

Certified Nursery Tree Production in Holland

Arie van den Berg

Verbeek Nurseries, Holland

As presented to growers during his visit to Australia in April 2002; reprinted with permission from Technical Bulletin of the Northern Victoria Fruitgrowers' Association (June 2002).

Verbeek Nurseries is situated in Holland where there are about 45 fruit tree nurseries with a total production of 7 million fruit trees per year. Verbeek produces more than 1 million fruit trees per year, about 80% apple and 20% pear, including 10 ha of rootstock beds. The total nursery area is 100 ha (247 acres).

NURSERY OPERATIONS

The fruit trees produced are for growers in Holland and other countries in Europe. Rootstocks from production beds are used for making bench grafts and sleeping eyes in our own nursery with some sold to other nurseries. M.9 337 (NAKB T337) is the major rootstock with a few M.9Fl (Fleuren) 56 produced. (M.9Fl 56 is a selection of M.9 that is less vigorous than M.9 337; it is used for special situations.) The pear rootstocks are quince C and quince Adams.

It takes 2 years to make an apple tree and 3 years to make a pear tree. New land is leased each year for the nursery. It is not possible to use any land more than once for apple and pear tree production because there is considerable reduction in tree quality from used ground. On a sandy/clay soil the trees grow regularly with no growing shocks. Areas that are regularly wet or too sandy are not used. This results in a number of small nursery blocks scattered around but it is manageable.

Crop protection is very important, as nursery trees need to grow steadily throughout the season with no growing shocks from pests or diseases. Regular weekly inspections are made with a report produced detailing the spray program for the period. Fertilizer is applied according to the soil analysis. The trees are given all the elements they need, mostly via foliar fertilizers. Nitrogen is sown two to three times during the season with a total of 150 to 200 kg pure N/ha applied.

Trees are lifted with a machine that can dig about 30,000 trees per day. They are graded in the field in different qualities (branch numbers) and stacked onto steel pallets. This is the only time the trees are handled until they are delivered to the grower. The lifted trees are transported to a storage shed where a fogging system regularly moistens them. If possible, trees are delivered within a week after lifting. If it is necessary to store the trees for 2 to 3 months, they are kept in the coolstore at 1°C. Trees are delivered in a closed truck so they cannot desiccate.

Trees with many branches (feathers, knipboom) give the highest production during their life cycle and require less labor.

VIRUSES AND CERTIFICATION

From about 1950 research on viruses increased. The impact on productivity was soon proven and the push began for virus-free material. In 1974 the industry in Holland had access to the first virus-free rootstocks, with most fruit varieties also established virus-free. In 1976 the nursery industry produced many virus-free fruit trees. This resulted in a better quality of tree, higher quality fruit and higher production. Nowadays all the fruit growers use and insist on virus-free fruit trees.

Viruses are very small organisms and come in many different forms. They need living plants for multiplication. Viruses were viewed for the first time with an electron microscope in 1939. There are about 600 kinds of plant viruses.

Viruses on pome fruit trees are transmitted only through budding and grafting. There are no known insect vectors as is the case in stone fruit, cherries, plums, etc. That is why it is so important to use only rootstocks and bud and graft wood that is not infected. Infection in the rootstock will be transmitted to the bud/graft wood and vice versa.

Infection of virus always results in smaller trees and lower production. Researchers at Wilhelmadorp research station in Holland evaluated the effect of virus on the production of Golden Delicious over 14 years by comparing virus-free and virus-infected trees in the orchard. The virus-free trees produced 327 kg/tree while the virus-infected trees produced 279 kg/tree (17% less). The difference in production per tree over 14 years equals 48 kg, multiplied by 2300 trees/ha equals 110,400 kg (110 tonnes) which equals **7.8 tonnes per year less production from virus-infected trees**. The same loss in production was consistent in other varieties and also with pears. This trial looked

at production only and did not take into account the fact the fruit quality was also affected by virus. Results from similar research carried out in Australia in the 1980s by Les Penrose et al. support this productivity loss from virus-infected trees.

It is very important to use only virus-free plant material in establishing an orchard.

In The Netherlands, various bodies certify materials, products and services. For fruit trees and rootstocks only one body is authorized to issue certificates and that is the **Naktuinbouw** (the new name for NAKB; Inspection Service for Floriculture and Arboriculture). All the rootstocks, bud and graft wood used in the nursery are certified by Naktuinbouw.

Every new variety is made virus-free as soon as possible. This is achieved by heat treatment. The variety is grafted onto a virus-free rootstock and placed in a pot in a growing chamber. The chamber is heated to a temperature of 37°C and the plant is managed for a period of up to 70 days (10 weeks) at this temperature. After that period the shoot tips on the plant are grafted onto healthy rootstocks and grown on in a hot house. The shoot tips are always virus-free because the growth of the plant at 37°C is faster than the growth of the virus so the virus does not infect them. Following indexing to ensure the viruses have been removed, nurseries can buy this material to make virus-free fruit trees.

Time frame for production of certified material:

1. 2002: Candidate plant (4 to 5 years, includes heat treatment and indexing).
2. 2007: Pre-basic material (1 to 2 years, fruit observed as true to type).
3. 2009: Basic material (1 to 2 years, observation for virus symptoms on fruit).
4. 2011: Certified mother trees (1 to 2 years, bud wood trees produced).
5. 2013: Certified graft and bud wood (1 to 2 years, wood collected to make 2-year-old knip trees).
6. 2015: Certified fruit trees.

As this is a long process, there are always varieties that are not yet 100% virus-free. These are usually new mutations that growers are eager to plant. The mutations can and usually do come from trees that are certified but that certification status is not passed onto the

mutation. Although there is a small risk that they are virus-infected, they are differentiated by a white tree label. In this way the growers and nurseries can be producing apples long before the whole certification process is completed.

NAKTUINBOUW QUALITY LABEL

Certified virus-free planting stock (trees from the nursery) can be recognized by the orange Naktuinbouw Certification label. Material not yet certified gets a white tree label. Every tree gets a label which has the information ensuring that trace back can occur if there is a problem with the tree sometime in the future. All the labels are supplied by Naktuinbouw to match the volumes of bud and graft wood supplied to the nursery. The nursery is responsible for placing the labels on the nursery trees. An inspector from Naktuinbouw audits this process.

REQUIREMENTS TO BE MET BY CERTIFIED STOCK

The most important requirement imposed by the Naktuinbouw is that certified trees must have been produced from certified rootstock and certified graft or bud wood from an official agreed propagation garden. The plants must be regularly inspected in the field. Both the internal quality (free of viruses, genetic properties, etc.) and the external quality are then inspected. These inspections are carried out by the fruit tree growers, nurserymen and by the Naktuinbouw's independent inspectors.

The nurseries affiliated with the Naktuinbouw are provided with virus-free rootstock and graft/bud wood from the propagation garden. If it is found that parental stock in the propagation phase or the ultimate trees before or during the trading phase do not meet the agreed requirements, the Naktuinbouw ensures that this stock is not traded as certified stock.

ADVANTAGES OF CERTIFIED STOCK

Certified stock offers you, as buyer and/or seller, extra advantages. Thanks to the Naktuinbouw's certification inspections, you can be certain that the nurseryman has made the greatest possible effort to obtain a certified product. The following aspects of the certified stock will have been inspected: origin, varietal purity, varietal trueness, external quality, free of viruses and absence of other diseases.

From the stringent requirements imposed, suppliers can infer that the products are of the highest quality.

The most important viruses on *Malus* (apple) are:

- apple chlorotic leafspot closterovirus
- apple mosaic ilarvirus
- apple stem grooving capillovirus
- apple proliferation MLO
- chat fruit
- green crinkle
- horseshoe wound
- rough skin
- star crack
- ring spot
- russet ring
- rubbery wood
- flat limb
- russet wart
- stem pitting
- spy epinasty and decline
- platycarpa scaly bark

If you buy a virus-free fruit tree in Holland, then this tree is absolutely free from these viruses.

PLANT A GOOD TREE

A very heavy frost in Holland in 1984/1985 resulted in large losses of trees both in the orchards and the nurseries. Many fruit growers planted so-called half products such as bench grafts and sleeping eyes. To demonstrate that it would be better to wait until the nurseries had good trees again, researchers at the research station at Zeewolde planted these half products and good feathered trees in the tree trial (Table 1) which clearly demonstrates the productivity benefits.

In Holland there are the following slogans: Plant only trees "ready for production," so trees must have many branches, and plant "volume," the best tree is not good enough. Trees with many branches (feathers, knipboom) give the highest production during their life cycle and require less labor. The trial results (Table 2) show the productivity value of planting trees with many branches (feathers).

KNIP TREES

A 1-year tree (the scion has grown for one season in the nursery) is an old-fashioned kind of tree that used to be grown in Europe 20 to 25 years ago. The nursery planted rootstocks in the spring and put a bud on in the summer. The following year a 1-year-old tree with branches was produced. These branches were very low to the ground and generally had to be cut off after the tree was planted. This type of tree resulted in the grower being a nurseryman for the first 2 years in the orchard, trying to grow branches instead of getting on with growing apples.

It was important to find a method of making trees that have a lot of branches that start at a higher level. After some years of experiments, the so-called knip tree was born. (In Dutch knip means cut and boom means tree.) Almost 100% of the trees that are produced nowadays in the nurseries are knip trees.

PRODUCTION PROCESS FOR KNIP TREES

In spring, bench grafts and sleeping eyes (sleeping eyes are dormant budded rootstocks that are lifted, graded and headed off to the bud) are planted into the nursery. The planting distance is 90 x 33 cm (35 x 13 inches). Immediately after planting, wooden sticks are placed next to the plants. In the year of planting, the shoot that grows out of the bud or bench graft is tied to the stick several times for support. This is necessary to get a straight stem which is very important. Shoots that are tied up grow better. In the first year the shoot will grow to a height of 120 to 150 cm (47 to 59 inches), depending on the variety. In late winter after one growing season in the nursery, the trees are cut (knip) back to about 70 to 80 cm (27 to 32 inches) above the ground.

The diameter at that height must be at least 10 mm (.39 inches). In spring the top bud is promoted and the other shoots below are progressively removed during the season so that the stem below the cut is clean. All the branches on the tree are produced on the new shoot with the first at about 90 to 100 cm (35 to 39 inches) above the ground, depending on the variety and the grower's requirements. After planting in the orchard, no branches have to be removed unless there are too many. They are

high enough and the orchardist can use all the branches to achieve high early production.

There are three ways to increase the number of branches on the nursery trees.

1. **Breaking leaves.** When the young top shoot of the knip tree has extended about 15 to 20 cm (6 to 8 inches) from the bud, the top leaves that are not yet totally unfolded are removed. The top leaves are held between the forefinger and thumb of the left hand and the upper part of the leaves is broken off with the forefinger and thumb of the right hand (or with a small pair of scissors). It is important that the growing point (shoot tip) is not damaged. This action is repeated 4 to 6 times. Usually this is once per week and, if the plant grows very fast, it may be necessary to complete this task twice in a week. The result is a lot of "feathers" (branches). How many branches will develop depends on the variety but, in any case, there will be many more than when nothing is done. This process needs to be started whatever the weather and repeated regularly whatever the weather.

What is the secret? The top of a growing shoot contains a lot of auxin, a growth hormone. The hormone stimulates growth. The growth of the top of the shoot is so strong that the buds below do not grow and develop. All the energy goes to the top of the shoot in a process known as apical dominance. When we break a part of the top leaves, then the auxin production of the young leaves will decrease by about 50%. The result is that the buds below the top of the shoot start growing and will develop into branches.

2. **Spraying Promalin.** Promalin contains 50% GA₄₊₇ and 50% cytokinin BA (=benzyladenine). Promalin stimulates the transport of auxin to the buds below the shoot tip with the result that the buds develop into branches. You can start spraying when the top shoot of the knip tree is 15 to 20 cm (6 to 8 inches) from the bud. It is necessary to add surfactant to the spray tank (in Holland: Citowett).

Concentration of Promalin is 25 to 50 ml per liter of water (=2.5 to 5%). One liter spray liquid is enough for at least 100 trees, maybe more. For spraying, you can use a knapsack sprayer with hand pump. Hold the nozzle just above the shoot top and moisten the shoot until the spray liquid drips on the ground. Promalin is used just once in a season (mostly in combination with removing a part of the top leaves [see above]). A warm and dry period (about a week) after spraying stimulates the effect.

3. **BA=benzyladenine=Paturyl.** Researchers at the research station in Wilhelminadorp in Holland have found that by itself BA (a part of Promalin) also stimulates the growth and development of branches. You can also start spraying when the top shoot of the knip tree is about 15 to 20 cm (6 to 8 inches) from the bud. For a good result it is necessary to spray 4 to 6 times (once per week).

The concentration for BA (20 g per liter of active) is 1.5 to 3 liters per 100 liters of water. You should add Citowett or Tween-20 surfactants. It is

important that the wetter (surfactant) is added very accurately as leaf and tip damage can occur if the amount of wetter is too high. The frequency and concentration depend on the variety. For instance, for Cox's and Elstar, 4 x 300 ml per 100 liters of water; for Golden Delicious and Jonagold, 6 x 300 ml per 100 liters of water. Good results are also found through the combination of spraying once or twice and breaking leaves (the first method) between the spraying.

FREQUENTLY ASKED QUESTIONS

- Q. Does the production of knip trees only apply to trees produced on M.9?
 A. No, M.9 is the rootstock that has been used in the research trials but the techniques apply similarly to other rootstocks. The technique ensures that growers receive a tree that already has a balance between vigor and crop potential.
- Q. In the heat treatment process, how do you know where to cut the shoot tip to ensure that the virus is not present?
 A. Many growing tips are taken and further tested for the presence of virus to ensure that the virus has been removed.
- Q. What do you do if the nursery does not want to supply the type of tree you want?
 A. You must keep asking. Proposed will be incremental. It will take time but ultimately all trees will be knip type.
- Q. How do you produce rootstocks in Holland?
 A. In layer beds mounded with sawdust. There are no special treatments.
- Q. What price is a whip tree in Holland and what price is the knip tree?
 A. Whip trees are not grown. The knip tree price is 3 euros (about US \$3.00) plus 6% tax and a delivery charge outside Holland, Germany and Belgium. There is tremendous competition in Europe in the nursery industry and growers will buy only the best trees, so this keeps considerable pressure on the price.
- Q. How is Promalin applied for branch promotion on the nursery trees?
 A. It is sprayed onto the tip of the tree until it runs down the stem and consequently into each of the buds.
- Q. What temperature is required for the branching sprays to be effective?
 A. Above 16°C (61°F) is necessary (20°C [68°F] is better) with a week of good weather following.
- Q. What is the minimum size of rootstocks used for making bench grafts?
 A. A good root system with 10 mm in diameter. Only 15% of stocks are used directly off the beds. Most are grown on in the field and grafted in the second year.
- Q. Why does it take so long to produce virus-free trees?
 A. The growing process in the cabinet (heat chamber) under controlled conditions is very short, but reestablishment and on-going indexing and observation of fruiting characteristics take time.
- Q. Does certification in Holland include fire blight and are virus-free trees less prone to it?
 A. No, it makes no difference. Trees are given a plant passport for movement between the countries of the European Union if they are free of fire blight infection. Reg-

ular inspections are made of the nursery and the surrounding areas by government inspectors, usually from the importing country.

- Q. How do you deal with fire blight in the nursery?
 A. Infected trees are removed and burned, along with all the trees in a 5 m radius.
- Q. What interstems are used on M.9 in Holland?
 A. Interstems are used on only a few specific varieties and include the following: Summerred, DZFI (a Dutch variety) and Golden Delicious Reinders.
- Q. What are sleeping eyes?
 A. The small stocks off the rootstock production beds (stoolbeds) are lined out very closely together (10 cm x 70 cm) in spring and are budded with the scion later in the summer. They are then lifted in the winter (the scion bud has not grown, it is sleeping), cut back to the bud, then planted in the spring of the next year to make knip trees.
- Q. What are the main nursery pests in Holland?
 A. Everything, apple scab, powdery mildew and many insects, which results in up to 25 chemical applications during the growing season.
- Q. Is there a rapid test for apple green crinkle disease in Holland?
 A. No, the causal agent is unknown.

- Q. Verbeek Nursery exports trees all over Europe. Why do you have only M.9, as there must be many different soil types?
 A. M.26 is used for some specific orders but is usually too vigorous. Growers ask only for M.9.
- Q. There is no lifting date on the tree tag. How do you know that the tree has not been lifted sometime in the past year?
 A. The unique number on the tag traces the date the budwood/graftwood was selected and when the tree tags were supplied to the nursery. It is practically impossible to sell a tree that has been in the coolstore for more than a year as it would be completely dried out.
- Q. When you are breaking the top leaves on the new shoot on the knip trees, how many trees per hour can be completed?
 A. Around 1000 trees per hour.
- Q. How deep do you plant the apple trees in the orchard and do you use a tree planter?
 A. All trees are planted by hand. The depth of planting is dependent on the variety and the soil. The bud/graft union needs to be at least 100 mm (4 inches) above the ground to avoid scion rooting. Deeper planting usually results in increased vigor. Growers of knip trees in Holland can afford the time to hand plant, as they do not have to spend any time as growers in many other countries do in developing the branched tree in the orchard.

TABLE 1

Yield of Jonagold trees of four different types planted in 1986 at 3 x 1.3 m = 2300 trees/ha at the Zeewolde Research Station, Holland.

Tree type	Production (kg/tree)					Total
	1987	1988	1989	1990	1991	
Table (bench) graft	0	10	20	25	30	85
Sleeping eye	0	10	18	24	25	77
Whip	3	16	23	31	30	103
Knip tree	15	20	34	27	32	128

TABLE 2

Yield of Jonagold planted in 1988 at 3 x 1.3 m (2564 trees per 10,000 m²; x 90% = 2300 trees/ha) at the Zeewolde Research Station, Holland.

Tree type	Production (kg/tree)			Total
	1989	1990	1991	
1-year 3-4 branches	13	17	27	57
1-year 6-7 branches	16	23	29	68
1-year 10-11 branches	17	22	28	67
Knip tree 5-6 branches	15	20	27	62
Knip tree 9-10 branches	16	26	28	70
Knip tree 12-14 branches	17	26	28	71