Project Title:	Evaluation and development of new rootstocks for apples, pears, cherries and plums
Project Number:	TF 172
Report:	First year report - issued July 2007
Previous reports:	Report (TF134 and TF141) to 31 March 2003 Report (TF134 and TF141) to 31 March 2004 Report (TF134 and TF141) to 31 March 2005 Report (TF168) to 31 March 2006
Project consultant:	None
Key Worker:	Mr David Johnson, East Malling Research
Location of Project:	East Malling Research Kent ME19 6BJ Tel: 01732 843833 Fax: 01732 849067
Project Co-ordinator:	Andrew Tinsley
Date Project commenced:	1 April 2006

Disclaimer

The results and conclusions in this report are based on an investigation conducted over one year. The conditions under which the experiment was carried out and the results obtained have been reported with detail and accuracy. However, because of the biological nature of the work, it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

CONTENTS

Grower summary

EAST MALLING RESEARCH

Principal scientists and authors of report:

D S Johnson (Post-harvest Physiologist and project leader)
Ms J E Spencer (Consultant)

Authentication

I declare this work was done under my supervision according to the procedures described herein and that this report is a true and accurate record of the results obtained.

.... D S Johnson
Signature

Date ....

Grower Summary

TF 172

Evaluation and development of new rootstocks for apples, pears, cherries and plums

Year 1 report – July 2007

Evaluation and development of new rootstocks for apples, pears, cherries and plums

Grower Summary

Headline

- A quince rootstock (C132) from the East Malling Research (EMR) breeding program that is more dwarfing than Quince C has performed well in trials carried out at EMR and in the Netherlands. Trees will be raised to enable grower trials to be planted in the winter of 2009/10
- 'Lapins' cherry trees on 'Gisela 5' rootstock continue to perform well with 50% greater cumulative yield and 3-fold higher yield efficiency than 'Colt'
- Two Russian rootstocks (VSL2 and LC52) have proved particularly precocious with high yields (22.6 kg/tree) of cherries cv. 'Summersun' in year 4 from planting
- VVA-1 has produced consistent dwarfing effects on three plum cultivars ('Opal', 'Valor' and 'Avalon')

Background and expected deliverables

The recent review of HDC-funded rootstock research projects (project TF158) acknowledged that there is a strong need for new or improved rootstocks for apples, pears, plums and cherries that are dwarfing, precocious, high yielding and offer some measure of drought tolerance. The report recognised that rootstocks are a vital part of commercial growing systems for tree fruits but those currently used have been grown for decades and all have some limitations. Breeding programmes in the UK and abroad have generated a number of promising rootstocks in recent years, which are becoming increasingly available to growers. The report recommended that UK trialling of promising UK and overseas material should continue and that technology transfer should be improved.

<u>Requirements in new apple rootstocks</u>

The TF158 report emphasised the need for rootstocks with intermediate vigour between M.27 and M.9 and a replacement for M.26 that does not suffer from burr knotting and poor calcium uptake. Fortuitously three new trials comprising eight rootstock selections in the required vigour range were planted spring 2003 and 2004 as part of the previous HDC project (TF134). The performance of these promising selections will be measured during the course of this project. Results of earlier screening trials have been published (Johnson et al., 2005) and four of the eight selections that were highlighted are included in the new trials at EMR and further selections are being built up in a commercial nursery prior to raising trees for future plantings.

Requirements in new pear rootstocks

The TF158 report stressed the need for increased dwarfing of pear scions to fit them into high-density systems without the need to resort to use of either plant growth regulating chemicals or root pruning. Although it was recognised that dwarfing quince stocks are the best way forward for scions such as ‘‘Conference’’ and ‘‘Comice’’, most new pear varieties are incompatible with quinces and require the use of expensive interstocks. A fully dwarfing and easy to propagate *Pyrus* stock would be beneficial to provide a much wider range of graft compatibility with new pear varieties, as well as providing better tolerance of drought and alkaline soils. New dwarfing rootstocks that improve pear cropping precocity are vital if pears are to remain economically viable.

Requirements in new sweet cherry rootstocks

The TF158 report identified the major requirement for a rootstock that is more dwarfing than either ‘Gisela 5’ or ‘Tabel’ that would control the vigour of trees sufficiently for easy growth within tunnels. Ideally these dwarfing stocks would be easier to propagate than either ‘Tabel’ or ‘Gisela’ series since this should allow the production of less expensive trees. Other requirements were for dwarfing rootstocks that are more suited to heavy clay soils (‘Gisela’ clones perform poorly in wet soils) and for dwarfing stocks that induce large fruit size.

Requirements in new plum rootstocks

The TF158 report recognised that there is a major requirement to provide increased dwarfing for plum trees to facilitate production under fully high density systems and for rootstocks that induce precocious and consistently abundant yields of large good quality fruits.

Overall objective

The main aim of this project is to acquire, evaluate and develop in UK growing conditions new apple, pear, cherry and plum rootstocks produced by breeding programmes both at EMR and abroad.

Specific objectives

Apple

- To select and develop apple rootstocks with intermediate vigour between M.27 and M.9, which perform well in the nursery and which produce precocious and consistently abundant yields of high quality fruits of the marketable size grades
- To select and develop a replacement rootstock in the M.26 vigour category, which does not suffer from burr knotting, poor calcium uptake or physiological disorders. This rootstock should also induce precocious and abundant yields of high quality fruits
- To select and develop dwarfing rootstocks for apple which exhibit improved resistance to drought, (weed competition) replant disease and soil borne diseases (e.g. collar/crown rot)

Pear

- To select and develop quince rootstocks more dwarfing than Quince C with improved precocity of cropping
- To select dwarfing *Pyrus* rootstocks that are easy to propagate and that induce good yield precocity/productivity

Cherry

- To select fully dwarfing rootstocks that are easy to propagate and that induce good yield precocity, fruit size and sustained productivity

Plum

- To select dwarfing rootstocks from material available overseas that induce precocious and consistently abundant yields of large good quality fruits

Summary of the project and main conclusion

Apple rootstock trials planted at EMR

Trials descriptions

Currently three trials of apple rootstocks raised by breeders at EMR are planted.

A trial was planted in spring 2003 (Plot EE 195) to evaluate new rootstocks from the breeding program at EMR. Trees of 'Queen Cox' on three new rootstock selections (AR 486-1, AR 295-6 and AR 120-242) are being compared with M.9 and trees of 'Bramley's Seedling' on four new rootstock selections (AR 628-2, AR 69-7, AR 360-19 and AR 801-11) are being compared with M.27. These same rootstock selections are being compared in similar trials planted at the same time in the organic area (Plot GE 182) at EMR. Although the performance of rootstocks under organic management is being assessed in a separate project (TF 141) it is appropriate to combine the reporting of rootstock trials under conventional and organic management.

A new trial was planted in spring 2004 (Plot CE 190) to evaluate new rootstocks from the breeding program at EMR. Trees of 'Queen Cox' on two new rootstock selections (AR 801-11 and AR 680-2) are being compared with M.9, M.26 and MM.106.

Main conclusions

It is too early to make any conclusions from trials planted in 2003 (Plots EE 195 and GE 182) and 2004 (Plot CE 190). There have been insufficient cropping years to make conclusions regarding yield and yield efficiency. The vigour of the rootstock selections is generally as expected based on results of previous trials. It is interesting to note the extent of the general suppression of tree growth and cropping under organic management (Table 1). Undoubtedly the failure to control rosy apple aphid has played a significant part in the poor performance of trees in the organic plots.

Table 1. Growth and cropping in 2006 of 'Queen Cox' and 'Bramley's Seedling' trees on a range of rootstocks from the EMR breeding program planted in spring 2003. Data are means of all rootstocks being tested

	'Queen Cox'		'Bramley's Seedling'	
	Conventional	**Organic**	**Conventional**	**Organic**
Girth (cm)	9.4	7.0	8.9	7.5
Tree volume (m^3)	6.6	2.1	2.4	0.7
Yield (kg)	6.3	1.6	1.9	0.4

Pear rootstock trials planted at EMR

Trials descriptions

Two trials of quince and *Pyrus* rootstocks planted at EMR continue to be evaluated. These trials include C132, a quince rootstock from the EMR breeding programme, which is slightly more dwarfing than Quince C and possibly more winter hardy. In one of these trials (Plot PR 184) C132 is compared with Quince C (EMC) and a promising Swedish *Pyrus* selection (BP30) and, in the other (Plot PR 173), it is compared with EMC and a dwarfing *Pyrus* selection from the EMR programme, QR 708/2.

Main conclusions

Results with C132, a quince rootstock from the EMR breeding programme, in the two trials at EMR continue to be contradictory particularly as regards the vigour of the rootstock in comparison with EMC. In the younger trial there was no greater dwarfing effect of C132 on either 'Conference' or 'Comice' and, though cumulative yield (total and Class 1 fruit above 65mm) was higher than for EMC, yield efficiency was similar. In the older trial 'Conference' on C132 was slightly more dwarfing than EMC and though cumulative yield was lower the yield efficiencies of C132 and EMC were the same. Tree density may be a factor influencing the comparative vigour of 'Conference' on the different stocks. In the older trial the trees were more densely planted than in the younger trial. In trials done in the UK and the Netherlands C132 has shown potential as a rootstock more dwarfing than EMC with similar yield efficiency and fruit size. Within the current phase of HDC-funded rootstock trialling it is intended that C132 is compared with EMC in grower trials. It is anticipated that 2-year-old 'Conference' trees of C132 will be available for planting in the winter of 2009/10.

In 2006 higher bud height (25 as opposed to 10 cm) was associated with a reduced girth of trees on C132 and, as in the previous 2 years, improved yield efficiency of EMC and C132 rootstocks.

BP30 (a promising Swedish *Pyrus* selection) has proved slightly more vigorous when budded at 25 cm than EMC and though cumulative yields were similar to those obtained with EMC yield efficiency of trees budded at 25 cm was lower. Overall the performance of BP30 has been similar to that of EMC and remains a promising selection where *Pyrus* rootstocks are preferred to quince.

Results for QR708/2, a dwarfing *Pyrus* selection from the EMR programme, have not been promising. QR708/2 continues to be more vigorous than EMC but has a lower cumulative yield and yield efficiency and appears to be incompatible with 'Conference' with the result that 50% of the trees have died.

<u>Cherry rootstock trials planted at EMR</u>

Trials descriptions

There are currently four trials of cherry rootstocks raised at EMR and abroad.

A major international trial testing 15 rootstock selections was planted at EMR (plot MP165) in spring 1999 using the cultivar 'Lapins'. Previous funders of the trial include the East Malling Trust for Horticultural Research in collaboration with the Stone Fruit Club. Although there has been no funding for the trial in the past 2 years the trial has been recorded and these results are being made available to the HDC in order that cumulative data can be provided in this and subsequent reports. It is important to study effects of rootstocks on sustained productivity and fruit size and it is intended to complete the trial after the 2007 season. A report on rootstock performance up to 2003 was presented at an EMRA Day in August 2003 and in EMRA News (Spencer, 2004).

Various smaller trials have been planted recently. These include a comparison of two Russian (Krymsk) selections (LC-52 and VSL-2) using the cultivar 'Summersun' (plot MP177) planted spring 2002. LC-52 is drought and cold tolerant and non-suckering. VSL-2 is similar in vigour to 'Gisela 5' and is precocious, non-suckering and can be propagated from cuttings. Four new selections from EMR are being compared with

‘Tabel Edabriz’ and ‘Gisela 5’ using the cultivar ‘Sunburst’. This trial was planted on plot MP183 in spring 2005. The latest trial was planted in the spring of 2006 and will compare the performance ‘Gisela 3’ with ‘Gisela 5’ using the cultivar ‘Penny’. ‘Gisela 3’ is considered to be the more dwarfing stock and therefore more amenable to tunnel production.

Main conclusions

In the international trial ‘Gisela 5’ proved to be a consistently high performer with a high cumulative yield and the highest yield efficiency. Compared with ‘Colt’ cumulative yield was 50% greater for ‘Gisela 5’ and yield efficiency was 3-fold higher. G154-7 and G523-02 were similar to ‘Gisela 5’ in terms of growth and cropping. Weiroot 53 was 30% more dwarfing than ‘Gisela 5’ (based on trunk girth measurements) but had similar yield efficiency.

Krymsk rootstocks VSL2 and LC52 induced precocious cropping of ‘Summersun’ cherries with 22.6 kg of fruit per tree in year 4 from planting.

The EMR rootstock selection C113-3 on ‘Sunburst’ appears to be more dwarfing than ‘Gisela 5’ but no cropping data is available in this trial planted in 2005.

A new trial was planted in 2006 to compare ‘Gisela 3’ and ‘Gisela 5’ on the cultivar ‘Penny’.

<u>Plum rootstock trial planted on a commercial farm</u>

Trial description

A major international trial testing 5 rootstock selections was planted on a commercial farm in East Kent in spring 2002 using the cultivars ‘Opal’, ‘Valor’ and ‘Avalon’. One year of funding (2003-4) of the trial was obtained from the East Malling Trust for Horticultural Research in collaboration with the Stone Fruit Club. Although there has been no funding for the trial in the past 2 years the trial has been recorded and these results are being made available to the HDC in order that cumulative data can be provided in this and subsequent reports.

Main conclusions

The vigour of trees on rootstocks being tested were either similar to or less than those on St. Julien A. Apart from VVA-1 the dwarfing effects of rootstocks varied according to cultivar. It is too early to comment on the effects of different rootstock / scion combinations on cropping but early indications are that some are more yield efficient than others. It is intended that the trial will continue until 2010 by which time a full evaluation of the rootstocks can be made in terms of growth, cropping, fruit size and suckering.

Financial benefits

There are major financial implications of identifying rootstocks with improved agronomic performance and that satisfy consumer requirements in terms of fruit size and quality.

Action points

- The dwarfing quince rootstock C132 has performed well and will be compared with Quince C in more extensive grower trials on 'Conference' planned for 2009. Interested growers should contact the author.
- Of the commercially available cherry rootstocks 'Gisela 5' has proved to be a consistently high performer with a high cumulative yield and high yield efficiency so should be considered for new plantings.

Science Section

Introduction

For the six years leading up to 31 March 2001 the selection, development and evaluation of new apple and pear rootstocks in the UK was funded by the East Malling Trust for Horticultural Research (EMTHR) with additional funding from the Apple and Pear Research Council (APRC) in 2000-01. A report on the work carried out during that 6-year period was prepared by Tony Webster and colleagues and submitted to APRC (SP123) and the EMTHR Trust in 2001. In 2001-02 the evaluation and development of new rootstocks for apples and pears was continued in a 1-year APRC project (SP134) and a report on the work carried out from April 2001 until March 2002 was submitted to APRC in April 2002. Subsequently the APRC agreed to continue project SP134 for a further three years (March 2005) and they also decided to fund additional work (SP141) to evaluate and develop in organic growing conditions new apple rootstocks produced by the breeding programme at EMR. From April 2003 to March 2005 these projects have been funded by the HDC (TF134 and TF141). In 2004 the HDC funded Dr David Pennell (then of ADAS) and Dr Tony Webster (consultant and formerly of HRI, East Malling) to carry out a review of HDC-funded rootstock research projects. The results of the review were not available in sufficient time for EMR to develop a new rootstock proposal before the 2005 growing season (Pennell, 2005). An interim proposal (TF168) was prepared and accepted by HDC in order that the recording of existing trials could be continued. A report on the work carried out from April 2005 until March 2006 was submitted to the HDC in August 2006. During 2006, a new proposal for the evaluation and development of new rootstocks for apples, pears, cherries and plums was accepted by the HDC (TF172). Funding is now secured for at least 6 years, which will allow the introduction of new material from EMR and abroad and the testing of the most promising selections on growers farms.

Recent successes of the trialling programme include the release in 2001 of a new dwarfing quince rootstock for pears (EMH) and a new apple rootstock resistant to crown / collar rot (M.116).

Objectives

Apple

- To select and develop apple rootstocks with intermediate vigour between M.27 and M.9, which performs well in the nursery and which produces precocious and consistently abundant yields of high quality fruits of the marketable size grades
- To select and develop a replacement rootstock in the M.26 vigour category, which does not suffer from burr knotting, poor calcium uptake or physiological disorders. This rootstock should also induce precocious and abundant yields of high quality fruits
- To select and develop dwarfing rootstocks for apple which exhibit improved resistance to drought, (weed competition) replant disease and soil borne diseases (e.g. collar/crown rot)

Pear

- To select and develop quince rootstocks more dwarfing than Quince C with improved precocity of cropping
- To select dwarfing *Pyrus* rootstocks that are easy to propagate and that induce good yield precocity/productivity

Cherry

- To select fully dwarfing rootstocks that are easy to propagate and that induce good yield precocity, fruit size and sustained productivity

Plum

- To select dwarfing rootstocks from material available overseas that induce precocious and consistently abundant yields of large good quality fruits

Apple rootstock trials planted at EMR

Currently, there are three trials of apple rootstocks raised and planted at EMR.

A trial was planted on 8 May 2003 (Plot EE 195) to evaluate new rootstocks from the breeding program at EMR. Using ‘Queen Cox’ three new rootstock selections (AR 486-1, AR 295-6 and AR 120-242) are being compared with M.9 and using ‘Bramley’s

Seedling' four new rootstock selections (AR 628-2, AR 69-7, AR 360-19 and AR 801-11) are being compared with M.27. These same rootstock selections are being compared in similar trials planted at the same time in the organic area (Plot GE 182) at EMR.

A trial was planted on 18 May 2004 (Plot CE 190) to evaluate new rootstocks from the breeding program at EMR. Using 'Queen Cox', two new rootstock selections (AR 801-11 and AR 680-2) are being compared with M.9, M.26 and MM.106.

Pear rootstock trials planted at EMR

Two trials of quince and *Pyrus* rootstocks planted at EMR continue to be evaluated. These trials include C132, a quince rootstock from the EMR breeding programme, which is slightly more dwarfing than Quince C and possibly more winter hardy. In one of these trials (Plot PR 184) C132 is compared with Quince C (EMC) and a promising Swedish *Pyrus* selection (BP30) and, in the other (Plot PR173), it is compared with EMC and a dwarfing *Pyrus* selection from the EMR programme, QR 708/2.

Cherry rootstock trials planted at EMR

There are currently four trials of cherry rootstocks raised by breeders at EMR and abroad.

A major international trial testing 15 rootstock selections was planted at EMR (plot MP165) in spring 1999 using the cultivar 'Lapins'. Previous funding of the trial was provided by the EMTHR in collaboration with the Stone Fruit Club. Although there has been no funding for the trial in the past 2 years, the trial has been recorded and these results are being made available to the HDC in order that cumulative data can be provided in this and subsequent reports. It is important to study effects of rootstocks on sustained productivity and fruit size and it is intended to complete the trial after the 2007 season. A report on rootstock performance up to 2003 was presented at an EMRA Day in August 2003 and in EMRA News (Spencer, 2004).

Various smaller trials have been planted recently. These include a comparison of two Russian (Krymsk) selections (LC-52 and VSL-2) using the cultivar 'Summersun' (plot MP 177) planted spring 2002. LC-52 is drought and cold tolerant and non-suckering. VSL-2 is similar in vigour to 'Gisela 5' and is precocious, non-suckering and can be propagated from cuttings. Four new selections from EMR are being compared with 'Tabel Edabriz' and 'Gisela 5' using the cultivar 'Sunburst'. This trial was planted on plot MP 183 in spring 2005. The latest trial was planted in the spring of 2006 and will compare the performance of 'Gisela 3' with 'Gisela 5' using the cultivar 'Penny'. 'Gisela 3' is considered to be the more dwarfing stock and therefore more amenable to tunnel production.

<u>Plum rootstock trial planted on a commercial farm</u>

A major international trial testing five rootstock selections was planted on a commercial farm in East Kent in spring 2002 using the cultivars 'Opal', 'Valor' and 'Avalon'. One year of funding (2003-4) of the trial was obtained from the EMTHR in collaboration with the Stone Fruit Club. Although there has been no funding for the trial in the past 2 years, the trial has been recorded and these results are being made available to the HDC in order that cumulative data can be provided in this and subsequent reports.

Materials and Methods

In all of the EMR trials, the tree rows were maintained weed free using conventional herbicides (excluding the organic trial on Plot GE 182) and the alleys between the rows were grassed down and maintained by frequent mowing. No supplementary irrigation was supplied to the trees. Minimal pruning was undertaken in the first few years following planting; the trees were, however, headed when necessary to encourage the production of lateral branches, but no branch tipping was undertaken. Where appropriate, very upright branches were tied down towards the horizontal and a modified form of 'long spur pruning' employed. No chemical growth regulators or root pruning techniques have been used to supplement growth control in any of the trials reported on.

Measurements were taken of trunk girth 25cm above ground level and, where appropriate, numbers and lengths of shoots and heights and spreads of the tree crowns (apple and pear) and fresh weights at the time of grubbing. Total yields and yields of class one fruit >65mm (or >80mm for 'Bramley' and >55mm for 'Conference') were measured for each tree and cumulative yields and yield efficiencies were calculated. Average fruit weights were calculated for cherry and plum. In the cherry and plum trials the numbers of suckers per tree were recorded. In all trials notes on tree health, graft compatibility and anchorage were made as required.

Results and Discussion

<u>Performance of 'Queen Cox' on new EMR rootstock selections</u>

Under conventional management

Selections AR 801-11 and 680-2 (Plot CE 190)

New selections AR 801-11 and AR 680-2 are being compared with M.9, M.26 and MM.106 in a randomised block experiment on plot CE 190 at EMR. At planting on 18 May 2004 the new selections had fewer feathers than the named rootstocks and the length of feathers was less on AR 801-11 than on M.9 or M.26 (see previous report for HDC project TF134). There were no differences in the heights of the trees at planting but AR 801-11 had a smaller girth than M.9 and M.26 (data not presented). After three years of growth AR 801-11 and MM.106 had similar girths and less than those of M.9 and M.26 although the effects just failed to reach statistical significance (Table 1). There were fewer shoots and less shoot length on AR 801-11 than on M.9. Similar effects were noted for AR 680-2 although they were not statistically significant. Although yield in 2006 and accumulated yield was lower for AR 801-11 than for M.9 there was no difference in yield efficiency (data not presented). It is rather early to comment on fruit production with trees in their third year. It is strange that MM.106 trees should have a smaller girth than M.9 or M.26, particularly as all trees in the trial were of the same age and were raised by the same nursery.

Table 1. Growth and cropping in 2006 of 'Queen Cox' trees (Plot CE 190) on rootstocks from the EMR breeding program planted in spring 2004. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Total shoot length 2006 (dm/tree)	Total shoot number/tree 2006	Yield 2006 (kg/tree)	Yield Class 1 >65 mm 2006 (kg/tree)
AR 680-2	7.2	73.2	16.7	2.3	1.3
MM.106	6.4	54.4	14.9	2.4	0.9
AR 801-11	6.4	51.6	13.1	1.6	0.9
M.26	7.3	84.5	21.6	4.0	1.5
M.9	7.5	104.8	21.9	3.6	1.8
SED (27 df)	0.49	19.64	3.24	0.82	0.44
LSD (P=0.05)	1.01	40.29	6.65	1.68	0.90
Rootstock effect	n.s.	n.s.	*	*	n.s.

Selections AR 486-1, AR 295-6 and 120-242 (Plot EE 195)

At the time of planting (8 May 2003), there were only sufficient grafted 2-year-old trees of AR 295-6 and AR 120-242 to complete blocks 4 and 5 of the eight blocks respectively. The remaining blocks were completed using budded 1-year-old trees. The analysis of the data up to 2006 was necessarily restricted to the four complete blocks of grafted trees. It is anticipated that as the trees get older any potential differences between the budded and grafted trees will diminish and it will be appropriate to use all eight replicate trees in the statistical analysis.

As in previous years, AR 486-1 appears to be less vigorous than M.9 with a smaller girth and tree volume (Table 2). AR 120-242 and AR 295-6 had a larger and smaller girth respectively than M.9 trees, although the differences just failed to reach statistical significance. Average yield was 6.3 kg/tree and there were no differences associated with rootstock.

Table 2. Growth and cropping in 2006 of 'Queen Cox' trees (EE195) on rootstocks from the EMR breeding program planted in spring 2003. Data presented for blocks 1-IV only (see text). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Tree Volume 2006 (m^3/tree)	Yield 2006 (kg/tree)	Yield Class 1 >65mm 2006 (kg/tree)
M.9	9.7	7.7	5.0	1.5
AR 486-1	8.4	4.5	6.5	1.6
AR 295-6	8.6	7.1	5.7	1.9
AR 120-242	10.8	7.0	7.8	2.0
SED (9 df)	0.53	0.84	1.79	0.95
LSD (P=0.05)	1.20	1.90	4.06	2.16
Rootstock effect	**	**	n.s.	n.s.

Under organic management

Selections AR 486-1, AR 295-6 and 120-242 (Plot GE182)

As with the conventional management trial on plot EE 195 there were only sufficient grafted 2-year-old trees of AR 295-6 to complete four of the eight blocks respectively. The remaining blocks were completed using budded 1-year-old trees. In order to compare all rootstocks the analysis of the growth data was necessarily restricted to the four complete blocks of grafted trees. Again, it is anticipated that as the trees get older any potential differences between the budded and grafted trees will diminish and it will be appropriate to use all 8 replicate trees in the statistical analysis. To compare only AR 486-1, AR 120-242 and M.9 the data can be restricted so that the data for all eight blocks are used.

All of the new rootstock selections had a lower tree volume than M.9 but there were no differences in trunk girth or fruit yields (Table 3). Overall there was a major impact of the production system on tree performance. Average tree volume and trunk girth were reduced from 6.6 m^3 and 9.4 cm to 2.1 m^3 and 7.0 cm respectively through the adoption of organic management. Whilst trees under conventional management produced an average yield of 6.3 kg those under organic conditions yielded only 1.6 kg.

Table 3. Growth in 2006 of 'Queen Cox' trees (Plot GE 182) on rootstocks from the EMR breeding program planted in spring 2003 and managed under organic conditions. Data presented for blocks 1-IV only (see text). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Tree Volume 2006 (m^3/tree)	Yield 2006 (kg/tree)	Yield Class 1 >65 mm 2006 (kg/tree)
M.9	7.0	3.2	2.4	0.2
AR 486-1	6.7	1.2	1.3	0.1
AR 295-6	7.0	2.0	1.5	0.1
AR 120-242	7.3	2.0	1.4	0
SED (9 df)	0.43	0.55	0.60	0.14
LSD (P=0.05)	1.00	1.27	1.38	0.32
Rootstock effect	n.s.	*	n.s.	n.s.

Performance of 'Bramley's Seedling' on new EMR rootstock selections

Under conventional management

Selections AR 628-1, AR 69-7, AR 360-19 and AR 801-11(Plot EE 195)

The design of the trial on EE 195 was complicated by insufficient numbers of grafted trees for AR 360-19 and AR 801-11 to complete eight blocks as planned. There were sufficient trees for five blocks of these rootstocks and eight blocks of AR 628-2, AR 69-7 and M.27 controls. Additional trees on AR 628-2, AR 69-7 were used to complete the blocks.

The analysis of the data was necessarily restricted to the five complete blocks of grafted trees. In addition the trees with eight replicates (AR 628-2, AR 69-7 and M.27) were analysed separately.

As in the previous year AR 801-11 was more vigorous than M.27 i.e. with a larger girth and greater tree volume (Table 4). Conversely AR 628-2 and AR 69-7 had a smaller tree volume than M.27 and tended to have smaller girths than M.27. The less vigorous AR 628-2 and AR 69-7 produced lower yields than M.27.

It is expected that the new rootstock selections will confer tree sizes in the M.27-M.9 range with the exception of AR 801-11 which should have a vigour status closer to M.26. It is anticipated that as the trees get older any potential differences due to tree age at planting will diminish. Clearly it will take a number of growing seasons for the trees to establish and produce significant quantities of fruit.

Table 4. Growth and cropping in 2006 of 'Bramley's Seedling' trees (Plot EE 195) on rootstocks from the EMR breeding program planted in spring 2003. Data presented for blocks 1-V only (see text). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Tree Volume 2006 (m^3/tree)	Yield 2006 (kg/tree)	Yield Class 1 >80 mm 2005 (kg/tree)
M.27	8.5	2.8	2.8	1.1
AR 360-19	8.2	1.2	1.7	1.2
AR 69-7	8.4	1.3	1.1	0.6
AR 628-2	7.5	0.6	0.8	0
AR 801-11	12.0	6.1	3.4	2.2
SED (16 df)	0.73	0.98	0.72	0.59
LSD (P=0.05)	1.55	2.08	1.56	1.28
Rootstock effect	***	***	**	*

Under organic management

Selections AR 628-1, AR 69-7, AR 360-19 and AR 801-11(Plot GE 182)

The constraints on the design of the orchard under conventional management imposed by lack of sufficient grafted trees (see above) applied also to the orchard planted in the organic area at EMR.

In 2006 AR 801-11 and AR 69-7 had larger girth measurements than M.27 and AR 801-11 had a larger tree volume (Table 5). There were no effects of rootstocks on fruit yield. The results for AR 801-11 were similar to those obtained in the orchard managed conventionally. It should be borne in mind that any differences in girth measurements may reflect the fact that the control (M.27) trees were one year old when planted and were obtained from a different UK nursery to the 2-year-old trees on the experimental rootstocks. However it is expected that these rootstocks are likely to provide tree sizes in the M.27-M.9 range with the exception of AR 801-11 which should have a vigour status closer to M.26. It is anticipated that as the trees get older any potential differences due to tree age at planting will diminish.

Overall there was a major impact of the production system on tree performance. Tree volume and trunk girth were reduced from 2.4 m^3 and 8.9 cm to 0.7 m^3 and 7.5 cm respectively through the adoption of organic management. Whilst trees under conventional management produced an average yield of 1.9 kg those under organic conditions yielded only 0.4 kg.

Table 5. Growth in 2006 of 'Bramley's Seedling' trees (Plot GE 182) on rootstocks from the EMR breeding program planted in spring 2003 and managed under organic conditions. Data presented for blocks 1-V only (see text). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Tree Volume 2006 (m^3/tree)	Yield 2006 (kg/tree)	Yield Class 1 >80 mm 2006 (kg/tree)
M.27	6.3	0.5	0.4	0
AR 360-19	5.8	0.3	0.2	0.1
AR 628-2	6.7	0.2	0.3	0
AR 69-7	7.7	0.7	0.5	0
AR 801-11	11.2	2.0	0.5	0
SED (16 df)	0.63	0.30	0.19	-
LSD (P=0.05)	1.34	0.64	0.42	-
Rootstock effect	***	***	n.s.	-

(- insufficient data for statistical analysis)

<u>Performance of 'Comice' and 'Conference' on Quince (EMC and C132) and *Pyrus* (BP30) rootstocks</u>

The trees on PR 184 were budded at a height of 10 and 25 cm. Previous work (see final report for APRC on SP123) had shown that increasing the height of budding on 'Comice' reduced the vigour of trees on EMC rootstock. In 2006 higher bud height was associated with a reduced girth of trees on C132 and, as in the previous 2 years, improved yield efficiency of EMC and C132 rootstocks (Table 6).
Trees on C132 budded at 10 cm had a greater trunk girth than EMC (Table 7). In 2006 total yield and yield of Class 1 fruit above 65mm or between 55-65mm ('Conference' only, data not presented) was higher for C132 than EMC (Table 6). Cumulative yield tended to be higher for C132 than EMC and for 'Comice' the cumulative yield of Class 1 fruit above 65mm was significantly higher than for EMC but there was no difference in yield efficiency.

The girths of trees on BP30 rootstocks budded at 25 cm were greater than those on EMC indicating greater vigour. In 2006 total yields of 'Conference' and 'Comice' were similar on EMC and BP30 rootstocks although the yield of 'Comice' above 65mm was less on BP30 rootstocks. Cumulative yields (total and Class 1 fruit above 65mm) were similar for EMC and BP30 although BP30 was less yield efficient where trees were budded at 25 cm.

Table 6. Cropping in 2006 of 'Comice' and 'Conference' trees on Quince (EMC and C132) and *Pyrus* (BP30) rootstocks planted spring 1999 (Plot PR 184). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Cultivar	Rootstock	Graft height (cm)	Total yield (kg/tree)		Yield Class 1 >65 mm (kg/tree)	
			2006	Cumulative	2006	Cumulative
'Comice'	EMC	10	13.0	45.0	8.9	35.1
	EMC	25	12.4	47.0	8.4	35.9
	BP30	10	10.8	40.2	5.2	30.5
	BP30	25	12.2	39.5	8.2	33.3
	C132	10	14.1	51.7	12.3	47.1
	C132	25	15.1	47.9	13.5	44.0
'Conference'	EMC	10	9.3	29.0	0.1	0.9
	EMC	25	7.8	31.9	0	1.1
	BP30	10	7.1	26.9	0	3.3
	BP30	25	9.6	31.7	0.2	3.9
	C132	10	11.5	34.2	0	2.5
	C132	25	10.7	35.3	0	5.5
Overall effect	EMC		10.6	38.2	4.3	18.2
	BP30		9.9	34.6	3.4	17.7
	C132		12.9	42.3	6.5	24.8
SED(94 df)			0.81	2.43	0.58	1.80
LSD (P=0.05)			1.61	4.83	1.17	3.59
Rootstock effect			***	**	***	***

Table 7. Growth in 2006 of 'Comice' and 'Conference' trees on Quince (EMC and C132) and *Pyrus* (BP30) rootstocks planted spring 1999 (Plot PR 184). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Variety	Rootstock	Graft height (cm)	Girth 2006 (cm/tree)	Tree Volume 2006 (m^3/tree)	Yield efficiency (kg/cm^2)
'Comice'	EMC	10	19.5	6.4	1.5
	EMC	25	18.4	6.2	1.7
	BP30	10	19.6	5.8	1.3
	BP30	25	19.9	6.0	1.3
	C132	10	21.3	7.0	1.4
	C132	25	18.8	7.2	1.7
'Conference'	EMC	10	14.2	5.0	1.8
	EMC	25	14.3	4.4	1.9
	BP30	10	14.0	4.1	1.7
	BP30	25	15.7	3.9	1.6
	C132	10	15.9	6.1	1.7
	C132	25	14.2	4.5	2.1
Overall effect	EMC		16.6	5.5	1.7
	BP30		17.3	5.0	1.5
	C132		17.5	6.2	1.8
SED (94 df)			0.48	0.44	0.07
LSD (P=0.05)			0.97	0.87	0.15
Rootstock effect			n.s.	*	***

<u>Performance of 'Conference' on Quince (EMC and C132) and *Pyrus* (QR708/2) rootstocks</u>

QR708/2 continues to be more vigorous than EMC, as evidenced by a greater girth in 2006, but it had a lower yield of fruit in 2006 and a lower cumulative yield and yield efficiency. As noted in previous reports (HDC project TF 134), there appears to be an incompatibility between 'Conference' and QR708/2 with the result that 50% of the trees have died.

Statistical analysis of the data was restricted in order to compare EMC and C132 without the effect of missing data values for QR708/2 in the analysis of variance. Analysis of the restricted data showed that C132 was less vigorous than EMC (smaller girth and tree volume) and although cumulative yield tended to be lower the yield efficiencies of C132 and EMC were the same (Tables 8 and 9). Results in 2006 were therefore essentially the same as those obtained in the previous years.

Table 8. Growth and cropping in 2006 of 'Conference' trees on Quince (EMC and C132) and *Pyrus* (QR708/2) rootstocks planted spring 1997 (Plot PR 173). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth 2006 (cm/tree)	Yield 2006 (kg/tree)			Tree Volume 2006 (m^3/tree)
		Total	Class 1 55-65 mm	Class 1 >65 mm	
QR708/2	23.1	3.8	0.4	0	5.0
C132	14.6	8.3	0.9	0	3.4
EMC	16.9	9.4	0.4	0	5.0
SED (13 df)	0.95	1.18	0.48	-	0.94
LSD (P=0.05)	2.08	2.55	1.05	-	2.03
Rootstock effect	***	***	n.s.	-	n.s.

Table 9. Cumulative yield and yield efficiency of 'Conference' trees on Quince (EMC and C132) and *Pyrus* (QR708/2) rootstocks planted spring 1997 (Plot PR 173). (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Cumulative yield 1999-06 (kg/tree)		Yield efficiency (kg/cm^2)
	Total	Class 1 >65 mm	
QR708/2	29.2	3.6	0.8
C132	39.2	5.5	2.3
EMC	49.2	5.7	2.2
SED (13 df)	5.55	1.29	0.12
LSD (P=0.05)	12.09	2.81	0.28
Rootstock effect	**	n.s.	***

International plum rootstock trial

In 2005 and 2006, the effect of rootstock on tree growth (trunk girth) varied according to cultivar (Table 10). This interaction between rootstock and cultivar has grown stronger with each year of the trial. Other than in the first year of recording (2003), none of the rootstocks under test were more vigorous than 'St. Julien A', irrespective of cultivar. VVA-1 has been less vigorous than 'St. Julien A' for all cultivars. In 2005 and 2006 'Jaspi' and 'Plumina' were less vigorous than 'St. Julien A' on 'Opal' and 'Valor' but not on 'Avalon'.

The first significant crop of fruit was produced in 2006 with an average yield of 5.1 kg per tree (Table 11). 'Ishtara' produced higher yields than 'St Julien A'. A similar effect was noted for 'Jaspi' although the difference just failed to reach statistical significance. When yields in 2006 were expressed in relation to trunk area, some of the rootstocks under test were more yield efficient than 'St Julien A'. For 'Opal' VVA-1, 'Jaspi' and 'Ishtara' were more yield-efficient. For 'Valor' only 'Jaspi' was more yield-efficient and for ‘Avalon’ no rootstocks provided yield efficiencies above that derived from ‘St Julien A’. In 2006 mean fruit weight was lower for VVA-1 and to a lesser extent ‘Jaspi’ than for ‘St Julien A’.

Most suckering was recorded for ‘Valor’ and least for ‘Opal’ (Table 13). There were strong interactive effects of cultivars and rootstocks on suckering in 2005 and 2006. There were no rootstock effects on numbers of suckers for ‘Opal’ trees in 2005 or 2006. For ‘Valor’ in both years there was more suckering on 'Jaspi’ than on ‘St Julien A’, and in 2005 more on ‘Plumina’. For ‘Avalon’ in 2006 more suckers were recorded on ‘Jaspi’ and VVA-1 than on ‘St Julien A’. ‘Ishtara’ had low sucker numbers in all years.

Table 10. The effect of rootstock on the girth of plum trees planted in spring 2002. Data are means for 3 cultivars i.e. ‘Opal’, ‘Valor’ and ‘Avalon’. The number of trees (replicates) per rootstock was either 15 or 30. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability). To compare means use appropriate standard error of the difference (SED)

	Girth (cm/tree)				Replication
	2003	2004	2005	2006	
St. Julien A	6.3	11.6	19.5	25.4	30
VVA-1	5.7	8.5	13.4	16.9	15
Fereley Jaspi	6.0	9.7	16.1	21.4	30
Ferciana Ishtara	7.0	12.2	19.8	26.2	15
Plumina (Ferlenain)	7.7	10.0	16.0	21.4	15
Rootstock effect	***	***	***	***	
Effect of interaction with Cultivar	n.s.	n.s.	**	***	
SED					
Min. replication	0.36	0.58	1.05	1.13	
Max. Min. replication	0.31	0.50	0.91	0.98	
Max. replication	0.25	0.41	0.74	0.80	
d.f.	77	74	73	73	
LSD (P=0.05)					
Min. replication	0.72	1.16	2.11	2.26	
Max. Min. replication	0.62	1.01	1.82	1.95	
Max. replication	0.51	0.82	1.49	1.59	

Table 11. The effect of rootstock on the yield, mean fruit weight and yield efficiency of plum trees planted in spring 2002. Data are means for three cultivars, i.e. 'Opal', 'Valor' and 'Avalon'. The number of trees (replicates) per rootstock was either 15 or 30. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability). To compare means use appropriate standard error of the difference (SED)

	2006			Replication
	Yield (kg/tree)	**Mean Fruit Weight (g)**	**Yield Efficiency (kg/cm^2)**	
St Julien A	4.60	52.2	0.09	30
VVA-1	4.37	43.0	0.18	15
Fereley Jaspi	5.76	48.5	0.16	30
Ferciana Ishtara	6.55	53.8	0.13	15
Plumina (Ferlenain)	3.73	54.2	0.11	15
Rootstock effect	**	***	***	
Effect of interaction with Cultivar	n.s.	n.s.	*	
SED				
Min. replication	0.92	1.89	0.023	
Max. Min. replication	0.79	1.64	0.020	
Max. replication	0.65	1.34	0.016	
d.f.	74	74	73	
LSD (P=0.05)				
Min. replication	1.83	3.78	0.047	
Max. Min. replication	1.58	3.24	0.040	
Max. replication	1.29	2.67	0.033	

Table 12. The effect of rootstock on the number of fruits harvested from plum trees planted in spring 2002. Data are means for three cultivars, i.e. 'Opal', 'Valor' and 'Avalon'. The number of trees (replicates) per rootstock was either 15 or 30. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability). To compare means use appropriate standard error of the difference (SED)

	Fruit number/tree			Replication
	2003	**2004**	**2005**	
St Julien A	1	1	0	30
VVA-1	2	0	0	15
Fereley Jaspi	0	2	0	30
Ferciana Ishtara	4	0	0	15
Plumina (Ferlenain)	3	0	0	15
Rootstock effect	Insufficient data for statistical analysis			

Table 13. The effect of rootstock on the number of suckers on plum trees planted in spring 2002. Data are means for 3 cultivars i.e. 'Opal', 'Valor' and 'Avalon'. The number of trees (replicates) per rootstock was either 15 or 30. (SED –Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability). To compare means use appropriate standard error of the difference (SED)

	Suckers/tree				Replication
	2003	**2004**	**2005**	**2006**	
St Julien A	0.4	0.6	0.8	1.4	30
VVA-1	1.0	0.6	1.1	2.1	15
Fereley Jaspi	1.8	2.4	3.4	7.4	30
Ferciana Ishtara	0.2	0.4	0.2	0.1	15
Plumina (Ferlenain)	1.0	2.0	2.9	2.6	15
Rootstock effect	**	***	***	***	
Effect of interaction with Cultivar	n.s.	n.s.	**	***	
SED					
Min. replication	0.55	0.62	0.82	0.93	
Max. Min. replication	0.47	0.54	0.71	0.81	
Max. replication	0.39	0.44	0.58	0.66	
d.f.	74	74	72	74	
LSD (P=0.05)					
Min. replication	1.10	1.24	1.63	1.86	
Max. Min. replication	0.95	1.07	1.41	1.61	
Max. replication	0.77	0.88	1.15	1.31	

Cherry rootstock trials at EMR

International trial (plot MP 165)

'Colt' was more vigorous than all other rootstocks as evidenced by the largest trunk girth in each year of the trial (Table 14). Many of the less vigorous rootstocks produced similar or greater yields of fruit than 'Colt' particularly in 2003 and 2006 and, apart from 'Tabel Edabriz', PHL-B, 'Weiroot 158', 'Damil', 'Weiroot 53' and G195-20, gave higher cumulative yields than 'Colt' (Table 15). 'Colt' were less yield efficient than all other rootstocks. Although in 2004 a number of rootstocks achieved a higher mean fruit weight than 'Colt' in other years there was generally no increased size (mean weight) compared with 'Colt' (Table 16).

'Gisela 5' was of intermediate vigour (girth) with 'Damil' and 'Weiroot 53' being less vigorous and PHL-A, G497-8 and G148-8 more vigorous. With the exception of G497-8 and G148-8 in 2004 and 'Piku' in 2005 none of the rootstocks gave higher yields than 'Gisela 5'. None of rootstocks gave higher cumulative yields than 'Gisela 5'. In contrast 'Colt' and 5 of the remaining rootstocks ('Tabel Edabriz', 'Weiroot 158', 'Damil', 'Weiroot 53' and G195-20) produced lower cumulative yields than 'Gisela 5'. For 'Colt' and most of the remaining rootstocks (except 'Weiroot 53', G154-7 and G523-02) the yield efficiency was lower than for ‘Gisela 5’. Occasionally mean fruit size was higher than for ‘Gisela 5’ (‘Gisela 4’ and G154-7 in 2005 and PHL-A, G195-20 and ‘Colt’ in 2006) but generally mean fruit weight for ‘Gisela 5’ was not exceeded.

Table 14. The effect of rootstock on the growth (trunk girth) of ‘Lapins’ cherry trees planted on plot MP 165 at EMR in March 1999. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth (cm/tree)						
	2000	2001	2002	2003	2004	2005	2006
Tabel Edabriz	8.4	11.7	15.6	18.5	22.7	24.6	26.2
Gisela 4	8.8	12.6	16.3	19.8	25.1	26.5	29.3
PHL-B	9.0	12.5	16.5	19.7	24.1	25.8	28.4
PHL-A	9.6	13.7	18.4	22.5	27.6	29.7	31.9
Weiroot 158	9.1	12.2	16.0	18.6	23.0	24.3	25.2
Gisela 5	8.7	11.9	16.3	19.7	24.6	26.6	27.7
Damil	6.6	8.8	12.5	15.3	18.9	20.3	22.0
G 497-8	9.6	13.6	18.5	21.9	27.2	29.6	32.0
Piku 4	8.6	12.1	16.8	20.7	26.3	29.2	31.4
Weiroot 53	6.9	9.2	12.2	14.0	17.1	18.6	19.3
G 148-8	8.7	12.5	18.4	22.0	27.7	30.0	31.2
G195-20	9.0	12.5	16.0	18.4	22.8	24.6	25.2
G154-7	8.2	12.1	16.5	18.9	24.5	25.6	26.8
G523-02	7.6	11.3	15.7	19.1	24.2	25.5	27.3
Colt	11.8	16.5	22.0	27.5	34.1	35.9	41.3
Effect of rootstock	***	***	***	***	***	***	***
SED (102 df)	0.53	0.80	1.01	1.16	1.37	1.59	1.68
LSD (P=0.05)	1.06	1.59	2.00	2.30	2.71	3.17	3.34

Table 15. The effect of rootstock on the annual and cumulative yield (kg) and yield efficiency (kg cm^{-2}) of 'Lapins' cherry trees planted on plot MP165 at EMR in March 1999. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Yield (kg/tree)				Cumulative Yield (kg/tree)	Yield Efficiency (kg cm^{-2})
	2003	2004	2005	2006		
Tabel Edabriz	1.5	0.9	5.8	8.5	16.7	0.33
Gisela 4	1.8	1.4	9.2	14.7	27.2	0.40
PHL-B	0.9	1.8	8.6	12.6	24.0	0.35
PHL-A	1.2	1.1	11.0	15.5	28.8	0.35
Weiroot 158	1.0	0.9	6.7	8.6	17.2	0.34
Gisela 5	2.6	1.9	10.3	14.0	29.8	0.49
Damil	0.1	0.3	6.1	9.4	15.9	0.40
G 497-8	1.4	2.8	12.8	15.4	32.4	0.39
Piku 4	1.6	1.5	13.9	14.1	31.2	0.40
Weiroot 53	0.9	1.3	5.3	6.5	14.0	0.47
G 148-8	2.0	3.0	10.2	14.3	28.2	0.36
G195-20	1.3	1.8	7.1	9.9	20.0	0.40
G154-7	0.8	1.6	10.0	14.6	27.2	0.46
G523-02	1.2	1.4	11.6	13.8	28.0	0.47
Colt	0.3	1.1	10.4	8.2	19.8	0.15
Effect of rootstock	***	***	***	***	***	***
SED (102 df)	0.34	0.41	1.62	1.79	3.30	0.036
LSD (P=0.05)	0.69	0.82	3.23	3.56	6.54	0.072

Table 16. The effect of rootstock on the mean weight (g) of 'Lapins' cherries from trees planted on plot MP 165 at EMR in March 1999. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Mean fruit weight (g)			
	2003	2004	2005	2006
Tabel Edabriz	8.6	8.6	7.6	8.1
Gisela 4	9.8	10.0	8.2	9.2
PHL-B	9.0	9.1	7.9	9.1
PHL-A	9.8	9.9	7.8	9.6
Weiroot 158	9.4	8.5	7.1	8.0
Gisela 5	9.2	10.0	7.4	8.7
Damil	8.9	8.5	6.8	6.9
G 497-8	9.4	9.9	7.2	8.7
Piku 4	9.4	9.8	7.7	9.3
Weiroot 53	9.2	8.3	7.3	7.8
G 148-8	9.1	9.6	7.1	8.3
G195-20	9.4	9.5	6.7	9.6
G154-7	9.7	9.2	8.4	9.3
G523-02	9.6	9.1	7.5	9.2
Colt	9.4	8.5	7.5	10.0
Effect of rootstock	*	***	***	***
SED (102 df)	0.33	0.38	0.37	0.36
LSD (P=0.05)	0.67	0.77	0.74	0.71

Russian ('Krymsk') rootstock trial (plot MP 177)

Compared with VSL2 trees on LC52 rootstock had longer leaders at planting, produced fewer suckers, were more vigorous (larger trunk girth) and produced higher yields (Tables 17, 18 and 19). Trees on VSL2 and LC52 were similar in terms of fruit size (mean fruit weight) and yield efficiency (Tables 19 and 20). Both rootstocks provided precocious cropping.

Table 17. The effect of rootstock on leader height and number of feathers and suckers of 'Summersun' cherry trees planted on plot MP 177 at EMR on 18 April 2002. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

	Leader height at planting (dm/tree)	Feather number/tree at planting	Number of suckers/tree		
			2003	2004	2006
LC52	14.8	4.7	0	1.2	0.3
VSL2	12.8	4.3	2.1	3.8	3.6
Effect of Rootstock	***	n.s.	**	n.s.	**
SED (17 df)	0.24	0.60	0.65	1.57	1.26
LSD (P=0.05)	0.51	1.27	1.37	3.31	2.65

Table 18. The effect of rootstock on the girth of 'Summersun' cherry trees planted on plot MP 177 at EMR on 18 April 2002. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

	Girth (cm/tree)					
	2001	2002	2003	2004	2005	2006
LC52	6.4	9.4	14.9	22.0	27.1	29.7
VSL2	5.5	8.1	12.4	19.0	24.1	26.3
Effect of Rootstock	***	***	***	***	***	***
SED (17 df)	0.18	0.25	0.34	0.40	0.56	0.83
LSD (P=0.05)	0.40	0.53	0.73	0.85	1.19	1.75

Table 19. The effect of rootstock on the yield and yield efficiency of 'Summersun' cherry trees planted on plot MP 177 at EMR on 18 April 2002. (SED –Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

	Yield (kg/tree)				Cumulative Yield (kg/tree)	Yield Effic. (kg/cm^2)
	2003	2004	2005	2006		
LC52	0.03	0.09	8.12	21.59	29.8	0.43
VSL2	0.01	0.09	5.70	16.51	22.3	0.41
Effect of Rootstock	n.s.	n.s.	*	***	***	n.s.
SED (17 df)	0.014	0.022	1.056	1.282	1.56	0.02
LSD (P=0.05)	0.031	0.046	2.228	2.704	3.30	0.05

Table 20. The effect of rootstock on the mean fruit weight of 'Summersun' cherry trees planted on plot MP 177 at EMR on 18 April 2002. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

	Mean Fruit Weight (g)			
	2003	2004	2005	2006
LC52	9.8	8.2	7.7	5.7
VSL2	10.2	8.1	8.6	5.8
Effect of Rootstock	n.s.	n.s.	*	n.s.
SED (17 df)	0.40	0.41	0.35	0.44
LSD (P=0.05)	0.94	0.86	0.74	0.94

'Gisela 3' and '5' comparison (plot MP 186)

At planting the leader length was less for 'Gisela 3' than for 'Gisela 5' and shoot numbers in 2006 were less for 'Gisela 3' (Table 21). Differences in girth at planting and after the first year of growth were not significant (Table 22).

Table 21. The effect of rootstock on leader length and shoot growth of 'Penny' cherry trees planted on plot MP 186 at EMR in March 2006. (SED–Standard Error of the Difference between means, LSD–Least Significant Difference between means, df–degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Leader length at planting (dm/tree)	Shoot growth 2006	
		Length (dm/tree)	Number/tree
'Gisela 3'	10.8	13.2	2.8
'Gisela 5'	13.6	15.5	4.6
Effect of Rootstock	***	n.s.	**
SED (7 df)	0.51	2.30	0.51
LSD (P=0.05)	1.21	5.45	1.21

Table 22. The effect of rootstock on the girth of 'Penny' cherry trees planted on plot MP 186 at EMR in March 2006. (SED – Standard Error of the Difference between means, LSD

– Least Significant Difference between means, df –degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth (cm/tree)	
	At planting	2006
'Gisela 3'	4.2	6.6
'Gisela 5'	4.8	6.8
Effect of Rootstock	n.s.	n.s.
SED (7 df)	0.32	0.34
LSD (P=0.05)	0.76	0.82

EMR rootstock selections tested on 'Sunburst' (plot MP 182)

'Tabel Edabriz' and 'Gisela 5' have performed similarly in terms of tree growth (Tables 23 and 24). At planting all EMR ('C') rootstocks had a smaller girth than 'Gisela 5' and C113-3 and C376-5 had a lower leader length. After 2 years of growth only C113-3 had a smaller girth and lower shoot length than 'Gisela 5'. C376-1 had a greater shoot length than 'Gisela 5' in 2005 and 2006.

Table 23. The effect of rootstock on leader length and shoot growth of 'Sunburst' cherry trees planted on plot MP 182 at EMR in April 2005. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df – degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	At planting	Shoot growth 2005		Shoot growth 2006	
	Leader length (dm/tree)	Length (dm/tree)	Number/tree	Length (dm/tree)	Number/tree
C113-3	9.0	7.6	2.8	41.2	6.2
C376-1	12.0	20.2	4.8	95.4	9.6
C376-4	11.8	9.6	3.0	54.7	7.4
C376-5	9.6	13.2	3.6	61.0	10.0
'Tabel Edabriz'	12.2	14.6	4.9	56.8	7.4
'Gisela 5'	13.7	15.1	5.4	68.8	9.4
Effect of Rootstock	**	***	***	**	n.s.
SED (14 df)	1.23	1.87	0.57	9.64	1.61
LSD (P=0.05)	2.63	4.03	1.22	20.83	3.48

Table 24. The effect of rootstock on the girth of 'Sunburst' cherry trees planted on plot MP 182 at EMR in April 2005. (SED – Standard Error of the Difference between means, LSD – Least Significant Difference between means, df –degrees of freedom, rootstock effect was either non-significant (n.s.) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability)

Rootstock	Girth (cm/tree)		
	At planting	2005	2006
C113-3	3.2	3.8	8.1
C376-1	3.9	5.3	11.4
C376-4	3.2	4.5	9.6
C376-5	3.4	4.4	8.9
Tabel Edabriz	4.9	6.2	11.2
Gisela 5	5.4	5.7	10.3
Effect of Rootstock	***	***	**
SED (14 df)	0.30	0.33	0.67
LSD (P=0.05)	0.66	0.70	1.46

Conclusions

Apple rootstock trials planted at EMR

It is too early to make any conclusions from trials planted in 2003 (Plots EE 195 and GE 182) and 2004 (Plot CE 190). There have been insufficient cropping years to make conclusions regarding yield and yield efficiency. The vigour of the rootstock selections is generally as expected based on results of previous trials. It is interesting to note the extent of the general suppression of tree growth and cropping under organic management. Undoubtedly the failure to control rosy apple aphid has played a significant part in the poor performance of trees in the organic plots.

Pear rootstock trials planted at EMR

Results with C132, a quince rootstock from the EMR breeding programme, in the two trials at EMR continue to be contradictory, particularly as regards the vigour of the rootstock in comparison with EMC. In the younger trial there was no greater dwarfing effect of C132 on either 'Conference' or 'Comice' and, though cumulative yield (total and Class 1 fruit above 65mm) was higher than for EMC, yield efficiency was similar. In the older trial 'Conference' on C132 was slightly more dwarfing than EMC and though cumulative yield was lower the yield efficiencies of C132 and EMC were the same. Tree density may be a factor influencing the comparative vigour of 'Conference' on the different stocks. In the older trial the trees were more densely planted than in the younger trial. In trials done in the UK and the Netherlands C132 has shown potential as a rootstock more dwarfing than EMC with similar yield efficiency and fruit size. Within the current phase of HDC-funded rootstock trialling it is intended that C132 is compared with EMC in grower trials. It is anticipated that 2-year-old 'Conference' trees of C132 will be available for planting in the winter of 2009/10.

In 2006, higher bud height (25 as opposed to 10cm) was associated with a reduced girth of trees on C132 and, as in the previous two years, improved yield efficiency of EMC and C132 rootstocks.

BP30 (a promising Swedish *Pyrus* selection) has proved slightly more vigorous when budded at 25 cm than EMC and though cumulative yields were similar to those obtained with EMC yield efficiency of trees budded at 25 cm was lower. Overall, the performance of BP30 has been similar to that of EMC and remains a promising selection where *Pyrus* rootstocks are preferred to Quince.

Results for QR708/2, a dwarfing *Pyrus* selection from the EMR programme, have not been promising. QR708/2 continues to be more vigorous than EMC, but has a lower cumulative yield and yield efficiency and appears to be incompatible with 'Conference' with the result that 50% of the trees have died.

<u>International plum rootstock trial on a commercial farm</u>

The vigour of trees on rootstocks being tested was either similar to or less than those on 'St. Julien A'. Apart from VVA-1 the dwarfing effects of rootstocks varied according to cultivar. It is too early to comment on the effects of different rootstock/scion combinations on cropping but early indications are that some are more yield efficient than others. It is intended that the trial will continue until 2010, by which time a full evaluation of the rootstocks can be made in terms of growth, cropping, fruit size and suckering.

<u>Cherry rootstock trials planted at EMR</u>

In the international trial, 'Gisela 5' proved to be a consistently high performer with a high cumulative yield and highest yield efficiency. Compared with 'Colt' cumulative yield was 50% greater for 'Gisela 5' and yield efficiency was three-fold higher. G154-7 and G523-02 were similar to 'Gisela 5' in terms of growth and cropping. 'Weiroot 53' was 30% more dwarfing than 'Gisela 5' (based on trunk girth measurements) but had similar yield efficiency.

Krymsk rootstocks VSL2 and LC52 induced precocious cropping of 'Summersun' cherries with 22.6 kg of fruit per tree in year 4 from planting.

The EMR rootstock selection C113-3 on 'Sunburst' appears to be more dwarfing than 'Gisela 5' but no cropping data is available in this trial planted in 2005.

A new trial was planted in 2006 to compare 'Gisela 3' and 'Gisela 5' on the cultivar 'Penny'.

<u>Technology Transfer</u>

No activity in 2006/7.

References

Johnson D.S. & Spencer J.E. (2002). Report on APRC project SP134

Johnson D.S. & Spencer J.E. (2005). Report on HDC projects TF134 and TF141

Johnson D., Evans K., Spencer J., Webster, T. & Adam, S. (2005). Orchard Comparisons of New Quince and Pyrus Rootstock clones. *Acta Horticulturae* (ISHS) 671: 201-207

Johnson D., Spencer J.E., Tobutt K. & Webster A.D. (2007). New Apple Rootstock Selections from the East Malling Breeding Programme. *Acta Horticulturae* (ISHS) 732: 43-50

Pennell, D. (2005). Review of HDC-funded rootstock research projects (TF158)

Spencer J. (2004). The International Cherry Rootstock Trial. *EMRA News* 4, January 2004

Webster A.D. (2001). Report on APRC project SP123