Techniques of Grafting

Preparation for grafting

Preparation for graftage
- Tools and accessories for grafting
- Grafting machines and grafting automation/robotics
- Selection, handling, and storage of scionwood
- Handling of rootstock.

The craftsmanship of grafting
- Manual techniques: speed, accuracy, enhancing success rates
- Record keeping
- Advantages in the mechanization of grafting

Aftercare of grafted plants
- In bench grafting systems
- In field and nursery grafting systems
Techniques of Grafting

Preparation for grafting

Tools and accessories for grafting

Common tools and accessories used for grafting include:

- Grafting knives
- Tying and wrapping materials
- Grafting waxes
Techniques of Grafting

Tools and accessories for grafting

Grafting knives

For propagation work, the two general types of knives used are the budding knife and the grafting knife.

Grafting blades are flat on one side and have a tapered edge on the other to make a sharp, clean cut.

Hence, grafting knives are available for either right- or left-handed people.
Techniques of Grafting

Tools and accessories for grafting

Grafting knives

The knives have either a folding or a fixed blade.

The fixed-blade type is stronger, and if a holder of some kind is used to protect the cutting edge, it is probably the most desirable.

A well-built, sturdy knife of high-carbon steel is essential.
Techniques of Grafting

Tools and accessories for grafting

Grafting knives

The metal flap (arrow) opposite the sharp end of the blade is used to separate the bark during the “T” –cut of the rootstock.

The quill is also used to separate the bark during T-budding.
Techniques of Grafting

Tools and accessories for grafting

Tying and wrapping materials

Grafting methods, such as the whip-and-tongue, splice (whip), side-veneer graft, and budding methods require that the graft union be held together by tying until the parts unite.

Some of these tying materials can also seal and help maintain a high relative humidity in the graft union area.
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Tools and accessories for grafting

Tying and wrapping materials

Some common tying materials for budding and grafting include:

- Budding rubbers
- Waxed string
- Plastic tape
- Parafilm
- Nursery tape
- Grafting clips
Techniques of Grafting

Tools and accessories for grafting

Tying and wrapping materials

Budding rubbers

Budding rubbers must be tied with a half-hitch or slip knot, which is done at the final turn of the tape by slipping it under the previous turn.

Budding rubbers do not deteriorate in full sunlight and must be removed later to prevent girdling the plant.
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Tools and accessories for grafting

Tying and wrapping materials

Waxed string

Waxed string or twine adheres to itself and to the plant parts without tying a slip knot.

It should be removed following healing of the graft union.
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Tools and accessories for grafting

Tying and wrapping materials

Plastic tape

Clear or colored polyethylene or polyvinyl chloride (PVC) budding and grafting strips, which are 0.5 to 1.3 cm (3/16 to ½ in.) wide and slightly elastic, allowing for a more secure wrap.
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Tools and accessories for grafting

Tying and wrapping materials

Plastic tape

Plastic tapes are also called flagging tape, green floral tape, white budding tape, or orange grafting tape.

They are not self-adhesive and require tying.
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Tools and accessories for grafting

Tying and wrapping materials

Parafilm

Parafilm tape is a self-sealing tying materials which has been used with successful results to wrap graft unions rapidly and for chip-budding roses.

This material is a waterproof, flexible, stretchable, thermoplastic film with a paper backing. The film is removed from the paper, wrapped around the graft union, and pressed into place by hand.
Techniques of Grafting

Tools and accessories for grafting

Tying and wrapping materials

**Parafilm**

Buddy tape is similar to parafilm tape, but thinner and more economical.

It seals and holds the graft or bud piece in place, but is thin enough for the bud to elongate and pass through it once the graft takes.
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Tools and accessories for grafting

Tying and wrapping materials

Parafilm

Sometimes budding rubbers are used to tie a graft, which is then sealed with Parafilm or buddy tape.
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Tools and accessories for grafting

Tying and wrapping materials

Nursery tape

Nursery adhesive tape is similar to surgical adhesive tape but lighter in weight and not sterilized.

Adhesive tape is useful for tying and sealing whip grafts.

When this type of wrapping is covered with soil, it usually rots and breaks before any girdling damage can occur.
Techniques of Grafting

Tools and accessories for grafting

Tying and wrapping materials

Grafting clips

Plastic graft clips are used in manual and machine splice grafting of vegetable crops.
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Tools and accessories for grafting

Grafting waxes

Grafting wax seals over the graft union, thereby preventing the loss of moisture and death of the tender, exposed cells of the cut surfaces of the scion and rootstock.

These cells are essential for callus production and healing of the graft union.
Techniques of Grafting

Tools and accessories for grafting

Grafting waxes

An ideal grafting wax should adhere well to the plant surfaces, not be washed off by rains, not be so brittle as to crack and chip during cold weather or so soft that it will melt and run off during hot days, but still be pliable enough to allow for swelling of the scion and growth enlargement of the rootstock without cracking.

There are both hot and cold waxes.
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**Tools and accessories for grafting**

**Grafting waxes**

Hot waxes require heating to keep the wax liquid.

They are special combinations of waxes that have a low melting point.
Techniques of Grafting

Tools and accessories for grafting

Grafting waxes

The wax should be hot enough to flow easily, yet not be boiling—which damages plant tissue.
Techniques of Grafting

Tools and accessories for grafting

Grafting waxes

Cold waxes contain volatile solvents that keep the wax liquid.

The cold wax solidifies when the solvents evaporate.
Several hand held and bench top grafting machines have been developed but few are used extensively.

When the scion and rootstock are the same size, these machines make tightly fitting grafts.
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**Tools and accessories for grafting**

**Grafting machines**

There are machines for grape grafting that cuts through both the rootstock and scion, one laid on top of the other, making an omega-shaped cut and leaving the two parts interlocked.
Techniques of Grafting

Tools and accessories for grafting

Grafting robots

Automated grafting robots have also been developed.

These are primarily used for grafting vegetable seedlings.

Vegetables are grafted with pathogen or nematode resistant rootstocks.
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**Tools and accessories for grafting**

**Grafting robots**

Grafted seedlings account for 81 percent of the commercial outdoor and greenhouse vegetable production in Korea, and 54 percent and 81 percent, respectively, for Japan.

One of the commercialized grafting robots is reported to graft 1,000 tomato seedlings per hour.
Techniques of Grafting

Selection, Handling, and Storage of Scionwood

Kind of wood

Since bench or field grafting of deciduous species takes place in winter or early spring, the use of scion wood that grew the previous summer is necessary.
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Selection, Handling, and Storage of Scionwood

**Kind of wood**

For most species, the wood should be 1-year-old or less (current season’s growth).

Avoid including older growth, although with certain species, such as the fig or olive, 2-year-old wood is satisfactory, or even preferable, if it is of the proper size.
Selection, Handling, and Storage of Scionwood

Kind of wood

Healthy, well-developed vegetative buds should be present.

Avoid wood with flower buds.

Usually, vegetative buds are smaller and pointed, whereas flower buds are larger, round and plump.
Kind of wood

The best type of scion material is vigorous (but not overly succulent), well-matured, hardened shoots from the upper part of the tree, which have grown 60 to 90 cm (2 to 3 ft) the previous summer.
Selection, Handling, and Storage of Scionwood

Kind of wood

Mature wood with short internodes should be selected.

The best scions are obtained from the center portion or from the basal two-thirds of the shoots.

Apple scion wood
Techniques of Grafting

Selection, Handling, and Storage of Scionwood

Kind of wood

Conifer scions are taken from the previous season’s terminal growth.

Scions from upright cultivars should be taken from upright growing shoots on the stockplant.

Scions from weeping or prostrate cultivars should be taken from horizontally oriented shoots.
Techniques of Grafting

Selection, Handling, and Storage of Scionwood

Source of material

Scionwood should be taken from source plants of the correct cultivar known to be pathogen-tested and genetically true-to-type.

Virus-diseased, undesirable sports, and virus-like genetic disorders must be avoided.
Source of material

Source plants can be produced in an orchard, vineyard, ornamental field or container nursery, or landscape are selected when the flowering, fruiting, and growth habits are known.

It is best to take propagation material from plants where production history is known.
Source of material

In commercial nurseries, special scion blocks are often maintained.

Such plants are handled differently than they would be for producing a crop.

For example, trees may be pruned back each year to produce a large annual supply of long, vigorous shoots well-suited for scion wood.
Techniques of Grafting

Selection, Handling, and Storage of Scionwood

Collection and handling

For deciduous plants to be grafted in early spring, the scion wood can be collected almost any time during the winter season when the plants are fully dormant.

Avoid collecting wood that appears to show winter injury.
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Selection, Handling, and Storage of Scionwood

Storing scion wood

Scion wood should be kept slightly moist and at a low temperature (32 - 40° F).

A common method is to wrap wood, in bundles of 25 to 100 sticks, in heavy, waterproof paper or in polyethylene sheets or bags.

All bundles must be labeled accurately.
Techniques of Grafting

Handling Rootstocks

Field grafting

The most common field grafted plants are specialty grafts such as weeping cherries.

Rootstocks are usually seedling liners planted at in rows at close spacing.

Scion growth the first year is rapid and trees are often dug as bare root liners after one year.
Techniques of Grafting

Handling Rootstocks

**Bench grafting**

Container-grown rootstock liners of woody ornamental plants are allowed to harden-off in minimum-temperature controlled poly houses or cold frames in the fall and then maintained just above freezing.

When new roots emerge from the rootstock in late winter, plants are ready for grafting.
Bench grafting

Bench grafting of the container rootstock with a splice graft is done in January and February.
Techniques of Grafting

Handling Rootstocks

**Bench grafting**

In general, bench grafting is best when new, white root tips of 6 mm (¼ in.) occur or buds start to swell on the rootstock of potted liner plants.
Aftercare of grafted plants

Environmental control

Graft unions are tied and sometimes waxed.

The type of wrapping material or whether the graft is waxed determines the subsequent environmental controls required for successful a graft union.
Techniques of Grafting

Aftercare of grafted plants

Closed case

Waxing may be omitted if grafts are to be protected from drying by packing the grafts in boxes or frames containing slightly moist peat.
Techniques of Grafting

Aftercare of grafted plants

Closed case

Unwaxed grafts can also be simply protected by a polyethylene bag or even glass jars. Care should be taken to shade grafts to prevent heat buildup under the cover.
Techniques of Grafting

Aftercare of grafted plants

Open case (bench)

Grafting can also be done in a temperature-controlled greenhouse or unheated polyhouse (depending on the season).

Waxing can be omitted in the bench graft if the grafts are covered as a group with poly-sheets.

Shading is used to reduce heat buildup under the cover.
Techniques of Grafting

Aftercare of grafted plants

Hot-pipe callusing

With some difficult to graft species, a warm temperature around the graft can be beneficial.

The hot-pipe callusing system warms the graft union to about 80 degrees F. but keeps the roots and buds on the scion cool (about 45 degrees F.) to prevent their premature growth.
Techniques of Grafting

Aftercare of grafted plants

Hot-pipe callusing

The graft union is kept warm by a PVC pipe that contains a hot wire or recirculating hot water system. The entire system is insulated around the graft and the scion and roots are kept cool.

Hot-pipe callusing is performed in the late winter or early spring.
Techniques of Grafting

Aftercare of grafted plants

Hot-pipe callusing

Species that benefit from this technique include various fruit crops and ornamentals like maple (*Acer*), hazel (*Corylus*) and beech (*Fagus*).
Techniques of Grafting

Hot-pipe callusing system

Only the graft union is placed in the hot pipe.

Mulching keeps containers moist.

Hot water recirculates in the pipe.

Containers are covered while tops remain cool.
Techniques of Grafting

Hot-pipe callusing system

A thermometer monitors hot water temperature.

A multirack system for Japanese maples.

Maple graft in PVC slot above hot water pipe.
Techniques of Grafting

Aftercare of grafted plants

**Staking**

Grafted plants are usually staked to stabilize the new shoot growth and initiate a straight upright trunk.