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RANDOM NOTES ON FRUIT TREE ROOTSTOCKS AND PLANT PROPAGATION

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ABSTRACT

In the course of a more detailed and extensive program on nursery problems, minor observations and less extensive experiments have been recorded which have not seemed sufficient for individual publication. Because of the application of several of these instances to problems of interest at the present time, a few of them are recorded here.

1. Species of plants widely separated botanically are commonly considered uncongenial for grafting, whereas closely related species are thought of as congenial. An instance is cited of a clonal apple rootstock, U. S. D. A. 227, upon which certain apple varieties, such as Baldwin, Northern Spy, Macoun, and Early McIntosh, appear congenial and vigorous, whereas, other varieties, as Delicious and McIntosh, appear uncongenial and weak. As regards congeniality and chromosome count, the rootstock is diploid (two sets of chromosomes); Baldwin, a triploid (three sets of chromosomes), is congenial, as are also Northern Spy, Macoun, and Early McIntosh, all diploids; while on the other hand, McIntosh and Delicious, both diploids, are uncongenial. As regards genetic make-up, altho McIntosh is uncongenial, Early McIntosh and Macoun, which are of McIntosh parentage, are congenial.

2. A trial of the leaf-bud cutting method of propagation of red, black, and purple raspberries shows the method valuable for certain materials. Red raspberries failed to root by this method, while black raspberries rooted excellently as did some purple raspberries. The success of the method seems associated with the presence of root primordia in the cuttings.

3. A block of three types of stooled quinces from which the rooted shoots had been cut in early fall were killed by severe winter cold, whereas an adjacent block of similar clonal material not disturbed, showed no injury, indicating an association with translocation and maturity.

4. Trials of seedbed coverage materials for fruit tree seed on heavy soils show good results with a covering of granulated peat moss (5,354 seedlings), followed in descending order by black paper mulch (4,789 seedlings), bank sand (2,229 seedlings), and soil (2,056 seedlings).

5. The accepted commercial practice of cutting back dormant-budded roses to just above the eye immediately the plants are set gave prompt bud start and vigorous shoot growth. Removing half the top or otherwise delaying removal of the top so as to permit the mother plant to become established resulted in markedly inferior plants.

6. Trials with pear rootstocks show both domestic and foreign seedling rootstocks of the French pear (Pyrus communis), including the Winter Nelis and Bartlett varieties, to be uniformly successful for Bartlett, Seckel, Anjou, and Kieffer cions. On the other hand, Pyrus calleryana, P. ussuriensis, and P. serotina have proved inferior except for Kieffer. P. betulaefolia offers promise as a superior stock for Seckel, Bartlett, and Kieffer but is uncongenial with Anjou.
RANDOM NOTES ON FRUIT TREE ROOT-STOCKS AND PLANT PROPAGATION

H. B. TUKEY, Chief in Research (Pomology), and K. D. BRASE, Assistant in Research (Pomology)

INTRODUCTION

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 notes recorded in this bulletin are as follows:
1. An instance of uncongeniality in the apple.
2. Propagation by leaf-bud cuttings.
3. Winter-killing of mounded quinces.
4. Seedbed coverage.
5. Dormant-budded roses.
6. Rootstocks for pears.

I. AN INSTANCE OF UNCONGENIALITY IN THE APPLE

In general, species of plants widely separated botanically are uncongenial when attempts are made to unite them by grafting or by budding, that is, the quince (Cydonia oblonga Mill) and the peach (Prunus persica Stokes) will not unite. On the other hand, closely related species may often be successfully worked one upon the other, as the pear (Pyrus communis L.) on the quince (C. oblonga Mill), the sour cherry (Prunus cerasus L.) on the sweet cherry (P. avium L.), and the plum (P. domestica L.) on the peach (P. persica Stokes).

Plants within the same species are usually accepted as compatible. Occasionally, however, instances are reported of uncongeniality between varieties within a given species, such as the case here cited of uncongeniality of certain apple varieties (Malus domestica Borkh) upon a rootstock with which other apple varieties are congenial.\(^1\)

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\(^1\) The uncongenial nature of this rootstock (U. S. D. A. 227) has been known for some time. It was first called to the attention of the senior author by G. E. Yerkes, United States Department of Agriculture, Washington, D. C., in 1927. While the findings here reported, therefore, are not new or original, they seem worthy of placing on record for New York nurserymen and fruit growers because of the commercial importance of some of the varieties involved and the significance of the results.
The rootstock in question is known as U. S. D. A. 227, being a seedling of Northern Spy selected in 1923 by G. E. Yerkes of the United States Department of Agriculture at Washington, D. C., for its promise as a rootstock, and propagated vegetatively from the original plant and sent by him for trial in New York State. This rootstock reproduces readily from root cuttings in which portions of the roots from the mother plant are cut into sections 2 or 3 inches long and about the diameter of a pencil. When planted in the ground in early spring these so-called root cuttings develop into vigorous plants 12 to 24 inches in height, which are very satisfactory as rootstocks upon which to bud or graft a desired variety of apple. Such material is known as a clon, in contrast to seedling material. Every plant of a clon is identical, all having been reproduced from the mother plant by vegetative means.

Several hundred rootstocks of U. S. D. A. 227 have been propagated by root cuttings during the past six seasons, and various commercial varieties of apple budded upon them for trial. Because of the vigor of this rootstock, and the ease of propagation, it has appeared especially promising to the authors and has for these reasons been looked upon favorably as a promising new rootstock.

In the spring of 1930, 77 rootstocks raised the previous season from root cuttings were lined out in the nursery row and budded to Baldwin, Delicious, McIntosh, Northern Spy, and Early McIntosh. The growth the following year of the resulting 1-year trees of Baldwin, Northern Spy, and Early McIntosh was superior to that of Delicious and McIntosh; but this was not considered extraordinary since the first three varieties are stronger growers in the nursery the first year than McIntosh, and possibly than Delicious.

During the next season, however, the trees of Delicious and McIntosh made surprisingly little growth, whereas trees of Baldwin, Northern Spy, and Early McIntosh continued vigorous growth. The resulting 2-year-old trees of Delicious and McIntosh were weak and small, as contrasted with the strong, vigorous trees of Baldwin, Northern Spy, and Early McIntosh (Table 1).

In the meantime, 200 additional rootstocks of U. S. D. A. 227 had been planted and budded in 1931; 51 to Baldwin, 50 to Delicious, 49 to McIntosh, and 50 to Northern Spy. As in the preceding test, Baldwin and Northern Spy made strong 1-year growth while Delicious and McIntosh made smaller and weaker growth. All trees were headed back to 24 inches in height in the spring of the second year.
Table 1.—Congeniality of Six Varieties of Apples on Rootstock U. S. D. A. 227 During Three Seasons.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Chromosome Count</th>
<th>Number of Rootstocks Planted</th>
<th>Number 2-Year Trees</th>
<th>Percentage 2-Year Trees</th>
<th>Condition of Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baldwin</td>
<td>Triploid</td>
<td>16</td>
<td>13</td>
<td>81</td>
<td>Vigorous</td>
</tr>
<tr>
<td>Delicious</td>
<td>Diploid</td>
<td>16</td>
<td>12</td>
<td>75</td>
<td>Small, weak</td>
</tr>
<tr>
<td>McIntosh</td>
<td>Diploid</td>
<td>16</td>
<td>12</td>
<td>75</td>
<td>Small, weak</td>
</tr>
<tr>
<td>Northern Spy</td>
<td>Diploid</td>
<td>15</td>
<td>13</td>
<td>86</td>
<td>Vigorous</td>
</tr>
<tr>
<td>Early McIntosh</td>
<td>Diploid</td>
<td>14</td>
<td>13</td>
<td>92</td>
<td>Vigorous</td>
</tr>
</tbody>
</table>

Rootstocks Planted 1930 — Trees Dug 1932

| Baldwin            | Triploid         | 51                           | 28                  | 55                       | Vigorous              |
| Delicious          | Diploid          | 50                           | 18                  | 36                       | Poor, no lateral growth |
| McIntosh           | Diploid          | 49                           | 0                   | 0                        | Small, weak, died during second season |
| Northern Spy       | Diploid          | 50                           | 31                  | 62                       | Vigorous              |

Rootstocks Planted 1931 — Trees Dug 1933

| Baldwin            | Diploid          | 20                           | 17                  | 85                       | Vigorous              |
| McIntosh           | Diploid          | 19                           | 0                   | 0                        | Small, weak, died during second season |
| Macoun             | Diploid          | 19                           | 13                  | 68                       | Vigorous              |

Rootstock Planted 1932 — Trees Dug 1934

It was at the beginning of the second season of tree growth that the symptoms of uncongeniality exhibited themselves most strikingly. At that time, the 1-year-old McIntosh trees leafed out but failed to make new growth, every tree in the lot dying during the season. With Delicious trees, also, the growth was markedly inferior, the trees leafing out but making only slight increase and dying the third season. On the other hand, the trees of Baldwin and of Northern Spy continued vigorously to give strong 2-year-old trees.

The evidences of uncongeniality were particularly apparent because of the way the plants appeared in the row. That is, the 2-year-old Baldwin trees came first with a height of 55 inches to be followed abruptly by the Delicious trees with a height of 29 inches, with the McIntosh trees next which died at 24 inches in height, and finally the Northern Spy trees at 54 inches in height. Fig. 1 presents a diagram of the plants as they appeared in the row.

A third test was begun in 1932, using Baldwin, McIntosh, and Macoun budded during 1932 upon rootstock U. S. D. A. 227 propagated from root cuttings the previous season. The same results were
Fig. 1.—Performance of six varieties of apples on the same rootstock (U. S. D. A. 227).

Note uncongeniality of Delicious and McIntosh, and congeniality of Baldwin, Northern Spy, Early McIntosh, and Macoun.

obtained, namely, Baldwin and Macoun developed vigorously into strong 2-year trees, whereas McIntosh made small weak trees the first season which died during the second season (Table 1).

DISCUSSION

The nature of uncongeniality is not disclosed by these facts, yet light is shed on some speculative factors, such as the chromosome make-up of the varieties and of the rootstock and the genetic make-up of congenial and uncongenial varieties.

The rootstock (U. S. D. A. 227) is a diploid (two sets of chromosomes). Baldwin is a triploid (three sets of chromosomes), yet appears congenial with the diploid rootstock. At the same time Northern Spy, Macoun, and Early McIntosh, all diploids, also appear congenial. On the other hand, McIntosh and Delicious, both diploids, are uncongenial. In other words, three diploid varieties are congenial with the diploid stock, two diploid varieties are uncongenial, and a single triploid variety appears congenial. If congeniality is associated with polyploidy, it does not appear in these records.
Again, the inheritance of uncongeniality is called to attention. Two varieties, namely, Early McIntosh and Macoun have McIntosh as one of the parents, Early McIntosh being McIntosh x Yellow Transparent and Macoun being McIntosh x Jersey Black. Macoun and Early McIntosh are both apparently congenial with rootstock U. S. D. D. 227, whereas the parent variety, McIntosh is uncongenial.

It is interesting to note, also, that uncongeniality showed more quickly in seasons of a deficiency of rainfall (1933 and 1934) than during a season of more nearly normal rainfall (1932). This would seem to indicate an interference with the movement of water or other materials from rootstock to cion or the reverse.

Thus uncongeniality of a marked nature appears in a group so closely related as the apple. Moreover, it appears in a variety which is one of the parents of two other varieties which, in turn, are congenial. Botanical relationship, therefore, is not sufficient evidence upon which to forecast performance, nor even is close relationship of varieties within a given group.

The results serve to emphasize the uncertainties of rootstock studies, the importance that obscure factors may play in final results, and the necessity for caution in making recommendations and in reporting results. The final criterion of congeniality seems to be the test of trial. It is to be hoped that more intensive studies of the rootstock problem may evolve a test for congeniality which may eliminate much of the time and energy that must now be expended to determine this point, and which is the greatest handicap in improvement of rootstocks for fruit trees.

II. PROPAGATION BY LEAF-BUD CUTTINGS

Stoutemyer, Maney, and Pickett\(^2\) have reported a rapid method of propagating raspberries and blackberries by leaf-bud cuttings. The method consists in making cuttings of a leaf, together with the bud in the axil of the leaf, and a small attached shield of bark and wood from the cane. The cutting is not unlike a shield bud as used in budding, but with the entire leaf attached (Fig. 2). When cut the middle of July to the middle of August and placed in

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rooting mediums of sand and sand and peat, these so-called "leaf-bud" cuttings rooted well (often 100 per cent) and made strong plants by the end of the growing season.

Such a method suggests several useful possibilities. It might be useful in the rapid propagation of new varieties where wood is scarce. It might be successful in propagating raspberry varieties which normally do not root well from either suckers or from tips,\(^3\) as in the case of certain crosses between the red raspberry (*Rubus idaeus* L. and *R. strigosus* Mich.) and the black raspberry (*R. occidentalis* L.) which give purple raspberries (*R. neglectus* Peck) which may not root well from tips as does the parent black raspberry nor from suckers as does the parent red raspberry, and therefore may be of no commercial value. Again, it might be used as an emergency or supplementary measure with other plant materials or after failure of hardwood cuttings, root cuttings, or similar methods where the stand can be observed by midsummer.

**MATERIALS AND METHODS**

The results reported here deal with trials of this method under New York conditions, having in mind the possibilities suggested in the previous paragraph. Three varieties were used *viz.*, red raspberry No. 5357, black raspberry No. 12417, and purple raspberry No. 2609. Six plants of each variety were brought from storage in the nursery cellar and planted in 6-inch pots in the greenhouse the last of February.

By the first week in April vigorous lateral shoots had developed and from these leaf-bud cuttings were made on

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April 12. They were placed in peat moss and sand in closed frames maintained at about 70°F with bottom heat. Cuttings were taken on two subsequent dates, namely, May 22 and July 2. (Fig. 3.)

RESULTS

Lot I.—Leaf-bud cuttings of the black raspberry made April 22 had rooted 93 per cent within 8 days and were potted on May 15. The purple raspberry behaved similarly, rooting 92 per cent within 8 days and being potted May 15. On the other hand no plants rooted from 243 cuttings of red raspberry. The cuttings callused in 10 to 15 days after being set, and the leaves remained green and fresh for 30 days. Later the leaves yellowed and died, while the portion of the cutting in the peat decayed.

Since the leaf-bud cuttings were made from lateral shoot growth of 1-year-old canes, it is not surprising that the buds which developed were all fruit buds, since this is normally the fruiting wood. That is, altho the cuttings of black and purple raspberry rooted, yet the buds developed into flowers, with no shoot growth. Likewise, the red raspberry cuttings developed flowers, altho they failed to root.

Lot II.—Since the cuttings from lateral wood developed flowers instead of new shoot growth, the second lot of cuttings, May 22, were taken from the current season’s suckers growing from the base of the plants. The black raspberry cuttings had rooted 86 per cent by June 26 (34 days after striking), while the purple raspberry cuttings had rooted 87 per cent. Eliminating the cuttings taken from the tips of the shoots, which were immature and failed to root, rooting was 100 per cent. Furthermore, the buds developed into vigorous new shoots as contrasted with the flowers which developed from the buds of leaf-cuttings from lateral growth of 1-year-old wood. The red raspberry cuttings again failed to root. They callused well and the buds had made short shoot growth 34 days after striking, but the cuttings subsequently yellowed and died.

FIG. 4.—Rooted Plants of Black Raspberry from Leaf-Bud Cuttings 1 Month After Rooting (Aug. 1, 1934).

Note original leaf of leaf-bud cutting at extreme left.
Lot III.—On July 2, a third lot of leaf-bud cuttings were made from the current season's suckers growing from the base of the plants, using only black and purple raspberries. Within 10 to 15 days 100 per cent of the cuttings had rooted, and by August 1, 30 days after striking, the plants were as shown in Fig. 4.

DISCUSSION

The success of this method with certain materials makes it useful for rapid propagation of new varieties where wood is scarce. It seems practicable also for emergency measures, whereby a failure with dormant wood propagation might be partially compensated by the rooting of leaf-bud cuttings. Its use to propagate material which normally does not root readily from cuttings or by layers, such as some red and purple raspberries, is unfortunately not successful.

Light is shed on the ability of some varieties to root from leaf-bud cuttings in Fig. 5 which shows a shoot from one of the black raspberries which had lodged and began rooting. At the base of each bud, roots have developed. Accordingly, when leaf-bud cuttings are made, which include the region from which the roots develop, the result is a high percentage of rooting. Apparently the success of this method with certain materials is to be associated with the presence of root primordia in the cuttings.
III. WINTER KILLING OF MOUNDED QUINCES

During the winter of 1933–34, a mother plantation of stooled quinces was entirely killed, whereas another plantation of similar material adjacent was uninjured, the facts suggesting that injury was associated with early removal of rooted shoots while still in full foliage.

To review the history of the injured block, it was planted in 1932 on fertile soil of Ontario stony loam top dressed with granulated peat moss. The planting consisted of 3,000 Angers quince types A and B, and common quince plants, comprising 26 rows, each row 150 feet long. Types A and B are selections made by the Research Station at East Malling, England, and propagated from the original plants, so that each plant of these lots is identical to another in genetic make-up. The plants were allowed to become established the first season they were planted. The second year they were cut back to stubs and gradually mounded with the mixture of peat moss and soil. The shoots grew to a height of 28 to 36 inches, an exceptionally vigorous stand of superior layered quinces.

The first week in November, 1933, the mounds were pulled away and the rooted shoots cut off. At that time the leaves had not yet dropped from the shoots. Eighteen thousand rooted plants were taken from the block. The mother plants were then mounded with 2 or 3 inches of soil as protection for the winter.

A week after this operation, November 16, the temperature dropped to 9°, as established by a recording thermometer within 100 yards of the planting. Again on February 8 and 9 the temperature dropped to —24°F.

An examination of the rootstocks on April 10, 1934, before new shoot growth had started showed the plants dead from the crown outward and downward, involving nearly the entire root system. During the summer of 1934 an occasional live shoot developed but quite by contrast to the solid block of 18,000 shoots of the previous season.

These facts in themselves might mean solely that the quince root is injured at the low temperatures to which it was subjected. Adjacent to the injured block, however, within 10 feet, was a second block of quinces which showed no injury whatsoever.

The uninjured block consisted of hardwood cuttings also of Angers types A and B and of common quince. These cuttings were
planted in the spring of 1933. By fall, because of the dry season, they were not as large as desired and were therefore left in the field over winter for a second season's growth. Upon examination of plants following the severe winter of 1933–34 no injury could be found. Woody tissues of both top and root appeared white and uninjured by contrast with the brown tissues of the adjacent injured block. During the following growing season of 1934 these plants made vigorous growth and developed into strong, salable plants by fall.

**DISCUSSION**

These facts show that the injury to one block and not to another cannot be accounted for (1) by position in the field, since the blocks were adjacent; (2) by variation in temperature, since the elevation and exposure were similar; (3) by soil variation, since the plats were of uniform soil type and were previously used as a soil fertilizer test because of their uniformity; and (4) by genetic make-up, since both blocks contained three clons of identical material.

The facts involved seem to be physiological, involving the internal composition of the plants. The first apparent difference would seem to be vigor prior to injury in which the injured block was highly vegetative in contrast to the less vegetative character of the uninjured block. The second apparent difference is in the removal of rooted shoots while still in full leaf from one block, whereas no shoots or foliage were removed from the other. In view of an experience with young cherry trees reported in a previous publication* in which defoliation in September resulted in killing by cold as contrasted with no killing where foliage was not removed, the authors are inclined to lay emphasis upon the removal of shoots while in full leaf.

Normal maturing or ripening processes in woody plants involve translocation and movement of materials from one part of the plant to another. It would seem that the early cutting of shoots—in this case the entire above-ground part of the plant—might be expected to upset internal conditions to such an extent as to result in injury by winter cold to the treated block, whereas the untreated block might be uninjured.

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IV. SEEDBED COVERAGE

In the production of seedling rootstocks for fruit trees, a serious problem in securing a good stand is the penetration of the seedlings thru the soil coverage. Fruit tree seedlings are planted either in the fall or very early spring. There is ample opportunity, therefore, for the soil above the seed to become firmly compacted prior to the time of seed germination. This is especially so if there have been driving rains in early spring or if the weather turns hot and bakes the soil surface.

Furthermore, fruit tree seeds germinate at low temperature so that it may be impossible to break up a compact soil surface with a drag, light harrow, or hard rake because of the wetness of the soil. Moreover, when the soil is heavy and wet, as after an early spring wet snowfall, it is a question whether lack of adequate aeration may not be a factor in good germination and emergence of the seedlings.

At all events, the problem becomes one of the cotyledons and functional leaves emerging above the soil surface before the food materials stored in the seed have been exhausted and before fungi may rot weakened seed. The problem is naturally accentuated on clay or silt soils and may not be serious on light soils. On the other hand, western New York nursery soils are characteristically heavy, with a high proportion of silt and clay. The soil in question is typical of good nursery soil, being an Ontario clay loam, upon which it had been repeatedly observed that the stand of seedlings was not satisfactory.

To remedy this situation, four coverage materials were tried, namely, granulated peat moss, mulch paper, bank sand, and soil. Trials were made during three seasons (1930, 1931, and 1932), using Mazzard cherry (*Prunus avium* L.), plum (*P. cerasifera* L.), apple (*Malus domestica* Borkh), and pear (*Pyrus communis* L.) with appreciably the same results. The data for Mazzard cherry during the season of 1931–32 will be presented as representative.

Mazzard seed was planted October 8, 9, and 10, 1931, in beds 45 feet long by 36 inches wide, with four rows of seedlings to each bed. All beds were planted alike, the seed being planted at a depth of \(\frac{1}{2}\) inch. The coverage materials were then applied. Granulated peat moss was first soaked with water and then spread \(\frac{1}{2}\) inch deep over the “peat” beds. Bank sand was sifted \(\frac{1}{4}\) inch deep over the “sand” beds. Black paper mulch was spread over the “paper” beds and fastened at the edges with soil and stones. The check or soil-covered
beds were not given additional treatment. Each of the four treatments was repeated six times, giving a total of 24 beds, as shown in Fig. 6.

![Diagram of seedbeds]

**Fig. 6.—Plan of Seedbeds for Mazard Cherry Seed, 1931–32.**

On April 29 following, the first seedlings were beginning to appear under the paper covering, and the paper was at once removed. On May 5, seedlings were emerging thru both the peat and sand coverings. On May 10, seedlings appeared on the check or soil-covered beds.

Table 2 shows the number and grades of seedlings from each of the four treatments. It will be seen at once that the soil-covered

**Table 2.—Effect of Various Seedbed Coverage Materials Upon Production of Mazard Seedlings.**

<table>
<thead>
<tr>
<th>Seedbed Nos.</th>
<th>Treatment</th>
<th>Number graded as</th>
<th>Total number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 5, 13, 17, 21, 25</td>
<td>Paper covering...</td>
<td>1,072</td>
<td>1,077</td>
</tr>
<tr>
<td>2, 6, 12, 16, 22, 26</td>
<td>Peat covering...</td>
<td>1,772</td>
<td>1,421</td>
</tr>
<tr>
<td>3, 7, 11, 15, 19, 23</td>
<td>Sand covering...</td>
<td>987</td>
<td>544</td>
</tr>
<tr>
<td>4, 8, 10, 14, 20, 24</td>
<td>Check (soil covering)...</td>
<td>955</td>
<td>541</td>
</tr>
</tbody>
</table>
beds were the lowest in total number of seedlings produced and that the sand-covered beds were not much superior. On the other hand, the mulch-paper beds show an increase of over 100 per cent over the check and the granulated peat moss beds an increase of over 150 per cent.

The superiority of the mulch paper over the check reckoned by number of seedlings, however, is not as real as it might appear when all factors are considered. The paper does not hold well over winter, sometimes tearing and blowing. In addition, an examination must be made daily in early spring to see whether the seedlings have germinated. Since the seed germinates several days earlier under paper than under sand, peat, and soil coverage, examinations must begin at a quite early date. Even with close observations, many seedlings may be crooked and etiolated. During one season the added misfortune of a late spring frost occurred, killing more than half of the seedlings in the mulch-paper beds, the seedlings having been further advanced as well as more tender.

The granulated peat moss coverage has been uniformly the best. The material is easily applied, requires no further attention, and has the further advantage of improving the texture of the soil for the remainder of the season. It must be well soaked before applying or it may blow badly. The effect of peat moss upon the crop is shown by comparing the grades of seedlings with the total numbers. It will be noticed that, altho the total number of plants in the peat-covered beds was only 15 per cent greater than in the paper-covered beds, the number of No. 1 grade was nearly 70 per cent greater and of the No. 2 grade nearly 50 per cent greater. In other words, even with a larger number of plants per given area, the average size of plant was greater in the peat-covered beds.

The poor showing made by the sand-covered plat may be accounted for in part by the blowing of the sand. Perhaps had a heavier application been made or a coarser grade of sand been used, the sand covering might have given better results.

The use of coverage materials, such as granulated peat moss, makes it possible to grow seedlings successfully on soils which are heavy and likely to affect emergence adversely.
V. DORMANT-BUDDED ROSES

Roses are propagated in the field during two growing seasons. The first year a rootstock is planted. Upon this rootstock the desired variety is budded during the ensuing growing season. The bud remains dormant the remainder of the season and over winter. In early spring the rootstock is cut off just above the bud, the growth of the bud being thus forced, making a new plant top.

Most of the trade demand is for rose plants of this type, but more recently florists and growers of cut flowers have been interested in using dormant-budded roses for cut flowers. Such plants are produced by digging the budded stock while the entire plant is dormant and before the bud has been forced. The plants are then set in the greenhouse and the top of the stock cut down to just above the bud, thus forcing growth and bloom.

Following the severe winter of 1933–34, field growers of rose bushes also became more interested in this method. Their interest lay in the possible winter injury to budded stock in the field, involving not only loss of the material itself, but also the loss of 2 years’ use of valuable land together with the loss of plants to fill future orders. As insurance against losses of this kind and to meet an emergency situation, it seemed that dormant-budded roses might be forced in the field.

In working with dormant-budded roses along the lines indicated above, a test was made of cutting back the tops at various times. It is recognized by the authors that normal practice requires the cutting back of the stock to just above the bud as soon as the plants are set. At the same time the question has been raised by inquirers as to whether cutting after the plant had become established might not be better. The following experiment is the result.

MATERIALS AND METHODS

Dormant-budded rose plants were secured from Texas during the early spring, being received in Geneva the last of March and planted in 6-inch pots in a cool greenhouse on April 1. These plants had been planted in the spring of 1933 and budded during the ensuing summer. The bud remained dormant during the remainder of the season and during the winter months, as described in the opening paragraph of this discussion. The plants were dug in early spring while still dormant and shipped north.
The treatment of the potted plants was as follows:

1. Tops not cut back at time of planting.
   A. Tops cut back 3 weeks after planting.
   B. Tops cut back 3½ months after planting.
   C. Tops cut back 4 months after planting.

2. Tops cut back 50 per cent at time of planting.
   A. Tops cut back 3 weeks after planting.
   B. Tops cut back 3½ months after planting.
   C. Tops cut back 4 months after planting.

3. Tops cut back at planting to just above the dormant bud.

Three varieties were used, namely, Radiance, Mrs. E. G. Hill, and Mrs. E. P. Thorn; 50 plants of each variety.

RESULTS

The plants of all three varieties which were either not cut back or which were cut back 50 per cent made strong growth from the stock above the bud, but the buds remained dormant. On the other hand, with the plants cut back to just above the bud at planting, the dormant buds started within 7 to 10 days and were forced into vigorous growth. They made plants as shown in Fig. 7D by August 1. It is of interest to note that four plants each of two varieties forced the bud into fair shoot growth and then died. Upon examination it was found that the roots of these plants were dead and shoot growth had apparently been made from the food materials stored in the plant and continued until exhausted.

Three weeks after the plants were set several plants of those not cut back to the bud were so treated. Immediately the bud, which had remained dormant thus far, began growing, but failed to make as sizeable plants as where the tops had been cut back at planting (Fig. 7C).

Three and one-half months after planting the tops of several other uncut plants were topped to just above the bud. The inserted buds,
which had remained dormant, now began active shoot growth, as in
the previous lot, but not as strong as in the preceding cases, and failed
to catch up with the plants cut back at planting (Fig. 7B).

Four months after planting and 3 days before the photograph
shown in Fig. 7 was taken, the tops of another lot of plants were cut
back to just above the bud. Again the bud, which had remained
dormant to this time, began active growth (Fig. 7A) but fell far
short of the plants cut back at planting.

DISCUSSION

The accepted commercial method of cutting back dormant-budded
rose plants to just above the bud immediately the plants are set gives
prompt bud start and vigorous shoot growth. Removing half of the
top or otherwise delaying removal of the top for 3 weeks, 3½ months,
and 4 months gave markedly inferior plants. There seems to be
nothing gained by permitting the dormant-budded plant to become
established before cutting the top back to the bud.

VI. ROOTSTOCKS FOR PEARS

The common cultivated pear (Pyrus communis L.), also called the
European pear and French pear, has been used universally in the
Western world as a rootstock for pears. It has been recommended by
an abundant seed and seedling supply, by uniformity of seedlings, and
by good union with cultivated varieties. It has several serious faults,
however, such as: (a) Susceptibility of seedlings in the nursery to
pear woolly aphids and leaf spot, the latter frequently resulting in
complete defoliation in mid-summer; and (b) extreme susceptibility
to blight both in the nursery and in the orchard. In the search for
improved pear stocks, P. betulaefolia, P. calleryana, P. serotina, and
P. ussuriensis have been included as likely possibilities worthy of
trial.6

Pyrus betulaefolia, or birch-leaf pear, is a widely distributed native
of northern and central China. It is recommended by abundant seed
production, by vigor of seedlings, freedom from leaf spot and woolly
aphids, by production of specially vigorous nursery trees, by adapta-
bility to a wide range of climatic conditions, and by a fair degree of
resistance to pear blight.

Pyrus calleryana is a native of central China introduced in 1908.
It has been recommended as a potentially desirable stock by vigorous

— Adapted from “Trials with Pear Stocks in New York,” by H. B. Tukey

6 Reimer, F. C. Blight resistance in pears and characteristics of pear species
growth of the seedlings in the nursery, good union with varieties of French pear, production of vigorous nursery trees, and a high degree of resistance to pear woolly aphids and pear blight. It has been suspected of tenderness to winter cold because it is not found outside the more favored sections of its home.

*Pyrus serotina* is a native of China and Japan introduced about 1840. It is one of the parents of Kieffer and related varieties and has been used longer in the United States as a pear stock than any other oriental species, particularly in the South and on the Pacific Coast. It has been recommended by seedlings which are more vigorous than those of French pear, more resistant to pear woolly aphids, and, in some sections, more resistant to leaf spot; by ability to unite easily and well with practically all varieties and species of pear; and by production of vigorous nursery trees. These assets are offset by reports of a greater susceptibility to winter injury and tendency of fruit of the cion variety to develop black-end disease on the Pacific Coast.

*Pyrus ussuriensis* is a native of northern China, Manchuria, Korea, and southeastern Siberia. Certain varieties of the species are recommended as stocks by their extreme hardiness; by resistance to blight and pear woolly aphids; by their abundant seed production; and by the vigor of their seedlings. The species falls short in the wide variation in desirable characters of seedlings unless produced from seed of selected varieties, and the tendency of fruit of the cion variety to develop black-end disease.

Because of plant quarantine restrictions which have prohibited the importation of seedling rootstocks of French pear, the desirability of seedlings of domestic varieties has been considered. Among these are Bartlett, recommended by an abundant seed supply from canning factories; and Winter Nelis, recommended by a fair seed supply and seedlings somewhat resistant to blight.

**MATERIALS AND METHODS**

To test these stocks under New York conditions, four varieties of pear, namely, Bartlett, Seckel, Beurré d’Anjou, and Kieffer, were propagated and grown on eight seedling rootstocks, namely, *P. betulaefolia*, *P. calleryana*, *P. serotina*, *P. ussuriensis*, *P. communis* (imported French pear seedlings), *P. communis* (domestic French pear seedlings), *P. communis* (domestic seedlings of Bartlett), and *P. communis* (domestic seedlings of Winter Nelis). All stocks and varieties were identified as true to species and variety. The trees were planted for trial as 2-year-old nursery trees in 1931, 10 feet apart in rows 10 feet apart, on uniform Ontario clay loam.
The number of trees of each variety on each stock were six Bartlett, five Beurré d'Anjou, five Seckel, and five Kieffer, with the exception of P. serotina where no Beurré d'Anjou and 10 Kieffer were included. Since not only the trees but also some of the seedlings were propagated at Geneva, the records deal with seven to eight growing seasons, altho the trees have been set in the orchard only 4 years. Altho this period is too short to warrant final recommendations as to superior stocks, the data are presented in a preliminary way for what help they may be and to point out some stocks which already have proved unsatisfactory.

RESULTS

The comparative size of the trees after four seasons growth in the orchard is shown by the measurements of trunk diameters (Fig. 8). In addition, the following observations may be made:

1. _Pyrus communis_ rootstocks have been uniformly successful for all varieties. The trees show good vigor, only one loss among 84 planted, and general uniformity. This is true for all four varieties, whether on imported French pear seedlings, domestic French pear seedlings, domestic Bartlett seedlings, or domestic Winter Nelis seedlings.

2. _Pyrus betulaefolia_ has produced Bartlett, Seckel, and Kieffer trees which are outstanding in size, vigor, and early fruiting; but Beurré d'Anjou trees on this rootstock are un congenial, being weak and unsatisfactory, three having died. Since the seedlings have been free from leaf-spot during six successive seasons as compared to the frequent defoliation of French pear seedlings during the budding season, this species deserves further trial in the East, keeping in mind the factor of un congeniality and black-end disease which may develop.

3. _Pyrus calleryana_ has been worthless for all four varieties, producing weak, tender trees with some mortality.

4. _Pyrus ussuriensis_ has been satisfactory for its near relative Kieffer, producing large, vigorous trees; Beurré d'Anjou has made

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8 Tufts, W. P. The importance of the rootstock in California pear production. _Blue Anchor, 10: 4. April, 1933._


9 See Johnston. _Loc. cit._
weak growth upon it, with some mortality and Bartlett and Seckel have made weaker growth than on *P. communis* and *P. betulaefolia*, also with loss of trees.

5. *Pyrus serotina* has been satisfactory for its close relative Kieffer, but has been unsatisfactory for Bartlett and Seckel, producing weak trees with some mortality.

**DISCUSSION**

Reference to Fig. 8 shows in general the uniformly satisfactory growth of pear trees on French pear roots, as contrasted with the more questionable behavior on roots of oriental species. With

![Figure 8](image)

**Fig. 8.—Trunk Diameters of Four Varieties of Pears on Eight Rootstocks.**

Dead trees designated "X."

French pear roots, regardless of the four types used, the growth of all four varieties worked on them has been uniform and satisfactory, with the loss of only 1 tree out of 84 planted. On the other hand,
the frequency of “X’s” on the chart is noticeably present with the oriental stocks as a whole, indicating some uncongeniality and variability of performance and considerable loss of trees.

The exception to this general statement comes with the variety Kieffer which has been relatively more successful on the oriental stocks than have Bartlett, Seckel, and Anjou. Kieffer is a hybrid with *P. serotina* and thence contains oriental blood,\(^\text{10}\) while the other three varieties are pure *P. communis*. They in turn have been more successful on *P. communis* roots.

The favorable report for domestic seedlings of Bartlett and Winter Nelis is of value at this time because of the quarantine regulations which compel domestic production of rootstocks.

While one of the oriental stocks (*P. betulaefolia*) gives promise as a vigorous, early fruiting stock for certain varieties its striking uncongeniality with Beurré d'Anjou sounds a warning for its use until it has been more thoroly tried. The inferior performance of *P. calleryana*, *P. ussuriensis*, and *P. serotina* should eliminate the use of these stocks in eastern pear orchards.

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