Variety Improvement for Canning Peaches

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SPC Ardmona Operations Limited

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Variety Improvement Program for Canning Peaches

Susanna Turpin et al.

State Government Victoria
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Horticulture Australia Project CF08003 (2009)
Variety Improvement Program for Canning Peaches

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The yellow-fleshed canning peach breeding program commenced in 1993. This report details progress from September 2008 to September 2009 in which the breeding and evaluation site was transferred from DPI, Tatura to Toolamba, the productivity evaluations completed on current selections and recommendations made to Industry on new peach varieties.

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Media Summary

New canning peach varieties that deliver improved quality and greater yields are vital to the survival of the Australian canned fruit industry.

The benefits of improved varieties have been clearly demonstrated with the success of Tatura 204 from the previous Department of Primary Industries (DPI) Tatura breeding program in the 1970's and 1980's. Tatura 204 reset the benchmark for fruit quality and productivity with a ten percent increase in pack-out rate and six percent annual increase in production. Tatura 204 also enabled the development of new product lines within the cannery because of its improved quality.

Over the last 15 years DPI Tatura has developed a new series of peaches with characteristics similar to the standard canning variety Tatura 204. These new canning peaches will even out the peaks in fruit supply to the cannery, and be adaptable to global climatic changes.

A large emphasis of the breeding program has been on improving the high productivity standard set by Tatura 204. Productivity evaluations have been made at low to high crop loads to determine the ability of each selection to produce fruit of a commercial size.

A new series of canning peach varieties has been recommended to SPC-Ardmona. They will be progressively released to the canning industry over the next 5 years as commercial trialling progresses. The first release is expected to be Tatura Blaze which ripens between Tatura 204 and Golden Queen.

After more than 7 decades of DPI research in the development of improved varieties of canning peaches for the Australian industry the breeding program closed in 2008. The Canning Industry through SPC-Ardmona will continue to breed peaches for future needs on a private basis at their new trial site. Peach germplasm required for future cross breeding has been transferred, along with recent selections still requiring further evaluation.

Technical summary

The consistent supply of high quality peaches, throughout the canning season, from productive and profitable orchards is integral to the sustainability of a viable and internationally competitive canning fruit industry. The Australian Canning Peach Breeding Program based at the Department of Primary Industries, Tatura has produced over two-thirds of the varieties currently used by the Australian Canning Industry, and has been developing a new series of peach cultivars over the last 15 years. A major aim of the breeding program was to maintain and improve upon the high productivity standard set by Tatura 204 and to determine the potential for genetic gain through reliable estimates of heritability.

In the first year of cropping the peach selections were compared to the control variety Tatura 204 at a low crop load of 15 fruit per tree. The crop load was increased to a medium level of 100 fruit per tree in 2007, and a high level of 200 fruit per tree in 2009. Selections were established on an Open-Tatura Trellis system at 1.5 x 4 m staggered double row tree spacing in 2004. A nearest neighbour experimental design with two blocks and eight single tree replicates was used with 270 selections and ten controls (Tatura 204, Tatura Noon, Golden Queen etc). The amount of fruit set and fruit removed from each tree was counted in November and the trees harvested in one to two picks when the majority of fruit was a bisque colour. Fruit less than canning size (60 mm) were removed to determine canning yield and the canning yield divided by the butt circumference area to determine canning yield efficiency (CYE).

There was genetic variation from Tatura 204 for the range of productivity traits including fruit weight, CYE, and fruit set based on their broad sense heritability. Approximately 11% of the selections had significantly higher CYE than Tatura 204 in 2009. These were the canning selections SAB 148, SAB 149, SAB 190, SAB 334, SAB 521, SAB 548, SAB 564, SAB 572, and SAB 603, and white-fleshed parental germplasm SAB 383 and SAB 393. Another 11% had significantly lower CYE and included Golden Queen and Tatura 222. Heritability of CYE was 33% and 38% respectively in 2008 and 2009. The heritability estimates were higher for fruit set and fruit size with values of 55% and 50% respectively in 2009. These intermediate heritability estimates indicate that the current method of evaluation is a good predictor of productivity. Narrow sense heritability estimates and genetic gain will be reported later in scientific papers encompassing these results.

The adaptability of new peach varieties to their climatic region is an important component of breeding programs. In the Goulburn Valley the accumulation of winter chill has varied erratically between 700 and 1000 chills hours over the last 20 years. Insufficient hours of chill can cause flower bud abscission, erratic foliation, and loss in fruit production. Two laterals from 4 replicates of each selection were collected weekly and buds forced at 20^{o}C for 3-4 weeks in 2009. Chill requirement was satisfied when 50% of buds reached balloon stage. Cumulative chill hours between 0 and 7.2^{o}C were calculated from the 1st May. The amount of hours below 7.2^{o}C required for these selections to break dormancy was between 580 and 680 hours (1070 – 1310 Utah chill units). The majority of these selections flowered between Tatura 204 and Golden Queen and the flowering period was similar to Tatura 204. Although the chill requirement of the majority of selections and controls were similar, the control Golden Queen, SAB 564 and SAB 572 varied in their speed of bud break and required 2-3 weeks for the buds to start to break compared to 1-2 weeks for peaches in the other chill groups. If the period of 'forcing' temperature had been restricted to 2 weeks the response curve of Golden Queen and the other selections in this chill group may have been more like those selections in the higher chill groups that Golden Queen traditionally represents. Hence the chill response of Golden Queen and SAB 564 and SAB 572 appears to be partly influenced by the methodology of the chill calculation.

Two elite selections, SAB 104 and SAB 145 progressed to third stage large-scale commercial trials, and SAB 572 will be distributed to grower trials in 2010. Provisional PBR protection has been placed on SAB 104 ("Tatura Blaze") which will be commercially released in 2010 if it continues to perform well in grower trials. The two varieties recently released from quarantine are recommended for future cross breeding to develop brown rot resistance within the Tatura germplasm from the Californian selection F8,5-159, and extension of the season with the Sicilian variety Gialla di Moavero.

Introduction

Evolution of canning peach breeding in Australia

Breeding and evaluation of canning peaches has been carried out at DPI Tatura since 1937. Many of the varieties grown in the Goulburn Valley in the 1940's and 1950's originated from California or were chance seedlings. Breeding efforts were initially directed at reducing problems with pre-harvest drop and improving fruit quality. The first commercial Tatura hybrids - Tatura Sunrise, Tatura Dawn, Tatura Sunset and Tatura Aurora - were released in 1960, and subsequently Tatura Noon in 1971 due to its popularity in grower trials. By the 1970's the variety Golden Queen, a chance seedling from New Zealand, had established itself as the industry benchmark. The majority of peach varieties grown were mid- to late-season because the earlier varieties were difficult to size, and an oversupply of Golden Queen type peaches to the canneries developed.

In 1971 a new breeding program was initiated at DPI Tatura using imported germplasm from the USA and South Africa. The canning industry required further gains in fruit productivity and quality, particularly in the early season time period, to balance out the high peak in supply of Golden Queen to the canneries. In the late 1980's the Tatura 200 series were released. Growers most rapidly adopted the early variety Tatura 204 because of its high productivity, superior canning quality, and price premium for early ripening. It became the new canning peach industry benchmark by replacing Golden Queen as the most planted variety in the Goulburn Valley. Over 250,000 trees of Tatura 204 have been planted since its release, and Tatura 204 now constitute about a third of the industry varieties. Another third of the industry varieties include the mid and mid-to late-season varieties Tatura 211 and Tatura 222.

In 1993 the Canning Industry again funded a new cycle of peach breeding at DPI Tatura. The major aim was to provide an even, high quality supply of peaches to SPC-Ardmona over the entire harvest period with traits similar to Tatura 204. Emphasis has been on the improvement in the high productivity standard set by Tatura 204 and to determine the potential for genetic gain through reliable estimates of heritability. The first release of new varieties from this program is expected to occur in 2010.

After more than 7 decades of DPI research in the development of improved varieties of canning peaches for the Australian industry the breeding program closed in 2008. The Canning Industry through SPC-Ardmona will continue to breed peaches for future needs on a private basis and drive the commercialisation of current cultivars released from the DPI program. This report details the transition of the program from DPI, Tatura to SPC-Ardmona.

Chill requirement

The adaptability of new peach varieties to their climatic region is an important component of breeding programs. In the Goulburn Valley the accumulation of winter chill has varied erratically between 700 and 1000 chills hours over the last 20 years. Insufficient hours of chill can cause flower bud abscission, erratic foliation, and loss in fruit production.

There are two main methods to determine bud chill requirement by either recording the percentage bud break during a specific period or by recording the speed of bud break to a specific stage of development under constant temperature conditions in the laboratory (Dennis, 2003). The method most relevant is determined by how well the laboratory data relates to bud break in the orchard. Generally the more chilling, the greater the percentage of bud break, and the greater the speed of bud break. There are also different models for determining chill requirement in fruit trees from the relatively simple model of Weinberger (1950) where 1 hour of temperature under 7.2^0C equals 1 chill unit, to more sophisticated models such as the Utah model. In the Utah model the value of the chill unit changes from 0 to 16^oC depending on the temperature, and negates accumulated hours with temperatures > 16^oC (Richardson et al., 1974).

Fruit productivity

Productivity of a peach variety is based on its ability to size a given amount of fruit over a given area. In addition to its genetic potential, its ability to size fruit is dependent upon the age and vigour of the tree and environmental and cultural influences. A fruit variety must also be able to set a crop consistently at or above the optimum crop load to maintain peak production. For a canning peach in the Goulburn Valley,

Australia, a tree is defined to be cropped at its optimum load when 90% of its fruit crop at maturity is more than 60 mm in diameter, the minimum size limit for processing. Formulas based on planting density and butt diameter (for the cultivar Golden Queen) have been developed to determine the required thinning levels at pit hardening for optimum productivity (Keatley et al., 1968). Productivity is an essential breeding criterion for the majority of plant breeding programs, for without a threshold level of yield their commercial production becomes non-viable. The heritability of productivity in terms of fruit yields is not known and intermediate for fruit mass in peach (Hansche, 1986; de Souza and Byrne, 1998).

Productivity evaluation is one of the most expensive and labour-intensive activities of a breeding program. This is why quicker and easier measures of fruit size and point scale estimates of crop loads are commonly used. In addition in fresh market breeding where the principal research has been conducted, productivity is less important than in processing fruit breeding. Where productivity is measured it's usually in terms of the amount of fruit per tree (Christensen, 1995), or maximum size of attainable fruit (Topp and Sherman, 1999) rather than a combined rating at which fruit number and fruit size is maximised. Consequently productive potential of new varieties from the majority of peach breeding programs is inadequately assessed. The size of heritability estimates are influenced by the accuracy of the phenotypic measurements (Hansche et al., 1972), and to determine the potential heritability of productivity more detailed and precise measurements of fruit productivity traits are required. Hansche et al. (1972) measured the heritability of crop load on a crude 1 to 9 scale and got a narrow sense heritability estimate of 8%. De Souza and Byrne (1998b) assessed fruit size based on dimensions and mass and found the highest measure of heritability was obtained with fruit mass at 32%. Fruit set was slightly improved at 43% (de Souza and Byrne, 1998a).

This report details the final results of intensive productivity evaluations conducted by DPI, Tatura over three years at low, medium and high crop loads, including recommendations of new peach varieties and heritability estimates on productivity traits.

Materials and Methods

Program objectives

The peach breeding program objectives are set by a steering committee who meets annually to review the project. The main objective of the breeding program is to develop new cultivars with productivity and quality characteristics similar to the standard canning peach cultivar Tatura 204 that will replace inferior cultivars initially mid and mid-late season.

Evaluation of chill requirement

Two laterals from 4 replicates of each selection were collected weekly and buds forced at 20^{o}C for 3-4 weeks. Chill requirement was satisfied when 50% of buds reached balloon stage. Cumulative chill hours between 0 and 7.2^{o}C were calculated from the 1st May. Corresponding Utah chill units were also calculated for comparison. The full bloom date and period of flowering was evaluated using the same 4 replicate trees in block 1 of the productivity trial (detailed below).

Productivity block establishment, management and evaluation at DPI, Tatura

Selections were established on a mini Open-Tatura Trellis system at 1.5 x 4 m staggered double row tree spacing in 2004. A nearest neighbour experimental design with two blocks and eight single tree replicates was used with 270 selections and ten controls (Tatura 204, Tatura Noon, Golden Queen etc).

Normal cultural practises were applied to the productivity block. Pheromones were placed in the blocks for oriental fruit moth (OFM), and OFM were monitored throughout the season. Weed competition was managed by strategic application of pre- and post-emergence herbicide. Water was applied through a micro-jet irrigation system and the soil moisture content monitored using tensiometers. Nitrogen fertiliser was applied in spring and post-harvest in autumn. The traffic lanes and headlands were sown down to ryegrass. The trees were annually pruned in July and thinned to a set crop load based on tree size in November.

The amount of fruit set and fruit removed from each tree was counted in November. The percentage pre-harvest drop in the week prior to harvest was recorded. The trees were harvested in one or two picks when the majority of fruit was a bisque colour. Gross yield was measured and the fruit graded into six size categories [<$2^{1/4"}$(<56mm), $2^{1/4"}$(56mm), $2^{3/8"}$(60mm), $2^{1/2"}$(63mm), $2^{5/8"}$(66mm) and >$2^{5/8"}$(>66mm)] following each pick. Blemished fruit and fruit less than canning size (≤ $2^{1/4"}$) were removed to determine canning yield.

Commercial evaluation sites

Six commercial evaluation sites for SAB 104 were established in 2006. The number of trees per site varied from 140 to 400 trees. The trials sites were all under a vase management system in which within row spacing and between row spacing varied from 2 – 3.3 m and 5 – 6 m respectively between sites. One commercial evaluation site for SAB 145 was established in 2008 of 275 trees, and a further 4 sites in 2009 from 100 to 400 trees. A further 1,000 SAB 145 trees and 1,000 SAB 572 trees were dormant budded onto virus-free rootstock (Elberta) in April 2009 for distribution to commercial evaluation sites in 2010. These trial sites will also be under a vase system, as it's considered the most cost-effective system for growing canning peaches commercially and the system most likely to be adopted by the majority of fruit growers for new canning peach varieties. Material Transfer Agreements (including non-propagation) were signed between DPI and each grower prior to any transfer of material.

Data analyses

The data for each trait were analysed as per nearest neighbour trial design using the residual maximum likelihood (ReML). The ReML model included the effects of replicate (B), row-within-replication (R:B), column-within replication (C:B), selection (S) and random residual. All effects were assumed to be random. ReML analysis provided, for each trait, the estimates of genetic variance (GV) among selections, standard error of GV, best linear unbiased prediction (BLUP) of the average performance of selections, and the SEd among selections. The existence of significant GV among selections was assessed from the ratio GV/SE(GV). A trait for which this ratio exceeded 1.96 was considered, assuming asymptotic normality, to possess significant genetic variation among the selections.

Results

Establishment of an alternate breeding/evaluation site

Approximately two hectares of land have been leased for this project from Mr. Ross Wheelhouse, an SPC-Ardmona canning fruit supplier. The new trial site at Pogue Rd, Toolamba is situated approximately 8 kilometres from the previous DPI site at Tatura.

The site had existing irrigation infrastructure, including a main supply pipeline through the centre of the block. A site layout and irrigation plan was prepared with the site divided into 3 blocks (Appendix 1):

- Primary Assessment Block 11 rows, 3032 trees, 5.0m x 1.0m
- Secondary Assessment Block 7 rows, 1080 trees,5.0m x 2.0m
- Germplasm Block 3 rows, 305 trees, 5.0m x 2.5m

The site was deep ripped, and tree lines prepared. Irrigation sub-mains and valves were installed in July 2008, with irrigation laterals and mini-jet sprinklers connected for the Secondary Assessment Block in preparation for planting.

Re-location of breeding germplasm and selected seedlings

Unevaluated peach selections, grafted onto Red-leaf Nemagard rootstocks, were planted out in August 2008. The trial was planted according to a 5 x 16 Alpha Lattice Randomization design. There are 5 replications each of 75 elite selections identified in 2006, 2007 and 2008 (Appendix 2), 2 imported varieties, Gialla di Moavero and F 8,5-159 (planted April 2009 upon release from quarantine) and 3 control varieties; Tatura 204, Tatura 212 and Golden Queen (Table 1).

A total of 275 trees of the promising selection SAB 145 have been planted in 2 guard rows on the east and west sides of the replicated trial in 2008. Material Transfer Agreements (including non-propagation) relating to all experimental materials have been signed between DPI and SPC-Ardmona (and the grower hosting the breeding/evaluation site). In July 2009 47 promising selections from the DPI Tatura Secondary Assessment Block were transferred to the new breeding/evaluation site for parental germplasm.

Table 1: Number of peach trees established at Toolamba breeding/evaluation site.

Year	No.	Description	Comments
2008	82	2005 selections (7) 2006 selections (12) 2007 selections (30) 2008 selections (26) 2008 selections Peentoa (2 – guard trees) T204, T212, Golden Q	Majority of trees spring budded 2007 (2005 – 2007 selections) or dormant budded 2008 (2008 selections).
	275	Commercial trial of SAB145	Spring budded 2007
2009	2	Imported cultivars Gialla di Moavero F 8,5-159	Spring budded 2008
	47	Pre 2005 selections High productivity	5 – 6 yo trees transferred from productivity trial.

Evaluation of chill requirement and full bloom

In season 2009-10 the chill requirement, full bloom date and flowering period were determined on some of the selections recommended for commercial evaluation. The amount of hours between 0 and 7.2°C required for these selections to break dormancy (greater then 50% bud swell) was between 580 and 680 hours (1070 – 1310 Utah chill units, Figure 1). The majority of these selections flowered between Tatura 204 and Golden Queen, and the flowering period was similar to Tatura (Table 2). Although the chill requirement of the majority of selections and controls were similar, the control Golden Queen, SAB 564 and SAB 572 varied in their speed of bud break and required 2-3 weeks for the buds to start to break compared to 1-2 weeks for peaches in the other chill groups.

Figure 1: Chill requirement of the selections recommended for commercial evaluation and controls in season 2009-2010 based on cumulative chill hours between 0 and 7.2°C. They are placed into 4 response groups based on time and speed to reach 50% bud swell.

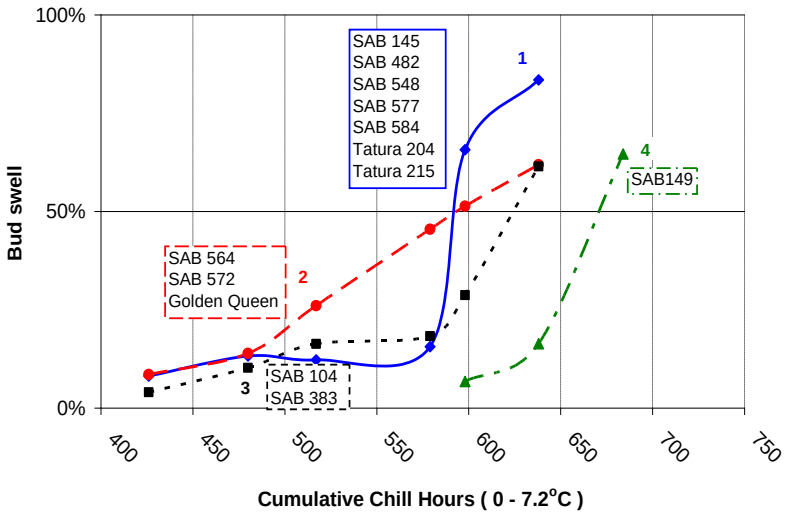


Table 2: Full bloom date and flowering period of recommended selections and controls in season 2009-2010.

Selection	Flowering period (days)	Full Bloom (date)
SAB 104	12.8	9-Sep
SAB 145	11.8	28-Aug
SAB 149	13.5	7-Sep
SAB 383	11.0	27-Aug
SAB 482	13.3	30-Aug
SAB 548	12.8	28-Aug
SAB 564	15.8	12-Sep
SAB 572	15.4	6-Sep
SAB 577	12.0	28-Aug
SAB 584	11.5	29-Aug
Tatura 204	12.5	28-Aug
Tatura 215	11.5	26-Aug
Golden Queen	12.8	11-Sep
L.S.D (5%)	2.4	1.8

Evaluation of productivity

Selections were compared against the control Tatura 204 for productivity and tree traits in 2009 at a high crop load. Only 35% of the original trial (92 selections and 6 controls) were evaluated in 2009. Selections with productivity and/or quality inferior to Tatura 204 were not evaluated with the exception of 20 selections for seasonal comparisons. All trees were thinned to 200 fruit per tree prior to tip change and those with lower crop loads left unthinned. Selections with consistently high yields over the last two fruit seasons are highlighted in Figure 2. There are several selections within each harvest period that have productivity and quality similar to Tatura 204, and some with significantly higher productivity, in terms of canning yield efficiency per butt area (CYE). A full list of the selections retained as germplasm for either commercial evaluation or parents for further cross breeding are listed in Appendix 3. The recommended selections for each harvest period are listed in Table 3 in order of maturity date. There is no recommended selection for the period directly after Tatura 204 because there are no selections that are significantly better in productivity and/or quality than the existing Tatura cultivar, Tatura 207, in that harvest period. Approximately 11% of the selections had significantly higher CYE than Tatura 204 in 2009. These were the canning selections SAB 148, SAB 149, SAB 190, SAB 334, SAB 521, SAB 548, SAB 564, SAB 572, and SAB 603, and white-fleshed parental germplasm SAB 383 and SAB 393. Another 11% had significantly lower CYE and included Golden Queen and Tatura 222. Heritability of CYE was 33% and 38% respectively in 2008 and 2009 (Table 3). The heritability estimates were higher for fruit set and fruit size with values of 55% and 50% respectively in 2009.

Commercial evaluations

The priority for the canning industry is to find superior varieties for the mid February and late February harvest periods between Tatura 204 and Golden Queen. SAB 104 and SAB 145 are two seletions that meet this criterion, and were established in large scale commercial trials in 2006 and 2008 respectively. SAB 104 ripens in mid February and produced its first commercial crop in 2009. Grower feedback has indicated that SAB 104 is easier to manage because of its more upright growth habit than T204 and T215, and is generally more vigorous. The laterals produce good budwood for next season and it appears to self-regulate its crop load in mid October with some fruit drop reducing its thinning requirement. The fruit colours more evenly for harvest than other varieties but it can get slight flecking or cracking on the base of some fruit similar to Tatura 222. However this flecking/cracking did not present a problem with skin removal in the cannery process in 2009. SAB 145 produced the highest potential canning yields in the productivity trials in 2008 of 46 t/ha and was consistently high yielding in 2009 with 44t/ha (Table 3). A further 4 commercial evaluation sites of SAB 145 were established in 2009 and additional trees propagated for establishment in 2010. Trees of another promising selection SAB 572 that ripens prior to Golden Queen were propagated in 2009 for distribution to commercial evaluation sites in 2010.

A new contract will need to be completed between AVS and SPC-Ardmona to cover maintenance of the additional 1000 seedlings each of SAB145 and SAB572 in the DPI Tatura nursery until they are transferred to grower trials in winter 2010. This will then complete the transition of peach germplasm/selections from DPI to SPC-Ardmona.

Application for Plant Breeder's Rights Part 1 has been accepted by IP Australia for SAB 104. Discussions have commenced with potential nursery partners, ANFIC and Flemings regarding the propagation of SAB 104 ("Tatura Blaze") for limited commercial release. Agriculture Victoria Services will provide assistance in the development of propagation agreements.

Discussion

Chill response

For bud break to occur in spring a variety requires exposure to low temperatures (calculated as chill hours) to satisfy its chill requirement, and then exposure to warmer temperatures (calculated as growing-degree-hours) to promote bud emergence. These effects on bud emergence and flowering are not necessarily sequential and additive. There appears to be an inter-relationship between chilling and the heat requirement, such that increased exposure to chill can decrease the number of days of 'forcing' temperature to achieve bud break (Jackson, 2003). This inter-relation may be reflected in the different response of dormant cuttings of Golden Queen and the selections SAB 564 and SAB 572 to 'forcing' temperatures in the laboratory than the other controls and selections (Figure 1). It was noted that this group of peaches had a slower response to the 'forcing' temperature of 20^{o}C and took 2-3 weeks for buds to swell compared to 1-2 weeks. For example Golden Queen showed an initial percentage bud swell of 12% following 638 hours of chill and 1-2 weeks of 'forcing' temperature. It took a further week of 'forcing' temperatures to reach 67% bud swell indicating that the chill requirement had been satisfied. However at 712 hours of chill the speed of bud break was greater and 82% of the buds swelled to balloon stage or further after 1-2 weeks of 'forcing' temperature, similar to the response of the selections and controls in the other chill groups. This type of response is more pronounced in high-chilling varieties such as Golden Queen than low-chilling varieties. If the period of 'forcing' temperature had been restricted to 2 weeks the response curve of Golden Queen and the other selections in chill group 2 may have looked more like those for chill groups 3 or 4. Hence the response of this group appears to be partly influenced by the methodology of chill calculation. Standardization of the chill calculation parameters is important in consistent determination of the chill requirement (Dennis, 2003).

The actual amounts of chill can only be used as a guide for other areas as chill requirement has been shown to differ for different latitudes (Jackson, 2003). The chill hours have also been calculated from a fixed start date of 1st May which may not necessarily correspond to the date of tree dormancy when the actual time for chill accumulation begins. The time of tree dormancy is based on complete leaf senescence which is a combination of leaf colour and advanced leaf abscission. The time of flowering can be used as an initial guide to chill and heat requirement as they are closely correlated (Hesse, 1971). Hence early flowering varieties generally have a lower chill and heat requirement than later flowering varieties. All the peaches in the higher chill groups 2 to 4 had significantly later full bloom dates than in the lower chill group 1, except for SAB 383. SAB 383 is derived from a white melting-fleshed peach, Yumyeong that has been crossed with a Tatura canning cultivar, Tatura 215. Its slightly different genetic background may influence its different response to chill and heat requirement compared to the other selections derived from crosses within the Tatura canning germplasm.

Evaluation of productivity

Productivity is a function of both fruit set and fruit sizing potential. If a tree cannot set sufficient fruit it can never obtain high fruit yields, and if a tree cannot size fruit at high crop loads then it can never obtain fruit of a commercial size. Peach selections and controls were evaluated at low, medium and high crop loads over a four year period to determine the selections with the highest and most consistent canning yields. The mean fruit set of the selections and controls was used to determine the crop load for each year of the experiment. Generally the selections with fruit set higher than the mean average only had the potential to produce the highest yields. The more productive selections were determined by comparing results between the medium and high crop loads (Figure 2). The reliability of productivity assessments in terms of mean and maximum fruit size at low crop loads requires further investigation. The response of

fruit productivity may vary between an immature and a mature tree at full fruit production. Assessment of the fruit sizing potential of selections in mature trees at low crop loads is recommended to determine if it varies significantly from that observed in immature trees at their first crop in 2006 (Richards, 2008). The interaction of fruit set with fruit sizing potential needs to be better quantified to help predict the most productive selections in terms of CYE.

Heritability estimates were made on all the selections for productivity traits in 2009 and were comparable to those derived in 2008 (Richards, 2008). The intermediate heritability estimates that were obtained for fruit set, mean fruit size and CYE indicate that the current method of evaluation is a good predictor of productivity potential. The more rigorous testing will occur once these selections go into large-scale commercial trials. The results from trials with SAB 104 so far indicate that its productivity is good and would make it viable as a commercial canning cultivar. Narrow sense heritability estimates and genetic gain will be reported later in scientific papers encompassing these results.

Technology Transfer

Two elite selections, SAB 104 and SAB 145, progressed to third stage large-scale commercial trials in 2006 and 2008/2009 respectively. SAB 572 has been propagated for distribution to grower trials in 2010. Provisional PBR protection has been placed on SAB 104 ("Tatura Blaze") which will be commercially released in 2010 if it continues to perform well in grower trials.

Recommendations

It is recommended that the selections listed in Table 3 be used in further cross breeding to continue genetic improvement in fruit productivity, and/or commercially evaluated for potential to replace existing varieties. For the other peach germplasm retained by SPC-Ardmona (Appendix 3) it is recommended they continue to be monitored for their canning potential.

The two varieties released from quarantine in April 2009 are recommended for cross breeding to develop brown rot resistance within the Tatura germplasm from the Californian selection F8,5-159, and extension of the season with the Sicilian variety Gialla di Moavero.

The selections developed from crosses with the white-fleshed Korean peach variety Yumyeong, SAB 383 and SAB 393 have the potential to significantly improve upon the productivity of Tatura 204 and introduce a degree of resistance to brown rot. SAB 383 had one of the highest CYE of all the crosses in both 2008 and 2009. SAB 383 can be selfed to regenerate both yellow- and white- fleshed firm peach seedlings suitable for canning. Some of the selections from Yumyeong crosses may also have potential for fresh market such as SAB 376 which ripens late January and has excellent flavour, large fruit size and high blush. Late yellow canning peaches such as SAB 149 which may not be suitable for canning could have a niche in the fresh market when there are fewer melting-fleshed varieties available with good eating quality.

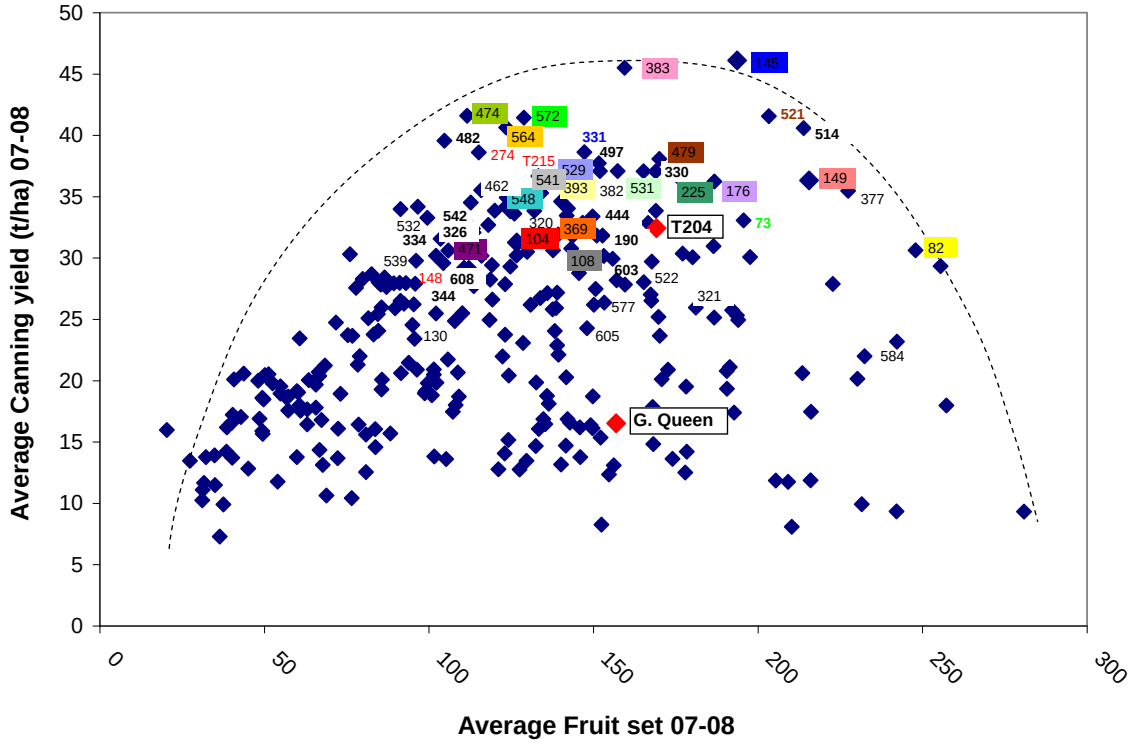
Publications

No publications

Acknowledgements

The development of the new breeding/evaluation site, managed by SPC-Ardmona would not have been possible without the offer of land from the participating fruit grower, Ross Wheelhouse. The contribution of staff at both SPC-Ardmona and DPI Tatura in the set-up and transfer of breeding germplasm and selections to the new breeding/evaluation site is greatly appreciated. The data analysis for this report was performed by the State-Wide Leader for Biometrics within DPI Vic, Dr. Subhash Chandra. His contribution is also gratefully acknowledged.

Figure 2: Range in canning yields of peach selections with fruit set in seasons 2007-08 and 2008-09 showing control cultivars Tatura 204 (T204) and Golden Queen (G.Queen).



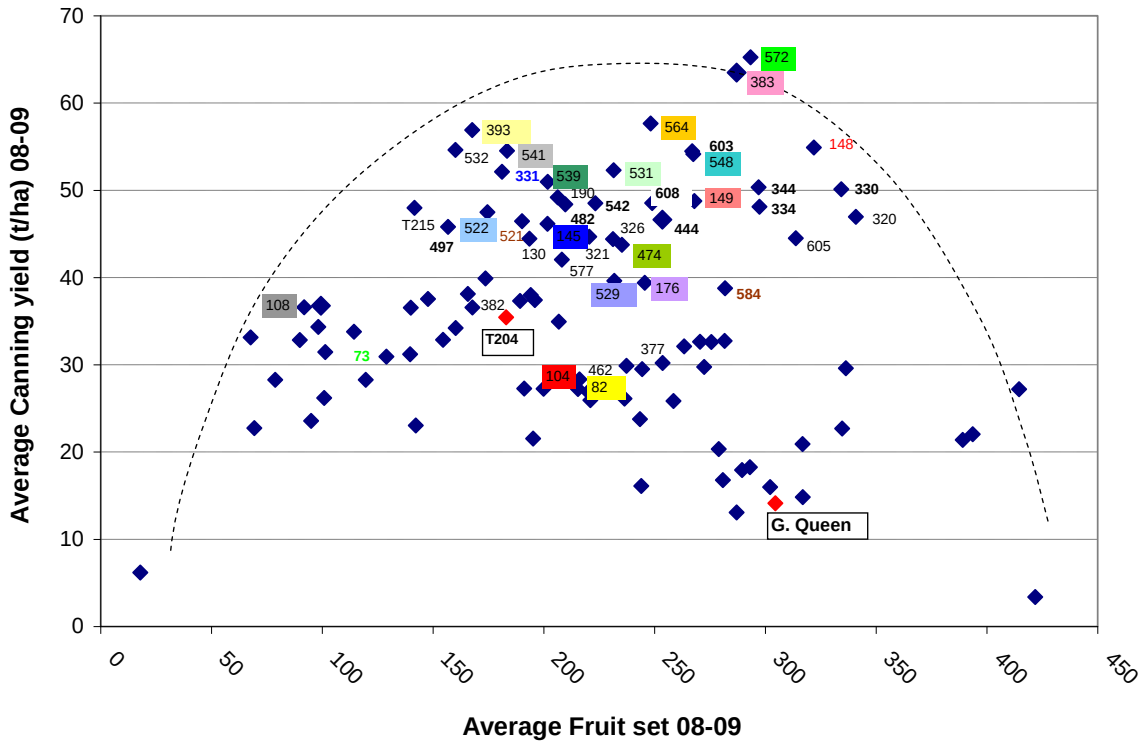


Table 3: Broad sense heritability of fruit productivity in season 2009, and quality and tree traits in 2008 of recommended selections and control cultivars Tatura 204 and Golden Queen.

Recommended Selections	Parents	Ripe date	Fruit set	% Thin	Mean fruit size (g)	% Smalls	Canning yield efficiency (kg/cm^2 butt area)	Potential Canning yield (t/ha)*	Full bloom (+- days T204)	Flesh Colour **	Average stone tip length (mm)***	Average stone weight (g)	Comments
		Season 2008-09							Season 2007-08				
SAB 577	BG7 x Oom Sarel	05-Jan	207	13	116	36	0.30	40	-0.3	12.1	2.33	4.7	
SAB 584	T204 x T211	13-Jan	277	28	101	46	0.25	38	-2.1	10.7	2.46	4.5	
Tatura 204	BG7 x Oom Sarel	22-Jan	199	8	121	24	0.29	34	0.1	10.7	2.65	4.2	
SAB 482	T212 x Oom Sarel	05-Feb	215	9	118	27	0.34	44	0.9	12.5	2.95	5.1	
SAB 104	T204 self	18-Feb	195	10	100	61	0.27	30	5.0	12.9	2.64	4.0	"Tatura Blaze"
SAB 145	T204 self	22-Feb	202	11	124	31	0.31	44	-1.6	14.5	2.63	4.5	
SAB 548	T204 x T235	01-Mar	263	24	115	32	0.40	50	-0.8	17.6	2.70	4.6	
SAB 572	T211 x T204	09-Mar	292	29	128	21	0.42	58	5.1	Orange	2.75	4.1	
Golden Queen	Unknown	13-Mar	291	34	87	77	0.15	19	8.3	Orange	2.94	4.0	
SAB 149	T204 self	14-Mar	257	32	121	24	0.42	45	6.2	14.4	2.76	3.5	
SAB 383	Yumyeong x T215	20-Feb	283	29	118	19	0.46	55	-0.1	1.6	2.64	4.0	Parent white & yellow flesh
SAB 393	Yumyeong x T215	25-Feb	175	6	133	22	0.44	51	7.9	0.3	3.13	3.4	Parent white & yellow flesh
SAB 564	T212 x T204	16-Mar	254	26	141	22	0.46	53	9.5	Yellow	2.96	4.6	Parent late season
Trial mean			221		116		0.43	36	2.9	12.2	3.00	4.2	
Genetic variance			5842		453.1		0.0066	121.7	19.769	12.34	0.259	0.182	
GV/SE(GV)			6.2		6.1		5.66	5.2	11.01	10.2	6.98	7.33	
Heritability (%) ****			55		50		38	30	89	87	44	48	
Average SEd			36.0		10.8		0.049	7.8	1.58	1.34	0.464	0.370	

** Potential canning yield calculation based on average yield of 8 replicate single tree plots in nearest neighbour trial design.*

*** Colour(hue) using CIELAB (D65/2^o) a value, where values >15 are classified as orange; >12 orange-yellow; >9 yellow-orange; >4 yellow and <4 white fleshed respectively.*
Note: Golden Queen and SAB 572 usually have a flesh colour value a >15 classified as orange and SAB 564 as yellow (a values not assessed in 2008).

**** A 1 mm width metal plate with a 10 x 2 mm opening is used to standardise the point at which the stone tip emerges from the stone for measurement of stone tip length.*

***** Heritability = [Genetic Var / (Genetic Var + Residual Var)]*100*

BG = BabyGold

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Appendix 1: Arial view and irrigation layout of the new breeding and evaluation site for the Canning Peach Breeding Program, managed by SPC-Ardmona.

STAGE 1 WORKS

Reconfigure existing 100mm valve hurdle to include 2 x 50mm hydraulic valves and an offtake for an additional 50mm valve (stage 2). Hurdle to include isolation valve and 80mm disk filter.

Stage 1 works to service rows 12 to 18 only with submains 2 & 3 to be extend to 2.5m east of row 18 and capped for future works. Submain 1 to include 7 x 25mm risers for lateral tube.

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ROSS WHEELEHOUSE

SPCA TRIAL AREA

SHEET 1 OF 1 | REF: TRIAL

Appendix 2: Selections from 2006 and 2007 established in an evaluation trial in 2008 on the SPC-Ardmona breeding/evaluation site.

Female	Male	Harvest day	Number selections	Traits
SAB101	SAB104	14-Feb	1	Yellow canning peach (C)
SAB126	SAB104	14 - 26 Feb	2	C
Taylor Queen	T204	24-Feb	1	C
T204	2-1-39	08-Jan	1	C
T204	7-1-42	7 Feb - 9 Mar	5	C
T204	T212	18 Jan - 2 Mar	11	C
T204	Taylor Queen	29 Jan - 4 Feb	5	C
T212	Andross	13-Feb	3	C
T212	Babygold 7	13 - 28 Feb	4	C
T212	Golden Queen	29-Jan	1	C
T212	self	14 Jan - 7 Mar	15	C
T212	Taylor Queen	07-Mar	1	C
T212	3-3-42	28-Feb	2	C
T212	4-1-5	4 - 7 Feb	2	C
T212	6-3-8	29-Jan	3	C
T204	SAB382 (Yumyeong x T215)	26-Feb	1	Potential brown rot resistance from Yumyeong (BR), C
T204 x Yumyeong	op	06-Mar	1	Dominant stony hard gene(SH), BR, C
SAB370 (Yumyeong x T215)	op	26-Feb	2	SH, BR, C
SAB379 (Yumyeong x T204)	op	29-Jan	1	SH, BR, C
SAB388 (Yumyeong x T204)	op	14 Feb - 6 Mar	2	SH, BR, C
T204	Jing Yu	08-Jan	1	Potential brown rot resistance from Jing Yu Yellow flesh, melting peach (M)
T204	SAB369 (Yumyeong x T215)	14-Feb	1	White flesh (W), BR
T212	Peentao	3 - 29 Jan	2	Yellow flesh, M, saucer shape
SAB151	op	17-Jan	1	SH, W
SAB336 (7-1-42 op)	op	08-Jan	1	W
SAB365 (Yumyeong x O/L)	T204	7 - 28 Feb	3	W, M, potential recessive SH gene, BR
SAB366 (Yumyeong x O/L)	T204	07-Feb	1	W, M, potential recessive SH gene, BR
SAB376 (Yumyeong x T215)	op	13 - 28 Feb	2	W, M, potential recessive SH gene, BR
SAB388 (Yumyeong x T204)	op	06-Mar	1	SH, W, BR
Total			**77**	

C = yellow-fleshed canning peach; BR = potential brown rot resistance; SH = stony hard gene; W = white-fleshed peach and M = melting flesh.

Appendix 3: List of peach germplasm transferred in 2009 to the SPC-Ardmona breeding/evaluation site.

Selection	Parents	Av. Ripe date	Full bloom 07 (+- days T204)	Canning yield 2008* (t/ha)	Canning yield 2009* (t/ha)	Selection	Parents	Av. Ripe date	Full bloom 07 (+- days T204)	Canning yield 2008* (t/ha)	Canning yield 2009* (t/ha)
577	B/G7 x O/S	06-Jan	0	26	40	190	T204 x T204	20-Feb	-2	32	46
444	T204 x Andross	12-Jan	6	34	43	393	Yumy x T215	21-Feb	8	37	51
584	T204 x T211	13-Jan	-2	22	38	145	T204 x T204	21-Feb	-2	46	44
T204	B/G7 x O/S	22-Jan	0	32	34	522	B/G7 x J/N	21-Feb	1	28	44
176	T204 x T204	23-Jan	-1	36	38	531	B/G7 x J/N	22-Feb	5	37	48
56	T204 x T204	25-Jan	-1	30	37	548	T204 x T235	25-Feb	-1	35	50
474	T211 x T204	29-Jan	-1	42	42	539	T204 x T237	27-Feb	0	30	47
82	T204 x T204	30-Jan	-2	31	29	130	T204 x T204	27-Feb	-1	25	42
377	T211 x T204	31-Jan	7	35	33	321	T204 x T212	27-Feb	7	26	43
73	T204 x T204	31-Jan	-1	33	33	605	T204 x T233	01-Mar	9	24	43
369	Yumy x T215	01-Feb	0	33		148	T204 x T204	01-Mar	7	28	50
225	6-3-8 x op	03-Feb	8	36		331	T211 x T204	01-Mar	-1	39	48
462	B/G7 x O/S	03-Feb	4	36	31	538	T211 x T215	02-Mar	0	34	38
382	Yumy x T215	04-Feb	0	37	36	541	T212 x O/S	02-Mar	4	37	50
514	T204 x T233	05-Feb	1	41		326	B/G7 x O/S	02-Mar	5	32	42
274	T211 x T204	07-Feb	2	39		542	B/G7 x J/N	03-Mar	4	32	46
482	T212 x O/S	07-Feb	1	40	44	572	T211 x T204	03-Mar	5	41	58
529	T204 x T237	11-Feb	-1	37	38	330	T212 x O/S	03-Mar	9	37	46
108	T204 x T204	15-Feb	-3	31	36	334	T212 x T211	04-Mar	7	32	45
104	T204 x T204	15-Feb	5	31	30	320	6-3-8 x op	06-Mar	8	33	44
383	Yumy x T215	19-Feb	0	46	55	149	T204 x T204	08-Mar	6	36	45
497	T211 x P/B	19-Feb	-5	38	43	603	T204 x G/Q	09-Mar	7	28	50
521	T204 x Clement	19-Feb	-1	42	43	564	T212 x T204	09-Mar	9	41	53
692	SAB365 x T204	20-Feb				608	T211 x I/M	10-Mar	5	30	45
532	B/G7 x J/N	20-Feb	2	33	50	344	T211 x self	14-Mar	4	28	47
Trial mean			2.6	24	43				2.6	24	43
Genetic variance			19.769	82.2	121.70				19.769	82.2	121.70
GV/SE(GV)			11.01	9.56	5.22				11.01	9.56	5.22
Heritability (%)			89	37	30				89	37	30
Average SEd			1.58	5.63	7.77				1.58	5.63	7.77

** Potential canning yield calculation based on average yield of 8 replicate single tree plots in nearest neighbour trial design. The 3rd and 4th crops were in 2008 and 2009. Trees were thinned to 100 and 200 fruit/tree respectively.*
B/G7 = BabyGold 7; O/S = Oom Sarel; J/N = Jan Neethling; I/M = Izac Malherbe, G/Q = Golden Queen, Yumy = Yumyeong and SAB365 = Yumyeong x Okubo Late.

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