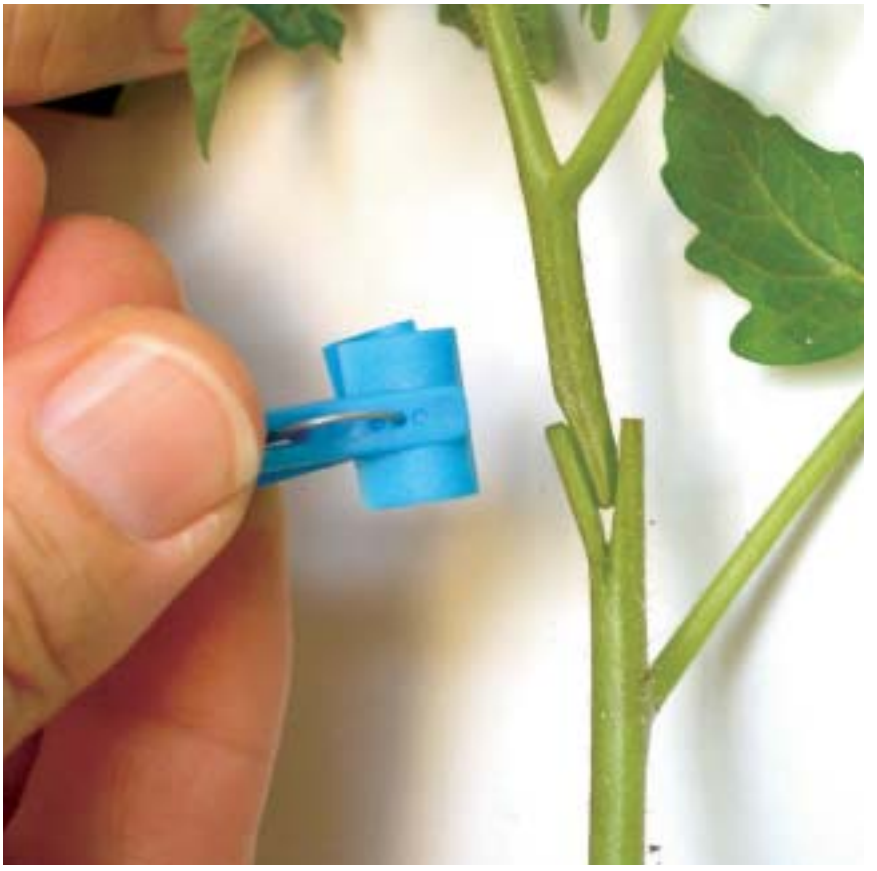
# Use of grafting makes a comeback



*Grafting has been known for many years but is making a comeback because by grafting new cultivars onto pathogen resistant rootstock it is possible to avoid toxic soil sterilisation methods.*

**By Harold C. Passam, Professor of Horticulture, Agricultural University of Athens, Greece**

***Cleft grafting: The scion is inserted into a vertical incision in the stem of the rootstock and the graft is held in place by a plastic clip.***

Vegetable cultivation in Greece, and more widely throughout the Mediterranean basin, is a highly intensive activity characterised by almost continuous cropping on a limited area of land. Production sites are usually within easy access of urban markets, whereas greenhouses are largely located near the coast so as to take advantage of the warmer climate there.

A problem that is inherent to intensive vegetable production in a confined area is the increase in soil-borne pathogens, notably Fusarium and Verticillium, as well as nematodes and other pests. In greenhouse crops, these pests and diseases are controlled by soil sterilisation, principally to date with methyl bromide. However, because the use of methyl bromide is being phased out since it is highly toxic to humans and damaging to the environment, alternative control measures will have to be introduced.

One possibility is the creation of new cultivars that are resistant to diseases, but this is costly and time consuming. On the other hand, the grafting of cultivated hybrids or varieties onto compatible resistant rootstocks offers an immediate and relatively economical alternative approach.

**Crops involved** - Vegetable grafting has been known for many years. Watermelon, for example, has been grafted on to resistant gourd rootstocks since 1900. However, with the increasing need to combat soil pathogens, the technique has assumed major commercial interest.

Watermelon is an important local and export crop, total production of which in 2000 amounted to 783,000 tons (18,590 ha) of which over 140,000 tons were exported. In southern Greece, watermelons are cultivated under low cover for early production and virtually 100% are grafted to provide resistance against Fusarium and for increased tolerance to low temperatures. Approximately 40-50% of melons and 5-10% of cucumbers are grafted for the same reasons, and 2-3% tomatoes and aubergines are grafted for resistance to Fusarium, Verticillium, Pseudomonas

*Tongue approach method: The stems of the rootstock and scion are cut vertically in opposite directions by a sharp razor blade.*

*The cut surfaces are united.*

*A plastic clip holds the graft in place during healing.*

*About 15-20 days after grafting the root of the scion is excised.*

and nematodes. Whereas traditionally the grower produced his own plants from seed, now nurseries exist to provide the growers with grafted plants.

**Techniques** - The following grafting techniques are currently of particular commercial importance to Greek producers although other methods do exist:

**Tongue approach grafting**

The tongue approach method is used almost exclusively for grafting Cucurbit scions, i.e. watermelon, melon and cucumber, onto resistant rootstocks such as gourds or pumpkins.
Because there is a difference in growth rate between the rootstock and the scion, the latter is sown 5-6 days earlier so that the stem diameter of both plants is the same at the time of grafting.

Seeds are sown separately in a peat-based substrate in seed boxes or plastic or polystyrene trays containing individual cells for each plant. Once the first true leaf has formed, the plants are ready for grafting. In the case of watermelon, this will be approximately 12-15 days from the sowing of the scion and the plants will be 8-10 cm tall, with relatively thick stems. During propagation, plants should receive plenty of light to prevent excessive stem elongation, which results in thin, weak stems
Grafting is carried out as follows:

- The substrate is well moistened the previous night so that the plants can be easily uprooted together with the adhering peat. The plants are then transferred to the bench where grafting is to be performed.
- The stem of the rootstock is cut by a sharp blade (razor or scalpel) approximately 2-3 cm below the cotyledons. The incision (8-12 mm in length) is made downwards from the cotyledons towards the root at an angle of 15-20% so as to reach the centre of the stem. It is important that the site of grafting should be relatively high on the stem so as to avoid contact with the soil during transplantation and growth in the field.
- The stem of the scion is then cut in a corresponding way 2-3cm below the cotyledons, but this time with the incision being directed from the root towards the cotyledons.
- The cut surfaces of the two plants are carefully brought into contact, which is then maintained by a plastic clip that firmly holds the plants in place.

The united plants are planted in pots containing moist peat and placed under shade in a greenhouse with a minimum

temperature of 16°C. Relative humidity within the greenhouse should be high, >95% for the first three days, but subsequently reduced in stages with a corresponding decrease in the shading. The cut surfaces adhere within 3-4 days of grafting and after 15-20 days the process is completed by excision of the root of the scion 1.0-1.5 cm below the graft and removal of the shoot of the rootstock just above the cotyledons (although this may be performed earlier). Depending on the season and outdoor temperatures, plants should remain in the greenhouse for up to about a month after grafting. Prior to transplantation, plants are progressively acclimatised by reducing the temperature and relative humidity.

**Cleft grafting** - In cleft grafting, which is used primarily for Solanaceous crops, i.e. tomato and aubergine, the seeds of the rootstock (tomato or wild species of aubergine) are sown approximately ten days earlier than those of the scion so as to produce plants that have the same stem diameter at the time of grafting. In this method, grafting occurs at a later stage, when the rootstock has 5-6 leaves and the scion 4-5 leaves. The shoots of both rootstock and scion are excised by a lateral cut so that each retain 2-3 leaves. A vertical incision of about 1-1.5 cm is made into the stem of the rootstock and the base of the stem of the scion is tapered by two wedge shaped cuts on either side, followed by insertion of the cut stem into the incision of the rootstock. The contact of the scion and rootstock is maintained by a plastic clip and the plants are kept in the under shade, with a minimum temperature of 16°C and high humidity (>95%) for 7-10 days before being transferred to normal light conditions within the greenhouse.

**Advantages**

The principal advantages of vegetable grafting are:

- The resistance conferred on the cultivated hybrid or variety by the rootstock enables cultivation in areas where soil-borne pathogens would otherwise prevent cultivation.
- The process precludes the need for application of soil sterilants and therefor contributes to the producer's safety and to the protection of the environment.
- Grafting may induce greater plant vigour, primarily as a result of increased water and nutrient uptake, increased earliness, tolerance of low temperatures and increased early and total yield.

**Disadvantages**

The disadvantages, however, include:

- The cost of grafting, which results from the need for time, space, specialised labour, suitable conditions and intensive post-graft care.
- A transient delay in plant development during the grafting period may result in a reduction in earliness if sowing times are not adjusted accordingly.
- Incompatibility, which may lead to failure of the graft, reduced vigour and inferior product quality.

**Overall success** - Provided that the scion and rootstock are compatible the success rate of both grafting is normally very high (over 90-98% for Cucurbits and 80-90% for aubergine). In the case of tongue approach grafting, the success of the method derives largely from the fact that the root system of the scion remains functional until the graft has successfully fused.

Other, less successful methods, such as hole insertion grafting (in which the stem of the rootstock is excised horizontally, a small hole bored vertically into the stem and the stem of the scion, which has been shaped into a peg, inserted into the hole) have now been abandoned.

In recent years, other techniques have been tested, including the use of externally applied plastic tubes or vertically inserted internal needles to hold the graft in place. In Japan, where vegetable grafting has been employed for the same crops for many years, robots have been developed to increase the efficiency of the grafting procedure. With increasing awareness of the need for horticultural practices that do not harm the environment, grafting may develop a permanent place in sustainable vegetable production. □

***References are available on request by emailing: helen.armstrong@reedbusiness.nl For further information email Harold Passam at passam@ama.gr***

## Rootstocks for grafting

Rootstocks should be carefully selected for maximum compatibility and to assist in this a number of evaluatory trials have been undertaken at the Agricultural University of Athens and at research centres of the National Agricultural Research Foundation.
Intergeneric grafting is generally used for the Cucurbits whereas inter-specific grafting is more common for aubergine. A large number of rootstock cultivars are commercially available based primarily on the following:

| Scion | Rootstock |
|---|---|
| Watermelon (*Citrullus vulgaris* Schad. syn. *C. lanatus* [Thunb.] Mansf.) | Bottle gourd (*Lagenaria siceraria* Standl.) |
| | White gourd (B*enincasa hispida* Cogn.) |
| | *Cucurbita* spp. |
| Melon (C*ucumis melo* L.) | White gourd (*Benincasa hispida* Cogn.) |
| | *Cucumis* spp. |
| | *Cucurbita* spp. |
| | *C. moschata* x *C. maxima* |
| Cucumber (*Cucumis sativus* L.) | Pumkin (*Cucurbita* spp.) |
| | *Cucurbita ficifolia* Bouché |
| Aubergine (*Solanum melongena* L.) | *Solanum integrifolium* Poir. |
| | *Solanum torvum* Swartz |
| | *Solanum melongena* L |
| Tomato (*Lycopersicon esculentum* Mill.) | Tomato (*Lycopersicon esculentum* Mill.) |