Propagation by Grafting

Propagation by Grafting

Grafting

Grafting is a term which covers many propagation techniques

It includes the scion or the above ground part of the plant

Scion

A piece of detached twig or shoot. The scion usually contains two or three buds, although it may contain more. When the scion is only a single bud, the type of grafting is known as budding.

Cultivar

This is a term now used in place of variety. It means cultivated variety and differentiates a plant from a botanical or natural variety.

The rootstock or lower portion of the grafted plant

The rootstock provides the root system for the new plant

Rootstock (also stock or understock)

This term means the part of the graft that produces the root system of the grafted plant. It must be related to the scion and often has dwarfing or other desirable characteristics.

Interstem on fruit trees help dwarfing or incompatibility

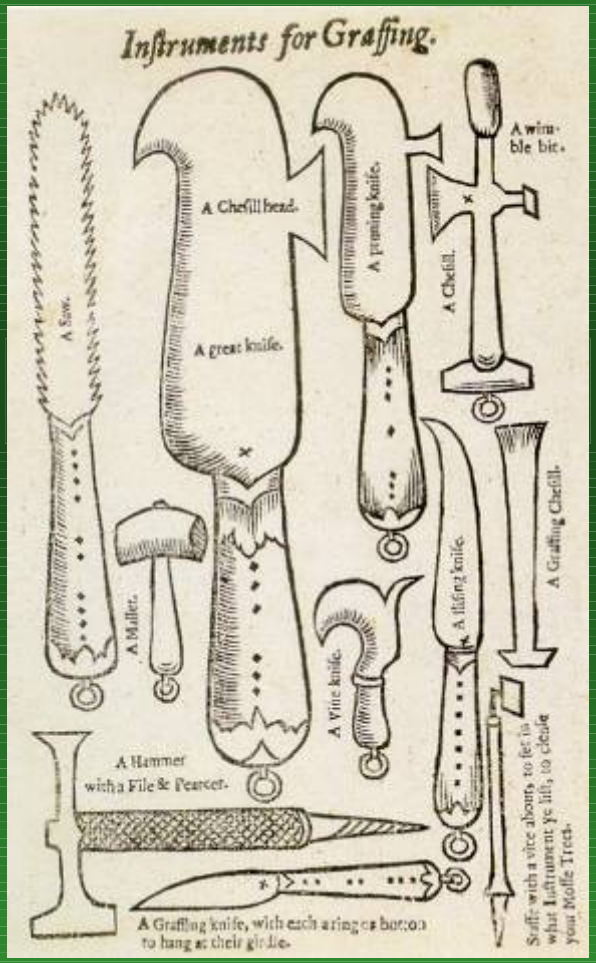
Interstock (also interstem)

This is a piece of plant (usually to form trunk or a portion of it) grafted between the scion and understock

Grafting with interstocks is double working

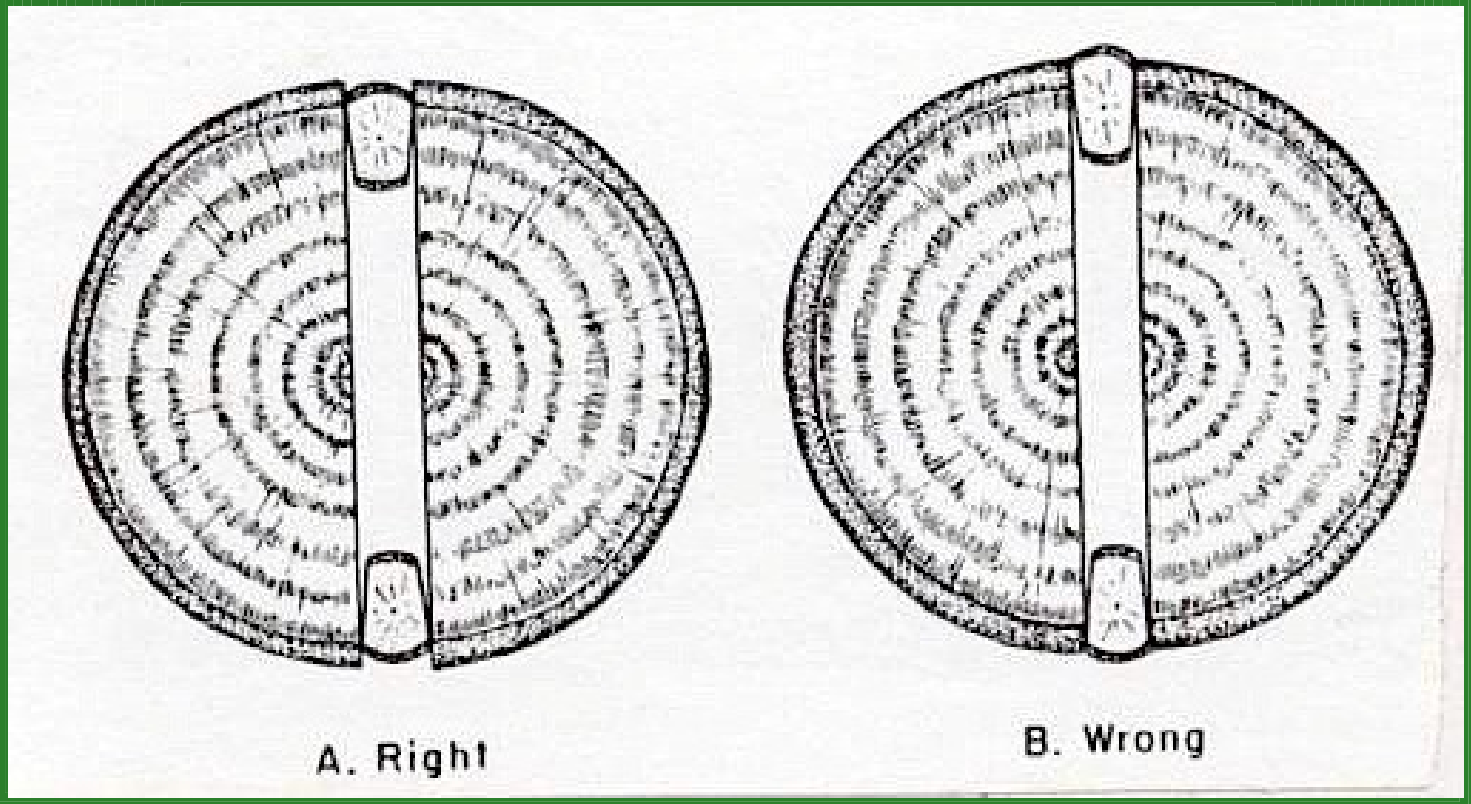
- **Interstocks are not normally needed with ornamental plants**

Grafting Tools

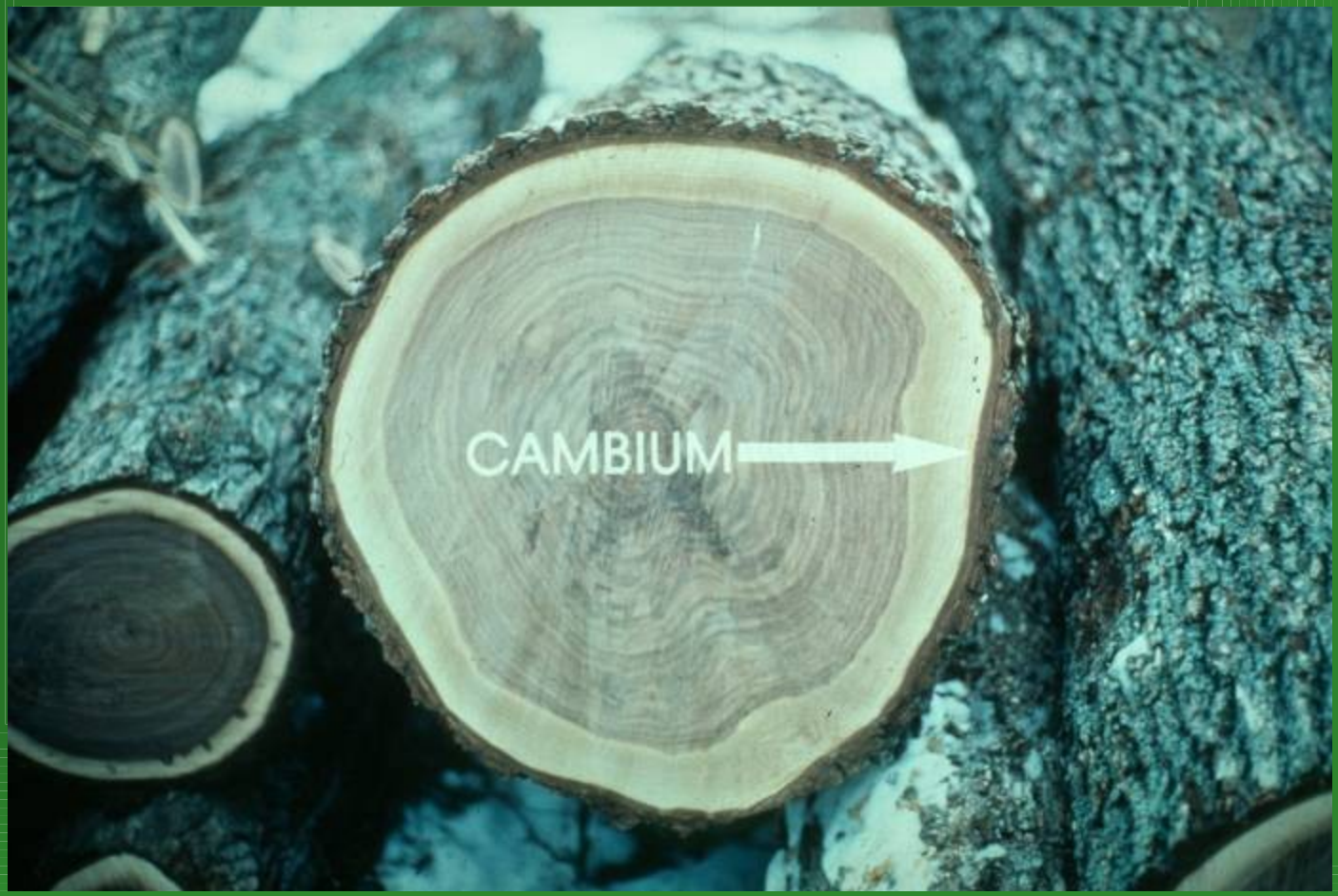


When grafting, make clean cuts in the tissue of the two pieces

The cambium tissues must match together



Cambium is the meristematic tissue layer in woody plants



It is a layer of tissue immediately under the bark in stem and roots

The botanical limits of grafting

Grafting within species

Grafting of species within the same genus

Grafting of different genera within the same family

- *Pyrus communis* (Pear)

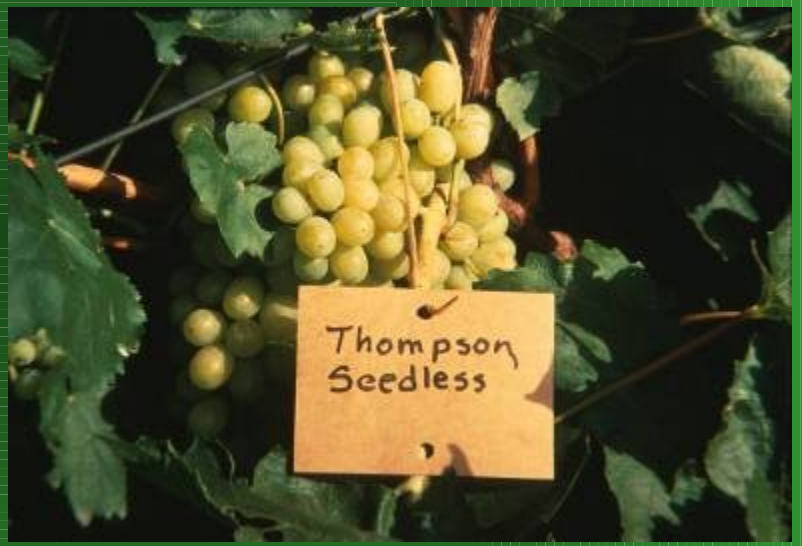
- *Cydonia oblonga* (Quince)

Grafting between families

- Plants of different families cannot be grafted successfully Reports of relatively short-lived grafts of herbaceous plants of different families have been made but there is no successful commercial or home grafting of different woody plant families

Reasons for grafting plants

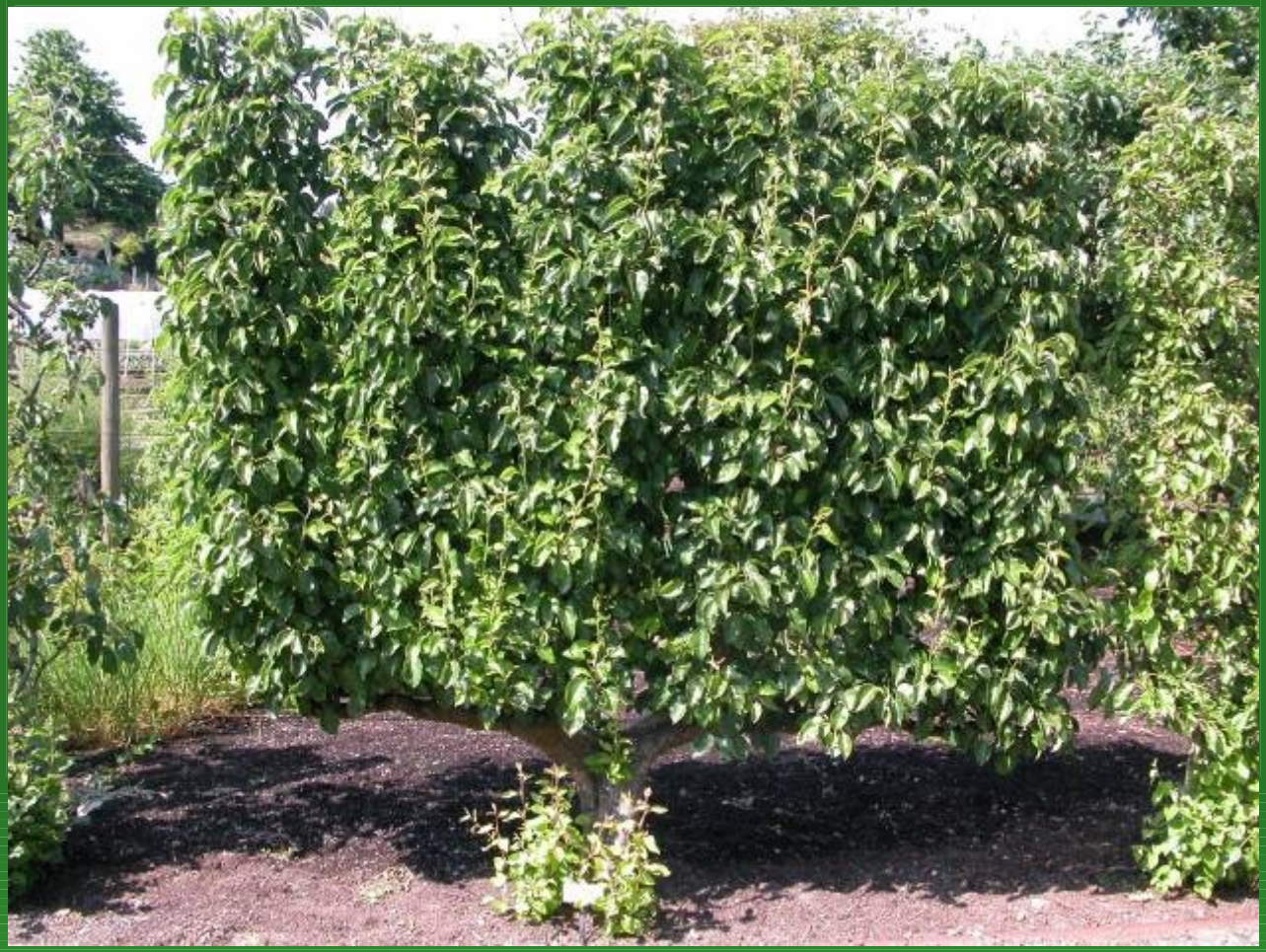
Propagate plants not economically done other ways



Cultivars of ornamental shrubs and trees

To control tree growth and performance

Apple and pear orchards

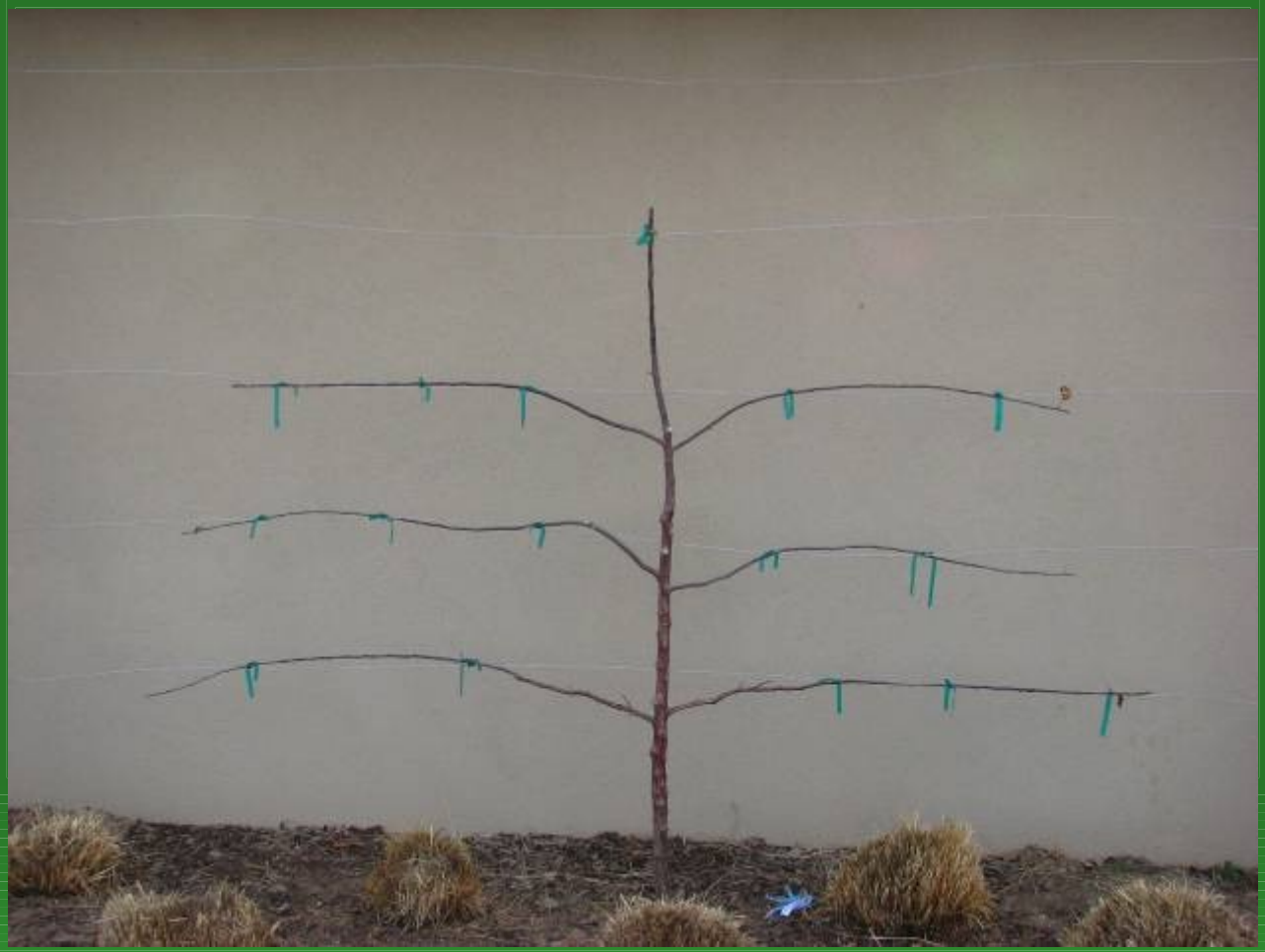


Malling series and other dwarf rootstocks

Malling 27, 26, 9 and other dwarf rootstocks

To control grape phylloxera, fire blight and other pathogens

To bring fruiting plants into production earlier



Add a pollinator

All fruit crops are commercially grafted

Fruit at 2-3 years

Grafting to obtain special effects in plants

Weeping standards

Multiple cultivars on the same tree

Preserve old cultivars

Grafting as an orchard management technique

Top working of fruit trees to change varieties

Frame working of fruit trees to assist pollination

Successful grafting needs

Time of year

Active growing stock

Dormant scion

Scion material at correct stage of growth

Growing environment

Healthy, growing trees without pest problems

Maintain correct polarity of stock and scion

The proximal scion end is fitted to the stock distal end

Incompatibility in grafting

Graft compatibility means two closely related plants will graft

There is no physiological or morphological reason for a union

Graft incompatibility occurs when

- **Morphological or physiolo**
  prevent related rootstock / **n**
  forming a strong union

Incompatibility is not common with ornamental plants

Most rootstocks used for grafting are closely related to the scion

TREE FRUIT COMPATIBILITY

STOCK \ SCION	ALMOND	APPLE	APRICOT	CHERRY, SOUR	CHERRY, SWEET	PEACH	PEAR	PLUM, EUROPEAN	PLUM, JAPANESE	QUINCE
ALMOND	X					X				
APPLE		X								
APRICOT			X			•		X	X	
CHERRY, SOUR				X	X					
CHERRY, SWEET				X	X					
PEACH	X		X			X		X	X	
PEAR							X			
PLUM, EUROPEAN	X		X			•		X	X	
PLUM, JAPANESE			X			•		•	X	
QUINCE							•			X

Trees bearing multiple types of fruit can be created by grafting or budding wood from one fruit type, or the scion, on to a tree, or the stock, of another fruit type. The chart above indicates compatibility between fruit types. The symbol • indicates that the combination is possible but may be short-lived or weak.

Vegetative propagation can transmit diseases

There are two basic grafting systems

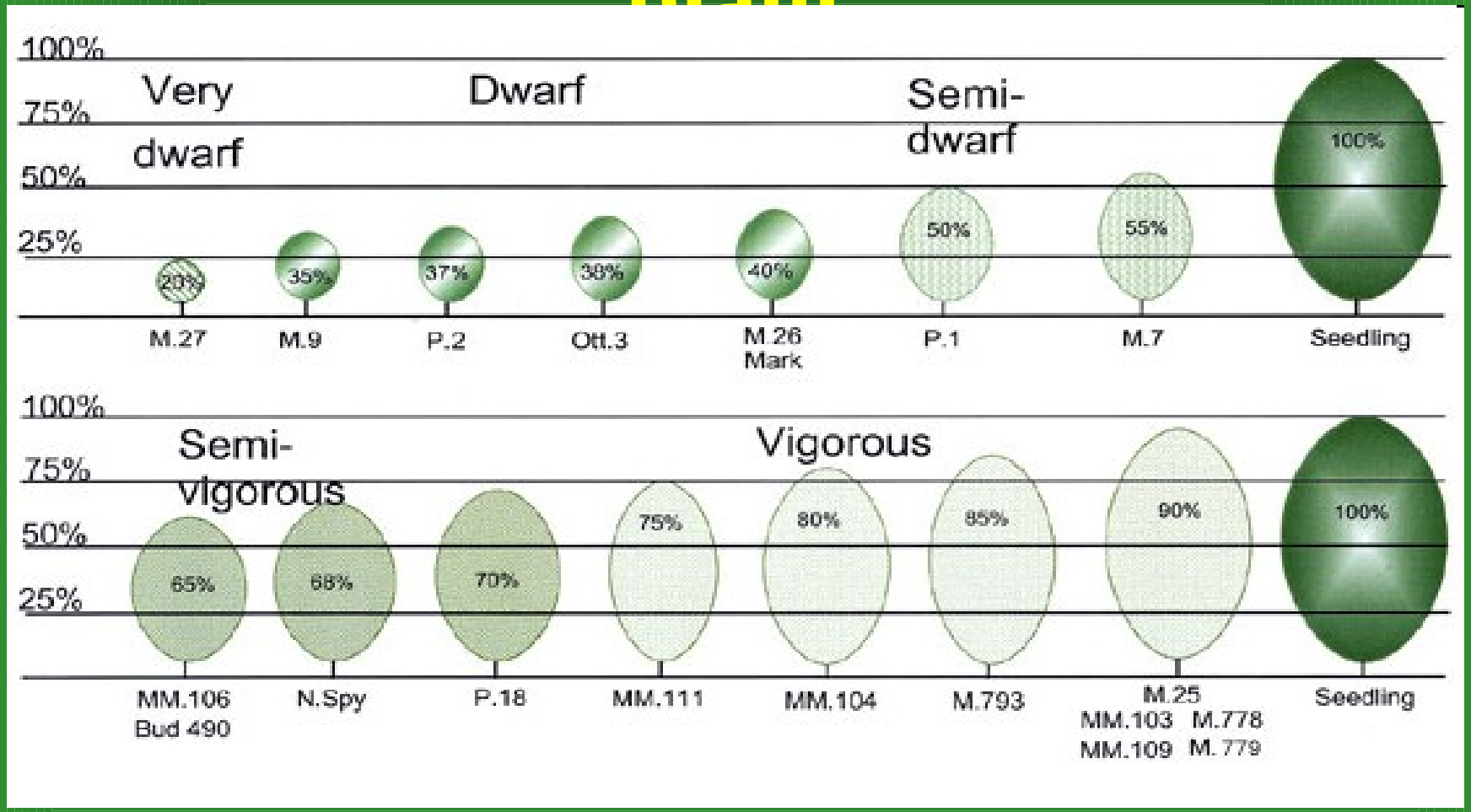
Field Grafting –rootstocks are grown and grafted in the field

Selection of suitable rootstocks

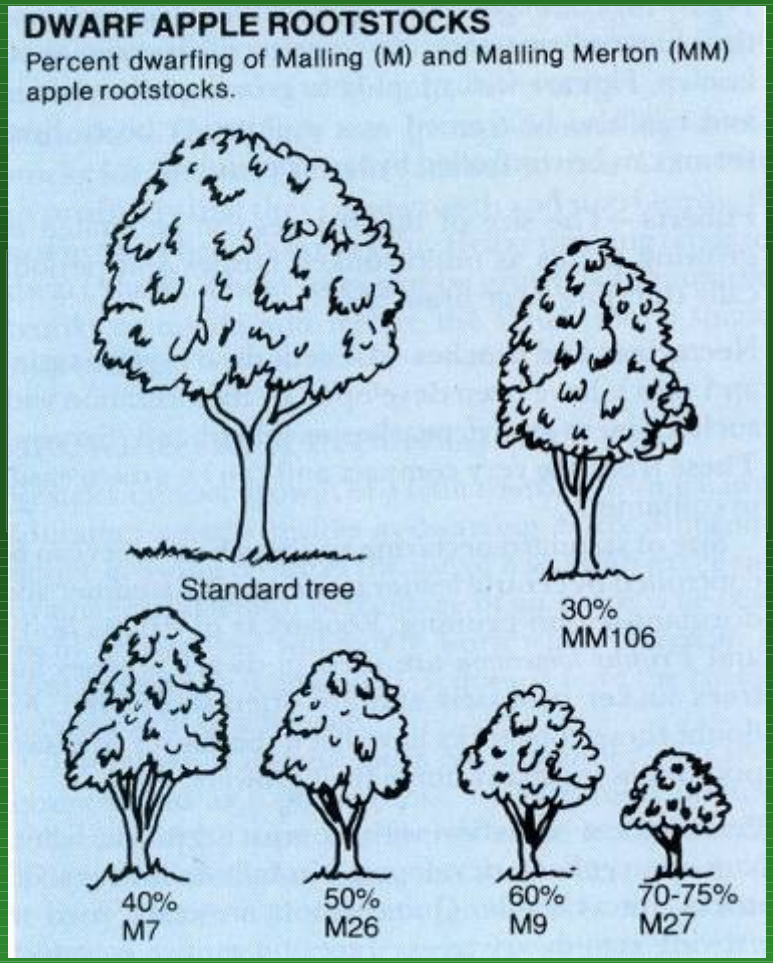
Ornamental rootstocks used are closely related species to the scion

Seeds are easy to propagate and fast growing

The rootstock vigor determine size and vigor of the grafted plant



This controls the size of fruit trees and shrubs




GK MACHINE
GK

Budding is a contraction of BUD GRAFTING

The scion is a single bud

It uses scarce scion material economically

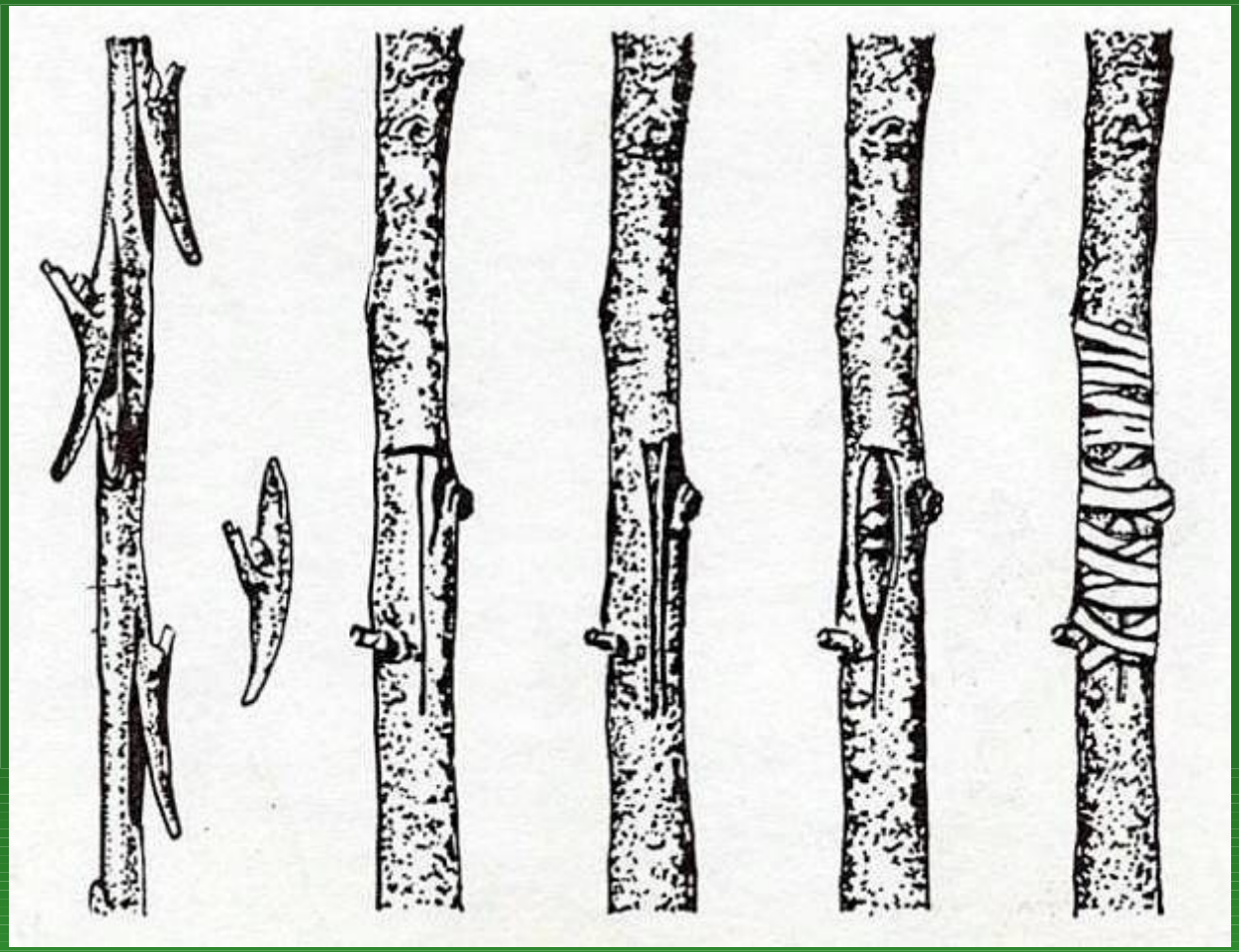
Simple to learn

Fast to do

High success rates (95-100% common)

Budding produces a strong union

T-budding



T-budding

T-budding

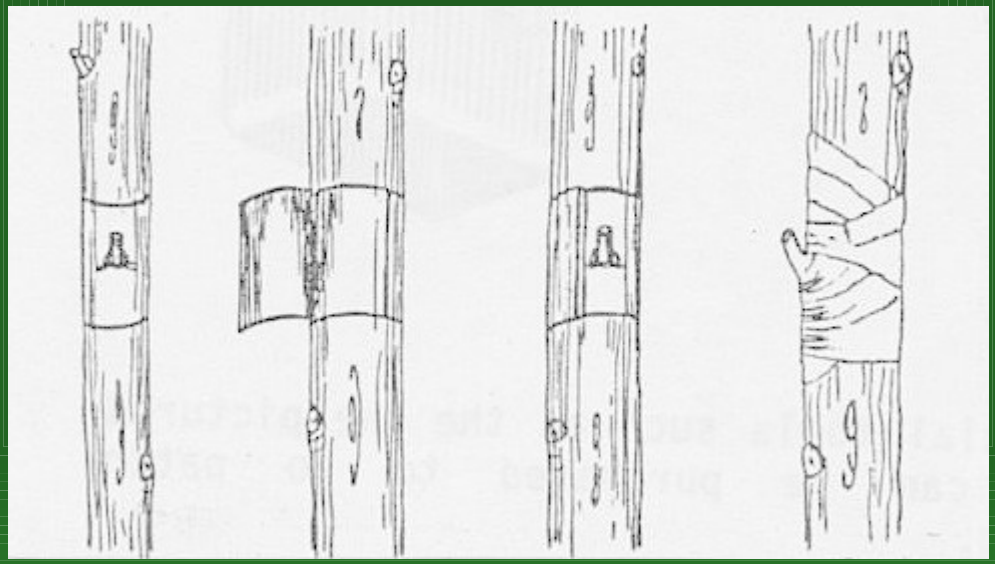
T-budding

T-budding

T-budding

Chip budding

Patch budding



Plants that are budded

Deciduous fruit trees

Nut trees

Citrus

Roses

Roses

Ornamental trees

Top grafting

In top grafting the top is removed from the rootstock

The scion shoot is grafted in to the top end of the rootstock stem

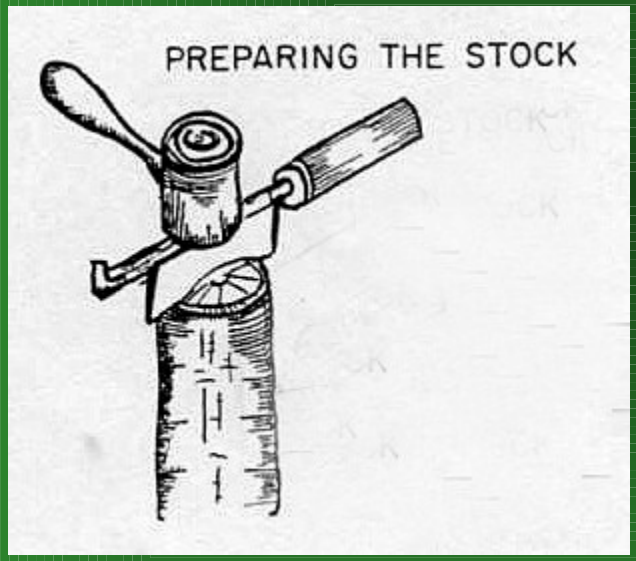
Used both in the field and in bench grafting

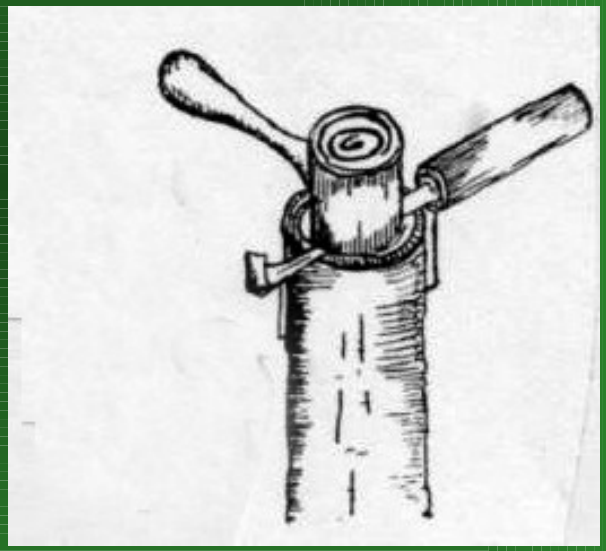
Top grafting is much slower than budding

Many styles are complicated to carry out

Used in spring when t-budding is not possible

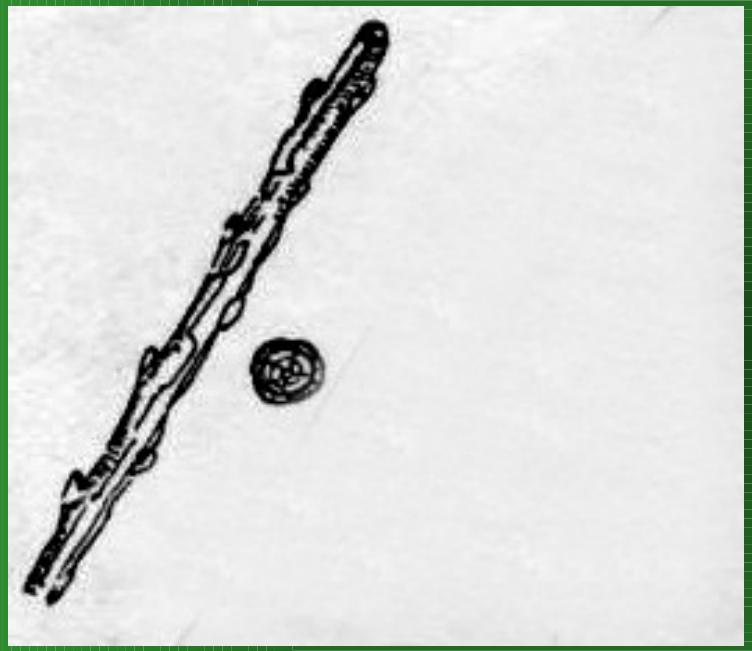
Cleft grafting





Cleft grafting

Cleft grafting



Cleft grafting

Cleft grafting

Cleft grafting

Cleft grafting

Cleft grafting

Cleft Grafting

Cleft Grafting

Bark Grafting

Bark Grafting

Bark Grafting

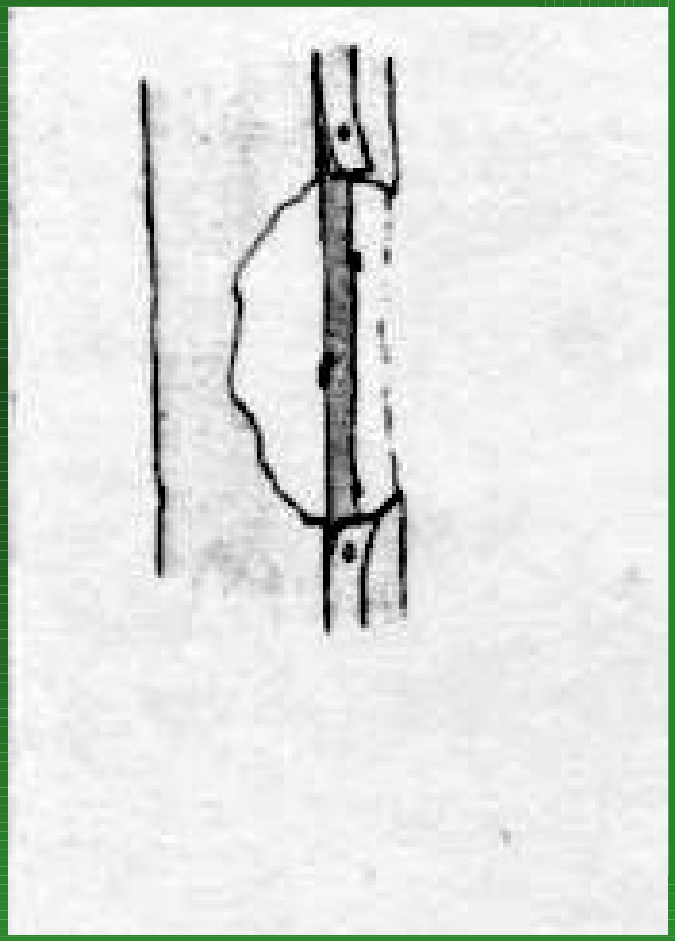
Bark grafting of walnuts

Bark grafting of walnuts

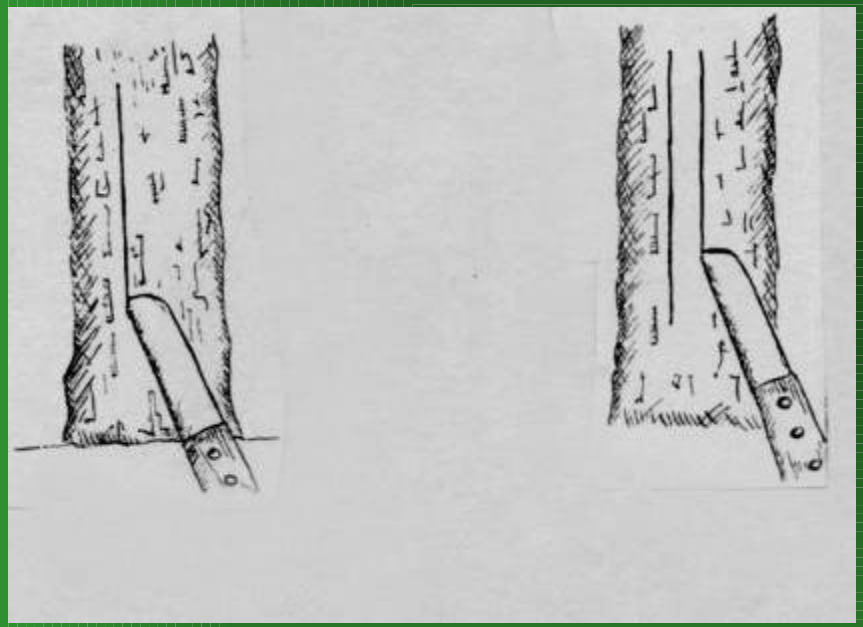
Bark grafting of walnuts

Bridge grafting

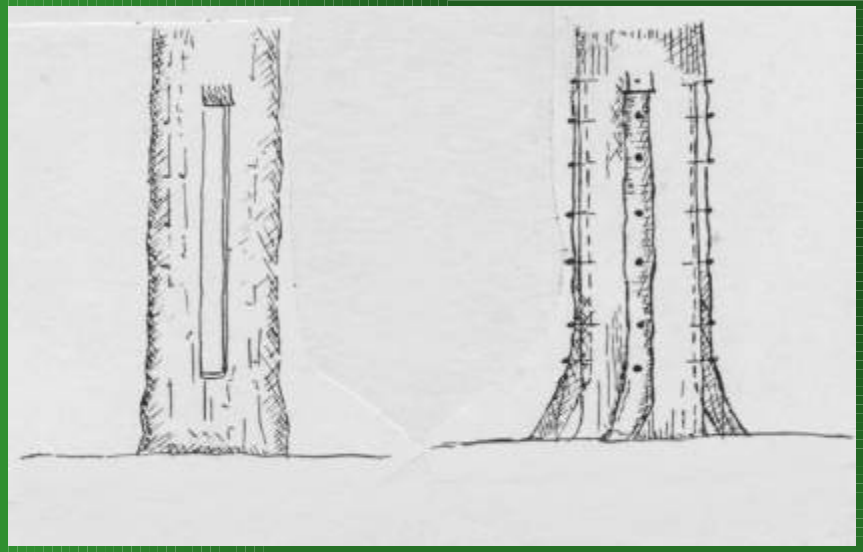
Bridge grafting



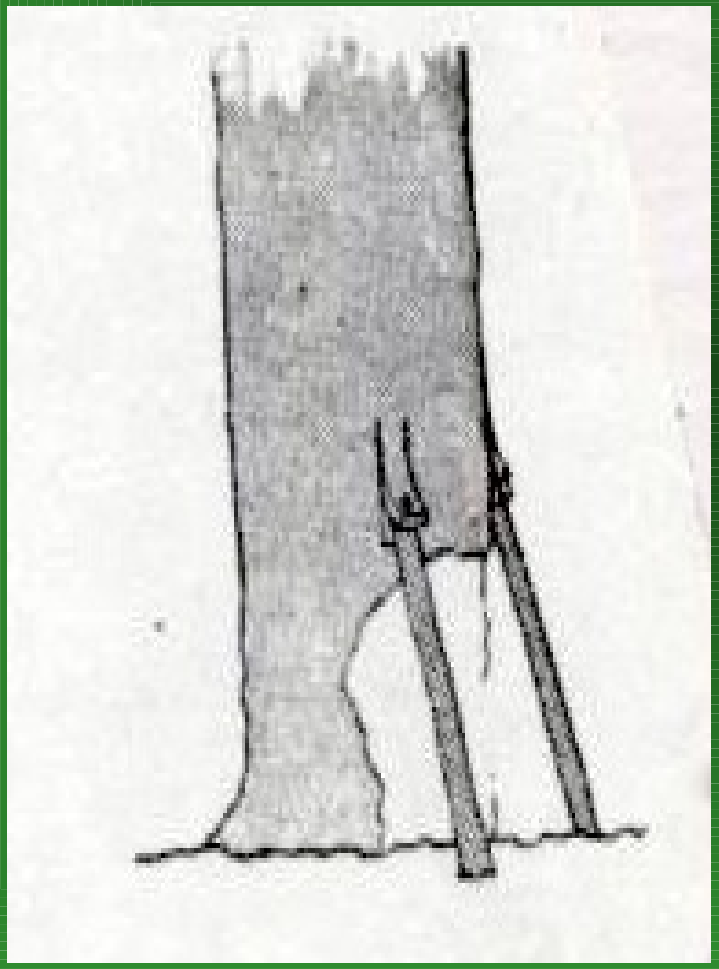
Bridge grafting



Bridge grafting



Inarching bridge grafting



Bridge grafting

Examples of top grafted plants

Many species do not respond well to top grafting

Once the top is removed from the rootstock

- Uptake of water and mineral nutrients is restricted
- This prevents a graft union from forming

Graft the scion onto the side of the rootstock in side grafting

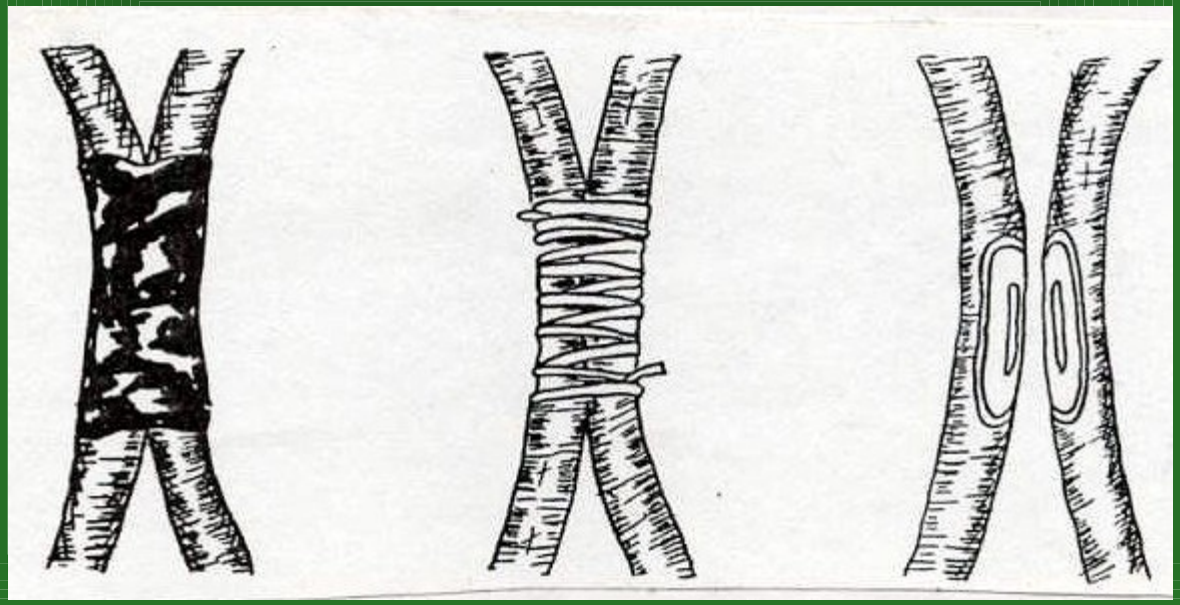
The top stays on the rootstock for moisture and nutrient uptake

Side grafting is only done on container grown rootstocks

The grafted rootstocks is grown on in a greenhouse

Collect dormant scion material in winter and cold store until use

Approach grafting



Approach grafting is an old fashioned horticultural curiosity

Usually considered to be the last resort in grafting

Approach grafting

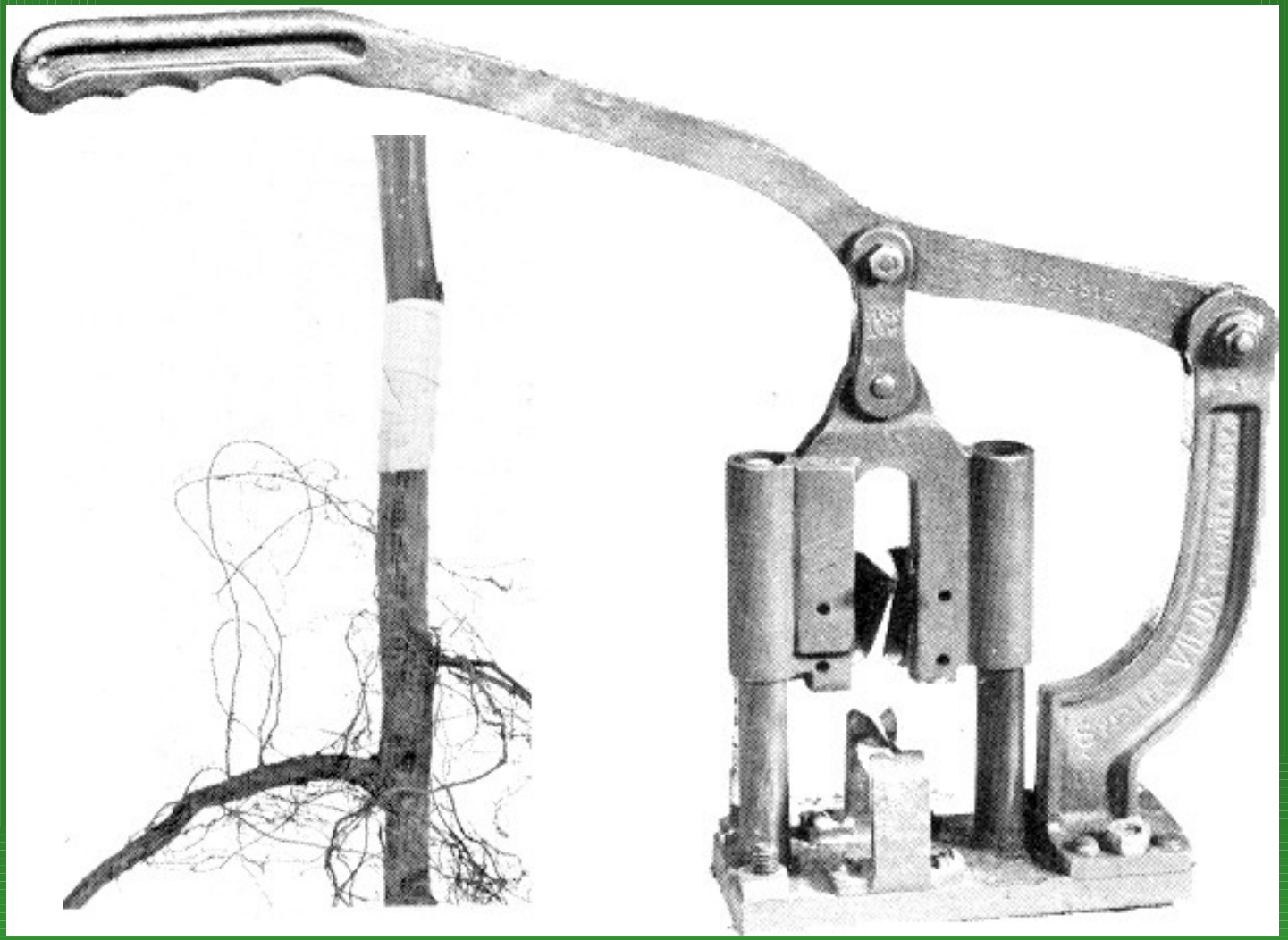
- In approach grafting the scion remains attached to the mother plant until the graft union forms

It is used to graft tomato varieties onto disease resistant rootstocks

Grafting unrooted cuttings eliminates rootstock production

The unrooted cutting roots develops as the graft union heals

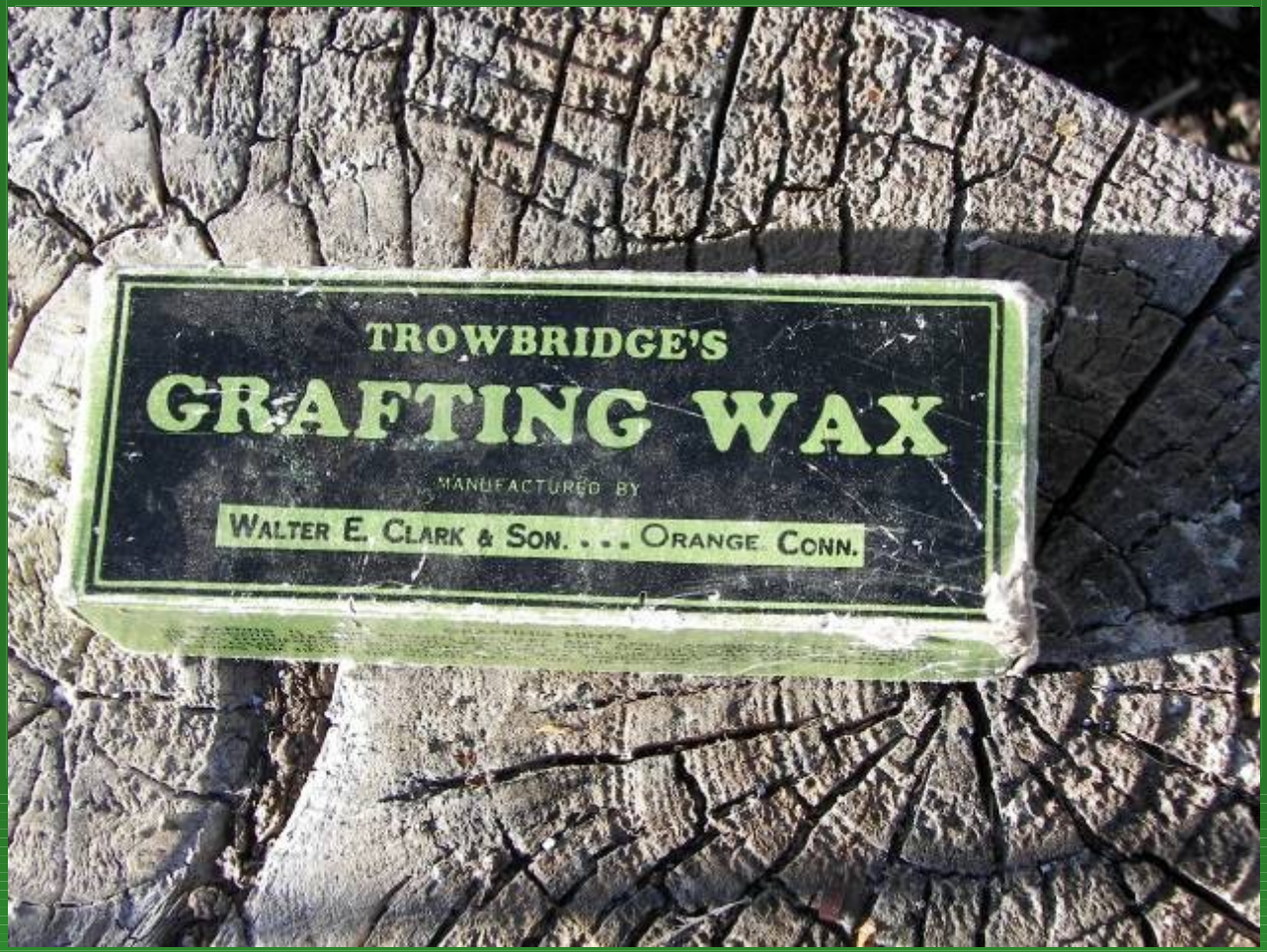
Grafting machines speed up the grafting process



It also enables the grafting to be carried out by less skilled staff

Scions and rootstocks must match in diameter

Several materials are used for securing the graft union



It depends on grafting technique and post-grafting environment

Tie or wax the union is to keep it from drying out

Tying materials for grafting

- Grafting Wax
- Toilet Bowl Wax
- Silicon Seal
- Plastic Roofing Cement
- Others?

With t-budding, use rubber bands that disintegrate

PVC tape is used but must be cut off after the graft forms

Use laboratory “Parafilm”

- This thin, stretchable tape keeps the graft union from drying out
- It degrades rapidly so it does not need to be removed

Reasons for failure

- Stock and scion were not compatible
- The cambiums were not meeting properly
- Scions were upside down
- Grafting was done at the wrong time

Reasons for failure

- Scions were dried out or injured by cold
- Scions were not dormant
- Stock and scion were not compatible
- The scion was displaced by storm, birds or other means

Reasons for failure

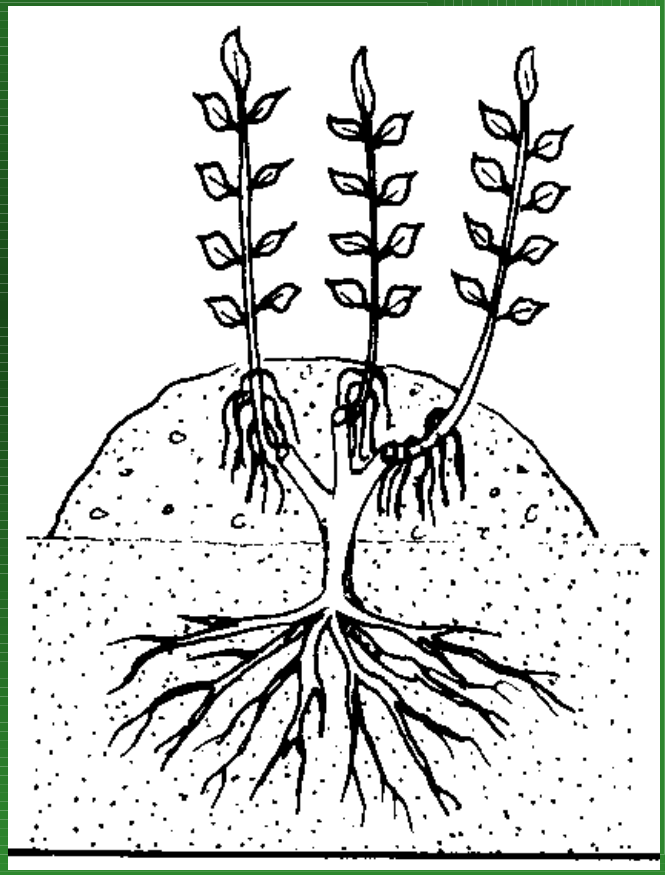
- The graft was not properly covered with grafting wax
- The graft was shaded too much by other growth
- The graft was attacked by insects or disease
- The graft union was girdled because tape was not cut or released in time

ROOTSTOCK NURSERY

- ROOTSTOCKS ARE PRODUCED IN SPECIALIZED NURSERIES
- CLONAL ROOTSTOCKS ARE PRODUCED WITH MOUND LAYERAGE
- SEEDLINGS ARE PRODUCED FROM SEED SOWN IN THE NURSERY ROW

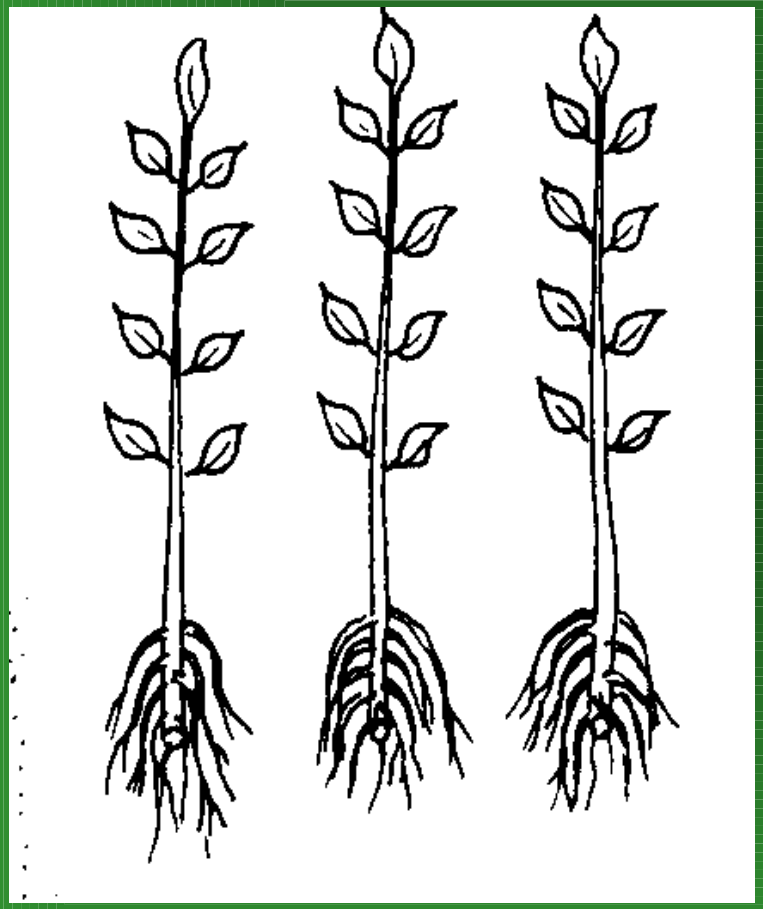
Mound layering:

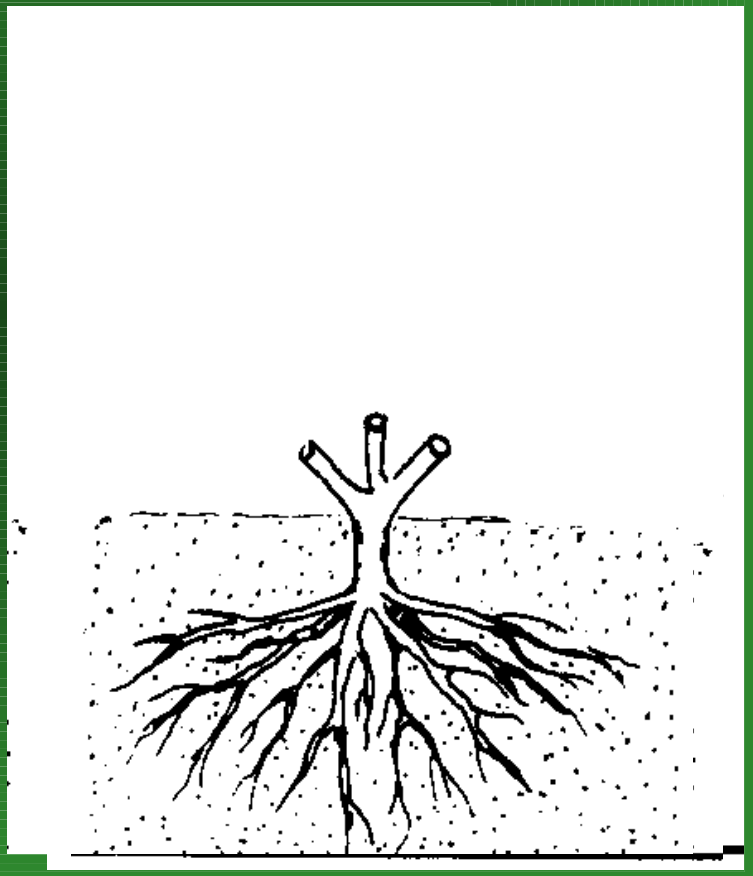
- Strong root systems are developed in rows The shoots that arise are cut back close to the root each year to force plants As the plants grow media is mounded around the shoot base for rooting



MOUND ESTABLISHMENT

Mound layering:





Layering:

Mound Layering Media

- **Sawdust or sawdust with added ingredients is added several times during the summer to induce ideal rooting conditions at and above the crown of the growing rootstocks**

Relative Size Compared to Seedling

Parentage

M.9 was selected at East Malling from a number of stocks of Juane de Metz, a rootstock with a very long history. The original M.9, of which a number of variant clones are now known to exist, was followed in 1962 by M.9a. Most of the M.9 clones and the M.9a clone were subsequently shown to be infected with latent virus and a replacement clone was prepared at East Malling by heat treatment and designated EMLA 9.

Influence on Scion Habit

EMLA 9 has a dwarfing influence on all scions worked on it. It induces cropping early in the life of the tree. Moreover, the fruit is larger and ripens earlier in the season, especially during the early years of the tree's life.

Trees on EMLA 9 show a wide degree of tolerance to soil conditions, withstanding heavy soils and wet conditions. It is not however suitable for dry light soils.

M.9a is a weaker rootstock than M.9. EMLA 9, though free of viruses, is distinctly more vigorous than M.9. All 9's rarely sucker, but their roots are brittle, and trees on these rootstocks require staking throughout their life.

Disease Resistance

EMLA 9 is resistant to collar rot (*Phytophthora cactorum*). It is susceptible to mildew in the nursery and a regular spray program is recommended.

Nursery Habit

EMLA 9 roots well under our controlled conditions. With our good quality rootstock, well feathered maiden trees can be produced.

Horticultural Value

In spite of some difficulties in producing 9's in the nursery, they are very widely used and can be recommended as dwarfing stock for all soils, excepting light soils in low rainfall areas. They are useful for high density plantings and as a temporary filler in plantings of trees on more vigorous rootstocks. Their ability to produce high quality fruit, in terms of better size and color, has led to their very widespread use in all apple growing areas of the world.

Oregon Certified
EMLA 9

CLONAL ROOTSTOCKS

- **APPLE**
  - MALLING
  - RUSSIAN
  - POLISH
  - NEW YORK (GENEVA)
  - MICHIGAN
- **PEAR**
  - OREGON

APPLE ROOTSTOCKS

- M 27 – 20-25% SDLG
- M 9 – 25% SDLG
- M 26 – 33% SDLG
- M106 – 50% SDLG
- M 7 – 50-60% SDLG
- M 111 – 66% SDLG
- EMLA = VIRUS FREE STOCKS

- GENEVA 65
- BUDAGOVSKI 9
- GENEVA 26
- GENEVA 30
- STOCKS BETTER THAN THOSE ON THE LEFT?

SPECIES AND CULTIVAR ROOTSTOCKS

- **THE MOST COMMON ROOTSTOCKS AVAILABLE TODAY INCLUDE:**

APPLE

Rootstock	M 27	M 9	M 7	M 106	M 111	Seedling (Golden Delicious)
Size*	20%	25%	33-50%	50%	70%	100%

*Size relative to seedling or own rootstock

PEAR

Rootstock	Hawthorne	EM Quince A Quince C OH x F51	Bartlett Sdlng	Old Home/Sdlng
Size	40%	50%	75%	100%

Pears not compatible with Quince = Bartlett, Bosc, Seckel, Clapps Favorite

PEACH

Rootstock	*P. tomentosa*	Marianna	St.Julien A	Nemaguard Lovell, Halford Peach sdlng
Size	25%	33%	70%	100%

APRICOT

'Royal' apricot seedlings

CHERRIES

Rootstock	Stockton-Morello	Mahaleb	Mazzard
Size	60%	100%	85%**

**Mahaleb is the best rootstock for sweet and tart cherries in Utah.
In other states and soils Mazzard may be larger than Mahaleb

PLUMS

Rootstock	Marianna (heavy soils)	Peach 'Lovell' (light soils)	Myrobalan (heavy soils)
Size	66%	88%	100%

HARVESTED ROOTSTOCKS

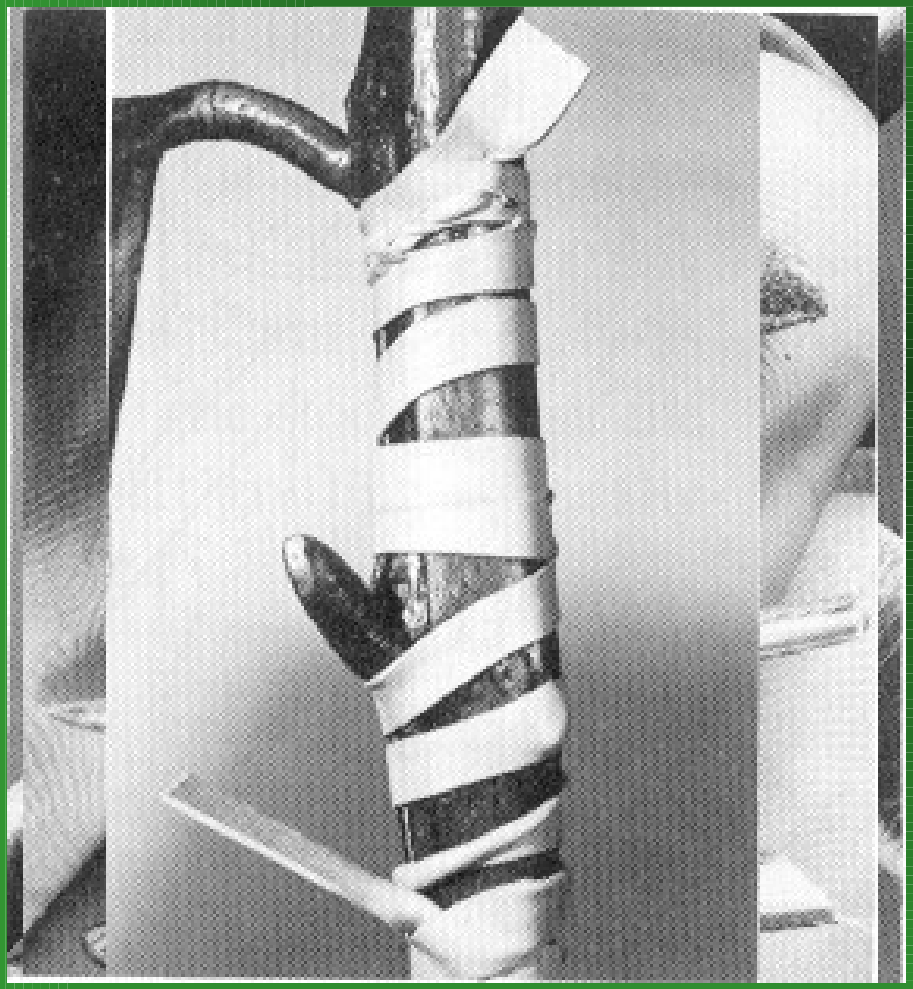
TREE PRODUCTION NURSERY

- ROOTSTOCKS ARE PLANTED ABOUT 6-10” APART, AND PARTIALLY DEFOLIATED IN AUGUST JUST BEFORE BUDDING IS DONE

Propagation by budding:

- T-bud
  fruit trees, roses
- Patch bud
  Walnut, pecan
- Chip bud
  fruit trees
  grapes

Budding:



- “T” bud

CHIP AND PATCH BUDDING

- Chip bud
- Patch bud

NEWLY BUDDED TREES

TOP PRUNING

- The rootstock tree top is cut off in the spring
- The cultivar tree grows during the year and is dug in the fall

Harvesting Nursery Trees

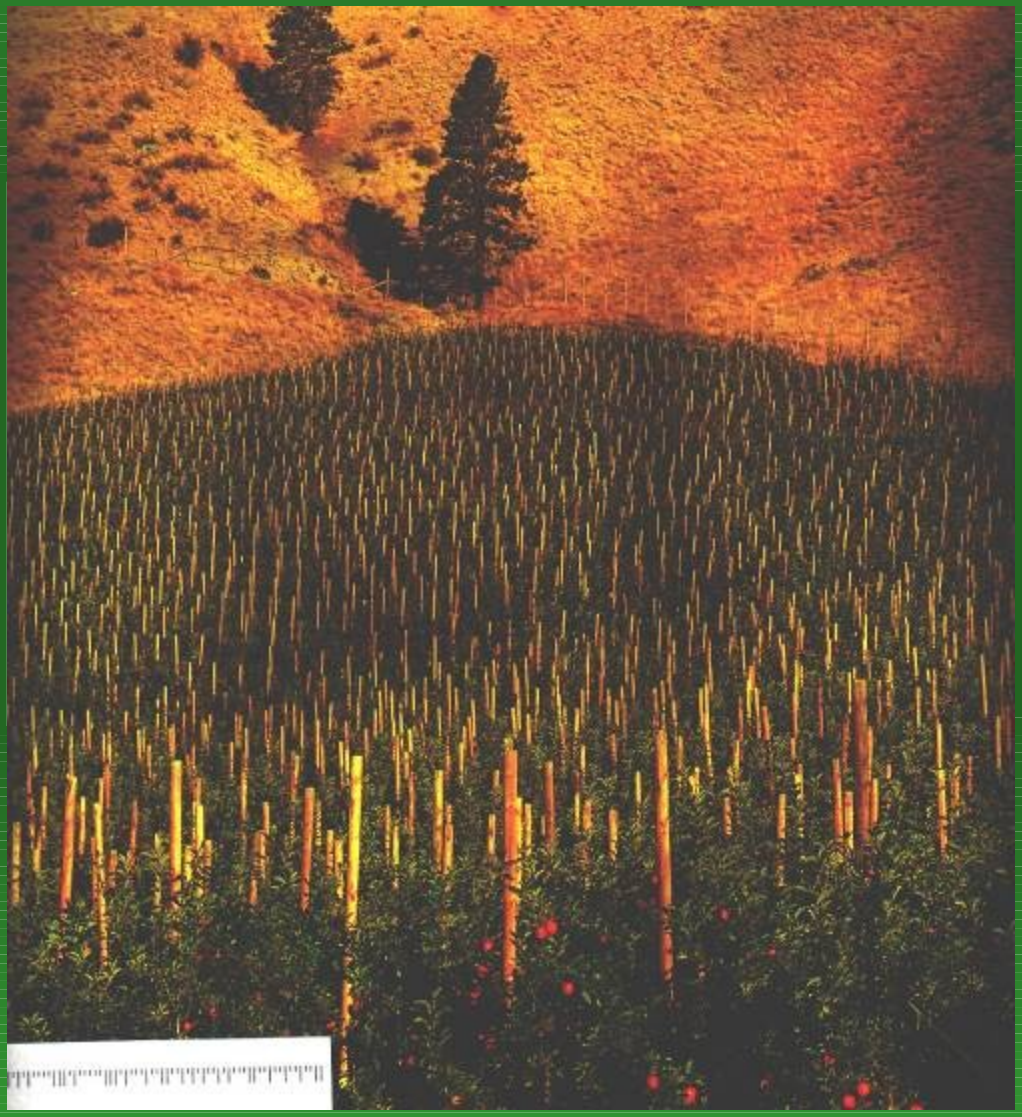
Harvested Trees

Harvested Trees

- Roots are broken in harvest operation
- Roots are pruned in the storage shed
- Roots need to be pruned for problems when the trees are planted

Harvested Trees on Wagon

High Density Staked Orchard



TIME-LINE FOR TREES

- LINERS PLANTED SPRING 2002
- BUDDED AUGUST 2002
- CUT ROOTSTOCK OFF SPRING 2003
- GROW CULTIVAR SUMMER 2003
- DIG TREES FALL 2003
- SELL TREES SPRING 2004
- INTERSTEMS – ADD ONE YEAR

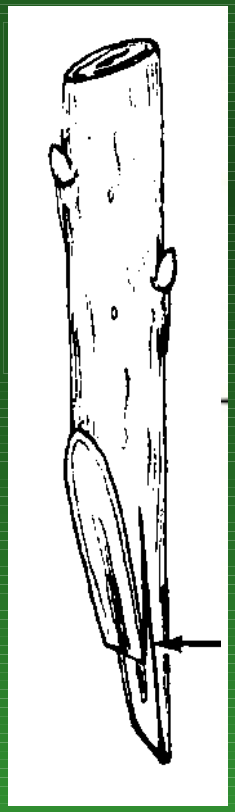
Propagation by grafting:

- **Whip/bench/tongue graft was used long ago for tree production**
- **A piece of root and a scion were joined with an elaborate graft in a root cellar in winter**

- **Top grafting: crown of the root, trunk, and on limbs**
- **cleft graft fruit trees**
- **bark graft fruit trees easier but not as strong as cleft graft**

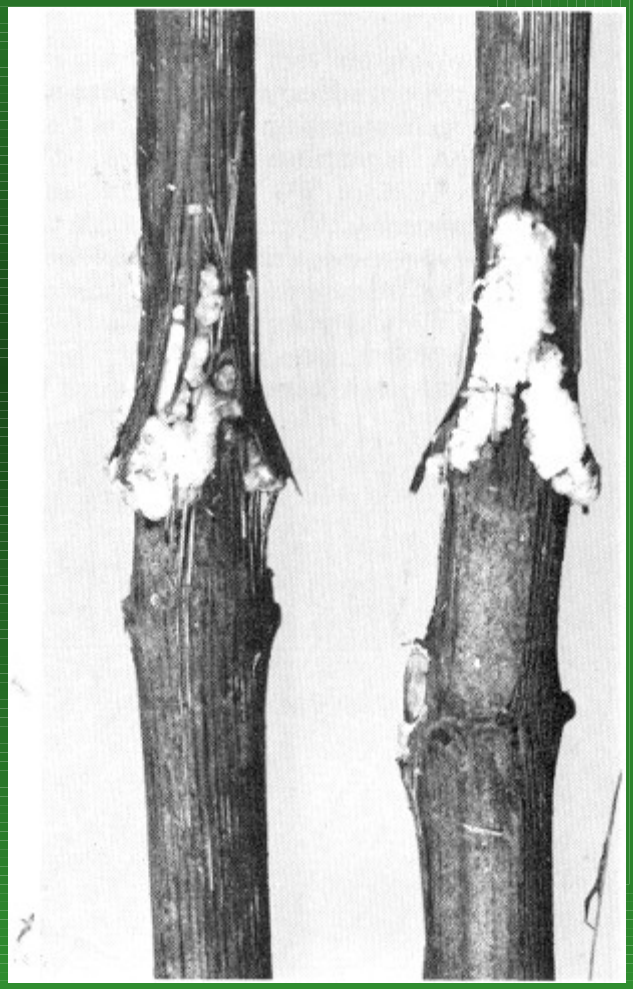
Grafting:

- Whip, bench, piece root, or tongue graft

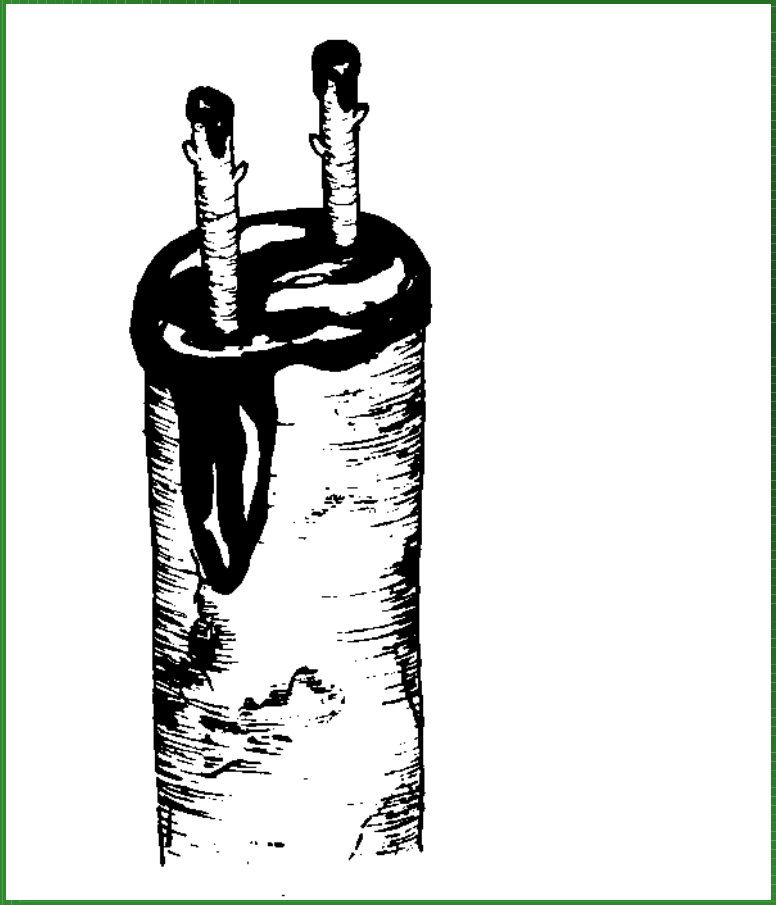


Graftage:

- When plants are difficult to root or wanted on another root than their own, grafts of the desired scion and a rootstock are made
- Graft = scion + root
- Bud = root + 1 bud

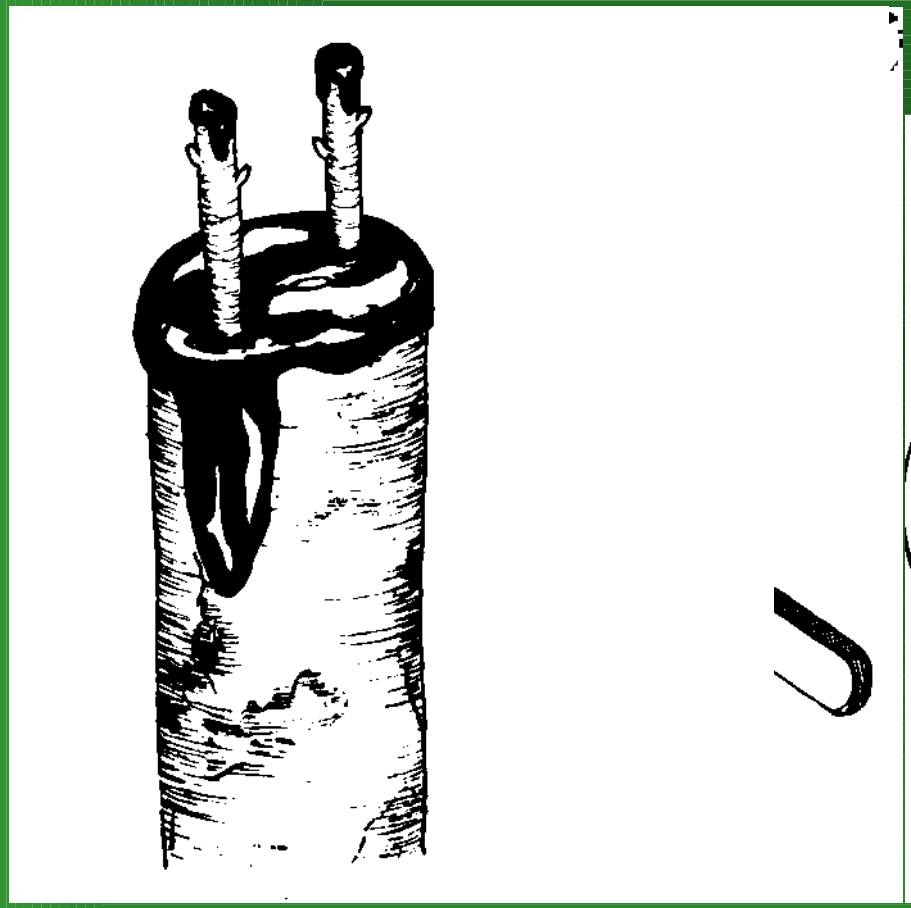


Graftage:

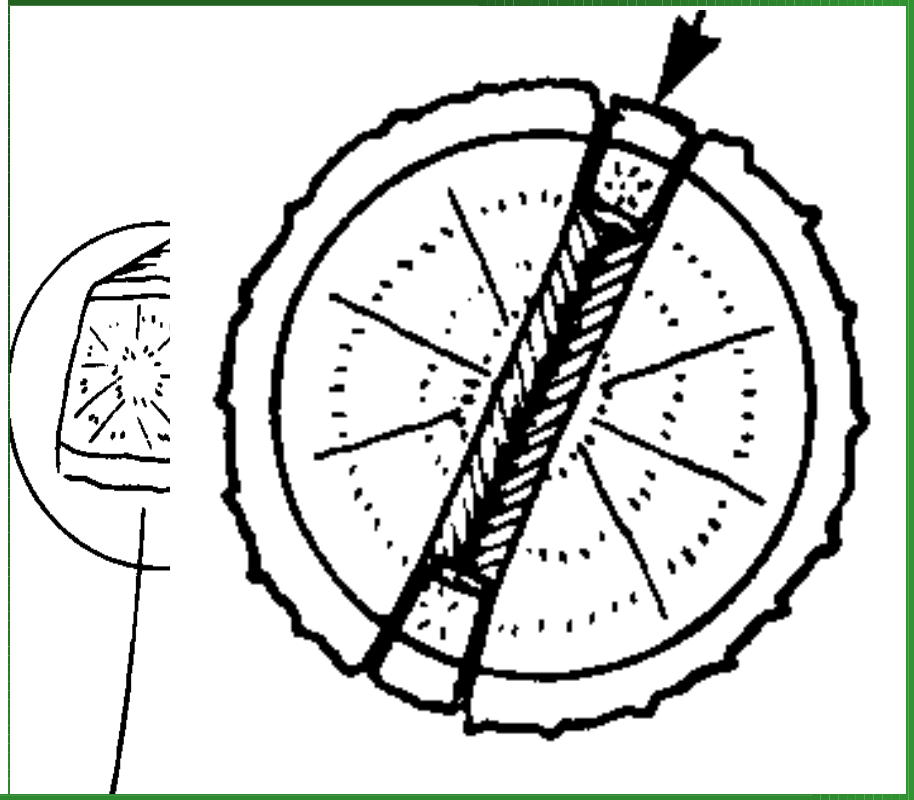


- Cleft graft:
  A scion of 4-5 buds is cut to form a double tapering (top to bottom, and out to in) wedge It is placed in the cleft of the rootstock so that cambium layers line up
  The union and tip of the scions are covered with grafting wax

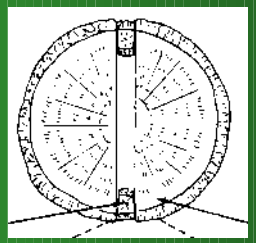
Cleft Graft:

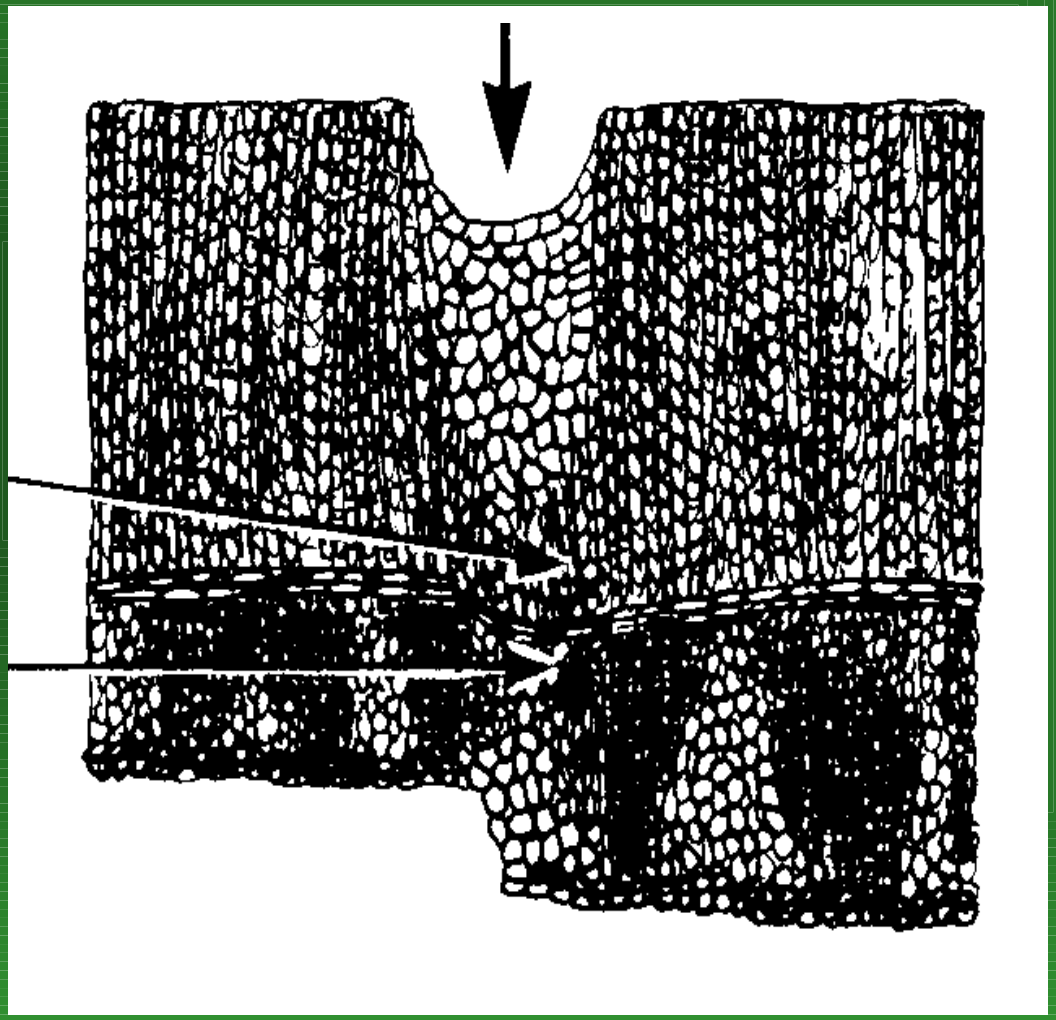


- Cleft graft:



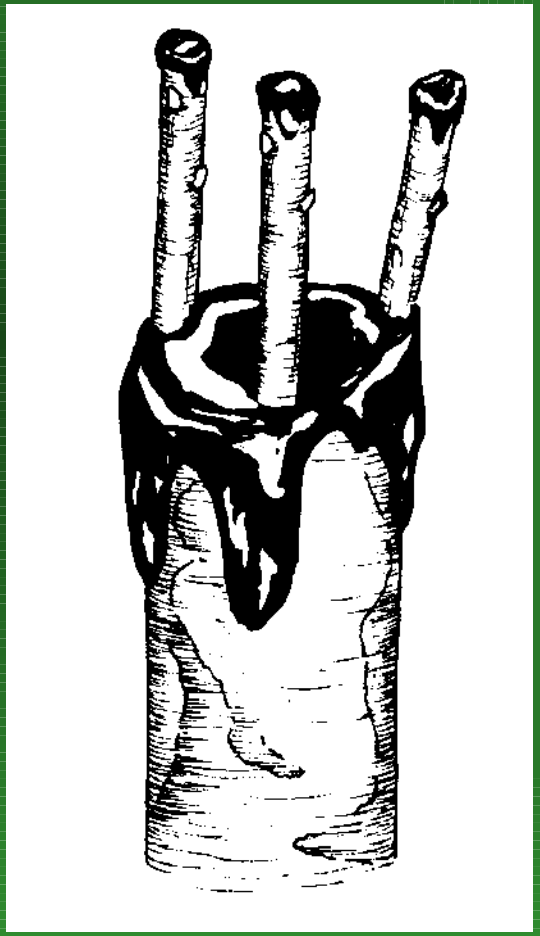
Healing:





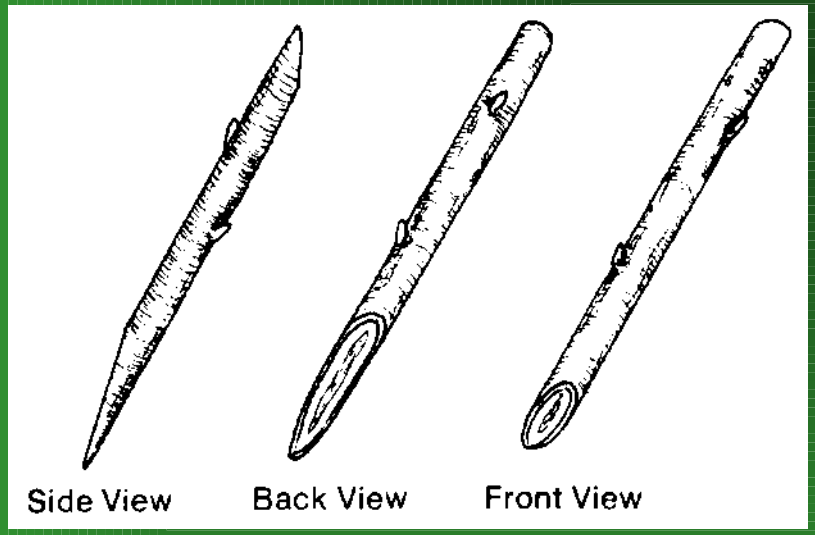
Bark Graft:

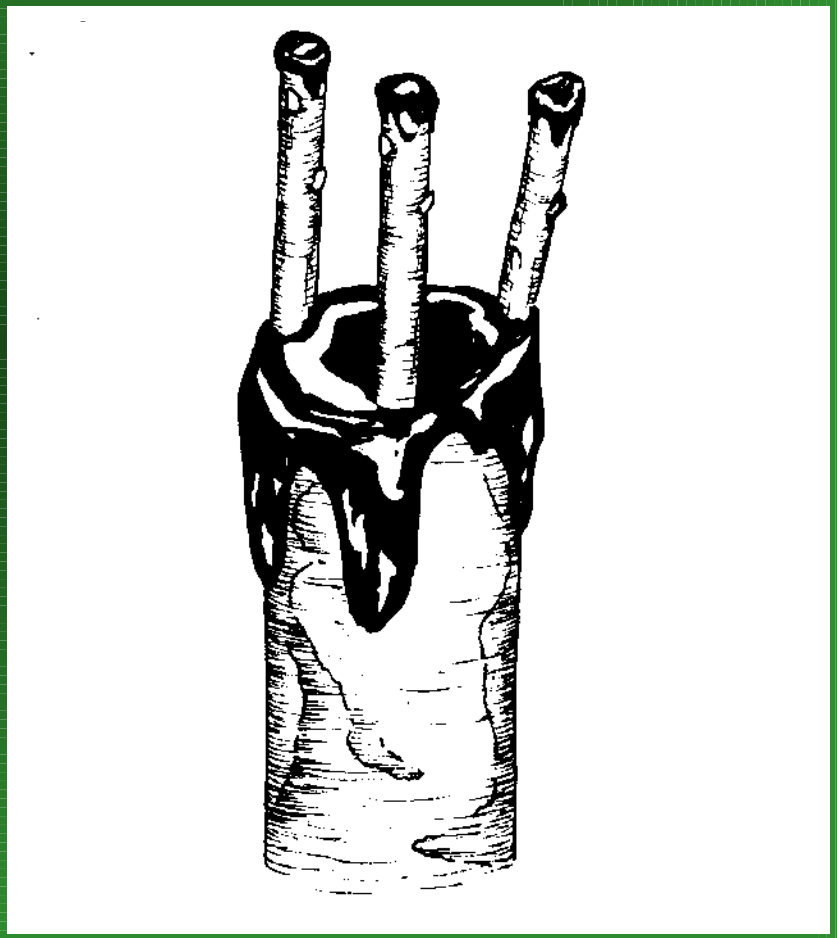
- Bark graft:
  Scions are placed when cambium is slipping The bark is cut to accommodate the scion and the scion (cut with a sloping cut) is nailed to the stock



Bark Graft:

- Bark graft:






Top Worked
apple tree
using bark graft

When to graft? When to bud?

- Graft in the spring
- Collect scions in mid- to late-winter
- Store scions in cool - 2-4 °C, moist conditions
- Graft just as cambium begins to divide!

- Bud in August in cool climates
- Collect scions just before budding
- Store scions in cool - 2-4 °C, moist conditions
- Bud while cambium is still dividing!