SIZE-CONTROLLED APPLE TREES AND THEIR ROOTSTOCKS

by

John C. Snyder *

The term dwarf tree, as commonly used when speaking of fruit trees, refers to small trees compared with standard trees. Because trees propagated on seedling rootstocks have been used so long, the tree size these seedling stocks produce has become standard. But within the past century, vegetatively-propagated stocks have been planted extensively in some parts of the world. Most of these stocks produce trees that are smaller than standard trees. Within the group of vegetatively-propagated stocks, of which there are many, there is considerable variation in the tree size they produce. The variation ranges from miniature trees six or eight feet tall, to trees as big as standard trees. By selecting appropriate stocks from these vegetatively-propagated stocks, one can control the size of his apple trees within these extreme limits. Because of this possibility, these stocks are rightly referred to as size-controlling stocks.

WHY INTEREST IN DWARF TREES?

Many commercial apple growers and home fruit gardeners are interested in size-controlled trees. There are several reasons why. The gardener may not have room for a large tree. Also, both for him and a commercial grower, it is easier to thin, spray or pick a small tree. Labor costs have risen recently and are continuing to rise. Small trees can be trained into decorative forms as garden features. Apple growers in other areas of the world have gone to size-controlled trees.

There is little question that some size-controlled trees start bearing earlier than standard trees. Fantastic yields, mainly from Golden Delicious plantings in Washington, have been reported from trees by the fifth year. These heavy yields, produced early in the life of the orchard, are real. They deserve serious consideration. But when weighing the advantages of early production, the total yield at the end of a given period, such as ten years, must be considered also. If the total production by the tenth year from standard trees is substantially greater, fantastic yields from dwarf trees during the early years can be misleading.

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A. N. Roberts, Oregon State University, Corvallis, Oregon; D. V. Fisher and D. R. Heninicke, Pomologist, Canada Department of Agriculture, Summerland, British Columbia; C. D. Schwartz, Western Washington Experiment Station, Puyallup; T. A. Merrill and F. E. Larsen, Department of Horticulture, Washington State University, Pullman, Washington; Walter Mellenthin, Superintendent, Mid-Columbia Branch Experiment Station, Hood River, Oregon; W. A. Luce, Alberheim Road, Yakima, Washington; and James K. Ballard, 233 Court House, Yakima, Washington, and L. P. Batjer, Tree Fruit Experiment Station, Wenatchee, Washington.
It may seem that a block of trees propagated on a given size-controlling stock should be absolutely uniform in size, but this is not always the case. Some blocks of standard trees are more uniform than similar blocks of small trees. This greater uniformity of standard trees may be due to the fact that seedling roots are less sensitive to soil variations and, in some cases, are better foragers.

Spring frosts comprise one of the big hazards in fruit growing. Sometimes the frost kills blossoms in the lower part of the tree without injuring those in the top. Small trees, of course, are more susceptible than tall trees to this hazard.

As far as Washington is concerned, there are many aspects of size-controlled trees about which more information is needed. It is not known just how much cold weather the various rootstocks will stand. In general, those now being planted seem to compare favorably with medium-hardy standard trees. Nor is it known just how long size-controlled trees will live in Washington. In many areas where they are used extensively, longevity seems to be the same as that of standard trees. Just how big size-controlled trees will get in irrigated central Washington, where apple trees normally are very productive, is still a matter of speculation. Getting trees into heavy production early and keeping them producing regularly tends to keep even standard trees small. This technique may be more effective here, where high production is usual, than in other areas.

ORIGIN OF SIZE-CONTROLLING STOCKS

Most of the vegetatively-propagated or clonal rootstocks being used now occurred in nature. Starting in the early part of the century, horticulturists collected and segregated 16 promising clonal strains for study. These 16 strains were studied at the East Malling Research Station in England. Each was given a Roman numeral instead of a name. Because the study was done at the East Malling Research Station in England, the letters "EM" were added to the Roman numerals (E.M. IX). The common practice now is to drop the "E" and use the letter "M" with the Roman numeral (M. IX). This system of nomenclature is used for all of the 16 stocks selected. Besides these there are M.XXV and M.26.

There is another group of size-controlling stocks called the Malling Merton series. The Malling Merton stocks differ from most of the Malling stocks in that they are the result of planned crosses and are resistant to root woolly aphids. The breeding program which produced them was started at the John Innes Horticultural Institution and East Malling Research Stations in 1922. M. B. Crane at Merton and H. M. Tydeman at East Malling Research Station made 3,758 crosses. Fifteen hybrids from these crosses showed outstanding root woolly aphid resistance. Each of these fifteen woolly aphid resistant productions was given an Arabic numeral and prefixed with M. M. for Malling Merton (M.M. 106). Because some of these stocks offered significant advantages over seedling stocks, plant breeders soon set up programs to produce more clonal stocks. Their primary objective was to develop clones resistant to root woolly aphid, but they did not overlook outstanding other characteristics. Programs were set up in different parts of the world. From the hundreds of crosses came some very promising hybrids. The Malling and Malling Merton series are only two of the many vegetatively-propagated rootstocks in existence.
OTHER METHODS OF CONTROLLING TREE SIZE

Using a size-controlling root as the rootstock is by far the most common method of producing small trees, but it is not the only method. Another is to use a strong-growing rootstock and then graft onto this rootstock, first a dwarfing interstem such as M.IX, and then in turn a variety like Delicious, onto this dwarfing interstem. This method is referred to as the "intermediate stem piece" or "interstem" method. In this case, the stem piece, instead of the root, exerts the dwarfing influence. Malling VIII and M.IX are used for making interstem trees. Standard seedling, M.XII or M.XVI can be used as the rootstock. More needs to be known about this method, but the most satisfactory length of stem piece appears to be in the neighborhood of six to 12 inches. Also, there is some danger of breaking at the graft unions of the interstem.

There are some rather ingenious modifications of the interstem method. Most interstem trees are made in the nursery or at least while the tree is young. But you can produce an interstem effect on an older tree by removing a band of bark and bridging it with scions of M.IX or M.VII. When using this method, the cambium exposed by removing the bark must not be allowed to restore itself. Presumably you can use this technique for controlling the size of almost any apple tree, provided you do it while the tree is small. The treatment appears to work well on trees from about three to 10 years old.

Using spur-type trees, of which there are many, is another method of producing smaller-than-standard trees. Spur-type strains, propagated on standard seedling roots, have certain advantages over trees on some dwarfing stocks. They are well anchored and highly productive. Unfortunately, there are many apple varieties for which no spur-type strains are available. Spur-type trees, when mature, are presumably about two-thirds the size of standard trees.

GROUPING AND BRIEF DESCRIPTIONS OF SOME SIZE-CONTROLLING STOCKS

The more common size-controlling stocks are divided into four groups as follows:

Dwarf . . . . . . . M.IX, M.26 (M.VIII used more as a stempiece)
Semi-Dwarf . . . . . M.IV, M.VII, M.M.106, stempiece
Standard . . . . . . M.XXV, seedling

M.IX: Can be maintained at eight to 10 feet tall; requires support; slightly susceptible to collar rot; moderately easy to root; roots are brittle; best on good soil; sometimes used as a stem piece; used in home fruit plantings and in very intensive commercial plantings.

M.26: Between M.IX and M.VII in size; can be maintained 10 to 12 feet tall; require support; not as well known as other Malling stocks; not resistant to woolly aphid; hard to root; produced by crossing M.IX x M.XVI.

Stem piece: Slightly smaller than VII; does not require support.
M.VII: Slightly less than half the size of a standard tree; can be maintained at 12 to 15 feet tall; sometimes suckers badly; requires temporary support; easy to propagate; used extensively; highly susceptible to crown gall and collar rot.

M.M.106: Woolly aphid resistant; same size as M.VII; can be maintained at 12 to 15 feet tall; does not sucker; propagates easily; Northern Spy x M.I.

M.IV: Slightly larger than M.VII; an early heavy cropper; poorly anchored; well adapted to light soils.

M.I.: About two-thirds size of standard tree; can be maintained at 15 to 18 feet tall; susceptible to collar rot; not good in dry soil.

M.II: About two-thirds size of a standard tree; can be maintained at 15 to 18 feet tall; quite well anchored; slightly resistant to collar rot; slightly susceptible to poor drainage; tolerates a wide variety of soil conditions; difficult to root.

M.M.111: About same size as M.II; can be maintained at 15 to 18 feet tall; woolly aphid resistant; propagates easily; drought resistant; a heavy cropper; Northern Spy x Merton 793.

M.M.104: Woolly aphid resistant; bigger than M.II; can be maintained at 16 to 18 feet tall; very heavy early cropper; with some varieties very well anchored; susceptible to poor drainage; M.II x Northern Spy.

M.XXV: On some varieties larger than M.II; can be maintained at 16 to 18 feet tall; a very heavy, early cropper; especially noted for early production; difficult to root; Northern Spy x M.II.

TREE SIZE

As with standard trees, there is no hard and fast rule stating how big size-controlled trees will get. The best that can be done is to approximate the size in relation to standard trees. With small and standard trees alike, there are many factors that determine ultimate tree size. Soil is probably the greatest one. A tree that starts bearing heavily while young and continues doing so, remains small much longer than one that bears lightly during the early period. The kind and amount of pruning also influences tree sizes. In suggesting the foregoing approximate heights, these and other factors were considered. In general, the spread is slightly greater than the height.

All trees on clonal rootstocks should be set so the graft union is at least four to six inches above the ground level.

PLANTING SYSTEMS

There are several plans or systems for locating the trees in the orchard. The most common systems are the square, the rectangle, the triangle and the hedgerow. In Washington the square system is the most popular. There are very few hedgerow plantings. These planting systems, except the triangle, are described briefly. Various planting distances, along with the number of trees required per acre, are given in Table 1.
The Square System

The greatest advantage the square system has over other systems is that it permits working around the trees from all directions. As with other systems, the trees roots soon fully occupy the ground. One of the most serious objections to it is that passageways occupy a higher percentage of space than is true of other systems. This disadvantage increases as the distance between trees decreases. With a distance of 20 feet or more, the extra convenience of getting through the orchard with equipment can easily offset the disadvantage of lost producing capacity.

The Rectangular System

Planting on the rectangle allows more trees per acre than planting on the square. That is, if the sums of the spacings of a rectangular and of a square system are the same, there are more trees per acre in the rectangular system than in the square system. For example, there are 116 trees per acre in an orchard set 15 x 25 on the rectangle. But if the trees are set 20 x 20 on the square, there are only 108 trees per acre. There is a difference of 8 trees, or 7.4% per acre. If you go to a spacing of 30 x 40 on the rectangle and 35 x 35 on the square, the difference is one tree per acre, or 2.85%. The difference in tree density decreases as the spacing increases. Whether you plant on the rectangle or the square, then, depends upon the importance of free passageways in relation to about three to seven per cent more trees.

The Hedgerow

The distance between the rows should vary with the type of training to be practiced and the type of equipment to be used. If the trees are to be trained to a strict hedge, the thickness of the hedge should not be more than six feet. The hedge then occupies three feet of space on each side of the row, or a total of six feet. With this as a base, the working space required by machinery to be used can be determined. Planting the rows 10 feet apart allows seven feet of working space. It appears that the most suitable spacing between hedgerows may well range from 10 to 14 feet.

The spacing in the hedgerow depends upon the urgency of early production. Four feet between trees is about as close as you should ever plant. At this spacing, the trees should be in substantial production by the fifth year. Planting at four feet assumes that every other tree is a filler. The spacing may well range from four to eight feet, but the ultimate distance between trees in the row probably should never be more than eight feet. Various planting distances, along with the number of trees required per acre are given in Table 1.
# TABLE 1

Number of Trees Required Per Acre for Various Planting Distances and Planting Systems

**DWARF TREES**

### In Hedgerow

<table>
<thead>
<tr>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
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<tbody>
<tr>
<td>4 x 8</td>
<td>1,361</td>
<td>5 x 10</td>
<td>871</td>
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<td>622</td>
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<td>5 x 8</td>
<td>1,089</td>
<td>6 x 10</td>
<td>726</td>
<td>6 x 14</td>
<td>519</td>
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<tr>
<td>6 x 8</td>
<td>908</td>
<td>7 x 10</td>
<td>622</td>
<td>7 x 14</td>
<td>444</td>
</tr>
<tr>
<td>7 x 8</td>
<td>778</td>
<td>8 x 10</td>
<td>545</td>
<td>8 x 14</td>
<td>389</td>
</tr>
<tr>
<td>4 x 9</td>
<td>1,210</td>
<td>4 x 12</td>
<td>908</td>
<td>4 x 16</td>
<td>681</td>
</tr>
<tr>
<td>5 x 9</td>
<td>968</td>
<td>5 x 12</td>
<td>726</td>
<td>5 x 16</td>
<td>545</td>
</tr>
<tr>
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<td>807</td>
<td>6 x 12</td>
<td>605</td>
<td>6 x 16</td>
<td>454</td>
</tr>
<tr>
<td>7 x 9</td>
<td>691</td>
<td>7 x 12</td>
<td>519</td>
<td>7 x 16</td>
<td>389</td>
</tr>
<tr>
<td>8 x 9</td>
<td>605</td>
<td>8 x 12</td>
<td>454</td>
<td>8 x 16</td>
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<tr>
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<td>1,089</td>
<td>4 x 14</td>
<td>778</td>
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<td></td>
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### In Rectangle

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<tr>
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<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 1/2 x 10</td>
<td>581</td>
<td>8 x 14</td>
<td>389</td>
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<td>311</td>
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<td>242</td>
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<tr>
<td>6 x 12</td>
<td>605</td>
<td>12 x 14</td>
<td>259</td>
<td>8 x 16</td>
<td>340</td>
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<tr>
<td>8 x 12</td>
<td>454</td>
<td>7 1/2 x 15</td>
<td>385</td>
<td>9 x 16</td>
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<tr>
<td>10 x 12</td>
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<td>363</td>
<td>10 x 16</td>
<td>272</td>
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<td>444</td>
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<td>323</td>
<td>12 x 16</td>
<td>227</td>
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</table>

### In Square

<table>
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<th>Spacing in Feet</th>
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<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
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</thead>
<tbody>
<tr>
<td>8 x 8</td>
<td>681</td>
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<td>436</td>
<td>12 1/2 x 12 1/2</td>
<td>279</td>
</tr>
<tr>
<td>9 x 9</td>
<td>538</td>
<td>12 x 12</td>
<td>303</td>
<td>15 x 15</td>
<td>194</td>
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</table>
### SEMI-DWARF TREES

#### In Rectangle

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<th>Spacing in Feet</th>
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<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>269</td>
<td>10 x 20</td>
<td>218</td>
<td>12½ x 25</td>
<td>139</td>
</tr>
<tr>
<td>10 x 18</td>
<td>242</td>
<td>12 x 20</td>
<td>182</td>
<td>15 x 25</td>
<td>116</td>
</tr>
<tr>
<td>12 x 18</td>
<td>202</td>
<td>14 x 20</td>
<td>156</td>
<td>18 x 25</td>
<td>97</td>
</tr>
<tr>
<td>14 x 18</td>
<td>173</td>
<td>15 x 20</td>
<td>145</td>
<td>20 x 25</td>
<td>87</td>
</tr>
<tr>
<td>9 x 20</td>
<td>242</td>
<td>18 x 20</td>
<td>121</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 x 18</td>
<td>134</td>
<td>22½ x 22½</td>
<td>86</td>
</tr>
<tr>
<td>20 x 20</td>
<td>109</td>
<td>25 x 25</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27½ x 27½</td>
<td>58</td>
</tr>
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</table>

#### SEMI-STANDARD TREES

#### In Rectangle

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<th>Spacing in Feet</th>
<th>Number of Trees Required/A.</th>
</tr>
</thead>
<tbody>
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<td>97</td>
<td>22½ x 30</td>
<td>65</td>
</tr>
<tr>
<td>17½ x 30</td>
<td>83</td>
<td>25 x 30</td>
<td>58</td>
</tr>
<tr>
<td>20 x 30</td>
<td>73</td>
<td>27½ x 30</td>
<td>53</td>
</tr>
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#### In Square

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>28 x 28</td>
<td>56</td>
</tr>
<tr>
<td>30 x 30</td>
<td>48</td>
</tr>
</tbody>
</table>
TREE SUPPORTS

Many dwarf and semi-dwarf trees require support. With some, the support is needed for only about ten years. There are many different kinds of supports. There also are various planting and training techniques that help the trees to stand without artificial supports.

Natural Supports

Budding high in the nursery so the tree can be planted six to 10 inches deeper than you plant standard trees seems to provide additional support. This practice has real merit, but additional staking may be needed on M.IX, M.26, M.VII and M.IV. Using an interstem with a strong rooting stock is another attempt to make the tree self-supporting. This technique is presently looked at with considerable favor. Training a tree so that the fruit load is evenly distributed over the trunk rather than allowing the load to develop more on one side than the other is an aid. Keeping the tree from bearing heavily, until it has become well anchored, is an especially good technique. Some authorities contend that when you utilize such techniques as these, dwarf trees compare favorably with standard trees as far as anchorage is concerned. But the roots of some stocks are brittle and highly susceptible to breakage.

Artificial Supports

Stakes are a common artificial support. Staking allows cross cultivation during the early years of the planting but is limited when it comes to spreading fruiting branches between trees in the row. The stake should be strong enough to support a tree carrying a box or more of fruit. This means at least the equivalent of a 2" x 2" wooden stake. A stake 18 to 24 inches above ground provides support enough to keep the main trunk from breaking off or bending over, but does not provide a stalk to which to train the central leader as it grows taller. To do this, the stake must be five or six feet above ground. Tall stakes have a serious objection. They often seriously injure the trunk and framework branches next to them. In all cases the stake can be inserted in the hole as the tree is planted or it can be put in later. If later, care should be taken to avoid injuring roots. One method is to use two stakes per tree, with the stakes 12 to 18 inches from the tree and on opposite sides. A tie going from one stake to the other and around the trunk holds the tree.

The wire trellis for dwarf trees is fairly common. The posts for this trellis should be six to eight feet above ground. Because there isn't much strain on the wires during the first several years, the posts can be farther apart at the beginning than later. Some orchardists set posts 30 to 40 feet apart when the trees are set and then about the third year they set a post between each two put in originally. In orchards where wire trellises are used, there are one to three wires with the bottom one 36 inches from the ground and each additional one 24 to 30 inches above the one below it. The wires must be kept tight, particularly during the early years. As the planting gets older, the adjacent branches can be intertwined or tied to each other.
In correcting narrow crotches on young trees there are several ways of elimi­
inating those that develop at the top of the whip following heading at setting
time. A method which retains the central leader is preferable to one that does
not. One practice is to clip out the offending shoots when they are three or
four inches long. Another method is to spread them sometime during the first
growing season, using wire pins or something of that sort. The sooner you do this
spreading, the better. This spreading or removing the narrow-crotched shoots
requires going over the trees about twice during the first growing season. It
has advantages over delayed heading. If nothing is done during the first grow­
ing season, the narrow-crotched branches can be removed or stubbed during the
first dormant pruning. But it is much better to do it early during the first
growing season.

Semi-Standard Trees

The training procedure can be similar to that for standard trees. The height
for heading the whip at setting time can be the same. Narrow crotches are as
bad as with standard trees.

THE FIRST DORMANT PRUNING

At this stage the new growth of the central leader is one to three feet long.
Head the central leader at 12 to 18 inches of new growth. This heading en­
sures branching that is not too high. Head those other branches which are over
24 inches long to about this length. Heading them prevents whippiness and in­
duces branching. This heading should not be great enough to induce undue stiff­
ness or force excessive growth. Head only those branches that need it. If there
are more than four or five major branches at the time of the first dormant prun­
ing, severely head or remove some. But, don't make a practice of heading every­
thing but the permanent leader branches. Leaving as many extra branches un­
headed as you can, induces early production. These extra branches can be head­
ed or eliminated as necessary after they spur up.

THE SECOND DORMANT PRUNING

Continue the practices started the first year. You may have to hold back some
of the leaders also. Do this mainly by thinning rather than heading. Correct
narrow crotches as necessary, but don't worry about those on temporary branches.
Keep "risers" from developing on scaffold branches. Throughout the training
period, techniques involving little or no pruning are much preferable to those
involving major cutting. Keep the main branch of each scaffold dominant over
its laterals.

SUBSEQUENT PRUNINGS

Follow this same general pattern until you come to modifying the central leader.
The exact time for modifying the central leader, if necessary, varies from a­
bout the fourth to the sixth year. The tree may or may not be in bearing. The
purpose of maintaining the central leader up to this stage is to help distribute
the framework branches on the trunk. There may well be four or five scaffold
branches spaced eight to 12 inches apart.
For those trees whose central leader must be modified artificially (Golden Delicious especially), head the central leader to a strong lateral branch. This means that at the same time of heading, the central leader must extend one to two feet beyond the point at which you want to head it. Ordinarily it is well to make the cut several inches above the side branch in order to avoid a weakening cut. This pruning is virtually the same as for standard trees, as is true of subsequent pruning also.

Trees of some varieties do not need heading to modify the central leader. The fruit on it pulls it into position. This is true with most varieties except Golden Delicious, whose wood is very stiff. Very vigorous varieties, like Gravenstein, that are slow to start bearing, can be helped to advantage also. Allowing the fruit load to pull the central leader into the position of a framework branch is a good practice.

Then the central leader, instead of being cut off, becomes the top scaffold branch. Retaining the central leader rather than cutting it has distinct advantages. It tends to encourage early production. But don't let the fruit on it pull it too far.

**Semi-Dwarf Trees**

In Washington most apple trees have been trained to more of a delayed open center than a modified central leader. This system has helped to produce a high percentage of extra fancy apples on seedling stocks. With smaller trees, the need for opening up the tree is not as great. There is not as much inside or "C" grade wood on a small tree.

When selecting leaders on semi-dwarf trees, it is very desirable to spread the leaders over 18 inches to two feet or more of trunk space. The situation is the same as with standard trees. It is well to maintain a central leader for the first several years. Practicing delayed heading is not necessary. If the center of a tree is to produce top quality fruit it must be exposed to sunlight. Because the radius of semi-dwarf trees through which light must penetrate is less than with standard trees, more leaders may be acceptable. There may be five or six but they should be spaced eight to 10 inches apart. A true modified central leader tree with well-spaced leaders, or a tree with the leader allowed to become a scaffold without modifying it, should be very satisfactory. It is just as important to avoid narrow angles with semi-dwarf trees as it is with standard trees.

**Dwarf Trees**

Dwarf trees require special treatment. They tend to start bearing very early and must be kept from bearing too heavily, particularly during the early years. Excessive fruiting during the second and third years can seriously stunt the tree. Young trees should grow 12 to 24 inches each of the first several years. The purpose in pruning is to develop tree size and structure that by about the fourth year can produce substantial tonnage.
The trellis referred to here is described under supports on page 8.

Training at Setting Time and During First Growing Season. Head the whip two or three inches above the bottom wire. In windy areas, tie the tree loosely to the wire. The tying helps the tree to become well anchored.

The First Dormant Pruning. Select one central branch and head it just below the second wire. Heading the central branch or leader forces branches for the second wire. Tie the central leader to the second wire. If the central leader does not reach the second wire clip off the tip of it. Then for the bottom wire, select two side branches as nearly opposite each other as possible. Head them slightly if they are over two feet long and appear to be whippy. If the side branches are almost vertical, bring them down to about 60 degrees and tie them. Remove all other major branches that seem likely to dominate those you have selected. The more small wood you can leave the better. During this second growing season, thin off all fruit. Do this as soon after bloom as possible. Producing even only three or four apples can greatly retard the growth of the tree and pull a branch out of shape.

The Second Dormant Pruning. Tighten the wires if necessary. Pull the first-wire branches down to about 45 degrees. They were tied at 60 degrees the previous season. Eventually you either pull them to a horizontal position or let them grow more or less free, just so they don't interfere too much with adjacent trees. Allowing fruiting wood to develop more or less free around the central stem, and using the wires to encourage the development of fruiting wood between trees rather than between rows, appears to be a very good practice. During early years the wires are used for tying branches down. Later, as the branches load with fruit, they are used for holding the branches up. Head to about 24 inches, those side branches that are longer than this. Eliminate, shorten, or tie to the wire, those branches that extend into the space between rows. The procedure for training branches to go on the second wire is the same as that used previously to train branches to the first wire. Pruning the other parts of the tree at this time is similar to that of the previous year. As you prune, try to (1) maintain a strong central stem, (2) keep branches growing mainly in the direction of the wires rather than out in the space between the rows, and (3) keep the extending branches between trees shortened enough to prevent naked areas on them.

The Third and Subsequent Dormant Prunings. The pruning procedure for the third and subsequent years is very similar to that of the second year. Growth usually starts to slow down about the third year. As it slows down and the branches spur up, heading becomes more useful. By continual heading, you can keep the fruiting wood fairly close to the trunk. Until the tree reaches the top wire, give special attention to keeping the central leader from overbearing. When it extends 18 to 24 inches beyond the top wire, head it or train it on the wire by simply pulling it down, whichever is the easier. Both methods are satisfactory. Always, the pruning operations should tend to keep the tree somewhat compact, with fruiting wood distributed as nearly as possible directly above the trunk. The question of vigor in relation to pruning is the same as with standard trees, except that with dwarf trees over-pruning is less likely to reduce color.
PRUNING TREES TRAINED TO A STAKE

The pruning will vary somewhat with the length of the stake. Training to short stakes requires special attention to developing and maintaining a strong central leader. A tall stake to which the central leader can be tied makes stiffening the central leader somewhat less necessary.

Pruning at Setting Time and During First Growing Season. Head the whip at 24 to 30 inches at setting time and tie it to the stake. This heading forces branching where you want the lowest branches on the trunk. During the first growing season, correct narrow crotches.

The First Dormant Pruning. Head the central leader to 18 inches of new terminal growth. The heading forces branching and helps to stiffen the central leader. Tie the headed leader to the stake. If there are strong branches that seem to dominate the tree, eliminate or head them severely. Tying these down instead of cutting them off hastens production. No other heading should be necessary. Nor should it be necessary to do much thinning -- only if branches are too low or several arise at one point. Allow branches to grow freely on all sides of the tree, much as around a spindle. It is here that training to a stake differs from training to a wire trellis. With the wire trellis the branches are trained in the direction of the wires.

The Second Dormant Pruning. Head the central leader to about 18 inches of new growth and tie it to the stake. Treat narrow-crotched branches as before. Some of the more horizontal branches often carry fruit buds at this time. Some of them may need heading to develop a compact tree. Thin off all fruit.

The Third Dormant and Subsequent Prunings. Continue to train the central leader as started previously. As horizontal branches spur up, head them to maintain vigor and keep the fruit close to the trunk. Shorten the spurred-up wood as much as necessary to regulate the crop and to keep bearing wood close to the trunk. When the leader reaches the desired ultimate size, head or pull it down to the top wire. Trees planted on the rectangle may well be allowed to overlap in the row, but between rows there must be space for orchard equipment.

The Espalier Form

Trees are sometimes trained into special forms for their decorative value. Trees trained to the espalier form are very attractive. The tree, instead of being round, is flat, similar to a wall 18 to 24 inches thick. It may be against a building or by itself. The tree itself consists of a strong central stem, with well-defined lateral branches extending horizontally from the central stem. To train an espalier tree, you need a trellis. The ordinary grape trellis, which consists of two to four wires stretched and fastened to well-anchored posts, is very satisfactory. The wires should be 18 to 24 inches apart. Trees to be trained into special forms, such as the espalier, should be on a dwarfing stock. Otherwise the tree may never come into fruiting.

To train an espalier tree, start with a whip at setting time. Head it slightly above the bottom wire and tie it loosely to the wire. Then select two buds just below the bottom wire so that the resulting shoots extend in the direction of the wires rather than perpendicular to them. In selecting these two buds, be sure that there is a third bud above them. After you have selected the
three buds remove all others from the whip. These three buds produce the framework for the tree. The two lower ones form the lower arms and the top one forms a continuation of the central stem or trunk. As shoots grow the first summer, allow the top one to grow upright, but support it as necessary with loose ties to keep it in place.

THE FIRST DORMANT PRUNING

Start by repeating on the second wire the training you did a year earlier on the first wire. At this time there is a strong central branch and two side branches. Pull the side branches down toward the bottom wire to an angle of about 45 degrees and fix them in this position with loose ties to the wire. If one appears to be growing faster than the other, lower it more than the other. If new growth is more than 24 inches long, head at this length. These branches should eventually be brought down almost even with the wire in a nearly horizontal position.

THE SECOND SUMMER PRUNING

At this stage there are many shoots on the two lower branches. Cut the more vigorous of these back to three buds. Do this when the shoots are 12 to 14 inches long. At this stage, which usually occurs in July, the basal buds are well developed.

Cutting back a shoot forces it to branch. The resulting branches near the end of the stub usually grow more vigorously than those near the base. The basal shoots usually form fruit spurs. So, by heading these shoots, you force them to "feather out" with fruiting spurs. Discontinue this summer pruning by early August so the tree will harden off.

THE SECOND DORMANT PRUNING

Continue the pattern of training and pruning started earlier. At this time some of the branches that developed as a result of the previous summer heading, are 12 to 18 inches long. Head them to about four inches. Leave the small ones unheaded. If any shoots, not headed last summer, are more than about eight inches long, head them. Otherwise, leave them unheaded.

During the subsequent seasons, repeat these operations with slight modifications as the tree gets older. For example, when the trunk reaches the top wire, train it to the wire. As the horizontal branches become too heavily loaded with spurs, thin out weak spurs.