Steps to Success in Replanting

Revised 2015 by

BC Tree Fruits Cooperative and Summerland Varieties Corp. in collaboration with the BC Ministry of Agriculture.

ACKNOWLEDGEMENT AND DISCLAIMER

This manual was funded by the Canada-British Columbia Orchard Revitalization Agreement (1991-1992). The Agreement, which provided a variety of programs for the development of the tree fruit industry, was funded by the government of Canada through Agriculture Canada, and was delivered by the British Columbia Ministry of Agriculture, Fisheries and Food through contract with the Okanagan Valley Tree Fruit Authority. The manual was updated in 2015 through the collaboration of BC Tree Fruits Cooperative, Summerland Varieties Corporation and the BC Ministry of Agriculture. Manual updates were funded by the BC Ministry of Agriculture.

The responsibility for the report as written and all conclusions reached herein are the authors' alone. The report does not necessarily reflect the opinion of the Federal and Provincial governments.

The original version of this manual was a joint production of the Okanagan Valley Tree Fruit Authority and the British Columbia Ministry of Agriculture, Fisheries and Food. In 2015, this manual was updated by BC Tree Fruits Cooperative and Summerland Varieties Corp. To comment on possible additions or changes, please contact:

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Preface

Fruit growing is a rewarding and challenging business. Innovative high density systems have allowed for growers to be adaptable to changing market trends and improved horticcultural methods, which in turn allows growers to remain competitive in present and future markets. High density systems address such challenges as increasing costs of labour and stricter demands on cosmetic and quality standards. Given the present expansion of tree fruit production throughout the world and the over-supply of fruit on world markets, this readiness to adapt is critical to continued business success.

Many new plantings fail to develop their full potential because of problems during the first years of a replant. Symptoms of replant disease are more severe in blocks where crops have not been rotated, such as, cherries removed and replanted to cherries. Other failures can be the result of missing a critical input at a critical timing. High density systems require more planning as well as more precise management skills. This publication summarizes the key steps necessary for new fruit tree plantings to prosper.

ELEVEN STEPS TO A SUCCESSFUL REPLANT

The following summarizes the critical steps described in this publication in replanting your orchard successfully. As each orchard is somewhat different, discuss your replanting plans with your local horticultural advisor and/or packinghouse field staff.

1. Timing Orchard Renovation
   - Develop a long-range plan to renovate on average 5-10% of your acreage each year.
   - Consider cultural and variety factors necessary to make an informed decision on the best variety(ies), rootstock(s), training system(s) and spacing(s) for your situation.

2. Variety Selection
   - Keep abreast of new varieties and the specific market and cultural conditions required for success.
   - Use government and industry sources of up-to-date information.

3. Rootstocks
   - Apples: Various clonal M.9, M.26 and B.9 are rootstock selections that are most readily available. Cornell Geneva rootstocks are promising due to their resistance to fireblight and replant disease.
   - Cherries: Mazzards are most widely planted for standard cherry trees, however, there are also several size controlling rootstock choices such as Gisela 5 & 6 and Krymsk 5, 6, & 12.
   - Size controlling rootstock selections for other fruits are quite limited in Canada at this time. Preferred choices are Old Home x Farmingdale (OHF) 87 and 97 for pears, Siberian C for peaches and nectarines, Haggith for apricots, and Myrobolan B for prunes and plums.

4. Training Systems and Spacing
   - Super spindle (1800-3500 trees/ac), tall spindle (1100-1200 trees/ac) and slender spindle (700-1200 trees/ac) are the best choices for the Southern Interior of BC at present.
   - Super spindle is the simplest system for hired labour, but requires dedication to the rules of the system to be successful.
   - Adjust spacing to maximize production, while matching growth characteristics of the trees and soil.
   - Some systems have a greater potential for mechanization than others.

5. Nursery Stock
   - Whips or trees with short feathers are preferred for apple super spindle.
   - Well feathered trees are preferred for apple slender spindle or tall spindle and for all stone fruit plantings.
   - Buy only high-quality trees in good condition.
   - Buy only the variety that you have planned for, do not purchase unsuitable varieties simply because the first choice was out of stock.
   - If you are considering growing your own replacement trees, refer to *Tree Fruit Home Nurseries: A Growers Manual, OVTFA, 1993.*

6. Site Preparation
   - Start planning well before planting and do a thorough job of site preparation.
   - Ensure soil is well tilled and aerated for planting.

- Ensure all old tree roots have been removed or well mulched.
- Replant orchard analysis is available for both pome fruits and soft fruits through the BC Tree Fruits Cooperative Quality Development Lab. Replant orchard analysis (includes soil nutrient analysis, plant pathogenic nematode count and replant seedling bioassay) will determine if soil treatments or amendments are required. For further information please contact the BCTFC Quality Development Lab at 250-766-2527 ext. 205.

7. Tree Handling
   - Plant as early in the spring as possible.
   - Protect trees from wind, sun and/or frost at all times before planting; do not store trees in a fruit storage room as ethylene gas can damage young trees.
   - Handle the trees as little as possible and below desired buds for branching.

8. Planting
   - Add organic matter, such as peat or compost, to planting hole, especially on lighter soils.
   - Pre-soak trees prior to planting and be prepared to water trees in within a day of planting.
   - Fertigate as soon as trees are planted or add fertilizer mix to planting hole and mix thoroughly.
   - Phosphorus is extremely important to tree growth and root establishment.
   - Plant trees at correct depth for rootstock type used.

9. Pruning and Training
   - Prune all trees immediately after planting.
     - Apples
       - Refer to Richard Marini, Ten-Year Summary of the 2003 NC- 140 Dwarf Apple Rootstock Trial and Bruce Barritt, The Tall Spindle-Evolution of a Practical Apple Orchard System for further details.
     - Soft Fruits and Pears:
       - Pears are normally trained to a central leader, as well as to a bi-axe system to spread out vigour.
       - Cherries are normally trained to a central leader or modified central leader.
       - Apricots, peaches, prunes, and plums are normally trained to a modified open centre, as well as to a trellis system.

10. Support Systems
    - Install appropriate support system(s) for the particular type of training system used; see K. Bert van Dalfsen. *Support Systems for High Density Orchards*, BCMAFF.
    - Install before or right after planting.
    - Tie trees to supports right after planting.

11. Helping Trees Grow
    - Maintain regular program of nutrition, pest control, irrigation, weed control and control of unwanted growth.
    - For detailed instructions on fertigation, see Peter Waterman, *Fertigation Guidelines in High Density Apples and Apple Nurseries in the Okanagan Similkameen*, BCMAFF, 1993.

STEPS TO SUCCESS IN REPLANTING

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STEPS TO SUCCESS IN REPLANTING

1.0 TIMING YOUR ORCHARD RENOVATION

Your decision on when to renovate any particular orchard block is not an easy one, but critical to your long-term business success. No single formula for renovation is possible because every grower's situation and orchard are different.

Markets can vary year by year for pricing and demand, which can make it hard to judge the decline in value in a block in a short period of time. By the time it is clear a block is past its peak production, returns will have declined and internal funding of new plantings may be reduced. It is not easy to pick with certainty a particular high point or point of decline at which you should renovate; neither the market nor tree production can be predicted precisely. Alternatives to this approach are clearly needed.

The most direct way to avoid having to pick a particular point in the production or market cycles at which to renovate your orchard is to develop a comprehensive, long-range plan. Any such plan will need to be flexible in order to incorporate unforeseen circumstances such as 'hot' new varieties or superior systems; however, on the basis of today's technology and variety selection, a reasonable approach is to plan on renovating between 5% and 10% of your acreage every year. This will ensure that the necessary preparation for replanting blocks, such as soil and replant analyses, can be done in plenty of time and that over a period of time, your orchard will be, and will continue to be, up to date.

1.1 Developing a Comprehensive Renovation Plan

The following factors should be considered in a comprehensive renovation plan:

- Timing of replant and long-term schedule for various blocks
- Variety selection
- Most suitable rootstocks for each orchard
- Training system(s)
- Type of tree: whip or feathered
- Tree quality
- Timing of nursery order
- Planting density
- Pollinizers
- Spacing
- Site preparation: timing and method
- Planting: timing and hand or machine planted

1.2 Planning Your New Planting

Deciding on the details of a specific new planting requires careful thought and should not be rushed. Allow plenty of time for possible adjustments and unforeseen holdups. A new planting is a big

investment of money and time and will not yield well without careful, knowledgeable management from the very start.

- Investigate the different varieties, rootstocks, training systems and spacings available to arrive at a combination that is most suitable for your particular site.
- Have soil analyses and bioassay results at least 6 months before you expect to plant; this will determine which treatments are necessary.
- Order nursery stock at least one, and preferably two years in advance of planting to make sure the varieties and number of trees you need are available. Consider having your trees grown under contract to ensure high quality and the number you need.
- Include pollinizers in your plan and order these with the trees.
- If you are using topsoil from another site for the planting holes, have it analyzed for pH and salt levels.
- Topsoil from another location may contain herbicide residues; sow cucumbers into this soil, as they are good indicators of such residues.
- Order materials for support systems, especially posts, well in advance of planting to make sure that supplies are available when needed.
- Have the irrigation/fertigation system designed so that materials are available and the system can be installed before or immediately after planting.

2.0 WHICH VARIETIES TO CHOOSE?

The most critical decision in renovating a block is what variety to plant. The market does not base prices on commodities, but on particular varieties and on the supply of and demand for them. Since the best prices are usually paid when a variety first comes on the market, it is very important to keep abreast of what new varieties are being developed. You must also know what orchard system(s) and management will get a new variety into heavy early production.

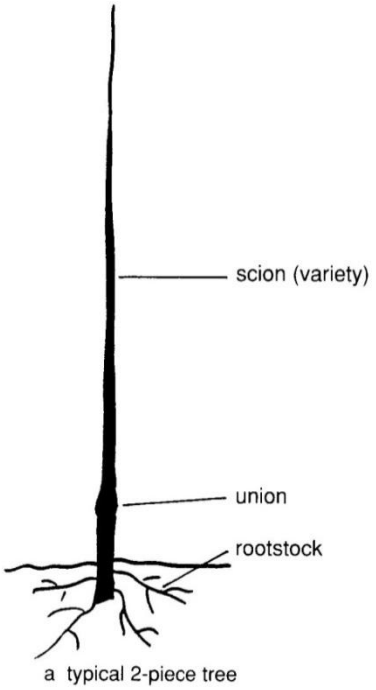
Information on varieties can be obtained from a number of reliable sources: Summerland Varieties Corp. (formerly PICO), BC Ministry of Agriculture, your packinghouse, the Horticultural Forum and local grower meetings, and the Goodfruit Grower and local publications.

3.0 THE CASE FOR HIGH DENSITY PLANTINGS

In British Columbia, high density planting is used primarily for apples. High density in BC is considered to be plantings of more than 1000 trees per acre. Most growers are now planting super spindle systems utilizing 1800 to 3500 trees per acre.

Research and observations of commercial orchards in BC show that high density plantings offer the greatest potential for net profit. Research has also shown that the level of early production is related directly to planting density to a point: the higher the density, the heavier the early production within the given systems outlined in this document. Economic analysis indicates that maximum profits are gained from tree fruit plantings that come into heavy production early. Early production is particularly important for new varieties so that the grower can gain the advantage of the higher prices

paid when a variety is in short supply for the market, so long as the early production does not take away from tree growth.



a typical 2-piece tree

3.1 Rootstocks for High Density Plantings

Apple and cherry growers can select what size tree they wish based on their choice of rootstock. There are rootstocks that will produce trees all the way from full size to less than 20% of full size. In general, as tree size decreases, precocity to fruit increases; the products of photosynthesis in dwarfed trees are directed from vegetative growth to fruit production. The disadvantage of using dwarfing rootstocks is that more trees per unit area are needed to establish a complete tree cover than with full-sized trees. Trees on dwarfing rootstocks also require support.

Tree density is important whatever rootstock is used. If it is too low, there is not enough fruiting area and the orchard will not reach its full yield potential. If tree density is too high, fruit size and quality will be reduced by the shade the trees cast. Techniques such as limb pruning, root pruning, limb bending, girdling, and nutrition and irrigation management help to control tree size, but are expensive and time consuming. For each rootstock-tree management system there is an optimum density at which fruit yields are highest and self-shading at a minimum. The challenge for the orchardist is to find that optimum level for each new planting (see section 4.1.5 for further tree ratios).

3.2 Choice of Clonal Rootstocks for High Density Apple Plantings in British Columbia

The following suggestions for rootstocks most suitable for use in British Columbia's high density plantings are based on local experience and information from research trials.

When selecting rootstocks, keep in mind that there is no perfect one. Each rootstock has advantages and disadvantages. If you expect too much from any one, you will be disappointed. Accept certain weaknesses in an otherwise suitable and productive stock and take steps to minimize the adverse effects of these weaknesses.

Clonal Rootstocks

3.2.1 Malling Series

Most Malling stocks produce a dwarf tree smaller than standard size. **Malling 9 is by far the most popular stock for this purpose.**

A number of sub-clones of M.9 exist. Dwarf and semi-dwarf roots will require staking for the life of the planting. Most of the M.9 rootstocks planted in the Okanagan valley in the past decade are:

M.9 T337

- Similar in size to M.9 EMLA in Summerland.
- Tolerant of heavy soils, needs good irrigation in light soils.

M.9 Pajam2

- Slightly larger tree, between M.9 and M.26 in size.
- No extra suckering in Summerland trials, but reports in the East of increased suckering.

M.9 Nic29

- Slightly larger tree, between M.9 and M.26 in size.
- No extra suckering in Summerland trials, but reports in the East of increased suckering.

M.9 EMLA

- Slightly more vigorous and a virus-free version of Malling 9 from East Malling.
- Similar in size to M.9 T337 in Summerland.

M.26

- More vigorous than M.9 and only slightly less vigorous than M.7.
- Trees require staking in early years or trees will sag to one side as good root development takes 4-5 years.
- Trees often have characteristic bulge at bud unions which can scion-root if too close to the ground.
- Trees are susceptible to fire blight infection.
- Caution must be exercised due to a tendency of increased biennial bearing and susceptibility to crown rot except perhaps with spur-type strains or weak growing varieties such as Honeycrisp or with weak soils where more vigor is desired.

3.2.2 Budagoysky 9 (B.9 or Bud9)

- Cold hardier and slightly larger than M.9, but smaller than M.26.
- Precocious and productive.
- Growers are encouraged to drive the younger trees to the top wire before fruiting occurs as trees can ‘runt out’ on weak soils once tree goes into full production.

3.2.3 Geneva Series

There are a number of new Geneva rootstocks becoming available in the US, some of which are fire blight, replant and woolly apple aphid resistant. Stocks are limited and the following comments are based on early trial results from PARC Summerland.

G.16

- Similar in tree size to M.9 though greater tree mortality and root suckering.
- Fruit size and yield was less than M.9.

G.41

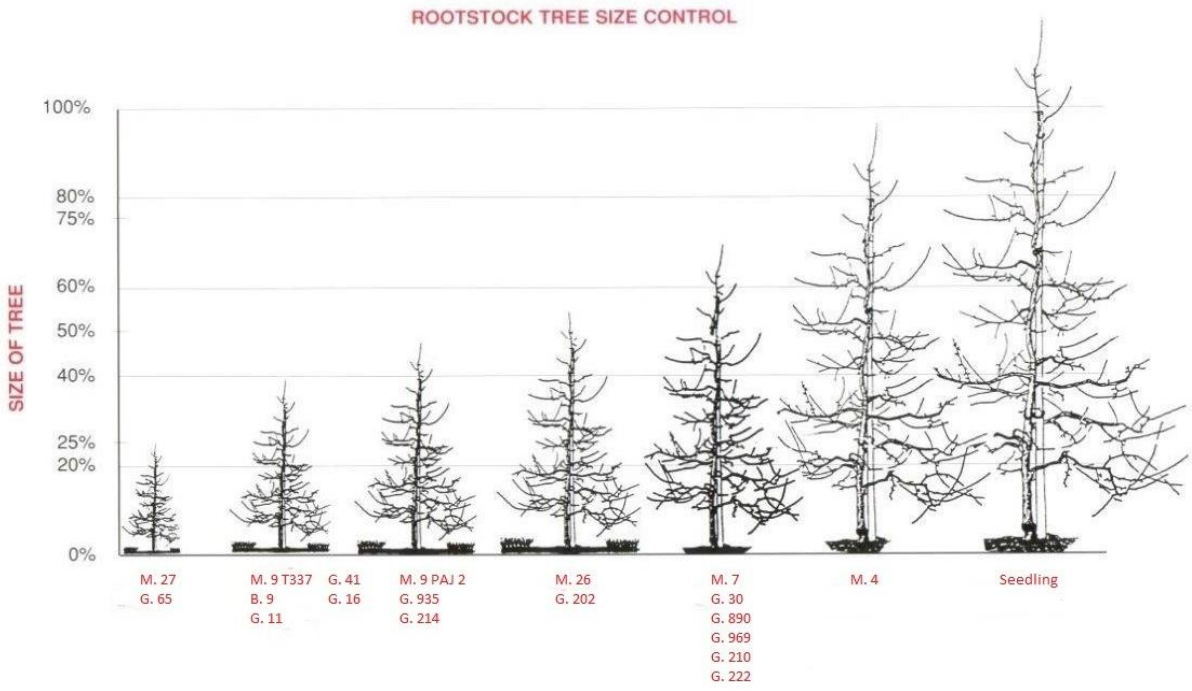
- Similar in tree vigour to M.9.
- Good survival.
- High yield efficiency and low root suckering.
- Cornell Geneva reports that this rootstock is cold hardy, resistant to woolly apple aphids, fire blight and tolerant to replant and crown rot in New York.

G.935

- Similar in size to M.26 but with better yield and yield efficiency, though suckering was a problem.
- Cornell Geneva reports that this rootstock is cold hardy, resistant to woolly apple aphids, fire blight and tolerant to replant and crown rot in New York.

3.2.4 Seedling Rootstocks

For economic reasons, seedling apple rootstocks should not be used.



3.3 Choice of Rootstocks for Sweet Cherry Plantings in British Columbia

There are some promising size-controlling cherry rootstocks from abroad (Gisela 6, Gisela 12, Krymsk 5, Krymsk 6). Mazzard F12/1 and Mazzard seedlings are the most widely planted at present. Colt is very susceptible to crown gall and Mahaleb rootstock can have incompatibility issues with PARC Summerland cherry varieties, neither are recommended in this area.

3.3.1 Mazzard rootstocks

Mazzard

- Seedling rootstock, large, vigorous, full size tree.
- Not as precocious as other rootstocks.
- Excellent compatibility with PARC Summerland cherries.
- Currently 95% of BC cherry production is on this rootstock.

F12/1

- Clonal rootstock, large, full size tree, slightly more vigorous than Mazzard.
- Similar attributes to Mazzard.

3.3.2 Gisela series

Gisela 6 (G6)

- Semi-dwarfing, larger than G5, precocious.
- Ideal for pedestrian style training system and non-precocious scions.
- Use of virus-free Budwood is extremely important.

Gisela 12 (G12)

- Standard size tree, good precocity and yield.
- Low to none root suckering.

Gisela 5 (G5)

- Semi-dwarfing, precocious, used for pedestrian style orchards.
- Not recommended in combination with precocious scions such as Sweetheart, Staccato, or Sentennial as over cropping with small fruit size can occur.
- Use of virus-free Budwood is extremely important.
- May not be suitable on soils that are very light.
- Pruning and irrigation are important to maintain tree vigor.

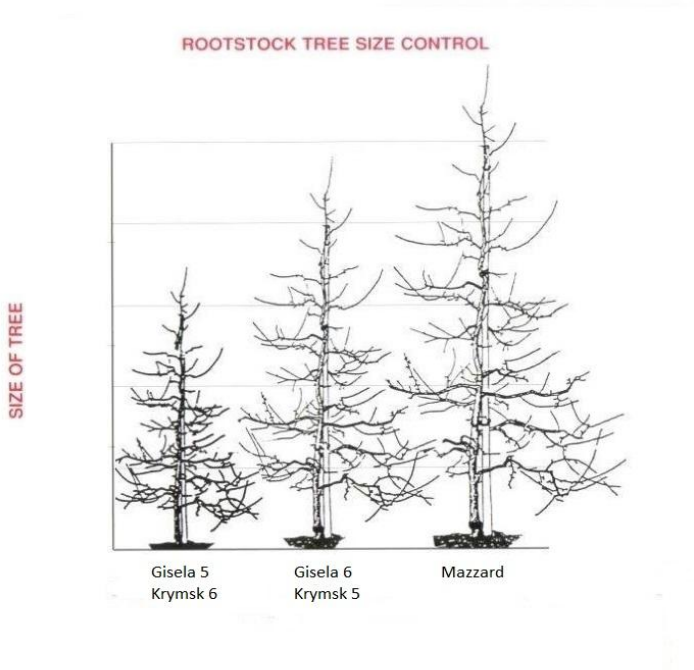
3.3.3 Krymsk series

Krymsk 5 (VSL-2 cv.)

- Semi-dwarfing, similar in size to Gisela 6, more precocious than Mazzard.
- Sensitive to viruses, **only use virus free propagative material**.

Krymsk 6 (LC-52 cv.)

- Dwarfing, similar in size to Gisela 12.
- Similar precocity and vigor as Gisela 6 (more precocious than Mazzard).
- Sensitive to viruses, **only use virus free propagative material**.



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3.4 Common Rootstock Choices for Other Fruit Commodities in British Columbia

For peaches, apricots, nectarines, prunes and plums, growers do not usually have any choices of rootstocks and receive what the nursery has available. For your records, however, find out what rootstock you have bought in case any rootstock-related problems arise. Common rootstocks in BC are as follows: for peaches and nectarines - Siberian C and Bailey; for apricots - Haggith,; and for prunes and plums - Myrobolan B.

For pears, some of the Old Home x Farmingdale (OHF 87 & 97) rootstock selections are more precocious and productive than seedling rootstocks although they do not give very much tree size control.

3.5 Virus Status of Rootstocks

There are a number of viruses that can seriously affect the growth and performance of apple rootstocks in the nursery and in the orchard. Growers are strongly recommended to make sure rootstocks they plant come from a source certified as virus free.

4.0 PLANTINGS SYSTEMS

4.1 Apple Training Systems

There are a number of training systems for high density apple plantings. At the present time, the super spindle seems the best suited for the Southern Interior of BC.

Local research has shown higher production from super spindle and slender spindle. The key to profitability will be sustained production and high returns; the system may work, but it must be profitable.

The following are short descriptions of the three main systems: super spindle, tall spindle and slender spindle.

4.1.1 Super Spindle

Super spindle are planted at 1800 to 3000 trees per acre on a trellis. The mature trees form a thin fruiting wall with no real branches; fruiting spurs (units) form directly off the trunk. Suitable for mechanization. Branches not needed on nursery trees.

4.1.2 Tall Spindle

Tall spindle are planted about 1100 to 1200 trees per acre on a trellis. The branching is all renewable, so the mature trees form a thick fruiting wall. Suitable for mechanization. Care should be taken that there is adequate vigour for the soil/rootstock/spacing combination .

4.1.3 Slender spindle

Slender spindle trees are planted at between 700 and 1200 trees per acre. They are supported by posts and grown to a height of 7 to 9 feet. The mature tree has semi-permanent basal whorl of branches and a Christmas-tree (A) shape. Suitable for stronger soil/rootstock combinations. Nursery trees should be feathered, or 2 year branched trees. Requires higher horticultural skills.

4.1.4 Other systems

There are other high density apple systems being implemented in other parts of the world, but often require higher input costs, horticultural skill or vigour than we have in BC. These systems may become more economical in the future as new rootstocks become available.

4.1.5 Comparison of Training Systems

	Super Spindle	Tall Spindle	Slender Spindle
Planting Densities	1800-3500 trees/acre	1100-1200 trees/acre	700-1200 trees/acre
Row Spacing	9’-10’	10’-12’	10’-12’
In-row Spacing	1’-2’	3’-4’	3’-5’
Tree Height	7’-10’	~10’	6’-8’
Rootstocks	Dwarfing	Dwarfing	Dwarfing
Tree Form	Fruiting Wall	Thick Fruiting Wall	Single Tree
Support	Trellis	Trellis	Post
Nursery Stock	Whip w/ short shoots	Feathered Preferred	
Costs to Establish	Highest	Middle	Middle-Low
Fruit Quality	High	High	Lower due shade
Labour Required	Lowest	Middle	Highest
Skill Required	Lowest	Middle	Highest
Planting Life	Similar		

4.2 Spacing and Row Configuration

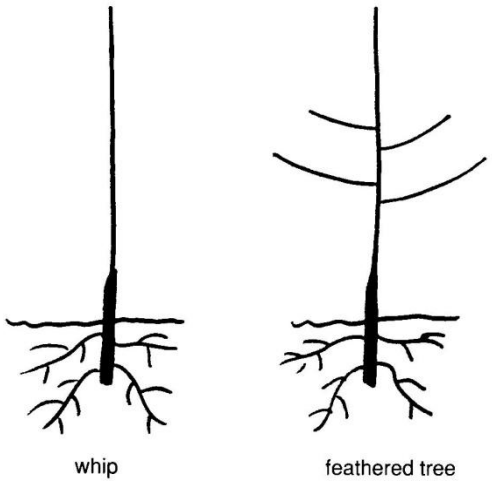
Once variety, system and rootstocks have been chosen the spacings are chosen to match all this to soil for maximum production. Proper spacing in high density plantings is critical to obtain high yields of good quality fruit. The goal is to have the tree intercept as much light as possible with good distribution of light throughout the tree. If there is too much space between rows, light interception will be poor and yields will be low.

If rows are too close together, there will be shading as the trees develop and heavy pruning will be needed to contain the growth. The pruning in turn, however, may cause trees to be overly vigorous and lead to poor quality fruit. In general, the closer the spacing, the more skill and understanding of the systems are needed.

A rough rule of thumb for Southern Interior conditions to get the maximum light interception in fruiting wall or central leader type systems is to space the rows a distance of about 1.0 times the height of the tree. Wherever possible, plant rows in a north-south direction rather than east-west to improve light distribution especially in fruiting wall and central leader. Occasionally land contours do not allow for safety issues, but quality and production will suffer.

4.2.1. Apples

The most common successful systems in BC are currently super spindle 10’ x 2’ on M9 type rootstock on a 9’ trellis. If vigorous varieties/soil such as McIntosh or Fuji are to be planted, increase these spacings by about 10% to 20%. If weak-growing varieties like Honeycrisp or spur type growth like Ambrosia or sandy/rocky soil are being planted, decrease spacings by about the same percentage.



You can even grow the trees lower, if the rows are closer together. Refer to rootstock relative size chart to adjust spacings based on rootstock. High density plantings are big investments and good quality nursery stock is essential for success. Feathered trees are preferred for either tall spindle or slender spindle systems; however, if these are not available, large caliper trees should be selected. The best are 5/8" to 11/16" followed by 9/16" and then 1/2". Anything less than 1/2" is not suitable.

The trees are measured 2" to 3" above the bud union. Feathers should be at least 8" to 10" long and at least 18" above the ground.

Whips or trees with short feathers are adequate for a super spindle system. Minimum caliper from 1/2"- 9/16".

Pears and stone fruit caliper should be 5/8" minimum, preferably 3/4".

All nursery stock should have the following characteristics:

- Roots well developed, fibrous and not dry
- Tree straight from rootstock to tip
- Tree free of frost or other injury
- Feathers intact
- Trees still dormant
- Bud union properly healed showing no sign of dieback
- Roots and rootstock shank free of crown gall
- Live buds in branching zone of tree (not rubbed off)

Orchardists considering growing their own trees should refer to *Tree Fruit Home Nurseries: A Growers' Manual*, Okanagan Valley Tree Fruit Authority, 1993.

4.2.2 Sweet cherries

Normal spacing for sweet cherries has been about 8' x 16' for a central leader on Mazzard. It is very important for fruit quality and disease control that there is wide enough row spacings for light and air drainage between rows.

There is still limited experience in BC with precocious cherry rootstocks. The tendency is to plant too far apart, especially with self- pollinating varieties, although this may be proved wrong in future when we have more experience managing crop on precocious rootstocks.

4.2.3 Pears

Suggested spacings range from 6' x 14' to 2' x 10' (refer to High Density Pear Production: An Opportunity for NY Growers (2010) for further information).

4.2.4 Peaches, prunes, plums

Suggested spacings range from 8-10'x 15'.

4.2.5 Apricots

Suggested spacings range from 12' x 15' to 15' x 20'.

5.0 SITE PREPARATION AND PLANTING

Site preparation is an extremely important part of any replant program. Poor growth on replanted trees is frequently traced to difficulties such as replant disease which can be prevented or mitigated by soil analysis/replant orchard analysis and proper preparation.

5.1 Site Preparation

Ideally, at least a year should be left between removing the old trees and replanting. This allows time to fumigate properly if fumigation is necessary and the site has adequate buffer zones, to add and incorporate cover crops and soil amendments such as lime, and to prepare the soil properly and plot out the site.

The following are guidelines on the steps required before you can fallow, fumigate or replant.

- Obtain a replant orchard analysis (also referred to as the Bioassay test) results at least 6 months before planting.
- Control weeds before removing trees.
- Remove trees along with as many roots as possible.
- Level the site and add topsoil or organic matter where topsoil was scraped away during leveling.
- On fine-textured soils such as silts and clays, deep subsoil and disc.
- Rotovate fine-textured soils only after ploughing and discing; rotovators work only in the top 4" to 6" of soil and often leave a hard layer beneath which can restrict drainage and root growth.
- Deep chisel or subsoil where hard layer of soil impede drainage; if either of these is not sufficient to break up the hard layer, drainage tiles may be necessary.
- On coarse or shallow soils, surface tillage may be sufficient or even preferable.

5.1.1 If the field is to be fallow the year before planting

- In spring of fallow, cultivate and seed cover crops to build up organic matter; oats and field peas can be seeded together in April.
- Incorporate cover crops before seed matures fully.
- Seed a second, and perhaps even a third, crop of oats incorporating them before seed matures fully.
- Mark out the planting area.
- If necessary, add lime to the planting area and incorporate it; do not apply lime within one month of applying boron or nitrogen.

5.1.2 If fumigant is being used in soil prior to replanting

- Contact Pesticide Management Regulatory Agency to complete an approved fumigation management plan prior to applying any fumigant.
- If trees can be removed after harvest and ground is still warm enough (10°C) then fumigant can be applied in the fall.
- Apply fumigant; follow directions carefully.
- If fall application is not possible, apply fumigant as per label directions in spring as soon as soil is warm enough.
- Leave soil undisturbed for about 2 weeks after fumigation.
- Aerate soil by shallow discing or cultivation.
- Leave for another week.
- Before planting, check for the presence of fumigants with a germination test: Plant lettuce, cucumber or cress seeds in a closed jar in soil from the fumigated plot.
- At the same time, plant similar seeds in soil from an untreated area.
- Compare germination rates of the two seedlings.
- If after a few days, germination in the treated soil is poor, repeat the test at 2 to 3-day intervals until germination appears normal, that is, similar to germination in the untreated soil sample.
- Plant trees as soon as tests indicate soil is free of fumigant

5.2 Tree Handling and Planting

Trees can be planted in early spring or fall, but fall planting risks winter damage in some years. Planting must also fit around fumigation. Airing out following fumigation should be done as soon as the ground can be worked in spring if planting is to be done then. Every attempt should be made to get the trees planted as early as possible in the spring.

Early planting aids root growth in particular. New roots form when soil temperature reaches 7°C, but existing roots start to grow at temperatures lower than this. The most active period of root growth extends into May and starts again towards fall. Root growth is slowest in summer when the above-ground tree parts are growing more rapidly.

Plant trees before the buds have begun to break and the roots to grow. Late planting of non-dormant nursery stock may inhibit tree growth and reduce the chances of survival.

5.2.1 Handling trees

- Handle trees carefully and never allow the roots to dry out; dehydrated plants may take several seasons to return to normal activity.
- Keep trees protected from wind and sun; cover when hauling.
- Cover roots with damp sawdust and keep all tree parts covered for transport from nursery.
- If planting soon after trees are received, place trees in a clean barrel of clean water for 6 to 12 hours.
- If trees cannot be planted for several days, store in a protected site free from wind, sun, and frost; break

.

NOTE: Never store trees in a fruit storage room as ethylene gas released from fruit can injure trees. Ethylene can persist even after the fruit has been removed unless the storage area has been thoroughly ventilated.

5.2.2 Before planting

- Roots can be pruned back to accommodate ease of planting.
- Remove any galls on roots.
- Dig holes with a shovel or an auger, or use a tree planter.
- If a shovel or auger is used, do not dig holes so far in advance of planting that the soil dries out.

NOTE: An auger can create glazing on the walls of the hole in all but the coarsest soils. This inhibits drainage, root penetration, and moisture transfer. If augers are to be used, be sure to break up the glazed surface with a shovel or fork. Augers can be modified by welding on flanges which reduces glazing.

5.2.3 Fertilizing with a high phosphorus fertilizer

- A planting-hole granular or liquid fertilizer is strongly suggested.
- Granular material (1 gm per litre soil of 11-52-0) must be well mixed with the soil or roots will be injured.
- Various high phosphorous soluble formulations have been used successfully. They can be mixed with water and applied to the ground or injected into the irrigation water following planting.
- Aim for 70 g P_2O_5 per tree in the first season in one to four applications starting immediately at planting.

5.2.4 Planting

It is critical that trees be planted at the correct depth.

- Plant trees on size-controlling rootstock so that the bottom of the bud union is 3”-4” above the ground after the hole is filled and smoothed out, and the ground has settled.
- The standard rule for trees not on size-controlling rootstocks is to plant them 1”-2” deeper than they were in the nursery.
- Trees can settle, so inspect height after planting and gently pull trees up to the correct height.
- If trees are planted with the bud union in the ground, the scion can root and the dwarfing effect of the rootstock will be lost.
- While planting, protect the trees from the drying effects of heat or wind.

- For maximum uniformity Plant the tree so that the bud union are all in the same direction.
- For slender spindle plantings, plant trees about 4" away from posts.
- Firm soil around roots.
- By end of day water trees in. If hand watering add phosphorous fertilizer to water. Remove any tree tags as these can damage trees as they grow.

5.2.5 After planting

5.2.5.1 Apples

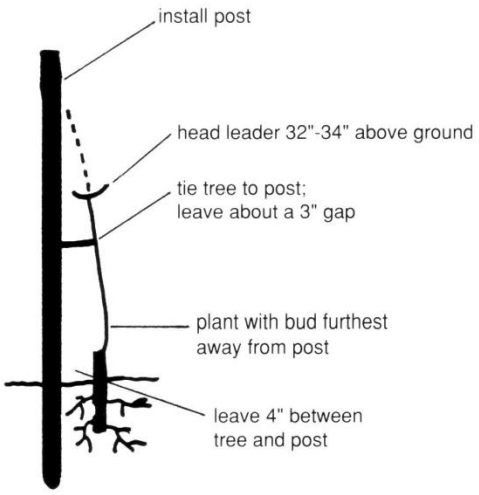
- Cut back whips to 32" to 34" from the ground (see diagrams a & b, p.22).
- On feathered trees, do not cut leader shorter than 8" above the top feather on slender spindle trees (see diagrams c & d, p.22).
- Do not cut the leader on feathered vertical axis trees (see diagram e, p.23); leader is not headed, except on whips in the planting years. To stimulate development of flat-angled shoots from leader, 2-3 shoots below terminal shoot are pinched by removing terminal when shoots are 3" to 4" long; 2 to 3 pinchings at 10 to 14-day intervals are required.
- For both systems remove any feathers closer to the ground than 20".
- If feathered trees do not have at least 4 full, well-spaced feathers starting at 20" from the ground, remove the feathers and treat the trees as whips (see diagrams c & f, page 22-23)

There is considerable debate over whether or not to head back feathers at planting time. Heading back of trees that grow well results in delayed cropping and excessive vigour.

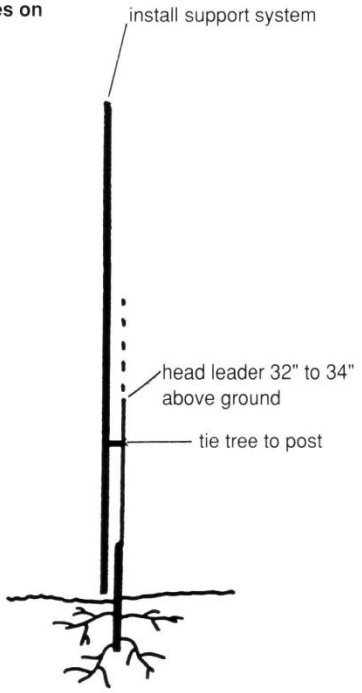
Whether or not to head feathers should be based on the variety's response to heading. Some varieties, most notably Spartan and Fuji, do not benefit from heading feathers. If these are to be headed at all, it is best to delay until the trees start to show new growth.

For other varieties, heading back should not be necessary if the trees have good root systems, replant problems have been taken care of, the trees are planted early and management is good. If these conditions have not been met, however, and past experiences has been of poor tree growth, then heading may at least help the trees get off to a better start. Head feathers back to about 12"-15" long.

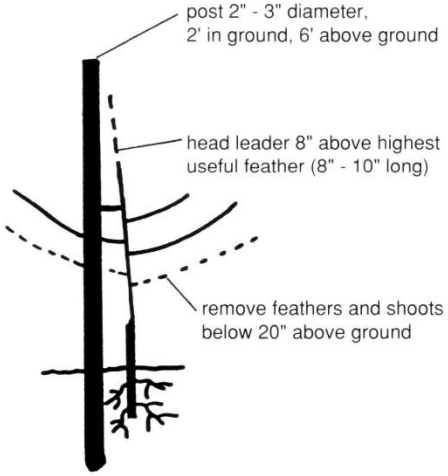
Post-Planting Treatment of Whips and Feathered Trees on Slender Spindle and Vertical Axis (Apples)



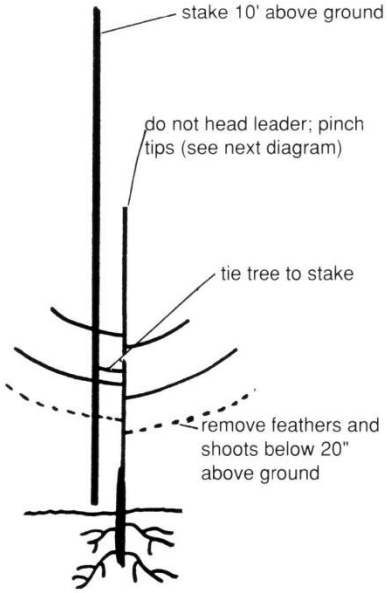
a) **Whip treatment for slender spindle**



b) **Whip treatment for vertical axis**



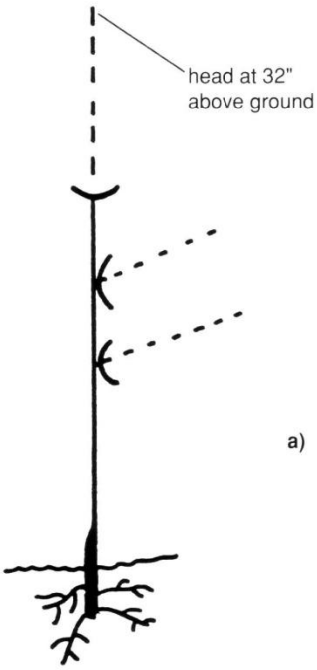
c) **Planting-year treatment of feathered tree for slender spindle**



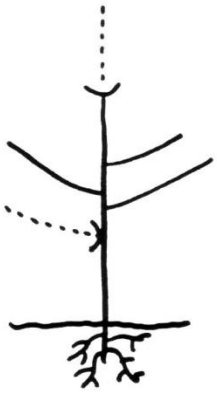
d) **Planting year treatment of feathered tree for vertical axis**

Post-Planting Treatment of Whips and Feathered Trees of Pears and Soft Fruits

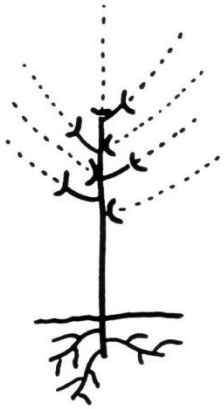
e) **Leader treatment of feathered trees on vertical axis**



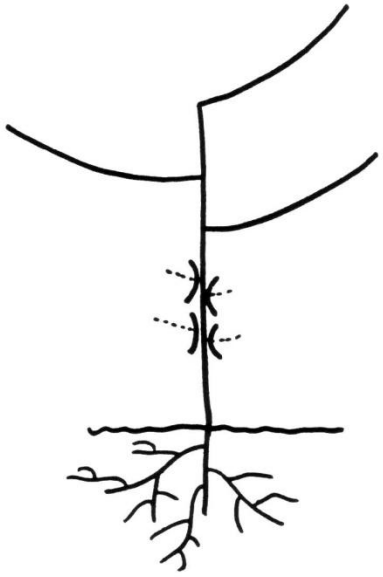
f) **Feathered trees lacking good feather arrangement**



a) **Pruning feathered trees for central leader**



b) **Pruning feathered peach trees to modified open centre**



c) **Additional treatment to note for all tree fruits and training systems**

5.2.5.2 Stone fruits and pears

Pears are normally trained to a central leader (see diagram a, p.23).

- If whips are planted, head back leaders to 32" to 34".
- If feathered trees are used, remove low feathers (to 20" above ground level).
- Select 4 to 5 well-spaced feathers and remove all others.
- Depending on strength of feathers, head back the leader 8" (weak feathers) to 3' (strong feathers) above the highest, full-length (8-10") feather.

Cherries are normally trained to a modified central leader or a central leader.

- If whips are planted, head back leader to 36".
- If feathered trees are planted, first remove low feathers; choose 4 to 5 well-spaced feathers and spread any sharp-angled feathers.
- Head leader back to about 3' above top feather.

Apricots, prunes, and plums are normally trained to a modified open centre tree.

- Treat trees as whips; that is remove any feathers, and head back to 32" to 36" above ground level.

Peaches are normally trained as a modified open centre tree (see diagram b, p.23). Nursery trees are usually feathered.

- Head to 36".
- Remove all feathers below 20" above the ground.
- Head feathers back by 1/3". With fumigated trees wait until until bud push to prune as many buds may be dead.

5.3 Support Systems

A strong, straight support system is crucial to the long term viability of the planting. Do not under engineer the trellis.

- Posts and trellises are usually installed after the trees are planted. Do this as soon as possible after planting is completed.
- Use properly treated posts.
- Posts for slender spindle and super spindle plantings are usually pounded in.
- When pounding posts in, place small end down; when setting posts by hand, place large end down.
- In trellis plantings, space row posts evenly between trees.
- When installing posts for slender spindle, leave about 4" between the tree and the post.
- Place posts so that the prevailing winds move the tree away from the post.
- As soon as supports are installed, tie trees to the post, or wire; on slender spindle trees, tie so that there is about a 3" gap between the tree and the post.

For complete details on support systems, refer to K. Bert van Dalfsen, *Support Systems for High Density Orchards*, BCMAFF.

6.0 HELPING THEM GROW

Once the trees are planted, considerable care and attention are needed to get them growing well. The aim should be to have at least 2' of terminal growth on whip branches in the first season. To achieve this, particular attention must be paid from the beginning to nutrition, pest control, irrigation, weed control, and unwanted growth.

6.1 Nutrition

6.1.1 Using fertigation

- If using fertigation, see Peter Waterman, *Fertigation Guidelines in High Density Apples and Apple Nurseries in the Okanagan Similkameen*, BCMAFF, 1993.
- In addition to fertigation, apply foliar nutrient sprays at about 10-day intervals starting when the new growth is about 5" long; complete by mid-July to ensure that trees do not grow too late into the fall.
- 6 to 8 sprays will be needed; use nitrogen, zinc and magnesium in all applications; in the third or fourth application, add foliar boron to the mix.

The following chart list rates for the various nutrients:

Material	Rate Dilute Application Per 100 L
20-20-20	1 kg
Zintrac (40%)	50mL
Magnesium Sulphate/Epsom salts (24.6%)	600g
Urea (46-0-0)	500g-1kg
	Depending on vigour, use lower rate when fertigating
Solubor (20.3%) to be applied only once	25g

6.1.2 Not using fertigation

- Apply nitrogen to soil, 2 applications 3 to 4 weeks apart.
- Start applications 2 to 3 weeks after trees start showing growth.
- Use 2 or 3 oz. (56 or 84 g) of 46-0-0 per tree, or 15.5-0-0 at 5 oz. (141 g) per tree or Can27 (27-0-0) at a rate of 2.9oz (81g) per tree.
- Do not apply nitrogen after mid-July as this could encourage late season growth which is susceptible to damage from low temperatures.
- Scatter nitrogen evenly around trees rather than leaving it in lumps; roots can burn from heavy concentrations of salt watered into the root zone.
- Follow the foliar nutrient program as given in section 6.1.1, p. 25.

6.2 Pest Control

Pests and diseases can affect the growth of young trees more than they would mature trees. For example, insect and powdery mildew levels considered safe for mature trees can often inhibit the growth of young trees. The most notable problems are apple leaf curl midge, mites, leafhoppers, aphids, leaf miners, and powdery mildew, but fireblight has become a problem with some of the new apple varieties.

Ensure good pest control by knowing the insects and following control recommendations in the Tree Fruit Production Guide. Sprays for powdery mildew, should be applied every 7 to 10 days as the new growth must always be protected. Start the mildew program when first leaves have formed.

6.3 Irrigation

Irrigation of newly planted trees must be timed according to soil moisture conditions. Never allow the soil to dry out as trees that are set back in growth will grow poorly, if at all, through the rest of the season.

On the other hand, be careful not to over-irrigate, especially early in the season as waterlogged soil can kill trees. During the season, irrigate newly planted trees more often with less water per application than for established trees as the former's roots are still shallow.

6.4 Weed Control

Poor weed control is one of the main reasons for poor tree growth. Weeds compete with trees for water and nutrients, and inhibit tree growth. Keep the newly planted trees free of weeds through August.

Weeds can be controlled by hand, tillage, mulching, herbicides or a combination of these. Because newly planted trees can be easily damaged, extra care must be taken with any method when tilling, hoeing or spraying chemicals. Protect the trunks with paint like material for light reflection (winter injury) and increased resistance to herbicides. Do not use gylphosate products (Round-up) in year of planting.

6.5 Unwanted Growth

Shoots will develop from the trunk below where branches are desired; that is, lower than 20" above the ground. Remove these regularly when they are about 3" long. Otherwise, they take vigour away from where it is needed and wanted. Pinching back to a stub of vigorous shoots that compete with the leader should be done as they develop.

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