Horticulture Innovation Australia

Final Report

Comparing the performance of new cherry rootstocks soon to be available to industry

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Summary

The choice of rootstock in tree fruits is critical for the commercial viability and productivity of the orchard. While the effects of rootstocks on tree size, productivity and disorder resistance are well known for most rootstocks in the apple industry this information is lacking for the recently introduced dwarfing cherry rootstocks in Australia. This project was designed to generate this information and investigate the use of bench grafted trees in orchard establishment to reduce the cost of planting and as a means of rapidly establishing the new rootstocks in industry. Three identical trials each in a different major cherry growing district were established for this study.

This project has identified that graft take and hence tree propagation on the new dwarfing rootstocks is far more difficult than the current industry standards. This means that the use of bench grafted trees for orchard establishment cannot be recommended as successful grafting in this situation can be expected to be below 50 percent resulting in significant regrafting costs over several seasons, uneven orchard development and delayed return on investment. It is far better to contain this poor graft take to the nursery and to invest in planting new orchards with established nursery trees to ensure even and productive orchard development.

The trials revealed huge differences in tree growth rates between the sites at different growing districts. While this set of trials was not established to study the impact of cherry replant disorder the data suggested that this disorder may occur in cherries and have a big impact on replanted tree and orchard performance. The site in Tasmania, located on virgin soil, as expected, indicated that 'Stallion' / 'Colt' produces a slightly smaller tree to 'F12/1' and all the other new dwarfing rootstocks were indeed dwarfing compared to 'F12/1'. In the other two growing districts, in freshly replanted orchards, the growth rate of trees on 'F12/1' was extremely poor and often worse than either 'Stallion' or the new Dwarfing rootstocks. Further targeted research is needed to quantify the resistance of the new rootstocks to cherry replant disorder to confirm this hypothesis for the site to site variation in the growth response.

If the hypothesis for the existence of cherry replant disorder is correct, temporarily it would appear that the published level of dwarfing, compared to 'F12/1' for the GiSelA rootstocks (Gi5 and Gi6) is averaged across orchards with and without replant disorder and due to their relative resistance to replant disorder, the level of dwarfing is greater for trees in virgin soil. Hence, in virgin soil it may be necessary to increase tree planting density of these cultivars compared to 'F12/1' to obtain the desired canopy density. Conversely it would appear that the published level of dwarfing of the Krymsk rootstocks (K5 and K6) is correct for virgin soil, however, if used in replant situations will be more vigorous than expected compared to 'F12/1' in this situation so a lower tree density may be utilized to obtain the desired canopy volume.

Keywords

Cherries, *Prunus avium*, rootstocks, Giesela, Krymsk, orchard establishment, tree performance, Tree growth.

Introduction

The choice of rootstock in tree fruits is critical for the commercial viability and productivity of the orchard. From the apple industry it is known that rootstocks have an impact on tree size, light penetration, pest resistance, productivity and fruit quality. In Australia, while these effects are well known for most rootstocks in the apple industry this information is lacking for the recently introduced cherry rootstocks. This project was designed to generate this information and investigate the use of bench grafted trees in orchard establishment to reduce the cost of planting and as a means of rapidly establishing the new rootstocks in industry.

In the cherry industry the choice of rootstocks in Australia has been limited and most orchards are based on 'Mazzard F12/1' or 'Colt'. Unfortunately both 'Colt' and 'Mazzard F12/1' are vigorous leading to large trees that take a few years to start producing fruit after they are planted. Considering that cherry trees require bird netting the slow return on the investment in planting an orchard is detrimental to overall orchard economic performance. Further, large trees require ladders or elevated platforms for picking and other management practices increasing the costs of production. While training methods such as Spanish Bush attempt to maintain a small tree size this has not always been successful and a ready supply of dwarf and productive rootstocks is required for industry.

Fortunately, in recent years there have been importations of new dwarf cherry rootstocks and these are starting to become available to industry. From Grahams Factree cherry trees on 'GiSelA5' (Gi5) and 'GiSelA6' (Gi6) rootstocks are now being offered while from the ANFIC group of nurseries the Krymsk range of rootstocks have become available in the past two years.

From the FacTree website for the GiSelA rootstocks, bred in Germany, Gi5 rootstocks are the most dwarfing of the two and produce trees about 45 percent the size of 'F12/1' while Gi6 produces trees that are about 70 percent the size of 'F12/1'. Both induce early production of fruit although both are prone to over cropping resulting in loss of tree vigor.

From the ANFIC website for the Krymsk rootstocks, which originated in Russia, 'Krymsk5' (K5) is a tree of about 90 percent the size of 'F12/1' and 'Krymsk6' (K6) is about 75 percent the size of 'F12/1'. In overseas research it has been shown that the Krymsk rootstocks are more precocious than the other cherry rootstocks and in the Netherlands it has been shown that K6 has high yields per trunk cross sectional area (Balkhoven and Maas 2008, Maas et al 2014). The Krymsk range of rootstocks tolerate wet soils well and are reported to tolerate hot growing conditions.

The study in the Netherlands is the only scientific research that compares the GiSelA rootstocks with the Krymsk rootstocks. These studies were carried out from 2002 till 2008 with cherry rootstocks Gi5, K5, and K6. The highest crop yield (18.9 kg/tree) was obtained from K6 compared to 14.4 and 15.5 kg/tree for Gi5 and K5, respectively. Gi5 produced the heaviest cherries, 12.0 g compared to 10.7 and 11.2 g for K6 and K5 respectively and cherries from K6 showed reduced cracking in the wet summer of 2007. Root suckers were more common in Krymsk, especially K5, although they were more suitable for wet growing conditions than Gi5. In this study it was found that K5 was prone to burr knots at the graft union but these could only be observed when the bark was removed.

Methodology

Thirty rootstocks each of the Gi5 and Gi6 GiSelA series were obtained from Graham's Factree in the winter of 2011. Rootstocks of Mazzard 'F12/1', 'Stallion' ('Colt') and K5 were provided by Tahune Fields Nursery. These rootstocks were grafted to 'Belise' and 'Simcoe' cherries during the winter of 2012. It was planned to graft these cultivars to K6 as well but no large K6 rootstocks were obtained in the first season after release from quarantine.

In the nursery while the graft take for Mazzard 'F12/1' was excellent (95%) the same was not true for the new rootstocks with no successful trees being established for Simcoe on K5 and very poor results of this cultivar on the GiSelA rootstocks. As the use of two cultivars was a risk management practice for this situation and given the limited quantity of rootstock material in Australia was limited it was decided to discontinue the studies on 'Simcoe' and use the spare rootstocks for studies on orchard establishment with bench grafts, as being requested by industry.

The nursery trees were dug from the nursery as two year old trees in the winter of 2014 and established in identical orchard trials in the Derwent Valley of Tasmania (virgin soil site), at Cobram in Victoria and at Young in NSW (both recent orchard replant sites). As well in these orchard trials newly propagated rootstocks were bench grafted, in the field, to 'Bellise' and planted at the sites. These benchgrafted trees included rootstocks of 'Mazzard F1/12', Stallion, Gi5, Gi6, K5 and K6 providing a complete set of rootstocks for comparison. At each site the trials were laid out as random complete block designs with four replicates and two trees per plot.

Data was collected, after two years of growth in the orchard, on tree survival, canopy volume (tree height by width) and trunk cross sectional area above the graft union. It was planned to measure yield and fruit quality during the third season in the orchard, however, due to poor fruit set conditions across Australia during the spring of 2016 (cold, wet and frosty) there was no fruit set during this season.

It had been planned to statistically analyze the data using the analysis of variance, however, due to poor tree survival with the bench grafted trees this was not possible and alternative statistical procedures were used to extract the desired information. For a comparison of the impact of using bench grafted trees or two year old nursery trees data where trees existed on the same rootstock by the two different propagation methods at the different sites were compared. This data was statistically analyzed by the Students 'T' test method. For the analysis of rootstock effects on tree growth two methods were used. With the two year old nursery trees, where there was a complete data set at all sites, data was analyzed by split plot analysis of variance with location as the whole plots to detect rootstock affects and locational differences and interactions between rootstocks and location. Sufficient bench grafted trees existed at each site to allow for an analysis of variance with the sites as replicates in space. This approach did not allow for statistical analysis of site to site affects or rootstock by site interactions.

Two publications for the industry magazine were written and submitted for publication.

Outputs

1) Knowledge of orchard establishment issues when bench grafts of the new dwarfing rootstocks are used for orchard establishment.

Two year old nursery trees cost growers approximately $15 each representing approximately $38,000/Ha of orchard establishment costs. An alternative approach is to use bench grafted trees at an approximate cost of $5 each resulting in a cost of $13,000/Ha, a saving of $25,000/Ha. Using existing vigorous rootstocks in orchard graft take is commonly above 80%. This necessitates subsequent minor orchard budding of the rootstocks where the graft was not successful slightly adding to the cost and delaying orchard development. However, if this process allows for orchard establishment of new cultivars prior to normal release from nurseries it can be financially beneficial to the grower. If graft take of a new rootstock is inherently poor though this approach is not desirable as it leads to substantially increased costs and poor orchard establishment. This project investigated this method of orchard establishment and identified that the new dwarfing rootstocks have poor in orchard graft take, below 50%, making the approach non-viable as a means of early, inexpensive orchard establishment.

2) Comparative information on the early orchard tree growth of new cherry rootstocks in three Australian cherry growing districts.

The early development of the fruiting canopy is essential for early high yields of fruit in the orchard. As dwarfing rootstocks have desirable characters for mature orchards, their low growth rate and small ultimate individual tree size means that more trees per hectare are needed to ensure optimal orchard canopy cover and productivity. The site in Tasmania, located on virgin soil, as expected, indicated that 'Stallion' / 'Colt' produces a slightly smaller tree to 'F12/1' and all the other new dwarfing rootstocks were indeed dwarfing compared to 'F12/1'. In the other two growing districts, in freshly replanted orchards, the growth rate of trees on 'F12/1' was extremely poor and often worse than either 'Stallion' or the new Dwarfing rootstocks. Averaged across the sites the data for tree canopy size and trunk cross sectional area clearly showed that after two years of orchard growth, Gi5 resulted in trees that were about 60 percent the size of the industry standard 'F12/1'. Trees on Gi6 were also reduced in size at about 75 percent that of 'F12/1'. These levels of dwarfing are similar to those published on the FacTree website for cherry rootstocks. The K5 rootstock, the most vigorous of the new dwarfing rootstocks, had no dwarfing character compared to 'F12/1' at both the Victorian and NSW sites and averaged across the three sites produced a tree that was about 20 percent larger than 'F12/1'. The ANFIC website indicates that this cultivar should be about 90 percent the size of 'F12/1', and this was the level of dwarfing found at the Tasmanian site planted on virgin soil. A similar result was found for the more dwarfing K6 rootstock suggesting that cherry replant disorder existed at the Victorian and NSW trial sites.

3) Cherry replant disorder

An unexpected output of this project was the suggestion in the data that 'F12/1' is more susceptible to cherry replant disorder than either 'Stallion' / 'Colt' or the new dwarfing rootstocks. This is a hypothesis that needs to be confirmed with targeted research but if true is very valuable information for the cherry industry.

4) Demonstration sites in three growing locations where growers can compare the performance of the different rootstocks

Trials have been successfully established in Young, Cobram and the Derwent Valley. As these trees mature over the coming 5 years and bear fruit these trial sites will become a valuable resource for industry to comparatively observe the different rootstocks growing side by side. As this project is terminating prior to this level of tree maturity this activity is outside the scope of this project. This activity was planned to be incorporated into a follow up project to monitor tree performance as they matured.

5) Articles explaining the different performance of the rootstocks in the industry magazine

Two grower orientated articles have been written and submitted to the publisher of Cherry, the industry magazine. One article (Appendix I) was on the use of bench grafts for orchard establishment and the follow up article (Appendix II) provided information on the growth performance of the rootstocks after 2 years in commercial orchard environments.

Outcomes

When considering planting or replanting an orchard a primary source of advice growers almost always use when selecting their rootstocks is obtained from their nursery suppliers. This project has provided its results to the major nursery tree suppliers to assist them in adjusting their advice to growers.

1) Tree size and planting density

This project had one main target outcome, as specified in the contracted project agreement, 'knowledge in industry to allow for informed decisions as to choice of rootstocks for cherries in future plantings and experience at correct management practices'. This project has demonstrated to industry that the GiSelA rootstocks are indeed dwarfing, with Gi5 reducing canopy size by 60 percent and Gi6 by 75 percent averaged across the test sites. This means that it will be easier to maintain the orchards as pedestrian workplaces than trees growing on the industry standard 'F12/1' and that with sound tree training methods it will be possible to maintain an orchard where ladder work is totally avoided. It also indicates that in order to adequately fill the space within a row Gi5 tree density should be planted with 70 percent more trees than a comparable orchard on 'F1/12' while Gi6 should be planted with 30 percent more trees. This means that if an orchardist normally plants cherry trees on 'F12/1' at 3000 trees/Ha then this should be 5,000 trees/Ha for trees on Gi5 and 4000 trees/Ha for trees on Gi6. This degree of dwarfing aligns with that stated on the Grahams FacTree website, the sole supplier of these rootstocks. This project has identified a potential interaction of level of dwarfing and cherry replant disorders (see below) which, if correct, indicates that these planting densities need to be adjusted for virgin or replant soils. Averaged across these sites K5, the most vigorous of the dwarfing rootstocks studied, would appear to be slightly more vigorous than 'F12/1' rather than slightly smaller as stated on ANFIC's website. This discrepancy to the published level of dwarfing may again prove to be related to a cherry replant disorder. The published level of dwarfing for both K5 and K6 would appear to be correct for plantings in virgin soil however in replant situations, the rootstocks are relatively resistant to replant disorders compared to 'F12/1' resulting in more vigorous growth than anticipated. Hence, as for the GiSelA series the planting densities need to be adjusted for virgin or replant soils. ANFIC has been advised of this finding and Tahune Nursery, the ANFIC nursery who financially contributed to this project is aware of these results and has adjusted their recommendations to industry accordingly.

2) The use of bench grafted trees to establish an orchard.

In addition to the above planned outcome an additional outcome was achieved. Some members of industry wanted to use bench grafted trees to rapidly establish orchards using the new rootstocks. This project clearly demonstrated that this approach is not as successful as when 'F12/1' or 'Stallion' / 'Colt' is used and the success of the approach was extremely poor for all dwarfing rootstocks studied. As such rootstocks were not provided to industry for this purpose to ensure growers were not disappointed.

3) Potential indication of rootstock susceptibility to cherry replant disorders.

While not a deliberate intent to study cherry replant disorders the trial sites were chosen to represent a range of cherry orchards in Australia. The fortunate selection of one site planted on virgin soil provides an indication of the rootstock resistance to cherry replant disorder. The trees growing on the site planted on virgin soil demonstrated that the new rootstocks are indeed dwarfing in this situation. The two sites planted on replant soil, however, indicated that the industry standard 'F12/1' is extremely susceptible to cherry replant disorder while the dwarfing rootstocks are more resistant and may develop trees with larger canopies to the 'F/12/1' industry standard. The second industry standard, 'Stallion' / 'Colt' would appear to also be relatively resistant to cherry replant disorder. Observation of 'Stallion' / 'Colt's resistance to cherry replant disorder has been made by growers and is documented on the FacTree website. While further targeted research is required to confirm and quantify this observation it is prudent for the nurseries to recommend 'Stallion' / 'Colt' or the new dwarfing rootstocks in replant situations and adjust suggested tree densities until further information is known.

Evaluation and Discussion

The use of bench grafted trees in the field for orchard establishment

Appendix I details results on the use of bench grafted trees as an inexpensive method of rapidly establishing new orchards on the new rootstocks. In summary figure 1 clearly shows that orchard establishment of bench grafted trees was well below the two industry standards 'Stallion' and 'F12/1'. This was particularly true for the GiSelA rootstocks used in this trial. This level of establishment would lead to large numbers of trees needing to be top worked in the following season at a large expense to the grower and would lead to extreme tree to tree variation in size and management practices in the first few years of orchard life. As such this method of orchard establishment could not be recommended to industry.

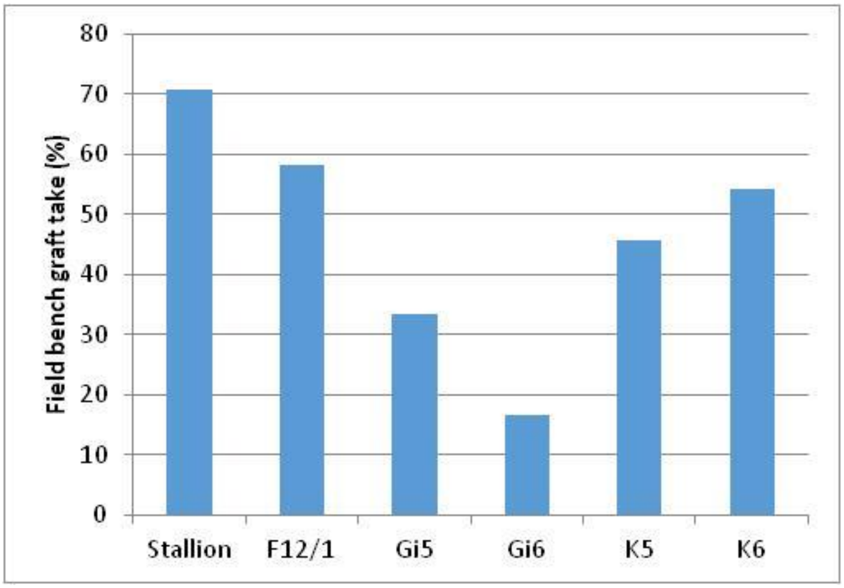

figure 1. Tree establishment on 6 different rootstocks for bench grafted trees in the field at 3 different orchards, after 2 years of orchard growth.

Appendix 2 covers the growth performance of the rootstocks in developing the fruiting frame after the first 2 seasons in the orchard.

For this study tree growth data for the two year old trees were averaged across the rootstocks and these were compared with the average growth data for the same cultivars from bench grafted trees at each site. The probability that the results were different was calculated from the paired Students T test using the average data for each rootstock at each site (12 pairs of trees).

This analysis showed that the use of trees that were bench grafted before planting produced trees, after two years of growth, that were 20 to 30 percent smaller than those from two year old nursery trees at the time of planting (table 1). Hence, if using bench grafted trees to reduce orchard establishment costs, apart from issues of graft take, the orchard trees will be smaller in the initial years with potential to reduce the gross income from fruit in the first season of cropping.

Table 1 The impact of using two year old trees versus bench graft trees to establish orchards at three sites on subsequent tree framework development after 2 years of growth.

	Benchgraft trees	Two year old nursery trees	Statistically different (T test)
Tree height (m)	1.6	1.7	Not different
Tree width (m)	1.0	1.3	**
Tree cross section (HxW m^2)	1.8	2.3	*
Tree H/W ratio	1.8	1.5	**
Trunk cross sectional area (cm^2)	1.3	1.8	*

* declared different at p=0.05 and ** declared different at p=0.01 (with 95 and 99% confidence respectively).

Rootstock effects on subsequent tree growth - two year old nursery trees

The finding that the trees from bench grafts were smaller than the trees from two year old rootstocks along with the uneven replication from poor graft take prevented a statistical growth analysis incorporating data from the bench grafted trees. A complete set of trees, in four replicates had established from the two year old nursery trees at each site allowing for statistical analysis (split plot analysis of variance where the whole plots, site, could not be randomized within the replicate).

Averaged across the sites the data for tree canopy size and trunk cross sectional area clearly showed that after two years of orchard growth, Gi5 resulted in trees that were about 60 percent the size of the industry standard 'F12/1 '(figure 2). Trees on Gi6 were also reduced in size and were about 75 percent that of 'F12/1'. These levels of dwarfing are similar to those published on the FacTree website for cherry rootstocks and these results confirm this information. The K5 rootstock, the most vigorous of the dwarfing rootstocks studied, had no dwarfing character as published on the ANFIC website and rather than produce a tree that was slightly smaller, produced a tree on average about 20 percent larger than 'F12/1'.

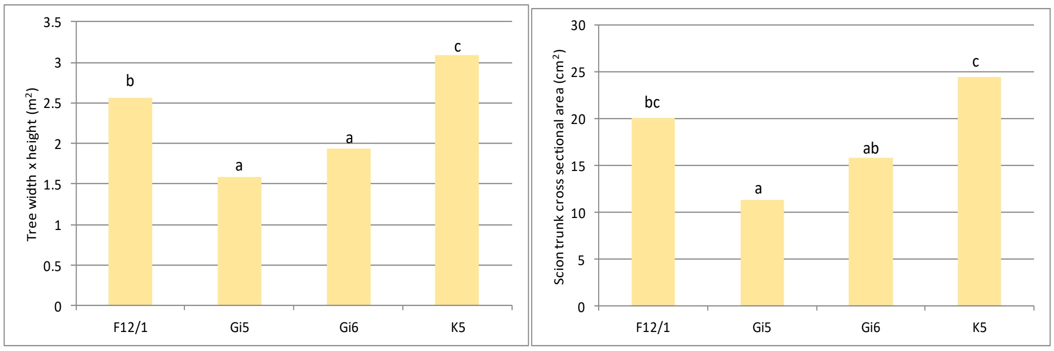

Figure 2. The impact of rootstock on tree size (foliar height x width and scion trunk cross sectional area) after two years of growth in the orchard. Columns with the same letter not considered different by LSD at p = 0.05.

Unfortunately the story is not that simple as there was a site by rootstock interaction detected in the data analysis. This means that the rootstocks did not perform in the same manner at the different sites.

While this study was not designed to study the impact of replant disorder on the different rootstocks, it may be that the different rootstock responses in the orchard sites was a result of this disorder. Only the Derwent site was planted into virgin soil that had been pasture for decades before planting. The other two sites were on old orchards that had been freshly removed.

At the Derwent site (planted into virgin soil) all the new rootstocks were dwarfing as anticipated (Figure 3). At the other two sites (replant sites) the 'F12/1' was not as vigorous as anticipated compared to the new rootstocks. Further at the Derwent site Gi5 and Gi6 were smaller than anticipated from the nursery website and K5 was slightly smaller than 'F12/1' as anticipated although at the other two sites it was more vigorous than 'F12/1'. If correct this data suggests that 'F12/1' is particularly prone to cherry replant disorder and that the new dwarfing rootstocks are relatively resistant to it. It would also appear that the GiSelA rootstocks are more dwarfing than indicated on the FacTree website when planted into virgin soil sites. If true this needs to be taken into consideration when recommending tree density into new locations. Targeted research is needed to confirm and quantify the new dwarfing rootstocks resistance to cherry replant disorder.

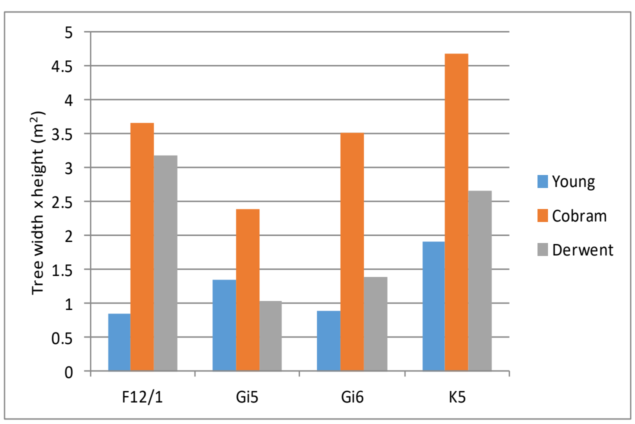

Figure 3. Canopy size, after two years of orchard growth, of cherries on different rootstocks at different sites (any two means more than 1m^2 different considered different by LSD at p = 0.05).

Initial data on fruit yield and quality was programmed for collection from the 2016/17 season, however, fruit set was extremely poor at all sites and no fruit was available for harvest. Unfortunately funding for this project terminates in 2017 and data from harvests in later years, as the trees mature, will probably not be collected and reported.

Rootstock effects on subsequent tree growth - bench grafted trees

The data discussed above on the two year old nursery trees did not include information on one of the dwarfing rootstocks, K6, nor the other industry standard, 'Colt' / 'Stallion'. This data was available for the bench grafted trees and is presented here.

The extremely large variation observed in this data set, possibly due to a site by rootstock interaction as detected in the two year old trees above, resulted in the statistical analysis unable to differentiate any rootstock impacts on canopy volume. Of note, however, is that the tree sizes for 'F12/1', Gi5, Gi6 and K5 indicate similar growth performance patterns to the growth response of the two year old nursery trees (Figure 4). This data also suggests that K6 produces a tree marginally smaller than K5 and that all the dwarfing rootstocks produce trees smaller than the 'Stallion' / 'Colt' industry standard. In these trials 'Stallion' / 'Colt' appears to have had substantially more vigor than 'F12/1'. Studying the individual site data it was found that 'Stallion' / 'Colt' was slightly smaller than 'F12/1' at the Derwent site on virgin soil as expected although at the two replant sites it was more vigorous, again suggesting that 'F12/1' is very prone to cherry replant disorder and not advisable for use in replant situations while 'Stallion' / 'Colt' is relatively resistant to it.

While further research is needed to verify and quantify the various rootstocks resistance to cherry replant disorder. If this hypothesis is correct, however, temporarily it would appear that the published level of dwarfing, compared to 'F12/1' for the GiSelA rootstocks (Gi5 and Gi6) is averaged across orchards with and without replant disorder and due to their relative resistance to replant disorder, the level of dwarfing is greater for trees in virgin soil. Hence, in virgin soil it may be necessary to increase tree planting density compared to 'F12/1' to obtain the desired canopy density. Conversely it would appear that the published level of dwarfing of the Krymsk rootstocks (K5 and K6) is correct for virgin soil, however, if used in replant situations will be more vigorous than expected compared to 'F12/1' so a lower tree density may be utilized compared to 'F12/1' in replant situations to obtain the desired canopy volume.

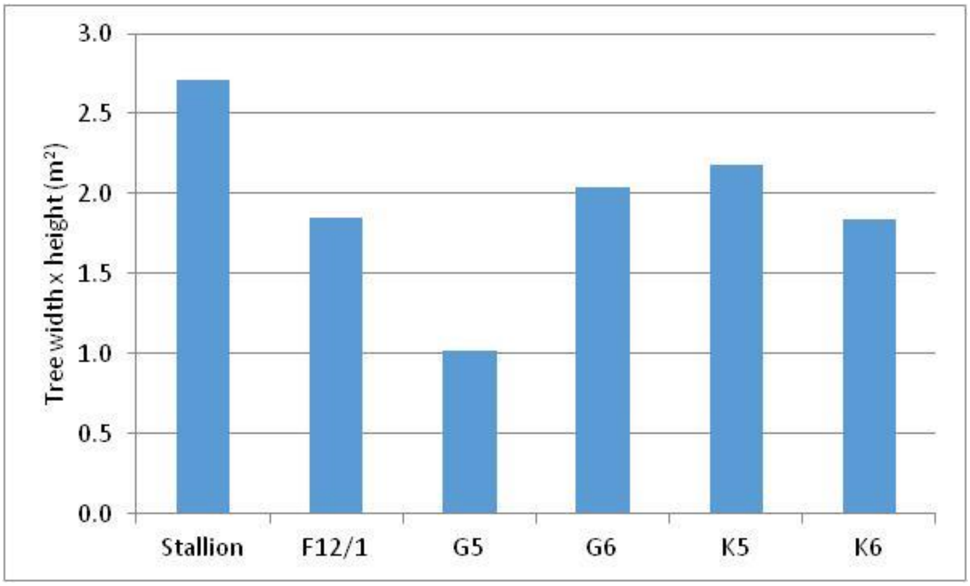

Figure 4. Canopy size, after two years of orchard growth, of cherries of bench grafted trees on different rootstocks at three sites. (any two means more than 1.7m^2 different considered different by LSD at p = 0.05)

In the fruit industry the growers rely heavily on the nursery suppliers for advise on rootstock selection when planning for their new orchards. Hence ensuring the nursery managers are aware of the results to aid them in correct grower advice is a very effective means of extending information on rootstocks to industry. Throughout this project Brendon Francis of Tahune Nursery has been involved with project operation and decision making and been involved in the results and discussion. In addition the ANFIC CEO has read and approved all articles associated with the project so is fully aware of results to date. In a similar manner Graham Fleming and Tony Wilcox from Grahams FacTree, the second major supplier of cherry trees to industry have also read and approved all articles for publication so they are equally aware and using the knowledge gained to provide advice to their growers.

Recommendations

This project has shown that:

- Establishment of orchards with inexpensive bench grafted trees is problematic with poor graft take which means that many trees will need regrafting or replanting in the following season at additional cost to the orchard. For this reason it is recommended that growers purchase established nursery trees rather than propagating their own for establishing new orchards.
- Orchards established from bench grafted trees will be 20 percent smaller than traditional nursery trees after two seasons of growth with a potential negative impact on the size of the first crop and hence on orchard income stream. If small trees are to be used for establishing an orchard it is recommended that the orchard budget be modified to reflect the delayed start of harvest.
- The GiSelA rootstocks have a dwarfing character with Gi5 and Gi6 on average producing trees, after two seasons of growth, 60 and 75 percent the size of F12/1 respectively. This data verifies the information being provided to growers such that they can accurately increase their planting density to compensate for smaller canopy volume per tree.
- When planted into virgin soil the K5 has a slight dwarfing character and K6 has a mild dwarfing character in line with the published information for these rootstocks. In this situation the information being provided to growers is correct such that they can accurately increase their planting density to compensate for smaller canopy volume per tree.
- There is site to site difference in rootstock effects on tree frame development indicating that rootstock effects on tree size and performance will be site specific. There is a suggestion in the data that this may be due to cherry replant disorder. It appears as though 'F12/1' is particularly susceptible to this disorder and cannot be recommended for replant situations although the second industry standard, 'Stallion' / 'Colt', appears to be relatively tolerant of the disorder. It also appears as though all the new dwarfing rootstocks are relatively resistant to the disorder compared to 'F12/1'. Hence when recommending rootstocks to industry for replant situations nurserymen need to avoid 'F12/1', however, the data suggests that any of the new dwarfing rootstocks as well as 'Stallion' / 'Colt' could be recommended with an adjustment to orchard tree density to ensure optimal tree canopy volume.

Scientific Refereed Publications

None

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Intellectual Property/Commercialisation

'No commercial IP generated

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Hansen Orchards, Derwent Valley orchard trial site

Boosey Fruits, Cobram orchard trial site

Cherry Export Australia, Young orchard trial site

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Appendices

Appendix I

Graftability and orchard establishment of GiSelA^{tm} and Krymsk^{tm} cherry rootstocks

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During the winter of 2012 a trial was initiated to compare the performance of recently introduced precocious cherry rootstocks under Australian conditions. This research was funded by Tahune Fields Nursery with matched funding through HAL (now Hort Innovation). During the first winter rootstocks of GiSelA^{tm} 5 and 6 were obtained from Grahams FacTree and Krymsk^{tm} 5 and Mazzard F12/1 from Tahune Fields Nursery. These were bench grafted to Bellise^{tm} and grown in the nursery for the following 2 years. It was planned to incorporate Krymsk^{tm} 6 however no large graftable rootstocks existed in 2012 and only young tissue culture plants were available. These were planted out and grown on for incorporation into the trial at a later date.

GiSelA^{tm} 5 (Gi5)

Is a cross between *Prunus cerasus* (sour cherry) and *P. canescens* (greyleaf cherry) and is reported to produce trees about 45% the size of F12/1. It is a very precocious dwarfing rootstock that shows adaptablility to a range of soil types and produces a tree with wide branch angles.

GiSelA^{tm} 6 (Gi6)

Is also a cross between *P. cerasus* (sour cherry) and *P. canescens* (greyleaf cherry) which produces trees about 70% the size of F12/1. It is a precocious, semi-dwarfing rootstock that produces an open, round tree structure which is reported to do well on heavier soils.

Krymsk ^{tm} 5 (K5)

Is a cross between *P. fruiticosa* (Mongolian cherry) and *P. lannesiana* (Japanese cherry) and is reported to produce trees about 90% the size of F12/1. The advantage of K5 over existing cherry rootstocks is its precocious nature.

Krymsk ^{tm} 6 (K6)

Is a cross between *P. cerasus* and a *P. cerasus* by *P. maackii* hybrid which produces trees about 75% the size of F12/1. As for K5 it is more precocious than either F12/1 or Stallion / Colt.

Stallion^{tm} or Colt^{tm}

Is a cross between *P. avium* (sweet cherry) and *P. pseudocerasus* (Cambridge cherry) and it is reported to be slightly smaller than F12/1. It induces early cherry production on young trees and is tolerant of wet soils and useful in cherry orchard replant situations.

Bench graft take, in the nursery, of the GiSelA rootstocks was poor, especially for the Gi5 trees (table 1). This poor graft take presents problems for nurseries as it slows down the production of trees making them expensive, slow to release to industry and difficult to ensure all advanced orders are adequately filled. For these trials however, sufficient trees were established to allow for a complete set of rootstocks to be incorporated into 3 trials each with 4 replicates. These trees were grown for a second season in the nursery prior to planting out in three different orchards, as 2 year old nursery trees, in the winter of 2014. When trees were assessed in the winter of 2016 it was determined that 98% had successfully established confirming no orchard establishment problems with 2 year old nursery trees.

Table 1. Success of bench grafted nursery trees (2012)

Mazzard F12/1	92%
Gi5	64%
Gi6	80%
K5	95%

Using bench grafted trees for planting out reduces the tree cost of orchard establishment and potentially all ows for rapid production of new cherry cultivars. For the rootstocks that had not been successfully grafted in the nursery in 2012 these were grown on for bench grafting, along with K6 rootstocks in 2014, within 30 minutes of being planting directly into the three experimental orchards. This allowed for a study of the efficiency of using 2 year old nursery trees versus bench grafted trees for orchard establishment.


Figure 1. Rootstock trial row at Cobram, Victoria.

As for in nursery grafting, the success of using bench grafted trees for establishing an orchard were extremely poor for all rootstocks (figure 2) with graft takes well below those encountered in the Nursery. This means that for all rootstocks this inexpensive method of orchard establishment will need reworking and replanting in the following season increasing the cost of orchard establishment, increasing tree to tree variation and potentially decreasing the time to full orchard production and profitability. Of note that averaged across the three orchards the GiSelA rootstocks had less than 30% successful take and the Krymsk rootstocks had between 40 and 55% such that the use of bench grafts for establishing orchards on these new rootstocks would be especially problematic. This compares to 98% success when using 2 year old nursery grown trees.

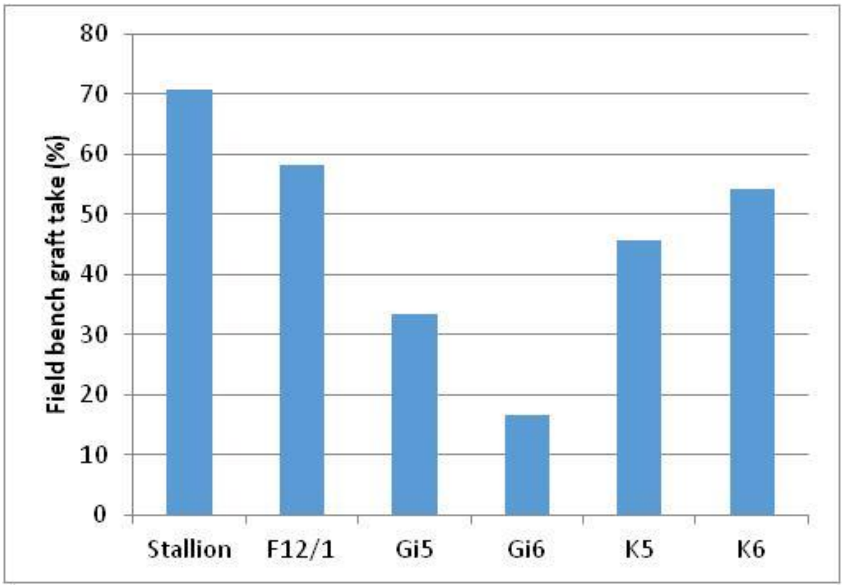

Figure 2. Graft take of rootstocks for bench grafted trees prior to planting out in 3 different orchards, after 2 years of orchard growth.

It was found that there was a huge orchard to orchard effect on graft take with the orchard at Young having on average 65% graft success while the orchard, bench grafted and planted on the previous day at Cobram having only 29% graft take while the orchard in southern Tasmania, grafted two weeks earlier, was between the other two sites with 46% graft take. This variation indicates that there is potential for research to reveal methods of handling trees to ensure high graft take which might make this alternative inexpensive method of orchard establishment viable.

Data on tree growth performance will be presented in a subsequent article and data on yield and quality of fruit in the 2016/17 season will be collected and published in 2017.

Acknowledgements

Hansen Orchards, Derwent Valley orchard trial site

Boosey Fruits, Cobram orchard trial site

Cherry Export Australia, Young orchard trial site

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Appendix II

Early tree growth of Bellise cherries on GiSelA^{tm} and Krymsk^{tm} cherry rootstocks in Australia

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This project aimed at studying the impact of using newly released cherry rootstocks on establishing a new orchard using bench grafts instead of 2 year old nursery trees, the effect of these new rootstocks on tree frame development and finally their influence on early fruit yield. In an earlier article it was identified that graft take on the newly released rootstocks is not as easy or successful as on the traditional rootstocks F12/1 and Stallion / Colt. This means that the use of bench grafts for establishing orchards is problematic and not desirable. This article will focus on the tree frame development of the 2 year old nursery trees and the bench grafted trees after two seasons of growth in the three test orchards used in the study.

As mentioned above there was an extremely high rate of unsuccessful graft take where bench grafts were used. As a result there were no successful bench grafted trees on Gi5 at the Cobram site and no trees on Gi6 at the Young site with only the Derwent site having at least one representative of all the rootstocks. While there were enough trees for a reliable comparison of the impact of using bench grafted trees versus two year old nursery trees for tree frame development the analysis of rootstock effects on tree growth was severely compromised for the bench grafted trees. Hence for this analysis of tree frame development only the trees established on two year old nursery trees were used to ensure reliable results.

For the assessment of tree growth measurements were taken of trunk cross sectional area above the graft union and calibrated images were used to measure the total tree height and width viewed from the neighboring tree row.

Bench graft trees versus two year old nursery trees.

For this study tree growth data for the two year old trees were averaged across the rootstocks and these were compared with the average growth data for the same cultivars from bench grafted trees at each site. The probability that the results were different was calculated from the paired Students T test using the average data for each rootstock at each site (12 pairs of trees).

This analysis showed that the use of trees that were bench grafted before planting produced trees, after two years of growth, that were 20 to 30 percent smaller than those from two year old nursery trees at the time of planting (table 1). Hence, if using bench grafted trees to reduce orchard establishment costs, apart from issues of graft take, the orchard trees will be smaller in the initial years with potential to reduce the gross income from fruit in the first season of cropping.

Table 1 The impact of using two year old trees versus bench graft trees to establish orchards at three sites on subsequent tree framework development after 2 years of growth.

	Benchgraft trees	Two year old nursery trees	Statistically different (T test)
Tree height (m)	1.6	1.7	Not different
Tree width (m)	1.0	1.3	**
Tree cross section (HxW m^2)	1.8	2.3	*
Tree H/W ratio	1.8	1.5	**
Trunk cross sectional area (cm^2)	1.3	1.8	*

* declared different at p=0.05 and ** declared different at p=0.01 (with 95 and 99% confidence respectively).

Rootstock effects on subsequent tree growth

The finding that the trees from bench grafts were smaller than the trees from two year old rootstocks along with uneven replication from poor graft take prevented a growth analysis incorporating data from the bench grafted trees. A complete set of trees, in four replicates had established from the two year old nursery trees at each site allowing for statistical analysis (split plot analysis of variance where the whole plots, site, could not be randomised within the replicate).

Averaged across the sites the data for tree canopy size and trunk cross sectional area clearly showed that after two years of orchard growth, Gi5 resulted in trees that were about 60% the size of the industry standard F12/1 (figure 1). Trees on Gi6 are also reduced in size and are about 75% that of F12/1. These levels of dwarfing are similar to those published on the FacTree website for cherry rootstocks. The Krymsk rootstock, however, had no dwarfing character in these trials and produced a tree that was about 20% larger than F12/1. The published benefit of this rootstock is improved tree fruitfulness such that it will be important to measure fruit yield and quality to determine the usefulness of this rootstock.

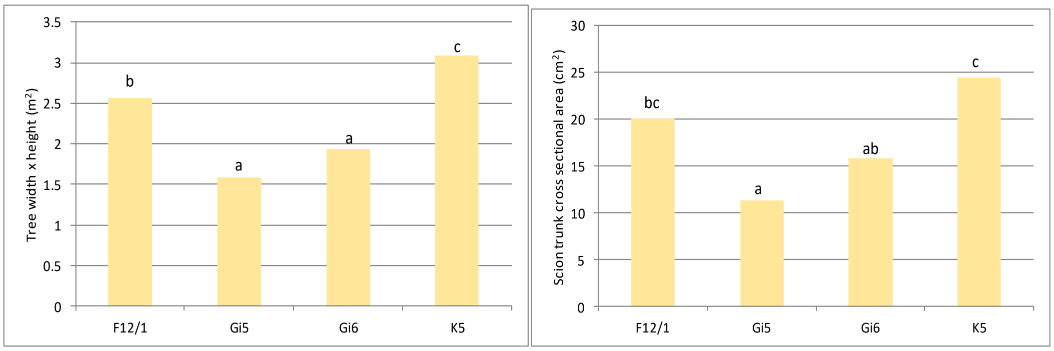

Figure 1. The impact of rootstock on tree size (foliar height x width and scion trunk cross sectional area) after two years of growth. Columns with the same letter not considered different by LSD at p = 0.05.

Unfortunately the story is not that simple as there was a site by rootstock interaction detected in the data analysis. This means that the rootstocks did not perform in the same manner at the different sites.

The first observable difference between the sites is the size of the trees (figure 2). Overall the trees at Young had poor growth compared to the other two sites. On closer examination it can be seen that F12/1 performed very poorly at the Young site while K5 was extremely vigorous at the Cobram site. Hence, assuming equal productivity, if dwarf trees are required then Gi5 would be chosen at Cobram, Gi5 or Gi6 could be used in the Derwent Valley and F12/1, Gi5 or Gi6 at Young. Another way of studying the site specificity of this data is that if a 2m^2 tree canopy is required after the first two seasons of growth then K5 should be chosen at Young, Gi5 at Cobram and Gi6 or K5 at the Derwent site.

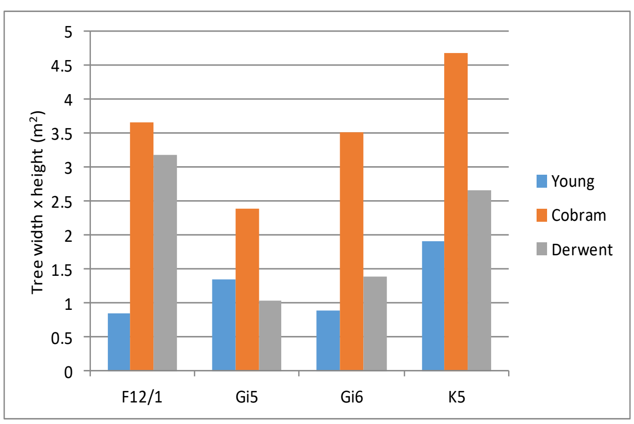

Figure 2. Canopy size, after two years of orchard growth, of cherries on different rootstocks at different sites (any two means more than 1m^2 different considered different by LSD at p = 0.05).

Ultimately, however, tree productivity is an important factor to consider when choosing rootstocks and while K5 does not make any real dwarfing claim it is claimed to induce the cherry trees to be very fruitful. Data on fruit yield and quality was programmed for collection from the 2016/17 season, however, fruit set was extremely poor at all sites and no fruit was available for harvest. Unfortunately funding for this project terminates in 2017 and data from harvests in later years, as the trees mature, will not be collected and reported.

Conclusions

This project has shown that:

- Establishment of orchards with inexpensive bench grafted trees is problematic with poor graft take which means that many trees will need regrafting or replanting in the following season at additional cost to the orchard.
- Orchards established from bench grafted trees will be 20 percent smaller than traditional nursery trees after two seasons of growth with a potential negative impact on the size of the first crop and hence on orchard income stream.
- The GiSelA rootstocks have a dwarfing character with Gi5 and Gi6 on average producing trees, after two seasons of growth, 60 and 75 percent the size of F12/1 respectively.
- Krymsk 5 trees appear to be about 20 percent more vigorous than F12/1 although they are stated as being more precocious so the impacts on fruit yield to be studied later this season will be important for this rootstock.
- There is site to site difference in rootstock effects on tree frame development indicating that rootstock effects on tree performance will be site specific requiring individual testing to be tailored for each orchard and there is no generic 'best rootstock' in this group of rootstocks.

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