Horticulture Innovation Australia

Final Report

Pear Rootstocks Trial

Garry Langford
Australian Pome Fruit Improvement Program Ltd.

Project Number: AP10016

AP10016

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Summary

Up until around the year 2000, Australian pear production had been largely based on the rootstock *Pryus calleryana* D6 (D6). This had been a good stock with exceptional longevity. However, it had two serious weaknesses:

- trees on D6 rootstock took up to 5 years to begin fruiting – i.e. they were not precocious in relation to fruit production; and
- the large size of the tree that was produced by D6 rootstock rendered it unsuitable for intensive plantings.

In the early 2000's a range of new pear rootstocks were introduced to Australia. These were dwarfing and semi-dwarfing compared to D6. However there was significant industry concern that these new rootstocks would not cope with the heavier soils and high temperatures of the Goulburn Valley - the production region that produces more than 85% of Australia's pears. There were also concerns that, in particular, the Quince stocks would not result in a tree large enough for the cultural systems used in the Goulburn Valley. The limited previous use of Quince had resulted in smaller trees.

In 2004 the initial trees of this trial were planted. The trial was an extension project, aimed at demonstrating the merit of the various rootstocks in producing the common pear varieties – Packham's Triumph, Williams Bon Cretin and Corella. Four rootstocks were used (D6 as the control, BM2000 BP1 and Quince A) these were thought to give trees about 75% of the size of D6. Two tree training regimes were imposed on the rootstock scion combinations – Central Leader and Open Tatura Trellis. Unfortunately trees on Quince a could not be obtained at the time of planting trees on the other stocks. The trees on Quince A were planted two years later.

2014 was the 10th anniversary of the trial's planting. After 10 seasons the results show that:

- for WBC and Corella pears, Central Leader tree training was the highest yielding system. For Packham pears Open Tatura Trellis was the highest yielding training system;
- The D6 rootstock was a high yielding or the highest yielding rootstock for all 3 scion varieties. However, D6 results in more limb extension growth and more water shoots in the tree - possibly resulting in more skin marks and lower packouts (skin marks and packouts were not measured). Increased cost in labour hours to control vigour and at pruning is also a negative of D6
- Apart from D6, the best rootstock for Packham and Corella was Quince A and for WBC it was BM2000

The yield efficiency of various variety/rootstock/variety combinations is also important as it demonstrates yield relative to tree size. In general, smaller trees with high yields perform well in higher density plantings. The key outcomes from the trial in terms of yield efficiency (yield in Kg/cm2 of trunk cross sectional area) were:

- For all three varieties, Open Tatura Trellis tree training delivered trees with greater Cumulative

Yield Efficiency than trees trained to the lower density Central Leader system

- The best rootstocks, in terms of Cumulative Yield Efficiency, were:
    - For Packham: BP1
    - For Williams: BM2000 and BP1
    - For Corella: Quince A

Note that the rootstocks that perform well in terms of yield efficiency are quite different to those that perform well in terms of yield.

The extension nature of the trial was supported by an annual field day (in winter) where growers could see the nature of the trees produced by the various rootstock/scion/tree training combinations. At the field day an annual report of the data collected from the trail was made available to industry.

Based on the value of this trial to the Australian industry, EcoDev Victoria has now planted a similar but more scientifically-valid pear rootstock trial at their Tatura Research Centre.

Keywords

pears
rootstocks
comparison trial
Quince A
BP1
BM2000
D6
Pyrus calleryana

1. Introduction

Up until around the year 2000, Australian pear production had been largely based on the rootstock *Pryus calleryana* D6 (D6). This had been a good stock with exceptional longevity. However, it had two serious weaknesses:

- trees on D6 rootstock took up to 5 years to begin fruiting – i.e. they were not precocious in relation to fruit production; and
- the large size of the tree that was produced by D6 rootstock rendered it unsuitable for intensive plantings.

Overall, while the D6 rootstock has served Australia well, due to is unsuitability to high density planting, it was one of the factors threatening the financial viability of Australian pear production.

During the early 2000's a series of new, precocious and semi-dwarfing rootstocks become available for pears. They were BM2000, BP1 and the quince series (A, C and BA29). Initially there was reluctance to use these stocks in the Goulburn Valley as it was thought that they would not cope with the region's heavier soils and that the vigour of D6 was required for these soils.

To address this issue, in 2004, this trial was planted. Its aim was to demonstrate the merit of the (then) new rootstocks in the Goulburn Valley. It was always designed as a demonstration/extension trial, with large plots (50 trees) of the various rootstock/scion combinations. Assessment was via some data collection but primarily by growers walking the plots and seeing for themselves how the various varieties grew on each stock. The trial compared three scion varieties (Packham's Triumph, William's Bon Cretin and Corella) grafted to four rootstocks (D6, Quince A with a Burre Hardy inter-stem, BP1 and BM2000) with trees planted across two tree training systems (Tatura Trellis and Central Leader) – 1200 trees in all. In 2011, a small number of trees on DCA Fox 11 rootstock were planted at the trial site. Each year a field day was held at the site to allow growers to see the differences in performance of the various rootstock/scion combinations. Measurements of tree growth and fruit yield and fruit quality were made on an annual basis, reported at the field day and published in an annual report. This report was made available to industry through the Australian Pome Fruit Improvement Program Limited (APFIP) and Apple and Pear Australia Limited (APAL).

2015 is the 10th year of the trial. It has now fulfilled its purpose by showing that Quince A is the preferred rootstock for the Goulburn Valley and that this rootstock is well suited to the common soil types of the Goulburn Valley region. The Department of Economic Development, Jobs, Transport and Resources (EcoDev), Victoria, has since planted a more detailed version of this trial at its Tatura Research Centre.

2. Methodology

2.1 Site Design:

The site is located at Lenne Orchards at Ardmona in the Goulburn Valley, about 10km south of Shepparton, on a soil known as Shepparton Fine Sandy Loam – one of the best soil types of the region. The site was initially planted in 2004 and has been designed to include 6 rootstocks (although only four were used), 3 scion varieties and two tree training systems. The site was always thought of as a demonstration site. Thus the trial is not replicated. Instead the plots are large and sufficient for growers to see commercial differences at the annual field day.

2.1.1 Rootstocks: The rootstocks in the trial were:

Prunus calleryana D6: In Australia, *Pyrus calleryana* D6 seedlings have been the most commonly used rootstock for commercial pear production. However, D6 is slow bearing and excessively vigorous – producing very large trees that are unsuitable for intensive pear production.

Quince A (with Burre Hardy inter-stem): Whilst there is often some variation in results between sites and scion cultivars, Quince A yields a tree approximately 75% of the size of the D6 seedling. Quince rootstocks provide good vigour control but show incompatibility with many important European pear scion cultivars such as Williams, Beurre Bosc and Packham. This can be overcome with the use of inter-stems of compatible cultivars such as Beurre Hardy – as was used in this trial.

BP1: BP1 originated in South Africa and is reported to have vigour similar to Quince A (approximately equal to 75% of Pyrus calleryana) and good yield efficiency. There are no reported compatibility issues between BP series rootstocks and scion cultivars. However, BP1 is highly susceptible to pear decline and fireblight and is difficult to propagate. Susceptibility to pear decline has limited use of BP1 as a rootstock in Europe.

BM2000. BM2000 originated in Australia as a result of open-pollination of likely parents Williams and Packham. It's described as having medium vigour compared to D6 and is thought to be precocious. There is little experimental data regarding precocity, productivity or yield efficiency in the literature. This trial is one of the first sources of data related to the comparative efficiency of BM2000

DCA Fox 11: Fox 11 is one of two rootstocks recently imported from Italy. It has not been widely tested in Australia. Fox 11 has vigour similar to Quince A and is recommended for tree densities between 2,000-2,500 trees/ha. It also has good compatibility and tolerates high alkalinity. A small number of trial trees were planted at the site in 2009.

Pyrodwarf: Pyrodwarf originated from a cross between Old Home and Bonne Luise d'Avranches. It reportedly has 50% lower vigour than D6 and good graft compatibility with European and some East-Asian pear varieties. Pyrodwarf has low susceptibility to iron chlorosis, is tolerant to water-logging and is winter hardy. However, evaluations in Europe suggest it's still too vigorous for intensive systems. It was considered for this trial but not finally planted.

2.1.2 Scion Varieties

Tree commercial scion varieties were utilised in the trial. They were:

Packham's Triumph (Packham): A medium sized green pear, susceptible to skin damage and marking. One of Australia's most common commercial pear varieties.

Williams Bon Cretin (WBC): a medium sized pear, famous for its smooth skin and yellow colour when ripe. A dual purpose pear used for both canning and fresh market sales

Corella: a small to medium sized pear which is also difficult to grow and suffers from low packouts due to colour and marking issues. Becoming more common in the Australian industry

2.1.3 Tree Training System

The trial trees were grown as either a centre leader tree or as an Open Tatura Trellis system. These systems are in common use in Australia and are described in Figures 1 and 2 below

Figure 1: pear trees utilising central leader (CL) training.

Figure 2: pear trees utilising Open Tatura Trellis (OTT) training

2.1.4 Total Tree Number

There were 50 trees of each rootstock/scion/tree training combination so that the total number of trees in the trial was:

4 rootstocks x 3 scion varieties x 2 tree training systems x 50 trees per rootstock/ scion/tree training treatment = 1200 tree all together = plus the DCA Fox 11 trees.

Note that the plots were not replicated such that statistical analysis of the data has not been possible

2.1.5 Measurements:

Fruit Measurements. 40 of the 50 trees in the plot were selected. From these 40 trees 30 pieces of fruit were collected. On these fruit the fruit size, fruit weight, sugar and pressure measurements were made.

Yield estimates. On 10 trees of the 40 selected for the plot, total fruit numbers were counted giving an average fruit number per tree for that rootstock/scion/tree training system. from this number yield per hectare was calculated according to the formulae:

Yield (tonnes/ha) = (ave. fruit/tree x ave. fruit weight (kg) x trees/ha)/1000

Tree measurements: butt circumference was measured at a set distance above the ground on marked trees in each plot. The same trees were measured each year

Table 1: trial measurements with definitions and comments.

Measurement	Description	Comments
Trunk Cross Section	The cross sectional area of the trunk in cm^2.	Measured in winter, when trees are dormant
Yield	The volume of fruit harvested reported as tons/Hectare	Measured at commercial harvest time.
Yield efficiency	The ability of the tree to produce fruit weight per cm^2 of the trunk cross section reported as kg/cm^2	Derived from yield data and trunk cross section area as measure in the winter after harvest.
Cumulative yield	The total volume of fruit harvested from a rootstock/scion/tree training combination from planting. Reported as tons/hectare	
Cumulative yield efficiency -	The total fruit weight produced by a rootstock/scion/tree training combination from planting expressed on a per cm^2 of the trunk cross section basis	Derived from Cumulative Yield and Trunk Cross Section data
Fruit size	The average diameter, at the widest point, of fruit sampled from a rootstock/scion/tree training combination. Based on a sample of 30 pieces of fruit.	Measured at harvest
Fruit Pressure	The average penetrometer reading of fruit sampled from a rootstock/scion/tree training combination. Penetrometer reading the	Measured at harvest

Measurement	Description	Comments
	average of the readings taken on both cheeks of the pear. Based on a sample size of 30 pieces of fruit	
Fruit Weight	The average weight in grams of a single piece of fruit, sampled from a rootstock/scion/tree training combination. Based on a sample size of 30 pieces of fruit.	Measured at harvest.

3. Outputs: Results of the Trial

AP10016 finished on 1 May 2015. This was before the trees in the trial had lost their leaves for the year. Accordingly, the last data reported below is for 2014. As noted above, the trial was not set up for statistical analysis – so no measures of statistical significance can be provided.

Results are reported in the following sequence:

- Packham on Central Leader
- Packham on Tatura Trellis
- WBC on Central Leader
- WBC on Tatura Trellis
- Corella on Central Leader
- Corella on Tatura Trellis

All Central Leader blocks were planted at a density of 1585 trees per hectare. All Tatura Trellis blocks were planted at a density of 2750 trees per hectare

3.1 Packham Pears

3.1.1 Packham pears using Central Leader tree training.

Table 2: Results for Packham pears using Central Leader tree training – 1585 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	131	949	34.0	190	0.2	1.5
BM2000	2004	75	701	25.0	133	0.2	1.8
BP1	2004	100	935	45.0	197	0.3	2.0
Quince A	**2006**	56	1318	31.0	146	0.4	2.6

Table 3: Yields for Packham on Central Leader (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	14	34	10	41	22	35	34
BM2000	2004	21	16	5	26	13	27	25
BP1	2004	17	13	14	36	31	42	45
Quince A	**2006**	0	8	13	41	25	28	31

3.1.2 Comments on tables 2 and 3

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.
Yields: Quince A was planted two years later than the other stocks. Consequently trees on Quince A are behind the other stocks for the first few years (Table 3) and cumulative yield never really caught up (Table 2). However yields in 2013 and 2014 (the 7th and 8th seasons for Quince A) compare well with yields in 2011 and 2012 – the 7th and 8th seasons for the other stocks. (Table 4)

Table 4: Combined yield for Packham on Central Leader for the 7th and 8th seasons. Re-analysis of data from Table 3.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	31.5	111
BM2000	2011 and 2012	19.5	81
BP1	2011 and 2012	33.5	100
Quince A	2013 and 2014	29.5	146

BM2000 started well but fell behind from 2009 onwards – cumulative yields were low. The best yielding stocks were D6 and BP1 with BP1 out performing D6 in the latter years of the trial. By the end of the trial trees of BP1 showed greater yield efficiency than that of D6 trees, but trees on Quince A were still 2 years behind – so it is not possible to say how they may have performed at the same age.
Tree size: trees on D6 had the largest cross sectional area (Table 2), and were larger than any of the other trees in the trial. The Quince A trees were planted two years later which explains their relatively poor performance compared to trees on other rootstocks.
Fruit Quality: no major differences were observed in 2014 or throughout the trial
Overall: D6 performed surprisingly well but its vigorous growth may have resulted in more fruit marking and lower packouts (not measured). Best stocks were Quince A and BP1. Table 4 shows that Quince A was well ahead by the end of the 8th season.

Figure 3: Packham on D6

Figure 4: Packham on Quince A

Note the much greater limb extension growth and presence of water shoots with the more vigorous D6 rootstock

3.1.3 Packham Pears using Open Tatura Trellis tree training

Table 5: Results for Packham pears using Open Tatura Trellis tree training – 2750 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	88	667	44.0	225	0.18	2.6
BM2000	2004	67	736	24.0	151	0.13	2.2
BP1	2004	62	838	66.0	230	0.39	3.7
Quince A	**2006**	52	1224	38.0	138	0.26	2.7

Table 6: Yields for Packham on Open Tatura Trellis (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	23	22	11	38	15	71	44
BM2000	2004	22	10	14	27	13	41	24
BP1	2004	17	12	11	38	26	61	66
Quince A	**2006**	0	0	14	21	27	38	38

3.1.4 Comments on tables 5 and 6

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.
Yields: Again, Quince A which was planted two years later was behind the other stocks for the first few years (Table 6) and again cumulative yield of trees on Quince A never really caught up (table 5). Re-analysis of the data in Table 6 to allow a comparison of the 4 stocks in their 7th and 8th seasons (Table 7) shows that at by the 7th and 8th season Quince A was performing well.

Table 7: Combined yield for Packham on Open Tatura Trellis for the 7thand 8th seasons. Re-analysis of data from Table 6.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	27.5	110
BM2000	2011 and 2012	20	86
BP1	2011 and 2012	32	104
Quince A	2013 and 2014	38	138

BM2000 did not perform well throughout the trial and again cumulative yields of trees on BM2000 were low. At the end of the trial the best yielding stocks were D6 and BP1 with BP1 out performing D6 in the latter years of the trial – although trees on Quince A were also performing well. By the end of the trial trees of BP1 again showed greater yield efficiency than that of D6 tree and BM2000.
Tree size: Again, due to late planting, trees on Quince A were the smallest – had the smallest cross sectional area (Table 5), and were much smaller than D6. Trees of BM2000 and BP1 were smaller than

trees on D6 stocks.
Fruit Quality: no major differences were observed in 2014 or throughout the trial
Overall: On the data presented, trees on BP1 stocks were easily the best performing – as can be seen from their substantially higher cumulative yield and cumulative yield efficiency (Table 5). Table 7 suggests that at the end of the 8th season, Quince A was the superior rootstock.

3.1.5 Packham: Central Leader vs Open Tatura Trellis tree training

Figures 3 and 4 provide a comparison of Packham grown on various stocks, under the two tree training systems. Data collected in 2014.

Figures 5 and 6 show that by 2014, trees on Open Tatura Trellis (generally) out performed trees on the lower density Central Leader system in terms of both **cumulative yields** and **cumulative yield efficiency**. It is likely that trees grafted to Quince A rootstock would have yielded as least as well as those on D6 and BP1 – had they been allowed the extra two seasons the trees on the other stocks had had.

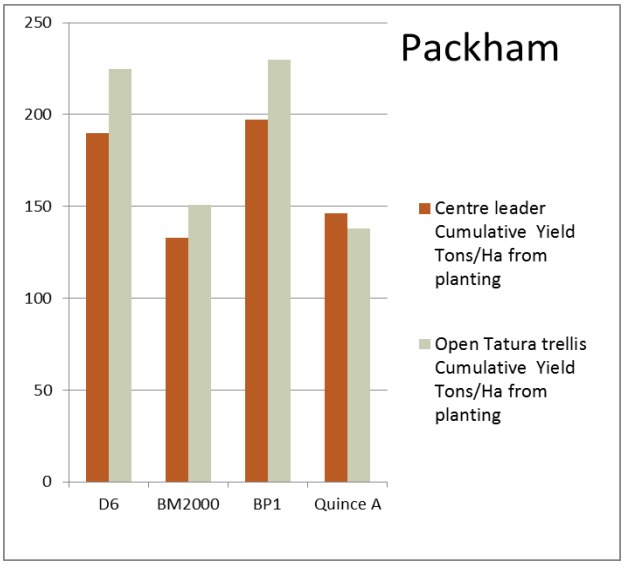


Figure 5: Packham – cumulative yield

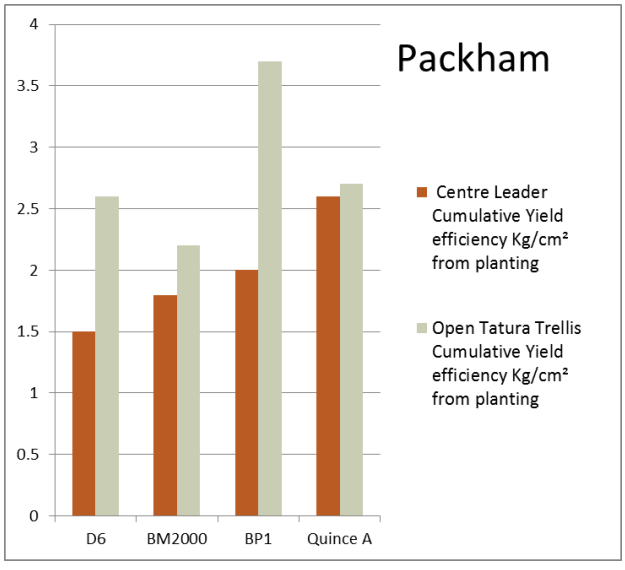


Figure 6: Packham cumulative yield efficiency

3.1.6 Best Stock and tree training system for Packham?

The data above suggests that Packham on either BP1 or Quince A stock, grown under an Open Tatura Trellis system is the best performing Packham combination at this trial site.

3.2 WBC Pears

3.2.1 WBC using Central Leader tree training

Table 8: Results for WBC pears using Central Leader tree training – 1585 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	78	750	31.0	264	0.15	3.4
BM2000	2004	49	628	10.0	197	0.07	4.0
BP1	2004	53	869	20.0	211	0.14	4.0
Quince A	**2006**	41	631	17.0	139	0.15	3.4

Table 9: Yields for WBC on Central Leader (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	15	12	48	55	40	63	31
BM2000	2004	29	17	39	37	25	40	10
BP1	2004	13	15	40	43	34	46	20
Quince A	**2006**	0	0	10	41	30	41	17

3.2.2 Comments on tables 8 and 9

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.
Yields: Trees on D6 out yielded all other stocks. At the end of the trial, the late-planted Quince A is behind the other stocks. However, averaging the yields for the 7th and 8th season for Quince A (2013 and 2014) and comparing those with the average yields for the 7th and 8th seasons (2011 and 2012) for the other stocks shows Quince A to be in front after the 8th season – Table 10. Table 10 also shows that cumulative yields to the end of the 8th season favoured Quince A

Table 10: Combined yield for WBC on C. Leader for the 7thand 8th seasons. Re-analysis of data from Table 9.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	27.5	130
BM2000	2011 and 2012	20	111
BP1	2011 and 2012	32	146
Quince A	2013 and 2014	38	156

Again BM2000 did not perform well throughout the trial and again cumulative yields from trees with this stock were low.
Tree size: Again, trees on D6 rootstock were the largest but showed the most vigour in limb extension

growth and water shoots in the canopy.
Fruit Quality: no major differences were observed in 2014 or throughout the trial
Overall: Trees on D6 were the best yielding. Quince A stocks were the best performing at the end of the 8th season – as can be seen from their substantially higher cumulative yield at the end of the 8th season (table 10).Whether they would have caught up to D6 trees cannot be determined from these results.

3.2.3 WBC using Open Tatura Trellis tree training

Table 11: Results for WBC pears using Open Tatura Trellis tree training – 2750 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	78	750	31.0	264	0.15	3.4
BM2000	2004	49	628	10.0	197	0.07	4.0
BP1	2004	53	869	20.0	211	0.14	4.0
Quince A	**2006**	41	631	17.0	139	0.15	3.4

Table 12: Yields for WBC on Open Tatura Trellis (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	15	12	48	55	40	63	31
BM2000	2004	29	17	39	37	25	40	10
BP1	2004	13	15	40	43	34	46	20
Quince A	2006	0	0	10	41	30	41	17

3.2.4 Comments on tables 11 and 12

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.
Yields: Trees on D6 had the highest cumulative yield with trees on BP2000 and BP1 next. At the end of the 8th season this order was maintained (Table 13) – with D6 out yielding all other stocks.

Table 13: Combined yield for WBC on Open Tatura Trellis for the 7th and 8th seasons. Re-analysis of data from Table 12.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	47.5	170
BM2000	2011 and 2012	31	147
BP1	2011 and 2012	38.5	145
Quince A	2013 and 2014	29	138

Tree size: Again, trees on D6 rootstock were the largest but showed the most vigour in limb extension growth and water shoots in the canopy.
Fruit Quality: no major differences were observed in 2014 or throughout the trial
Overall: trees on D6 stocks were easily the best performing, even in this higher density situation. What would happen in future years is unknown. In contrast to WBC with Central Leader tree training, Quince A was not a high performing stock in this situation and BM2000 performed better with this variety/tree training combination.

3.2.5 WBC: Central Leader vs Open Tatura Trellis tree training

Figures 7 and 8 provide a comparison of WBC grown on various stocks, under the two tree training systems. Data collected in 2014.

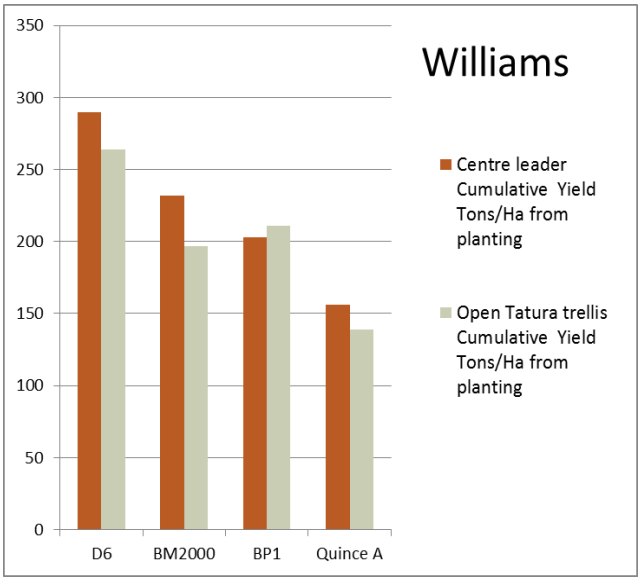


Figure 7: WBC – cumulative yield

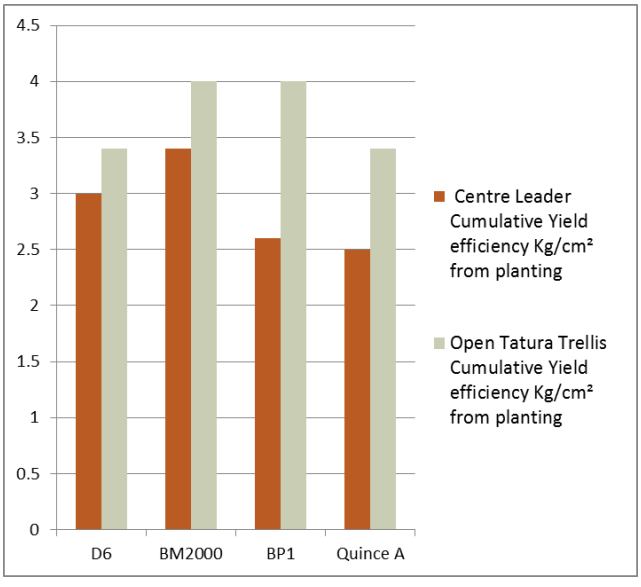


Figure 8: WBC cumulative yield efficiency

In terms of **Cumulative Yield**, Central Leader trees outperformed Open Tatura Trellis with all stocks except BP1.
In terms of **Cumulative Yield Efficiency**, Open Tatura Trellis was the best tree training system for all rootstocks.

3.2.6 Best Stock and tree training system for WBC?

The data above suggests that WBC on D6 stock, grown under a Central Leader system is the best performing WBC combination at this trial site. The downside to this combination is the “more wild” trees on D6 showing greater annual limb, extension growth and more water shoots in the tree.

3.3 Corella Pears

3.3.1 Corella using Central Leader tree training

Table 14: Results for Corella pears using Central Leader tree training – 1585 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	139.0	1336.5	29.0	206	0.13	1.5
BM2000	2004	106.0	1737.7	27.0	123	0.16	1.2
BP1	2004	141.0	1658.8	17.0	115	0.07	0.8
Quince A	**2006**	67.0	2093.8	28.0	130	0.26	1.9

Table 15: Yields for Corella on Central Leader (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	0	34	13	15	65	50	29
BM2000	2004	0	16	14	20	23	23	27
BP1	2004	0	13	11	13	36	25	17
Quince A	**2006**	0	8	9	12	42	31	28

3.3.2 Comments on tables 14 and 15

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.

Yields: At the end of the trial, the annual yield of the late-planted Quince A trees equalled the yield of both trees on D6 and BM2000 planted two years earlier (Table 15). D6 had generally outperformed all other rootstocks up to that point. Averaging the yields for 2013 and 2014 for Quince A and comparing those with the average yields for 2011 and 2012 for the other stocks shows D6 to be a clear leader (Table 16), with around 30% greater yields than other stocks in those seasons. However, Table 16 also shows that cumulative yields to the end of the 8th season were similar between D6 and Quince A with Quince A – Quince A had caught up.

Table 16: Combined yield for Corella on C. Leader for the 7thand 8th seasons. Re-analysis of data from Table 15.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	40	127
BM2000	2011 and 2012	21.5	73
BP1	2011 and 2012	24.5	73
Quince A	2013 and 2014	29.5	130

Neither BP1 nor BM2000 performed particularly well with cumulative yields (at the end of the trial) less than those of two years younger trees on Quince A.

Tree size: Trees on D6 and BP1 rootstock produced the largest trees. Trees on D6 showed the most vigour in limb extension growth and water shoots in the canopy.

Fruit Quality: no major differences were observed in 2014 or throughout the trial

Overall: Trees on D6 and Quince A stocks were easily the best performing – as can be seen from their substantially higher cumulative yield at the end of the 8th season (Table 16). BP1 and BM2000 did not perform well under this variety/tree training regime.

3.3.3 Corella using Open Tatura Trellis tree training

Table 17: Results for Corella pears using Open Tatura Trellis tree training – 1585 trees per hectare

Rootstock	Year Planted	2014 Trunk Cross Section/cm2	% increase Trunk Cross Section/cm2 from 2006	2014 Yield Tons/Ha	Cumulative Yield Tons/Ha from planting	Yield efficiency 2014 Kg/cm²	Cumulative Yield efficiency Kg/cm² from planting
D6	2004	98	1089	19.0	171.0	0.12	1.7
BM2000	2004	76	1310	11.0	110.0	0.09	1.4
BP1	2004	79	1039	13.0	123.0	0.10	1.6
Quince A	**2006**	48	1371	21.0	125.0	0.27	2.6

Table 18: Yields for Corella on Open Tatura Trellis (tonnes/ha)

Rootstock	Year Planted	2008	2009	2010	2011	2012	2013	2014
D6	2004	0	16	15	19	62	40	19
BM2000	2004	0	11	16	24	20	28	11
BP1	2004	0	11	14	20	43	22	13
Quince A	**2006**	0	0	10	13	51	30	21

3.3.4 Comments on tables 17 and 18

Stock/Scion compatibility: All combinations were growing well with no signs of incompatibility.

Yields: As with Corella under Central Leader training, at the end of the trial, the late-planted Quince A equalled the annual yield of trees on two-year-older D6 trees. D6 again generally outperformed all other rootstocks up to that point. Averaging the yields for 2013 and 2014 for Quince A and comparing those with the average yields for 2011 and 2012 for the other stocks shows D6 to be a clear leader (Table 19), with more than 30% greater yields than other stocks in those seasons. However, Table 19 also shows that by the end of the 8th season cumulative yields of trees on Quince A had caught up and passed the cumulative yields of the trees on D6.

Table 19: Combined yield for Corella on C. Leader for the 7th and 8th seasons. Re-analysis of data from Table 18.

Rootstock	Years of 7th and 8th seasons	Average yield in 7th and 8th seasons (tonnes/ha)	Cumulative yield to the end of the 8th season (tonnes)
D6	2011 and 2012	40.5	112
BM2000	2011 and 2012	22	71
BP1	2011 and 2012	31.5	88
Quince A	2013 and 2014	25.5	125

Neither BP1 nor BM2000 performed particularly well with cumulative yields (at the end of the trial) similar to or less than those of two-years-younger trees on Quince A.

Tree size: Trees on D6 and BP1 rootstock produced the largest trees. Trees on D6 showed the most vigour in limb extension growth and water shoots in the canopy.

Fruit Quality: no major differences were observed in 2014 or throughout the trial

Overall: As with Central Leader tree training, Corella trees on D6 and Quince A stocks were easily the best performing – as can be seen from their substantially higher cumulative yield at the end of the 8th season (table 19). BP1 and BM2000 did not perform well under this variety/tree training regime.

3.3.5 Corella: Central Leader vs Open Tatura Trellis tree training

Figures 9 and 10 provide a comparison of Corella grown on various stocks, under the two tree training systems. Data collected in 2014.

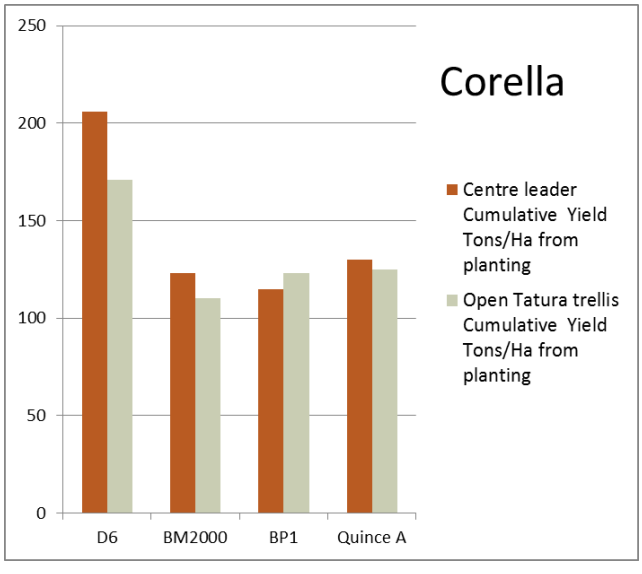


Figure 9: Corella – cumulative yield

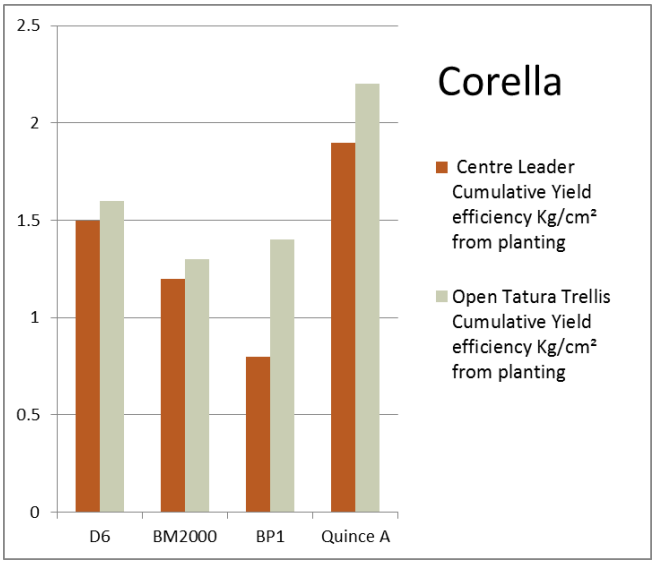


Figure 10: Corella cumulative yield efficiency

In terms of **Cumulative Yield**, Central Leader trees outperformed Open Tatura Trellis with all stocks except BP1. – exactly the same as for WBC

In terms of **Cumulative Yield Efficiency**, Open Tatura Trellis was the best tree training system for all rootstocks – again this is the same as the situation for WBC

3.3.6 Best Stock and tree training system for Corella?

The data above suggests that Corella on D6 stock, grown under a Central Leader system is the best performing WBC combination at this trial site. The downside to this combination is the “more wild” trees on D6 showing greater annual limb extension growth and more watershoots in the tree. In terms of annual yield, Corella on Quince A stock had caught up to D6 by the end of the trial – even though the trees on Quince A were two years younger.

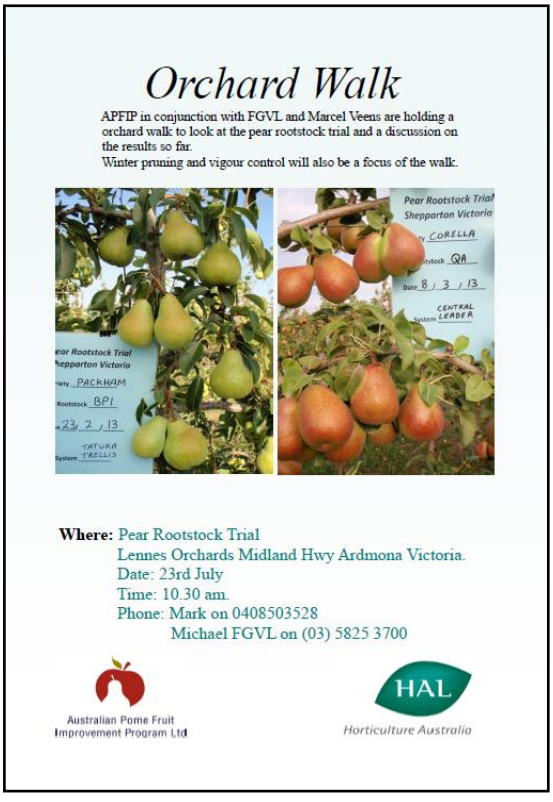
3.4 Annual Field Days and Annual Report

There were two other important outputs from the project.

As noted above the trial was primarily established as a demonstration of the value of Quince and other semi-dwarfing rootstocks for pear production in the Goulburn Valley. To get the most out of the demonstration an annual field day was held (Figure 11). The field day was held in winter when the leaves were off the trees and the structure of the trees could be more easily seen. The field day was organised by the Project Leader – either Mark Hankin or Garry Langford - from the Australian Pome Fruit Improvement Program Limited (APFIP).

Critical to the success of the field day was promotion of the event beforehand and the Annual Report that was available at the field day and from both APFIP and APAL afterwards.

Promotion was via the Australian Fruit Grower magazine and direct distribution of flyers (e.g. Figure 11) to growers. The field days attracted between 30 and 50 growers each year.


Orchard Walk

APFIP in conjunction with FGVL and Marcel Veens are holding a orchard walk to look at the pear rootstock trial and a discussion on the results so far.
Winter pruning and vigour control will also be a focus of the walk.

Where: Pear Rootstock Trial
Lennes Orchards Midland Hwy Ardmona Victoria.
Date: 23rd July
Time: 10.30 am.
Phone: Mark on 0408503528
Michael FGVL on (03) 5825 3700

Australian Pome Fruit Improvement Program Ltd

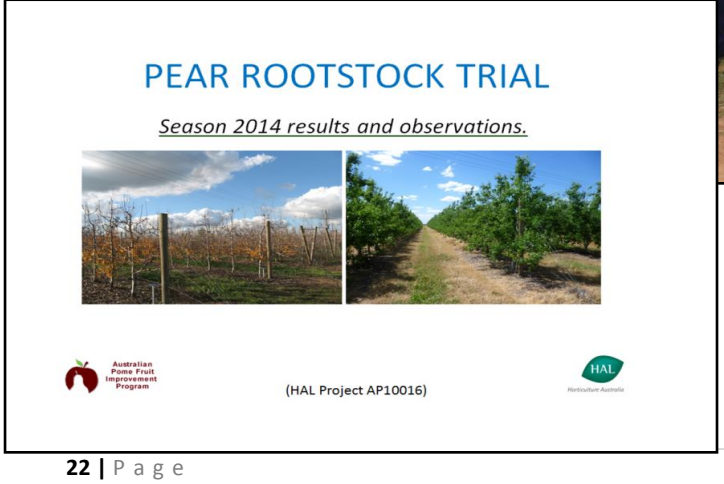
HAL
Horticulture Australia

Figure 12: Field Day Flier

Annual reports (e.g. Figure 13, below), summarising data collected at the trial site in that year, were published for every year of the trial apart from 2015 – when the project finished before the final measurements were made.

Figure 11: Field day at the trial site

Figure 13: Front cover of 2014 Annual Report


PEAR ROOTSTOCK TRIAL

Season 2014 results and observations.

Australian Pome Fruit Improvement Program

(HAL Project AP10016)

HAL

4. Outcomes:

The outcomes of the trial are clear in some cases and less clear in others. To summarise:

For Packham:

D6 or BP1 rootstock, using Open Tatura Trellis tree training, were the most successful rootstock/tree training combinations. However, it is likely that trees grafted to Quince A would have caught up to trees on these stocks had they had time to do so. Right throughout the trial, trees on D6 rootstock showed more vigour, greater limb extension growth and more water shoots – a serious detractor for trees on this rootstock. The BM2000 rootstock resulted in trees that did not yield as well as trees on other rootstocks

For WBC:

Trees on Central Leader consistently out yielded trees on Open Tatura – except when grafted to BP1 rootstock. Trees on D6, grown as a Central Leader were the best performing in terms of yield but the more vigorous tree is again a down side. In contrast to Packham, WBC trees on BM2000 stock performed well.

For Corella:

Trees utilising Central Leader tree training out yielded those using Open Tatura Trellis tree training except when BP1 stocks were used. As with WBC, D6 was the best yielding stock for Corella in the trial situation. However, Quince A was quickly catching up to D6 in terms of annual yield and at the end of the trail annual yield of trees on Quince A were producing at similar levels to trees on D6 – even though they were two years younger.

In Industry:

Quince stocks are now the stocks of choice for most new plantings. For example, the Tahune Fields nursery (a major supplier of both pear and apple trees) have transitioned from 100% D6 10 years ago to 100% Quince today. They are of the view that there are still some management issues to work out with Quince stocks but the EcoDev Vic project will solve most of these. APFIP certified Quince rootstocks are the basis for all the Quince rootstock production.

5. Evaluation and Discussion

Factors that compromise the trial scientifically:

The results of the trial are compromised by:

- the fact that statistical analysis cannot be performed on the results. This means that no definite conclusions can be drawn – only trends and apparent results can be discussed.
- No measure on fruit skin quality was taken. The level of limb marks, russet, and other skin damage can significantly reduce packout in commercial pear orchards. It is likely that the more vigorous trees on D6 may have shown more skin marking which would have reduced packout. However, without data no conclusions can be drawn.
- The fact that the trees on Quince A rootstock were planted two years after the other trees made it is difficult to compare the performance of trees on these stocks with that of the other trees in the trial

While these factors reduce the value of the trial from a scientific point of view, the trial has been an **important success** from an industry development perspective. The trial has been instrumental in facilitating the adoption of Quince and other semi-dwarfing rootstocks for pear production in the Goulburn Valley – the region that produces over 85% of Australia's pears.

A very good outcome from the trial is that EcoDev Victoria has now planted a similar, but more scientifically-valid trial at their research centre at Tatura. This will provide the definite recommendations this trial has been unable to make.

6. Recommendations

That the pear industry, through the apple and pear levy, support the ongoing pear rootstock evaluation research underway at EcoDev Tatura.

7. Publications

Because of the extension nature of the trial no scientific or refereed publications have been published for the trial. However there have been publications in the form of

- the Annual Report of the trial – each year for 5 years from 2010 to 2014 inclusive
- Articles related to the results of the trial in the Australian Fruit Grower magazine. Articles were published as follows;
    - 2010 “APFIP Pear Rootstock Trial, Shepparton, Victoria” - highlighting the trial results so far.
    - All annual reports were published on the APFIP website followed by a note in either Australian Fruit Grower magazine or “Industry Juice” e-newsletter referencing the report.
- 2011-2014 orchard walk flyers were published and circulated via EcoDev Victoria.

8. Intellectual Property/Commercialisation

As the results of the trial are in the public domain, intellectual property and commercialisation are not relevant to this report.

9. Acknowledgements

The authors would like to acknowledge:

Mr Matthew Lenne, of Lenne Orchards, Ardmona, who hosted the trial, managed the trial from a day to day agronomic management point of view and hosted the field days each year.

Ms Susannah Turpin of Tatura for annual trial data collection.

Mr Marcel Veens for involvement in the annual orchard walks and pruning demonstrations.

Mr Garry Langford, General Manager, Intellectual Property Division, Apple and Pear Australia Limited and Manager of the Australian Pome Fruit Improvement Program Ltd (APFIP) for his help with the trial and ongoing support and interest in its operations.

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