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AUTHENTICATION

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

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GROWER SUMMARY

Headline

- In one trial nearing completion, two selections from the East Malling Rootstock club breeding programme were assessed but neither AR801-11 nor AR680-2 were an improvement on the M9 rootstock for Queen Cox grown under conventional management
- Of the more recently planted conventional and organic rootstock plots, it is too early to determine if any of the selections evaluated are better than current industry standards

Background

A review of AHDB Horticulture-funded rootstock research projects (project TF 158) acknowledged that there was 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 the currently used growing systems for tree fruits but those currently used in tree fruit production 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. This work was then undertaken in AHDB Horticulture project TF 172 Evaluation and development of new rootstocks for apples, pears, cherries and plums.

This project (TF 172a) is a continuation of AHDB Horticulture project TF 172 but focusing only on apple rootstocks. The main aim of the project was to acquire, evaluate and develop in UK growing conditions new apple and pear rootstocks produced by breeding programmes both at EMR and abroad. This project provided continuity of the trialling of fruit tree rootstocks at EMR, looking for rootstocks of intermediate vigour between M27 and M9 and a replacement for M26 in apple with continued evaluation of existing plots that were identified as having new rootstocks of potential merit.

Selection and release of improved rootstocks to the industry will be of benefit as the

introduction of new rootstocks with increased precocity and yield with fewer requirements for chemical or mechanical growth control will have a huge impact on the profitability of UK orchards.

Summary

This project (TF 172a) is a continuation of AHDB Horticulture project TF 172 for the evaluation of trees in some of the existing plots from AHDB Horticulture project TF 172, these plots were those identified as containing rootstocks with potential as commercial rootstocks rather than selections that were identified as 'also ran'.

Three existing plots containing the following rootstocks were assessed:

- Plot CE190: Rootstocks planted in May 2004 with Queen Cox scion and compared to M9 were AR801-11 and AR680-2.
- Plot EE207: AR852-3, AR839-9, B24, R59 and R104 were assessed with M26, M9 and M27 standards; the orchard was planted in March 2010 with Braeburn and Gala scion varieties.
- Plot VF224: AR10-3-9, AR809-3, AR835-11, R80 were assessed with MM106 and M116 standards with Red Falstaff as scion variety, planted in March 2010.

Financial Benefits

It is too early to determine if there are any financial benefits from the recently planted plots.

Action Points

There are no action points at present.

SCIENCE SECTION

Introduction

A review of AHDB Horticulture-funded rootstock research projects (project TF 158) acknowledged that there was 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 the currently used growing systems for tree fruits but that those currently used in tree fruit production 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. This work was then undertaken in AHDB Horticulture project TF 172 entitled 'Evaluation and development of new rootstocks for apples, pears, cherries and plums'.

This new project is a continuation of the evaluation of trees in some of the existing plots from AHDB Horticulture project TF 172. These plots were those identified as the ones containing rootstocks with potential as commercial rootstocks rather than selections that were identified as 'also ran'. The main aim of the project was 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. In this continuation of the work, only selections of apple rootstocks that were deemed to have potential, related to the following objectives, were evaluated:

- To select and develop apple rootstocks with intermediate vigour between M27 and M9, 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 in the scion fruit. This rootstock should also induce precocious and abundant yields of high quality fruit;
- To select and develop dwarfing rootstocks for apple which exhibit improved resistance to drought (and weed competition), replant disease and soil borne diseases (e.g. collar/crown rot).

Selection and release of improved rootstocks to the industry will be of benefit as the introduction of new rootstocks with increased precocity and yield with fewer requirements for chemical or mechanical growth control will have a huge impact on the profitability of UK orchards.

Materials and methods

The trial was conducted at East Malling Research, New Road, East Malling, Kent. Three plots were evaluated: plots CE190 and EE207, which were under conventional management and plot VF224, which was under organic management.

Under conventional management tree rows were maintained weed free using conventional herbicides (a rotary hoe was used for plots under organic management) and the alleys between the rows were grassed down and maintained by frequent mowing.

No supplementary irrigation was supplied to the trees once established. Minimal pruning was undertaken in the first few years following planting; the trees were, however, headed back 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. No chemical or manual fruit thinning was carried out.

Rootstocks planted in May 2004 in plot CE190 with Queen Cox scion and compared to M9 were AR801-11 and AR680-2. In plot EE207 the selections AR852-3, AR839-9, B24, R59 and R104 were assessed with M26, M9 and M27 as standards. The orchard was planted in March 2010 with Braeburn and Gala as the scion varieties. Plot VF224, planted in March 2010, included AR10-3-9, AR809-3, AR835-11, R80, MM106 and M116 rootstocks with Red Falstaff as the scion variety.

Each orchard was assessed for:

- Tree growth: girth (mm), measured 15mm above the graft union;
- Cropping: total yields, yield of Class I >65mm (cumulative yields were calculated);
- Miscellaneous: notes of tree health, graft compatibility and anchorage were made where appropriate.

Results

Plot CE190

In this plot, two East Malling Rootstock Club selections were compared to M9 under conventional management with 'Queen Cox' as the scion. Overall, yields in 2013 were higher than those achieved in 2012.

The mean total yield and the number of fruit from trees grafted on AR860-2 were comparable to those produced by M9, but with a lower mean yield and number of fruit from the Class 1 category, although this difference was found not to be statistically significantly (Table 1).

Trees on AR801-11 gave a lower mean total yield than those on M9, although the mean Class 1 yield was fairly similar but, again, these results were not significant (Table 1).

When looking at the cumulative yield from 2004-13 then total and Class 1 yield for M9 was significantly higher than that produced from AR801-1 and significantly higher for Class 1 yield when compared to AR680-2 (Table 2).

Girth size on AR801-11 was significantly smaller than for both AR680-2 and M9 and corresponds with the results from 2012, which showed this rootstock to have reduced crown volume when compared to the other two genotypes (Table 3).

Table 1. Yield of 'Queen Cox' trees (Plot CE190, 2013)

	Yield (kg/tree)	Yield (number/tree)	Yield Class I >65mm (kg/tree)	Yield Class I >65mm (number/tree)	Mean individual fruit weight (kg)
AR801-11	14.5	263	3.31	21.7	0.08
AR680-2	21.7	406	0.49	3.2	0.07
M9	20.1	401	2.33	15.6	0.09
SED (27 df)	5.7	152	1.37	9.1	0.02
Rootstock effect*	ns	ns	ns	ns	ns

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 2. Cumulative yield of 'Queen Cox' trees (Plot CE190, 2004-2013)

	Cumulative yield 2004-2013 (kg/tree)	Cumulative yield Class I >65mm 2004-2013 (kg/tree)
AR801-11	48.3	14.9
AR680-2	65.4	19.5
M9	84.7	32.9
SED (28 df)	11.4	4.96
Rootstock effect*	*	*

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 3. Girth measurements of 'Queen Cox' trees (Plot CE190, 2013)

	Girth measurements (cm)
AR801-11	15.6
AR680-2	18.4
M9	19.5
SED (27 df)	1.2
Rootstock effect*	*

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Plot EE207

Two East Malling Rootstock Club selections and three externally sourced rootstocks were compared to M9, M26 and M27 under conventional management with 'Braeburn' and 'Gala' as scions.

Braeburn

Significant differences were found in 2013 for total yield and yield of Class 1 fruit, both in terms of weight and numbers of fruit (Table 4). R104 gave a significantly higher yield and total and Class 1 yield when compared to all other rootstocks with the exception of AR852-3. Although AR852-3 gave a high total and Class 1 yield, this was found to be significantly different from only one of the controls (M27). Conversely, B24 gave a significantly lower total yield when compared to the other rootstocks, and lower Class 1 yield except when compared to M27 and R59.

There were significant differences in the girth of the variety 'Braeburn' grown on the different rootstocks, with R59 and M27 having significantly smaller girth sizes (Table 5) than the other rootstocks. Girth measurements on R104 and AR852-3 were comparable to those on M26, but significantly greater than on M9. These results give similar rankings to those observed in 2012.

Table 4. Yield of 'Braeburn' trees (Plot EE207, 2013)

	Yield (kg/tree)	Yield (number/tree)	Yield Class I >65mm (kg/tree)	Yield Class I >65mm (number/tree)
AR852-3	7.41	45.89	6.06	32.8
AR839-9	2.91	18.06	2.26	12.12
B24	0.67	3.80	0.62	3.37
M26	4.88	31.04	3.66	18.55
M27	4.12	34.0	2.74	16.5
M9	5.46	40.25	3.54	20.5
R104	10.34	82.30	6.33	38.32
R59	4.84	42.15	2.0	10.86
SED (45 df)	1.46	12.89	1.29	7.45
Rootstock effect*	***	***	**	**

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 5. Girth measurements of 'Braeburn' trees (Plot EE207, 2013)

	Girth measurements (cm)
AR852-3	11.04
AR839-9	9.43
B24	10.79
M26	11.02
M27	6.93
M9	9.74
R104	11.46
R59	6.54
SED (45 df)	0.61
Rootstock effect	***

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Gala

Unlike 'Braeburn', there were no significant differences in 2013 for either total or Class 1 yield, despite M9 giving a mean total yield of 20kg/tree, almost double that of the next highest yielding rootstock, M26 (Table 6).

However there were significant differences in the total number of fruit produced per tree, with M26 yielding the highest number of fruit, with a significantly higher number of fruit than AR839-9, B24 and M27.

Girth measurements showed three significance categories, with R59 being similar to M27; AR852-3, AR839-9 and R104 being similar to the controls M26 and M9; and B24 being an outlier, conferring the largest girth size (Table 7).

Table 6. Yield of 'Gala' trees (Plot EE207, 2013)

	Yield (kg/tree)	Yield (number/tree)	Yield Class I >65mm (kg/tree)	Yield Class I >65mm (number/tree)
AR852-3	6.45	80.85	2.26	16.97
AR839-9	6.30	53.39	3.33	23.05
B24	3.08	36.65	2.56	17.17
M26	10.34	106.11	4.37	30.19
M27	4.26	40.9	2.09	15.37
M9	20.85	92.54	3.79	27.60
R104	5.48	66.64	3.55	23.13
R59	6.34	88.02	1.55	15.6
SED (44 df)	7.40	21.65	1.35	10.83
Rootstock effect	ns	**	ns	ns

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 7. Girth measurements of 'Gala' trees (Plot EE207, 2013)

	Girth measurements (cm)
AR852-3	10.26
AR839-9	9.88
B24	13.56
M26	10.69
M27	6.75
M9	10.17
R104	11.21
R59	7.04
SED (45 df)	0.75
Rootstock effect	***

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Plot VF224 – organic production

Three East Malling rootstock club selections (AR10-3-9, AR809-3 and AR835-11) and one externally sourced rootstock (R80) were compared to M116 and MM106 under organic management with 'Red Falstaff' as the scion variety. There were no significant differences in terms of yield in 2013 (Tables 8 and 9) or in mean girth size (Table 10). AR809-3 produced the smallest girth size of all the rootstocks tested, although not significantly so, but which corresponds to the reduced vigour observed in 2012.

Table 8. Yield of 'Red Falstaff' trees (Plot VF224, 2013)

	Yield 2013 (kg/tree)	Yield 2013 (number/tree)	Yield Class I >65mm 2013 (kg/tree)	Yield Class I >65mm 2013 (number/tree)	Mean individual fruit weight (kg)
AR10-3-9	0.99	8.75	1.32	4.39	0.12
AR809-3	0.90	6.75	1.61	4.25	0.12
AR835-11	0.58	12.38	1.33	0.63	0.17
M116	0.96	12.75	0.28	2.38	0.07
MM106	1.69	14.5	1.66	7.75	0.10
R80	2.34	20.13	2.08	7.38	0.11
SED (35 df)	0.66	6.82	0.61	3.59	0.04
Rootstock effect	ns	ns	ns	ns	ns

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 9. Cumulative yield of 'Red Falstaff' trees (Plot VF224, 2011-2013)

	Cumulative yield 2011-2013 (kg/tree)	Cumulative yield Class I >65mm 2011-2013 (kg/tree)
AR10-3-9	1.88	0.93
AR809-3	1.53	0.75
AR835-11	1.37	0.69
M116	1.84	0.55
MM106	2.56	1.36
R80	3.8	1.53
SED (35 df)	0.8	0.57
Rootstock effect	*	ns

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Table 10. Girth measurements on 'Red Falstaff' trees (Plot VF224)

	Girth measurements (cm)
AR10-3-9	10.1
AR809-3	6.8
AR835-11	9.6
M116	10.8
MM106	10.2
R80	9.5
SED (35 df)	0.7
Rootstock effect	ns

*rootstock effect was either non-significant (ns) or significant at the 5 (*), 1 (**) or 0.1% (***) level of probability

Discussion

Plot CE190

Although no significant differences were found in for total and Class 1 yield between rootstocks in 2013, the cumulative yield (2004-13) of AR801-11 and AR680-2 was significantly lower than that for 'Queen Cox' on the standard M9 rootstock. This shows that neither of the rootstocks AR801-11 or AR680-2 are an improvement on the M9 rootstock for 'Queen Cox' grown under conventional management. Furthermore, tests carried as part of the East Malling Rootstock Club (Project TF 182) in the last two years strongly suggest that

they are both susceptible to fire-blight and woolly apple aphid. We propose to complete the trial after the 2014 harvest and winter records have been collected, analysed and compared with overseas trials with different scions, if appropriate.

Plot EE207

Only the yield results from the 'Braeburn' trial were found to be significant, with R104 and AR852-3 giving the highest yields. Both these selections also had the largest girth sizes, which were comparable to M26. R59 appears to be the most comparable to M9 with a 'Braeburn' scion in terms of yield but has a significantly smaller girth size, more comparable to M27. This corresponds with data from 2012 that indicated that R59 tree size was intermediate between M27 and M9. For 'Gala', M9 gave the highest yield, although not significantly. As with 'Braeburn', R59 had a girth size comparable to M27 and, although the number of fruit produced was comparable to M9, the total yield was much less, suggesting smaller fruit size.

However with an average of only 35 and 20 fruit per tree respectively from 'Braeburn' and 'Gala' grafted onto the controls it is clear that the trial has yet to meet commercial levels of production and it is therefore still too early to draw any real conclusions of the effect on rootstocks with these scions when grown under conventional management.

Plot VF224

There were no significant differences in any of the yield assessments from this plot, as in previous years. Selection AR809-3 had narrower girth than any of the other selections, although this was not significant, but which corresponds well with the reduced vigour conferred by this selection in previous years. This is still a relatively young trial so it is still too early to draw any real conclusions from this plot.

Conclusions

- Neither AR801-11 nor AR680-2 appear to be an improvement on the M9 rootstock for 'Queen Cox' grown under conventional management.
- It is too early to determine if any of the selections in plots EE207 or VF224 are suitable replacement rootstocks.