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APRC Project Report

**Project SP75** Evaluation of promising apple and pear rootstocks

**Project Staff:** A.D. Webster, E. Bonham, Ms. Jane Spencer, Mrs. Ann Lucas

**Date:** Report to 31 March 1998

## Apple Rootstocks

### Propagation tests

Hardwood cuttings have been taken of all of the promising rootstocks selected in the Apple and Pear Breeding Club screening trials. The aim is to build up sufficient rootstocks to facilitate trials on grower sites of the most promising new rootstocks. Details of the propagation of these and other apple rootstocks are given in the report on Project T13. Attempts to achieve this build-up using a commercial nursery have been abandoned and effort refocused on propagation at HRI-East Malling.

### Orchard comparisons

Frost damage in spring 1997 reduced yields to almost nil on most apple rootstock trials and no trials warranted fruit storage or grading.

In a trial comparing rootstocks bred in Poland, the Czech Republic, Sweden and Germany with Malling and Malling Merton standards, the Czech stocks J-TE-E and J-TE-F are producing trees larger than those on M27 but smaller than those on M9. Yields, although all very poor in 1997, were best for trees on J-TE-E, J-TE-F and M27.

In a trial comparing rootstocks bred at Cornell University in New York State with Malling and Malling Merton standards, most rootstocks are more invigorating than M9. However, two stocks, numbers 179 and 210 are similar in vigour to M9 and another, 902, is much more dwarfing.

## Pear Rootstocks

### Propagation tests

Propagation by hardwood cuttings has continued on a range of quince and *Pyrus* clonal rootstocks. These are clones selected from screening trials funded under the Apple and Pear Breeding Club initiative. Rooted cuttings from propagation initiated in 1996 and grown-on in 1997, have been lined out to extend hedges and stoolbeds. These will supply larger numbers of liners for subsequent field trials of the new rootstocks on growers farms.

### Orchard comparisons

Despite some tree deaths in the first year, trees on the quince selection QR193-16 have, in most cases, established well following planting on four grower sites in spring 1997.

In a trial planted in 1988 with Conference as scion, the smallest trees are those on the quince rootstocks QR 530/4 and QR 530/11 which are significantly smaller than trees on QC. Trees on the *Pyrus* rootstock QR 708-2 are similar in size to trees on QC whilst those on QR 708-12 are smaller and those on QR 708-36 larger.

Trees of Comice and Concorde planted in 1990 on QR 193/16 are slightly smaller than trees on QA but slightly larger than those on QC.

Comice trees budded at 15, 30 or 45 cm above ground and planted in 1994 all made similar extension growth in 1997. The trees bore no fruits due to frost damage and this suggests that previous differences in shoot growth noted on trees budded at different heights may have been influenced by treatment effects on cropping.

Conference trees planted in spring 1997 on the new German *Pyrus* rootstock clone 'Pyrodwarf' made less than half the total shoot growth of trees on QC in the first season. Trees of Comice were slower to establish and trees on all stocks made similar growth, which was less than that made by the Conference trees. Trees of Conference on BP1, a *Pyrus* stock of South African origin, which were two years old at planting in spring 1997, made more extension growth in 1997 than 2-year-old trees of Conference/QC.

Interstocks of two dwarfing clones of the French Brossier series of *Pyrus* rootstocks, all of which are very difficult to propagate, have had no initial effect on the vigour of Williams or Comice trees planted in 1996 with QA rootstocks. A new *Pyrus* rootstock selection OH 11 selected in Angers, France, has been named Pyriam. Materials of this stock will be supplied to HRI-EM for testing in 1999.

Cherry Rootstocks

New propagation tests have begun on Gisela 6, a cherry rootstock which is currently in short supply in the UK. Most stocks of Gisela 6 are raised by micropropagation in its country of origin Germany. Previous tests at East Malling showed that the stock could be raised quite easily by softwood cuttings under mist. New tests have begun evaluating its potential for propagation by hardwood cuttings.

Cuttings taken in summer of 1997 of a virus-free clone of hexaploid Colt have been successfully weaned and overwintered. The build-up of this new rootstock clone will continue this summer.

**CONTRACT REPORT**
**SP75**

Evaluation of promising apple and pear rootstocks

*Undertaken for APRC*

30/9/98

**APRC Project Report**

**Project SP75:** Evaluation of promising apple and pear rootstocks

**Project Staff:** A.D. Webster, E. Bonham, Ms. Jane Spencer, Mrs. Ann Lucas

**Date:** Report to 30 September 1998

## Apple Rootstocks

### HRI-East Malling Selections

Several dwarfing rootstock clones continue to show promise in orchard trials. AR 672-1 is producing trees similar in vigour to those on M.27 and with similar cumulative yields. Yields of Class I >65 mm fruits on AR 672-1 are slightly higher than on M.27.

AR 669-1 is intermediate in vigour, and cumulative yields are between M.27 and M.9. Cumulative yields of Class I >65 mm fruits are highest on M.9 but those on AR 669-1 are much higher than on M.27.

Trees on AR 680-2 are slightly smaller than those on M.9 and cumulative yields are 60% greater than from trees on M.9. Of particular interest are the yields of Class I >65 mm fruits on AR 680-2, which are almost twice those on M.9.

The rootstock selection AR 801-11 is producing trees larger than M.9 and very similar in size to trees on M.26. However, cumulative yields on the trees on AR 801-11 are much higher than on M.26 and its yields of Class I >65 mm fruits are twice those on M.26.

Propagation tests and build up, using layering and macro cutting techniques, are continuing with these and other promising apple rootstock clones.

### Foreign Rootstock Selections

The trials comparing apple rootstocks bred in Poland, USA, Sweden, The Czech Republik and Germany cropped well in 1998. The fruits are currently in storage and results will be presented in the March Report.

## Pear Rootstocks

Concorde trees planted in 1990 on the quince rootstock selection QR193-16 cropped better in 1998 than trees on QA, QC or another quince selection QR 193/2 (Table 1.). However, Comice trees on QC bore higher total yields than those on QR 193-16. Yields of Class I >65 mm diameter fruits of Concorde were highest on QR 193-16 whilst Class I yields of Comice were similar on QR 193-16 and QC. The effects of QR 193-16 in inducing large sized scion fruits has proved a consistent effect in this trial.

Comice trees, planted in 1994 in a trial to compare three heights of budding onto either QC or QR 193-16, bore their first small crop in 1998. Yields were much better on QC than on

QR 193-16. This supports findings in other trials that trees on QR 193-16 are less precocious in cropping than trees on QC. Highest yields of Comice on QC were harvested from the trees which were budded high (Table 2.).

Table 1. Yield in 1998 of Concorde and Comice trees planted at HRI-East Malling in 1990

| Scion | Rootstock | Total Yield (kg/tree) | Yield Class I >65 mm (kg/tree) |
|---|---|---|---|
| Concorde | QR 193-16 | 10.8 | 2.8 |
| | QR 193-2 | 8.3 | 1.3 |
| | QA | 7.1 | 1.1 |
| | QC | 8.5 | 2.0 |
| Comice | QR 193-16 | 6.8 | 1.7 |
| | QR 193-2 | 5.5 | 0.8 |
| | QA | 5.1 | 1.3 |
| | QC | 10.5 | 1.6 |

Table 2. Yields of Comice trees budded at three different heights and planted in 1994

| Rootstock | Height of budding above ground (cm) | Total Yield (kg/tree) | Yield Class I >65 mm (kg/tree) |
|---|---|---|---|
| QC | 15 | 1.8 | 0.5 |
| | 30 | 3.1 | 1.3 |
| | 45 | 5.0 | 1.0 |
| QR 193-16 | 15 | 0.1 | 0.1 |
| | 30 | 0.4 | 0.3 |
| | 45 | 0.2 | 0.2 |

Conference and Comice trees planted as maidens in spring 1997 on the new dwarfing *Pyrus* rootstock clone 'Pyrodwarf' (Rhenus 1) developed almost no floral buds in 1998. In contrast, trees on QA or QC rootstocks developed significantly more floral buds. This preliminary result suggests that, contrary to results from German trials, trees on Pyrodwarf may prove less precocious than similar trees on quince rootstocks.

Conference, planted as 2-yr-old trees in 1997 on the South African BP 1 *Pyrus* rootstock clone, developed only half the numbers of floral buds compared with similar trees on QC. Despite some initial fruit set, almost no fruits persisted through until harvest in this trial.

Trials planted in the last two-three years comparing *Pyrus* clones from the HRI breeding programme and clones from INRA in France (Brassier) produced some flower buds in 1998 but set very few fruits.

Cherry Rootstocks

Propagation build-up of a virus-tested clone of Hexaploid Colt has continued using micro- and macropropagation techniques.

**CONTRACT REPORT**
**SP75**

Evaluation of promising
Apple and pear rootstocks

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Table 2. The effects of seven new rootstock clones raised in Geneva, New York, on the 1998 yields of Queen Cox apple trees planted in 1998. (All trees trickle-irrigated)

| Rootstock | Trunk girth spring 1998 | | Total yield | | Yield of Class 1 > 65 mm Ø | |
|---|---|---|---|---|---|---|
| | cm | % of M.9 | kg/tree | % of M.9 | kg/tree | % of M.9 |
| Geneva 11 | 13.8 | 105 | 7.5 | 155 | 4.2 | 200 |
| Geneva 30 | 15.6 | 118 | 7.0 | 144 | 2.8 | 132 |
| Geneva 179 | 12.1 | 92 | 4.1 | 84 | 2.1 | 101 |
| Geneva 202 | 13.5 | 103 | 6.7 | 138 | 3.2 | 155 |
| Geneva 210 | 13.0 | 99 | 4.5 | 92 | 2.2 | 105 |
| Geneva 730-20 | 10.3 | 78 | 3.8 | 79 | 2.1 | 99 |
| Geneva 902 | 10.5 | 80 | 5.9 | 122 | 3.4 | 162 |
| MM.106 | 15.8 | 120 | 4.6 | 95 | 2.5 | 120 |
| M.9 | 13.2 | 100 | 4.8 | 100 | 2.1 | 100 |

## EAST MALLING TRUST FOR HORTICULTURAL RESEARCH REPORT

Project SP75: Evaluation of promising apple and pear rootstocks

Project Staff: A.D. Webster, J.E. Spencer, E.C. Bonham

Date: Report to 30th September, 1999

Income: £17K

### Pear rootstocks

East Malling trial evaluating the HRI-EM quince selection QR.193-16

The vigour of Comice and Concorde trees planted in 1990 on the quince rootstock selection QR.193-16 is intermediate between the vigour of the varieties on QA and QC rootstocks. Vigour on another quince selection QR.193-2 is slightly greater than on QA (Table 1). Cumulative yields 1994-1998 have been poor on this site, on account of frequent spring frost damage. However, the cumulative yields and the percentages of Class 1 fruits (>65 mm diameter) have been slightly better on QR.193-16, than on the other rootstocks. In contrast, the variety Comice has produced the best cumulative yields when budded on QA rootstock and the percentages of Class 1 fruits have been similar for trees of Comice on all of the rootstocks.

Table 1: The effects of quince rootstock selections on the tree size (trunk girth), cumulative yields and fruit grades of Concorde and Comice pear trees planted in spring 1990

| Scion | Rootstock | Trunk girth 1998/99 (cm) | Cumulative yields (kg/tree) 1994-1998 | |
|---|---|---|---|---|
| | | | Total | Class I >65 mm |
| Concorde | QC | 19.7 | 22.9 | 21 |
| | QR.193-16 | 21.4 | 23.7 | 26 |
| | QA | 23.8 | 23.3 | 19 |
| | QR.193-2 | 24.1 | 20.5 | 20 |
| Comice | QC | 24.3 | 23.5 | 30 |
| | QR.193-16 | 26.3 | 19.8 | 28 |
| | QA | 27.9 | 29.0 | 29 |
| | QR.193-2 | 29.8 | 18.9 | 27 |

Grower trials of QR.193-16

On sites in Kent and Suffolk, the trunk girths of Concorde trees planted in 1998 on QR.193-16 were smaller in spring 1999 than the girths of similar trees on QA rootstock.

Also, Conference trees planted in the same spring on QR.193-16 were smaller in spring 1999 than similar trees on QC rootstock. However, the trees on QR.193-16 were smaller than average at the time of planting and records in subsequent seasons will be required to ascertain the true vigour of this new quince rootstock on these sites. Very few fruits were produced on any of the trees in 1999, but there was an indication that floral precocity of trees on QR.193-16 was slightly poorer than for trees on QC or QA. Records in subsequent seasons should show whether the larger fruit sizes, induced by QR.193-16 in previous trials at HRI-East Malling, will be achieved also in these grower trials.

Trials comparing other new HRI-EM quince and *Pyrus* rootstock selections

In a trial planted in 1988, which compares the growth and cropping of Conference trees on several different quince and *Pyrus* rootstock clones, the smallest trees (31%-37% less vigorous than trees on QC) are those on the quince selections QR.530-4 and QR.530-11 (Table 2). Trees on the HRI quince selection C.128, raised from seeds collected in the Caucasus area many years ago, are similar or slightly smaller than trees on QC. Amongst the *Pyrus* rootstocks, QR.708-12 has produced the smallest trees and the USA selection OHF.34 the largest.

Table 2: Tree size and cumulative yields of Conference pear trees planted on quince and Pyrus rootstock clones in 1988

| Rootstock clone | Rootstock type | Trunk girth (cm) 1998/99 | Cumulative yields (kg/tree) 1993-1998 | |
|---|---|---|---|---|
| | | | Total | Class I >65 mm |
| QA | Quince | 25.2 | 43 | 24 |
| QC | " | 20.8 | 40 | 14 |
| QR.191-3 | " | 22.9 | 35 | 19 |
| QR.196-8 | " | 27.7 | 39 | 22 |
| QR.196-9 | " | 28.1 | 52 | 29 |
| QR.196-10 | " | 27.2 | 38 | 22 |
| QR.523-1 | " | 23.2 | 35 | 20 |
| QR.527-2 | " | 25.9 | 41 | 21 |
| QR.530.4 | " | 13.1 | 19 | 7 |
| QR.530-11 | " | 14.4 | 23 | 9 |
| C.85 | " | 27.2 | 36 | 22 |
| C.128 | " | 19.8 | 37 | 16 |
| QR.708-2 | *Pyrus* | 25.5 | 15 | 5 |
| QR.708-12 | " | 17.7 | 14 | 7 |
| QR.708-13 | " | 31.7 | 39 | 12 |
| QR.708-36 | " | 29.8 | 46 | 16 |
| OHF.34 | " | 33.5 | 65 | 26 |

Yields on the frost prone site at HRI-East Malling have been poor unfortunately. The quince rootstock inducing the highest cumulative yields (20% more than by trees on QA or QC) has

been QR.196-10, which induces approximately 11% more vigour than QA. Approximately 57% of the yields on this rootstock have been in the larger size grades, compared with 35% and 55% for trees on QC and QA respectively. Cumulative yields on the very dwarfing quince stocks QR.530-4 and QR.530-11 have been poor, only half those on QC, indicating poorer yield efficiency on these very dwarfing clonal stocks. The trees on C.128 have produced similar cumulative yields to trees on QC but with a slightly higher percentage of the total in the larger size grades. Amongst the *Pyrus* rootstocks, the highest cumulative yields were harvested from the very large trees on OHF.34. Trees on the HRI-EM selection QR.708-36 also bore good yields. Fruit grades were poorer, generally, for trees on *Pyrus* compared with trees on quince rootstocks.

In a trial planted in spring 1995 trees of the variety Williams are similar in size and vigour on an HRI-EM fireblight resistant Pyrus rootstock clone, QR.517-9 and on the quince rootstock QA. Trees on this *Pyrus* rootstock have produced similar numbers of flower buds to trees on QA, but spring frost damage has in the last few years affected severely the fruit set of all of the trees in this trial.

Trials evaluating the Brossier Pyrus rootstock clones bred by INRA at Angers, France

Many of the Brossier Pyrus selections, which were derived from Perry pear seedlings, were shown in French trials to be dwarfing when used as rootstocks for pear scions. Unfortunately, they have never been commercialised on account of the extreme difficulties experienced with their vegetative propagation. In an attempt to overcome this difficulty, a trial was planted at HRI-EM in spring 1996 to test two of the Brossier clones, G54-11 and G.28-119 as interstocks with QA rootstocks and Williams and Comice scions. Measurements of shoot growth and trunk girth in 1997 and 1998 have shown no dwarfing benefits using these Brossier rootstock clones as interstocks. However, their use may improve the graft compatibility of Williams with quince rootstocks such as QA.

In a second trial planted in spring 1997, the Brossier selections RV113, RV134 and G.28-119 are compared with QA and QC as rootstocks for Williams and two of the selections, RV113 and RV134, are also compared with QA and QC as rootstocks for Comice. The Brossier rootstocks were raised with some difficulty using micropropagation techniques. Another more dwarfing Brossier selection, RV.139, although multiplied *in vitro* failed to wean in sufficient numbers to be compared in the trial.

Williams trees on RV.113 have made slightly more shoot growth and are slightly larger in trunk girth than trees on QC, but have made less growth than trees on QA (Table 3). Williams on RV134 are less vigorous than trees on QC. Similar results have been recorded with Comice, where trees on RV.134 are also less vigorous, to date, than trees on QC. Floral bud production (precocity of flowering), however, has been better on the quince than on these *Pyrus* rootstocks. It is not known if these differences are attributable to differences in speed of establishment of the trees and results in future years will be needed to ascertain this. In France, recent results indicate that a sibling Brossier stock, G28-150, not included in this trial, is the best. However, difficulties in propagation have been encountered and the stock is unlikely to be commercialised unless these can be overcome.

Table 3: Effects of Brossier rootstock clones on the growth and floral precocity of Williams and Comice pear trees planted in spring 1997

| Scion | Rootstock | Total extension growth/tree (m) | Trunk girth (cm) | Floral bud numbers/tree |
|---|---|---|---|---|
| | | 1998/99 | 1998/99 | 1999 |
| Williams | RV113 | 8.7 | 8.9 | 36 |
| " | RV134 | 4.9 | 6.6 | 15 |
| " | G28-119 | 4.4 | 6.9 | 26 |
| " | QA | 13.5 | 9.6 | 56 |
| " | QC | 7.9 | 8.1 | 48 |
| Comice | RV113 | 11.4 | 9.6 | 26 |
| " | RV134 | 4.8 | 7.1 | 16 |
| " | QA | 14.7 | 9.6 | 25 |
| " | QC | 13.4 | 9.1 | 49 |

Evaluation of Pyrodwarf and BP1 Pyrus rootstocks

Pyrodwarf is a clonally propagated *Pyrus* rootstock bred some years ago at Geisenheim in Germany. In the preliminary German trials it performed well, dwarfing trees and inducing good yield precocity and productivity, and adequate fruit size. It is also reported to be relatively easy to propagate and resistant to fireblight. BP1 is a *Pyrus* rootstock bred in South Africa, which has gained some popularity there on account of its ability to reduce the vigour of pear trees worked upon it.

Conference trees planted as maidens on Pyrodwarf in spring 1997 have made less extension shoot growth than trees on QA or QC (Table 4). However, the dwarfing effects of Pyrodwarf on the variety Comice have, to date, been less than those recorded on Conference. Flower bud production on the trees grafted on Pyrodwarf has been less than for trees on the quince rootstocks.

Trees on BP1, planted as 2-y-olds, made less growth and fewer flower buds than similarly aged trees on QA. However, during the summer of 1999 many of the trees on BP1 have died. Examination by Dr. David Davies (HRI-East Malling) has shown that all of the dead and dying trees were/are infected with the phytoplasma that is the causal agent of Pear Decline. The symptoms noted on the affected trees, yellowing then necrosis and shrivelling of the leaves prior to tree death, are different from those normally associated with Pear Decline when it affects trees on quince rootstocks. Studies in Italy have also shown BP1 to be highly susceptible to Pear Decline.

Table 4: Effects of Pyrodwarf and BP1 rootstocks on the growth and floral precocity of Conference pear trees planted in spring 1997

| Scion | Rootstock | Age of tree at planting (y) | Total shoot growth/tree (m) 1998 | Trunk girth (cm) 1998/99 | Floral bud Nos/tree 1999 |
|---|---|---|---|---|---|
| Conference | Pyrodwarf | 1 | 3.5 | 6.2 | 17 |
| " | QA | 1 | 6.3 | 8.7 | 30 |
| " | QC | 1 | 8.8 | 9.1 | 74 |
| " | BP1 | 2 | 5.8 | 9.2 | 54 |
| " | QC | 2 | 9.0 | 9.7 | 94 |
| Comice | Pyrodwarf | 1 | 10.4 | 7.6 | 12 |
| " | QA | 1 | 8.7 | 8.9 | 24 |
| " | QC | 1 | 12.7 | 9.0 | 28 |

Influence of budding height on the growth, flowering and yield of Comice on two quince rootstocks

Increasing the height of budding on dwarfing apple rootstocks is known to increase their dwarfing effect on the scion. In a trial of the variety Comice, planted in spring 1994, three different heights of budding, 15, 30 and 45 cm above ground level, were compared on two quince rootstocks, QC and QR.193-16.

The results, to date, show that the increased height of budding Comice on QC rootstock has reduced scion shoot growth and trunk girth (Table 5). In contrast, increased height of budding on QR.193-16 has had no similar effect. Increased height of budding on QC rootstock also increased flowering and cropping.

Table 5: The effects of height of budding on the growth, flowering and yield of Comice pear trees planted in spring 1994

| Rootstock | Height of budding | Total shoot growth (m) 1998 | Trunk girth (cm) 1998/99 | Floral bud numbers/tree 1998 | Yield/tree (kg) 1998 |
|---|---|---|---|---|---|
| QC | 15 | 24 | 17.9 | 72 | 1.8 |
| " | 30 | 15 | 16.6 | 111 | 3.1 |
| " | 45 | 10 | 15.4 | 211 | 5.0 |
| QR.193-16 | 15 | 22 | 18.0 | 35 | 0.1 |
| " | 30 | 30 | 17.2 | 33 | 0.4 |
| " | 45 | 23 | 17.7 | 29 | 0.2 |

Effects of the method of rootstock propagation on the growth of Conference trees.

Three HRI-EM clones of *Pyrus* rootstock, QR. 708-2, QR.708-13 and QR.515-24, were propagated either conventionally, by hardwood cuttings or by micropropagation. The rootstocks were then used to raise trees of Conference pear which were planted in an orchard at HRI-EM in spring 1996.

Trees on two of the rootstocks, QR.708-2 and QR.515-24, made more growth in 1997 and 1998 when the trees were propagated on rootstocks raised from hardwood cuttings (Table 6). In contrast, the reverse effect was recorded with QR.708-13, where trees on the rootstocks raised from micropropagation made the most growth. With QR.708-2 and QR.708-13, floral bud numbers were influenced by tree size, whereas with QR.515-24 there was no relationship between tree size and flowering abundance.

Table 6: Effects of method of rootstock propagation on the growth and flowering of Conference scions planted in spring 1996

| Rootstock | Method of propagation | Total shoot growth/tree (m) 1997+1998 | Trunk girth (cm) 1998/99 | Floral bud nos/tree 1999 |
|---|---|---|---|---|
| QR.708-2 | H.W. cutting | 24.8 | 11.3 | 126 |
| " | Micropropag. | 12.0 | 7.9 | 69 |
| QR.708-13 | H.W. cutting | 15.2 | 9.1 | 65 |
| " | Microprop. | 21.5 | 10.0 | 106 |
| QR.515-24 | H.W. cutting | 24.5 | 12.1 | 104 |
| " | Microprop. | 18.3 | 11.0 | 112 |

**Apple Rootstocks**

Research trials comparing many new clones of apple rootstocks continued during 1999. The results from these trials will be presented in the March 2000 report.

**Rootstocks for Cherries and Plums**

The new international trial of cherry rootstocks, planted at HRI-East Malling in the spring of 1999, has established well and no trees were lost.

Plans are in progress to obtain materials of a new dwarfing plum rootstock bred in Russia. If negotiations are completed successfully, a collaborative trial with Dutch researchers will be implemented.

**CONTRACT REPORT**
**SP75**

# Evaluation of promising apple and pear rootstocks

*Undertaken for APRC*

31/3/00

**East Malling Trust for Horticultural Research Report**

**Project SP75:** Evaluation of promising apple and pear rootstocks

**Project Staff:** A.D. Webster, E.C. Bonham, J.E. Spencer.

**Date:** Report to 31 March 2000

## Apple Rootstocks

Trials at HRI-East Malling on rootstock selections produced in breeding programmes abroad

Records have continued on a trial planted in spring 1994, to compare eight apple rootstock clones. Promising rootstock selections from the Czech Republic, Germany, Sweden and Poland are compared with M.27, M.9, M.26 and MM.106 as rootstocks for the variety Queen Cox. The trees were planted in trickle irrigated and non-irrigated blocks in spring 1994. Since 1998, the irrigation has been applied only when the recorded soil moisture deficit reached 50mm and sufficient applied to alleviate this deficit. In 1999 irrigation was applied only twice during the summer.

As shown by the measurements of tree crown volume, the irrigation has had only small effects on the size of trees planted on the standard Malling rootstocks (Table 1). In contrast, trees on Bemali, P.60 or the Czech rootstocks were much more sensitive to irrigation and large differences in tree size have developed in response to irrigation. Queen Cox planted on J-TE-E has produced trees smaller than on M.9 but larger than on M.27. Bemali also produced trees slightly smaller than on M.9 but only if the trees were unirrigated.

Table 1: Influence of apple rootstock clones selected in the Czech Republic, Germany, Sweden, Poland and the UK, on the tree size of Queen Cox (trees planted spring 1994)

| Rootstock | Origin | Crown Volume ($m^3$) in 1999 | |
|---|---|---|---|
| | | + Irrigation | - Irrigation |
| M.27 | UK | 6.0 | 6.6 |
| J-TE-E | Czech | 15.1 | 8.5 |
| Bemali | Sweden | 24.1 | 13.7 |
| M.26 | UK | 19.7 | 19.4 |
| J-TE-F | Czech | 20.6 | 18.7 |
| M.9 | UK | 21.1 | 18.5 |
| P.60 | Poland | 24.5 | 19.2 |
| P.1 | Poland | 25.5 | 21.9 |
| MM.106 | UK | 22.1 | 27.3 |
| Jork 9 | Germany | 23.9 | 28.7 |
| J-TE-H | Czech | 30.4 | 26.2 |

Trees on Jork 9 are now quite vigorous and similar in crown volume to trees on MM.106. Irrigation applied to trees on both of these rootstocks has had a slightly

negative influence on tree vigour. Where irrigated, trees on J-TE-H were larger than trees on any of the other rootstocks in the trial.

The yields in 1999 and cumulative yields 1994-1999 for trees on M.27 rootstock were unaffected by the irrigation treatment (Table 2). Trees on M.26 have also shown no positive benefit of irrigation, whilst trees on M.9 and MM.106 both produced slightly higher yields when irrigated. The lack of positive effect for trees on M.27 is surprising but it is possible that this rootstock requires more frequent irrigation to achieve any benefits. As noted above for vigour of growth, most of the other rootstocks tested were much more responsive to occasional irrigation. The only exception was Jork 9, which produced lower yields on the irrigated trees.

This preliminary evidence suggests that two of the dwarfing rootstocks, J-TE-E and J-TE-F may have some potential for producers of Queen Cox. However, unless planted on deep soils with good moisture reserves, they will require intermittent irrigation to perform to their optimum potential.

Table 2: Influence of apple rootstock clones selected in the Czech Republic, Germany, Sweden, Poland and the UK, on the and yields of Queen Cox (trees planted spring 1994)

| Rootstock | Total yield/tree (kg) 1999 | | % Class I >65mm 1999 | | Cumulative yield (kg/tree) 1994-1999* | |
|---|---|---|---|---|---|---|
| | + irrig | - irrig. | + irrig | - irrig | + irrig | - irrig |
| M.27 | 9.1 | 9.0 | 68 | 65 | 30.0 | 30.0 |
| J-TE-E | 18.0 | 14.6 | 68 | 66 | 46.6 | 28.7 |
| Bemali | 26.3 | 15.6 | 64 | 58 | 64.8 | 37.7 |
| M.26 | 23.3 | 23.2 | 65 | 63 | 44.9 | 48.1 |
| J-TE-F | 50.7 | 18.3 | 91 | 63 | 78.4 | 41.2 |
| M.9 | 14.3 | 12.5 | 32 | 27 | 48.2 | 40.9 |
| P.60 | 30.4 | 20.6 | 60 | 61 | 71.9 | 48.0 |
| P.1 | 20.2 | 22.5 | 52 | 48 | 71.0 | 54.9 |
| MM.106 | 36.2 | 33.3 | 53 | 64 | 70.0 | 60.5 |
| Jork 9 | 19.6 | 39.7 | 42 | 46 | 59.1 | 73.7 |
| J-TE-H | 32.0 | 25.9 | 69 | 52 | 73.5 | 56.1 |

* No crop in 1997 following severe frost damage at flowering time

In a trial planted in 1995, seven apple rootstock clones bred at the Geneva research station in New York State are being compared with M.9 and MM.106 as rootstocks for Queen Cox. Table 3 shows trees on three of the USA rootstocks, 730-20, 902 and 202 are smaller in size than trees on M.9. Indeed the trees on 730-20 are very small and more similar to the size of trees on an M.27 rootstock. Trees on selections 11 and 210 are similar in size to trees on M.9, and trees on 179, intermediate between M.9 and MM.106 size. Selection 30 is producing trees of similar size to trees on MM.106.

Preliminary yields on the dwarfing clones amongst these new USA rootstocks show promise in comparison with yields of trees on M.9. However, the grade out of large (>65 mm) Class I fruits was poor in 1999 on all the rootstocks and the reasons for this are not understood.

Results from the USA indicate that selection 202 (now referred to as CG5202), which is the result of a cross between M.27 and Robusta 5 shows good resistance to woolly apple aphid and fireblight, but can prove difficult to stool in the nursery. This stock has shown significant promise in New Zealand trials, where it may be released within the next few years. Another of the Geneva selections showing promise in New Zealand trials is 210 and this is being built up for release in the Southern Hemisphere. There have been problems with selection 11 (now G 11), which comes from a M.26 cross with Robusta 5 on account of mixtures occurring in the plants distributed to nurseries. This has now been rectified but it has seriously delayed its release that is now not planned until 2005. When true-to-type it is a competitor for the M.9 to M.26 vigour range, which has moderate resistance to fireblight. Trees on the true-to-type G.11 have shown good yield efficiency and very good fruit size in USA trials. Trees on selection 30 (now G.30), which comes from a cross between M.9 and Robusta 5, are quite vigorous and considered similar to M.7 in USA trials. This stock is resistant to fireblight but has proven difficult to propagate on the stoolbed and forms trees with brittle unions. This selection appears to have very little to recommend it to UK growers.

Table 3: Influence of seven different rootstock selections raised in the USA on the tree size and yield of Queen Cox trees
(trees planted spring 1995)

| Rootstock | Crown Volume ($m^3$) 1999 | Total Yield (kg/tree) 1999 | % Class I >65 mm 1999 | Total cum. Yield/tree (kg) 1998-1999* |
|---|---|---|---|---|
| 730-20 | 8.5 | 8.0 | 39 | 12.5 |
| 902 | 12.2 | 11.5 | 23 | 19.4 |
| 202 | 15.0 | 17.7 | 39 | 25.8 |
| 11 | 16.1 | 15.4 | 25 | 24.9 |
| M.9 | 16.8 | 10.5 | 12 | 17.9 |
| 210 | 16.9 | 12.5 | 26 | 18.1 |
| 179 | 22.3 | 14.6 | 40 | 19.4 |
| 30 | 28.3 | 19.7 | 13 | 28.5 |
| MM.106 | 29.1 | 23.8 | 36 | 30.2 |

* No crop in 1997 following severe frost damage at flowering time

Attempts are under way to propagate five rootstock clones obtained several years ago from Vineland in Canada. These have shown some promise in trials conducted in the USA, where their strong resistance to winter cold is a benefit. Propagation by softwood cuttings is proving difficult however, with on average only 35% of the cuttings rooting and establishing. A few poor quality trees were planted on these stocks in spring 2000. Further attempts will be made to produce better trees.

Negotiations are in progress to obtain selections of apple rootstocks from Japan, that are dwarfing and also resistant to the woolly apple aphid.

**Pear Rootstocks:**

A full report of the trials on pear rootstocks was presented in the September 1999 report. Further results will be presented in the September 2000 report.