3 Container-grown nursery trees

Introduction

Most commercial citrus nurseries use grafting to propagate nursery trees. However, there are more than 30 kinds of citrus pathogens which can be transmitted by grafting, via infected budwood. These include citrus greening, tristeza, exocortis, tatter leaf, xyloporosis and psorosis. Once a plant is infected, such diseases may have a serious influence on growth. They shorten the life-span of the orchard and reduce yields and fruit quality.

Citrus-growing areas all over Asia are threatened by viruses and virus-like diseases. It is important to establish a national or central program to propagate certified nursery trees which are free of virus and other diseases.

There are three major ways in which plants may become infected.

- One is via an infected scion when the plant is grafted.
- The second is mechanical infection, when tools are used, for example, to prune an infected tree and then used to prune a healthy one, without being sterilized first (tatter-leaf, exocortis and xyloporosis).
- The third source of infection is insect vectors which suck the sap of infected trees, and carry the infection to healthy ones. For example, the greening pathogen is vectored by psyllids, while citrus tristeza virus is spread by aphids.

To grow healthy nursery trees, the scion must come from certified disease-free mother stock. Grafting and pruning tools must be sterilized by 1% hypochlorite. Finally, there must be intensive control of insects which are vectors of virus.

Collection of rootstock seeds

There are more than ten different kinds of important rootstock (Table 3-1). They vary in terms of their disease resistance, growth vigor, fruit quality and yield etc. Not all rootstocks are compatible with all scions, and care must be taken in matching rootstock and scion. They also vary according the kind of environment where they do best. However, whatever the kind of rootstock, the same procedure is used to produce healthy nursery trees.

To avoid contamination with soil-borne diseases, the fruit of rootstock trees should be harvested before they fall to the ground. The pectin around the seeds must then be removed. This can be done simply by soaking the seeds in tap water for 3-5 days.

They should be stirred frequently, and the water should be changed every day. If a large number of seeds are being treated at one time, α-amylase can be added.

The seeds are then dried in the shade for a few days. After treatment with a seed fungicide, they can be planted.

Seeds have a higher germination rate when they are used fresh than when they have been stored at room temperature for some time. However, seeds can be sealed in a plastic bag and stored at a low temperature (about 4°C) for six months without greatly reducing their vitality.

Caring for the seedlings

The seeds are sown on a bed of sand or vermiculite. They should be covered with the medium, and watered once or twice a day to maintain their moisture content. Seeds usually begin to germinate within one or two weeks under optimum temperatures of 25 - 30°C.

They can be transplanted two or three weeks later, when the first true leaf is fully expanded (Fig. 3-1 and Fig. 3-2). Seed germination is enhanced if part of the seed coat is removed.

Twice as many seeds should be sown as the number of seedlings needed. Only the best should be kept for grafting, and the rest discarded.

Pummelo has 4 - 5,000 seeds per kilogram, while there are approximately 8,000 in a kilogram of sour orange seeds.

Most citrus rootstocks exhibit some degree of polyembryony (i.e. a single seed contains multiple embryos). The exception is pummelo, which is always monoembryonic (each seed has a single embryo). That means most of the seedlings (nucellars) are likely to be fairly uniform in their genetic make-up and growth, after the off-types have been eliminated.

Container-grown seedlings may be transplanted only once, or may be transplanted twice. For single transplanting, the seedlings are transplanted into a large pot when their first leaf is fully expanded (Fig. 3-3), about one month after sowing. They remain in the same pot until they are grafted, and are then planted out in the field.

In double transplanting, the seedlings are transplanted into small containers such as a plug tube (Fig. 3-5) when their first leaf is fully expanded. Four to five months later, the bigger seedlings are trans-planted into larger pots until they are ready for grafting (Fig. 3-6).

Alternatively, they may remain in the same plug tube until grafting (about 12 months after sowing). After the scion comes into the first flush, they are then transplanted into a large pot until they are ready for sale or planting out. The total growing time for the single trans-planting procedure is 15 - 18 months. Double transplanting takes 20 - 24 months.

Seedlings grown by the single-transplanting procedure have a faster growth rate and need less labor, but are less uniform. The discard rate may be high, which means a greater loss of planting material. Transplanting seedlings twice makes better use of growing space and scions.

A good container nursery tree ready for sale should have roots which fill the container. When the tree is pulled out at transplanting, less than 10% of the growing medium should fall away (Fig. 3-7).

After transplanting, only the main stem of the seedling should be kept, and supported by a stake. All the branches should be removed. When the scion has reached a height of 70 cm, it should be topped at a height of 45 cm to encourage branching. The seedling is ready for transplanting when the new branches are well developed.

Grafting

The scion

Scions should be fully developed, with mature leaves. The epidermis (outer skin) should still be tender, not woody. The one or two buds at the base which are blind buds or not fully developed should be discarded. After the scion is cut, the leaves should be cut off immediately, and the budwood washed in detergent. After the cutting has been dried in the shade, it can be used for grafting.

If the budwood is not needed immediately, it can be sealed inside a plastic bag and stored in a refrigerator for up to two weeks. Provided it does not dry out, it will still be viable after this time. If the scions need to be stored for longer, they should be kept inside a sealed plastic bag with wet tissues to avoid desiccation.

The grafting procedure

Grafting is usually carried out in spring or fall in subtropical and temperate areas. The survival rate is generally higher if the climate is dry and mild.

The grafting method used depends on the kind of rootstock, and the preferences of the grower. T-budding (Fig. 3-8) or side grafting (Fig. 3-9) can be used for rootstock with fast growth, such as pummelo (*Citrus grandis* Osbeck). Plants with slower growth or rougher stems, such as Sunki (*Citrus sunki* Hort. ex Tanaka), and trifoliate orange (*Poncirus trifoliata* Raf.), are more difficult to graft by budding. For these, cut grafting is preferred.

The part of the plant used for grafting should be approximately 10 - 15 cm high. For cut grafting (Fig. 3-10), the rootstock is cut at the graft site. In budding or side grafting, the rootstock is not cut, or only slightly pruned. Usually only one bud is used for grafting. Paraffin film or plastic tape is used to wrap the bud and fix it in place. It takes about two weeks for the graft site to heal.

During this time, the grafted plant should not be given too much water, and should not be kept wet. The bud can emerge from the paraffin film by itself, but if plastic tape is used, the tape should be removed before bud emergence. If the rootstock has not been pruned at grafting, this should be done when the graft heals. When plants are being grown in containers, because of high planting density, looping treatment to enhance scion growth is not practiced during the bud emergence stage.

Growth media

The growth of plants in containers is greatly influenced by the growing medium. The pH of the medium should be kept between 5.5 and 6.5. A pH of more than 7 would affect the absorption by the seedling of some micronutrients.

The traditional medium is a mixture of equal parts (by volume) of manure, fine sand and soil. It is low in cost, and allows plants to grow well. However, this medium is rather heavy, and drainage is poor. It may become water-logged during the rainy season.

Various soiless media are also available, such as peat, vermiculite, perlite or stylarform granules. They all have the advantage of being clean and light, and they have good drainage. However, they are expensive. Because soiless media have a light texture, they should be pressed down firmly during transplanting.

Table 3-2 shows the different growth media used at Chiayi Agricultural Experiment Station in Taiwan. Provided the pH level was properly controlled, there was no significant difference in growth between seedlings in different media.

Growers should therefore decide what medium to use according to the cost and availability. Experimental results have shown that seedlings grown in a mixture of soil, rice hull and pig manure at a ratio of 3:2:2 (by volume) had a good rate of growth.

Since the nursery should have a high density of seedlings, a container which holds 2.5 - 3.0 liters and is 30 cm in height is large enough. The container should be in a shape which prevents roots from coiling through.

If the top is wider than the bottom, it is easier to pull out the seedlings for transplanting. However, the precise volume and shape of the container should be adjusted according to the desired size of the nursery trees when they are sold to growers.

Fertilizer management

There is no standard practice for fertilizing citrus nursery plants. Media which contain a certain percentage of soil generally do not have problems of fertility. Growers usually apply too much fertilizer in an attempt to speed up plant growth. This fertilizer may be leached out by frequent watering.

It should be noted that the recommended rate for fertilizers varies in different areas. However, the same amount of water-soluble fertilizer NPK (nitrogen, phosphorus, potassium), with additional calcium, magnesium and other micronutrients, should be applied once or twice a week. This should be sufficient for the growth of the young plants.

Slow-release fertilizers may be mixed into the medium before transplanting. If this is done, there may be no need for an additional top-dressing of fertilizer in the later growing stages.

Diseases and pests

Many diseases occur on citrus. There are fewer diseases if nursery trees are growing under a protected structure than in the open field, but good management is still needed to prevent soil-borne diseases and mites.

If the nursery is not properly managed, e.g. if there are holes in the netting or if the entrance is left open, then aphids, leaf miners and psyllids may enter, and even citrus canker. All nursery trees should be checked frequently for any pests or diseases. Yellow sticky paper is often used to trap insects.

Care should be taken to prevent soil-borne diseases caused by *Phytophthora* spp. It is most important to keep the planting medium, tools, instruments and seeds as clean as possible. Benches should be raised, and should not touch the ground (Fig. 3-4).

Insects such as mites, leaf miners, aphids and psyllids should be controlled by a preventative spray before they appear, or at a very early stage of infection.

Fig. 3-1. Seeds are sown in vermiculite medium. The first transplanting is done when the first two true leaves are fully expanded

Table 3-1. Important citrus rootstocks and their tolerance to diseases

Common name	Scientific name	Tolerance to diseases				
		Phyto	CN	CTV	Xylo	CEV
Rough lemon	*Citrus jambhiri* Lush.	S	S	T	T	T
Rangpur lime	*Citrus limonia* Osbeck	S	S	T	S	S
Sour orange	*Citrus auarantium* Linn.	T	S	S	T	T
Sweet orange	*Citrus sinensis* (L.) Osbeck	S	S	T	T	T
Trifoliate	*Poncirus trifoliata* Raf.	R	R	R	T	S
Troyer citrange	*Citrus sinensis* (L.) Osbeck x *Poncirus trifoliata* Raf.	S	T	T	T	S
Swingle citrumelo	*Citrus paradisi Macf.* x *Poncirus trifoliata* Raf.	T	T	T	T	S
Cleopatra	*Citrus reshni* hort. ex Tan.	T	S	T	T	T
Sunki	*Citrus sunki* Hort. ex Tan.	S	S	T	T	T

Phyto = Phytophthora rot; CN = Citrus nematode; CTV = Citrus Tristeza Virus; Xylo = Xyloporosis; CEV = Exocortis
S = susceptible; T = tolerant; R = resistant

Table 3-2. Container media used in citrus nursery by Chiayi Agricultural Experiment Station, Taiwan

Type of medium	Ratio (by volume)						
	I	II	III	IV	V	VI	VII
Peat moss		3	1	2	1	2	2
Cattle manure	1			2	1	2	2
Vermiculite		1		1/2	1/2	1/4	1/2
Sand	1		3	1	1/2	1/4	1/2
Soil	1		3	2	1	1	2
Bark compost			3		1/2		
Perlite		1				1/4	
Cyathea dust		1				1/4	

Fig. 3-2. Rootstock seedlings from Fig. 3-1. The seedlings have few branch roots and are easy to transplant. Poor-quality seedlings should be discarded at this stage.

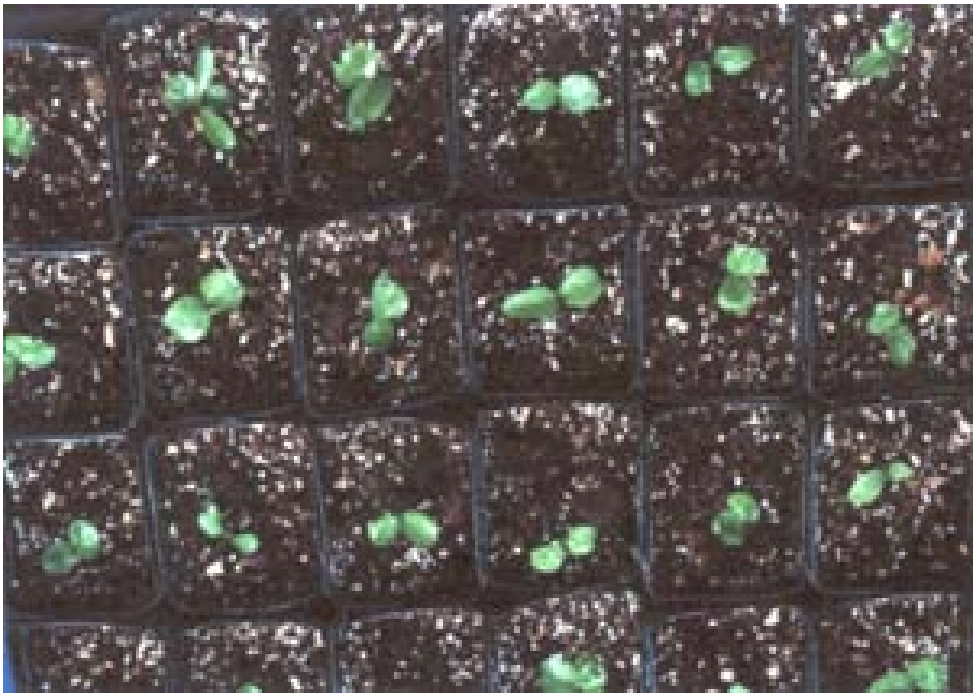

Fig. 3-3. Young seedlings at this stage are transplanted directly into a large container. (Single transplanting procedure).

Fig. 3-4. Seedlings should be kept on a raised bench to prevent soil-borne diseases.

Fig. 3-5. Five-month-old rootstock seedlings grown in plug cells.

Fig. 3-6. Young plants two to three months after being grafted into plug cells. They are now ready for transplanting into bigger pots.

Fig. 3-7. Good nursery trees show roots growing the full length of the container.

Fig. 3-8. T-budding. Buds are sliced from the budstick (top) and inserted into the T-cut in the rootstock (bottom).

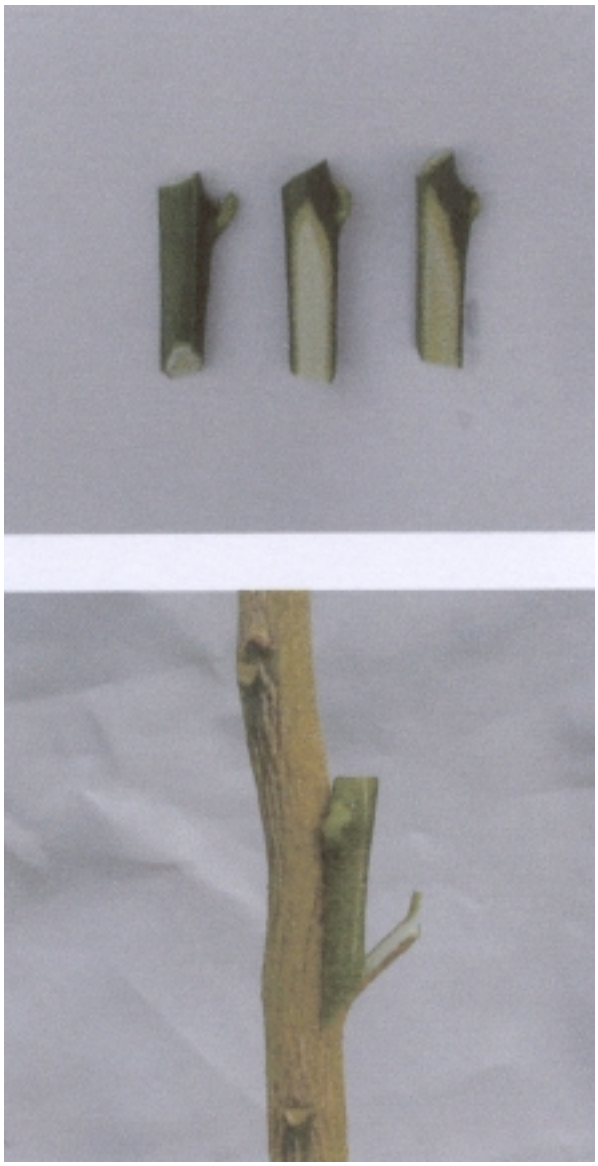

Fig. 3-9. Side grafting. Collection of bud (top). The bud is inserted into the vertical cut in the rootstock (bottom).

Fig. 3-10. Cut grafting and growth of scions.