WINTER INJURY TO FRUIT TREES.

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H. J. RUSTACE.

SUMMARY.

The cold of the winter of 1903 and 1904 was unusually severe and prolonged. The climatic conditions during the growing season of 1903 were not normal and not altogether favorable. Insects and fungus epidemics were serious upon some kinds of fruit trees. It was a combination of all of these factors that injured or killed many thousand trees, especially peach and pear.

Trunk and branch injury was most common. Root injury was not often found.

The damage was greatest in the Hudson River Valley where the cold was most severe, more than 40° below zero being reported. In the fruit growing regions of Western New York temperatures of from — 10° to — 15° were frequently reported. At the end of the winter the outward appearance of the trees was normal. Upon examination the bark and wood of the trunk above the snow line and of the branches were found to be discolored from black to all shades of brown.

No reliable symptom of fatal injury was found that was applicable at the end of the winter. Discoloration of the bark and wood is a symptom of injury, but not an indication of death.

Old trees did not withstand the cold nor recover as well as young trees.

Trees died at irregular times during all of the growing season of 1904. Fruit that matured on injured trees was undersized. In proportion to the degree of injury the foliage was undersized and of abnormal color, and the usual amount of new growth was not made.
Trees and vines in low "spots" or "pockets" where the cold air settled suffered severely, as they also did on flat land where air drainage was poor.

Difference in variety was usually subordinate to location, age and previous health of the trees, though in many cases there was plainly a difference in the susceptibility of varieties.

Experiments indicated that, when peach trees were less than five years old, a severe pruning or cutting back to large limbs was a successful method of treating injured trees. The same treatment for older trees was a failure. Trees that did not carry any fruit made a better recovery than those that carried even a light crop.
INTRODUCTION.

The winter of 1903 and 1904 was an unusually severe one throughout New York State. In many places the temperature was the lowest on record, and the periods of extreme cold were protracted. As a result the end of the winter found many of the orchards, especially those of peaches and pears, extensively and seriously injured. Orchardists were anxious for information that would enable them to distinguish between trees fatally injured and those in which recovery was probable, and also desired to know what methods of treatment would be most likely to bring about a speedy recovery.

Reliable information upon these points was very meager, and such as was available did not well apply to the conditions as found in New York State. For these reasons and also because the opportunity was a good one it was deemed advisable to make some observations and experiments with injured trees with the hope of learning more about the subject, and to place on record facts that it is believed will be of some value should a similar disaster occur in the future.

Before a consideration of the injuries of the winter it will be necessary to review some of the unusual climatic conditions and insect and fungus epidemics of the growing season of 1903.

The climatic conditions were of the two extremes—the drought during the spring and the excessive rains of the fall—especially in the Hudson Valley. For a continuous period from "April 16 until June 10, a most severe drought occurred, during which there was no rain sufficient to benefit growing crops."1 Coming during these months the tax upon the vitality of all trees was very great, but especially where the soil was shallow, or the tree was not a deep rooting one, or was young and had not become well established. Naturally the soil in many orchards became so hard that the usual and much needed spring cultivations had to be delayed, greatly to the detriment of the trees.

1 New York Section of the Climate and Crop Service of the Weather Bureau. Annual Summary 1903, p. 5.
Following a dry September there was an excessive amount of rain during October, the precipitation being 2.78 inches more than normal—which tended to prolong the growth and prevent the wood from ripening properly before the end of the season.

The prolonged dry weather of the spring furnished favorable conditions for insect development; and several injurious species became so abundant as to cause serious epidemics, and became an important factor in maintaining even ordinary health of the trees. Upon pear trees the ravages of the psylla, *Psylla pyricola*, were extremely severe. In many orchards it was a difficult matter to save enough of the foliage to ripen the fruit; and cases were frequent where the fight against them had to be given up in despair.

The foliage of apple orchards and nursery stock was damaged by an attack of green aphis that was no less severe. During the early part of the season large amounts of foliage were destroyed or injured, the result of which could not be other than to impair greatly the vigor of the trees.

The climatic conditions and insect epidemics were further complicated and their severity increased by outbreaks of fungous diseases. Pear leaf spot, *Septoria piri cola* Desm., was serious in the Hudson Valley, where, unfortunately, the psylla was most severe. During the period of drought there was an exceedingly virulent outbreak in many places of the peach leaf curl, *Exoascus deformans* (Berk.)Fckl.). Where spraying had not been done or had been neglected until too late to be effective, many trees lost all of their foliage, thus further taxing the vitality of the tree.

At the end of the winter it was evident that the trees most injured by the cold were those most seriously affected by the unusual climatic conditions and the insect and fungus epidemics. There can be little doubt but that it was a combination of the effects of the cold and unusual detrimental factors of the previous season that caused the death or injury of many of the trees, and had it not been for these combinations the resulting damage would have been comparatively small.
OBSERVATIONS.

KINDS OF WINTER INJURY.

Winter injury is usually classified under three heads, root injury, trunk injury and branch injury. In the last class may be included the destruction of fruit buds.

Root injury, the freezing of the roots causing death or injury, occurs at times in the winter when the temperature is unusually low and the ground is bare. In some of the Western states this is a common and serious trouble, but it is unusual in New York except on very light soils and in exposed locations where the snow blows away and no mulch or cover crop is used to cover the ground and hold the snow.¹

Trunk injury may be due to the freezing, causing death or injuries within the trunk or limbs, of the active tissue known as the cambium, a thin layer of succulent formative cells between the wood and the bark, from which new tissues are developed. When the temperature is so low as to destroy the cambium layer the tree dies. However this layer is capable of withstanding much cold and of recovering after a severe injury. It was injury of this kind that was common and serious in New York State in 1904.

Branch injury is the killing back of the new and tender wood from the tip to a definite place. This form of injury occurs to some extent every year and depends very largely upon whether the wood ripens well or grows late in the fall and contains a large amount of moisture.

HOW COLD CAUSES INJURY.

The earlier plant physiologists believed that the death of plants was caused by the water in the cells freezing and the resulting expansion bursting the cell walls, thus permanently disorganizing the tissues of the plant which resulted in its death.

Later investigations showed that this theory was incorrect, and that instead of the water freezing within the cells the cold withdrew it from them and that this withdrawal of the moisture

¹Green, W. J. and Ballou, F. H. Winter Killing of Peach Trees. Ohio
was continuous with low temperatures and all plants that are unable to withstand this desiccation, or drying out, must ultimately be killed.

When the supply of moisture in the cells is large it is more readily withdrawn and the injury is greater. This explains why branches having an excessive amount of moisture are more readily injured or killed than those in which the moisture has been reduced by the branch ripening normally in the fall.

TEMPERATURES.

The desire to know just what minimum temperature is fatal to the various species of cultivated fruit trees has often been expressed. But it is evident that such a thing cannot be determined in any way to be of value for the reason that there are many factors other than the temperature that are highly important in connection with the low temperature, such as age of the tree, variety, previous care and health, exposure and altitude of location, character of the soil, and climatic conditions and insect and fungous epidemics during the growing season preceding the dying.

The difference in individual trees is very marked, as was noticed in orchards of the same age and variety where all other conditions were as nearly parallel as could be determined, and trees that were killed stood adjacent to trees that were apparently uninjured.

However, a record of the minimum temperatures in some of the important fruit sections will be interesting as evidence of what some trees have withstood and lived—some to bear crops the same year.

In the Hudson Valley the official records are as follows; the temperature in each case being the lowest recorded during the winter. Albany—24°; Athens, Greene Co.—20°; Greenwich, Washington Co.—28°, Honeymead Brook—28° and Wappingers Falls—34°, both in Dutchess Co. The following records have been reported, though not officially, for Ulster Co., Marlboro—28°, Milton—12° to—16° for high locations and—12° to—32° in hollows and valleys. In Orange Co., at Middle Hope—25° to—40°, Newburg—26°, and Washingtonville—42°.
In the central and western part of the State the cold was not as severe, the official records being as follows; Syracuse—20°, Fayetteville, 12 miles south east of Syracuse—29°, at Romulus, Seneca Co.—12°, Penn Yan, Yates Co.—15°, Shortsville, Ontario Co.—10°, Rochester—14°, Brockport, Monroe Co.—14° and Lockport—12°.

It seems almost impossible that peach trees could survive such low temperatures as occurred in the Hudson Valley, but the facts are that only a small percentage was killed outright, though the crop was almost a total failure. In orchards of considerable elevation and good air drainage a fair crop of fruit was harvested.

Throughout the peach sections of the central and western portions of the state some trees were killed or injured so they died subsequently. The crop was a normal one, though temperatures that are commonly supposed to mean death to fruit buds existed in hundreds of orchards.

APPEARANCE OF TREES AT END OF WINTER.

At the end of the winter the external appearance of the trees was entirely normal. The bark of the trunk was smooth and of normal color and the twigs in all parts of the trees were plump and bright. Nothing about the trees looked unusual or wrong but upon cutting into the trunk anywhere above the snow line it was found that both bark and wood were discolored for some depth into the trunk. The discoloration was most pronounced just above the snow line, and became less as the height from this point increased until on the branches in most cases the normal color and conditions, or very near them, were found.

This discoloration is due to oxidation, or the beginning of decay, and can occur only when moisture is present. It varied in intensity from black or dark brown to very light brown or what might be called a water-soaked appearance. The intensity was directly proportional to the amount of moisture in the tissue at the time of the low temperature.

Upon the discovery of this discoloration much alarm and anxiety arose. It was feared that trees showing this condition were dead, and some fruit growers removed many trees upon this supposition. It was argued that though the roots and the branches
were apparently uninjured it would be impossible for the sap to pass up from the roots as the conducting tissue was destroyed at the point of discoloration. But observations made during the summer and fall showed these fears to be unwarranted.

Below the snow line, even a fraction of an inch, both the bark and wood were entirely normal as to color and condition. This well illustrated the great value of snow as protection against frost, and indicated that the roots were uninjured.

SYMPTOMS OF INJURY.

It was hoped that some common symptom of fatal injury caused by cold could be found—such as would enable the fruit grower to determine the condition of his trees soon after a freeze, or at the end of the winter, so that if fatally injured they could be taken out and new plantings made the same spring, thereby gaining a year in the growth of a new tree, and saving the use of the land and the expense of cultivation for a season in waiting for the injury to manifest itself during the summer.

It was at first thought that the degree of discoloration of the bark and the wood of the trunk would prove of some value in this connection, and that such trees as were badly discolored—when the bark and wood were black—could be classed as certainly dead.

To determine this point some peach and pear trees on a fruit farm in the Hudson Valley were selected and marked for examination during the growing season. These trees were of different ages and grew in a low hollow or "pocket" where the cold air settled, and the soil was moist and rich, favorable to growth late in the fall. On March 24th, 1904, the condition of these was as follows: Snow line 6 to 8 inches from the ground, bark tight to the wood in all parts of the trees, though very dark brown all through, the wood black in the trunk; on the limbs the bark and wood discolored as high as a man can reach.

On September 28, 1904, the last examination of these trees was made and the conditions were found to be as follows: Trees have made a good growth of new wood and have a good crop of foliage. The bark and wood of both trunk and limbs is of normal color and condition. The discolored wood is overgrown with new
wood about three-quarters of an inch thick. Many fruit buds have formed. None of the trees bore any fruit this season.

The trees marked for particular observation were in the center of an orchard of about 200 trees and the above descriptions were typical. However, it must be understood that this orchard was given good care and cultivation during the growing season.

In most of the trees there were many small twigs that had been killed, and an occasional tree on which the foliage was not of a good color. But it certainly would have been unwise to remove all of the trees in this orchard upon the supposition that they were dead because of the discoloration of the bark and wood of the trunk and limbs. This orchard and the marked trees were examined again in the early part of June, 1905. Practically every tree was in good condition, had a good crop of large and well colored foliage and a large amount of fruit.

The discoloration is, of course, a symptom of injury, and the stronger the discoloration the more severe the injury. But with peach and young pear trees the discoloration, even though very pronounced is not a certain indication of death.

No reliable symptom of fatal injury from frost was found that was applicable at the end of the winter.

AGE OF TREES AND SUSCEPTIBILITY TO INJURY.

With peach and pear trees there was a well marked difference in the degree of injury depending upon the age of the tree.

Observations upon this point were made at many places, but most carefully upon a fruit farm of about 5,000 peach and an equal number of pear trees, at Milton on the Hudson River, where the injury was most severe. The elevation of this farm was very uneven, varying from 200 to 500 feet above sea level, and containing many "pockets" or "hollows." The peach trees were from one to fifteen years old and the pear trees from three to twenty-five years old.

Peach trees one year set were examined in March and showed only slight discoloration of the bark and wood. Late in September, when last examined, all of these young trees were found to have made a splendid growth during the season, and a few that were cut off below the snow line to have made a vigorous growth
Peach trees under five and six years did not show severe cases of discoloration, though it was more marked on trees in low places where the cold settled and late growth was favored by rich moist soil. In practically all cases trees of these ages made a rapid and satisfactory recovery during the summer.

With peach trees over seven or eight years old the injury was found to be far more serious. The discoloration was much more pronounced, and increased in intensity with the age of the tree, when the other conditions were parallel, being greatest again upon trees located in low places and on moist rich soil. The older trees did not make a rapid nor vigorous recovery. The foliage was scanty, undersized and of a pale color—in contrast with the younger trees on which the foliage was normal in these respects. There were also more small dead twigs scattered through the tops of the older trees than there were in the younger trees.

Many pear trees from two to five years old were examined in which the bark and wood were badly discolored, the bark being filled with brown streaks, instead of a solid color as in the case of the peach. The common opinion was that trees in which this discoloration was marked were practically ruined, and the best way would be to cut them off below the snow line, and let them send up sprouts from the stump. If there had been time enough in the spring for the work, the owner of these trees would have treated several thousand of them in this way. But the growing season proved the fallacy of the prediction. Lack of time was fortunate for the fruit grower.

With but very few exceptions these young trees made a good recovery, had a good crop of healthy foliage, made a good amount of new wood and enlarged in the diameter of the trunk very noticeably. Wire labels loosely fastened on the trees in March had, in September, become imbedded in new growth.

All of these trees were examined again in June, 1905, and practically all of them had made a very good recovery. Nearly all of the peach trees and many of the young pear trees had a good crop of fruit.
EFFECT OF INJURY UPON TREES.

The injury manifests itself in various ways and at different times, depending upon the degree.

In some cases the trees did not show any life at the opening of spring, being killed outright during the winter. This was more common with pear trees that were seriously affected by the psylla. The number of peach trees that died in this way was comparatively small.

In most cases some growth started in the trees, as it was able to do with the starch in the branches, but when this became exhausted in May or June and plant food was unable to come up from the roots in sufficient quantities the leaves dropped and the trees perished.

With some trees a limited amount of plant food could be forced up into the branches and here the growth continued until July or August when a few days of continuous dry, warm weather would cause the demand for more moisture than could be forced up through the injured tissues of the trunk and the tree would die.

The dying of the trees at such unusual and irregular times gave rise to much alarm among the fruit growers in some localities. It was feared that a virulent attack of the "yellows" had broken out or some new and serious disease had become prevalent.

Upon injured trees that did survive the most striking effect of the damage was noticeable in the foliage. In proportion to the degree of damage the leaves were under normal size and not of their natural color. On some of the trees they were about one-third size, and the color was usually a pale green, though occasionally tinges of red not unlike that produced by the leaf curl disease were noticeable. This effect was so striking as to be conspicuous from a long distance. The effect was very noticeable in the amount of new growth made during the growing season. In some instances this did not exceed a few inches in length, and from this it varied up to practically the normal amount.

Fruit that did mature on injured trees was under normal size for the variety. This effect was especially noticeable on peaches and pears.
ENVIRONMENT AS RELATED TO INJURY

Altitude, air drainage and conditions of the soil had a very important bearing upon the severity of the injury. The advantages of a high altitude were best shown in some of the peach orchards in the Hudson Valley. Orchards that were located on the highest sites were injured the least of any, and many of them bore a fairly good crop of fruit. Those located on the low sites were injured the most and none of them bore any fruit. Frequently the benefit of an elevation of a few feet was apparent. In March it was noticed that the discoloration of the bark and wood of the trunks of the trees became less intense as the altitude of the location of the tree increased.

So thoroughly has the advantage of high altitudes as sites for peach orchards been impressed upon fruit growers that many have expressed their intention of using only such sites for peach orchards in the future.

The reason for the difference in the amount and seriousness of the damage between trees and vines in low as compared with those on high sites is because the cold air rapidly passes from the high lands and settles into the lower places. This, of course, causes a very low temperature for a considerable length of time in these places, while the temperature of the high lands moderates to some extent.

Thus the factor of air drainage becomes an important one. This was strikingly brought out in an observation of the damage done to trees and vines growing in hollows or "pockets," and also upon flat lands, though of good altitude but so level as to furnish no means for the cold air to drain away. An example of the latter was found at Marlboro where all the vines in a young vineyard of Delaware grapes planted upon a very level field were killed to the snow line, but at one side of the field there was a sharp decline and the vines growing there where the cold air sank away were entirely alive. Many similar observations could be given, but this one is typical.

The great disadvantage of using hollows or "pockets" for orchards and vineyards was apparent in many places throughout the hilly fruit region of the Hudson Valley. In these places the cold air settled and remained, doing immense damage. In many
of such orchards all of the trees in these low places were practically ruined. In a vineyard of Campbell’s Early grapes at
Warlimont, all of the vines growing in the lowest part of a "post" were killed to the snow line, while none of the vines on
the surrounding higher land were seriously injured.

In many of the peach orchards of Western New York there
are areas of slight depression or "low spots." On these it was
common to find that the trees had either been killed or were seri-
ously injured, while the surrounding trees, on land but a few
feet higher, were bearing fair crops of fruit.

The explanation of this difference seems to be that the excess-
ive amount of soil moisture in these places induced a late growth
instead of the essential ripening of the wood. Further, this
excessive moisture made the soil water-table high which tended
to the development of shallow rooted trees, as was noticed upon
the removal of many trees from these low places. Such trees
very naturally, suffered more from the low temperature than the
deeper rooted ones on dry or drained soil.

The difference in susceptibility to winter injury of trees grow-
ing on tile drained as compared with undrained land was seen in
a peach orchard at Williamson. The trees were Elbertas, about
ten years old and had always been under a high state of cultiva-
tion. In a part of the orchard the land was tile drained and in
another part was undrained. The trees on the drained portion
were not seriously injured and when examined the latter part of
August were in a vigorous condition, while the trees on the
undrained land were dead or practically ruined.

Instances of serious damage done by wind were frequently
observed. Trees on the western side of exposed peach orchards
where the wind had an unobstructed sweep were often killed or
severely injured, while others a short distance in the orchard
were not seriously damaged.

In some orchards the dead or injured trees were noticed
to be confined to certain portions which indicated that the wind
had blown through these places more constantly and with greater
force than in other parts of the same orchard, as trees but a
little distance away were not seriously damaged. Sometimes
these injured portions would be an exposed corner or a more or
less definitely marked path the width of several rows through the orchard.

In the Hudson Valley fruit region wind damage was apparent in peach orchards on exposed western slopes or among trees on the western crest of a hill where the force of the wind was greatest and the snow blew off.

**DIFFERENCE IN VARIETY.**

The difference in the susceptibility of varieties to the injury usually appeared subordinate to such other factors as location, age and previous health and condition. However, some observations were made in orchards and vineyards where the difference in injury could be plainly seen to be due to variety.

One of the most striking differences was seen in a vineyard at Marlboro. There were two varieties, Niagara and Worden. All of the former were killed to the snow line while none of the latter seemed to be seriously injured. The vines were of the same age, and all conditions as to soil, altitude and care were the same.

Some interesting differences were seen in a peach orchard at Milton. The orchard was of 730 trees, five years old, located on an elevated site, sloping to the west. The soil was uniform and the trees had always been well cared for. A careful examination showed the following conditions:

Elberta: No fruit except a very small amount on the trees in the highest part of the orchard. Reeves Favorite: No fruit on any of the trees. Stevens Rareripe: Good crop of fruit on all of the trees. Bray: Some fruit but less than on the Stevens Rareripe.

The difference in hardiness of Baldwin, Rhode Island Greening and Ben Davis apple trees was seen at Marlboro. In an orchard of one year old trees of these varieties all of the Baldwin and Rhode Island Greening trees were killed back to within three or four feet of the ground (the trees had been about six feet high) while none of the Ben Davis trees appeared to be injured. The susceptibility of Baldwin trees to cold has also been observed by Longyear in Michigan.3

The following observations were made upon a farm at Middle Hope: Several hundred Lawton pear trees that had been top-grafted the previous year were killed, while adjacent trees that had not been grafted were not seriously injured. In a cherry orchard the fruit buds of Early Richmond and Montmorency were killed. The Morello trees bore a good crop. Wilson Jr. blackberry bushes were killed. Early Harvest and Eldorado blackberry had a good crop of fruit. Orange quince trees were killed to the snow line. However, they were in a low place. Chinese Cling peach trees were injured more than other varieties. Stevens *Rareripe*, Elberta, Thurber and Salway were not seriously injured.

A number of fruit growers reported the difference in varieties injured in their orchards as follows:

*Peaches.*—Frank L. Young, Lockport.—Globe injured the most. Late Crawford set fruit but it dropped. Early Crawford injured but little. Elberta and Stevens *Rareripe* not injured.

C. F. Stout, Olcott.—Early varieties injured the most.

Wm. H. Outwater, Olcott.—Smock and Late Crawford injured the most.

J. O. Lockwood, Olcott.—Globe and Chair's *Choice* injured the most. Triumph, Reeves Favorite and Alexander injured the least.

James Austin, Morton.—Crawfords injured the most. Crosby the least.

I. L. Dickinson, Appleton.—Niagara injured the most, St. John next and Early Crawford the least.

Jay E. Allis, Medina.—Surprise, Orleans and Elberta injured the most. Crawfords, Niagara and Chair's *Choice* injured the least.

*Pears.*—W. T. Mann, Barkers.—Reeves Favorite nearly all killed, Crawfords injured, Elberta not injured.

*C. G. Yelle & Son, Marlboro.*—Bartlett and Seckel pear trees injured the most.

A. W. K. Dick, Germantown.—Bartlett and Kieffer, injured the most. Clapp's Favorite, Anjou, Clairgeau and Seckel injured the least.
J. R. Cornell, Newburg.—Bartlett injured the most.

Apples.—A. W. K. Dick, Germantown.—Baldwin apple trees injured.

Wm. H. Hallock, Washingtonville.—Baldwin and Gravenstein apples injured the most.

Grapes.—C. G. Velie & Sou, Marlboro.—Delaware grape vines very severely injured.

It will at once be seen that these reports are very contradictory and conflicting, even some from the same localities. This difference is undoubtedly due to the unlike environment, condition and age of the trees, as soil, altitude, previous care and crops; and shows very conclusively the relative unimportance of variety as compared with these other factors.

RECOVERY OF SOME TREES.

Specific mention of the recovery of some trees under observation will be interesting as showing how unreliable the early appearance of a tree is as an indication of the extent of the injury.

On the fruit farm at Milton, previously referred to, many of the old peach trees growing in the bottoms of the "hollows" were examined in March when the bark and wood of both trunk and limbs were found to be black or very dark brown. On many of these trees the bark of the trunk could easily be pulled from the wood. They were thought to be dead beyond any question by all who examined them.

When these trees were examined in June they were in fairly good condition, there was a good crop of foliage of good size and color, and a layer of new wood had formed over the old discolored one in the trunk and limbs.

At an examination the last of September, the trees were in even better condition than in June, and a good many vigorous fruit buds had formed.

In June, 1905, most of these trees were in nearly normal condition. They had a good crop of large and strong colored foliage and a large crop of fruit.

At Marlboro, an orchard of Kieffer pear trees growing upon low ground was examined in March, and the bark and wood were discolored black all through. The trees were thought to be dead
by all who examined them. Late in September these trees had a fair crop of fruit (though undersized) and the bark and wood contained many brown streaks, but had made a remarkable recovery. On one tree examined, a layer of new wood 5 mm. thick had grown over the discolored layer.

These trees were examined again in June, 1905, and most of them found to be in splendid condition. The foliage was good size and color, a good new growth was being made and there was a large amount of fruit set.

In an orchard of Bartlett pear trees about 15 years old at Middle Hope many of the trees were considered to be ruined by all who examined them in March. In September, they were in good condition, had a good amount of foliage and a fair crop of fruit, and the old discolored wood was overgrown with a layer of new wood.

A row of young sweet cherry trees showed, when examined in March, various degrees of discoloration of the bark and wood according to the altitude. All of the trees were alive in September, and had an abundance of good foliage, had made some new growth and the wounds made in the trunk in the examinations in March had all grown over.

An orchard of Japan plums was examined in March and to every indication the trees were dead, but they ripened a fair crop of fruit, and when examined in September a thick layer of new wood and bark had covered the old discolored layer. In one tree the new wood was 8 mm. thick and the bark 4 mm. thick.

In all of the vineyards where vines had been killed to the snow line there was a very vigorous growth of shoots that started out from below this point. Usually there were four to ten of these shoots and many of them made a growth of fifteen feet.

**TREATMENT OF INJURED TREES.**

During the spring there was much demand for information as to the best way to prune injured trees so as to induce a most rapid recovery. All manners of ways were advised, as cutting the young trees off below the snow line, cutting the old trees back to the large limbs or 'dehorning,' a moderate pruning and to do nothing at all.
As obtainable information upon this point was unsatisfactory, and not based upon actual experiments it was decided to make some experiments, to be supplemented by observations, with the hope of being able to gain some knowledge that would be useful in the future.

Upon the fruit farm previously referred to a number of old peach trees in different orchards were cut back to where the limbs were about an inch and a half to two inches in diameter. This was done early in April. Adjacent trees, injured to the same degree, were marked and left unpruned and others pruned for comparison.

When an examination was made about the middle of June a few of these "dehorned" trees were putting out some vigorous shoots from the limbs, and the indications were that they would make a good recovery.

At an examination late in September it was very evident that this method of treatment had been a total failure. All of the trees were entirely dead or had only a few straggling leaves. The vigorous shoots that promised so well in June were all dead. The discoloration of the bark and wood was nearly the same as it was in March.

The result with old pear trees that were "dehorned" was the same as with these old peach trees; they died in the same way.

Observations made in orchards in various fruit sections of the State confirmed the results of these experiments with both peach and pear trees.

In the case of young peach trees the reverse seems to be true. Upon the farm of Mr. Gregory Brundage, Salisbury Mills, about ten miles from Newburg, were 5000 peach trees from 2 to 5 years old, of the following varieties: Elberta, Champion, Stevens' Rarereipe, Chair's Choice, and Salway. Soon after the extreme cold of January 5 and 6, Mr. Brundage decided that the trees were seriously injured and began at once to "dehorn" them. In one orchard the work was finished in a few weeks. In the others the work was delayed until the last of March.

When these trees were examined in June they had made a splendid recovery. Many vigorous shoots had started out from the
branches and there was an abundance of large well colored foliage. In some of the trees the new growth had become so thick as to require thinning.

It was very apparent that the trees cut back in January had recovered better and were making a more vigorous growth than those on which the work was delayed until March.

In one field three trees were not cut back but left for comparison. By the middle of June two of these trees were dead, the other was making a fair recovery, but the new growth was all in the top, making an undesirable tree. Three trees were hardly enough to compare with 5000 but their condition indicated that Mr. Brundage did not make a mistake in cutting these trees back.

At the time of the last examination, about the first of October, the trees had made an immense growth, more than five feet in many cases, and it was still evident that the trees cut back early were better than those cut back in March. Less than 25 trees failed to recover, and the death of some of these is attributed to mouse injury.

These trees were carefully examined again in June, 1905. Practically all of them came through the winter in good condition notwithstanding the large amount of new wood they had. Many of the trees had a small amount of fruit.

The greatest objection to cutting back peach trees in this way is that it induces too large a growth of new wood and the tree becomes bushy. A good deal of judicious pruning is necessary to make such trees satisfactory.

These results indicate that the winter injured trees of over seven or eight years are killed by "dehorning," while younger trees may be treated in that way and expected to make a good recovery.

The results from a moderate pruning were encouraging in the case of both young and old peach trees. Trees adjacent to those "dehorned" were moderately pruned and marked for comparison, and others to which nothing was done were also marked. In all cases these trees were under parallel conditions and of the same age and variety.

When examined the middle of June it was plain to see that they were much superior to the trees that had nothing done to them. The foliage was much more abundant in all parts of the tree; it was larger size, and more nearly normal in color.
At the examination the latter part of September the difference was more striking than in June, for during the interval some of the unpruned trees had deteriorated, and parts of them had died.

Plate I shows the difference fairly well on September 27, 1904. These were adjacent trees, of the Fitzgerald variety and about six years old. The tree shown in Fig. 2 was moderately pruned in April and that in Fig. 1 was unpruned.

The difference between the pruned and unpruned trees was very apparent in June, 1905. The trees that had been pruned could easily be distinguished from the others by the foliage which was larger and better colored, by more compact tops and by larger crops of fruit.

The result was invariably the same with a large number of trees treated in this way, and the conclusion cannot be other than that a moderate pruning of winter injured trees is much superior to no pruning, and in the case of trees over six or seven years old it means recovery where "dehorning" would be fatal.

These results confirm the reports of observations made in the Michigan peach belt the season after the severe freeze of 1899.4

By far the largest part of the injured trees were not pruned nor treated in any way. The conditions of these trees varied greatly. Many of them made a fair recovery, in some cases such as seemed satisfactory to the growers. But it was very apparent that the average conditions of unpruned trees as compared with those lightly pruned was that they contained a much larger amount of dead wood, and that the new growth tended to be only at the extreme ends of the branches, which made the top of the tree too spreading.

An experiment conducted by the entomologist of this Station 5 in a peach orchard near Geneva showed a way whereby many thousand winter injured trees might have been saved. In an orchard of Fitzgerald peach trees about eight years old some were sprayed in November, 1903, with different kinds of sulphur washes, and some were left unsprayed.

In the Spring it was seen that the spray mixtures had destroyed

5 See Bulletin 254 of this Station, page 328.
FIG. 1.—UNPRUNED.

FIG. 2.—PRUNED IN APRIL.

PLATE I.—EFFECT OF MODERATE PRUNING ON WINTER-INJURED FITZGERALD PEACH TREES.
Photographed Sept. 27.
the fruit buds, for there were no blossoms upon the trees that had been sprayed, and there were upon the untreated trees. Otherwise there was no very great difference during the spring in the appearance or growth of the trees. But in July many of the untreated trees began to deteriorate rapidly, and by August many were dead and others had dropped all of their fruit and much of their foliage, while practically all of the sprayed trees remained in splendid condition and so continued during the growing season.

The greatest demand upon the vitality of the tree was made during the warm weather of July and this together with the additional demands of the developing fruit upon the untreated trees was too great for them to overcome with their vitality already depleted from the injuries of winter.

It was evident that the loss of the crop of fruit by the destruction of the fruit buds with the spray mixture saved a good many of the trees.

Many thousand bearing peach trees, especially in Western New York orchards died during the summer that might have been saved and enabled to make a good recovery if the crop of fruit or a part of it had been removed early in the season.