RANDOM NOTES ON FRUIT TREE ROOTSTOCKS AND PLANT PROPAGATION, II

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PUBLISHED BY THE STATION
UNDER AUTHORITY OF CORNELL UNIVERSITY
ABSTRACT

SINCE publication of Bulletin No. 649 of this Station, bearing a similar title, accumulation of additional timely minor observations has called for a second in the series.

1. When exposed to $-24^\circ$ F, tops of pear trees (*Pyrus communis* L.) propagated on quince roots (*Cydonia oblonga* Mill.) for dwarfing purposes were injured no more than adjacent pear trees on pear rootstocks, yet the quince rootstocks were killed. Past failures with dwarf pears in America may be traceable in part to winter injury to the quince root. A hardy quince rootstock is needed upon which to work the pear for dwarfing purposes.

2. In propagation of quinces (*Cydonia oblonga* Mill.) by hardwood cuttings, heel cuttings have given higher percentage rooting than straight cuttings. Wood collected in fall has given higher percentage rooting than wood collected in spring.

3. Clonal rootstocks developed at the East Malling Research Station in England are on trial as improved rootstocks for fruit trees in America. Their ability to withstand vicissitudes of eight winters and summers, including two summers of drought and a test winter of $-25^\circ$ F, is indicated. All types have succeeded to some degree, at least.

4. To meet emergency conditions, it is possible to top-work 2-year-old nursery apple trees by whip grafting the main stem and to secure satisfactory growth when planted in the orchard the same year.

5. In cherry sections of western New York during the severe winter of 1933–34 ($-31^\circ$ F), neither Mazzard nor Mahaleb rootstocks showed such injury in the orchard as to make either a commercial liability, yet many cion varieties of sweet and sour cherries were killed. By contrast, Mazzard seedlings in the nursery were severely injured, whereas Mahaleb seedlings were injured little or none. Some of the difficulty with Mazzard seedlings in the nursery may be traceable to leaf spot and the factor of maturity.

6. Trees of the relatively hardy Montmorency cherry were killed back by winter cold to exactly the line of union with the rootstock, whereas the more tender Mazzard and Mahaleb rootstocks were uninjured. The effect of the union as a factor in hardiness is considered.

7. Rose plants packed in granulated peat moss with a pH of 3.2 (strongly acid) failed to make root growth and died. Correction to pH 5.7 to 6.0 (slightly acid) by the addition of ground limestone resulted in normal root development and satisfactory plant growth.

8. Fall application of fertilizers to apple and cherry trees in the nursery prior to digging and applications of fertilizers to the roots of dormant trees in storage failed to increase growth and vigor in the orchard.
RANDOM NOTES ON FRUIT TREE ROOTSTOCKS AND PLANT PROPAGATION, II

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INTRODUCTION

A year ago the first publication on Random Notes on Fruit Tree Rootstocks and Plant Propagation was published as Bulletin No. 649 of this Station, with these introductory comments: "From time to time in the course of a more detailed and extensive research program on nursery problems, minor observations and less extensive experiments have been recorded which have not seemed sufficient for publication individually. In view of the timeliness of application of several of these instances to particular problems of interest at the present time, however, it has seemed worth while to chronicle a few of them for what they may be worth."

The interested response to this publication and the accumulation of additional timely notes has called for this second in a series of similar publications. The notes recorded in the present bulletin are as follows:

1. Tenderness of quince roots to winter cold, a limiting factor with dwarf pears.
2. Factors in the propagation of quinces from hardwood cuttings.
3. Adaptability of Malling apple rootstocks to New York State conditions.
4. Top-working young apple trees the same season before planting in the orchard.
5. Performance of Mazzard rootstock in the nursery and in the orchard in Western New York during the severe winter of 1933–34.
7. Effect of pH of package material upon root development of package roses.
8. Effect of fall fertilizer applications in the nursery upon subsequent performance of apple and cherry trees.
1. TENDERNESS OF QUINCE ROOTS TO WINTER COLD,
A LIMITING FACTOR WITH DWARF PEARS

Dwarf pear trees are produced by working the desired variety upon quince roots (*Cydonia oblonga* Mill.). While dwarf pear trees are a feature of the Old World, and while large commercial plantings of dwarf pear trees are successful in England and on the Continent, culture of the pear on the quince in America has not been overly popular. Records of pear culture in America from Colonial times indicate the many attempts to grow dwarf pears and many disappointments. Various reasons have been ascribed to this situation, such as cion rooting, blight susceptibility of the quince root, and poor vigor of dwarf trees under American climatic conditions. The problem is again called up for attention by the recent renewed interest in dwarf pears and in pear trees trained to special forms in eastern United States. The substance of this note is that the tenderness of the quince root to winter cold is a limiting factor in dwarf pear production.

On February 8 and 9, 1934, at Geneva, N. Y., the temperature dropped to — 24 degrees F as recorded on a thermometer located on a parcel of nursery land upon which were growing several lots of 1- and 2-year-old pear trees on both pear (*Pyrus communis* L.) and quince roots (*Cydonia oblonga* Mill.). Among the varieties were Bartlett, Beurré d’Anjou, Seckel, Kieffer, Cayuga, and Clairgeau. In addition, there were several dwarf pear trees in the process of being trained to special forms, varying in age from 1 to 3 years.

Upon first examination of the trees following the severe winter cold, the pear wood was found to be badly blackened, altho the cambium was alive and many parenchyma cells thruout the plant were uninjured. This situation applied equally to varieties on pear roots and on quince roots. On the other hand, the quince roots were dark brown in color and showed the water-soaked appearance associated with badly injured tissue.

Several trees on both quince and pear roots were dug and brought into the laboratory. When placed in water in a warm room the pear buds developed into vigorous growth and the severe discoloration of the injured tissues largely disappeared. On the other hand, the quince roots appeared dead and failed to make new growth. When leaves had developed to a length of 45 mm and shoot growth had reached 40 to 50 mm, the shoots and leaves suddenly wilted and dried up. Pear trees on pear roots brought into the laboratory and placed under
similar conditions for comparison continued vigorous and normal growth of both root and top until discarded.

The behavior of the trees in the nursery was similar. The pear tops began growth in spring, developing good shoot growth and good foliage comparable to the development of adjacent pear trees on pear roots. As growth continued, the black wood discoloration of the top largely disappeared, and the trees from superficial examination might have been said to be making a vigorous recovery from severe winter injury.

When the new shoots were 4 to 6 inches long, and about the first week in June, occasional browning of the margins and yellowing of leaves was observed, together with occasional wilting of shoots. Within a day or two of the first signs of wilting and drying, the tops suddenly wilted badly, browned, and dried, so that by the middle of June the entire lot of pears on quince roots were dead, whereas adjacent blocks of pears on pear roots were making good growth.

Examination of the roots of the dwarf trees showed the quince roots entirely dead, brown and disintegrating, apparently having been killed outright by the severe winter cold. Yet the portion of the quince rootstock just above the ground was not seriously injured. This portion of the rootstock is stem-like in structure, being the stem of the original quince rootstock upon which the pear varieties had been budded. In budding practices the bud is inserted on the rootstock 2 inches above the ground, and the top of the rootstock is later cut off to force the bud of the desired variety into growth.

DISCUSSION

These observations call attention to the need for a hardy quince rootstock upon which to work the pear for dwarfing purposes. One wonders how many of the reported failures with dwarf pears in the past may be traced to winter injury to the quince root. The type of root injury here reported might easily have gone unobserved, since the pear top began normal shoot and foliage development, dying suddenly during the summer. Whereas severe cold spells such as occurred during the winter of 1933–34 are rare, their damaging effect upon dwarf pears on quince roots indicates winter cold to be a limiting factor in the use of the quince root for dwarfing pears in America.

An interesting point is the fact that the stem portion of the quince rootstock above ground was not killed, whereas the roots were en-
tirely destroyed. In a previous publication the writers\textsuperscript{1} have cited an instance where mounded quinces from which the rooted shoots had been taken were destroyed by cold, whereas adjacent plantings which had not been disturbed were uninjured both in the roots and in the tops.

2. FACTORS IN THE PROPAGATION OF QUINCES FROM HARDWOOD CUTTINGS

In the propagation of quinces from hardwood cuttings, tests have been made of different types of cuttings and of different times of collecting wood from which to make the cuttings. The material used was secured from the East Malling Research Station, East Malling, Kent, England, as clonal lines of the common quince (Cydonia oblonga Mill.). Two lines were used, namely, Angers quince type A, and common quince type B. The plants in any one group are genetically identical, each line having been propagated from one original plant.

Wood was collected in November, when the plants were dormant but before any severe cold spell had occurred, and stored in a nursery cellar in sand.

Fig. 1.—Bundles of Heel Cuttings of Quinces at Planting.
Other wood was collected in the spring of the year, in late February or early March, while the plants were still dormant. Cuttings were made 8 or 9 inches long in late February and early March and stored in sand in a cool cellar at a temperature of about 40° F until planted (Fig. 1).

In both the fall-collected and spring-collected wood, two types of cuttings were made, namely, "straight cuttings" and "heel cuttings." The straight cutting is of the type made with a straight clean cut of the knife and consists solely of wood of a single shoot. The heel cutting is made by tearing lateral shoots from a main stem so that a portion of the main stem remains at the base of the cutting.

The comparison of fall vs. spring collection of wood and of straight vs. heel cuttings is given in Table 1.

It can be seen at once that heel cuttings have given the better percentage of rooted plants, namely, 82.94 with one lot from heel cuttings as compared with 51.04 from straight cuttings (Fig. 2).

It can also be seen that the percentage stand is much higher from wood collected in the fall of the year before it has been exposed to cold weather than from wood collected in the spring after it has been exposed to winter cold. The percentage stand from one lot of November-collected wood is 58.99 as compared with 12.61 for spring-collected wood. In another case, the percentage from fall-collected wood is 82.94, as compared with 2.74 for spring-collected wood.

**DISCUSSION**

Altho the figures given in Table 1 are for only one season, the same general situation has been observed to apply for several seasons past.
Table 1.—Comparison of Fall- vs. Spring-collected Wood and Straight vs. Heel Cuttings of Quince.

<table>
<thead>
<tr>
<th>Wood Collected</th>
<th>Type of Cutting</th>
<th>Cuttings Made</th>
<th>Number Planted</th>
<th>Number Rooted</th>
<th>Percentage Rooted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov., 1934</td>
<td>Straight</td>
<td>February</td>
<td>690</td>
<td>407</td>
<td>58.99</td>
</tr>
<tr>
<td>Early Mar., 1935</td>
<td>Heel</td>
<td>Early March</td>
<td>872</td>
<td>110</td>
<td>12.61</td>
</tr>
<tr>
<td>Nov., 1934</td>
<td>Heel</td>
<td>February</td>
<td>490</td>
<td>383</td>
<td>78.16</td>
</tr>
</tbody>
</table>

Angers Quince Type A

<table>
<thead>
<tr>
<th>Wood Collected</th>
<th>Type of Cutting</th>
<th>Cuttings Made</th>
<th>Number Planted</th>
<th>Number Rooted</th>
<th>Percentage Rooted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov., 1934</td>
<td>Straight</td>
<td>February</td>
<td>1,105</td>
<td>564</td>
<td>51.04</td>
</tr>
<tr>
<td>Early Mar., 1935</td>
<td>Heel</td>
<td>Early March</td>
<td>475</td>
<td>13</td>
<td>2.74</td>
</tr>
<tr>
<td>Nov., 1934</td>
<td>Heel</td>
<td>February</td>
<td>850</td>
<td>705</td>
<td>82.94</td>
</tr>
</tbody>
</table>

Accurate figures are available, however, for only the one season as given. In no instance has there been any noticeable injury to spring-collected quince wood by winter exposure.
3. ADAPTABILITY OF MALLING APPLE ROOTSTOCKS TO NEW YORK STATE CONDITIONS

A number of rootstocks have been developed in England at the East Malling Research Station which are considered valuable as improved rootstocks for fruit trees. They are vegetatively propagated by layering. Each particular line is composed of individuals identical to the others in that line since they have been propagated vegetatively from one original plant for each line.

Besides uniformity, each line is represented by differing degrees of vigor and of dwarfing, by differing adaptabilities to soils and climate, and by varying relations to the varieties used as parents.

Inasmuch as there is at the present time a dearth of information regarding the performance of these Malling selections in America, a brief report of their relative ability to withstand American conditions during eight seasons from 1928 to 1935 may not be out of place. Furthermore, this period includes one so-called "test winter," and two years of drouth conditions, so that some indication is given of the ability of these English stocks to withstand periods of unfavorable climatic conditions in America.

From a shipment of rootstocks secured from the East Malling Research Station, East Malling, England, in the early spring of 1928, six plants of each type were planted together in one block as a mother plantation. The soil is a heavy clay loam, quite uniform, with only fair drainage. The plants were allowed to develop one year after planting. The second year and thereafter they were layered, and the rooted shoots were removed each fall or spring.

During the winter of 1933–34, the temperature dropped to $-25^\circ$ F as recorded by an official thermometer located on a hill 30 feet above the planting. A quarter of a mile away on level land the official reading was $-31^\circ$ F. None of the plants was killed outright by this exposure, and the degree of injury to the tops is recorded in Table 2.

While it must be understood that this information may not give an absolute indication of the relative hardiness of these rootstocks, it at least indicates that most of them were sufficiently hardy to withstand this low temperature, and that some were unhurt by it. For comparison, tender varieties of apple, such as Baldwin, Rhode Island Greening, and Gravenstein, were badly injured by the same exposure, although such hardy varieties as McIntosh showed only browning of the pith. The summers of 1933 and 1934 were drouth-y.
### Table 2.—Survival of Malling Apple Rootstocks after Seven Seasons.

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Effect of Severe Cold upon Shoots</th>
<th>Mother Plants Surviving 8 Seasons (1928 to 1935)</th>
<th>Percentage Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malling I</td>
<td>No injury</td>
<td>6 out of 6</td>
<td>100</td>
</tr>
<tr>
<td>Malling II</td>
<td>No injury</td>
<td>5 out of 6</td>
<td>83</td>
</tr>
<tr>
<td>Malling III</td>
<td>No injury</td>
<td>6 out of 6</td>
<td>100</td>
</tr>
<tr>
<td>Malling IV</td>
<td>Pith badly discolored</td>
<td>5 out of 6</td>
<td>83</td>
</tr>
<tr>
<td>Malling V</td>
<td>No injury</td>
<td>6 out of 6</td>
<td>100</td>
</tr>
<tr>
<td>Malling VI</td>
<td>Slight browning in pith and some in xylem</td>
<td>2 out of 6</td>
<td>33</td>
</tr>
<tr>
<td>Malling VII</td>
<td>Browning in pith and some in xylem</td>
<td>6 out of 6</td>
<td>100</td>
</tr>
<tr>
<td>Malling VIII</td>
<td>Browning in pith and some in xylem</td>
<td>1 out of 6</td>
<td>17</td>
</tr>
<tr>
<td>Malling IX</td>
<td>No injury</td>
<td>3 out of 6</td>
<td>50</td>
</tr>
<tr>
<td>Malling X</td>
<td>Pith and xylem badly injured</td>
<td>3 out of 6</td>
<td>50</td>
</tr>
<tr>
<td>Malling XII</td>
<td>Browning in pith and xylem rays</td>
<td>5 out of 6</td>
<td>83</td>
</tr>
<tr>
<td>Malling XIII</td>
<td>Slight discoloration</td>
<td>3 out of 6</td>
<td>50</td>
</tr>
<tr>
<td>Malling XV</td>
<td>Browning in pith and some in xylem</td>
<td>2 out of 6</td>
<td>33</td>
</tr>
<tr>
<td>Malling XVI</td>
<td>Pith badly injured</td>
<td>6 out of 6</td>
<td>100</td>
</tr>
<tr>
<td>Malling XVII</td>
<td></td>
<td>1 out of 6</td>
<td>17</td>
</tr>
</tbody>
</table>

The general ability of the stocks to withstand the vicissitudes of eight winters and summers is indicated by the last column in Table 2. The loss of plants is not due entirely to low temperature, but to all causes, and may be considered in a measure as a general indication of the success of these stocks under American conditions.

**DISCUSSION**

It is, of course, not safe to say that those types which have suffered most may not succeed, but it is at least possible to say that all types have succeeded to some degree, and that others have grown thru eight seasons of unusual severity with no mortality whatsoever.

It must be remembered, also, that this report covers the performance of these rootstocks when growing as entire plants exposed to both above-ground and below-ground conditions. The records are doubly valuable, therefore, not alone as indicating the adaptability of the root portion of the plant itself, but also as indicating the overwintering ability of these lines when lined-out for budding purposes in the nursery.
4. TOP-WORKING YOUNG APPLE TREES THE SAME SEASON BEFORE PLANTING IN THE ORCHARD

Because of the acute shortage of apple trees in the nursery during 1933 and 1934, several emergency methods of propagation were tried. Among these was an attempt to meet the demand for certain varieties of apple by top-working onto an over-supply of another variety and planting the trees in the orchard the same year the grafts were made.

The trees to be top-worked were of the Baldwin variety, 2 years old, grown on the Station grounds at Geneva, N. Y., and dug in the fall of 1934. They were stored in the nursery cellar by cording in a horizontal position in bins, the roots being covered with dampened excelsior.

In February, the tops of the Baldwin trees were cut off 30 inches above the crown, and any lateral branches or buds below this point were removed. Cions of McIntosh about 8 inches long and with 5 buds were cut from nursery trees in the cellar and whip grafted upon the Baldwin trees. The stock and the cion were carefully matched, care being taken to pick a cion of as nearly identical diameter as the stock as possible. The graft was wrapped with grafting tape, and the trees stored in the nursery cellar until planting time.

While still in the nursery cellar and before planting, the grafts had opportunity to callous.

The resulting unions were excellent, the stock and cion unit-
ing on all sides of the graft to give a smooth surface which could scarcely be detected from the stem of either stock or cion.

The trees were planted in the spring under good growing conditions and the subsequent growing season was favorable. Every bud on the cions developed and made strong shoot growth (Fig. 3). The amount of foliage and top growth was similar to what might be expected of a spring-planted 2-year-old nursery tree not top-worked. The total average growth was 123.5 inches per tree and 28.7 inches per bud.

The only mortality in the lot was one tree from which the grafting tape was removed soon after the trees were planted in order to examine the graft union. The removal of the tape so weakened the graft that it blew out, sufficient foliage having developed to be caught by the wind before the growth of new wood had become great enough to hold the cion in place.

DISCUSSION

The results of this test answer the question as to whether nursery stock may be top-worked and planted in the orchard the same year. Usually, it might be considered best to permit the tree to grow in the orchard for 1 year before top-working, perhaps even allowing the scaffold branches to develop and then whip grafting each branch. On the other hand, to meet emergency conditions, it is shown that when the grafts are carefully made and allowed to callous before planting, it is possible to top-work apple trees in the main stem and plant in the orchard the same year with good results.
5. PERFORMANCE OF MAZZARD ROOTSTOCK IN THE NURSERY AND IN THE ORCHARD IN WESTERN NEW YORK DURING THE SEVERE WINTER OF 1933–34

It is recognized that the Mazzard (Prunus avium L.) rootstock is more tender to winter cold than the Mahaleb (P. mahaleb L.). In some sections of the country where severe winters are the rule, the use of the Mazzard rootstock as an understock for cherries is limited by this fact. Carrick\textsuperscript{2} has shown that in laboratory tests with Mazzard and Mahaleb roots, the Mazzard root is killed by a temperature of \(-10^\circ\text{C}\) to \(-11^\circ\text{C}\) \((12^\circ\text{F}\) to \(14^\circ\text{F}\)), whereas the Mahaleb roots are not killed until a temperature of \(-15^\circ\text{C}\) \((5^\circ\text{F})\) is reached. The question naturally arises as to just how important this relative tenderness of the Mazzard may be in the cherry growing regions of New York State, especially in view of the test winter of 1933–34, when the temperature fell on February 9, 1934, to \(-31^\circ\text{F}\), in some parts of the State.

Anderson\textsuperscript{3} has shown that in the Hudson River Valley the Mazzard rootstock was more injured than the Mahaleb rootstock by the low temperatures prevailing in that region during the winter of 1933–34. The greatest injury occurred on a sandy or gravelly soil (Hoosic gravelly loam) in the northern part of the Valley. His conclusion from an extensive survey of trees of various ages growing in different sections and under different cultural treatments was that even with the possible increased losses from winter injury to Mazzard rootstocks in especially severe winters, the Mazzard rootstock, taking all factors into consideration, was still to be preferred for both sweet and sour cherries in the Hudson River Valley.

In the following paragraphs are several observations in western New York nursery and fruit growing sections in regard to the behavior of the Mazzard rootstock during the severe winter of 1933–34.

**ORCHARD OBSERVATIONS**

Requests were made from orchardists and agricultural workers about western New York for any reports of injury to Mazzard roots


by low temperature. Altho tops of both sweet and sour cherries were injured to greater or lesser degree in different sections, only one case was called to attention which involved the possible tenderness of the Mazzard root. This was the Anderson and Robinson orchard, 10 miles east of Oswego, New York, where considerable loss of sour cherry trees was reported during the summer of 1934.

Because inland Oswego County is generally considered as nearing the limits of cherry culture, it was felt that this site might show up differences in relative tenderness of Mazzard and Mahaleb rootstocks where other more favored cherry sections of the State might not.

The nearest United States Weather Bureau Station at Oswego, on Lake Ontario, recorded — 25° F on February 8—9, 1935. The Anderson and Robinson orchards 10 miles inland were said to have experienced a lower temperature, but no official thermometer readings were available. A light snow covered the ground.

The orchards were planted in 1927, replantings having been made in 1930 and 1931. The varieties were Montmorency and Chase. Some of the trees were on Mazzard rootstock and some on Mahaleb rootstock, thus giving opportunity to study trees of different ages growing side by side on different rootstocks. The soil is variable, some sandy and some stony loam. The topography is undulating.

The first symptoms of injury were shown in the early summer of 1934 by browning of the leaves. When the orchard was visited on August 10, 1934, many trees were found to be dead and dying. Leaves on affected trees had browned and dried, shoot growth had ceased and fruit was small, uneven in ripening, and often shrivelling. Injury seemed greatest on knolls and in low spots. A central ridge running thru the orchard showed good stands of uniform trees, with little or no injury. All trees showed good growth until the season of 1934 and were good size for the age and variety. 4

Severe bark splitting on the trunks extended vertically 6 inches to 2 feet, and in many cases the bark curled back and separated from the wood the entire distance around the trunk (Fig. 4). Large masses of gum exuded from wounds. Wood was discolored and badly injured.

To study the roots, trees were pulled with a tractor. Trees were examined both on Mazzard and on Mahaleb rootstocks, both with and without symptoms of injury, and of different ages.

Uninjured trees were found on both Mazzard and Mahaleb roots.

4The authors are indebted to Mr. Henry Page, Farm Bureau Manager of Oswego County, for calling attention to this orchard, and for helping in the survey.
Of all the trees examined, only two cases of root injury were found. One case was a portion of a Mahaleb root and the other was a portion of a Mazzard root. Both showed injury subsequent to the growing season of 1933, but the cause of injury could not be established. In both cases the injured rootstocks were within 50 feet of uninjured rootstocks of both Mazzard and of Mahaleb.

In brief, injury was to the cion variety, both Montmorency and Chase, and not to the roots. Both Mazzard and Mahaleb roots were found to be sufficiently hardy to survive the conditions described, altho the cion varieties were severely injured. The greatest damage was to the trunks due to bark splitting, altho the wood was also brown and discolored.

Two other Montmorency orchards were examined near Geneva, both on Mazzard roots. The trees had been pulled in order to release the land for other purposes. Of several hundred trees that were observed, no signs of winter injury to the roots were found (Fig. 5). The temperature in this section dropped to —25° to —31° F. The soil was an Ontario stony loam.

**Observations in the Nursery**

It is a common statement in nursery circles that the Mazzard rootstock is much more difficult to handle and is much more likely to be injured by winter cold than is the Mahaleb rootstock. The severe winter of 1933–34 offered the opportunity to study this situation to good advantage.

At Dansville, New York, two nursery companies planted blocks of Mazzard rootstocks and blocks of Mahaleb rootstocks in the spring of 1933. These had been budded during the summer of 1933, and were exposed to the low temperatures of the winter of 1933–34.

In these nurseries, the temperature dropped to between —25° and —31° F on the night of February 8–9, 1934. From these two blocks of 30,000 budded Mazzard rootstocks there were not suffi-
Fig. 5.—Montmorency Cherry Orchard on Mazzard Roots Dug Following Severe Winter of 1933–34 and Showing No Injury to Roots.

cient surviving plants to make it profitable to attempt to save them. Both blocks were plowed under and entirely destroyed (Fig. 6).

On the other hand, blocks of budded Mahaleb stocks under similar conditions only a row width distant from the Mazzard blocks

Fig. 6.—Nursery Block of Budded Mazzard Stock Entirely Winter-killed by — 31° F, February 8–9, 1934.
were injured little, if any. They developed good budded trees and were commercially profitable by contrast with the total loss on Mazzard (Fig. 7).

**Fig. 7.—Nursery Block of Budded Mahaleb Stock Uninjured by — 31° F. February 8-9, 1934.**

**DISCUSSION**

These facts seem to indicate that in the cherry growing sections of western New York during the severe winter of 1933–34 neither the Mazzard nor the Mahaleb rootstock, when used in commercial cherry orchards, was injured to such an extent as to make either of them a commercial liability. Altho records show clearly that the Mazzard rootstock is more tender to winter cold than is the Mahaleb, the conditions of the test winter of 1933–34 did not reach a point where the tenderness of the rootstock became a limiting factor.

On the other hand, the cion tops of both sweet and sour cherry varieties on both rootstocks were equally and severely affected by winter cold regardless of rootstock. Most of the injury to cherry trees in western New York in the winter of 1933–34 seems to have been to the top and not to the roots.

Quite by contrast with this favorable report for both Mazzard and Mahaleb rootstocks in the orchard, the evidence in the nursery is clearly to the effect that the Mahaleb is much more satisfactory from the nurseryman’s point of view.

It should be pointed out that budded rootstocks are exposed both top and root the first year after budding, whereas with grafted plants
or with plants 1 year old or older, the top is of the cion variety so that only the root of the rootstock is subject to a test winter. In the cases of budded nursery stock here cited, therefore, both top and root were exposed to winter cold. In the orchard, by contrast, snow covering and soil moisture would enter into consideration. Accordingly, nursery and orchard conditions do not lend themselves well to close comparison, and a stock which might be sufficiently hardy in orchard use might conceivably be tender in nursery use.

Some of the difficulty with Mazzard seedlings is traceable directly to the factor of maturity. Mazzard seedlings, unless the season is favorable or unless properly sprayed, are likely to develop leaf spot (Coccomyces spp.) so severely as to be partially or entirely defoliated before they have properly matured. Mahaleb seedlings, on the other hand, are less subject to leaf spot and usually go into the winter in good condition. Where Mazzard stock is kept vigorous and growing and where the foliage is kept free from insect and disease attack, less winter injury may be expected.

An experience has already been recorded showing the effect of defoliation upon the hardiness of Mazzard seedlings which may bear repeating for the application it may have. One row of Mazzard stock was stripped of leaves on September 1. Another row was stripped of leaves on September 13, and a third row was left with good foliage which had been protected from leaf spot by spraying with bordeaux mixture. Neighboring unsprayed blocks were slightly defoliated by leaf spot.

An early fall freeze damaged the stock in direct proportion to the earliness and degree of defoliation. That is, the stock from which the leaves had been stripped on September 1 was killed outright. The stock which was stripped of leaves on September 13 was killed back from 12 to 18 inches. The unsprayed blocks which had lost some leaves from leaf spot were killed back approximately 6 to 8 inches, whereas the sprayed block was entirely uninjured.

One wonders how much of the injury to Mazzard stock in the nursery during the winter of 1933–34 may have been traceable to partial defoliation and to immaturity.

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6. STOCK AND CION RELATIONS IN REFERENCE TO WINTER INJURY

In a study of winter injury to cherry trees during the summer of 1934, some observations were made involving the relation between stock and cion which seem worthy of placing on record for what they may be worth.

The trees were 7-year-old Montmorency sour cherry, budded on Mazzard and on Mahaleb rootstocks. Both rootstocks overgrew the cion. Severe winter cold resulted in killing the Montmorency tops but did not injure the roots.

Moreover, in several instances the injury to the cion extended exactly to the union. Above the union the tissues of the cion were dark brown to nearly black, while below the union the tissues showed no discoloration and appeared to be uninjured. Trees on both Mazzard and Mahaleb rootstocks were equally affected. That this situation was not due to snow coverage or other protection to the rootstock was shown by several unions which were undulating and at an angle with the horizontal, so that the union on one side of the

![Diagram of Montmorency Cherry on Mazzard Rootstock, Showing Winter Killing of Top Downward Exactly to Line of Graft Union; Rootstock Uninjured.](image)

Note the dark coloration of injured cion just above the union and no discoloration of rootstock just below the union.
tree was several inches above the union on the other side. Yet the injury followed the line of union exactly, the cion being severely injured and the stock being uninjured (Fig. 8).

One instance was found where the tree had been set below the union and the cion had rooted on one side but not on the other. On the cion-rooted side there was no injury to either the cion or the root, whereas on the opposite side the cion was severely injured down to the union and the rootstock was uninjured (Fig. 9). The disposition for the rootstock to sucker just below the union is another interesting point.

![Diagram showing the relationship between cion and rootstock](image)

**Fig. 9.—Cion-rooted Montmorency Cherry Tree on Mahaleb Roots, Showing Cion Uninjured on Side Above Cion Root But Dead Downward to Union Where Not Cion-rooted; Rootstock Uninjured.**

**DISCUSSION**

The relatively greater hardiness of the rootstock over the cion under these conditions raises the question of relation between stock and cion and the importance of the union. In the case of Mazzard and Mahaleb rootstocks, the stock overgrows the cion. The Mazzard makes a stronger and more long-lived union than the Mahaleb. Often when cherry trees are pulled with a chain and a tractor, the top will break off at the union with the Mahaleb rootstock.

This type union, together with the tendency for the rootstock to sucker, suggests the possibility of different growth relations of stock and cion, possible interference with translocation processes, and an effect upon maturity.
Ringing affects the downward movement of materials in a stem. It has been shown\(^7\) that stock-cion relationships involve physiological problems of materials above and below the union. It is suggested that crown injury to certain varieties of fruit trees when budded or grafted upon rootstocks may possibly be associated with the stock-cion relation and with the maturity factor.

7. EFFECT OF pH OF PACKAGE MATERIAL UPON ROOT DEVELOPMENT OF PACKAGE ROSES

To meet retail trade, nurserymen have in recent years become interested in packing dormant plants so that they may be sold over the counter and in retail stores without losses from drying out. To protect the roots, granulated peat moss has been used, pressed around the roots.

Packed in this way, lots of hybrid tea roses of various varieties were found to be making unsatisfactory development. Shoots might start out but would fail to continue growth; while often the plants would be killed in the package. Only occasionally where one of the roots broke thru the side wall of the package into the surrounding medium would the plant develop normally.

Examination showed no root development in the package. Altho the woody roots might be alive, any new roots which might start would reach only a fraction of an inch in length and then brown and die.

Testing the peat moss for acidity showed it to have a pH of 3.2 (strongly acid). It has been shown that a pH of 3.8 is the lower limit beyond which protoplasm of some plants will survive.\(^8\)

Accordingly, the acidity was corrected in a rough way by the addition of limestone. On a computation of the total acidity of the peat moss, it was figured that approximately one large handful (2½ ounces) of ground limestone per bushel of granulated peat moss (12½ pounds) would bring the pH to 6.0, (pH 7.0 is neutral), a figure which has been shown favorable for rose growth. Subsequent tests showed samples ranging from pH 5.5 to 7.0 (slightly acid) after being corrected for acidity by the addition of limestone in this rough way.

Roses packed in corrected peat moss showed good root development and satisfactory growth.

8. EFFECT OF FALL FERTILIZER APPLICATIONS IN THE NURSERY UPON SUBSEQUENT PERFORMANCE OF APPLE AND CHERRY TREES

One of the most serious problems in the nursery is the frequent low vigor, in the spring, of plants dug in the fall and stored in nursery cellars over winter. When planted out the following spring such nursery stock is often slow in starting, sometimes remaining for 30 days before beginning shoot and leaf development. In dry and unfavorable seasons the losses and replacement demands are large, particularly with certain plants, such as sweet cherries. Accordingly, attention is focused upon methods of increasing the vigor of nursery stock to the end that it may be transplanted with greater satisfaction.

In this connection a test was conducted in 1932 in which a nitrogen fertilizer was applied to the trees in the fall of the year before the trees were dug to ascertain whether or not the trees might be able to take up additional amounts of fertilizer and store it over winter so that it may be available in early spring for vigorous shoot growth.

One hundred and fifty 2-year-old McIntosh apple trees on French Crab roots and 150 2-year-old Montmorency cherries on Mazzard roots were used. The trees were grown in the Station nursery on an Ontario stony loam and were in good vigor. On October 25, 1932, when the leaves were still green, nitrate of soda was applied in varying amounts to the plants as they stood in the nursery row. At the time of application the soil was moist, and conditions were favorable for rapid movement of the fertilizer into the soil. Moreover, the leaves were green and functional and weather conditions for 2 weeks were favorable to movement of materials into the plant from the soil.

Applications and the number of individuals treated were as follows:

<table>
<thead>
<tr>
<th>Group No</th>
<th>Treatment</th>
<th>Number of Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>McIntosh Apple</td>
</tr>
<tr>
<td>1</td>
<td>¼ lb. nitrate of soda per plant</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>½ lb. nitrate of soda per plant</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>1 lb. nitrate of soda per plant</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Check (no application)</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Check (storage treatment)</td>
<td>30</td>
</tr>
</tbody>
</table>

On November 14, 1932, 20 days after the fertilizers were applied, the trees were dug and placed in the nursery cellar for over-winter-
ing. The trees were placed horizontally in bins and the roots covered with dampened excelsior.

One additional treatment was given in storage, namely, with the plants in group 5 the excelsior used to pack about the roots in storage was soaked in a solution of nitrate of soda before applying. This treatment was made in order to see whether or not it might be possible to induce greater vigor in plants thru the uptake of fertilizers while the plants were in the cellar rather than thru field applications. Such a treatment would be more economical of fertilizer and the time and method of application would fit well into the nursery program.

The trees were planted in the orchard the following spring and a record kept of their performance. Their development was characteristic of stored plants, the plants making delayed but satisfactory growth during the first year and good growth during the following seasons.

No differences could be detected between treatments in the time of foliation, nor during the growing season as regards color of foliage, and no differences were shown in amount of shoot growth during either the first season or in subsequent seasons. After 3 years in the orchard, the records show no gain in increased vigor or growth from any of the treatments tried.

DISCUSSION

While it does not necessarily follow from such a limited test, that under some conditions there may not be an increase in vigor and in growth induced in nursery stock by fall application of fertilizers prior to digging or by storage application of fertilizers prior to planting, yet the records do show that in this particular instance such treatments had no effect. Other factors apparently outweighed any benefits that might have been induced by fertilizer treatments, or else with well-grown nursery stock such as that used in this test, some other factors than nutrient requirements are more important in affecting rapid starting and vigorous growth the first year the trees are set.

Additional support is given to the view that nutrients are not the limiting factor by other work with apple trees in which fertilizer applications have been made soon after the trees were set. Tukey, H. B. The comparative effect of various kinds and amounts of fertilizers upon yearling apple trees. Proc. Amer. Soc. Hort. Sci., 23: 1-9. 1926.
data showed not only no benefits from fertilizer applications at planting, but also the possibility of injury from improper or excessive applications. It would seem that well-grown nursery stock in which the trees are kept in good growing condition throughout their lives in the nursery has stored within it the materials necessary for the initiation of growth the first year it is set, and that some other factors than nutrient requirements are responsible for delayed starting and poor growth.