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AN EXPERIMENTAL STUDY OF THE REST PERIOD OF PLANTS
THE EFFECT OF REST PERIOD BREAKING AGENCIES
UPON HARDWOOD CUTTINGS

by

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INTRODUCTION

It is a well known fact that a great majority of our woody plants root only sparingly and slowly, in many cases not at all, from cuttings. Bailey (11, p. 59)* in discussing cuttings says: "Some plants, as oaks and nut trees are propagated from cuttings only with great difficulty *****. It is probable, however, that all plants can be multiplied by cuttings if properly treated". With the latter statement in mind the writer undertook this investigation, to discover, if possible, some of these proper treatments.

The writer has been unable to find reports of any work done upon this subject. Much work, however, has been done within the past twenty years upon forcing into growth of plants of all kinds, hard wood twigs and pot grown plants, herbaceous perennials, bulbs, tubers, seeds and vegetables by the use of such agencies as ether, chloroform, desiccation, freezing, wounding, electricity, warm baths, nutrient salt solutions, radium, etc.. The rest period

of the plants has in a large number of cases, been much shortened and in some cases even entirely eliminated. The use of these agents in breaking the rest period suggested to the writer, the idea that they might be successfully used in inducing an earlier callus and root formation and that they might provide sufficient stimulus to cause the plants to produce adventitious roots thus making the use of these agencies a matter of economic importance in commercial nursery practice.

The following report deals with results obtained from trials of some of the above-mentioned substances. It is a continuation of the general study of the rest period of plants begun several years ago by Dr. W.L. Howard, then, of the Missouri Experiment Station. In this case the rest period of dormant cuttings was studied. The work was done under the direction of Professor W.H. Lawrence, successor to Dr. Howard, and the writer wishes to express his appreciation for the help and useful suggestions offered by him. This thesis will be in the nature of a preliminary report as it covers but a single season's investigations.

*See bibliography at end of paper.

HISTORICAL DISCUSSION OF THE REST PERIOD

Before proceeding further it will be of interest to review the theories regarding the nature of the rest period. For the purposes of this discussion, the rest period may be defined as: "a phase or stage in which plants are, for the most part, incapable of responding to favorable growing conditions" (Howard 53, p. 5). The rest period must not be confused with the dormant period, which, in our climate, begins in the autumn as soon as the leaves fall and continues until the buds open in the spring. The dormant period is brought about partly by the "voluntary inactivity" --internal-- and partly by a "forced inactivity"-- external (Johannsen 62, p. 9). This "forced inactivity" results from unfavorable external conditions such as extreme cold or lack of moisture which make growth impossible. This forced inactivity is most influential, in the temperate zones, in late winter or early spring, at which time many species of plants have finished their rest period and are only awaiting favorable weather conditions to push forth their buds. The cause and control of the rest in plants have for a long time been a subject of much study, not only because of their scientific interest but because of the practical value which might result from a knowledge of these facts.

In spite of the vast amount of work done upon

this subject there still exists two schools of thought, directly opposed to each other, regarding the cause of the rest period. One school claims that the rest period is caused by changing external conditions, while the other considers that it is the result of fixed, hereditary, internal conditions. A middle stand is taken by some workers, who attribute the rest period to a "co-operation of an hereditary tendency to rythm with the after effect of periödic repetition of reactions induced by external conditions" (Pfeffer 91, p. 214). This diversity of opinion, among the workers, as to the cause of the rest period in plants is, no doubt, due to the variety of materials worked with and to the lack of exact reliable experimental data.

Among the older workers we find that Grisebach (Pfeffer 97) in 1872, considered the yearly periodicity, in plants of temperate zones, to be entirely an hereditary property, due probably to natural selection of plants to withstand the alternating external conditions through a long series of years. Askenasy (9) in 1877, on the other hand, took a directly opposite stand. He was able by a rise in temperature, a simple change of external conditions, to cause Forsythia viridissima and Cornus Mas to flower in December and Prunus avium in January. These results convinced him that the rest period was directly due to external conditions. Sachs (96) in 1887 made many unsuc-

cessful attempts to force tubers and bulbs, which ripen in the autumn, to put forth their germinal shoots during November, December, and January, when placed under favorable growing conditions. When the plants were placed under even less favorable conditions later in the season (in February and March) their germinal shoots were readily produced. As a result of these experiments, Sachs, gives the following conclusions: "I come to the conclusion that in the case of dormant period it may be a matter of very slow production of ferments, which are formed in the buds capable of growth, and that the possibility of putting existing reserve materials into the active state in which they are directly suitable for the requirements of growth, only appears when they have been produced in sufficient quantity". It is thus seen that Sachs believed the rest period to be due to a deficiency of soluble food and that its cessation was due to a gradual production of enzymes. He does not state whether internal or external causes are responsible for this deficiency nor does he state the nature of the process which increases these enzymes.

Pfeffer (91) in 1901 took a middle stand between the two schools; he believed that there were two forms of rest periods in plants, one he called "autonomic", due to inward causes, the other he termed "aitionomic", the result of external influences. Later, in 1904, he modified this view. After discussing the rise and fall of growth

in tropical plants he concluded that this rythm, inasmuch as the changes occurred during the most uniform outward conditions, was due to autonomic causes and "was independent of the external conditions". As the result of six years experimenting with the mold, Saprolegnia mixta, and years of work with the house leek, Sempervivum Funki, Klebs (65) disagreed with Pfeffer. He found that in the case of the mold, each stage of development required an alteration of external conditions and that the various stages of development could be produced or prevented at will by merely changing one or more factors of the environment. He obtained the same results with the house leek. In discussing the question, he declared that the external conditions at the different places on the stem caused internal differences and the formation of different organs. His stand therefore was that the changes in the form of plants were due to internal conditions but that these internal conditions were the direct result of external changes; in other words, he concluded that all rest periods of vegetation are traceable to one cause and that one cause is environment. Klebs (66) transferred forty living European plants from their native environment to Java to note the effect of changed external conditions. He found that the plants there continued to grow during periods when in Europe they would be at rest. These results further convinced him that periodicity depends very largely upon climatic and nutritive conditions.

Howard (49) from 1905-07 experimented with 283 species of deciduous trees and shrubs native to the temperate zone. He first tested their ability to grow by placing twigs from them, with their cut ends in water, in the greenhouse under favorable growing conditions. Those which failed to respond he subjected to artificial treatment. Discussing the results of these experiments he states. "This shows conclusively, that the majority of species, indigenous to the temperate climates, do not have firmly fixed rest periods from which they cannot be awakened". In this report he included only the winter rest in his investigations, yet in his general conclusions he thinks both summer and winter rest are due to unfavorable external conditions. If these unfavorable external conditions occur at regular intervals of time, the plant readily adapts itself to the new conditions and the rest becomes a habit which may continue to be repeated automatically for a longer or shorter period of time. The habit of rest thus induced is often very strongly fixed and is apparently transmissible. In his later works (52 and 53), Howard takes a different stand. In discussing the rest period of seeds, he says: "It is thus seen that the resting phase is due to internal causes". He came to this conclusion when a large percentage of the seeds tested failed to grow when placed under favorable environmental conditions. After a careful study of the physiological changes accompanying the breaking of the rest period (53), he concluded that

the resting phase of all plants is closely connected with the work of enzymes. The beginning of the rest, particularly in woody plants, he thought to be due wholly to inner causes which, however, might be hastened before the complete state of rest is reached, by external conditions. The end of the rest period, he thinks, may be due to inner causes but that this may be either hastened or delayed by the environmental conditions of the plant. He concludes this discussion with this statement. "For the most part, tho, it may be said that the rest sets in and later passes away, independent of outward conditions".

Müller-Thurgau's original conception of the rest period was very similar to that of Sachs. His later work in combination with O. Schneider-Orelli (86) led them to conclude that the rest period of plants was not dependent directly upon the amount of food material present nor upon low temperature only, but that the cessation of growth rests also upon the internal properties of the protoplasm of the meristem. These internal properties are inherited effects of the winter temperatures on the process of growth which after a long time become fixed in the protoplasm.

There is much experimental data to show that the effects of environment can overcome those of habit in causing plants to enter or break their natural rest period. Flammarion (35) in 1891, planted a number of acorns of Quercus robur in pots and kept them protected from winter conditions

for fifteen years with the result that the young trees have changed their habit of growth until they resemble evergreen species, in that the young leaves now appear before the fall of the old ones. Klebs (66) in 1963, reported some remarkable results with bulbs of Hyacinthus and Ficaria. He succeeded in making these plants grow throughout the year thus eliminating their natural long rest period. He believes that by using suitable cultural methods, this acquired habit of rest can be broken up with the majority of plants. Howard (49) cites a case in which northern and southern grown trees of different species were planted on the grounds of the Missouri Experiment Station in 1896. At first there were marked differences in the rate of growth and leaf fall between those from the different localities but after eight or nine years these differences were no longer present as the species from the different environments had taken on characters intermittent between the two extremes, thus adapting themselves to their new environment. These examples furnish experimental proof that environment may be much stronger than heredity in causing the rest period of plants.

Drude, Nauman and Ledieu (29) refer to the rest period as being due to certain metabolic changes within the plant itself. Johannsen (62) also states that the influences which cause rest may be designated as "inner causes". In discussing the rest he states that it is in the nature of a "hindrance" (Hemmung) which prevents growth, but when growth

is secured by treatment it is because this "hindrance" has been removed or greatly weakened or that the power of growth (Wachstumstätigkeit) is increased.

Schimper (97) in 1898 gave us the first real knowledge of the peculiar habit of tropical plants with reference to suspension of growth and rest. In places where favorable growing conditions exist for the entire year, many plants show a rhythmic alternation of periods of rest and activity of the growth processes. Schimper declared that this opinion was dependent upon a conception of the rest period differing from the one generally held. By this he meant that the whole plant did not undergo rest at the same time but that only individual functions rest for longer or shorter periods of times. Schimper states: "Tropical plants are just as subject to the periodic alternations of rest and of activity as are those of the cooler and cold zones.***** Internal causes are mainly or solely responsible for the alteration of rest and activity in a nearly uniform climate. Such a rhythmic change is, however, never abandoned, for it arises from the nature of the living organism and not from existing conditions; its connection with external conditions is a secondary feature -- an adaptation".

Since Schimper's work, the tropical plants have been a popular subject for study in determining the relation of external conditions to rest periods. Klebs (66) in 1911 reports the results of his studies on the tropical vegetation of Java where climatic conditions show little varia-

tion. Investigations were made with twenty four species of plants, exact measurements of twigs were made to determine the amount of growth made over a series of months, accurate data on leaf fall and other related phenomena were kept. He also cultivated a number of European and Japanese plants in Java. Native plants of Java were likewise transplanted in Heidelberg, where they were grown in a greenhouse under constant temperature and moisture conditions. These, his most recent studies, led him to firmly deny the existence of a periodicity of growth, which is independent of external conditions. To account for the rest period in tropical plants he formulated the following hypothesis: When the growth ability is weakened, by a deficiency in one or more of the external factors of growth, carbon assimilation proceeds at first at the normal rate resulting in a storage of organic materials. These materials check the activity of certain enzymes and thus cause a rest period. All means of breaking the rest period simply liberate these enzymes and allow them to become active. He lays great emphasis on salts as the means of breaking the rest period of tropical plants, since the factors of temperature and moisture are constantly favorable for growth in Java.

Volken (110) in 1912 reports the results of one year's investigations on tropical vegetation in Java. Although his observations were made in the same place and often even on the same trees as those of Klebs, he comes to different conclusions. He fails to see any relation between

the rest periods of tropical plants and external conditions.

He considers that they must be due to internal causes, although he offers no explanation as to the nature of the causes. Volkens does not include the factor of salts among the external conditions which may affect the processes of growth. He and Klebs do not have the same conception of internal causes. Volkens thinks that everything is governed by internal conditions, which cannot be influenced by environment; in other words he considers these internal causes as hereditary causes. Klebs, on the other hand, makes a distinction between inherited specific structures and internal conditions. He believes that the rest period is caused by a change in the inner conditions of the plants but he considers that these changed inner conditions are direct results of changes in external conditions.

Appleman (4) in 1915 reports the results of experiments in which he succeeded in eliminating the rest period of potato tubers by simply removing the skin. He was able in this way to sprout potatoes within ten days after planting at any time during the rest period. This elimination of the rest period was not due to water absorption from the exterior, for tubers with skins removed sprouted, even in dry storage, much earlier than those with skins intact. His experimental determinations show that the elimination or

abreviation of the rest period is correlated with increased oxygen absorption. He considers that under normal conditions the skin becomes suberized before the completion of some growth mechanism requiring oxygen. The ratio of oxygen diffusion through the suberized skin he considers to be the factor that determines the rest period in the case of potato tubers. He concludes his report with these words: "The rest period of the potato tuber is not firmly fixed and hereditary. It is not of internal origin due to autogenic metabolic changes, as it can be eliminated by means which maintain a proper adjustment between the bud tissue and external agents, chiefly oxygen. In nature the oxygen supply to the internal tissue is regulated by skin characters which are greatly influenced by moisture relations".

This rather brief discussion of the rest period shows that its cause is by no means a settled question. There is still much room for experimental work upon this question. For a more detailed discussion of this subject the following works should be consulted: Pfeffer's Physiology of Plants (91), Johannsen's Aether-Verfahren beim Frühtreiben (62) and Howard's first report on the Winter Rest (49).

EFFECT OF ARTIFICIAL AGENTS IN BREAKING THE REST PERIOD

Although there is much controversy over the cause of the rest period, the fact that it can be broken is now well established. Numerous attempts have been made to shorten the rest period of various plants, tubers, seeds and bulbs by artificial means and some have been successful. Little is known regarding the actual effect of these artificial agents. For the purpose of discussion, however, their effects may be considered under two heads.

A. The Growth Acceleration or After Effect upon
Resting Plants.

B. The Physiological Effect, or Immediate Effect
upon Plants.

A. Growth Acceleration, or After Effect of Artificial Agents upon Resting Plants

Müller-Thurgau (87) in 1885 shortened the rest period of potato tubers one month by storing at zero degrees centigrade. Johannsen (62) on November 17, 1893 showed for the first time, before the Academy of Sciences at Copenhagen, a lilac that had been forced by ether. The use of ether and chloroform in plant forcing dates back to this work. His theory is that the rest period is divided into three stages: 1. The early rest, in which the development

of the plants is diminishing. 2. The middle rest, a stage of complete rest. 3. The after rest, when development is ready to begin again. In the lilac, for example, the winter buds are said to be in early rest until midsummer, then in middle rest until the end of October. From the end of October until the end of December or January they are in the after rest stage. It is during this stage of after rest that the use of ether is most effective. Johannsen by the use of ether succeeded in forcing buds open from three to six weeks earlier than normal.

Howard (49) from 1905-07, in experiments previously noted (p.7) showed the influences of high temperature, of freezing and of desiccating in breaking the rest period. He made two collections of 283 species of deciduous trees and shrubs, one was made in November and the other in January. The plants were merely brought into a warm greenhouse, where favorable moisture and temperature conditions existed. Of the first collection over one half grew and about eighty-six per cent of the last grew. Special forcing treatments were tried upon those species that refused to grow when untreated. The treatments tried were ether, freezing, drying and confining in a moist dark-chamber. Between November 17, and December 24, 1905, one hundred thirty-three different species were treated and all but seven were caused to grow by January or earlier.

Aymard (10) in 1903 found that roots of Lily-of-the-valley placed under a bell jar with phosphoric anhydride and other drying liquids forced even more quickly than when submitted to ether vapors. Molisch (82) in 1907, caused an earlier opening of buds by immersing cut branches of various trees and shrubs in water at 35 degrees centigrade, from nine to twelve hours. The following year the same treatment was successfully used in stimulating the growth of certain bulbs and tubers, as well as in hastening the germination of seeds which had undergone a portion of their rest period. Stuart (99, 100, and 101) in 1906, discovered that placing plants in a vacuum was an effective method in causing plants to break their rest period. Bos (17 A) in 1907, was able to arouse plants from their dormancy by the use of the galvanic current. McCullum (81) in 1909, used ethyl bromide and other vapors in arousing potato tubers from their quiescent state. He also used carbon tetrachloride, ammonia, gasoline, ethylene chloride, and bromine with almost as good success. Weber (111) in 1910, found that wounding and in addition thereto, injecting water at the base of the bud caused an earlier growth in the buds of dormant twigs. In 1911, Jesenko (59) found that injecting weak solutions of hydrochloric, sulphuric, and tartaric acids, as well as alcohol and water, saturated with carbon dioxide, into the stems of woody plants caused

an early growth of buds. Harshberger (41) found that resting buds treated with ammonium hydroxide forced much quicker than untreated buds. In 1912, Lakon (69), in an endeavor to test Klebs conception regarding the importance of salts in bud growth stood cut twigs of trees and shrubs in Knop's solution. In some cases the rest period was shortened from two to three weeks and in all cases but one there was an earlier unfolding of the buds than normally. Howard (53) in 1915, reports bathing twigs in plant extracts, copper sulphate, potassium chloride, sodium nitrate, oxalic and acetic acid dilutions, has shortened the rest period. The same author reports that painting twigs with manganese dioxide has a similar effect.

Howard (53, p.6) in discussing the value of these artificial agents says: "The value of agents and methods for breaking the rest period varies with the species and other factors, such as time and intensity of application, condition of the twig, etc.. Some agents are more effective than others. In general, the intensity of all treatments, that is, the concentration of the liquids, the density of the vapors, the duration of application, or the degree of heat etc., must be decreased as the season advances and as the close of the rest period is approached. Applications which are effective in December may be very injurious during March". Practically all the workers agree with this

statement concerning the intensity of the treatments.

This brief review merely gives the originators of new methods of breaking the rest period. These various methods, both alone and in combination, have been successfully used by many workers since their introduction. The writer has made no attempt to outline the results obtained by these various workers. A more detailed account of forcing practices and methods of breaking the rest period may be obtained by consulting the works given in the bibliography at the end of this paper.

B. The Physiological or Immediate Effect of Artificial Agents upon Plants

There has been much written upon the physiological effects of rest period breaking agencies upon plants, yet there has been very little actual experimental work performed to substantiate the views given. According to Aymard (10), and Johannsen (62), Claud Bernard (17) was the first to discover the influence of anesthetics on plants. When a bird, a mouse, a frog, and a sensitive plant were placed under a bell jar and subjected to fumes of ether, the highest forms of life were the first to succumb. Since all were rendered insensible to external stimuli, he concluded that anesthetics had the same physiological effect upon plants as on animals. He thought that anesthetics caused

a coagulation of the protoplasm. Dubois (30) in 1891, found that when succulent plants were subjected to ether fumes, large drops of water formed on the surface of the leaves. Incidentally, the writer often noticed these drops of water upon the sides of the etherizing apparatus. Dubois concluded that this was due to a withdrawal of water from the protoplasm very similar to that which occurs when freezing takes place. Johanssen (62, p. 57) disagrees with Dubois, he says this dehydration occurs only when plants have been exposed to ether long enough to injure the tissue. Dubois' results, however, have been generally accepted by later experimenters. Aymard (10) in 1903, emphatically supports this view: in support of his opinion he cites an experiment in which lily-of-the-valley pips when treated with a dehydrating agency like phosphoric anhydrid forced even more quickly than when treated with ether. Stuart (101) in 1910, also favors this theory. In speaking of anesthetics he says: "Their effect upon the plant is to arrest growth, extract moisture from the cell protoplasm, and through these physiological derangements imparting a severe shock to the whole plant which when removed causes a decided growth". He also thinks that toxic substances like acetone, alcohol, etc., and non-toxic agents like freezing, vacuum treatments and desiccation cause growth in the same way.

Molisch (82) in 1908, showed that soaking in warm

water, flowering branches, or rooted trees or shrubs of woody plants for from nine to twelve hours produced even greater growth than when ether was used. From this it is evident that the drying effect is not essential in shortening the rest period. In speaking of the effect of the warm water bath Stuart says: "hot water imparts a distinct shock to the cell protoplasm and tissue, and acts as a solvent in softening up the winter protecting scales inclosing the leaf and flower buds". Howard (53) in 1915, found by weighing several lots of twigs before and after etherization, that there was no appreciable loss of weight due to etherization. He concludes therefore that etherization does not cause desiccation. He found that treatments such as etherization, warm water bath, alcohol bath, hydrochloric acid bath, drying, mechanical injury, etc., when applied during the early winter increased the amount of readily soluble reducing sugars within twenty-four hours after applications are made.

Johannsen (62) believed that the influence of ether upon the plants does not act directly upon growth but rather upon the factors which prevent growth. The ether he regards as a disturbance upon the regulatory mechanism of the plant. He explains that small amounts of ether favor vegetative activity but large amounts, such as are used to break the rest period, weaken the factors which prevent growth, thus indirectly favoring vegetation.

Müller-Thurgau (87) in 1883, found an accumulation of sugar in potato tubers stored at zero degrees centigrade. The experiments of Butler (20) in 1912, and Appleman (4) in 1914, confirm these results. At this temperature Müller-Thurgau explains that protoplasmic activities are much depressed, hence the fermentation processes produce more sugar than can be used, therefore, the accumulation. When these potatoes were removed to a warm room respiration was increased due, he thinks, to the large amount of sugar that was placed at the disposal of the protoplasm. Howard (49) in discussing the physiological effect of rest period breaking agents, says: "The foundation principle to be worked from is whether a given agency as, ether, drying, etc., will cause the formation of sugar in a plant". To test the effect of these artificial agents upon sugar formation was one of the secondary objects of this problem as will be seen later on in the paper.

Drude, Nauman, and Ledieu (29) in 1903, advanced the theory that ether and chloroform checked some of the changes within the plant while at the same time respiration was increased. Beltz (15) thought that etherization caused an enlargement of the cells such as occurs in spring. Iraklionow (56) in 1911, found that warm water caused an increased respiration in potato tubers. He believed that the breaking of the rest period by means of warm water is a simultaneous action of the high temperature and the water, and that the warm bath influences enzymes chiefly oxidases.

The enzymes are liberated and they act as a lubricant in hastening the reactions necessary for life. Hempel (48) in 1911, after extensive investigations of the effect of etherization on plant metabolism recognizes three stages of narcotization. 1. Exciting phase-- produced by small doses for short duration-- in this, normal processes (respiration, sugar formation, destruction of proteids, accompanied by formation of amids^{of}), plant activity were accelerated. 2. Narcosis proper-- produced by small doses for protracted periods, or by enlarged doses for short duration, characterized by a retardation of the normal processes of plant activity. 3. Toxic phase, where large doses are used for long exposures, which produce all phenomena characteristic of the death of plants.

Klebs (66) is of the opinion that in the rest period there is an accumulation of organic foods which are assimilated after length growth ceased, yet while the leaves were still active. He thinks ether is an important factor in the liberation of enzymes which convert these accumulated foods into favorable forms thus causing growth and the breaking of the rest period. Fisher (53) studied the changes in the starch content of trees during the rest period. He found that the maximum content of starch in trees was from leaf fall to November. In November the starch was gradually lowered until a minimum was reached in late winter. Starch synthesis began again in March and reached

the maximum again in April, after which reduction again occurred until the minimum was reached during the latter part of May, at the time of the beginning of vegetative activity. He claims that the resting buds of trees cannot be made to grow until a certain minimum of insoluble starch has been changed, "to easily respired, therefore, energy yielding material". Howard (53) in 1915, states that all artificial rest period breaking agents merely act as stimulants to the enzymes, which are induced to become active or, "are stimulated into greater activity by treating twigs with ether and other agents".

It is thus seen that many theories have been, and are still being advanced in regard to the physiological changes accompanying the breaking of the rest period of plants.

OBJECTS OF THIS INVESTIGATION

The objects of this investigation were five in number, as follows:

I. To answer the question; Can artificial agents such as desiccation, freezing, etherization or combinations of them be used to induce earlier callus and root formation, in dormant hardwood cuttings? The answer to this question naturally involves another; Can these agents be economically used in commercial nursery practice for this purpose?

II. To determine ^{the} effect of previous;

1. Desiccating.
2. Etherizing.
3. Freezing.
4. Desiccating and etherizing.
5. Desiccating and freezing.
6. Freezing and etherizing.
7. Desiccating, freezing and etherizing.

upon the callusing, root formation and starting of buds into growth, of dormant cuttings of the following woody plants.

- a. Pyrus malus, Linn., varieties Jonathan and Ben Davis.
- b. Pyrus communis, x Pyrus Sinensis, var. Kieffer.
- c. Prunus persica, Sieb., varieties Elberta and Rice's Seedling.
- d. Ribes rubrum, Linn., variety Burbank.
- e. Ribes oxycanthoides, Linn., variety Pearl.
- f. Liriodendron Tulipifera, Linn., Tulip tree.

- g. Fraxinus excelsior, Linn., European Ash.
- h. Quercus palustris, Linn., Pin Oak.
- i. Pinus Laricio, Poir., Austrian Pine.
- j. Pinus sylvestris, Linn., Scotch Pine.

III. To determine the effect of the same treatments upon the same plants at different times during the season.

IV. To determine the effect of the above treatments upon the sugar content of treated cuttings as compared with untreated cuttings.

V. To determine the effect of after treatment upon treated and untreated cuttings:

1. Placing immediately in cutting bed in greenhouse where the night temperature averaged 55 degrees Fahrenheit and the day temperature about 65 degrees Fahrenheit.
2. Placing in damp sawdust in a cool basement room.
3. Placing outside in a box of sand.

Miscellaneous experiments were conducted at intervals during the season. Their objects will be found in the later pages of this paper.

General Statement

A large number of our woody plants cannot be grown successfully from cuttings because they fail to root even under the best ^{of} treatment. Sorauer (102 p.172) says; "of our fruit trees, apples and pears very readily form a strong protective callus over a cut but do not easily produce ad-

ventitious roots". One of the main objects of this experiment was to try to induce these and other plants to form roots by the use of such artificial agents as desiccation, freezing, and etherization, and all possible combinations of the three. Any form of treatment which might bring about this result would be of great importance to commercial nurserymen. A large part of the expense of budding and grafting would be done away with, as will be shown by describing briefly, the methods commonly used in propagating our drupaceous and pomaceous fruits.

The drupaceous fruits are commonly propagated by budding and a description of this process in the case of the peach will serve for practically all of our drupes. In the case of the peach, the seeds are stratified in the fall and in the spring or early summer, after they have sprouted, the seedlings are transplanted into nursery rows, in thoroughly cultivated soil. These plants are generally budded in July or August; although further south, where they attain a larger size earlier in the season, they may be budded in June. This budding process is a very expensive one due to the large number of operations which must be performed. A day or two before the actual budding is done the stock must be gone over to rub off all the lower leaves for a space of five or six inches above the ground, in order that these will not interfere with the budding. When the time for budding arrives, a man must be sent out into the field to get

well hardened shoots of the season's growth and of the desired varieties. These shoots must be trimmed to form the "sticks". These sticks are kept wrapped up in damp burlap bags while the operation of budding is going on. The stock must next be slit, then the bud is inserted. A boy follows the budder to do the tying, which is ordinarily done with raffia. A week or two after the budding has been done, the whole field has to be gone over to remove or cut the strings, which if left on too long will girdle the stem and often kill the bud. At this time those stocks which have failed to set buds, may be rebudded, which, in some seasons, must be done three or four times to obtain a good stand. The following spring the whole field must be gone over to cut off the stock above the bud and to remove all suckers below the bud. Practically the same operation is performed when other fruits like the apple and pear are budded, except that they cannot be budded the same year that the seed is sown. They are not budded until the second year after the seed has been sown.

If a method could be perfected whereby ether, freezing, drying or other artificial agents could be successfully used in growing these plants from cuttings, the cost of propagation would be greatly reduced. Then the only operations necessary would be to procure the wood in the fall, make the cuttings, give them the necessary artificial treatment, store them away in damp sawdust in a cool cellar or outside in a callus pit, and finally set them out in the nursery rows, as soon as weather conditions become favorable.

This desired method would thus do away with, the sowing of the seed, the rubbing off of leaves previous to budding, the trimming of the bud sticks, the inserting of the buds, the tying of the buds, the rebudding, the cutting of the strings after the setting of the buds and the cutting off of the stock the following spring. The following operations would cost about the same in each case; the procuring of well matured shoots for bud sticks and the procuring of wood for cuttings; the transplanting of the seedlings into the nursery rows and the setting of the cuttings into the nursery rows; the cost of the raffia would probably more than counter-balance the cost of the material used in the artificial treatment of the cuttings.

Such an artificial process of treating cuttings would effect a similar saving in the case of graftage, which method is commonly used in the propagation of our pome fruits. A description of the processes of graftage used in the propagation of the apple will serve as a typical example for all. In the case of the apple the seeds are washed from cider-mill pomace. This seed may either be planted in the fall or stratified in moist sand until spring and then planted. The seedlings are allowed to grow for one season, then they are dug up in the autumn and packed in sawdust or damp moss in a cool cellar. Cions of well matured wood of the desired varieties are next obtained and packed away in a similar manner. These are taken out as needed, to a warm room,

where cions of the desired variety are grafted onto the seedling roots. When the union is made, it is tied with either waxed paper, cloth, or string. When these grafts are completed they are tied in bundles and put away, packed in boxes very firmly in clean sand or sawdust, in a cold cellar. Early in the spring they are planted in the nursery. Could an artificial means, like that described in the previous paragraph, be discovered, it would eliminate the cost of; washing the seed from the pomace, stratifying and planting the seed, digging and storing seedlings, grafting cion onto stock, tying, and the storing of the grafts after they are made. The cost of obtaining and storing cuttings under the desired method would be no greater than the cost of obtaining and storing cions under the present method of treatment. The expense of purchasing and applying the artificial agent to be used under the desired treatment would be counter-balanced by the cost of the wax and tying material used under the system now in vogue.

It is plainly seen that if such a method were discovered the cost of propagating our woody plants would be greatly reduced. The nurserymen would not be the only ones to benefit from such a discovery but the growers and planters would also be greatly helped. They could then purchase or raise the trees at a much lower rate than they are now paying.. It was with this thought of saving time, labor and money for the growers and nurserymen that the author undertook to determine the effect of some of these artificial agents upon dormant cuttings of some of our woody plants.

EXPERIMENTAL WORK, 1915-16

Method of Collecting Material

In order to secure as nearly uniform samples as possible only one year twigs, i.e. the growth that had matured during the season of 1915, were used. The reasons for selecting this material were; first, it would callus and form roots much easier than older wood, second, it had not been exposed to environmental influences for as long a time and hence had not had as much opportunity to become changed. All twigs were taken from the tops of the trees where all were subjected to the same environmental conditions. Only well matured twigs, with perfectly developed buds were used. The collection from each tree was kept separate until divided into experimental lots. In each case the twigs were obtained on separate days. On the first day material was obtained for the following treatments; 1. Desiccation, 2. Desiccation and Etherization, 3. Desiccation and Freezing, 4. Desiccation, Freezing and Etherization, 5. Check. On the following day, in each case, material was obtained for the following treatments; 1. Etherization, 2. Freezing, 3. Freezing and Etherization. For each of the above treatments 25 cuttings were required, thus making a total of 200 for the eight treatments. In each case the collections were from the same tree on each day. For example, when the twigs for the Jonathan apple were obtained, 5 trees

were selected and, on the first day, 25 cuttings were obtained from each tree, on the second day, 15 cuttings were obtained from each of the same 5 trees.

After the material was secured, cuttings ranging from 12 to 16 cm. were made, using only the tips of the twigs for these. The samples were then divided into similar lots in the following manner; all the cut surfaces of the cuttings from a single tree were placed down, the terminal buds up. The bunch of cuttings from a single tree, was held loosely between the hands and then struck lightly on the table until all cut ends occupied the same plane. The bunch was held in one hand, and with the other, the twigs were distributed according to length, commencing with the longest and ending with the shortest. For example, on the first day, there would be 25 cuttings from each tree, those from the first tree were laid in a row according to length, one at a time, commencing with the longest and ending with the shortest or the twenty-fifth cutting. The cuttings from the second tree were laid down in a similar manner, directly below the first row, so that cutting No. 1 (the longest) of the second row came directly under cutting No. 25 (the shortest) of the first row; the cuttings of the third, fourth and fifth trees were laid down in the same reverse order, with the final result that the cuttings were divided into 25 equal lots of five cuttings each, one cutting from each tree, and the same number of short and long cuttings in each lot.

Plate I.

Cutting Bed used in the Experiment.
Note Muslin Shades for Controlling Sunlight.

Five of the above 25 lots, of 5 cuttings each, were used in each of the 8 treatments, mentioned on Page 30. One lot of cuttings from each treatment was placed in a cool cellar and buried, inverted, in damp sawdust; a second was placed outside, inverted in a frame of sand; and a third was planted in a well prepared cutting bed in a warm greenhouse, shown in Plate I. The fourth and fifth lots were saved for the sugar tests, described on Page 86.

On the second day 15 cuttings were obtained from each of the same trees used the day before. They were divided into 15 equal lots, of 5 cuttings each, as previously described. Five of the 15 lots were used in each of the last three treatments, mentioned on Page 30. One lot, in each case, was placed outside, one was inverted and buried in moist sawdust in a cool basement room and one was planted directly into the cutting bed, shown in Plate I.

General Notes on Methods and Apparatus Used in the Experiment

The desiccation, in all the treatments, was performed by merely spreading out the cuttings on a table in a class room where the temperature varied between 55° and 70° F. In all cases this treatment lasted 24 hours.

The general appearance of the apparatus used in etherizing the cuttings is shown in Plate II. This is merely a 12 liter specimen jar provided with a clamp screw

and rubber washer, by means of which the jar could be made air tight. Before etherizing the cuttings, about one inch of dry sand was poured into the jar. The cuttings were then stood in this, cut ends up, then more sand was added, until a point about $\frac{1}{2}$ inch from the top of the cuttings was reached. The jar was then shook back and forth vigorously several times until the sand was parallel with the top of the table, upon which the jar stood. Then melted paraffin wax, cooled to about 42° to 45°C. , was poured onto the sand so that it covered the sand at all points. The wax was never poured until it had begun to solidify, thus avoiding injury to the cuttings by heat, which, no doubt, would have occurred, had the wax been added at a temperature much above the melting point. Since it was the plan to etherize the cut ends to induce callusing and root formation, and not to accelerate bud growth, the wax was added to prevent the ether from penetrating into the sand and reaching the buds. Following the cooling of the paraffin, commercial sulphuric ether, at the rate of 0.5 cc. per liter of air space was added. The lid was immediately put in place and securely clamped.

In all treatments previous to January 19, the cuttings were subjected to ether fumes for 48 hours, after that date 24 hour exposures were made. In all of the etherizing mentioned in this paper, commercial sulphuric ether at the rate of 0.5 c.c. per liter of air space was used.

Plate II.

A. ETHERIZING CHAMBER:

Note Ash Cuttings under Treatment

B. MEAT CHOPPER

For the treatments requiring freezing the apparatus shown in Plate III was used. The cuttings were fastened to the inner Cylinder I. This was set in Cylinder II, which was enough larger than cylinder I to leave a surrounding space of about two inches, Cylinder II was about six inches taller than the inner one, and was set within Cylinder III, leaving a two inch air space between them, Cylinder III was set inside of cylinder IV, which does not show in the plate, as it was permanently placed inside of frame V. There was a space of about $2\frac{1}{2}$ inches between cylinders III and IV. Cylinder IV was well insulated as the space between it and frame V was packed with dry sawdust. Lid A fitted closely over cylinder II. A freezing mixture of ice and salt was packed loosely and then firmly in the space between cylinders II and III. In this way the temperature could be lowered generally to from -15°C. to -19°C. , To avoid variations in temperature, cylinder I, to which the cuttings were attached, was kept slowly revolving by means of the small electric motor seen in the Plate. In all of the experiments performed previous to January 19, the materials were subjected to the freezing temperatures for 24 hours but after that date, they were subjected for only 18 hours.

After the preliminary treatments were administered one lot of cuttings, from each of the 8 treatments, was placed in a cool north basement room, inverted in moist sawdust; one lot was placed outside, inverted in a large frame of sand. The frame was about 10 feet long and 8 feet wide,

Plate III.

FREEZING APPARATUS.

I. Galvanized iron cylinder to which the cuttings were fastened;
 II. and III. Galvanized iron cylinders placed one within the other;
 IV. Cylinder to receive III. (does not show in plate).
 The space between cylinder IV. and insulating frame V. is filled
 with sawdust. A. Lid for II. Note wheel operated by electric
 motor, and string to turn I. continuously while freezing.

containing about two feet of sand. During the cold weather of winter, this frame was covered with hay to prevent the sand from freezing. A third lot was removed to a warm greenhouse, where the average night temperature was about 55° F. and the average day temperature about 65° F., and set out in a well made cutting bed, as shown in Plate I.

The results obtained by the various treatments in the three places are given in Tables Nos. 1-30 inclusive. In these tables the treatments employed are referred to by numbers as follows:

1. Desiccated.
2. Etherized.
3. Frozen.
4. Desiccated and Etherized.
5. Desiccated and Frozen.
6. Frozen and Etherized.
7. Desiccated, Frozen and Etherized.
8. Check (Untreated)

Where S. and G. occur at the head of the table and just below the number of treatment, these letters refer respectively to sawdust and greenhouse, where the cuttings were placed following treatment. In the column headed, "Condition" we find the terms "No. Callused", "No. Started" and "No. Dead". Under No. Started, when L follows any number it refers to the number of cuttings which have started into leaf growth or in other words, which have broken their rest periods; when R. follows a number

it has reference to the number of cuttings which have formed roots. The tables are otherwise self explanatory.

The cuttings of the outside lot, on April 1 and 3, were transplanted into a cold frame containing about two feet of well compacted sand. The cuttings of the sawdust lot were set out in the same bed, on April 4. The bed was covered with sash, on cold nights, otherwise no artificial heat was applied. The cuttings were watered whenever necessary.

In reading these tables it must be borne in mind that the cuttings were moved every two or three weeks so that notes could be taken. This disturbance, no doubt, checked the growth considerably and prevented cuttings from callusing and rooting that otherwise would have, had they not been disturbed. The check on growth for the treated and untreated cuttings was the same, so that comparative results were not effected by moving the cuttings.

DISCUSSION OF TABULATED RESULTS

Cuttings of *Pyrus malus*, Linn., var. Jonathan.

Treated Oct. 10-15. (Cf. tables 1 and 3, pp. 37-39)

A study of tables 1 and 3 shows that the freezing treatment, in all cases used, proved too severe. The check material, placed in sawdust, was the first to callus. (Cf. Table 1). The callusing, in this case, started two months after treatment. The desiccated and etherized (4) cuttings, which had been placed in the greenhouse, were the first to break their rest periods. This occurred upon Jan. 22. This treatment also caused the first breaking of the rest period in the case of the cuttings placed outside after treatment.

None of the treatments employed, induced the rooting of cuttings. The results obtained from the early fall treatment of Jonathan apple cuttings, show that artificial treatments delay the callus formation.

Treated Nov. 30 - Dec. 4. (Cf. tables 2 and 3)

A review of table 2 shows that the cuttings, placed in the greenhouse after treatment, started to callus before those stored in sawdust. When examined Dec. 15, it was found that the frozen and etherized (6) material, placed in a cutting bed in the greenhouse, had the largest percentage callused. On Jan. 22 all of the untreated cuttings, placed in the cutting bed in the greenhouse were callused. This did not occur in any of the artificial treatments. The rest period was first broken on Jan. 3, in those cuttings

which had been desiccated, frozen and etherized (7), then grown in the greenhouse. The cuttings, placed outside after treatment (Cf. table 3), show that upon April 3, the etherized (2) and the frozen (3) treatments had a greater percentage callused.

Treated Feb. 15-18 (Cf. tables 2 and 3)

The cuttings grown in the greenhouse cutting bed, were again the first to callus and break their rest periods. In no case did the artificial treatments prove beneficial in causing an earlier callus or root formation.

The results obtained by treating Jonathan cuttings at different times during the dormant season, then, after treatment, placing them under different environments, show that artificial agents are of no use in hastening the callus and root formation. Some of the treatments, however, caused an earlier leaf growth or, in other words, an earlier breaking of the rest period.

Table No.1.

Showing eight methods of treatment (See p. 35) on cuttings of *Pyrus malus*, Linn., var. Jonathan, treated Oct. 10-15, a set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a cutting bed in the greenhouse (G); and the condition of cuttings--dead, dormant, growing, callused and rooted--on ten separate dates of inspection beginning Nov. 5, 1915 and continuing through April, 22, 1916.

Date of Notes*	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 13	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 26	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	5	5	0	3	5	3	0	5	1	4	0	0
Dec. 12	No. Callused	0	0	0	0	-	-	0	0	-	0	0	-	0	0	2	0
	No. Started	0	0	0	0	-	-	0	0	-	0	0	-	0	0	0	0
	No. Dead	0	2	0	0	-	-	0	3	-	5	5	-	5	5	0	0
Jan. 3	No. Callused	0	0	0	0	-	-	0	0	-	-	-	-	-	-	2	0
	No. Started	0	0	0	0	-	-	0	0	-	-	-	-	-	-	0	0
	No. Dead	0	3	0	0	-	-	0	3	-	-	-	-	-	-	0	0
Jan. 22	No. Callused	0	0	0	0	-	-	0	0	-	-	-	-	-	-	2	0
	No. Started	0	0	0	0	-	-	0	1L	-	-	-	-	-	-	0	0
	No. Dead	0	3	0	1	-	-	1	3	-	-	-	-	-	-	0	1
Feb. 12	No. Callused	0	0	0	1	-	-	0	0	-	-	-	-	-	-	2	2
	No. Started	0	0	0	0	-	-	0	1L	-	-	-	-	-	-	0	0
	No. Dead	0	3	0	1	-	-	1	5	-	-	-	-	-	-	0	1
Feb. 26	No. Callused	0	0	0	1	-	-	0	-	-	-	-	-	-	-	2	2
	No. Started	0	0	0	0	-	-	0	-	-	-	-	-	-	-	0	0
	No. Dead	0	5	0	1	-	-	1	-	-	-	-	-	-	-	0	1
G-Mar 18	No. Callused	0	-	1	4	-	-	0	-	-	-	-	-	-	-	2	3
	No. Started	1L	-	4L	0	-	-	3L	-	-	-	-	-	-	-	3L	0
S-Ap. 4	No. Dead	0	-	0	1	-	-	1	-	-	-	-	-	-	-	0	2
Apr. 22	No. Callused	0	-	0	4	-	-	0	-	-	-	-	-	-	-	2	3
	No. Started	1L	-	4L	0	-	-	3L	-	-	-	-	-	-	-	3L	0
	No. Dead	0	-	2	1	-	-	2	-	-	-	-	-	-	-	2	2

* None had started when examined Nov. 5.
L Producing leaves.

Table No.2.

Showing eight methods of treatment(See p. 35) on cuttings of *Pyrus malus*, Linn., var. Jonathan, one set treated Nov. 30-Dec. 4, a second set treated Feb. 15-18, one lot of each set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed(G); and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on seven separate dates, in the first lot, and on three separate dates in the second lot.

Date	Treated Nov. 30- Dec. 4	Treatment															
		1		2		3		4		5		6		7		8	
Notes	Condition	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Dec. 15	No. Callused	0	1	0	1	0	0	0	0	0	0	0	4	0	0	0	2
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 3	No. Callused	0	3	0	1	0	4	0	2	0	1	0	4	0	2	0	4
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Jan. 22	No. Callused	0	4	0	2	0	4	0	2	0	1	0	4	0	3	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	No. Dead	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Feb. 12	No. Callused	0	4	0	4	0	5	0	2	0	2	0	4	0	3	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	No. Dead	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Feb. 22	No. Callused	0	4	0	4	0	5	0	3	0	2	0	4	0	3	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0
	No. Dead	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0
G=M. 18	No. Callused	4	4	4	5	4	5	3	5	3	2	5	4	1	3	5	5
	No. Started	4	0	4	1	3	0	5	0	5	0	3	1	1	2	0	0
S=Ap. 4	No. Dead	0	0	0	0	0	0	0	2	0	2	0	0	0	1	0	0
Apr. 22	No. Callused	4	4	4	5	4	5	3	3	3	2	5	4	1	3	5	5
	No. Started	4	0	4	1	3	0	5	0	4	0	3	1	1	2	0	0
	No. Dead	0	0	0	0	0	0	0	2	1	2	0	0	0	1	0	0
Treated Feb. 15-18																	
Feb. 26	No. Callused	0	5	0	5	0	5	0	3	0	5	0	3	0	3	0	5
	No. Started	0	0	0	2	0	3	0	0	0	1	0	0	0	0	0	1
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G=M. 18	No. Callused	2	5	5	5	2	5	2	4	0	5	3	4	0	4	5	5
	No. Started	0	3	0	4	0	3	0	1	0	3	0	3	0	2	0	2
S=Ap. 4	No. Dead	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Apr. 22	No. Callused	2	5	5	5	5	4	4	5	2	5	3	4	3	4	5	5
	No. Started	0	4	0	5	1	2	2	4	2	5	3	4	0	3	0	3
	No. Dead	6	3	0	0	0	5	0	0	0	2	1	1	0	1	0	0

Table No. 3.

Showing eight methods of treatment(See p.35) on cuttings of *Pyrus malus*, Linn., var. Jonathan, one set treated Oct. 10-15, another treated Nov. 30-Dec.4, a third treated Feb.15-18, then placed outside in a frame of sand, and the condition of cuttings--- dead, dormant, growing, callused and rooted-- on two separate dates.

Jonathan		Treatment								
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Oct. 10-15	Apr. 1	No. Callused	2	5	0	3	3	0	0	0
		No. Started	0	0	0	1L	0	0	0	0
		No. Dead	0	0	5	0	1	5	5	5
	April 22	No. Callused	2	5	-	3	3	-	-	-
		No. Started	3L	2L	-	1L	1L	-	-	-
		No. Dead	0	2	-	3	2	-	-	-
Nov. 30 through Dec. 4	April 3	No. Callused	2	4	4	0	0	1	0	2
		No. Started	4L	3L	0	3L	1L	2L	2L	1L
		No. Dead	0	0	0	0	0	0	0	0
	April 22	No. Callused	2	4	4	3	2	1	3	2
		No. Started	4L	3L	0	2L	3L	3L	2L	1L
		No. Dead	0	0	0	0	0	0	0	0
Feb. 15 through Feb. 18	April 3	No. Callused	5	5	3	3	5	0	4	5
		No. Started	0	0	0	0	0	1L	1L	0
		No. Dead	0	0	0	0	0	1	0	0
	April 22	No. Callused	5	5	3	3	5	3	4	5
		No. Started	2L	1L	0	4L	0	1L	2L	0
		No. Dead	0	0	2	0	4	1	1	0

Cuttings of *Pyrus malus*, Linn., var. BenDavis.

Treated Oct.10-15 (Cf. tables 4 and 6)

The freezing treatments proved too severe in all cases used, as is seen by consulting the rows headed "No. Dead", in tables 4 and 6. The cuttings of the desiccated and etherized (4) set, placed in the greenhouse following treatment, were the first to break their rest periods. In this case the rest period was broken previous to Feb. 26, Of those cuttings placed outside after treatment, the desiccation treatment (1) caused a slightly greater percentage of callus formation than did the check (8). (Cf. table 6).

Treated Nov. 30-Dec.4, (Cf. tables 5 and 6).

The cuttings placed in the greenhouse cutting bed, were again the first to callus. The most severe of the treatments (the desiccated, frozen and etherized) caused the earliest breaking of the rest period. The freezing treatment, on this later date, caused no injury. Of those cuttings placed outside after treatment, (Cf. table 6), the desiccated and etherized treatment (4) caused an earlier and greater percentage of callusing and bud growth.

Treated Feb. 15-18.(Cf.tables 5 and 6).

The cuttings placed in the greenhouse cutting bed were the first to callus and break their rest periods. There was no difference in the rate of callus formation under the various treatments. In all cases the untreated callused as quickly as did the artificially treated material.

The results obtained by treating Ben Davis cuttings with artificial agents, at different periods of the dormant season, show that they are not effective in hastening callus or root formation. There were no roots produced in either the treated or untreated material. The early fall freezing proved more severe than did the same treatment applied later during the season.

Table No. 4.

Showing eight methods of treatment (See p.35) on cuttings of *Pyrus malus*, Linn., var Ben Davis, treated Oct. 10-15, a set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a cutting bed in the greenhouse (G); and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on ten separate dates of inspection beginning Nov. 5, 1915 and continuing through April 22, 1916.

Date of Notes * Condition	Treatment															
	1		2		3		4		5		6		7		8	
	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 13 No. Callused	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 26 No. Callused	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. Dead	0	0	0	0	5	5	0	0	3	5	5	5	4	2	0	0
Dec. 12 No. Callused	0	0	0	0	-	-	0	1	0	-	-	-	0	0	1	3
No. Started	0	0	0	0	-	-	0	0	0	-	-	-	0	0	0	0
No. Dead	0	0	0	0	-	-	0	0	5	-	-	-	4	5	0	0
Jan. 3 No. Callused	0	0	0	0	-	-	0	1	-	-	-	-	0	-	3	3
No. Started	0	0	0	0	-	-	0	0	-	-	-	-	0	-	0	0
No. Dead	0	4	0	0	-	-	0	2	-	-	-	-	5	-	0	1
Jan. 22 No. Callused	0	0	0	0	-	-	0	1	-	-	-	-	-	-	3	3
No. Started	0	0	0	0	-	-	0	0	-	-	-	-	-	-	0	0
No. Dead	0	4	0	1	-	-	0	2	-	-	-	-	-	-	0	1
Feb. 12 No. Callused	0	0	1	0	-	-	0	1	-	-	-	-	-	-	3	3
No. Started	0	0	0	0	-	-	0	0	-	-	-	-	-	-	0	0
No. Dead	0	4	0	1	-	-	0	3	-	-	-	-	-	-	0	1
Feb. 26 No. Callused	0	0	1	0	-	-	0	1	-	-	-	-	-	-	3	4
No. Started	0	0	0	0	-	-	0	1L	-	-	-	-	-	-	0	0
No. Dead	0	5	0	1	-	-	0	3	-	-	-	-	-	-	0	1
G= M. 18 No. Callused	0	-	1	0	-	-	0	1	-	-	-	-	-	-	3	4
S= No. Started	3L	-	4L	0	-	-	2L	1L	-	-	-	-	-	-	3L	0
A. 4 No. Dead	0	-	0	1	-	-	0	3	-	-	-	-	-	-	0	1
Apr. 22 No. Callused	0	-	1	0	-	-	0	1	-	-	-	-	-	-	3	4
No. Started	3L	-	4L	0	-	-	2L	1L	-	-	-	-	-	-	3L	0
No. Dead	0	-	0	1	-	-	2	3	-	-	-	-	-	-	0	1

*None started when examined Nov.5.

Table No.5.

Showing eight methods of treatment (See p.35) on cuttings of *Pyrus malus*, Linn., var. Ben Davis, one set treated Nov. 30-Dec. 4, a second set treated Feb. 15-18, one lot of each set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted--on seven separate dates, in the first lot, and on three separate dates in the second lot.

[illegible]

Table No.6.

Showing eight methods of treatment(See p. 35) on cuttings of *Pyrus malus*, Linn., var. Ben Davis, one set treated Oct. 10-15, another treated Nov. 30- Dec. 4, a third treated Feb. 15-18, then placed outside in a frame of sand; and the condition of cuttings---dead, dormant, growing, callused and rooted-- on two separate dates.

Ben Davis			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Oct. 10-15	April 1.	No.Callused	4	3	0	2	0	0	0	3
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	5	0	5	5	3	0
	April 22.	No.Callused	5	4	-	3	-	-	0	4
		No.Started	2L	1L	-	2L	-	-	0	1L
		No.Dead	0	1	-	1	-	-	5	0
Nov. 30 through	April 3.	No.Callused	2	0	2	3	2	2	1	1
		No.Started	0	1L	0	2L	1L	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
Dec. 4	April 22.	No.Callused	2	2	2	3	2	2	1	2
		No.Started	2L	0	1L	2L	1L	0	0	0
		No.Dead	0	0	0	0	2	0	1	0
Feb. 15 through	April 3.	No.Callused	5	5	5	5	5	5	1	5
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
Feb. 18	April 22.	No.Callused	5	5	5	5	5	5	1	5
		No.Started	0	2L	0	0	0	1L	0	0
		No.Dead	0	0	0	0	0	0	0	0

Cuttings of *Pyrus communis* X *Pyrus Sinensis*, var. Kieffer.

Treated Oct. 19-23, (Cf. tables 7 and 9).

In some of the treatments (Cf. 1,4,5,6, and 7) the cuttings grown in the greenhouse callused earlier than those stored in sawdust; in others (Cf. 2,3, and 8) the material buried in sawdust was the first to callus. The desiccated and frozen (5), the frozen and etherized (6), and the desiccated, frozen and etherized (7) cuttings were the first to break their rest periods. The desiccated and etherized (4) cuttings were the only ones to form roots. The freezing treatment proved injurious to the cuttings.

Of those cuttings placed outside after treatment (Cf. table 9) the untreated, callused and broke their rest periods as soon as did any of those artificially treated. The freezing again proved too severe.

Treated Dec. 7-11. (Cf. tables 8 and 9).

The material grown in the cutting bed callused and broke its rest period ahead of that stored in sawdust. The frozen set alone produced rooted cuttings. The only cutting rooted, is shown after being potted, in Plate V. This photograph was taken on Feb. 23, 1916. Plate IV, photographed at the same time, shows the other greenhouse cuttings. Note the effect of the desiccate and ether (4) treatment in causing leaf growth. In the material placed outside after treatment, (Cf. table 9) the artificial agents caused a large percentage of the cuttings to callus but in no case did any roots form.

Treated Feb. 21-24. (Cf. tables 8 and 9).

The check cuttings began to callus and to produce leaf growth as early as did the treated cuttings. The cuttings set out in the greenhouse cutting bed had a slightly larger percentage callused than did those packed in damp sawdust. Among the cuttings treated in autumn, desiccation (1) and etherization (2) hastened root formation. Freezing, as a winter treatment induced earlier root formation. The results obtained, however, were not marked enough to warrant the use of these artificial agents for inducing earlier callus and root formation in the case of Kieffer pear cuttings. The freezing treatment in the early fall proved very injurious to the cuttings.

Kieffer Pear Cuttings, Placed in Greenhouse After Treatment. Photographed 64 days after treatment.

Plate V.

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A Kieffer Pear Cutting Frozen for 48 Hours then Placed in Greenhouse, Following Treatment. Photographed 64 days after treatment.

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Table No. 7.

Showing eight methods of treatment (See p. 35) on cuttings of *Pyrus communis* x *Pyrus Sinensis*, var. Kieffer, treated Oct. 19-23, a set then stored in sawdust in a cool basement room(S) with a duplicate lot set in sand in a cutting bed in the greenhouse(G); and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on ten different dates of inspection beginning Nov. 5, 1915 and continuing through April 22, 1916.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 5	No. Callused	0	1	5	4	4	2	0	5	2	4	1	3	0	5	5	4
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 13	No. Callused	0	2	5	4	5	2	0	5	5	5	5	4	0	5	5	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 26	No. Callused	0	5	5	5	5	2	0	5	5	5	5	4	0	5	5	5
	No. Started	0	0	0	0	0	0	0	0	0	2L	0	3L	0	2L	0	0
	No. Dead	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0
Dec. 12	No. Callused	0	5	5	5	5	2	0	5	5	5	5	4	0	5	5	5
	No. Started	0	1R	0	1R	0	0	0	0	0	2L	0	3L	0	2L	0	0
	No. Dead	0	0	0	0	0	3	0	0	0	0	0	1	0	1	0	0
Jan. 3	No. Callused	0	5	5	5	5	2	2	5	5	5	5	4	0	4	5	5
	No. Started	0	2R	0	1R	0	0	0	0	0	2L	0	3L	0	2L	0	0
	No. Dead	0	0	0	0	0	5	0	0	0	2	0	3	1	1	0	0
Jan. 22	No. Callused	0	5	5	5	5	-	2	5	5	3	5	2	0	4	5	5
	No. Started	0	2R	0	1R	0	-	0	0	0	2L	1L	1L	0	2L	0	0
	No. Dead	0	0	0	0	3	-	0	0	0	5	0	3	1	2	0	0
Feb. 12	No. Callused	1	5	5	5	2	-	5	5	5	-	5	2	1	3	5	5
	No. Started	0	2R	0	1R	0	-	0	0	0	-	1L	1L	0	2L	0	0
	No. Dead	0	0	0	0	3	-	0	0	3	-	2	4	1	2	0	0
Feb. 26	No. Callused	3	5	5	5	2	-	5	5	2	-	3	1	4	3	5	5
	No. Started	0	2R	0	1R	0	-	0	0	0	-	0	0	0	2L	0	0
	No. Dead	0	0	0	0	3	-	0	0	3	-	2	4	1	2	0	0
G=M 18	No. Callused	5	5	5	5	2	-	5	5	2	-	3	1	4	3	5	5
	No. Started	5L	2R	5L	1R	0	-	5L	0	2L	-	3L	0	4L	2L	5L	0
S=Apr. 4	No. Dead	0	0	0	0	5	-	0	0	3	-	2	5	1	5	0	0
Apr. 22	No. Callused	5	5	5	5	-	-	5	5	2	-	3	-	4	-	5	5
	No. Started	5L	2R	5L	1R	-	-	5L	0	2L	-	3L	-	4L	-	5L	0
	No. Dead	0	2	0	0	-	-	0	0	3	-	3	-	1	-	0	0

* R- Developing roots from the callus.

50
Table No. 8.

Showing eight methods of treatment (See p. 35) on cuttings of *Pyrus communis* x *Pyrus Sinensis*, var. Kieffer, one set treated Dec. 7-11, a second treated Feb. 21-24, one lot from each set then stored in sawdust in a cool basement room (S) with a duplicate set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused, and rooted--on six separate dates in the first lot, and two separate dates in the second lot.

Date of Notes	Treated Dec. 7-11 Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Jan. 3	No. Callused	0	5	0	5	0	4	0	4	0	5	0	5	0	2	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 22	No. Callused	0	5	2	5	2	5	1	5	0	5	0	5	0	2	4	5
	No. Started	0	0	0	0	0	1R	0	0	0	2L	0	0	0	5L	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb. 12	No. Callused	4	5	4	5	2	5	4	5	5	5	2	5	1	4	4	5
	No. Started	0	3L	0	2L	0	4L	0	5L	0	3L	0	3L	0	5L	0	2L
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	1	9	9	9
Feb. 26	No. Callused	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	No. Started	0	3L	5L	2L	0	4L	5L	5L	0	3L	0	3L	0	5L	2L	2L
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G=M. 18	No. Callused	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
S=Ap. 4	No. Started	5L	3L	5L	5L	5L	5L	5L	5L	5L	3L	5L	3L	5L	5L	5L	2L
	No. Dead	0	0	0	0	0	0	0	0	0	2	0	2	0	4	0	1
Apr. 22	No. Callused	5	5	5	5	5	5	5	5	3	5	3	5	1	5	4	
	No. Started	5L	3L	5L	5L	5L	5L	5L	5L	1L	5L	1L	5L	1L	5L	2L	
	No. Dead	0	1	0	0	0	0	0	3	0	2	0	2	0	5	0	1
Treated Feb. 21-24										*							
G=M. 18	No. Callused	4	5	5	5	5	5	1	5	0	5	-	-	0	5	5	5
	No. Started	0	4L	3L	5L	3L	5L	0	4L	0	5L	-	-	0	4L	4L	5L
S=Ap. 4	No. Dead	0	0	0	0	0	0	0	0	0	0	-	-	0	0	0	0
Apr. 22	No. Callused	5	5	5	5	5	5	2	5	4	5	-	-	0	5	5	5
	No. Started	3L	5L	3L	5L	5L	5L	0	5L	1L	5L	-	-	0	5L	5L	5L
	No. Dead	0	0	0	0	0	0	0	0	0	0	-	-	0	0	0	0

*Because of lack of material Treatment No. 6 was not applied on those cuttings treated Feb. 21-24.

51
Table No. 9.

Showing eight methods of treatment (See p. 35) on cuttings of *Pyrus communis* x *Pyrus Sinensis*, var. Kieffer, one set treated Oct. 19-23, another treated Dec. 7-11, a third treated Feb. 21-24, then placed outside in a frame of sand; and the condition of cuttings--dead, dormant, growing, callused and rooted-- on two separate dates.

Kieffer			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Oct. 19-23	Apr. 1	No. Callused	2	5	0	5	0	0	5	5
		No. Started	2L	4L	0	5L	0	0	5L	5L
		No. Dead	0	0	5	0	5	5	0	0
	Apr. 22	No. Callused	2	5	-	5	-	-	5	5
		No. Started	4L	4L	-	5L	--	-	5L	5L
		No. Dead	2	0	-	0	-	-	0	0
Dec. 7-11	Apr. 3	No. Callused	5	5	4	4	4	5	5	1
		No. Started	0	0	0	2L	4L	0	1L	0
		No. Dead	0	0	0	0	0	0	0	0
	Apr. 22	No. Callused	5	5	5	4	4	5	5	2
		No. Started	0	0	0	2L	4L	0	1L	1L
		No. Dead	0	0	2	0	2	3	0	0
Feb. 21-24	Apr. 3	No. Callused	5	5	5	0	4	5	2	5
		No. Started	4L	4L	4L	0	0	3L	0	5L
		No. Dead	0	0	0	0	0	0	0	0
	Apr. 22	No. Callused	5	5	5	5	5	5	4	5
		No. Started	4L	4L	4L	3L	3L	3L	2L	5L
		No. Dead	0	0	0	0	0	0	0	0

Cuttings of *Liriodendron Tulipifera*, Linn.,

Treated Nov. 9-13. (Cf. tables 10 and 12).

In all cases the cuttings, placed in the greenhouse cuttingbed following treatment, callused before those which had been packed away in sawdust. Freezing in all cases, used both alone and in combination, proved too severe. The desiccated and ether treatment (4) of the lot packed in sawdust was the only one that induced a breaking of the rest period. There were no roots formed as a result of the various treatments.

Treated Dec. 7-11. (Cf. tables 11 and 12).

The frozen (3) and the desiccated and frozen (5) cuttings were the first to callus when placed in the cutting bed following treatment. (Cf. table 11). In practically all cases the cuttings planted in the greenhouse callused earlier than those placed in sawdust. The three treatments, which caused the earliest breaking of the rest period of those cuttings placed in the greenhouse cutting bed, were the etherized (2), the frozen (3), and the frozen and etherized (6). None of the treatments caused roots to form.

Treated Feb. 21-24. (Cf. tables 11 and 12).

In all cases the material set-out in the greenhouse cutting bed callused before that placed in sawdust. In none of the sawdust or greenhouse lots was the rest period broken nor were roots formed. The frozen and etherized treatment (6) caused two of the cuttings, which were buried in a frame of sand in the open air, to break their rest periods. Artificial agents failed to cause earlier callus and root formation.

Table No. 10.

Showing eight methods of treatment (See p. 35) on cuttings of *Liriodendron Tulipifera*, Linn., treated Nov. 9-13, a set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a cutting bed in the greenhouse (G); and the condition of cuttings---dead, dormant, growing, callused and rooted-- on eight different dates of inspection beginning Nov. 26 and continuing through April 22, 1916.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 26	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec. 12	No. Callused	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 3	No. Callused	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	5	0	4	0	5	0	0
Jan. 22	No. Callused	0	2	0	1	0	2	0	0	0	-	0	0	0	-	0	5
	No. Started	0	0	0	0	0	0	0	0	0	-	0	0	0	-	0	0
	No. Dead	0	1	0	3	1	4	0	4	0	-	0	4	0	-	0	0
Feb. 12	No. Callused	0	2	0	1	0	2	0	1	0	-	0	0	0	-	0	5
	No. Started	0	0	0	0	0	0	0	0	0	-	0	0	0	-	0	0
	No. Dead	0	1	0	3	1	5	0	4	0	-	0	5	0	-	0	1
Feb. 26	No. Callused	0	2	0	1	0	-	0	1	0	-	0	-	0	-	0	4
	No. Started	0	0	0	0	0	-	0	0	0	-	0	-	0	-	0	0
	No. Dead	0	1	0	3	1	-	0	4	0	-	0	-	0	-	0	1
G= M. 18	No. Callused	0	2	0	1	0	-	0	1	0	-	0	0	0	-	0	4
	No. Started	0	0	0	0	0	-	0	0	0	-	0	-	0	-	0	0
S= Ap. 4	No. Dead	0	5	0	5	5	-	0	5	3	-	4	-	5	-	0	3
Apr. 22	No. Callused	0	-	1	-	-	-	0	-	0	-	0	-	-	-	0	2
	No. Started	0	-	0	-	-	-	2L	-	0	-	0	-	-	-	0	0
	No. Dead	0	-	0	-	-	-	3	-	3	-	1	-	-	-	0	3

Table No. 11.

Showing eight methods of treatment (See p. 35) on cuttings of *Liriodendron Tulipifera*, Linn., one set treated Dec. 7-11, a second treated Feb. 21-24, one lot from each set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings-- dead, dormant, growing, callused, and rooted-- on six separate dates in the first lot, and two separate dates in the second lot.

Date of Notes	Treated Dec. 7-11 Condition	Treatments															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Jan. 3	No. Callused	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 22	No. Callused	0	1	1	1	0	3	1	0	0	1	0	2	0	1	2	4
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Feb. 12	No. Callused	0	2	1	1	0	3	1	1	0	1	0	2	0	0	2	4
	No. Started	0	0	0	2L	0	3L	0	0	0	0	0	1L	0	0	0	0
	No. Dead	0	1	0	0	0	1	0	4	0	3	0	0	0	5	0	1
Feb. 26	No. Callused	0	1	1	1	0	3	1	1	0	1	0	2	0	-	2	3
	No. Started	0	0	0	2L	0	3L	0	0	0	0	0	1L	0	-	0	1L
	No. Dead	0	3	0	3	0	2	0	5	0	4	0	5	0	-	0	1
G-M. 18	No. Callused	0	1	1	1	0	2	1	-	0	0	0	-	0	-	2	3
	No. Started	0	0	0	0	0	1L	0	-	0	0	0	-	0	-	0	1L
S=Ap. 4	No. Dead	0	4	0	4	1	3	0	-	0	5	0	-	0	-	0	2
Apr. 22	No. Callused	0	1	1	1	0	2	1	-	0	-	0	-	0	-	0	2
	No. Started	0	0	0	0	0	1L	0	-	0	-	0	-	0	-	0	1L
	No. Dead	0	5	0	5	1	5	0	-	1	-	0	-	1	-	0	2
Treated Feb. 21-24																	
G=Ma. 18	No. Callused	0	0	0	1	0	3	0	0	0	1	0	1	0	0	0	2
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S=Ap. 4	No. Dead	0	0	0	1	0	0	0	5	0	1	0	3	0	5	0	0
Apr. 22	No. Callused	0	0	0	0	0	3	0	-	0	0	0	0	0	-	0	0
	No. Started	0	0	0	0	0	0	0	-	0	0	0	0	0	-	0	0
	No. Dead	0	5	0	5	0	3	0	-	1	5	0	2	2	-	0	5

Table No. 12.

Showing eight methods of treatment (See p. 35) on cuttings of *Liriodendron Tulipifera*, Linn., one set treated Nov. 9-13 another treated Dec. 7-11, a third treated Feb. 21-24, then placed outside in a frame of sand; and the condition of cuttings -- dead, dormant, growing, callused and rooted-- on two separate dates.

Tulip Tree			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Nov. 9-13	Apr. 1	No. Callused	5	5	3	5	0	0	3	4
		No. Started	0	0	0	0	0	0	0	0
		No. Dead	0	0	0	0	5	5	2	1
	Apr. 22	No. Callused	5	5	3	5	-	-	3	3
		No. Started	1L	0	0	1L	-	-	0	0
		No. Dead	4	5	5	5	-	-	5	5
Dec. 7-11	Apr. 3	No. Callused	0	0	0	0	0	0	0	0
		No. Started	0	3L	0	3L	0	0	0	0
		No. Dead	0	0	0	0	1	0	0	0
	Apr. 22	No. Callused	0	0	0	0	0	0	0	0
		No. Started	0	1L	0	3L	1L	0	1L	3L
		No. Dead	5	5	5	5	5	5	5	5
Feb. 21-24	Apr. 3	No. Callused	0	0	0	0	0	0	-	0
		No. Started	0	0	0	0	0	2L	-	0
		No. Dead	0	0	0	0	0	0	-	0
	Apr. 22	No. Callused	0	0	0	0	0	0	-	0
		No. Started	0	0	0	0	0	0	-	0
		No. Dead	1	0	0	2	1	0	-	0

Cuttings of *Prunus Persica*, Sieb., var. *Elberta*.

Treated Oct. 23-27. (Cf. tables 13 and 15)

Untreated cuttings, grown in the greenhouse, were the first to callus. All of the cuttings, placed in both the greenhouse cutting bed and the damp sawdust, with the exception of the untreated ones placed, in the cutting bed, died before Feb. 12. One of these check cuttings started into leaf growth before April 4. All of the cuttings, placed outside (Cf. table 16) were dead when examined April 1.

Treated Dec. 17-21. (Cf. tables 14 and 15)

The material placed in the greenhouse cutting bed following treatment, callused and broke its rest period before that placed in sawdust. All cuttings in both the greenhouse cutting bed and the damp sawdust sets, were dead when examined on April 22. The freezing treatment caused the earliest callus formation in those cuttings placed outside in a frame of sand, (Cf. table 15). When these were examined on April 22, all of the cuttings, excepting two of the desiccated (1) and one of the desiccated and frozen (5) sets were dead. In none of the lots treated at this time were any roots formed.

Treated Feb. 29-March 3. (Cf. tables 14 and 15).

The check (8) and the frozen (3) cuttings, transferred to the greenhouse cutting bed following treatment, were the first to callus. There was only one cutting which started into leaf growth and that was an untreated cutting grown in the cutting bed. All of the cuttings, placed outside in the frame of sand, were dead when examined on April 22.

The peach cuttings died earlier and in larger numbers than did cuttings of other woody plants tested. In none of the cases tried, did artificial agents have any economic effect in hastening the callus or root formation of Elberta peach cuttings.

[illegible]

Table No. 14.

Showing eight methods of treatment (See p.35) on cuttings of *Prunus Persica*, Sieb., var. *Elberta*, one set treated Dec. 17-21, a second set treated Feb. 29-Mar. 3, one lot from each set then stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted--on six separate dates in the first lot, and two separate dates in the second lot.

Date of Notes	Treated Dec. 17-21 Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Jan. 3	No. Callused	0	1	0	4	0	5	0	2	0	4	0	3	0	0	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 22	No. Callused	0	5	0	5	0	5	0	3	0	4	0	4	0	1	0	5
	No. Started	0	0	0	0	0	0	0	1L	0	1L	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb. 12	No. Callused	0	5	0	5	0	5	0	3	0	4	0	4	0	1	0	5
	No. Started	0	2L	0	0	0	0	0	1L	0	1L	0	0	0	0	0	1L
	No. Dead	0	0	0	1	0	4	0	5	0	4	0	5	0	5	0	2
Feb. 26	No. Callused	0	5	0	4	0	1	0	-	0	1	0	-	0	-	0	3
	No. Started	0	2L	0	0	0	0	0	-	0	0	0	-	0	-	0	0
	No. Dead	0	5	0	5	0	5	0	-	0	5	0	-	0	-	0	5
G=Ma. 18	No. Callused	0	-	2	-	2	-	0	-	0	-	0	-	0	-	3	-
	No. Started	0	-	3L	-	1L	-	0	-	0	-	0	-	0	-	3L	-
S=Ap. 4	No. Dead	5	-	0	-	0	-	5	-	5	-	5	-	5	-	0	-
Apr. 22	No. Callused	-	-	2	-	2	-	-	-	-	-	-	-	-	-	3	-
	No. Started	-	-	3L	-	1L	-	-	-	-	-	-	-	-	-	3L	-
	No. Dead	-	-	5	-	5	-	-	-	-	-	-	-	-	-	5	-
Treated Feb. 29-Mar. 3																	
G=Ma. 18	No. Callused	0	1	0	2	0	5	0	0	0	0	0	0	0	0	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1L
S=Ap. 4	No. Dead	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0
Apr. 22	No. Callused	0	4	0	2	0	5	0	0	0	0	0	-	0	-	0	5
	No. Started	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	1L
	No. Dead	5	5	5	5	4	5	5	5	4	5	0	-	0	-	0	5

Table No. 15.

Showing eight methods of treatment (See p. 35) on cuttings of *Prunus Persica*, Sieb., var. *Elberta*, one set treated Oct. 23-27, another treated Dec. 17-21, a third treated Feb. 21-24, then placed outside in a frame of sand; and the condition of cuttings -- dead, dormant, growing, callused, and rooted-- on two separate dates.

		Elberta	Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Oct. 23-27	Apr. 1	No. Callused	0	0	0	0	0	0	0	0
		No. Started	0	0	0	0	0	0	0	0
		No. Dead	5	5	5	5	5	5	5	5
	Apr. 22	No. Callused	-	-	-	-	-	-	-	-
		No. Started	-	-	-	-	-	-	-	-
		No. Dead	-	-	-	-	-	-	-	-
Dec. 17-21	Apr. 3	No. Callused	3	0	5	3	3	2	0	1
		No. Started	2L	2L	5L	4L	5L	5L	2L	5L
		No. Dead	0	0	0	0	0	0	0	0
	Apr. 22	No. Callused	3	0	5	3	3	2	0	1
		No. Started	2L	2L	5L	4L	5L	5L	2L	0
		No. Dead	3	5	5	5	4	5	5	5
Feb. 29 through Mar. 3	Apr. 4	No. Callused	0	0	4	0	0	0	0	5
		No. Started	0	0	3L	0	0	0	0	2L
		No. Dead	0	0	0	0	0	0	0	0
	Apr. 22	No. Callused	0	0	4	0	0	0	0	5
		No. Started	0	0	3L	0	0	0	0	2L
		No. Dead	5	5	5	5	5	5	5	5

Cuttings of *Prunus Persica*, Sieb., var. Rice's Seedling.

Treated Oct. 23-27. (Cf. tables 16 and 18).

The untreated cuttings set out in the greenhouse bed were the first to callus. In most cases the cuttings placed in the greenhouse cutting bed following treatment, callused before those packed away in sawdust. All of the cuttings in all treatments , excepting the untreated set placed in sawdust, were dead when examined Feb. 12. The latter all died before Feb. 26. All of the cuttings placed in the frame of sand, were dead when examined on April 1. In none of the lots treated at this time, was the rest period broken nor were roots formed.

Treated Dec. 17-21. (Cf. tables 17 and 18).

The cuttings placed in the greenhouse cutting bed following treatment, callused before those placed in sawdust. The untreated cuttings, grown in the cutting bed, were the first to break their rest periods. All of the material placed in the cutting bed following treatment, was dead before March 18, and all of the material stored in damp sawdust, was in the same condition when examined on April 22. In the lot placed outside in a frame of sand, the freezing treatment caused the largest number of cuttings to break their rest periods at an early date. There was only one cutting alive in the outside lot, upon April 22, and this was one which had been etherized.

The artificial treatments proved of no advantage in hastening callus and root formation of cuttings of the Rice's Seedling peach.

Table No. 16.

Showing eight methods of treatment (See p. 35) on cuttings of *Prunus Persica*, Sieb., var. Rice's Seedling, treated Oct. 23-27, a set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on eight separate dates of inspection beginning Nov. 5 and continuing through Feb. 26.

[illegible]

Table No. 17.

Showing eight methods of treatment (See p.35) on cuttings of *Prunus Persica*, Sieb., var. Rice's Seedling, treated Dec. 17-21, a set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted-- on six separate dates beginning Jan. 3 and continuing through April 22.

[illegible]

Table No. 18.

Showing eight methods of treatment (See p. 35) on cuttings of *Prunus Persica*, Sieb., one set treated Oct. 23-27, a second set treated Dec. 17-21, then placed outside in a frame of sand; and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on two separate dates.

Date Treated	Date of Notes	Rice's Seedling.	Treatments							
		Condition	1	2	3	4	5	6	7	8
Oct. 23-27	Apr. 1	No. Callused	0	0	0	0	0	0	0	0
		No. Started	0	0	0	0	0	0	0	0
		No. Dead	5	5	5	5	5	5	5	5
	Apr. 22	No. Callused	-	-	-	-	-	-	-	-
		No. Started	-	-	-	-	-	-	-	-
		No. Dead	-	-	-	-	-	-	-	-
Dec. 17-21	Apr. 3	No. Callused	0	2	1	1	0	3	0	0
		No. Started	0	1L	4L	0	1L	1L	0	0
		No. Dead	0	0	0	0	0	0	0	1
	Apr. 22	No. Callused	0	2	1	1	0	3	0	0
		No. Started	0	1L	4L	0	1L	1L	0	0
		No. Dead	5	4	5	5	5	5	5	5

Cuttings of *Ribes oxycanthoides*, Linn., var. Pearl.

Treated Oct. 26-30. (Cf. tables 19 and 20)

Untreated cuttings, placed in the greenhouse cutting bed following treatment, were the first to callus and break their rest periods. The freezing treatment proved severe in all cases causing an earlier death of the cuttings thus treated. In those cuttings placed outside in a frame of sand (Cf. table 20), the desiccation treatment was the first to break the rest period. The freezing treatment in this lot also, showed marked injury. In none of the lots were there any rooted cuttings.

Artificial agents were found to be useless in hastening the callus and root formation of dormant gooseberry cuttings.

Cuttings of *Ribes rubrum*, Linn., var. Burbank.

Treated Oct. 26-30. (Cf. tables 20 and 21).

The cuttings placed in the greenhouse cutting bed following treatment, callused and formed roots before those packed in sawdust but the latter were the first to break their rest periods. Treatments 2,3,5,6 and 7 of the greenhouse material caused an earlier root formation than occurred in the case of untreated cuttings. The differences noted were not sufficient to recommend the use of any of these artificial agents for hastening the callus and root formation of currant cuttings. There was very little difference in the cuttings of the various treatments in the outside lot, although the desiccated, frozen and etherized (7) material suffered greatest injury.

Showing eight methods of treatment (See p. 35) on cuttings of *Ribes oxycanthoides*, Linn., var. Pearl, treated Oct. 26-30, a set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted-- on nine separate dates of inspection beginning Nov. 13 and continuing through April 22.

[illegible]

Table No. 20

Showing eight methods of treatment (See p. 35) on cuttings of *Ribes oxycanthoides*, Linn., var. Pearl and of *Ribes rubrum*, Linn., var. Burbank, both treated Oct. 26-30, then placed outside in a frame of sand; and the condition of cuttings--dead, dormant, growing, callused and rooted-- on two separate dates of inspection.

Gooseberry, var. Pearl			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Oct. 26-30	Apr. 1	No.Callused	2	1	0	0	0	0	0	2
		No.Started	2L	0	1L	0	0	0	0	0
		No.Dead	2	1	3	3	5	5	5	0
	Apr. 22	No.Callused	2	2	0	0	-	-	-	2
		No.Started	2L	1L	0	1L	-	-	-	2L
		No.Dead	3	1	5	4	-	-	-	0
Currant, var. Burbank										
Oct. 26-30	Apr. 3	No.Callused	5	5	4	5	5	5	2	5
		No.Started	5L	5L	5L	4L	4L	3L	5L	5L
		No.Dead	2R	1R	2R			2R		2R
	Apr. 22	No.Callused	5	5	4	5	5	5	2	5
		No.Started	5L	5L	5L	4L	4L	3L	5L	5L
		No.Dead	2R	1R	2R			2R		2R

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Table No. 21.

Showing eight methods of treatment (See p.35) on cuttings of *Ribes rubrum*, Linn., treated Oct. 26-30, a set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and condition of cuttings --dead, dormant, growing, callused and rooted-- on ten separate dates of inspection beginning Nov.5 and continuing through Feb.26.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 5	No.Callused	0	5	0	2	0	4	0	3	0	3	0	3	0	1	0	5
	No.Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 13	No.Callused	0	5	0	3	4	5	0	4	0	4	2	4	0	2	1	5
	No.Started	0	0	0	1R	0	1R	0	0	0	1R	0	2R	0	2R	0	0
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov. 26	No.Callused	0	5	0	4	4	5	0	4	0	4	2	4	0	5	1	5
	No.Started	0	3R	0	2R	0	3R	0	0	0	2R	0	4R	0	2R	0	2R
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec. 12	No.Callused	0	5	2	4	4	5	0	4	0	4	3	4	0	5	1	5
	No.Started	0	4R	0	3R	0	3R	0	2R	0	2R	0	4R	0	2R	0	5R
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 3	No.Callused	0	5	2	4	4	5	0	5	0	4	3	4	0	5	1	5
	No.Started	0	5R	0	3R	1R	3R	0	2R	0	2R	0	4R	0	2R	0	5R
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 22	No.Callused	0	5	2	5	4	5	2	5	0	5	3	5	0	5	2	5
	No.Started	0	5R	0	4R	2R	3R	0	2R	0	2R	1R	5R	0	2R	0	5R
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb. 12	No.Callused	0	5	2	5	5	5	2	5	1	5	3	5	1	5	3	5
	No.Started	0	5R	0	4R	2L	3R	0	2R	2L	2R	1R	5R	0	1L	0	5R
	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb. 22	No.Callused	0	5	2	5	5	5	2	5	1	5	3	5	3	5	3	5
	No.Started	0	5R	0	4R	2L	3R	0	2R	3L	2L	3L	2L	0	1L	0	5R
	No.Dead	0	0	0	0	2	1	0	2	0	0	0	0	0	5	0	0
G=Ma. 18	No.Callused	3	5	3	5	3	4	5	3	5	5	4	5	4	-	4	5
S=Ap. 4	No.Started	4L	5R	5L	4R	2L	3R	3L	2R	4L	2L	4L	2L	4L	-	5L	5R
	No.Dead	2R		4R		2R		1R		1R	2R	3R	5R		3R		0
Apr. 22	No.Callused	3	5	3	5	2	4	4	3	5	5	4	5	4	-	4	5
	No.Started	4L	5R	5L	4R	0	3R	2R	2R	4L	2L	4L	2L	4L	-	5L	5R
	No.Dead	2R		2R		5	1	5	2	0	3	1	0	1	-	0	0

Cuttings of *Prunus triflora*, Roxbg., var. Chabot.

Treated March 7-10 (Cf. tables 22 and 23).

The check treatment proved as efficient, in causing callusing and bud growth, as any of the artificial treatments. None of the cuttings, placed in either the greenhouse cutting bed or the damp sawdust rooted.

Artificial agents to hasten callus and root formation cannot be recommended in the case of the Chabot plum.

Cuttings of *Ribes rubrum*, Linn., var. White Cherry.

Treated Feb. 29-March 3 (Cf. tables 22 and 23).

The etherized cuttings, placed in sawdust after treatment, were the first to root but the untreated cuttings, in the end, were callused, leaved and rooted in as large numbers as were those artificially treated. In the case of the outside material (Cf. table 23) there was very little difference between treated and untreated cuttings.

The results obtained do not justify the use of artificial treatments to hasten callus and root formation of dormant cuttings of the White Cherry currant.

Table No. 22.

Showing eight methods of treatment (See p. 35) on cuttings of *Prunus triflora*, Roxbg., var. Chabot, treated March 7-10, and five methods of treatment on cuttings of *Ribes rubrum*, Linn., var. White Cherry, treated Feb. 29-March 3, one set (in each case) placed in a greenhouse cutting bed(G); and a duplicate lot stored in sawdust in a cool basement room (S); and the condition of cuttings--dead, dormant, growing, callused and rooted--on two separate dates of inspection.

Prunus triflora, Roxby.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		7		8			
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
G=Ma.	No.Callused	0	3	5	0	5	5	0	2	2	2	0	0	5	5		
18	No.Started	0	0	0	0	0	4L	0	0	0	0	0	0	0	5L		
S=Ap.	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4																	
Apr.	No.Callused	3	4	5	0	5	5	2	4	5	5	0	0	5	5		
22	No.Started	2L	4L	4L	1L	5L	5L	0	5L	4L	5L	0	2L	4L	5L		
	No.Dead	0	0	0	4	0	1	0	3	0	3	0	4	0	1		

Ribes rubrum, Linn.,

G=Ma.	No.Callused	0	5	5	5	-	-	0	5	0	5	-	-	5	5		
18	No.Started	0	4L	1R	5L	-	-	0	5L	0	4L	-	-	0	5L		
S=Ap.	No.Dead	0	0	0	0	-	-	0	0	0	0	-	-	0	0		
4																	
Apr.	No.Callused	2	5	5	5	-	-	2	5	4	5	-	-	5	5		
22	No.Started	1L	4L	5L	5L	-	-	2L	5L	1L	5L	-	-	5L	5L		
			1R	1R	1R				2R		2R			2R	2R		
	No.Dead	0	0	0	0	-	-	0	0	0	0	-	-	0	0		

- Treatments omitted because of lack of material.

Table No. 23.

Showing seven methods of treatment (See p.35) on cuttings of *Prunus triflora*, Roxbg., var. Chabot treated March 7-10, and five methods of treatment on cuttings of *Ribes rubrum*, Linn., var. White Cherry, treated Feb. 29-Mar. 3, both (following treatment) placed outside in a frame of sand; and the condition of cuttings--dead, dormant, growing, callused and rooted on two separate dates of inspection.

<u>Plum, var. Chabot</u>										
			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Mar. 7-10	Apr. 4	No.Callused	4	5	5	0	0	-	0	5
		No.Started	0	0	3L	0	0	-	0	0
		No.Dead	0	0	0	0	0	-	0	0
	Apr. 22	No.Callused	4	5	5	0	5	-	1	5
		No.Started	4L	5L	5L 1R	2L	4L	-	3L	4L
		No.Dead	0	0	0	0	0	-	0	0

Currant, White Cherry.

Feb. 29- Mar. 3	Apr. 4	No.Callused	5	5	-	4	5	-	-	5
		No.Started	3L	2L	-	4L	3L	--	-	5L
		No.Dead	0	0	-	0	0	-	-	0
	Apr. 22	No.Callused	5	5	-	5	5	-	-	5
		No.Started	4L	2L	-	4L	3L	-	-	5L
		No.Dead	3R	1R	-	1R	1R	-	-	3R

- Treatments omitted because of lack of material.

Cuttings of *Quercus Palustris*, Linn.,

Treated Nov. 9-13 (Cf. tables 24 and 26).

The cuttings placed in the greenhouse cutting bed following treatment, callused earlier than did those stored in sawdust. The freezing treatment proved to be the most severe especially when used in combination with other treatments. The desiccated (1) and the desiccated and etherized (4) cuttings placed in the greenhouse cutting bed, were the first to break their rest periods. In the outside lot (Cf. table 26) none of the cuttings callused but the check material had the largest percentage of bud growth, when examined on April 22.

Treated Jan. 19-22 (Cf. tables 25 and 26).

The cuttings, grown in the greenhouse cutting bed following treatment, callused before those stored in sawdust. The desiccation treatment caused the largest number of cuttings to callus and break their rest periods early. Of the cuttings placed outside in a frame of sand following treatment, the desiccated and frozen treatment (5) caused the earliest breaking of the rest period. The check set contained the largest number of dead cuttings when examined on April 22.

Treated Mar. 7-10 (Cf. tables 25 and 26).

The cuttings set-out in the greenhouse following treatment, were in all cases ahead of those stored in sawdust in callusing and breaking their rest periods. The desiccate (1), ether (2), freeze (3), and desiccate and freeze (5) treat-

ments, of those cuttings placed in the greenhouse cutting bed, proved more effective in causing an early callus formation, than did the check treatments. No callusing or root formation occurred in those cuttings placed outside after treatment (Of. table 26).

The results obtained do not justify the recommendation of any of the artificial treatments used, to hasten the callus and root formation of pin oak cuttings.

Table No. 24.

Showing eight methods of treatment (See p. 35) on cuttings of *Quercus Palustris*, Linn., treated Nov. 9-13, one set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings-- dead, dormant, growing, callused and rooted-- on eight separate dates of inspection beginning Nov. 26 and continuing through April 22.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 26	No. Callused	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec. 12	No. Callused	0	3	0	4	0	1	0	3	0	1	0	0	0	0	0	3
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0
Jan. 3.	No. Callused	0	3	0	4	0	1	0	3	0	2	0	0	0	0	0	3
	No. Started	0	1L	0	0	0	0	0	1L	0	0	0	0	0	0	0	0
	No. Dead	0	1	0	0	0	3	0	0	0	2	0	5	0	3	0	0
Jan. 22	No. Callused	0	3	0	4	0	1	0	3	0	1	0	-	0	0	0	3
	No. Started	0	1L	0	0	0	0	0	1L	0	0	0	-	0	0	0	0
	No. Dead	0	1	0	1	0	3	0	1	0	4	0	-	0	5	0	0
Feb. 12	No. Callused	0	3	0	4	0	1	0	3	0	0	0	-	0	-	0	3
	No. Started	0	1L	0	0	0	0	0	1L	0	0	0	-	0	-	0	0
	No. Dead	0	1	0	1	0	4	0	1	0	5	0	-	0	-	0	0
Feb. 26	No. Callused	0	3	0	4	0	0	0	3	0	-	0	-	0	-	0	3
	No. Started	0	1L	0	0	0	0	0	1L	0	-	0	-	0	-	0	0
	No. Dead	0	1	0	1	0	4	0	1	0	-	0	-	0	-	0	0
G-Ma. 18	No. Callused	0	3	0	4	0	0	0	3	0	-	0	-	0	-	0	3
	No. Started	0	1L	0	0	0	0	0	1L	0	-	0	-	0	-	0	0
S-Ap. 4	No. Dead	0	3	0	1	1	5	4	3	5	-	3	-	4	-	0	2
Apr. 22	No. Callused	0	1	0	4	0	-	0	2	-	-	0	-	0	-	1	3
	No. Started	0	0	0	0	0	-	0	0	-	-	0	-	0	-	0	0
	No. Dead	0	0	0	1	3	-	5	3	-	-	5	-	5	-	0	2

Table No. 25.

Showing eight methods of treatment (See p. 35) on cuttings of *Quercus Palustris*, Linn., one set treated Jan. 19-22, a second set treated March 7-10, one lot of each set then stored in sawdust in a cool basement room(S) with a duplicate lot set in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted-- on four separate dates in the first lot, and on three separate dates in the second lot.

Date of Notes	Treated Jan.19-22 Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Feb. 12	No.Callused	0	4	0	0	0	1	0	1	0	0	0	3	0	2	0	2
	No.Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No.Dead	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Feb. 22	No.Callused	0	4	0	3	0	1	0	1	0	3	0	3	0	2	0	4
	No.Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No.Dead	0	0	0	2	0	5	0	0	0	0	0	1	0	0	0	0
G=Ma. 18	No.Callused	0	4	0	2	0	-	0	1	0	3	0	3	0	2	0	4
	No.Started	0	4L	0	1L	0	-	0	2L	0	3L	0	2L	0	0	0	2L
S=Ap 4	No.Dead	0	0	0	3	0	-	0	1	0	0	0	1	0	4	0	0
Apr. 22	No.Callused	0	4	0	2	0	-	0	1	0	3	0	3	0	1	0	4
	No.Started	0	4L	0	1L	0	-	0	2L	0	3L	0	2L	0	0	0	2L
	No.Dead	0	4	0	3	0	-	0	3	0	5	0	3	0	5	0	3

Treated March 7-10

G=Ma. 18	No.Callused	0	3	0	1	0	2	0	0	0	4	0	0	0	0	0	1
	No.Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S=Ap 4	No.Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr. 22	No.Callused	0	5	0	4	0	3	0	1	0	4	0	0	0	0	1	2
	No.Started	1L	3L	0	2L	0	0	0	1L	0	1L	0	0	0	0	0	0
	No.Dead	0	0	0	0	0	2	0	3	0	0	0	2	0	5	0	0

Table No. 26.

Showing eight methods of treatment on cuttings of *Quercus Palustris*, Linn., one set treated Nov. 9-13, another treated Jan. 19-22, a third treated Mar. 7-10, all sets placed outside in a frame of sand; and the condition of cuttings--dead, dormant, growing, callused and rooted-- on two separate dates of inspection.

Pin Oak			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Nov. 9-13	Apr. 3	No.Callused	0	0	0	0	0	0	0	0
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
	Apr. 22	No.Callused	0	0	0	0	0	0	0	0
		No.Started	2L	1L	0	0	0	0	1L	4L
		No.Dead	1	2	5	3	5	5	5	3
Jan. 1922	Apr. 3	No.Callused	0	0	0	2	0	0	4	3
		No.Started	0	0	0	0	5L	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
	Apr. 22	No.Callused	0	0	0	2	0	0	4	3
		No.Started	5L	2L	0	2L	5L	0	3L	0
		No.Dead	0	0	0	1	3	1	0	5
Mar. 7-10	Apr. 4	No.Callused	0	0	0	0	0	0	0	0
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
	Apr. 22	No.Callused	0	0	0	0	0	0	0	0
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	0	0	0	0	1	0

Cuttings of *Fraxinus excelsior*, Linn.,

Treated Nov. 16-20 (Cf. tables 27 and 29).

The untreated cuttings grown in the greenhouse cutting bed were the first to callus. The freeze (3), and the desiccate, freeze and ether (7) treatments of the cuttings placed in the cutting bed, were the first to cause a breaking of the rest period. The freezing treatment of those cuttings placed in the greenhouse cutting bed after treatment, was the only one to cause any root formation.

Treated Jan. 19-22 (Cf. tables 28 and 29).

The cuttings placed in the greenhouse cutting bed following treatment, callused before those stored away in sawdust. The ether (2), the freeze (3), the desiccate and ether (4), and the desiccate and freeze (5) treatments were the first to cause a breaking of the rest period. A photograph of the greenhouse lot, taken on Feb. 23, is shown in Plate VI. It will be noted that the ether (2) and the freeze and ether (6) treatments were especially effective in accelerating growth but neither produced any roots. The check (8) and the desiccate, freeze and ether (7) treatments were the only ones which caused a formation of roots. Of the material placed outside, the check callused as soon as any of the treated lots.

The results obtained do not justify the recommendation of these artificial agents for use in hastening callus and root formation of dormant cuttings of the European ash.

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Ash Cuttings Placed in Greenhouse After Treatment.
Photographed one month after treatment.

Table No. 27.

Showing eight methods of treatment (See p. 35) on cuttings of *Fraxinus excelsior*, Linn., treated Nov. 16-20, one set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted-- on eight separate dates of inspection beginning Nov. 26 and continuing through April 22.

Date of Notes	Condition	Treatment															
		1		2		3		4		5		6		7		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Nov. 26	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec. 12	No. Callused	0	4	0	5	0	4	0	3	0	3	0	3	0	3	0	4
	No. Started	0	0	0	0	0	5L	0	0	0	0	0	0	0	1L	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan. 3	No. Callused	0	4	0	5	0	4L	0	3	0	3	0	3	0	3	0	4
	No. Started	0	0	0	0	0	1R	0	0	0	0	0	3L	0	1L	0	0
	No. Dead	0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	0
Jan. 22	No. Callused	0	4	0	5	1	3	0	3	0	3	1	3	0	3	0	5
	No. Started	0	0	0	0	0	4L	0	0	0	0	0	2L	0	0	0	0
	No. Dead	0	0	0	0	0	1R	0	0	0	2	0	1	0	1	0	0
Feb. 12	No. Callused	0	4	0	5	0	1	0	4	0	3	0	4	0	3	0	5
	No. Started	0	0	0	0	0	1L	0	0	0	0	0	2L	0	0	0	0
	No. Dead	0	0	0	0	0	5	0	0	1	2	0	1	0	5	0	0
Feb. 26	No. Callused	0	4	0	5	0	-	0	4	0	3	0	4	0	-	0	5
	No. Started	0	0	0	0	0	-	0	0	0	0	0	2L	0	-	0	0
	No. Dead	0	0	0	0	0	-	0	0	1	2	0	1	0	-	0	0
G=Ma. 18	No. Callused	4	4	5	5	3	-	1	4	1	3	3	4	3	-	5	5
	No. Started	0	0	0	0	1L	-	0	0	3L	1L	0	2L	0	-	0	0
S=Ap. 4	No. Dead	0	0	0	0	2	-	0	0	2	3	1	2	0	-	0	0
Apr. 22	No. Callused	4	4	5	5	3	-	1	4	1	2	3	3	5	-	5	5
	No. Started	0	0	0	0	1L	-	0	0	2L	0	0	0	0	-	0	0
	No. Dead	0	0	0	0	2	-	0	0	2	3	1	2	0	-	0	0

Table No. 28.

Showing eight methods of treatment (See p.35) on cuttings of *Fraxinus excelsior*, Linn., treated Jan. 19-22, one set stored in sawdust in a cool basement room (S) with a duplicate lot set in sand in a greenhouse cutting bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted-- on four separate dates of inspection.

Date of		Treatment															
		1		2		3		4		5		6		7		8	
Notes	Condition	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Feb. 12	No. Callused	0	1	0	5	0	4	0	1	0	2	0	5	0	1	0	4
	No. Started	0	0	0	2L	0	2L	0	2L	0	2L	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Feb. 22	No. Callused	0	2	0	5	0	5	0	1	0	2	0	5	0	4	0	4
	No. Started	0	2L	0	5L	0	5L	0	3L	0	2L	0	5L	0	4L	0	3L
	No. Dead	0	2	0	0	0	0	0	1	0	3	0	0	0	1R	0	1R
G=Ma. 18	No. Callused	1	2	1	5	0	5	0	1	0	1	0	5	0	4	0	4
	No. Started	0	1L	0	5L	0	5L	0	2L	0	2L	0	5L	0	4L	0	3L
S=Ap. 4	No. Dead	0	3	0	5	0	4	0	4	0	4	0	4	0	3	0	4
Apr. 22	No. Callused	1	3	1	-	0	1	0	1	0	0	0	1	0	2	0	1
	No. Started	0	0	0	-	0	1L	0	0	0	0	0	1L	0	1L	0	0
	No. Dead	2	4	0	-	0	5	1	5	0	5	0	5	0	4	1	5

Table No. 29.

Showing eight methods of treatment (See p.35) on cuttings of *Fraxinus excelsior*, Linn., one set treated Nov. 9-13, a second set treated Jan.19-22, both sets placed outside in a frame of sand; and the condition of cuttings--dead, dormant, growing, callused and rooted-- on two separate dates of inspection.

European Ash			Treatments							
Date Treated	Date of Notes	Condition	1	2	3	4	5	6	7	8
Nov. 16-20	April 3	No.Callused	1	1	0	1	0	0	0	1
		No.Started	0	0	0	0	0	0	0	0
		No.Dead	0	0	3	0	3	3	0	0
	April 22	No.Callused	2	2	0	1	0	0	0	1
		No.Started	0	2L	0	0	1L	1L	0	0
		No.Dead	0	1	5	1	5	4	2	3
Jan. 19-22	April 3	No.Callused	0	2	1	1	2	1	1	2
		No.Started	1L	0	0	0	0	0	0	0
		No.Dead	0	0	0	0	0	0	0	0
	April 22	No.Callused	0	3	1	1	2	1	1	2
		No.Started	2L	2L	0	0	0	0	1L	1L
		No.Dead	2	0	0	2	2	0	0	0

Cuttings of *Pinus Laricio*, Poir.

Treated Nov. 24-27 and Feb. 10-13 (Cf. table 30).

None of the treatments used, started any callus or root formation in the case of the Austrian Pine. The treated cuttings, placed in the greenhouse cutting bed following treatment, died before the untreated. The same statements hold true for Austrian Pine cuttings, made later during the season.

Cuttings of *Pinus sylvestris*, Linn.,

Treated Nov. 24-27 and Feb. 10-13 (Cf. table 30).

The freezing (3) and check (8) treatments caused callusing but in none of the sets were any roots formed. The treatments caused an earlier death in those cuttings placed in the greenhouse cutting bed, following the application of the artificial agents. Of those cuttings treated Feb. 10-13, none of the treatments caused any callus or root formation. The treatments caused an earlier death in the case of cuttings placed in the greenhouse cutting bed.

From these results it is seen that artificial agents cannot be successfully used to cause an earlier callus or root formation with Austrian and Scotch Pines.

Table No. 30.

Showing four different methods of treatment on cuttings of *Pinus Laricio*, Poir., and of *Pinus sylvestris*, Linn., one set of each species treated Nov. 24-27, a second set treated Feb. 10-13, then one lot of each stored in sawdust in a cool basement room (S) with a duplicate lot set in a greenhouse bed (G); and the condition of cuttings--dead, dormant, growing, callused and rooted--on seven different dates in the first set and on two separate dates in the second set.

		<i>Pinus Laricio</i>								<i>Pinus sylvestris</i>							
Date of *	Notes Condition	Treatment								Treatment							
		1		2		3		8		1		2		3		8	
		S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
Jan. 22	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	1	0	0	0	3	0	4	0	2	0	1
Feb. 12	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	1	0	1	0	0	0	5	0	5	0	5	0	4
Feb. 26	No. Callused	0	0	0	0	0	0	0	0	0	-	0	-	0	-	0	0
	No. Started	0	0	0	0	0	0	0	0	0	-	0	-	0	-	0	0
	No. Dead	0	5	0	5	0	4	0	1	0	-	0	-	0	-	0	5
Mar. 18	No. Callused	0	-	0	-	0	0	0	0	0	-	0	-	0	-	0	-
	No. Started	0	-	0	-	0	0	0	0	0	-	0	-	0	-	0	-
	No. Dead	0	-	0	-	0	5	0	5	0	-	0	-	0	-	0	-
Apr. 22	No. Callused	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
	No. Started	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
	No. Dead	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Treated Feb. 10-13																	
Mar. 18	No. Callused	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	0	0	0	0	0	0	0	0	4	0	4	0	4	0	0
Apr. 22	No. Callused	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Started	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. Dead	0	5	0	3	0	5	0	3	0	5	0	5	0	5	0	5

*None started on Dec. 12 or Jan. 3.

Summary of Results.

1. Freezing cuttings, at temperatures of from -15° -19° C, in the early fall proved to be too severe a treatment since it caused the death of practically all of the cuttings thus treated. The treatment was more severe at this time than upon later dates. This may be explained by the fact that the cuttings were not in as mature a condition as they were later in the season. The rapid fall of temperature, no doubt, caused a good share of the injury. There was less injury to the cuttings, later in the season, because of the fact that the cuttings were more matured and hardened. They had also gradually become accustomed to much lower temperatures than those cuttings treated during the fall, which enabled them to better withstand the rapid falls of temperature under the artificial freezing treatments.

2. The cuttings placed in the greenhouse after treatment, as a rule, callused before others similarly treated but placed in sawdust following the application of the artificial agent. This result might naturally be expected, since in the greenhouse, the cuttings were constantly under favorable growing conditions.

3. In all cases, except the apple, there was no difference in the rate of callusing of cuttings made at different times during the season. Jonathan and Ben Davis apple cuttings made in the fall required more time to callus than those made later during the season.

4. The artificial treatments, in most cases caused an earlier breaking of the rest period but they did not cause earlier callusing or root formation.

5. A careful individual study of approximately 3,200 cuttings--representing 14 varieties from eleven different species of woody plants--made at different times during the dormant season, then subjected to eight different methods of treatment (See p.35), then (after treatment) placed under three different conditions of environment, shows conclusively that desiccation, freezing, etherization, and all possible combinations of the three treatments do not induce earlier callusing or root formation in cuttings of the following woody plants; the apple, pear, peach, plum, gooseberry, currant, tulip, ash, oak and Scotch and Austrian Pines. These agents, therefore, cannot be economically used in commercial nursery practice, to ^{hasten} the callus and root formation of dormant hard wood cuttings.

Sugar in Treated and Untreated Cuttings

Dormant twigs contain starch, which is an insoluble form of plant food, and therefore not directly available to the plant. Starch must first be converted into sugar before it can be assimilated by the plant. The conversion of starch into sugar is brought about by the action of an enzyme, called diastase. Heinicke (47) and Howard (53) demonstrated that the sugar content of twigs is directly proportional to the diastatic activity. When the starch content of a plant is high there is very little sugar present and therefore the diastatic activity is low. The main object of this experiment was to note the effect of the various treatments used in the previous experiments, upon the sugar content of the cuttings. The sugar content was used as an index of diastatic activity in the cells.

The cuttings, 24 hours after receiving their preliminary treatments, i.e. the application of the rest period breaking agents, were ground up in the food chopper shown in Plate II. Entire cuttings were used. The procedure previous to Nov. 30 was as follows:: Ten gram samples of the ground up wood, from each treatment were placed in coarse 18½ cm. filter papers. Each sample was then leached with 100 c.c. of distilled water. The water was poured over the material as quickly as possible so that the entire 100 c.c. was added before any water came through the filter.

The extract passed through the filter very rapidly indicating that the materials in solution were very highly soluble. The presence and amount of sugar in the extract were determined by means of Allhin's modification of Fehling's solution

prepared according to the Official Methods of Agricultural Chemists (U.S. Department of Agriculture 106). Unless otherwise noted, in all of the tests performed, 2 c.c. of Fehling's solution were added to 10 cc. of the extract and boiled for about 2 minutes. These mixtures were allowed to cool. All determinations were run in duplicate. The color of the supernatant liquid after the precipitate had settled was used as an indicator for estimating the relative amounts of sugar present. The colors of the spectrum through blue, were used as standards of comparison; these colors were red, orange, yellow, green and blue. A dark red color showed there was a comparatively large amount of sugar present, whereas a blue color showed the sugar present was insufficient to reduce Fehling's solution. The following simple experiment will illustrate the method of testing and recording explained above.

Several 10 c.c. samples of an apple cutting extract were taken as follows: 1. Before diluting; 2. after diluting to twice its original volume; 3, to four times its original volume; 4. to eight times its original volume. To each of these samples 2 c.c. of Fehling's solution was added. They were then heated for about two minutes. After cooling and settling, the liquid in (1) was red; in (2) a reddish orange; in (3) a yellowish green; in (4) a blue. The amount of precipitate was greatest in (1) and least in (4).

After Nov. 30 the method of preparing the material for the tests was slightly modified. Ten gram samples of the ground up wood from each treatment were weighed as before. These, instead of being placed in coarse filter papers to be leached, were

allowed to soak in 100 c.c. of distilled water for one hour. Ten c.c. of the filtrate were tested in duplicate as before. Better comparisons of the different treatments were obtained by this method. Upon this date also the colors obtained were compared to a standard list of colors, given in Dauthenay's *Repertoire de Couleurs* (28A), and the results tabulated as shown in Tables No. 31-41 inclusive.

The first column of tables 31 to 41 gives the dates of application of the various treatments. The second column gives the relative order of sugar content, beginning with 1. which contains the most sugar, through 8., which contains the least sugar. The treatments applied are given in the next column. It must be remembered that in all cases the treatments were exactly the same as those applied in the previous experiments; i.e. in all cases the length of the desiccation period was 24 hours; the duration of the exposures to ether vapors and freezing temperatures, in all experiments conducted previous to Jan. 19 was 48 and 24 hours respectively, but in all experiments conducted thereafter 24 and 18 hours respectively. Columns four, five, and six refer respectively to the color, shade and page, taken from Dauthenay's *Repertoire de Couleurs* (28A).

Table No. 31.

Sugar in Cuttings of *Pyrus malus*, Linn. var. Jonathan.

Cuttings treated Oct. 10-15.

The largest sugar content in the 1. Frozen and Etherized material; 2. Check, and Frozen about equal; 3. Desiccated, Frozen and Etherized; 4. Desiccated and Etherized*; 5. Desiccated; 6. Etherized; 7. Desiccated and Frozen*.

Date of Treatment	Order of Sugar Content.	Treatment	Color	Shade	Page
Nov. 30-Dec. 4	1	Des. and Frozen#	Mineral Green	3	263
	2	Frozen#	Emerald Green	3	259
	3	Ether#	Bright Moss Green	3	274
	4	Des., Frozen & Eth.	Grass Green	2-	273
	5	Frozen and Eth.	Bright Moss Green	1	274
	6	Des. and Eth.	Terra vert	3	242
	7	Check	Sky Blue Green	3	256
	8	Desiccated	Bluish Sulph. Green	3	255
Feb. 15-18	1	Des., Frozen & Eth.	Indian Chestnut Red	3	333
	2	Frozen and Eth.	Burnt Sienna	1	320
	3	Des. and Eth.	Neutral Orange	2	319
	4	Des. and Frozen	Neutral Orange	2-	319
	5	Frozen	Neutral Orange	1	319
	5	Desiccated	Neutral Orange	1	319
	6	Etherized	Raw Sienna	4	329
	7	Check	Raw Sienna	2	329

* Only 5 g. of ground up wood used, therefore only 50 c.c. of water used for the leaching.

Sugar tests made 48 hours after treatment.

Table No. 32.

Sugar in Cuttings of *Pyrus malus*, Linn. var. Ben Davis.

Cuttings treated Oct. 10-15.

The largest sugar content in 1. Desiccated and Etherized; 2. Frozen and Etherized; 3. Desiccated; 4. Frozen; 5. Desiccated, Frozen and Etherized*; 6. Desiccated and Frozen; 7. Check; 8. Etherized.

Date of Treatment	Order of Sugar Content.	Treatment	Color	Shade Page	
Nov. 30-Dec. 4	1	Des. and Frozen#	Cyprus Green	3	264
	2	Frozen #	Grass Green	2	273
	3	Des. and Etherized	Cyprus Green	4	264
	4	Frozen and Etherized	Emerald Green	3	259
	5	Des.,Froz. & Eth.	Malachite Green	1	258
	6	Desiccated	Sky Blue Green	2	256
	7	Check	Bluish Sulph.Green	1	255
Feb. 15-18	@				
	1	Des.,Froz. and Eth.	Neutral Orange	2	319
	2	Frozen and Eth.	Neutral Orange	2-	319
	3	Des. and Frozen	Neutral Orange	1	319
	3	Des. and Eth.	Neutral Orange	1	319
	3	Check	Neutral Orange	1	319
	4	Desiccated	Yellowish Tan	2	315
	4	Etherized	Yellowish Tan	2	315
	5	Frozen	Bistre Green	3	296

*Only 5 g. of ground up wood used, therefore only 50 c.c. of water used for the leaching.

#Sugar tests made 48 hours after treatments.

@The etherized material lost in manipulation.

Table No. 33.

Sugar in Cuttings of *Pyrus communis*, x *Pyrus Sinensis* var. Kieffer.

Cuttings treated Oct. 19-23.

The tests showed no difference in any of the treatments. The color of the extract was in every case a clear blue, indicating that there was no sugar present.

Order of Sugar Con- tent. Date of Treatment		Treatment	Color	Shade	Page
Dec. 7-11	1	Des. and Frozen	Coppery Yellow	2	32
	2	Des., Froz. and Eth.	Snuff Brown	1	303
	3	Frozen and Eth.	Snuff Brown	1-	303
	4	Des. and Eth.	Snuff Brown	1-	303
	5	Etherized	Dark Drab Green	1	237
	6	Frozen	Bottle Green	1	251
	7	Desiccated	Bottle Green	3	251
	8	Check	Turquoise Blue Green	3	225
Feb. 21-24	1	Des., Frozen and Eth.	Indian Chestnut Red	2	333
	2	Desiccated	Snuff Brown	4	303
	3	Des. and Etherized	Golden Bronze	2	298
	4	Des. and Frozen	Golden Bronze	2-	298
	5	Frozen and Eth.	Snuff Brown	1	303
	6	Frozen	Sap Green	2	280
	7	Check	Dull Sage Green	2	278
	8	Etherized	Dull Grey Green	2	277

Table No. 34.

Sugar in Cuttings of *Liriodendron Tulipifera*, Linn.

Cuttings treated Nov. 9-13.

There was no difference in sugar content following the various methods of treatment.

Date of Treatment	Order of Sugar Content	Treatment	Color	Page	
				Shade	
Dec. 7-11	1	Des. and Etherized	Copper Yellow	4	32
	2	Check	Copper Yellow	3	32
	3	Desiccated	Copper Yellow	1	32
	4	Des., Frozen and Eth.	Bistre Green	3	296
	5	Frozen and Eth.	Bistre Green	2	296
	6	Etherized	Bottle Green	3	251
	7	Des. and Frozen	Bottle Green	2	251
	8	Frozen	Turq. Blue Green	2	225
Feb. 21-24	1	Des. and Frozen	Neutral Orange	2	319
	2	Des. and Etherized	Ru Ochre	4	314
	3	Des., Froz. and Eth.	Ru Ochre	3	314
	4	Check	Yellowish Tan	1	315
	5	Desiccated	Ru Ochre	2	314
	6	Frozen and Eth.	Ru Ochre	1	314
	7	Frozen	Golden Bronze Green	1	298
	8	Etherized	Reseda	4	294

Table No. 35.

Sugar in Cuttings of *Prunus Persica*, Sieb. var. *Elberta*.

Cuttings treated Oct. 22-26.

The largest sugar content in 1. Desiccated, Frozen and Etherized; 2. Frozen and Etherized; 3. Desiccated and Etherized*; 4. Desiccated; 5. Etherized*; 6. Frozen; 7. Desiccated and Frozen; 8. Check.

Date of Treatment	Order of sugar Content	Treatment	Color	Shade	
					Page
Dec. 17-21	1	Des. and Etherized	Natural Orange	3	319
	2	Des., Froz. and Eth.	Natural Orange	3-	319
	3	Frozen and Eth.	Mars Yellow	3	316
	4	Des. and Frozen	Natural Orange	2	319
	5	Frozen	Natural Orange	1	319
	6	Desiccated	Yellowish Tan	3	315
	7	Etherized	Yellowish Tan	2	315
	8	Check	Dull Yellow Green	1	292
Feb. 29-March 3	1	Des. and Frozen	Mahogany	2	335
	1	Des. and Etherized	Mahogany	2	335
	2	Des., Frozen & Eth.	Indian Chestnut Red	2	333
	2	Frozen and Eth.	Indian Chestnut Red	2	333
	3	Etherized	Red Ochre	3	332
	3	Desiccated	Red Ochre	3	332
	4	Frozen	Bistre	3	328
	# 5	Check	Yellow Ochre	3	326

* Received 72 hours of the ether treatment.

For test soaked 5 c.c. of ground up material in 50 c.c. of distilled water. Then used only 5 c.c. of the filtrate with 1 c.c. of Fehling's.

Table No. 36.

Sugar in Cuttings of *Prunus Persica*, Sieb. Var. Rice's
Seedling.

Date of Treatment	Order of Sugar Con- tent	Treatment	Color	Page	
				Shade	
Oct. 22-26	1	Des., Frozen & Eth.	No data		
	2	Frozen and Etherized	" "		
	3	Desiccated and Eth.	" "		
	4	Etherized	" "		
	5	Desiccated	" "		
	6	Frozen	" "		
	7	Des. and Frozen	" "		
	8	Check	" "		
Dec. 17-21.	1	Des. and Etherized	Natural Orange	3	319
	2	Des., Frozen & Eth.	" "	3-	319
	3	Frozen & Etherized	Mars Yellow	3	316
	4	Frozen	Natural Orange	2	319
	5	Des. and Frozen	" "	1	319
	6	Desiccated	Yellowish Tan	2	315
	7	Etherized	" "	1	315
	8	Check	Apple Green	1	276

Table No. 37.

Sugar in Cuttings of *Ribes rubrum*, Linn. (currant)

Date of Treatment	Order of Sugar Content.	Variety Burbank		Shade	Page
		Treatment	Color		
Oct. 26-30	1	Des. and Frozen	No data		
	2	Frozen	" "		
	3	Des., Frozen & Eth.	" "		
	3	Etherized	" "		
	3	Frozen & Etherized	" "		
	3	Des. and Etherized	" "		
	4	Desiccated	" "		
	5	Check	" "		
Variety White Cherry					
Feb. 29-Mar. 5*	1	Desiccated	Raw Sienna	2	329
	2	Check	Yellow Ochre	2	326
	3	Des. and Frozen	Bistre Green	1	296
	3	Des. and Etherized	" "	1	296
	3	Etherized	" "	1	296

* Because of scarcity of material only 5 treatments used. In making the sugar tests only 5 c.c. of material was soaked in 50 c.c. of water for one hour, used 5 c.c. of the filtrate with 1 c.c. of Fehling's.

Table No. 38.

Sugar in Cuttings of *Ribes oxyacanthoides*, Linn.
(Gooseberry) and *Prunus triflora* (Japanese plum).

Treatment	Date of Treatment	Order of Sugar Content	Gooseberry Var. Pearl		Shade	Page
			Treatment	Color		
Oct. 26-30	1		Desiccated	No data		
	2		Etherized	" "		
	3		Frozen	No dif. in last 6 cases		
	3		Des. and Ether.	" " " " " "		
	3		Des. and Frozen@	" " " " " "		
	3		Frozen & Ether.	" " " " " "		
	3		Des. Frozen & Eth.	" " " " " "		
	3		Check	" " " " " "		
Plum, Var. Chabot						
Mar. 7-10 *	1		Des., Frozen & Eth.	Indian Chestnut Red	1	333
	1		Des. & Etherized #	" " "	1	333
	1		Desiccated	" " "	1	333
	1		Des. and Frozen	" " "	1	333
	2		Etherized	Bistre	3	328
	3		Frozen	Brown Pink	3	297
	3		Check	" "	3	297

* Only 7 treatments used.

2.5 g. of material soaked in 25 c.c. of water for 1 hour; in the other treatments 5 g. soaked for 1 hour in 50 c.c. In all treatments used 5 c.c. of the filtrate with 1 c.c. of Fehlings.

@ Only 5 c.c. of material soaked in 50 c.c. of water for 1 hour.

Table No. 39.

Sugar in Cuttings of *Quercus Palustris*, Linn. (Pin Oak)

Cuttings treated Nov. 9-13.

The largest sugar content in 1. Check; 2. Etherized; 3. Desiccated; 4. no difference in a. Frozen; b. Desiccated and Etherized; 5. no difference in a. Desiccated and Frozen; b. Desiccated, Frozen and Etherized; c. Frozen and Etherized.

Date of Treatment	Order of Sugar Content.	Treatment	Color	Shade	Page
Jan. 19-22	1	Des., Frozen & Ether.	Brown Pink	4	297
	2	Des. and Etherized	" "	3	297
	3	Desiccated	" "	2	297
	4	Check	" "	1	297
	5	Frozen & Etherized	Dull Yell. Green	3	292
	6	Des. and Frozen	" " "	2	292
	7	Frozen	Lettuce Green	3	267
	8	Etherized	" "	2	267
March 7-10*	1	Frozen & Etherized	Burnt Sienna	2	320
	2	Des. & Etherized	Tan Color	2	317
	2	Desiccated	" "	2	317
	2	Etherized	" "	2	317
	2	Des. and Frozen	" "	2	317
	3	Des., Frozen & Eth.	Gold. Bronze Gr.	1	298
	3	Frozen	" " "	1	298
	4	Check	Dull Yell. Green	1	292

* Soaked 5. g. of ground up material in 50 c.c. of water for 1 hour, then used 5. c.c. of filtrate with 1.c.c. of Fehling's.

Table No. 40.

Sugar in Cutting of *Fraxinus excelsior*, Linn.
(European Ash)

Date of Treatment	Order of Sugar Content	Treatment	Color	Shade	Page
Nov. 16-20	1	Frozen and Etherized	No data		
	2	Des., Frozen & Ether.	" "		
	3	Des. and Frozen	" "		
	4	Frozen	" "		
	5	Desiccated	" "		
	6	Desiccated and Ether.	" "		
	7	Etherized	" "		
	8	Check	" "		
Jan. 19-22.	1	Desiccated	Neutral Orange	3	319
	1	Etherized	" "	3	319
	1	Frozen	" "	3	319
	1	Des. & Etherized	" "	3	319
	1	Des. and Frozen	" "	3	319
	1	Frozen & Etherized	" "	3	319
	1	Des., Frozen & Ether.	" "	3	319
	1	Check	" "	3	319

Table No. 41.

Sugar in Cuttings of *Pinus Laricio*, Poir. (Austrian Pine)
and *Pinus sylvestris*, Linn. (Scotch Pine)

Date of	Order of Sugar Content	Austrian Pine		Shade	Page
		Treatment	Color		
24-27 Nov.	1	Etherized	No data		
	2	Desiccated	" "		
	2	Frozen	" "		
	2	Check	" "		
10-15 Feb.	1	Frozen	Neutral Orange	3	319
	2	Check	Terra Cotta	3	331
	2	Etherized	" "	3	331
	3	Desiccated	" "	4	331
Scotch Pine					
24-27 Nov.	1	Etherized	No data		
	2	Desiccated	" "		
	3	Check	" "		
	4	Frozen	" "		
10-15 Feb.	1	Check	Rust Red	3	318
	2	Frozen	Neutral Orange	4	319
	2	Desiccated	" "	4	319
	3	Etherized	Burnt Sienna	4	320

It will be seen from Table 31 that, when treatments were applied in the early fall, the diastatic activity in Jonathan apple cuttings was checked by all treatments, with the exception of the Frozen and Etherized. In practically all cases, in both of the later tests, the diastatic activity was increased by the various treatments. It will also be noted that the diastatic activity increased as the season advanced since in the second test, only shades of green are found, while in the later, shades of red and orange are noted.

A study of Table 32 shows that in the test conducted in the early fall, all treatments, except etherization, caused an increased diastatic activity in cuttings of the Ben Davis apple. In the second test the sugar content was increased by all of the treatments. In the last test the more severe treatments increased the diastatic activity while the less severe checked the development of diastase enzymes. In this case, also, the diastatic activity is found to be greater as the season advances, since in the second experiment only shades of green were noted while in the later test shades of orange and yellow appear along with one shade of green.

A review of Table 33 shows that the sugar content of cuttings of the Kieffer pear was not influenced by any of the treatments applied in the early fall. In the later

tests the treatments increased the diastatic activity in all cases but one. Here again we find that the diastatic activity increases as the season advances.

The data in Table 34 show that the early fall treatments have no effect upon the sugar content of Tulip tree cuttings. In the test conducted about a month later, one treatment increased diastatic activity. As the season advanced we again find that diastatic activity was increased by the various treatments.

A study of Tables 35 and 36 shows that in both the Elberta and Rice's Seedling peaches, the diastatic activity was increased by the various treatments at all times during the dormant period. In the Elberta we find that, as the season advances, the colors approach the red, or in other words, there is an increased diastatic activity.

In Table 37 two different varieties of currants were tested at different seasons, so no comparison could be made as to the diastatic activity at different periods in the season. Among other factors the diastatic activity varies with the variety as may be seen by consulting Tables 31 and 32. In the case of the variety Burbank, treated early in the fall, all treatments increased the sugar content. In the case of the variety, White Cherry, tested during late winter, only one of the five treatments used, stimulated the diastatic activity.

The data in Table 38 show that two treatments stimulated diastatic activity in the Pearl gooseberry, while none of the treatments inhibited the action of the diastase enzymes. In the case of the Chabot plum all treatments, except one, stimulated diastatic activity. Freezing in this case seemed to have no effect upon the sugar content of the cuttings.

It will be seen from the data in Table 39 that all treatments applied in the early fall had an inhibitory influence upon the diastatic activity in cuttings of the Pin Oak. In the next test, three of the treatments slightly increased the sugar content. In the last test the diastatic activity was stimulated by all of the treatments. It is thus seen that, as the season advances, the various treatments become more effective in stimulating diastatic activity in Pin Oak cuttings.

A review of Table 40 shows that the sugar content of the European Ash was increased by all treatments applied in the fall test. In the next test, however, the various treatments had no effect in stimulating diastatic activity. We may conclude from these results that, in the case of the European Ash, the various treatments have less effect in stimulating diastatic activity, as the season advances.

A study of Table 41 shows that, with both the Austrian and Scotch pines, the treatments had more effect, earlier in the season, in increasing diastatic activity,

than they had later during the season. In the last test, with one exception, all the treatments had an inhibitory influence upon the diastase enzymes.

A summary of the results of the above tables show that in a large number of cases the diastatic activity was increased by the treatments. The amount of increase obtained varies in different cases depending upon the treatment used, (cf. Tables 31-41), the species, (cf. Tables 31-41), variety (cf. Tables 31 and 32), and the date of application. In some cases (cf. Tables 35 and 36) all of the treatments stimulated diastatic activity, while in other cases (cf. Tables 31, 32, 33, 34, 37, 38, 39, 40 and 41) only part of the treatments increased the activity of these enzymes. The date of application is an important factor in the enzyme determination. In some cases the enzymes were not stimulated during the early part of the season; but the same treatments later in the season caused increased enzyme activity. (cf. Table 31, 33, 34 and 39). In other cases, treatments which proved effective early in the season, had little or no effect later. (cf. Tables 32 and 40). In still other cases the late treatments caused the enzymes in the tissue to become less active than those in the untreated material. (cf. Tables 37 and 41) It should be noted that in practically all cases, the enzyme activity of the untreated cuttings increased as the season advanced. These results agree in general with those reported by Heinicke (47) and Howard (53).

MISCELLANEOUS EXPERIMENTS

A number of experiments and observations were made which have no direct bearing upon cuttage. These, however, are directly concerned with the more general study of the rest period of plants, especially with the effect of ether upon peach twigs and upon apple grafts. The results of these miscellaneous experiments will be given at this time, along with a brief discussion in each case. The reader is to some extent, left to draw more detailed conclusions from the results noted.

I. The Effect of Ether in Breaking the Rest Period of Different Varieties of Peaches

The object of this experiment was to note the effect of ether in shortening the rest period of different varieties of peaches. On Dec. 2, Dec. 3, and Dec. 10, ten or twelve twigs of one year wood from one tree of each of 63 varieties were obtained. These were taken into the greenhouse and each of the 63 bunches of twigs was divided into two equal lots of five or six twigs each. One lot was subjected to the fumes of ether for 48 hours. The other lot was immediately placed in jars of water and left in the greenhouse to be forced. Following the treatment the etherized twigs were placed in similar jars of water to be forced. The water in all jars was changed once a week and at that time the ends of the twigs were cut back to allow free passage of water up the xylem of the twigs. The results obtained are given in Tables 42, 43, 44.

A study of Table 42 shows that ether induced a shortening of the rest period in 5 of the 9 varieties tested.

Table No. 42

Peach Twigs Treated Dec. 2, 1915

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Tiebot Eth.	Dec. 21	Upper 1/3	Dec. 31, 4 dead; Jan. 17, all dead.
Tiebot Ch.	Jan. 17	Lower end	Jan. 17, all alive.
Straus Early Eth.	Dec. 21	Upper 1/2	Dec. 30, all dead except one.
Straus Early Ch.	_____	_____	Jan. 25, all alive.
Victor Eth.	Dec. 21	Terminals	Dec. 30, 3 dead; Jan. 17, all dead.
Victor Ch.	_____	_____	Jan. 17, all alive.
Mayflower Eth.	Dec. 30	Upper 1/5	Dec. 30, 3 dead, other 2 dying; Jan. 17, dead.
Mayflower Ch.	_____	_____	Jan. 17, all alive.
Chinese Cling Eth.	Jan. 8	Lower 1/3	Dec. 30, all dead but lower 1/3; Jan. 17, dead.
Chinese Cling Ch.	Jan. 25	Upper 1/8	Jan. 25 all alive.
Matthew's Beauty Eth.	_____	_____	Dec. 30, all dead.
Matthew's Beauty Ch.	_____	_____	Jan. 25 all alive.
Carman Eth.	_____	_____	Dec. 30, all dead.
Carman Ch.	_____	_____	Jan. 17, all alive.
Salway Eth.	_____	_____	Dec. 30, all dead.
Salway Ch.	Jan. 8	Terminals	Jan. 17, all alive.
Augbert Eth.	_____	_____	Dec. 30, all dead.
Augbert Ch.	Jan. 17	Terminals	Jan. 17, all alive.

_____ Rest period not broken on Jan. 25.

The length of this period of growth acceleration varied from 17 days, in the case of the Chinese Cling, to 35 days in the case of the Victor. In two varieties, Matthew's Beauty and Carman, the rest period was not broken in either the treated or untreated twigs, showing that these varieties have deep rest periods. In the case of the treated material, however, this may have been due to the fact that the twigs were all killed before Dec. 30. With the Salway and Augbert, the untreated material forced ahead of the etherized, although this is probably due to the fact that all of the twigs of both varieties died before Dec. 30, due to the action of the ether. In all cases the ether caused a drying of the tissues which caused a premature death of the twigs.

In 7 of the 9 cases where growth was obtained, the buds on the apical half of the twigs were the first to start. These results show that the buds on the peripheral parts of twigs are the first to break their rest periods. They are therefore the most susceptible to injury by low temperatures, especially following periods warm enough to start the buds into growth. The buds at the basal end of the twigs did not start into growth until after the buds on the upper end had started and are, therefore, the more hardy. These results confirm the findings of Chandler(21).

Of the 24 varieties of peaches tested Dec. 3, 1915, the ether treatment caused an earlier breaking of the rest

Table No. 43

Peach Twigs Treated Dec. 3, 1915.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Redbird Cling Eth.	Dec. 30	Upper 1/2	Jan. 26, all alive.
Redbird Cling Ch.	Jan. 17	Terminals	Jan. 26, all alive.
Connet Eth.	Jan. 8	Terminals	Jan. 26, two dead.
Connet Ch.	_____	_____	Jan. 26, two dead.
Crawford Early Eth.	Jan. 8	Upper 1/5	Jan. 26, all alive.
Crawford Early Ch.	_____	_____	Jan. 17, 3 dying; Jan. 26, all dead.
Elberta Eth.	Jan. 8	Terminals	Jan. 17, 3 dying; Jan. 27, all dead.
Elberta Ch.	Jan. 26	Lower 1/5	Jan. 26, 1 alive.
Heath Cling Eth.	Jan. 8	Upper 1/2	Jan. 26, all alive.
Heath Cling Ch.	Jan. 17	Terminals	Jan. 26, all alive.
Mt. Rose Eth.	Jan. 26	Upper 1/3	Jan. 26, all alive.
Mt. Rose Ch.	_____	_____	Jan. 26, all alive.
Lemon Cling Eth.	Jan. 25	Upper 1/8	Jan. 25, all alive.
Lemon Cling Ch.	Jan. 25	Upper 1/4	Jan. 25, all alive.
Superb Eth.	Jan. 17	Upper 1/6	Jan. 26, all alive.
Superb Ch.	Jan. 17	Lower 1/6	Jan. 26, all alive.

Table No. 43. Continued.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Bell of Georgia Eth.	_____	_____	Jan. 17, 1 dead.
Bell of Georgia Ch.	Jan. 17	Terminal	Jan. 26, 1 dead.
Waddell Eth.	_____	_____	Jan. 26, all dead.
Waddell Ch.	Jan. 17	Terminal	Jan. 26, 1 alive.
Alton Eth.	_____	_____	Jan. 26, 5 dead; 1 alive.
Alton Ch.	_____	_____	Jan. 26, 5 dead; 1 alive.
Blanchard Eth.	_____	_____	Jan. 26, one alive. Jan. 17, 4 dead; others dying.
Blanchard Ch.	_____	_____	Jan. 17, 4 dead. Jan. 26, all dead.
Bokhara Eth.	_____	_____	Jan. 26, all alive.
Bokhara Ch.	_____	_____	Jan. 26, all alive.
Champion Eth.	_____	_____	Jan. 17, 3 drying up.
Champion Ch.	_____	_____	Jan. 17, 2 drying up; Jan. 26, 4 dead.
Chinese Free Eth.	_____	_____	Jan. 26, 1 dead.
Chinese Free Ch.	_____	_____	Jan. 26, 1 dead.
Conover Eth.	_____	_____	Jan. 8, 1 dead, 4 drying up. Jan. 26, dead.
Conover Ch.	_____	_____	Jan. 17, 1 dead; Jan. 26, 3 dead.
Crosby Eth.	_____	_____	Jan. 17, 1 dead; Jan. 26, all dead.
Crosby Ch.	_____	_____	Jan. 26, all alive.

Table No. 43. Continued.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Fitzgerald Eth.	_____	_____	Jan. 17, 1 dead; Jan. 26, all dead.
Fitzgerald Ch.	_____	_____	Jan. 26, all alive.
Greensboro Eth.	_____	_____	Jan. 8, 1 drying up; Jan. 17, 1 dead. Jan. 26, all dead.
Greensboro Ch.	_____	_____	Jan. 17, 2 drying up; Jan. 26, all dead.
Graves No. 2 Eth.	_____	_____	Jan. 17, 2 dead.
Graves No. 2 Ch.	_____	_____	Jan. 26, 1 alive.
Hills Chili Eth.	_____	_____	Jan. 17, 3 dead; Jan. 26, all dead.
Hills Chili Ch.	_____	_____	Jan. 17, 1 dead; Jan. 26, all dead.
Stump Eth.	_____	_____	Jan. 26, 1 alive.
Stump Ch.	_____	_____	Jan. 26, 1 alive.
Triumph Eth.	_____	_____	Jan. 26, 3 dead.
Triumph Ch.	_____	_____	Jan. 26, 2 dead.
Washington Eth.	_____	_____	Jan. 26, all alive.
Washington Ch.	_____	_____	Jan. 26, all alive.

period in the following 6 varieties; Redbird Cling, Connet, Crawford Early, Elberta, Heath Cling and Mt. Rose. In the cases of Mt. Rose, Connet and Crawford Early, an accelerated growth was obtained, whereas, the checks failed to start into growth. In the other 3 cases the rest period was shortened from 9 to 18 days, by the use of ether. With Lemon Cling and Superb there was no difference between treated and untreated material. In the cases of Belle of Georgia and Waddell the ether proved injurious for the check material was forced whereas the etherized material was killed. In the last fourteen varieties of Table 43, the rest period was not broken by ether of the two treatments. In 6 of these 14 cases the ether caused a greater and earlier killing of the twigs, in 6 cases there was no difference in the rate of killing, in 2 cases the check material died before the etherized.

Where growth was secured, the buds in the upper part of the twigs were the first to start in all cases but two. These results tend to verify the statement previously made, that the peripheral buds are more tender than those nearer the trunk of the tree.

Of the 30 varieties treated on Dec. 10, ether caused an earlier growth in the 20 varieties listed first in Table 44; in 2 cases an earlier growth was secured by merely forcing in water, in 2 cases there was no difference between the treated and untreated material; in 6 instances the rest period was not broken before Jan. 26. Of the 20 varieties whose rest period was shortened by the use of ether, there were 13 whose rest periods were not broken up to Jan. 25, by the check

Table No. 44.

Peach Twigs Treated Dec. 10, 1915

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Deweys' Choice Eth.	Dec. 30	Upper 1/4	Jan. 8, 2 dead; Jan. 26, all dead.
Deweys' Choice Ch.	_____	_____	Jan. 26, all alive.
Guinn Eth.	Dec. 30	Upper 1/3	Jan. 8, drying up; Jan. 26, all dead.
Guinn Ch.	_____	_____	Jan. 17, 1 twig dead.
Kalamazoo Eth.	Dec. 30	Upper 1/8	Jan. 8, 3 dead; Jan. 17, all dead.
Kalamazoo Ch.	_____	_____	Jan. 26, all alive.
Russell Eth.	Dec. 30	Terminal	Jan. 17, 4 dead, 2 alive; Jan. 26, all dead.
Russell Ch.	_____	_____	Jan. 17, 1 dead.
Shipley Red Eth.	Dec. 30	Upper 1/6	Jan. 17, 3 drying up; Jan. 26, all dead.
Shipley Red Ch.	_____	_____	Jan. 8, all dead, due to lack of water.
Smock Eth.	Dec. 30	Upper 1/5	Jan. 17, 5 dead; Jan. 26, all dead.
Smock Ch.	_____	_____	Jan. 17, 3 dead.
Grant's Favorite Eth.	Dec. 30	Upper 1/6	Jan. 17, all drying up; Jan. 26, all dead.
Grant's Favorite Ch.	Jan. 8	Lower 1/8	Jan. 26, all alive, and plump.
Lemon Free Eth.	Dec. 30	Upper 1/8	Jan. 17, 5 dead, Jan. 26, all dead.
Lemon Free Ch.	Jan. 17	Lower 1/4	Jan. 17, all healthy, Jan. 26, 1 alive.

Table No. 44. Continued.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Ringold Eth.	Dec. 30	Upper 1/4	Jan. 8, 1 dead; Jan. 17, 3 dead; J.26, dead.
Ringold Ch.	Jan. 17	Lower 1/10	Jan. 26, all alive.
Wheeler Eth.	Dec. 30	Upper 1/9	Jan. 8, 2 dead; Jan. 17, 4 dead; J.26, dead.
Wheeler Ch.	Jan. 17	Lower 1/3	Jan. 26, all alive and plump.
Diamond Eth.	Jan. 8	Upper 1/4	Jan. 17, 1 dead; Jan. 26, all dead.
Diamond Ch.	_____	_____	Jan. 17, 3 alive.
Foster Eth.	Jan. 8	Upper 1/6	Jan. 17, 1 dead; Jan. 26, all dead.
Foster Ch.	_____	_____	Jan. 17, all healthy.
Henrietta Eth.	Jan. 8	Upper 1/8	Jan. 8, 4 dead; Jan. 26, all dead.
Henrietta Ch.	_____	_____	Jan. 17, 2 dead; Jan. 26, all dead.
Hyslop Cling Eth.	Jan. 8	Upper 1/6	Jan. 26, 2 alive.
Hyslop Cling Ch.	_____	_____	Jan. 26, all alive.
Mixon Cling Eth.	Jan. 8	Upper 1/8	Jan. 26, all dead.
Mixon Cling Ch.	_____	_____	Jan. 26, all alive.
Hiley Eth.	Jan. 8	Terminal	Jan. 26, only 2 alive.
Hiley Ch.	Jan. 17	Terminal	Jan. 26, 3 alive.

Table No. 44. Continued.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Mixon Free Eth.	Jan. 8	Upper 1/10	Jan. 26, all alive.
Mixon Free Ch.	Jan. 17	Lower 1/10	Jan. 26, all alive.
Gold Dust Eth.	Jan. 17	Terminal	Jan. 17, all alive.
Gold Dust Ch.	_____	_____	Jan. 17, all dead.
Whitford Eth.	Jan. 8	Terminal	Jan. 26, 1 alive.
Whitford Ch.	Jan. 17	Terminal	Jan. 17, 1 drying up; Jan. 26, all dead.
Magnum Bonum Eth.	Jan. 17	Upper 1/5	Jan. 26, all dead.
Magnum Bonum Ch.	_____	_____	Jan. 26, 5 alive.
Krummel Eth.	Jan. 8	Upper 1/5	Jan. 26, all dead.
Krummel Ch.	Jan. 8	Terminal	Jan. 26, 1 alive.
Yellow Swan Eth.	Jan. 8	Terminal	Jan. 26, all dead.
Yellow Swan Ch.	Jan. 8	Terminal	Jan. 26, 1 alive.
Crawford Late Eth.	_____	_____	Jan. 26, all dead.
Crawford Late Ch.	Jan. 17	Lower 1/4	Jan. 26, all alive.
Snow's Orange Eth.	_____	_____	Jan. 8, all dead.
Snow's Orange Ch.	Jan. 8	Lower 1/2	Jan. 8, 2 dead; Jan. 26, all dead.

Table No. 44. Continued.

Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Early Barnard Eth.	_____	_____	Dec. 30, all dead.
Early Barnard Ch.	_____	_____	Jan. 26, one dead.
Early Violet Eth.	_____	_____	Jan. 26, 1 alive.
Early Violet Ch.	_____	_____	Jan. 26, 1 alive.
Lewis Eth.	_____	_____	Jan. 8, 2 dead; Jan. 17, 4 dead, 1 alive.
Lewis Ch.	_____	_____	Jan. 26, 3 alive.
Rareripe Eth.	_____	_____	Jan. 8, 4 dead; Jan. 26, 5 dead, 1 alive.
Rareripe Ch.	_____	_____	Jan. 26, 5 dead, 1 alive.
Rice's Seedling Eth.	_____	_____	Jan. 26, all dead.
Rice's Seedling Ch.	_____	_____	Jan. 26, all dead.
Stanwick Eth.	_____	_____	Jan. 26, all dead.
Stanwick Ch.	_____	_____	Jan. 26, 4 alive.

treatment. The experiment was discontinued on Jan. 26. The rest period in 6 of these 13 cases was shortened by over 31 days. In the other 7 cases the rest period was shortened from 9 to 18 days.

The ether treatment caused an earlier death of the twigs in 22 of the 30 varieties tested, in 4 cases the check material died first, in 4 varieties there was no difference, in the amount or rate of dying. These results show that ether, used in doses strong enough to break the rest period, proves very injurious to the twigs.

In 26 of the 33 cases in which results were secured, growth started first in the upper buds. Since these are the first buds to open, they must be the most tender and, therefore, the most susceptible to injury by low temperatures.

Summary of Results

1. Different varieties of peaches have rest periods of varying length and intensity as shown by the fact that some forced quickly and easily, others only with great difficulty and in some cases not at all.

2. Ether caused an earlier growth of from 9 to 35 days in 31 of the 63 varieties tested, with 4 varieties there was no difference in the case of the treated and untreated material. In 6 cases the ether proved less effective than the check treatment. In 22 cases the rest period was not broken by either of the two methods of treatment. These results show that 22 of the varieties tested had deep rest-

ing periods from which they were not easily aroused. In the remaining 41 varieties the dormant period was broken by at least, one and in some cases both of the treatments used.

3. In nearly all cases the ether proved injurious to the twigs as it caused an earlier and greater killing of the material.

4. A glance at Tables 42, 43, and 44, clearly shows that the peripheral buds are the first to start into growth. From these results we may conclude that they are the most tender buds on the twig and are, therefore, most easily injured by low temperatures, especially after warm periods which have caused the buds to start into growth.

II. The Effect of Ether in Breaking the Rest Period of Different Varieties of Pears and Cherries.

On Dec. 10, four varieties of pears and one variety of cherries were tested as in the previous experiment. The results, given in Table 45, show that the rest period was easily broken, in all of the varieties of pears, by both treatments, neither method having any decided advantage over the other. In all of the varieties of pears used, excepting the Vt. Beauty, only one year wood was used so no flower buds were found. In the case of the Vt. Beauty, however, the flower buds on the old wood burst into growth before the leaf buds on the new wood. The leaf buds, as a rule, started into growth evenly on all parts of the twigs. No injurious effect, due to the action

Table No. 45.

Pear and Cherry Twigs Treated Dec. 10, 1915

Pear			
Variety	Rest Period broken before	Location of buds starting first	Remarks on Twigs
Vt. Beauty Eth.	Jan. 8	Evenly distributed	Flower buds opened first on old wood in both cases.
Vt. Beauty Ch.	Dec. 30	Evenly distributed	
Kieffer Eth.	Jan. 8	Terminal	In both cases used 1 yr. wood, so only got leaf buds started.
Kieffer Ch.	Jan. 17	Evenly distributed	
Surprise Eth.	Jan. 8	Terminal	In both cases used 1 yr. wood, so only got leaf buds started.
Surprise Ch.	Jan. 8	Terminal	
Garber Eth.	Jan. 17	Evenly distributed	Only 1 yr. wood used.
Garber Ch.	Jan. 17	Evenly distributed	
Cherry S.P.I. 18262			
1 yr. wood Eth.	Jan. 8	Terminal	Flower buds were first to start in both cases.
1 yr. wood Ch.	Jan. 8	Upper 1/3	
1 yr.&2 yr. wood Eth.	Dec.30	Upper 2/3	
1 yr.&2 yr. wood Ch.	Jan. 8	Lower 1/2	

of ether, was noted in any case.

The rest period of the cherry was easily broken by both treatments. In the case where the twigs contained both one and two-year wood, the ether caused an earlier breaking of the rest period than where no ether was used. Where only one-year wood was used there was no difference in the growth acceleration in either treatment. The flower buds were, in the case of the cherry, also found to start growth earlier than the leaf buds.

The results of the experiments on the Vt. Beauty pear and on the cherry S.P.I. 18262 would tend to show that the flower buds have a shorter and less intense rest period than do the leaf buds, and, as a result, are more easily forced into growth.

III. Sugar in Peach Twigs

On Jan. 26, 1916 it was decided to discontinue the forcing of the peach twigs used in Experiment I. Before discarding these twigs, it was deemed advisable to test for sugar one twig of each lot, along with one twig of each variety freshly cut from the field. This twig fresh from the field was taken from the same tree that the forced, etherized and untreated twigs, had been taken.

The object of this test was primarily to determine the effect of ether upon the sugar content of twigs. The sugar content of twigs, as shown by Heinicke (47) and Howard (53), acts as a measure of diastatic activity. In those twigs

where the percentage of sugar is high, the diastatic activity is proportionally high and vice versa.

The sugar tests were made in the same way as those previously noted. In each case, the healthiest and plumpest of the etherized and untreated greenhouse twigs were selected, to be compared with a twig freshly cut from the same tree. Each twig was first ground-up in the food chopper, then 5 grams of the ground up wood were allowed to soak for 1 hour in 50 c.c. of distilled water. This was then filtered through a coarse filter paper. The filtrate was tested for sugar by using Fehling's Solution as previously described. In making the test 1 c.c. of Fehling's Solution was added to 5 c.c. of the filtrate and this was boiled for from 1 to 2 minutes. In all cases duplicate tests were run. The precipitate was allowed to settle and then the color of the supernatant liquid was read. The results of the test are given in Table 46.

In the first column of Table 46, the variety and treatment are given. The treatment used is denoted by the letters A, B, and C: A, denoting the untreated material forced in the greenhouse; B, the etherized material forced in the greenhouse; C, the check material cut fresh from the field. The figures 1, 2, and 3, at the left of the letters denote the order of the treatments as regards sugar content; figure 1 indicating the largest amount of sugar and figure 3 the least. Columns two, three and four refer respectively to the

Table No. 46.

Peach Twigs Tested for Sugar on Jan. 29, 1916.

Variety and Treatment	Color	Shade	Page	Number of days required to break Rest Period
Alton				
1.A	Rust Red	3	318	53#
2.B	Mars Yellow	4	315	53#
3.C	Ru Ochre	1	314	—
Bokhara				
1.A	Mars Yellow	4	316	53#
2.B	Pale Sugar Green	2	279	53#
3.C	Verdant Green	2	268	—
Champion				
1.A	Mahogany	3	335	53#
2.B	Ru Ochre	3	314	53#
3.C	Yellowish Green	4	291	—
Chinese Free				
1.A	Indian Chest-nut Red	2	333	53#
2.B	Bistre	2	328	53#
3.C	Bistre Green	3	296	—
Connet				
1.A	Brown Lake	2	336	53#
2.B	Bistre	3	328	36
3.C	Yellow Ochre	2	326	—
Conover				
1.A	Tan Color	4	317	53#
2.C	Brown Pink	2	297	—
3.B	Yellowish Green	4	291	53#

Table No. 46. Continued

Variety and Treatment	Color	Shade	Page	Number of days required to break Rest Period
Crawford Early				
1.A	Neutral Orange	4	319	53#
2.B	Yellow Tan Color	2	315	36
3.C	Yellowish Green	4	291	—
Elberta				
1.B	Burnt Sienna	3	320	36
2.A	Rust Red	2	318	54
3.C	Yellow Green	2	291	—
Heath Cling				
1.B	Indian Chestnut Red	3	333	36
2.A	Burnt Sienna	3	320	45
3.C	Dull Yellow Green	2	292	—
Henrietta				
1.B	Indian Chestnut Red	1	333	29
2.A	Bistre	2	328	46
3.C	Apple Green	4	276	—
Hills Chili				
1.B	Terra Cotta	3	331	53#
2.A	Dull Brick Red	3	330	53#
3.C	Roman Ochre	3	327	—
Lemon Cling				
1.A	Tan Color	3	317	53
2.B	Bistre Green	2	296	53
3.C	Verdant Green	2	268	—

Table 46. Continued.

Treatment and Variety		Color	Shade	Page	Days required to break Rest Period
Mt. Rose					
	1.B	Bistre	3	328	54
	2.A	Yellowish Tan Color	3	315	53#
	3.C	Grass Green	1	273	—
Superb					
	1.A	Neutral Orange	2	319	45
	2.B	Bistre Green	3	296	45
	3.C	Bistre Green	1	296	—
Triumph					
	1.A	Tan Color	3	317	53#
	2.B	Golden Bronze Green	1	298	53#
	3.C	Yellowish Green	3	291	—
Victor					
	1.A	Tan Color	4	317	53#
	2.B	Ru Ochre	2	314	19
	3.C	Pale Sage Green	2	279	—
Washington					
	1.A	Tan Color	3	317	53#
	2.B	Tan Color	3	317	53#
	3.C	Ru Ochre	1	314	—
Augbert					
	1.A	Ru Ochre	1	314	46
	2.C	Grass Green	1	273	—
Carman					
	1.A	Mahogany Red	3	335	54#
	2.C	Dull Green Yellow	1	292	—

Table No. 46. Continued.

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period
Chinese Cling				
1A	Indian Chestnut Red	1	333	53#
2.C	Pale Sage Green	2	279	—
Matthew's Beauty				
1.A	Neutral Orange	3	319	54#
2.C	Dull Yellow Green	2	292	—
Mayflower				
1.A	Tan Color	2	317	54#
2.C	Dull Yellow Green	1	292	—
Salway				
1.A	Ru Ochre	1	314	37
2.C	Grass Green	2	273	—
Straus Early				
1.A	Indian Chestnut Red	2	333	53#
2.C	Dull Yellow Green	3	292	—
Tiebot				
1.A	Bistre	2	328	46
2.C	Bistre Green	1	296	—
Blanchard *				
1.A	Ru Ochre	3	314	53#
2.C	Yellow Apple Green	3	266	—
3.B	Moss Green	2	272	53#
Crawford Late				
1.B	Indian Chestnut Red	1	333	43#
2.C	Yellowish Tan Color	3	315	—
3.A	Bistre Green	3	296	38

*Varieties from Blanchard-Guinn, inclusive, tested Feb.4 and 5.

Table No. 46. Continued.

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period
Diamond				
1.B	Burnt Sienna	4	320	53#
2.A	Ru Ochre	3	314	53#
3.C	Bistre Green	2	296	—
Early Violet				
1.C	Mars Yellow	3	316	—
2.A	Ru Ochre	3	314	43#
3.B	Moss Green	2	272	43#
Graves No. 2				
1.B	Ru Ochre	4	314	53#
2.C	Ochre	3	313	—
3.A	Yellowish Green	3	291	53#
Greensboro				
1.B	Ru Ochre	3	314	53#
2.A	Dull Yellow Green	3	292	53#
3.C	Pale Sage Green	1	279	—
Hyslop Cling				
1.B	Bistre	3	328	29
2.A	Yellowish Tan Color	3	315	43#
3.C	Yellowish Green	3	291	—
Lewis				
1.B	Burnt Sienna	3	320	55#
2.A	Pale Sage Green	1	279	53#
3.C	Verdant Green	3	268	—

Table No. 46. Continued.

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period
Magnum Bonum				
1.B	Ru Ochre	3	314	38
2.A	Lettuce Green	2	267	43#
3.C	Emerald Green	3	259	—
Rareripe				
1.B	Indian Chestnut Red	3	333	43#
2.A	Ru Ochre	3	314	43#
3.C	Bistre Green	3	296	—
Russell				
1.B	Mahogany	2	335	20
2.A	Indian Chestnut Red	2	333	43#
3.C	Lettuce Green	4	267	—
Smock				
1.B	Mahogany	2	335	20
2.A	Bistre	3	328	43#
3.C	Ru Ochre	2	314	—
Snows Orange				
1.A	Mahogany	2	335	29
2.C	Brown Terra Cotta	2	322	—
3. B	Grass Green	2	273	43#
Stanwick				
1.B	Bistre	3	328	43#
2.C	Moss Green	1	272	—
3.A	Grass Green	2	273	43#

Table No. 46. Continued.

Variety and Treatment		Color	Shade	Page	Days required to break Rest Period
Stump					
	1.A	Ru Ochre	3	314	53#
	2.B	Ru Ochre	2	314	53#
	3.C	Ochre	4	313	—
Waddell					
	1.B	Tan Color	3	317	53#
	2.A	Tan Color	2	317	45
	3.C	Mars Yellow	3	316	—
Whitford					
	1.B	Burnt Sienna	4	320	29
	2.A	Ru Ochre	3	314	38
	3.C	Ochre	2	313	—
Yellow Swan					
	1.B	Tan Color	3	317	29
	2.C	Ru Ochre	3	314	—
	3.A	Lettuce Green	4	267	29
Crosby					
	1.A	Dull Yellow Green	4	292	53#
	2.C	Yellowish Green	4	291	—
Guinn					
	1.A	Bistre	3	328	43#
	2.C	Bistre	1	328	—

Table No. 46. Continued.

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period
Dewey's Choice*				
1.B	Mahogany	3	335	20
2.A	Ru Ochre	3	314	43#
3.C	Ru Ochre	1	314	—
Grant's Favorite				
1.B	Indian Chestnut Red	3	333	20
2.A	Ru Ochre	3	314	29
3.C	Ru Ochre	1	314	—
Hiley				
1.B	Bistre	2	328	29
2.C	Golden Bronze Green	1	298	—
3.A	Dull Yellow Green	1	292	38
Mixon Cling				
1.B	Indian Chestnut Red	1	333	29
2.A	Ru Ochre	2	314	43#
3.C	Bistre Green	2	296	—
Redbird Cling				
1.A	Indian Chestnut Red	1	333	45
2.B	Rust Red	2	318	27
3.C	Dull Yellow Green	2	292	—
Rice's Seedling				
1.B	Dull Yellow Green	4	292	43#
2.C	Dull Yellow Green	2	292	—
3.A	Wellowish Green	3	291	43#

* Remainder of varieties tested Feb.7.

Table No. 46. Continued

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period
Ringold				
1.B	Ru Ochre	4	314	20
2.C	Bistre Green	3	296	—
3.A	Bistre Green	2	296	38
Success				
1.B	Indian Chestnut Red	2	333	—
2.A	Yellowish Olive Green	2	289	—
3.C	Yellowish Olive Green	1	289	—
Wheeler				
1.B	Burnt Sienna	4	320	20
2.A	Ru Ochre	2	314	38
3.C	Dull Yellow Green	2	292	—
Early Barnard				
1.A	Tan Color	3	317	43#
2.C	Ru Ochre	2	314	—
Lemon Free				
1.A	Bistre Green	3	296	38
2.C	Yellowish Green	4	291	—
Mayflower				
1.A	Brown Terra Cotta	2	322	53#
2.C	Ru Ochre	1	314	—
Kalamazoo				
1.A	Indian Chestnut Red	3	333	43#
2.C	Ru Ochre	3	314	—

Table No. 46. Continued.

Variety and Treatment	Color	Shade	Page	Days required to break Rest Period	
Foster					
1.B	Indian Chestnut Red	3	333	29	
2.C	Lettuce Green	4	267		
Krummel					
1.B	Burnt Sienna	4	320	29	
2.C	Verdant Green	4	268		
Mixon Free					
1.B	Burnt Sienna	4	320	29	
2.C	Bistre Green	2	296		
Name Lost					
1.C	Yellowish Green	4	291		
2.B	Verdant Green	4	268		

Table No. 47.

Summary of Results of Table 46.

Date	A			A B C Total	B			C			A		C		B		C	
	1	2	3		1	2	3	1	2	3	1	2	1	2	1	2	1	2
Jan.29	11	5	0	1	5	10	1	0	1	16	8	0	0	8	-	-	-	-
Feb.4-5	3	11	4	-	14	1	3	1	6	11	2	0	0	2	-	-	-	-
Feb. 7	1	5	3	-	8	1	0	0	3	6	4	0	0	4	3	1	1	3
Total	15	21	7	1	27	12	4	1	10	32	14	0	0	14	3	1	1	3

A = Untreated, forced in Greenhouse

B = Etherized, forced in Greenhouse

C = Check, untreated, freshly cut from field

1 = Most Sugar

2 = Medium amount of sugar

3 = Least amount of sugar

color, shade, and page taken from Dauthenay's *Repertoire de Couleurs* (28A). Column five, derived from Tables 42, 43 and 44, gives the number of days required to break the rest period. The sign # following any number, for example 53#, means that the rest period was not broken after 53 days forcing, therefore, more than 53 days or 53# days were required to break the rest period. The summarized results of Table 46 are given in Table 47.

The foregoing data show that of 62 varieties tested, 44 received all three treatments, 14 varieties received only the A and C treatments, while 4 received only the B and C treatments. That some varieties received only two treatments is due to the fact that in the forcing treatments some varieties died, and were discarded before completing the forcing experiment. The sugar tests of the 44 varieties which received all three treatments, shows that in 27 cases the etherized material contained the most sugar, in 15 cases the untreated forced material rank highest, in 7 cases the material freshly cut from the field ranked first; in one case there was no difference between the etherized forced and the untreated forced material. In the 14 cases where the lots contained only untreated forced and material freshly cut from the trees, the forced lots showed a higher sugar content. In 3 of the 4 cases where only etherized forced and freshly cut materials were used, the etherized forced showed the greater sugar content.

These results show that forcing increased the sugar content of peach twigs over those not forced in 60 of the 62 varieties tested. The ether forced material ranked highest in sugar content in 27 of the 44 varieties, which contained material from all 3 lots, in 15 cases the untreated forced ranked highest, in one case there was no difference between the etherized forced and the untreated forced material, in one case the material fresh from the field contained more sugar than either of the two forced lots. This then shows that ether increased the sugar content of peach twigs over those similarly forced but not etherized.

A careful study of column 5 of Table 46 shows that of the 44 varieties tested, that contained material from all three lots, there was no difference in the length of the rest period between the twigs of lots A and B in 22 cases. In the other 22, however, there was a difference since one or the other of the treatments caused a shortening of the rest period. Of the 22 varieties showing a difference in the length of the rest period due to treatments A and B, in 16 cases the treatment which produced the shortest rest period showed the higher sugar content. In the other 6 cases, where the rest period was shortened, the treatment producing the longer rest period produced the most sugar. This observation leads us to conclude that those treatments which increase the sugar content of twigs tend to shorten the rest period. The rest period is, therefore, broken because of the fact that there is more sugar present and, of course available for growth when the twigs are placed under favorable growing conditions.

IV. Hardiness of Peach Buds

The objects of this experiment were; 1. To determine the relative hardiness of the different varieties of peaches in the station orchard, by actual count of the buds injured after the killing temperature of -11° F., registered on Jan. 13, 1916. 2. To determine whether or not there was any correlation between hardiness, as shown by the low temperature of Jan. 13, and the length of the rest period as obtained from the data in Tables 42, 43 and 44.

The fall of temperature on Jan. 12 and Jan. 13 was very rapid as will be seen from the following figures, obtained from the U.S. Weather Bureau Station at Columbia. The Temperature fell from a minimum of 28° F, on Jan. 11, to a minimum of -6° F. on Jan. 12, the temperature then rose again to 34° F. when it fell to -11° F. on the morning of Jan. 13. The average mean temperature for the two preceding weeks was 33.6° F. Rapid falls of temperature are more injurious than gradual changes as shown by Chandler (22). The rapid fall of temperature in this case, no doubt, caused the severe killing of peach buds noted in Tables 48 and 49.

The buds for the determinations in Table 48 and 49 were obtained by cutting 5 or 6 twigs from the same trees used in Tables 42, 43 and 44. These twigs were cut from different points on the tree so as to make the tests as near representative of the tree as possible. The same trees were used in this experiment as were used in the forcing experiment so that as good a comparison as possible could be made between hardiness

Table No. 48.

Showing the Percentage of Peach Buds Killed

Jan.13, 1916 by a Temperature of -11° F.

Buds examined Jan.14 and Jan. 15.

Variety	Number Counted	Number Dead	Number Alive	%Dead	%Alive
Redbird Cling	88	77	11	87.5	12.5
Fitzgerald	85	75	10	88.2	11.8
Salway	121	110	11	90.9	9.1
Alton	82	75	7	91.4	8.6
Blanchard	178	164	14	92.1	7.9
Mt. Rose	69	65	4	92.7	7.3
Matthew's Beauty	69	64	5	92.7	7.3
Mayflower	88	82	6	93.2	6.8
Belle of Georgia	99	94	5	93.9	6.1
Waddell	114	108	6	94.7	5.3
Graves	105	101	4	95.2	4.8
Heath Cling	95	91	4	95.5	4.5
Conover	114	109	5	95.5	4.5
Crawford Early	156	150	6	96.1	3.9
Elberta	79	76	3	96.2	3.8
Crosby	121	117	4	96.7	3.3
Connet	105	102	3	97.1	2.9
Champion	75	73	2	97.3	2.7

Table No. 48, Continued.

Variety	Number Counted	Number Dead	Number Alive	%Dead	%Alive
Straus Early	140	138	2	98.5	1.5
Chinese Cling	142	140	2	98.5	1.5
Victor	154	152	2	98.7	1.3
Tiebot	90	89	1	98.8	1.2
Chinese Free	124	123	1	99.2	0.8
Greensboro	124	123	1	99.2	0.8
Augbert	115	115	0	100.0	0.0
Bokhara	58	58	0	100.0	0.0
Carman	161	161	0	100.0	0.0
Stump	102	102	0	100.0	0.0
Triumph	167	167	0	100.0	0.0

Table No. 49.

Showing the Percentage of Peach Buds Killed Jan. 13,
1916 by a Temperature of - 11° F.

Buds examined Jan. 17 and 18.

Variety	Number Counted			Number Alive			Percentage Alive		
	In	Out	Total	In	Out	Total	In	Out	Total
Yellow Swan	92	72	164	4	5	9	3.3	6.9	5.4
Hills Chili	61	68	129	5	0	5	8.2	0.0	3.9
Diamond	80	75	155	2	2	4	2.5	2.7	2.6
Smock	65	60	125	0	3	3	0.0	5.0	2.4
Ringold	26	24	50	0	1	1	0.0	3.8	2.0
Magnum Bonum	58	--	58	1	-	1	1.7	--	1.7
Dewey's Choice)--	30	36	69	1	0	1	3.4	0.0	1.4
Kalamazoo	126	104	230	0	3	3	0.0	2.7	1.2
Wheeler	92	85	177	0	2	2	0.0	2.3	1.2
Foster	105	133	238	0	2	2	0.0	1.5	1.0
Krummel	57	45	102	1	0	1	1.6	0.0	1.0
Snow's-- Orange	107	109	216	2	0	2	1.9	0.0	1.0
Mixon Cling	71	46	117	0	1	1	0.0	2.1	0.8
Lewis	60	81	141	0	1	1	0.0	1.2	0.7
Russell	78	92	170	0	1	1	0.0	1.2	0.6
Conover	116	174	290	1	0	1	0.9	0.0	0.5
Hiley	86	86	172	0	1	1	0.0	1.2	0.5
Crawford-- Late	61	32	93	0	0	0	0.0	0.0	0.0
Early Barn-- ard	17	--	17	0	--	0	0.0	--	0.0
Gold Dust	32	28	60	0	0	0	0.0	0.0	0.0
Grant's Favorite---	35	39	74	0	0	0	0.0	0.0	0.0

(Continued on next page)

Table No. 49 (Continued)

Showing the Percentage of Peach Buds Killed Jan. 13,
1916 by a Temperature of - 11° F.

Buds examined Jan. 17 and 18.

Variety	Number Counted			Number Alive			Percentage Alive		
	In	Out	Total	In	Out	Total	In	Out	Total
Gwinn	70	31	101	0	0	0	0.0	0.0	0.0
Hyslop Cling	38	40	78	0	0	0	0.0	0.0	0.0
Lemon Cling	66	35	101	0	0	0	0.0	0.0	0.0
Mixon Free	106	95	201	0	0	0	0.0	0.0	0.0
Rareripe	50	59	109	0	0	0	0.0	0.0	0.0
Stanwick	61	68	129	0	0	0	0.0	0.0	0.0
Success	28	42	70	0	0	0	0.0	0.0	0.0
Superb	35	69	104	0	0	0	0.0	0.0	0.0
Washington	66	66	132	0	0	0	0.0	0.0	0.0
Whitford	78	71	149	0	0	0	0.0	0.0	0.0

and length of the rest period. Since only one tree of each variety was used, the figures obtained do not serve as a true index of hardiness for the variety. For the purposes of comparing the hardiness of the varieties with the rest period, however, one tree serves well, for the twigs on any one tree are subject to practically the same conditions of environment.

In Table 48 the twigs were obtained only from the outside of the tree but in Table 49, 3 twigs were taken from different points on the outside of the tree and 3 were taken from different parts of the inside of the tree. A study of Table 49 shows that in 13 cases out of 19, where any difference was noted in the rate of killing, the outside buds had a larger percentage alive, while in 6 cases the inside buds showed a greater percentage alive. These data show that there is very little difference in the rate of killing of buds on inside and outside branches, when low temperatures occur early in the winter before the buds have started growth. The buds are at this early date perfectly dormant. Later, after the buds have been started into growth by warm spells, the buds on the outside of the tree are less hardy (Whitten 112)

The varieties examined on Jan. 14 and 15 are arranged in order of their hardiness in Table 48. Those tested on Jan. 17 and 18 are arranged in a similar way in Table 49. Since there is very little difference in the rate of killing between buds from the inside of the tree and those from the outside, the varieties in Tables 48 and 49 may be placed in order of hardiness as shown in Table 50, where also their dates of

Table No. 50.

Comparing Hardiness of Peach Buds
with Length of Rest Period

Variety	Percentage of buds alive	Length of rest period in days	Rest period broken before
Redbird Cling	12.5	27	Dec. 30
Fitzgerald	11.8	53#	Not before Jan. 25
Salway	9.1	37	Jan. 8
Alton	8.6	53#	Not broken
Blanchard	7.9	53#	Not broken
Mt. Rose	7.3	54	Jan. 26
Matthew's Beauty	7.3	54#	Not broken
Mayflower	6.8	28	Dec. 30
Belle of Georgia	6.1	45	Jan. 17
Yellow Swan	5.4	29	Jan. 8
Waddell	5.3	45	Jan. 17
Graves	4.8	53#	Not broken
Heath Cling	4.5	36	Jan. 8
Conover	4.5	53#	Not broken
Crawfords Early	3.9	36	Jan. 8
Hills Chili	3.9	53#	Not broken
Elberta	3.8	36	Jan. 8
Crosby	3.3	53#	Not broken

Table No. 50. Continued.

Variety	Percentage of buds alive	Length of rest period in days	Rest Period broken before
Connet	2.9	36	Jan. 8
Champion	2.7	53 [#]	Not broken
Diamond	2.6	29	Jan. 8
Smock	2.4	20	Dec. 30
Ringold	2.0	20	Dec. 30
Magnum Bonum	1.7	38	Jan. 17
Chinese Cling	1.5	37	Jan. 8
Straus Early	1.5	19	Dec. 21
Dewey's Choice	1.4	20	Dec. 30
Victor	1.3	19	Dec. 21
Kalamazoo	1.2	20	Dec. 30
Tiebot	1.2	19	Dec. 21
Wheeler	1.2	20	Dec. 30
Foster	1.0	29	Jan. 8
Krummel	1.0	29	Jan. 8
Snows Orange	1.0	29	Jan. 8
Chinese Free	0.8	53 [#]	Not broken
Greensboro	0.8	53 [#]	Not broken
Mixon Cling	0.8	29	Jan. 8
Lewis	0.7	43 [#]	Not broken

Table No. 50. Continued

Variety	Percentage of buds alive	Length of rest period in days	Rest Period broken before
Russell	0.6	20	Dec. 30
Conover	0.5	53#	Not broken
Hiley	0.5	29	Jan. 8
Augbert	0.0	46	Jan. 17
Bokhara	0.0	53#	Not broken
Carman	0.0	54#	Not broken
Crowford Late	0.0	38	Jan. 17
Early Barnard	0.0	43#	Not broken
Gold Dust	0.0	38	Jan. 17
Grant's Favorite	0.0	20	Dec. 30
Guinn	0.0	20	Dec. 30
Eyslop Cling	0.0	29#	Jan. 8
Lemon Cling	0.0	53#	Jan. 25
Mixon Free	0.0	29	Jan. 8
Stanwick	0.0	43#	Not broken
Stump	0.0	53#	Not broken
Success	0.0	—	—
Superb	0.0	45	Jan. 17
Triumph	0.0	53#	Not broken
Washington	0.0	53#	Not broken
Whitford	0.0	29	Jan. 8

Table No. 51.

Summary of Results of Table No. 50.

Number of Varieties	Division I.		Number of Varieties	Division II.		Number of Varieties	Division III.	
	Rest Period	After Days		Rest Period	After Days		Rest Period	After Days
8	not broken	53	3	not broken	53	1	not broken	54
1	" "	54	1	" "	43	4	" "	53
9			4			2	" "	42
1	broken	54	1	broken	38	7		
2	"	45	1	"	37	1	broken	53
1	"	37	5	"	29	1	"	46
4	"	36	6	"	20	1	"	45
1	"	29	3	"	19	2	"	38
1	"	28	20			4	"	29
1	"	27				2	"	20
20			Average length of rest period -- 32.95† days.			18		
Average length of rest period -- 44.35† days.						Average length of rest period -- 40.44† days.		

breaking the rest period and the length of their rest periods are given. The data for the date of breaking, and length of the rest periods were obtained from Tables 42, 43 and 44.

Table 50 seems to show no correlation between the hardness of peach buds and length of the rest period. However when the table is divided into three parts, as in Table 51, the first division containing the first 20 varieties, which have the ~~hardest~~ hardest buds; the next division containing the twenty varieties which have medium hardy buds; and the third division containing the most tender buds, we find that those varieties having the longest rest periods are the hardest.

The twenty hardest varieties have a rest period averaging 44.35 days, while the tenderest lot have an average rest period of 40.44 days. The medium hardy varieties, however, have a rest period of only 32.95 days, so we cannot say that there is a direct correlation between hardness and the length of the rest period. These data do show, however, that hardy varieties of peaches have longer rest periods than do tender or medium hardy varieties.

V. The Effect of Ether Upon Soft Wood Cuttings

The object of this experiment was to note the effect of ether upon soft wood cuttings, used at the rate of 0.5 c.c. per liter of air, for exposures of different lengths. On Jan. 11 ten cuttings of several species and varieties of soft wood plants were made. These were divided into two equal lots,

Table No. 52.

Showing the Effect of Exposing Softwood Cuttings
to Fumes of Ether for six Hours.

Treatment Jan. 11, 1916.

Species Treated	No. Rooted on Feb. 2		Remarks
	Ch.	Eth.	
Achyranthes Herbstii, Hook	5	0	Ether too severe.
Achyranthes Herbstii, Hook, var. aurea-reticulata.	5	4	Checks rooted better; Ether too severe.
Iresine Lindenii, van. Routte.	3	4	Checks look better; Ether too severe.
Alternanthera Parony- chioides, Hort.	0	0	Drying 6 hours killed all.
Alternanthera amoena, Regel.	5	0	Ether too severe.
Alternanthera versicolor, Regel.	0	0	Ether look as good as check.
*Begonia albo-picta, Hort.	2	2	Etherized cuttings some- what injured.
Coleus Hybrida	5	5	Etherized cuttings look as good as checks.
Coleus Verschaffeltii Lem.	5	3	Ether too severe; 2 Eth. cuttings dead.
Pelargonium quercifolium, Ait.	3	0	Ether killed all 5 cuttings, leaves injured.
Pelargonium hortorum, Bailey.	4	3	Ether killed 2 cuttings; on other 3 leaves injured.
Heliotropium Peruvianum Linn.	0	0	Ether 5 dead. Checks all alive.
Lantana Camara, Linn.	0	0	Etherized dead; checks alive and callused.
Salvia splendens, Ker-Gawl.	1.5	0	Ether too severe.

* Only two plants used in each treatment.

each lot being placed in a separate specimen jar. One was subjected to the fumes of ether for 6 hours, while the other lot was left untreated to serve as a check for the etherized lot. The results obtained are given in Table 52.

A study of Table 52 shows that exposing to fumes of ether for 6 hours had an injurious effect upon the following softwood cuttings; 1. Severe injury upon; Pelargonium quercifolium, Bailey (Rose Geranium), Heliotropium Peruvianum, Ait. (common heliotrope), Lantana Camara, Linn., and Salvia splendens, Ker-Gawl.; 2. Injury not so severe upon; Achyranthes Herbstii, Hook, Alternanthera Amoena, Regel, Coleus Verschaffeltii, Lem., Pelargonium hortorum, Bailey (zonale geranium), Iresine Lindeni, Van Houtte, ; 3. Mild injury upon; Achyranthes Herbstii, Hook, var. aurea-reticulata, Begonia Albo-picta, Hort.. Drying for 6 hours proved injurious to Alternanthera Paronychioides, Hort.. for both check and etherized treatments were injured. Ether caused no injury in the case of Alternanthera versicolor, Regel and Coleus Hybrida.

In no case did exposure of soft wood cuttings to the fumes of ether for 6 hours, prove beneficial in hastening the root formation. In most cases it had a very injurious effect, therefore, its use upon soft wood cuttings cannot be recommended. The injury caused by the ether resembled that of frost, the leaves blackened and wilted down and, in cases of severe injury, the cuttings later died.

On Feb. 17, the experiment on the use of ether on soft wood cuttings was continued. Due to lack of material only four different plants were used. These were; 1. Achyranthes Herbsteri, Hook. 2. Achyranthes Herbsteri, Hook. var. aurea reticulata, 3. Coleus Hybridus, 4. Pelargonium hortorum, Bailey (zonale geranium). Five cuttings of each of these plants were subjected to the following seven treatments:

1. Check-untreated; cuttings planted as soon as made,
2. Etherized- 15 minutes,
3. Etherized- 30 minutes,
4. Etherized- 1 hour,
5. Etherized- 2 hours,
6. Check- left in specimen jar for 2 hours, then planted,
7. Etherized- 3 hours.

In case of the fifteen minute treatment the ether had not all evaporated when the cuttings were removed. With the thirty minute treatment the ether had scarcely evaporated.

On Feb. 18, the following notes were taken:

- "1. Check- untreated:- All plants alive and looking healthy.
- "2. Etherized- 15 minutes:- This treatment has injured the Geraniums the worst of any of the treatments. Three of the 4 Geraniums treated are severely injured. The injury in each case resembles frost injury; i.e. there is a drying out of the leaf tissues. Only one of the Coleus Hybridus

cuttings is injured, only one of the Achyranthes Herbstii, Hook. var. aurea-reticulata seems to be injured. Two of the Achyranthes Herbstii, Hook are injured.

"3. Etherized- 30 minutes:- All of the geraniums were slightly injured by the treatment. All of the coleus were injured. All of the cuttings of both varieties of achyranthes were also injured.

"4. Etherized- 1 hour:- The geraniums were all slightly injured, the tips of the leaves were burnt. This treatment proved almost as injurious for the geraniums as was the 15 minute ether treatment. The coleus were all badly injured, in fact this treatment caused the most severe injury for this plant. All of the cuttings of Achyranthes Herbstii, Hook var. aurea-reticulata were injured, but the injury in this case was not as severe as that caused by the 30 minute treatment. Only two of the cuttings of Achyranthes Herbstii, Hook, were injured, the injury was not near as severe as that caused by the 30 minute treatment.

"5. Ether- 2 hours:- Three of the geraniums were very slightly injured. This treatment caused the least injury to the geraniums. None of either the coleus or Achyranthes Herbstii, Hook, var. aurea-reticulata were injured. One cutting of Achyranthes Herbstii, Hook was slightly injured. This treatment was by far the least severe of any tried.

"6. Check- 2 hours in jar:- Geraniums and coleus are all alive and look healthy. One of Achyranthes Herbstii, Hook var. aurea-reticulata cuttings is slightly damaged.

There is a slight dying in 3 of the Achyranthes Herbstii.
Hook, cuttings.

"7. Etherized- 3 hours:- All of the geraniums were badly injured by the treatment. The Coleus and both varieties of Achyranthes are all alive and have a healthy appearance.

"The cuttings of the 2 hour ether treatment have a better appearance than those of the two hour treated lot. They have almost as good an appearance as the check untreated."

These notes show that the 2 hour ether treatment caused the least injury of any of the ether treatments. Why exposure of cuttings to fumes of ether for two hours should prove less injurious than exposures of 15, 30 or 60 minutes, the writer is unable to state. Further notes on these cuttings are given in Table 53 ,

A study of Table 53 shows that the 30 minute ether treatment caused the most severe injury in all cases. The two hour ether treatment, on the other hand proved the least injurious. The writer cannot explain why a two-hour exposure to fumes of ether should prove less injurious than a half-hour exposure. In 3 of the 4 plants tested the 2 hour ether treatment showed an increased root development over similar untreated cuttings. In the case of Coleus Hybrida, the fourth plant tested, there was no difference in the root development of cuttings in the 2 hour ether treated lot and those in the 2 hour untreated lot. In none of the cases, however, was there enough difference between the treated and untreated material to recommend the use of ether for soft wood cuttings.

Table No. 53.

Showing the Effect of Exposing Soft Wood Cuttings to Fumes of Ether for Various Lengths of Time.

Treatment No.	Achyranthes Herb-stii, Hook.		Achyranthes Herb-stii, Hook var. aurea-reticulata		Coleus Hybrida		Pelargonium hortorum, Bailey		Pelargonium hortorum, Bailey	
	No. rooted	Feb. 26 Remarks	No. rooted	Feb. 26 Remarks	No. rooted	Feb. 26 Remarks	No. rooted	Feb. 26 Remarks	No. rooted	March 1 Remarks
1	5	All well; best of all	4	Look well	5	Very well rooted; best of all	@	All alive; thrifty	@	Longest roots 1/4"
2	4	Leaves slightly injured	1	Leaves on 2 cuttings injured	5	Leaves injured on one cutting	--	Leaves badly injured	--	Longest roots 1/2"
3	3	Leaves injured most severely of all	0	Leaves most severely injured of all	5	Not as well rooted as (1). Leaves badly injured	0	Callus end decaying on 3 cuttings	1	Longest roots 3/4"
4	1	Leaves not as badly injured as 30.min. exposure	0	Leaves on all cuttings injured but not as bad as in (3)	0	3 dead. On other 2 leaves very severely injured	0	Leaves injured	4	Longest roots 1 1/4"
5	5	Roots about as well as check. Leaves uninjured	5	Leaves uninjured but not rooted as well as (1)	5	Leaves uninjured but not as well rooted as (1).	0	Leaves least injured of any etherized	1	Longest root 1 1/16"
6	3	Not near as well rooted as (5). Leaves uninjured.	3	Leaves uninjured Not so well rooted as (5)	5	Roots longer than (1)	0	Look better than (1). None injured.	4	Longest root 1/8"
7	1	Leaves uninjured.	0	Leaves slightly injured.	5	Leaves uninjured not so well rooted as (1) or (6)	0	Leaves injured worst of all treatments.	3	Longest root 1/16" 1 cutting dead

@ 6 cuttings used

-- 4 cuttings used

Table No. 53 (continued)

Showing the Effect of Exposing Soft Wood Cuttings to Fumes of Ether for Various Lengths of Time.

Achyranthes Herbstii, Hook.		Achyranthes Herbstii, Hook. var. aurea- reticulata		Coleus Hybrida		Pelargonium hortorum, Bailey	
Treatment No.	No. rooted	March 6 Remarks	No. rooted	March 6 Remarks	No. rooted	March 6 Remarks	No. rooted
1	5	Not as well root- ed as (5). Longest root 2 1/2"	5	Not rooted as well as (5). Longest root 2 1/2"	5	Very well rooted; longest root 3".	5
2	5	Equal (1) in root development. Long- est root 2"	5	Not rooted as well as (1). Longest root 2"	5	Not as well root- ed as (1); longest roots 2 1/2"	4
3	3	Longest root 1 1/2"	3	Longest root 1/2"	5	Longest roots 1/4"	3
4	5	Longest root 1 1/4"	5	Longest root 1/4"	1	Longest root 5/8". 4 dead.	4
5	5	By far best rooted of all; longest root 2 1/4"	5	Best rooted of all; longest root 2 1/4"	5	Well rooted equal to (6); longest root 2"	4
6	5	Longest root 1 1/2"; not as well rooted as (5), (1), or (7)	5	Not quite as well rooted as (1). Long- est root 1 3/4"	5	Longest root 2". Well rooted equal to (5)	3
7	4	One dead. Longest root 2 3/8"	2	3 dead. Longest root 1 5/8"	5	Well rooted equal to (5) & (6). Longest roots 2 1/2"	2

@ 6 cuttings used

— 4 cuttings used

Because of lack of material this experiment could not be continued, using different amounts of ether as well as different exposures, as was the original plan. The writer is of the opinion that by using smaller doses of ether a method might be worked out which could be economically used to hasten the root formation of some of our slower rooting soft wood plants.

V. The Effect of Ether upon Root Grafted Apple Trees

The object of this experiment was to answer this question: Will ether hasten the callusing of graft wounds on whip-grafted apple trees?

On Feb. 11, twenty whip-grafts of the Winesap apple were made. These were divided into two lots, as nearly alike as possible. Each lot was placed in a specimen jar, one was subjected to the fumes of ether for 24 hours while the other was left untreated. At the end of the twenty-four hours, each lot was tied in a separate bundle and placed in damp sawdust in a cool basement room, to callus. On the following day twenty Jonathan grafts were made and treated in the same way. On Feb. 16, ninety Gano whip-grafts were made, thirty of these were etherized for twenty-four hours, thirty were frozen at a temperature ranging from -13°C. to -17°C. while thirty were run as checks. The results obtained are given in Table 54.

It will be seen from Table 54 that ether hastened the callus formation, at the root end, in the case of the

Table No. 54.

Showing the Effect of Ether and Freezing on
Whip-Grafted Apple Trees.

Notes taken March 18, 1916

Variety	Treated Date	Treatment	Number Treated	Number start ing to cal- lus at root end.	Number starting to callus at union.
	2/11	Check	10	9	9
Winesap -	2/11	Eth. 24 hrs.	10	1	10
	2/12	Check	10	10	10
Jonathan-	2/12	Eth. 24 hrs.	10	0	3
	2/16	Check	30	19	25
	2/16	Eth. 24 hrs.	30	23	28
Gano	2/16	Froz. 24 hrs.	30	0	4

Gano only. With the Jonathan and the Winesap the callusing at the root end was greatly delayed. At the union, there was a slight hastening in the callusing with both the Gano and the Winesap but in the case of the Jonathan, the ether caused a serious delay in the callus formation. The results were not in any case sufficiently gratifying to warrant the use of ether in hastening the healing-over of graft wounds.

The freezing of the Gano grafts proved very injurious as eight of the roots were so severely injured that they had to be discarded. In the remaining twenty-two only four were callused at the union while twenty-five and twenty-eight were callused by the check and ether treatments respectively.

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CONCLUSIONS

1. Artificial treatments such as desiccation, freezing, etherization and combinations of the three, cause a shortening of the rest period but do not cause earlier callusing or root formation of dormant cuttings of woody plants.

2. These agents cannot be economically used, in commercial nursery practice, to hasten the callus and root formation of dormant hardwood cuttings.

3. The diastatic activity of dormant hardwood cuttings increases as the season advances.

4. Different varieties of peaches have rest periods of varying length and intensity.

5. Ether is an effective agent in breaking the rest period of peach twigs.

6. The peripheral buds of peach twigs are the first to start growth and are, therefore, more tender than buds nearer the trunk of the tree.

7. Flower buds of the cherry and pear have shorter rest periods than do leaf buds of the same species.

8. Ether treatment of peach twigs increases the sugar content, thereby converting stored food into a form available for use thus causing a shortening of the rest period.

9. Hardy varieties of peaches have longer rest periods than do tender or medium hardy varieties.

10. The use of ether in hastening the rooting of softwood cuttings cannot be recommended.

11. Exposure to ether vapors does not hasten the calling of graft wounds of whip-grafted apple trees.

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UNIVERSITY OF MISSOURI
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May 24, 1916.

DEPARTMENT OF BOTANY

Dean Walter Miller;
Academic Hall.

My dear Dean Miller:

I am herewith returning the thesis of Mr. P.E. Corriveau submitted as partial fulfillment of the requirements for the degree of Master of Arts. I have looked over this thesis carefully and am quite convinced that it is up to the standard for a Master's thesis.

Yours very truly,

EMR:MSM

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AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF HORTICULTURE

May 15, 1916

Dean Walter Miller,
Graduate School,
Columbia, Missouri.

Dear Dean Miller:

I herewith transmit the thesis prepared by Mr. Paul Edward Corriveau, entitled "An Experimental Study of the Rest Period of Plants: The Effect of Rest Period-Breaking Agencies Upon Hardwood Cuttings," submitted in partial fulfillment of the requirements for the degree of Master of Arts in the Graduate School, University of Missouri.

I take pleasure in submitting the same with my approval and state that Mr. Corriveau has completed the requirements for graduation from the Department of Horticulture, other than the preparation of the thesis.

Very truly yours,

A handwritten signature in cursive script, reading "W. H. Lawrence". The signature is written in dark ink and is positioned below the typed name "W. H. Lawrence".

This thesis is never to go from this room. Neither is it to be checked out overnight.

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