Techniques of Grafting

Learning Objectives:
Understand the requirements for successful graftage.
Describe the techniques of detached scion graftage, approach.
graftage, and repair graftage.
Discuss the preparation for grafting—tools, accessories, machines, automation, and processing scionwood.
Explain the craftsmanship of grafting—manual techniques, record keeping, and mechanization.
Describe the aftercare of grafted plants—in bench grafting systems, and field and nursery grafting systems.
Identify field, bench, and miscellaneous grafting systems.
Techniques of Grafting

Requirements for successful grafting

1. The rootstock and scion must be compatible.

2. The *vascular cambium* of the scion must be placed in direct contact with that of the rootstock.

3. The grafting operation must be done at a time when the rootstock and scion are in the proper physiological stage.

4. Immediately after the grafting operation is completed, all cut surfaces must be protected from desiccation.

5. Proper care must be given to the grafts for a period of time after grafting.
The rootstock and scion must be compatible.

They must be capable of uniting.

Usually, but not always, closely related plants, such as two apple cultivars, can be grafted together.

Distantly related plants, such as oak and apple, cannot make a successful graft combination.

English walnut on California black walnut rootstock.
Techniques of Grafting

Requirements for successful grafting

*The vascular cambium of the scion must be placed in direct contact with that of the rootstock.*

The cut surfaces should be held together tightly by wrapping, nailing, wedging, or some similar method.

Rapid development of the graft union is necessary so that the scion may be supplied with water and nutrients from the rootstock by the time the buds start to open.
Immediately after the grafting operation is completed, all cut surfaces must be protected from desiccation.

The graft union is covered with tape, grafting wax, Parafilm tape, or the grafts are placed in moist material or a covered grafting frame.
Techniques of Grafting

Requirements for successful grafting

Proper care must be given to the grafts for a period of time after grafting.

Shoots coming from the rootstock below the graft will often choke out the desired growth from the scion.

In some cases, shoots from the scion will grow so vigorously that they break off unless staked and tied or cut back.
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Grafting systems

Grafting systems are organized as:

(1) **Field grafting**, which includes crown grafting, top-grafting, topworking, and repair grafting.

(2) **Bench grafting**, which includes bare root grafting, container grafting, and herbaceous grafting.

(3) **Miscellaneous grafting**, that includes cutting grafts (stenting) and micrografting.
Field grafting of deciduous plants is done from late winter to late spring.

Grafting should take place shortly before new growth starts.

The scions should be prepared from mature, dormant wood of the previous season’s growth.
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Grafting systems

Bench grafting

Bench grafting refers to any graft procedure performed on a rootstock that is not field planted.

This includes grafts performed on bare-root or potted liner rootstock that is grafted at a bench or table.
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Grafting systems

Miscellaneous grafting

Micrografting is performed using small scion and rootstock parts using tissue culture techniques.

It has been mainly used to obtain virus-free plants from plants like apple or citrus that do not root readily from cuttings.
Types of grafts can be categorized as:

(1) **Detached scion graftage**, which includes apical, side, bark, and root graftage.

(2) **Approach graftage**, where the root system of the scion and shoot system of the rootstock are not removed until after successful graft union formation occurs.

(3) **Repair graftage** of established trees.
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**Types of grafts**

**Detached Scion Graftage**

**Apical Graftage**

- Splice graft
- Whip-and-tongue graft
- Cleft graft (split graft)
- Saw-kerf graft
- Inlay graft
- Saddle graft
- Wedge graft
- Four-flap graft (banana graft)
- Hole Insertion Graft for vegetables
Techniques of Grafting

Types of grafts

Splice (whip) graft

The splice graft is simple and easy to make.

A simple slanting cut of the same length and angle is made in both the rootstock and the scion.

These are placed together and wrapped or tied as described for the whip graft.
Splice (whip) graft

If the scion is smaller than the rootstock it should be set at one side of the rootstock so that the vascular cambium layers will be certain to match along that side.
Techniques of Grafting

Types of grafts

Splice (whip) graft

The splice graft is particularly useful in grafting plants that have a very pithy stem or that have wood that is not flexible enough to permit a tight fit when a tongue is made as in the whip-and-tongue graft.
Types of grafts

**Splice (whip) graft**

The splice graft is used in greenhouse production of vegetable crops for grafting disease-resistant rootstocks.

For vegetable crops such as cucurbitis or *Solanaceae*, this graft is sometimes referred to as One Cotyledon Grafting (OCG).
Types of grafts

One cotyledon grafting (OCG), which is a form of the splice graft used with cucurbit vegetable crops.
One cotyledon grafting (OCG), which is a form of the splice graft used with cucurbit vegetable crops.
Types of grafts

Splice (whip) graft

The graft can be performed manually or with sophisticated, robotic grafting machines.
Types of grafts

Preparing the rootstock.

Rootstock at robot.  Rootstock is held in place.  Rootstock is cut.
Techniques of Grafting

Types of grafts

Previously cut graft partners.

Partners are brought together.

Clip moves into position.

Clip joins the graft.
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

The whip-and-tongue graft is particularly useful for grafting relatively small material about 6 to 13 mm (¼ to ½ in.) in diameter.

It is highly successful if done properly because there is considerable vascular cambium contact.

It heals quickly and makes a strong union.
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

This graft is similar to a splice graft, except that a second reverse "tongue" cut is made in both the scion and rootstock that allows the partners to fit tightly together.
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

PREPARING THE STOCK

A long, sloping cut 2.5 to 6 cm (1 to 2½ in.) long is made at the top of the stock.

A second downward cut is made starting one-third of the distance from the tip to the base of the first cut.

Pulled apart it looks like this.

Rootstock
Techniques of Grafting

Types of grafts
Whip-and-tongue graft

PREPARING THE SCION

A long, sloping cut is made at the base of the scion the same length as the cut on the stock.

A second cut is made under the first, just as for the stock.
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

The stock and scion are slipped together, the tongues interlocking.

The graft is then tied and waxed.
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

Whip-and-tongue grafts can be used in both bench grafting and field top grafting.
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Types of grafts

Whip-and-tongue graft

Cutting scion

Cutting stock

Tongue cut

Joining partners
Techniques of Grafting

Types of grafts

Whip-and-tongue graft

Aligning cambium

Wrapping graft

Grafting wax

Wrapped and waxed
Techniques of Grafting

Types of grafts

Cleft graft

The cleft graft is one of the oldest methods of grafting. It is used to topwork trees, either in the trunk of a small tree or in the scaffold branches of a larger tree.

In topworking trees, this method should be limited to rootstock branches about 2.5 to 10 cm (1 to 4 in.) in diameter and to species with fairly straight-grained wood that will split evenly.
Techniques of Grafting

Types of grafts

Cleft graft

Although cleft grafting can be done anytime during the dormant season, the chances for successful healing of the graft union are best if the work is done in early spring just when the buds of the rootstock are beginning to swell, but before active growth has started.
Techniques of Grafting

Types of grafts

Cleft graft

PREPARING THE STOCK

The stub is split several cm (in.)

A smooth straight-grained section should be used so the split will be even.
Techniques of Grafting

Types of grafts

Cleft graft

The scion is made by cutting a long, gradually tapering wedge.

The outside edge of the wedge should be slightly thicker than the inside.
Techniques of Grafting

Types of grafts

Cleft graft

INSERTING THE SCIONS INTO THE STOCK

The split in the stock is held open by a wedge for insertion of the scions.

Two scions are inserted in a stub, one at each end of the split. The scions must be carefully placed so the cambium layers match.
Techniques of Grafting

Types of grafts

Cleft graft

After the scions are properly placed, the wedge is withdrawn. The entire union, including the tips of the scions, is then thoroughly covered with grafting wax.
Saw-kerf graft

Like the cleft graft, the saw-kerf graft is mostly used for topgrafting and is made in late winter or early spring before the bark begins to slip (separates easily from the wood).

The diameter of the stock to be grafted is the same as for the cleft graft — 5 to 10 cm (2 to 4 in.), and the scions are also the same size — 10 to 13 cm (4 to 5 in.) long and 10 to 13 mm (⅜ to ½ in.) in thickness.
Techniques of Grafting

Types of grafts
Saw-kerf graft

PREPARING THE ROOTSTOCK

A heavy sharp knife is pounded into the side of the stub to make two cuts to form a V.
Techniques of Grafting

Types of grafts
Saw-kerf graft

PREPARING THE SCION

The scion should be about 10 to 13 cm (4 to 5 in.) long, 10 to 12 mm (3/8 to 1/2 in.) thick, and with 2 or 3 healthy vegetative buds. The basal ends should be cut to a V-shaped wedge, matching the opening in the stock.
 Techniques of Grafting

Types of grafts

Saw-kerf graft

INSERTING THE SCIONS INTO THE ROOTSTOCK

The scion is gently tapped into the V-shaped opening in the stock, matching the cambium layers at a slight angle so that the cambium of stock and scion cross.

Scion should be inserted at an angle so that the cambium layers of stock and scion are closely matched, barely crossing each other.

After scions are in place all cut surfaces are thoroughly covered with grafting wax.
Techniques of Grafting

Types of grafts

Inlay graft

In an inlay or veneer graft, a wedge-shaped cut is made in the side of the rootstock that is replaced by a scion cut to the same shape.
Techniques of Grafting

Types of grafts

Inlay graft

An inlay graft can also be used for topgrafts in place of a whip-and-tongue graft in situations where the scion and stock are different in stem diameter.
Types of grafts

Inlay graft

The scion cut is formed into a long sideways wedge with two long tapering cuts.

A corresponding side wedge is cut into the larger diameter rootstock and the scion inserted.
Techniques of Grafting

Types of grafts

Inlay graft

Inserted scion

Wrapping graft

Wrapped graft
Techniques of Grafting

Types of grafts

Saddle graft

The saddle graft can be bench grafted by hand or machine.

The rootstock and scion should be the same size.

The scion is prepared by cutting upward through the bark and into the wood on opposite sides of the scion to form a wide wedge or saddle.
Techniques of Grafting

Types of grafts

Saddle graft

The rootstock is cut transversely and receives two upward cuts on either side. This should be done to expose the vascular cambium of the rootstock to match vascular cambium in the saddle of the scion.

The saddle graft is used for bench grafting grape and *Rhododendron* cultivars.
Wedge graft

Wedge grafts are best when the scion and rootstock are about the same diameter.

A downward V-shaped cut is made into the center of the rootstock.

A corresponding V-shape is cut into the base of the scion and the two partners fit together.
Types of grafts

Wedge graft

Wedge grafts work well for herbaceous and succulent plants.
Types of grafts
Wedge graft

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.
Techniques of Grafting

Types of grafts

Four-flap graft

The four-flap or banana graft is used in topworking small-caliper trees or tree limbs up to 2.5 cm (1 in.) in diameter.

This field graft is normally done manually, but there is a tool that aids in stripping the rootstock bark flaps from the wood.

It is a graft used on pecans in Texas.
The top of the rootstock is cut horizontally, and the bark is cut vertically into four strips.
Techniques of Grafting

Types of grafts

Four-flap graft

The four bark flaps are peeled down and the inner wood removed.
Techniques of Grafting

Types of grafts

Four-flap graft

The scion bark is removed and the wood retained.

The flaps of the rootstock cover the cut surfaces of the scionwood and are temporarily held by a rubber band.

The graft is then tied with grafting tape.
Techniques of Grafting

Types of grafts

Four-flap graft

Aluminum foil is wrapped around the graft to exclude heat and the grafted area is wrapped with a cut poly bag, which is sealed to retain high relative humidity until the graft takes.
Hole insertion graft

This technique is used for grafting watermelon to squash rootstock.

It requires few materials, has high efficiency, 1500+ plants/day/worker, and simpler management technique.

Image courtesy of R. Hassell.
Techniques of Grafting

Types of grafts
Hole insertion graft

When both cotyledons and first true leaf start to develop, the rootstock plant is ready to graft.

Remove the growing point and open a hole with a sharp probe.

The scion is then cut on a 35- to 45-degree angle, on both sides, on the hypocotyls and inserted into the hole made in the rootstock.