°.
	Sunny.	No. 359.	22 1/2°.	No. 358.	23 °.
9'X9'X 10'.	In center of tree.	No. 359.	22°.	No. 358.	19 3/4 °.
6'X6'X 10'.	Tied to under side of tree.	No. 323.	21 1/2°.	No. 321.	20 1/4°.
6'X6'X 10'	Tied to one of the high branches.	No. 323.	24°.	No.321.	22 1/2°.
6'X6'X 10'.	Inserted in soil to depth of 2". 1 1/2 ' from trunk of tree*	No. 323.	16 1/2°.	No. 321.	19 1/2°.
6'X6'X 10'.	In center of tree.	No. 323.	21°.	No.321.	21 1/2°.

* The soil was a great deal moister inside the cages.

A slight breeze was blowing while the writer was taking the temperature.The leaves on the outside were rustling while those on the inside were practically quiet.In covering the cages it was noticeable that they excluded practically all the wind. It took a very strong wind to cause the leaves inside the cages to stir. For growing conditions see Fig. 12, page 43.

DESCRIPTION OF THE FLOWERS.

Wagener.

Blossoms larger than in other varieties. Petals pinkish in appearance. Veinlets in the petals a deep pink. Odor stronger and somewhat more agreeable than in the other varieties. Stamens variable in length. Pistils relatively large and spreading. Style large and thick. Stigma greatly enlarged. Length of pistil variable. When just opened it it generally longer than the stamens. Two of the pistils are generally longer than the rest.

Grimes.

Blossoms smaller than the Wageners. Petals not as large. White in color, no pink being visible. The veinlets does not show any pink. The petals have a semi-brilliant lustrous covering. The odor is not as strong as the odor of the Wagener. Stamens variable in length. Pistils spreading. Stigmatic surface smaller than that of the Wagener. The pistils are usually above the stamens in flowers just opening. In some of the older flowers the pistils were bent down toward the stamens. This fact may indicate that pollen from their own stamens is used as a last resort.

Rome.

Blossoms medium in size. Petals not as large as those of the Wagener variety. Color white showing some pink. Odor of medium strength. Stamens of medium length. Pistils not so spreading and more compact in arrangement. Stigmatic surface not so large and prominant as in the case of the Wageners.

Variation in the length and position of the pistils. Some extend upward above the stamens while others are not as long.

Jonathan.

Flowers not as large as Wagener flowers.Petals set closer together and not as large as Wagener.Edges of petals pinkish in color.Veins of petals do not show much pink. Odor fainter and sweeter than the Grimes. Stamens quite variable in length. Pistils closer together than the pistils of the Wagener variety. They are not as spreading and also more slender.The stigma is not as greatly enlarged as in the case of the Wagener. The pistils , as a rule are shorter than the other varieties studied. They are generally completely below the tops of the stamens. Blossoms of this variety contain a great deal more necter than the Grimes,Rome or Wagener.

SETTING OF FRUIT UNDER NATURAL CONDITIONS.

In order to determine the amount of fruit set under natural conditions the writer tagged 20 clusters on each of ten trees of of the four varieties. These varieties were tagged on May 24 and notes were taken on the amount of fruit set onJune 15. The following tables indicate the results obtained.

WAGENER.

Tree No.	No. clusters bagged.	Avg. No.of flowers in a cluster.	Avg. No. of fruit set.	Percent of fruit set.	Percent of fruit failed.
249	20	5.95	2.95	49.6	50.4
250	20	5.95	3.70	62.2	37.8
251	20	5.50	2.95	53.6	46.4
270	20	6.10	3.20	52.5	47.5
271	20	5.50	4.05	73.6	26.4
272	20	5.55	4.30	77.5	22.5
274	20	5.60	3.35	59.8	40.2
275	20	5.65	3.15	55.8	44.2
276	20	5.75	2.50	43.5	56.5
277	20	5.45	3.05	56.0	44.0
GENERAL AVG.		5.70	3.32	58.3	41.6

GRIMES.

Tree No.	No. Clusters bagged.	Avg. No. of flowers in cluster.	Avg. No. of fruit set.	% fruit set.	% failed.
280	20	5.55	4.20	75.7	24.3
281	20	5.45	3.90	71.5	29.5
282	20	5.40	4.35	80.6	19.4
283	20	5.15	3.30	64.1	36.9
284	20	5.30	3.90	73.6	26.4
305	20	5.50	4.50	81.8	18.2
306	20	5.35	4.35	81.3	18.7
307	20	5.30	4.00	75.5	24.5
308	20	5.45	3.65	67.0	33.0
309	20	5.40	4.80	88.9	11.1
GEN'L AVG.		5.39	4.10	76.00	24.15

JONATHAN.

Tree No.	No. clusters bagged.	Avg. No. of flowers in cluster.	Avg. No. of fruit set.	% fruit set.	% Failed.
342	20	5.45	4.40	81.8	18.2
343	20	5.65	4.90	86.7	13.3
344	20	5.50	4.30	78.2	21.8
345	20	5.30	4.60	86.8	13.2
346	20	5.65	4.10	72.6	27.4
365	20	5.35	2.65	49.5	50.5
367	20	5.35	4.00	74.8	25.2
368	20	5.60	3.80	67.9	32.1
369	20	5.65	4.30	76.1	23.9
371	20	5.75	3.60	62.6	37.4
GEN'L AVG.		5.53	4.07	73.52	25.48

RESULTS FROM CAGED TREES.

Two methods were used in determining the results from the caged trees.

First Method.

Determine the total number of blossoms and the total number of fruits set on each tree by counting the number of clusters and the number of fruits set on one of the scaffold limbs. Multiply this result by the number of scaffold limbs on the tree. The number of blossoms can be obtained by multiplying the number of clusters by the average number of blossoms in a cluster secured from averaging the results from tagging the twenty clusters on ten trees of each variety. The average number of flowers to a cluster are given in the "General average" at the bottom of the tables on pages 53-56. Count the actual number of fruits set on each tree and compare this with the number determined from the above data.

Second Method.

Three limbs, one a large or scaffold limb and two smaller limbs were selected and the number of clusters and amount of fruit set on each was counted. This table will give the relative amount of fruit set and the percentages will perhaps be a little more accurate as no attempt was made to secure results from other than the limbs counted.

RESULTS FROM CAGED TREES.

Tree No.	No. of Clusters on limb.	No. of fruits set.	No. of scaffold limbs.	No. of cl. on tree.	Avg. No blossoms per cl.
		JONATHAN.			
359	90	33	5	450	5.5
360*	225	40	5	1225	5.5
361	160	5	5	800	5.5
Total.	475	78	15	2475	
		WAGENER.			
247	154	150	3	462	5.7
264*	14	18	2	28	5.7
261.5	0	0	?	0	5.7
Total.	168	168	5	580	
		ROME.			
322	100	6	5	500	5.5
323*	33	10	5	165	5.5
331	70	48	5	350	5.5
Total.	203	64	15	1015	
		GRIMES.			
292*	90	18	3	270	5.4
293	24	0	3	72	5.4
297	185	12	5	915	5.4
Total.	299	30	11	1257	

* Some of the blossoms hand-pollinated with pollen from the same tree.

FIRST METHOD.

Total No. of blossoms per tree.	No. of fruit set.	% of fruit set.	% failed.	Actual No. of apples counted.	Error.
		JONATHAN.			
2475	165	6.7	93.3	121	44
6737.5	200	3.0	97.0	182.	18
4400	25	0.7	99.3	38	13
13612.5	390	2.9	97.1	341	95
		WAGENER.			
2633.4	450	17.1	82.9	612	162
159.6	36	22.6	77.4	29	7
?	0	0	?	0	0
2793	486	17.4	82.6	641	169
		ROME.			
2750	30	1.1	98.9	26	4
907.5	50	5.5	94.5	57	7
1925	240	12.5	87.5	198	42
5582.5	320	5.7	94.3	281	53
		GRIMES.			
1458	54	3.7	96.3	52	2
388.8	0	0.0	100.0	3	3
4941	60	1.2	98.8	24	36
6719.8	114	1.7	98.3	79	41

RESULTS FROM CAGED TREES. SECOND METHOD.

Tree No.	Limb No.	No. of clusters.	Avg.No.fl. per cl.	Total No. of flowers.	No. set.	% set.	% failed.	Blossoming. % full.
				WAGENER.				
247	1	77	5.7	438.9	75	17.1	82.9	95.
*247	2	25	"	142.5	28	19.6	80.4	"
*247	3	23	"	131.1	33	25.2	74.8	"
		125		712.5	136	19.1	80.9	
264	1	14	5.7	79.8	18	22.6	77.4	3.
*264	2	13	"	74.1	11	13.5	86.5	3.
		27		153.9	29	18.8	81.2	

264.5 (Did not find any fruit set. Not more than three clusters blossomed.) 0.05

* Tree 247 bore a light crop last year. Nos.264 and 264.5 boreheavily.

Tree No.	Limb No.	No. of clusters.	Avg.No.fl. per cl.	Total No. of flowers.	No. set.	% set.	% failed.	Blossoming. % full.
				GRIMES.				
292	1	60	5.4	324.	12	3.7	96.3	70.
292	2	30	5.4	162.	9	5.6	94.4	"
292	3	10	5.4	54	1	1.9	98.1	"
		100		540	22	4.1	95.9	
293	1	26	5.4	140.4	2	1.4	98.6	15.
293	2	12	5.4	64.8	0	0.0	100.0	"
293	3	6	5.4	32.4	0	0.0.	100.0	"
		44		237.6	2	0.8	99.2	
297	1	65	5.4	351.0	6	1.7	98.3	70.
297	2	61	5.4	329.4	4	1.2	98.8	"
297	3	10	5.4	54.0	1	1.9	98.1	"
		136		734.4	11	1.5	98.5	

RESULTS FROM CAGED TREES: SECOND METHOD (CONTINUED).

Tree No.	Limb No.	No. of clusters.	Avg. No. fl. per cl.	Total No. of flowers.	No. set.	% set.	% failed.	Blossoming. % full.
				ROME.				
322	1	50	5.5	275.0	3	1.2	98.8	70
322	2	23	5.5	127.5	2	1.6	98.4	"
322	3	20	5.5	110.0	7	6.4	93.6	"
		93		512.5	12	2.3	97.7	
323	1	33	5.5	181.5	10	5.5	94.5	70.
323	2	15	5.5	82.5	1	1.2	98.8	"
323	3	20	5.5	101.0	18	16.4	83.6	"
		68		384.0	29	7.6	92.4	
331	1	35	5.5	192.5	24	12.6	87.4	70
331	2	15	5.5	82.5	4	4.8	85.2	"
331	3	21	5.5	115.5	9	7.8	92.2	"
		71		390.5	37	9.5	90.1	
				JONATHAN.				
359	1	60	5.5	330.0	22	6.7	92.3	80.
359	2	28	5.5	154.0	6	3.9	96.1	"
359	3	36	5.5	198.0	8	4.0	96.0	"
		124		682.0	36	5.3	94.7	
360	1	75	5.5	412.0	12	2.9	97.1	90.
360	2	13	5.5	71.5	2	2.8	97.2	"
360	3	55	5.5	302.5	13	4.3	95.7	"
		143		786.0	27	3.4	96.6	
361	1	40	5.5	220.0	5	2.3	97.7	90.
361	2	34	5.5	187.0	1	0.5	99.5	"
361	3	18	5.5	99.0	2	2.0	98.0	"
		92		506.0	8	1.6	98.4	

ENCLOSING CLUSTERS IN PAPER BAGS.

STATION ORCHARD NO. III.

Tree No.	No. of clusters.	No. of blossoms.	No. of fruit set.	Avg. No. of blossoms per cl.	% fruit set.	% failed.	Date bagged.	Date final notes.
			WAGENER.					
258.	65	65	10	1	16.9	81.3	5/13.	6/13.
258.5*	4	4	3	1	75.0	25.0	"	"
259.5	5	5	1	1	20.0	80.0	"	"
260	7	7	4	1	57.1	42.9	"	"
261	3	3	0	1	0.0	100.0	"	"
266.	5	5	1	1	20.0	80.0	"	"
266.5	1	1	0	1	0.0	100.0	"	"
	90	90	19	1	21.1	78.9	"	"
251.5	38	76	15	2	20.0	80.0	"	"
253.5	18	36	3	2	8.3	91.7	"	"
258	58	116	15	2	13.0	87.0	"	"
260.5	2	4	1	2	0.0	100.0	"	"
	116	232	34	2	21.7	85.3	"	"
258	114	342	18	3	12.7	87.3	"	"
259	3	9	0	3	0.0	100.0	"	"
260	6	18	3	3	16.7	83.3	"	"
266	15	45	7	3	15.6	84.4	"	"
	138	414	28	3	6.8	93.2		

* Trees whose numbers end in .5 are fillers. For example tree No. 258.5 is the tree between trees No. 258 and 259.

ENCLOSING CLUSTERS IN PAPER BAGS.

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STATION ORCHARD NO. III.

Tree No.	No. of clusters.	No. of. blossoms.	No. of fruit set.	Avg. No. of blossoms per cl.	% fruit set.	% fail-ed.	Date bag-ged.	Date final notes.
				WAGENER.				
250.5	40	160	17	4	10.6	89.4	5/13.	6/13.
251.5	72	288	38	4	13.2	86.8	"	"
253.5	164	656	60	4	9.1	90.9	""	"
256.5	48	192	1	4 4	0.5	99.5	""	"
257.5	4	16	3	4	18.7	81.3	"	"
261	20	80	4	4	5.0	95.0	"	"
263	8	32	0	4	0.0	100.0	"	"
265.5	20	80	9	4	13.3	88.7	"	" "
273.5	8	32	3	4	9.4	90.6	"	"
	384	1536	135	4	8.8	91.2		
250.5	10	41	22	4.1	53.7	46.3	5/13.	6/14.
251.5	10	53	25	5.3	47.1	52.9	"	"
253.5	9	31	13	3.4	42.0	58.0	"	"
268.5	8	37	20	4.6	54.1	45.9	"	"
269.5	5	22	6	4.5	27.3	72.7	"	"
	42	184	86	4.5	46.7	53.3	"	"

ENCLOSING CLUSTERS IN PAPER BAGS.

KNAPP ORCHARD.

Tree No.	No. of clusters.	No. of blossoms.	No. of fruit set.	Avg. No. of blossoms per cluster.	% set fruit	% failed	Date bagged.	Date final notes.
			WAGENER.					
1	5	19	8	3.8	42.1	51.9	5/17.	6/17
2	1	1	0	1.0	0.0	100.0	"	"
3	1	2	2	2.0	100.0	0.0	"	"
4	4	18	4	4.5	22.2	88.8	"	"
5	9	25	12	2.8	48.0	52.0	"	"
6	39	120	39	3.1	32.5	67.5	"	"
7	30	119	32	4.0	27.7	72.3	"	"
10	17	56	19	3.3	33.9	66.1	"	"
11	15	61	19	4.0	31.1	68.9	"	"
15	2	9	5	4.5	55.6	44.4	"	"
17	1	5	2	5.0	40.0	60.0	"	"
32	8	22	7	2.8	31.8	68.2	"	"
34	6	23	8	3.8	34.8	65.2	"	"
35	1	3	2	3.0	66.7	33.3	"	"
36	7	25	3	3.6	12.0	88.0	"	"
40	8	28	8	3.5	28.6	71.4	"	"
50	16	51	25	3.2	43.9	56.1	"	"
52	3	10	5	3.3	50.0	50.0	"	"
	173	603	200	3.4	33.2	66.8	"	"

ENCLOSING CLUSTERS IN PAPER BAGS.

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STATION ORCHARD NO. III.

Tree No. No.	No. of clusters.	No. of blossoms.	No. of fruit set.	Avg. No. of blossoms per cluster.	% set fruit.	% failed.	Date bagged	Date final notes.
			GRIMES.					
290	13	13	1	1	7.7	92.3	5/15.	6/14.
291	11	11	1	1	9.1	90.9	"	"
294	5	5	0	1	0.0	100.0	"	"
295	10	10	0	1	0.0	100.0	"	"
296	36	36	3	1	8.3	91.7	"	"
298	30	30	2	1	6.7	93.3	"	"
299	56	56	6	1	1.1	98.9	"	"
	161	161	13	1	8.1	91.9		
							"	"
291	24	90	9	3.8	10.0	90.0	"	"
294	20	69	1	3.5	1.4	98.6	"	"
295	47	195	7	4.1	3.6	96.4	"	"
296	51	224	19	4.4	8.8	91.2	"	"
298	55	205	26	3.7	12.7	87.3	"	"
	197	793	62	3.9	7.8	92.2		

ENCLOSING CLUSTERS IN BAGS.

Tree No.	Location.	No. bl.	No. bl.	No. fruit set.	Avg. No. of blossoms per cluster.	% set fruit.	% failed.	Date bag-ged.	Date final notes.
				JONATHAN.					
357	Sta.Orch No. III.	18	18	4	1	22.2	87.8	5/15.	6/14.
40	Henderson.	25	25	1	1	4.0	96.0	5/17.	6/17.
50	Henderson.	24	24	2	1	8.3	91.7	"	"
		67	67	7	1	10.4	89.6	5/17.	6/17.
356	Sta Orch. No.III.	10	46	10	4.6	21.8	78.2	"	"
358	"	10	50	2	5.0	4.0	96.0	"	"
581	" No.V.	5	16	3	3.2	18.8	81.2	"	"
582	"	5	21	1	4.2	4.8	95.2	"	"
60	Henderson.	25	108	1	4.3	0.9	99.1	"	"
70	"	26	116	2	4.5	1.7	98.3	"	"
1	Knapp.	22	90	8	4.1	8.9	91.1	"	"
2	"	25	101	14	4.0	13.9	86.1	"	"
10	"	25	104	3	4.1	2.9	97.1	"	"
11	"	27	135	5	5.0	3.7	96.3	"	"
20	"	27	128	5	4.7	3.9	96.1	"	"
21	"	24	108	8	4.5	7.4	92.6	"	"
30	"	29	138	7	4.8	5.8	94.2	"	"
31	"	25	118	4	4.7	3.7	96.3	"	"
		285	1269	73	4.4	5.7	94.3		

ENCLOSING CLUSTERS IN BAGS.

Tree No.	Location.	No. Cl.	No. bl.	No. fruit set.	Avg.No. blossoms per cl.	% fruit set.	% failed	Date bagged.	Date final notes.
				ROME.					
326	Sta. Orch. No. III.	22	22	0	1	0.0	100.0	5/16.	6/14.
327	"	21	21	0	1	0.0	100.0	"	"
328	"	21	21	1	1	4.8	95.2	"	"
329	"	25	25	0	1	0.0.	100.0	"	"
		89	89	1	1	1.1	98.9	"	"
324	"	28	140	1	5.0	0.7	99.3	**	"
325	"	18	99	2	5.6	2.0	98.0	"	"
327	"	2	8	1	4.0	12.5	87.5	"	"
328	"	25	139	3	6.0	2.0	98.0	"	"
329	"	25	143	6	5.7	4.[illegible]	95.9	"	"
10	Henderson.	25	143	21	5.7	14.7	85.3	5/17.	6/18.
11	"	15	7o	3	4.7	4.3	95.7	"	"
20	"	25	165	2	6.6	1.2	98.8	"	"
30	"	23	110	6	4.8	5.5	94.5	"	"
50	Knapp.	26	144	3	5.6	2.1	97.9	"	6/17.
51	"	25	129	5	5.1	3.9	96.1	"	"
53	"	25	148	15	5.9	10.1	89.9	"	"
62	"	24	120	2	5.0	1.7	98.3	"	"
		286	1668	71	5.3	4.3	95.8		

SUMMARIES.

	No. Cl.	No. bl.	No. fruit set.	Avg.No. blossoms per cl.	% fruit set.	% failed
Station Orchard.	98	839	13	6.3	1.8	98.2
Henderson Orchard.	88	488	32	4.4	6.6	93.4
Knapp Orchard.	100	541	25	4.3	4.6	95.4
General Average.	286	1668	71	5.3	4.3	95.8

RESULTS OF POLLINATION EXPERIMENT.

Female.	Location.	Male.	Location.	Date Emasculation.	Date. Pollination.
		WAGENER.			
247.5	Sta. Orch. No. III.	Wagener	Sta. Orch. fillers. No. III.	5.14	5/18
248.5	"	"	"	"	"
249.5	"	"	"	"	"
250.5	"	"	"	"	"
251.5	" "	"	"	5/18	"
253.5	"	Wagener Heard.	Moscow Idaho.	5/14	"
273.5	"	"	"	"	"
274.5	"	Wagener	Sta. Orch. fillers. No. III.	"	"
276.5	"	"	"	"	"
277.5	"	"	"	"	"
278.5	"	"	"	"	"

GRIMES.

290	Sta. Orch. No. III.	Grimes.	Sta. Orch. No. III.	5/15	5/23
		"		"	"
291	"	"	"	"	"
				"	"
294.	"	"	"	"	"

RESULTS OF POLLINATION EXPERIMENT.

Age of pollen.	No. of clusters.	No. of blossoms pollinated.	No. fruits set.	% fruit set.	% failed.
		WAGENERS.			
7 Hrs.	37	124	6	4.8	95.2
"	17	68	1	1.5	98.5
3 Hrs.	17	63	6	9.5	90.5
"	4	12	2	16.7	83.3
"	1	3	0	0.0	100.0
2 Hrs.	4	19	1	5.3	94.7
5 1/4 Hrs.	19	19	5	26.3	73.7
6 Hrs.	56	81	11	13.6	86.4
"	3	6	0	0.0	100.0
6 1/2 Hrs.	18	36	2	5.6	94.4
"	12	34	0	0.0	100.0
7 hrs.	6	18	2	11.1	88.9
	194	483	36	8.1	91.9
		GRIMES.			
290	63	197	0	0.0	100.0
291	90	257	3	1.1	98.9
294	23	77	0	0.0	100.0
	176.	531	3	0.6	99.4

RESULTS OF POLLINATION EXPERIMENT.

Female.	Location.	Male.	Location.	Date Emasculated.	Date Pollinated.
			ROME.		
324	Sta. Orch. No. III.	Rome.	Veatch Orchard.	5/16	5/27
325	"	"	"	"	"
326	"	"	"	"	5/24
326	"	"	"	5/24	"
327	"	"	"	5/16	"
327	"	"	"	5/24	"
328	"	"	"	5/16	"
328	"	"	"	5/24	"
329	"	"	"	5/16	"
329	"	"	"	5/24	"
			JONATHAN.		
354	Sta. Orch. No. III.	Jonathan.	Sta. Orch. No. III.	5/16	5/24
356	"	"	"	"	"
357	"	"	"	"	"
358	"	"	"	5/15	"
583	Dwarf Orch. Station.	"	"	5/19	"
584	"	"	"	m "	"
585	"	"	"	"	"
586	"	"	"	"	"

RESULTS OF POLLINATION EXPERIMENT.

Age of pollen.	No. of clusters.	No. of blossoms pollinated.	No. fruits set.	% fruit set.	% failed.
		ROME.	0		
7 1/2 Days.	29	62	0	0.0	100.0
"	33	91	0	0.0	100.0
6 Days.	28	74	0	0.0	100.0
"	4	7	0	0.0	100.0
"	27	82	1	1.2	98.8
"	3	5	0	0.0	100.0
"	34	76	0	0.0	100.0
"	3	6	0	0.0	100.0
"	22	54	0	0.0	100.0
"	3	4	0	0.0	100,0
	186	461	1	0.2	99.8

JONATHAN.

Age of pollen.	No. of clusters.	No. of blossoms pollinated.	No. fruits set.	% fruit set.	% failed.
3 Days.	23	63	3	4.8	95.2
"	39	90	0	0.0	100.0
"	51	144	0	0.0	100.0
"	38	110	0	0.0	100.0
"	8	16	1	6.3	93.7
"	22	4	0	0.0	100.0
"	10	20	2	10.0	90.0
"	3	5	0	0.0	100.0
	174	452	6	1.3	98.7

SUMMARY OF RESULTS CONTINUED.

Experiment.	Number of blossoms.	No. Set.	% Set.
ROME (Continued).			
Pollination Work.	461	1	0.2
Cages. (First Method).	5582	320	5.7.
(Second Method).	1287	78	6.1.
Natural Conditions. 200 cl. Avg. 5.46 fl. per cl. set 46.5 %.			
WAGENER.			
Bagging (Single Flowers)	90	19	21.0
Bagging (Clusters).			
Station Orchard.	1536	135	8.8.
Station Orchard(2)	184	86	46.7.
Station Orchard (3).	232	34	21.7.
Station Orchard (4).	414	28	6.8.
Knapp Orchard.	603	200	33.2.
Average.	2969	483	16.0.
Pollination Work.	483	36	8.1.
Cages. (First Method).	2793	486	17.4
(Second Method).	886	165	19.1.
Natural Conditions. 200 cl. Avg. 5.7 fl. per cl. set 58.3%.			

certain extent, to fertilize themselves. This was especially true of the Wagener. It varies, however, with different varieties.

VII. The flowers of a given tree may fertilize the blossoms on that tree. The same limitations as in No. VI. apply here. Very few blossoms of some varieties are fertilizwed in this manner.

VIII. The writer was unable to detect any material difference between the action of pollen matured on a tree and the pollen matured on another tree of the same variety. This was a minor problem and did not receive sufficient attention to merit any definite conclusions.

IX. A comparison of the flowers showed that the flowers of the Wagener variety were larger than those of the other varieties. The pistils of the Wagener were more spreading and the stigmatic surface was much larger. The pistils of the Jonathan variety were especially sticky. Other minor differences were noted.

X. From the fact that the blossoms are colored and possess attractive odors, it is probable that nature intended these blossoms to be fertilized by insects.

XI. These results show that there is a difference in the sterility and fertility of apples. The following variations int the per cent of fruit set under natural conditions were noticed.

Grimes. From 61.1 % to 88.9 % with an average of 76.0%.

Jonathan. From 62.6% to 86.8% with an average of 73.5 %.

Rome. From 27.2 % to 69.4 % with an average of 46.5 %.

Wagener. From 43.5% to 77.5 % with an average of 58.3 %.

If further investigation will disclose similar results, there must be a variation in the reproductive ability of fruit trees such as there is in animals.

XII. Sterility is not a constant character with a given variety. It varies somewhat with different trees. Variations in the per cent of fruit set of different trees can be found in several of the tables.

XIII. If such variations exist it is both possible and practical to select orchard fruits for their reproductive ability.

XIV. Hand-pollinating blossoms within the cages did not make any material difference in the results except in the case of the Grimes variety. The per cent of fruit set in the cage where some of the blossoms were hand-pollinated was 4.1 %. The other cages set were .8 % and 1.5 % respectively. In the other varieties the results were no higher than that of the other cages. The differences between the per cent of fruit set in the hand*pollinated and check cages of the Grimes is not necessarily due to the hand-pollination. Even greater variationssoccur in the amount of fruit set in the check cages of theother varieties.

XV. The writer did not observe any cases where a variety was sterile to its own pollen and fertile to pollen from another tree of the same variety.

XVI. By comparing the results of the bagged clusters and clusters that were tagged only, one can readily see that far more fruit is set under conditions allowing cross-pollination. The Following table shows this point clearly.

Grimes.

Normal percent of fruit set	76.0
Per-cent set when bagged	5.2

Jonathan.

Normal percent of fruit set 73.5

Per cent set when bagged 4.8

Rome.

Normal per cent of fruit set 46.5

Per cent set when bagged 3.0

Wagener.

Normal per cent of fruit set 58.3

Per cent set when bagged 12.3

XVII. It is not advisable to plant solid blocks of any of the varieties tested .

XVIII. It is advisable to compare in detail, the caging and bagging method of testing the self-fertility or self-sterility of fruit trees.

A comparison of the amount of fruit set by thw two methods is given below.

Grimes.

Bagging. 1485 blossoms set 78 apples or 5.2 %.

Cages. First Method. 6720 blossoms set 114 apples or 1.7 %.

Second Method. 1512 blossoms set 35 apples or 2.3 %.

Jonathan.

Bagging. 1788 blossons set 86 apples or 4.8 %.

Cages. First Method. 13613 blossoms set 390 apples or 2.9 %.

Second Method. 1975 blossoms set 71 apples or 3.6 %.

Rome.

Bagging. 2418 blossoms set 72 apples or 3.0 %.

Cages. First Method. 5583 blossoms set 320 apples or 5.7 %.

Second Method. 1287 blossoms set 78 apples or 6.1 %.

Wagener.

Bagging. 2456 blossoms set 302 apples or 12.3 %.

Cages. First Method. 2793 blossoms set 486 apples or 17.4 %.

Second Method. 866 blossoms set 165 apples or 19.1 %.

XIX. Enclosing blossoms places them under an unnatural enviromment. Light, temperature and moisture conditionds are all affected. These factors affect the delicate sexual organs. A small per cent of the failures are perhaps due to this cause.

XX. It would be advisable to carry on this work for several years as is the case with Experiment Station problems. Each years work would then serve as a check and the results obtained would not possibly be attributed to any peculiarities of season or other similar causes.; and the larger the numbers used,the more accurate the results. The present results however, are as reliable as can be expected from the work of one season.

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