Canning peach breeding & evaluation program

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Canned Fruits Industry Council of Australia

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Horticulture Australia Project CF10003 (2010 - 2013)
Variety Improvement Program for Canning Peaches

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The yellow-fleshed canning peach breeding program commenced in 1993. The breeding program was privatised in 2009 and transferred from the Victorian Department of Primary Industries, Tatura to an orchard in Toolamba. The results of breeding and evaluations undertaken at Toolamba from 2010 to 2013 are reported herein.

The Canned Fruit Industry Council of Australia and Horticulture Australia Limited financially support the yellow-fleshed canning peach breeding program.

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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. Cultivars with resistance to major pest and diseases and adaptability to climatic change also provide more sustainable cultivars for future development of the industry.

Breeding over the last 4 decades has developed high quality and productive canning peach cultivars such as Tatura 204 (200 series) and Tatura Blaze (300 series). However these cultivars are very susceptible to fungal infection by brown rot. Brown rot is the most economically damaging disease of canning peaches and costs the industry millions of dollars to control annually. A brown rot resistant peach selection F8,5-159 derived from a cross between almond and peach was imported from the Californian Canning Peach Breeding Program in 2006. F8,5-159 has subsequently been crossed with a range of Australian peach cultivars to transfer across genes for brown rot resistance.

Selections will be made from these seedling populations over the next few years and will then undergo productivity, quality and disease resistance evaluations to develop new brown rot resistant cultivars for the Australian peach processing industry.

New selections have also been bred using the white Korean peach cultivar Yumyeong. Yumyeong has slight resistance to brown rot, high productivity and contains the stony hard gene which prevents normal fruit ripening. Stony hard cultivars stay firm on the tree due to the absence of ethylene production which causes fruit softening. They can be control ripened to the desired eating attributes by the addition of ethylene at the time of processing. Ethylene is a natural ripening agent also utilised in the banana industry to ripen green bananas prior to delivery to the fresh market.

SAB383 and SAB392 are melting, white fleshed selections produced from a cross between Yumyeong and the yellow fleshed processing peach Tatura 215. Stony hard, yellow flesh colour and non-melting texture are controlled by single, recessive genes. Self-pollination of SAB383 and SAB392 were used to produce a range of yellow and white fleshed progeny with either melting (soft), non-melting (firm) or stony hard flesh textures dependent upon the genetic recombination of these recessive genes. Twenty four seedlings of yellow fleshed fruit with either stony hard or non-melting flesh texture were selected for further evaluation.

A late season Italian peach cultivar, Gialla di Moavero has also been imported to cross with the late ripening Australian processing peach cultivars to extend the processing season into April. These seedlings populations will be evaluated over the next five years.

Two selections, SAB705 and SAB706 initially bred by the Department of Primary Industries Victoria and then evaluated by the SPC-Ardmona breeding and evaluation program have been recommended for commercial evaluation. SAB705 and SAB706 ripen between Tatura 204 and Tatura Blaze, have high canning yield potential and display quality attributes similar to Golden Queen. One thousand trees each of SAB705 and SAB706 were propagated for planting on five orchards in 2013. Another selection SAB725 which was derived from the white fleshed, stony hard parent Yumyeong by cross pollination with Tatura 204 has also been recommended for commercial evaluation on one orchard.

Technical summary

The consistent supply of high quality peaches, throughout the processing season, from productive and profitable orchards is integral to the sustainability of a viable and internationally competitive processing fruit industry.

The Californian almond x peach backcross selection F8,5-159 has been utilised in cross breeding to develop brown rot resistance within the Tatura germplasm, and the Sicilian variety Gialla di Moavero to extend the peach harvest season. Field observations over the last three years at the SPC Ardmona breeding and evaluation site has shown that F8,5-159 possesses moderate resistance to brown rot and good fruit sizing and flesh quality attributes suitable for use as a major parent in cross-breeding. Gialla di Moavero has a harvest period following Taylor Queen at the end of March/early April. Cross pollination with these introduced cultivars have been performed over the last three seasons.

The recessive stony hard gene was bred into the Tatura processing peach germplasm from the white fleshed, non-melting Korean cultivar Yumyeong. As stony hard, yellow flesh colour and non-melting texture are controlled by single, recessive genes, more than one generation of breeding is required to develop stony hard, yellow fleshed cultivars. The recessive stony hard selections SAB383 and SAB392 were produced in the first generation of breeding from a cross between Yumyeong and the yellow fleshed processing peach Tatura 215. Self and open-pollination of SAB383 and SAB392 were then undertaken to produce a range of yellow and white fleshed progeny with either melting, non-melting or stony hard flesh textures dependent upon the genetic recombination of these recessive genes. Twenty four seedlings of yellow fleshed fruit with either stony hard or non-melting flesh texture were selected for further evaluation in 2013.

Productivity evaluations over the last three years have shown that two homozygous stony hard selections, SAB699 and SAB725 produced processing yields in excess of Tatura 204. The canning potential of SAB699 was further investigated in 2012 under a University of Western Sydney student project (Muhlsimmer et al, 2012b). Fruit of SAB699 were treated with propylene, an ethylene homologue which induced normal softening and flavour development. Upon softening SAB699 improved in flavour but developed a melting flesh texture that was unsuitable for processing. It was subsequently recommended that stony hard fruit with a non-melting background would be more suited to processing. The other high yielding stony hard selection SAB725 was an open pollinated seedling derived from a cross between Yumyeong and Tatura 204. This selection possesses orange, non-melting flesh texture and ripens a week before Golden Queen harvest. It has been recommended for commercial evaluation and cross bred with the brown rot resistant cultivar F8,5-159. Elite progeny will require an additional generation of breeding either by selfing or crossing with another yellow, non-melting stony hard selection to recover expression of the stony hard gene in combination with brown rot resistance.

Two selections, SAB705 and SAB706 initially bred by the Department of Primary Industries Victoria and then evaluated by the SPC-Ardmona breeding and evaluation program have been recommended for commercial evaluation. SAB705 and SAB706 ripen between Tatura 204 and Tatura Blaze, have high canning yield potential and display fruit quality attributes similar to Golden Queen. One thousand trees each of SAB705 and SAB706 were propagated for planting on five orchards in 2013.

Introduction

Provision of a consistent supply of high quality, productive peaches throughout the harvest season is integral to the maintenance of a vibrant and competitive processing fruit industry. “An ongoing (peach breeding) program is required to ensure that the industry has access to fruit varieties that maximise yield, spread the harvest and processing season, and provide fruit that optimises processing efficiencies” (Gray P. 2004). Cultivars with resistance to major pest and diseases and adaptability to climatic change also provide more sustainable cultivars for future development of the industry.

Breeding for harvest period

Breeding over the last 4 decades has developed high quality and productive canning peach cultivars such as Tatura 204 (200 series) and Tatura Blaze (300 series) in the early and mid-season harvest periods respectively. However higher yielding cultivars are still required for the harvest period following Tatura 204 in early February and late season to replace the cultivars Golden Queen and Taylor Queen. A late season Italian peach cultivar, Gialla di Moavero was imported in 2006 to cross with the late ripening Australian processing peach cultivars to extend the processing season into April.

Breeding for 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 percentages of bud break, and the greater the speeds 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).

Breeding for brown rot resistance

The current Australian processing peach cultivars are very susceptible to fungal infection by brown rot. Brown rot is the most economically damaging disease of canning peaches, causing an average annual loss of $19 million despite an annual expenditure of about $25 million on disease control (Holmes et al, 2011). Along with improved brown rot forecasting models, the development of new peach varieties with brown rot resistant should reduce the costs of disease management and provide consumers with a higher quality product. New cultivars with brown rot resistance will be developed principally utilising the almond x peach backcross selection F8,5-159 imported to Australia from the Californian Processing Peach Breeding program in 2006. It has epidermis-based resistance to brown rot caused by Monilinia fructicola. Hence it is important to control pest infections which could provide an entry point for disease infection to breakdown this resistance early in fruit development and to minimise fruit damage and fruit-to-fruit disease spread post-harvest.

Breeding for stony hard

The stony hard gene bred into the Tatura peach germplasm was derived from the Korean cultivar Yumyeong which is melting and white fleshed. Yumyeong has also been shown to possess slight resistance to brown rot (D. Bassi, personal communication). The stony hard trait

prevents the natural production of ethylene that controls many enzymes associated with ripening (Gamberini, 2006), and is controlled by a single recessive gene (hd) [Haji et al, 2005]. The quality of stony hard peach cultivars is the same as non-stony hard peaches once ethylene emission is initiated by the addition of ethylene postharvest and the fruit softens. Peach cultivars that contain the stony hard gene stay firm on the tree due to the absence of ethylene production. Then during processing heat and ethylene can be applied to initiate normal fruit ripening to provide the fruit grower and fruit processor improved harvest, handling and storage life and the consumer a more consistent, higher quality product.

With further breeding, two selections SAB 383 and SAB 393 developed from a cross between Yumyeong and Tatura 215, have potential to significantly improve upon the productivity of the processing peach germplasm and introduce a degree of brown rot resistance. SAB 383 has consistently high processing yield efficiency ((PYE; Turpin et al, 2009) and significant breeding values for fruit weight, PYE and percentage smalls (fruit below minimum processing diameter of 60.3mm). Based on a typical 3:1 Mendelian segregation for non-stony hard and stony hard, self-pollination of SAB 383 and SAB393 will recover expression of the stony hard gene. The other recessive genes for yellow flesh colour and non-melting texture will also be expressed and generate a range of progeny with different combinations of yellow and white flesh colour and non-melting and melting flesh texture. Only $^{1}/_{64}$ of this seedling population will be stony hard in combination with yellow, non-melting flesh (Fig. 1).

This report details the final results of intensive productivity evaluations conducted by SPC-Ardmona over the last four years at low, medium and high crop loads, including recommendations of new peach cultivars.

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 high processing yield potential and quality characteristics similar to the standard canning peach cultivar Tatura 204. The highest priories are for a new cultivar in the harvest period following Tatura 204 in early February and late season to replace the cultivars Golden Queen and Taylor Queen.

Evaluation of chill requirement

Two laterals from 4 replicates of each selection were collected weekly and buds forced at 20^{o}C for 1-2 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 replicate trees. Time of flowering is used as an initial guide to winter chill requirement on selections in the seedling population.

Hybridisation and seedling establishment

From 2 to 5 crosses will be made annually to produce a maximum of 1000 seedlings. Flower buds are collected at balloon stage and the anthers extracted by lightly rubbing the buds over a 2-mm mesh. Anthers can also be collected from later maturing varieties by forcing the buds to mature at warmer temperatures. The anthers are dried at room temperature following extraction for at least 24 h and the dehisced anthers and pollen stored in small glass jars in a desiccator. The parent trees are enclosed in shade-cloth prior to pollination to protect the emasculated buds from extremes of wind and temperature. In the Goulburn Valley, fruit set is very low on hand pollinated trees that are left uncovered.

The majority of trees are pollinated twice with a one to two day interval between to improve percentage fruit set. Flower buds are emasculated at balloon stage when the trees have reached 5-10% full bloom and the buds pollinated the same day. A 4-mm square length of rubber is used to apply the pollen onto the exposed stigmas. All flower buds open prior to emasculation or displaying any trace of pollen is removed to prevent self-pollination.

Fruit are harvested at maturity and the seed stratified for at least 5 to 8 weeks in moist perlite to overcome dormancy. When the radicles are 2mm or longer, the seed is planted into a commercially available pasteurised potting mix. The peach seedlings are moved from plastic igloos to a shade house when they have 5 to 6 leaves for hardening off prior to field planting.

Phenology and fruit quality evaluation

Time of flowering is used as an initial guide to winter chill requirement (WCR). In the breeding blocks trees that reach full bloom (>80% open flowers) when Tatura 204 is at 20% open flowers are marked to indicate that their WCR is potentially too low for the Goulburn Valley. The trees that bloom the same time as Tatura 204 and up to Taylor Queen are marked as meeting the preferred chill requirement (i.e. 500 to 700 hrs.). These trees are given a higher priority than those that flower before Tatura 204 or following Taylor Queen. In the productivity block all selections and controls in at least 3 replicates are assessed every 3-4 days for flower emergence.

Both selected progeny from the breeding block and selections in the productivity block are assessed for similar quality traits which include red pigment in the pit and flesh; firmness in kg; sugar in ^{o}brix; stone width and stone tip size in mm; flesh colour and an overall subjective evaluation of appearance and eating quality. The quality traits listed above are collected on 5 fruit from selected progeny. Whilst fruit quality in the productivity block is assessed on 5 fruit collected from one to three replicates. The titratable acidity and sugar/acid balance are only assessed on elite selections.

Productivity evaluation

Selected progeny from the breeding blocks showing ideal quality and productivity characteristics are harvested to determine average fruit weight and gross yield. Selections in productivity trials are assessed for productivity and processing traits for at least three seasons before they are recommended by the project steering committee for large-scale commercial evaluation. Productivity evaluations are made successively at a range of crop loads from low, medium to high, to determine the ability of each selection to consistently size fruit to a high fruit weight.

Peach selections are annually grafted onto either Red-leaf Nemagard or Elberta rootstocks. Productivity trials are randomized with 3 to 4 replications each of elite selections plus control cultivars (i.e. Tatura 204 and Golden Queen). Trees are planted at 2 x 5m tree spacing and trained to a vase structure.

The selections are thinned and fruit counted at tip change and then re-thinned and counted to equal fruit numbers based on tree size (i.e. trunk cross sectional area) for comparison of fruit size at harvest. In the first cropping year trees are thinned to a low crop load (i.e. 0.5 fruit per cm^2 butt area); in the second year to a medium crop load (i.e. 5.0 fruit per cm^2 butt area); and in the third year to a high crop load (i.e. 8.5 fruit per cm^2 butt area). The percentage pre-harvest drop in the week prior to harvest is recorded. The trees are harvested in one or two picks when the majority of fruit is a bisque colour. Gross yield is measured and the fruit graded into two size categories (<60mm, 60 - 63mm and >63mm) following each pick. Fruit less than canning size (60mm) are removed to determine canning yield and 5 - 10 fruit in the 60 – 63mm canning size range retained for evaluation of quality traits. Additional fruit are retained from other size categories if insufficient number in the canning size range. Productivity data was analysed by REML repeated measures using Genstat 14.

Breeding and evaluation site management

Seedlings are planted in the breeding block at 1 x 5m spacing and the productivity evaluation block at 2 x 5m spacing. The roots of new seedlings are dipped in a biological control agent formulation for the Crown Gall bacterium (i.e. No Gall®) when planted into previously used horticulture land. The trees start to crop in their second or third leaf. Normal cultural practises are applied to the breeding and productivity blocks. Pheromones are placed in the blocks for oriental fruit moth and pesticide sprays applied when threshold levels are exceeded. Sprays for brown rot are not routinely applied in order to monitor brown rot resistance levels. Weed competition is managed by strategic application of pre- and post-emergence herbicide. Water is applied through a micro-jet irrigation system and fertiliser applied in spring and post-harvest in autumn. Management practices are similar in both the breeding and productivity blocks except the trees in the productivity evaluation block are annually pruned and the fruit thinned.

Commercial evaluation sites

Evaluation sites are grown under a central leader or vase system, as the most cost-effective system for growing processing peaches commercially and the system most likely to be adopted by the majority of fruit growers for new processing peach cultivars. Material Transfer Agreements (including non-propagation) were in place prior to any transfer of material and the selections screened to be free of prunus dwarf virus, apple chlorotic leaf spot virus and prunus necrotic leaf spot virus. Feedback is collated on economic and agronomic traits collected from the commercial evaluation sites at the end of the season. This data is then used to draft information sheets on each of the subsequent released varieties, to assist in industry adoption and promotion of new cultivars.

Plant Breeders Rights

The Victorian Department of Primary Industries (DPI) has developed the Peach Varieties (Appendix 5) with financial assistance of Horticulture Australia Limited (HAL) and SPC Ardmona (SPCA). Agriculture Victoria Services is the entity responsible for the protection, management and commercialisation of DPI's intellectual property, which includes DPI's interest in Peach Varieties.

Pursuant to an agreement between AVS and HAL governing the creation and ownership of the Peach Varieties, HAL has granted AVS the rights to grant SPCA an exclusive licence to plant and propagate the peach varieties for the purpose of evaluation.
Intellectual Property Rights in the Peach Varieties and in any varieties developed through this breeding program are and will be owned by AVS.
Prior to the execution of a licence to Exploit a Plant Variety, AVS will apply for PBR registration for the plant variety.
Where AVS lodges an application for PBR registration, SPCA will carry out the distinctiveness, uniformity and stability trials and collect all data required from these trials to support the PBR application. In the first instance, data will be used from the productivity trials, providing that suitable comparator control varieties were used in the trial. Otherwise a separate PBR trial would need to be established.
AVS will own all PBR and other rights subsisting in any DPI Germplasm evaluated by SPCA through this program.
HAL and SPCA will own all PBR in any newly developed varieties made or discovered from SPCA Breeding Programs that use the DPI Germplasm.

Results

Breeding outcomes

Selfed and open pollinated crosses of SAB383 (Yumyeong x Tatura 215) and SAB393 (Yumyeong x Tatura 215) were performed in 2009-10 to produce $^{1}/_{16}$ yellow fleshed selections suitable for processing, of which $^{1}/_{64}$ of the population were yellow fleshed, non-melting, homozygous stony hard selections (Fig. 1). These seedling trees commenced cropping in 2012 and 24 selections were made in 2013 for establishment in replicated trials (Table 2). Two of these selections SPCA-16 and SPCA-23 (Photo 1) were tested at the University of Western Sydney for their rate of ethylene emission and were confirmed as stony hard.

Cross-pollinations over the last three seasons were performed principally to extend the harvest season to the end of March utilising Gialla di Moavero, a late season yellow cling peach imported from Sicily and to incorporate brown rot resistance using F8,5-159, a peach-almond selection from the Californian canning peach breeding program (Table 1). Tatura Blaze, Tatura 204, SAB145, SAB149 and SAB572 were used to incorporate high processing yields.

Table 1: List of crosses and seedling trees established at SPC-Ardmona breeding and evaluation site for 2009-10, 2010-11, 2011-12 and 2012-13 respectively.

Season	Female	Male	No. trees
2009-10	SAB383	self	64
	SAB383	Open pollinated	300
	SAB393	Open pollinated	116
2010-11	SAB572	F8,5-159	246
	SAB572	Gialla di Moavero	108
	SAB572	SAB145	205
	Tatura Blaze	Tatura 204	85
	Tatura Blaze	F8,5-159	66
2011-12	Gialla di Moavero	SAB145	40
	Gialla di Moavero	SAB564	45
	Gialla di Moavero	SAB572	35
	F8,5-159	Gialla di Moavero	15
	F8,5-159	T204	100
	F8,5-159	Tatura Blaze	25
2012-13	F8,5-159	SAB149	
	F8,5-159	Tatura 215	
	F8,5-159	SAB716	
	Gialla di Moavero	Tatura 215	
	Gialla di Moavero	F8,5-159	
	SAB725	F8,5-159	
	SAB719	self	
Total			1450

Fig. 1: Proportion of yellow, white, non-melting, melting types, stony hard and non-stony hard types of progeny expected from the second generation self and open pollinated crosses of SAB 383 and SAB 393 undertaken in season 2009-10. The yellow fleshed progeny suitable for processing are highlighted in the text boxes.

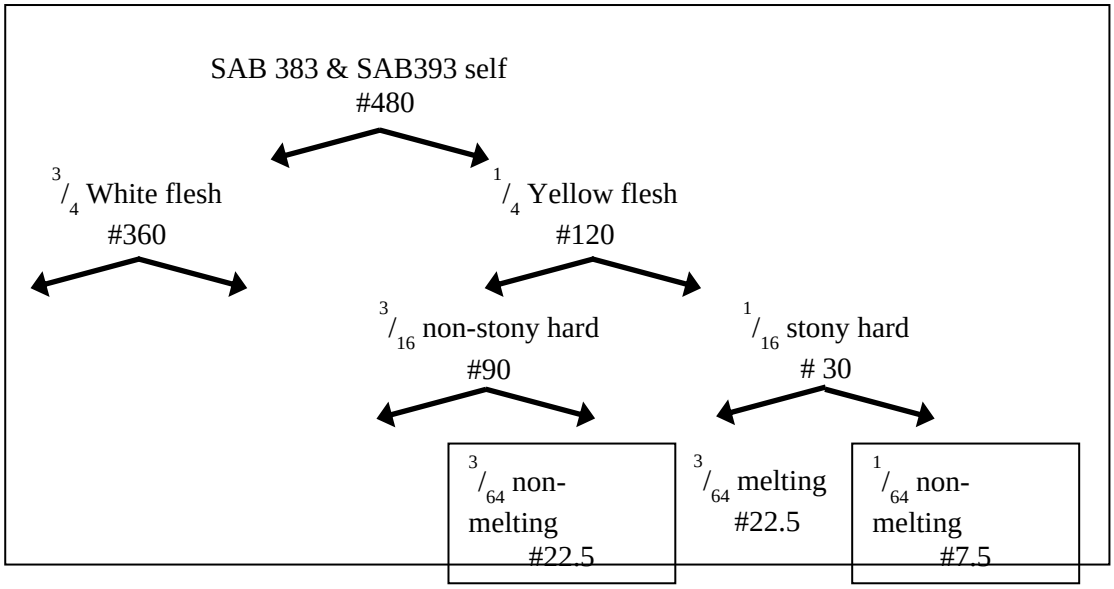


Photo 1: Stony hard, yellow fleshed selections generated from open pollinated crosses of SAB383(Yumyeong x Tatura 215) bred in 2009.

a . SPCA-23

b. SPCA-16

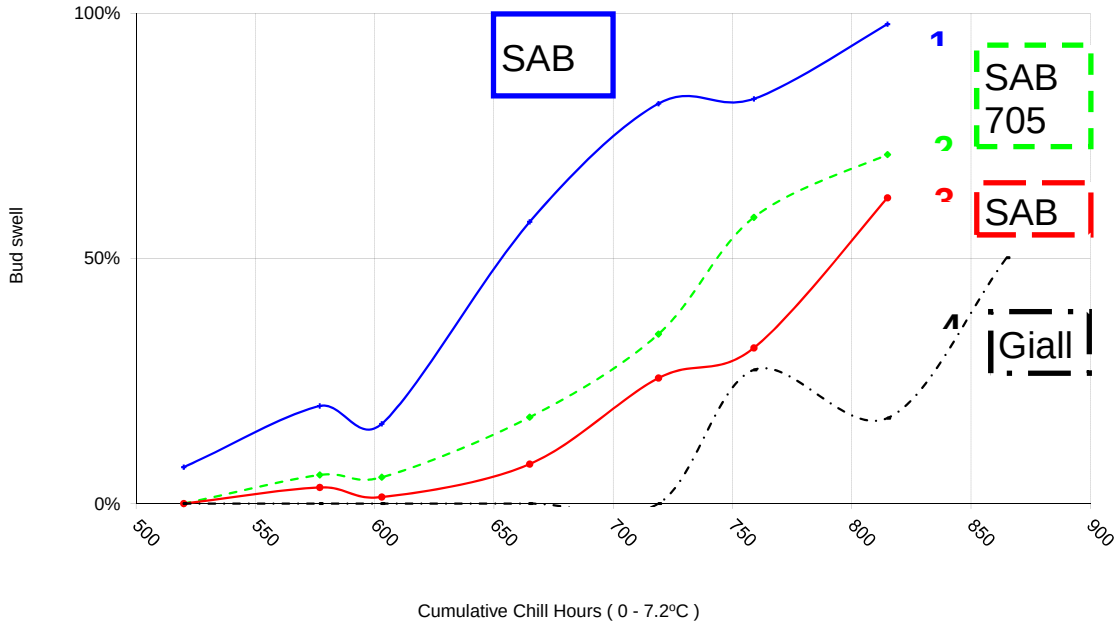
Chill requirement and flowering traits

In season 2012-13 the chill requirement was determined on some of the selections recommended for commercial evaluation, imported cultivars F8,5-159 and Gialla di Moavero and controls Tatura 204 and Golden Queen. Selections and cultivars were grouped into four based on their chill requirement and their average % bud swell plotted based on cumulative chill hours (Fig.2). The amount of hours between 0 and 7.2^{o}C required to break dormancy (greater than 50% bud swell) ranged from 665 hours for Tatura 204, SAB145 and SAB683 (i.e. Group 1)

to 815 hours for the Italian cultivar Gialla di Moavero (i.e. Group 2). The recommended selection SAB705 had a lower chill requirement than SAB706 of 759 hours compared to 815 hours.

Interestingly SAB705 and SAB706 had the same average full bloom date of 14th September and a 13 day bloom period which was similar to Golden Queen (Table 5). Both SAB705 and SAB706 had high percentage bud sets of 57.4% and 53.4% respectively which was significantly greater than Tatura 204 (27.7%) and similar to that of Golden Queen (49.6%). The number of buds per standard 40cm lateral and the percentage number of single, double, triple and quad buds was similar between Tatura 204 and SAB705. Whilst SAB706 had a bud distribution similar to that of Golden Queen with a more even proportion of single and double buds.

Fig. 2: Chill requirement of the selections recommended for commercial evaluation and controls in 2012 based on cumulative chill hours between 0 and 7.2°C from 1st May.



Replicated productivity trial

Selections were compared against the controls Tatura 204, Tatura 212 and Golden Queen for productivity and tree traits at low, medium and high crop loads in 2010, 2011 and 2012 respectively (Fig. 3 to 5). The mean fruit set of the selections and controls was used to determine the crop load for the first and second year of the experiment which was 0.5 and 5.0 fruit/ trunk cross sectional area (TCSA) respectively. The steering committee determined that the productivity trial should be evaluated at a high crop load based on 120% of the potential performance of Tatura 204. In 2011-12 the highest average crop load/TCSA on two of the replicate trees of Tatura 204 was 7.0 fruit/TCSA. This gave Tatura 204 a potential processing yield of 50 to 60t/ha based on an average fruit weight at harvest of 115g (the minimum processing weight for Tatura 204 which is equivalent to a fruit diameter of 60.3mm) and a planting density of 1000 trees/ha. Hence in the third year of the trial the crop load was set 20% above 7.0 fruit/TCSA to 8.5 fruit/TCSA. The trial was culled to 38 selections at the end of the 2011-12 season based on each selections ability to set crop loads to 8.5 fruit/TCSA in combination with a high fruit sizing potential (Fig. 6a,b).

In the first cropping year of the productivity trial (2009-10) selections SAB688, SAB708, SAB712, SAB717, SAB719 and SAB720 were amongst the best performers based on processing yield efficiencies but varied in their fruit set and fruit sizing capacity and did not show the same yield potential the following season (highlighted in yellow in Fig. 3 to 6).

Whereas selections SAB683, SAB705 and SAB706 that ripen after Tatura 204 in early February continued to display high processing yields (highlighted in red in Fig.3 to 6).

In the second year of cropping in season 2010-11 trees sustained large fruit drop due to brown rot, which could not be easily controlled due the mixture of trees with a range of harvest dates in the experimental trial. Hence, processing yield was adjusted to include fruit drop due to brown rot at harvest. The number of dropped fruit due to brown rot was multiplied by the average weight of fruit remaining on the tree and then added to the processing yield of fruit harvested.

Fruit set varied from 40 to 450 fruit at tip change with an average of 200 fruit per tree. Tatura 204, Tatura 212 and Golden Queen had an average fruit set of 342, 231 and 174 fruit respectively. Trees were thinned to between 32 and 213 fruit per tree based on a crop load of 5.0 fruit/TCSA which gave a thinning range from 7 to 65% and an average thinning rate of 32% similar to that of the controls. Only 5 out of the 15 top ranking selections in 2010 (SAB683, SAB699, SAB705, SAB706, SAB713) were consistently ranked as high yielding in both 2010 and 2011 (Fig. 4).

In the third year individual trees were cropped at their highest possible cropping level following an initial thin to remove clumps of fruit (Fig. 5). The crop load was set at 8.5 fruit/TCSA (based on 120% of the crop load of the industry standard; Tatura 204). This crop load was applied to 23% of the trial trees. The remainder of the trees did not set sufficient fruit to sustain this high level of cropping after the initial thin. Only 22% of the trees had less than 5.0 fruit/TCSA. The average crop load for the whole trial in 2012 was 6.5 fruit/TCSA. Based on 1000 trees per ha and the average fruit number set in spring and fruit weight at harvest, the average crop load was equivalent to 38t/ha. Tatura 204 had a low average processing yield. Within the Tatura 204 replicates the set crop load varied from 12 to 56t/ha. However the actual canning yield at harvest was much lower due to failure of the majority of Tatura 204 fruit to reach processing size and some losses due to brown rot. Four selections were identified as the most consistent, high performers over the three seasons of testing (SAB713) of which three selections ripened within harvest period following Tatura 204 (SAB383, SAB705 and SAB706).

The trial was extended an extra year in 2013 since the age and size difference between the spring budded trees (i.e. Pre-2008 selections with ID numbers less than 727) and the dormant budded trees (i.e. 2008 selections with ID numbers greater than 726) prevented a thorough examination of the productivity potential of the younger and smaller 2008 selections. Selections were evaluated at both low and high crop loads to assess their ability to produce consistent processing yields and to finalise selections to be retained as future breeding germplasm. When SAB383, SAB705 and SAB706 were cropped at 8.5 fruit/TCSA for a second year in succession they could not sustain a high processing yield due to small average fruit size of 104, 83 and 85g respectively (Fig. 6a). However their performance at the low crop load of 2.5 fruit/TCSA confirmed their ability to produce high fruit weights (Fig. 6a) which was previously demonstrated in the first year at a low crop load (Fig. 3). Hence a yearly target crop load of 8.5 fruit/TCSA is too high for these selections and they should be cropped at an amount slightly under 8.5 fruit/TCSA. The only selection able to produce high processing yields at a crop load of 8.5 fruit/TCSA two years in succession was the white fleshed, non-melting selection 695 derived from a YumyeongxT215 cross.

Selection performance

Tables 3 to 5 list productivity, quality and flowering traits of 14 selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen recommended for commercial evaluation and/or retention as breeding germplasm against the standard processing cultivar Tatura 204. A complete set of results for all selections and controls are included in appendix 1 to 3.

Table 2: Fruit productivity and quality traits of seedling block selections for season 2012-13 compared to Tatura 204 and Golden Queen..

2013 selections	Cross	Bloom	Harvest	Fruit weight (g)	Flesh colour	Firm (Kg)	Sugar (^{o}Brix)	Stone tip length[2] (mm)	Stone tip width (mm)	Stone width (mm)	Texture	Appearance and flavour preference (1 – 7 scale[2])	
Tatura 204		T204	26-Jan	115	8	2.2	15.2	1.6	2.8	25.3		6	5
SPCA-01	SAB383 op	T204	10-Feb	99	8	3.2	16.5	1.2	3.0	22.8		6	5
SPCA-02	SAB393 op	Post-T204	10-Feb	170	8	2.7	14.6	4.4	2.8	24.3		6	6
SPCA-03	SAB393 op	Post-T204	10-Feb		8			1.8	3.2	23.9			
SPCA-04	SAB393 op	Post-T204	20-Feb	140	9	4.2	17.7	3.2	2.8	22.5	sh ?	6	5
SPCA-05	SAB393 op	Post-T204	20-Feb	99	8	2.7	14.7	2.8	2.8	23.1		6	6
SPCA-06	SAB383 op	Post-T204	22-Feb	102	9	2.4	18.5	1.5	2.7			4	6
SPCA-07	SAB393 op	Pre-T204	22-Feb	216	8	3.4	16.8	2.9	2.9	29.3		6	6
SPCA-08	SAB383 op	T204	22-Feb	245	8	3.8	17.0	2.8	3.0			6	6
SPCA-09	SAB383 op	Pre-T204	22-Feb	140	8	3.5	17.5	2.5	3.1	21.9		5	6
SPCA-10	SAB383 op	T204	22-Feb	257	8	4.4	17.4	3.1	3.5		sh ?	7	5
SPCA-11	SAB383 self	T204	22-Feb	186	9	3.6	20.4	1.8	3.5			7	6
SPCA-12	SAB383 self	T204	25-Feb	149	9	3.7	15.9	2.6	3.5	23.2		6	5
SPCA-13	SAB383 op	T204	4-Mar	182	8	4.8	21.3	2.9	3.4			6	7
SPCA-14	SAB383 self	Pre-T204	< 7 Mar	162	8	5.1	20.0	3.1	3.5		sh ?	6	7
SPCA-15	SAB393 op	T204	7-Mar	147	9	5.0	16.7	2.3	3.1	25.6	sh	5	5
SPCA-16	SAB383 op	Post-T204	7-Mar	111	8	5.5	15.7	2.9	2.7	21.5	sh	6	6
SPCA-17	SAB383 self	T204	7-Mar	187	8	5.2	22.6	2.0	2.7	25.6	sh ?	7	7
SPCA-18	SAB383 op	Post-T204	7-Mar	140	8	4.3	16.8				sh ?	6	6
SPCA-19	SAB383 self	T204	7-Mar	136	8	2.4	17.7	1.8	3.2	23.6		5	6
SPCA-20	SAB383 self	Pre-T204	7-Mar	140	8	3.8	16.3	1.9	2.8			6	6
SPCA-21	SAB393 op	T204	7-Mar	133	8	4.7	20.9	1.9	3.1	22.1	sh ?	6	7
SPCA-22	SAB383 op		7-Mar	161	9	5.2	19.2	4.0	3.2			6	6
Golden Queen		Post-T204	9-Mar	124	9	1.7	18.0	3.8	3.4	23.7		6	6
SPCA-23	SAB383 op	Post-T204	11-Mar	128	8	5.7	14.9	2.7	2.8	21.8	sh	6	5
SPCA-24	SAB383 self	Post-T204	24-Mar	140		2.8	16.8	2.6	2.6	21.9		5	5

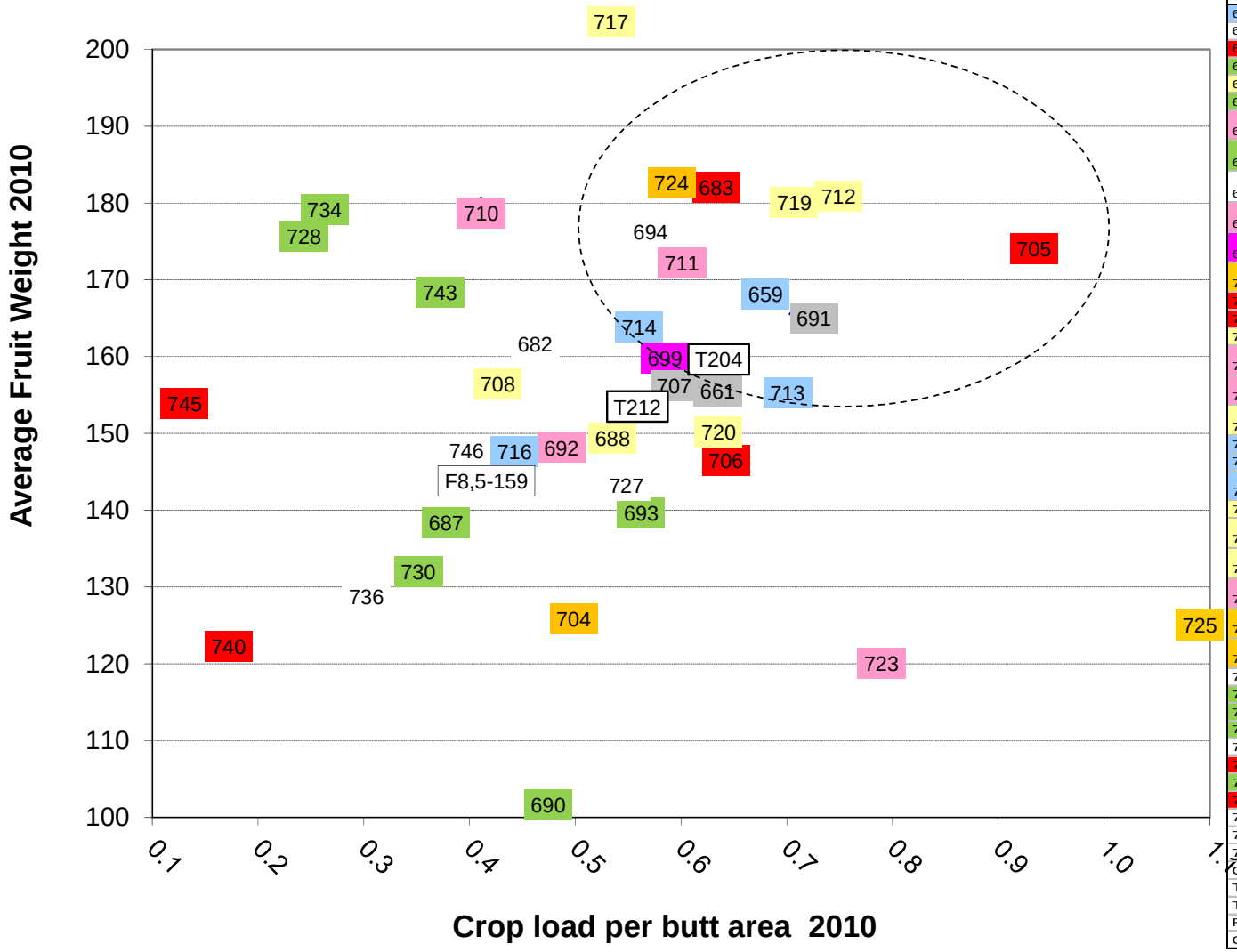
1. A 1 mm width metal plate with a 10 x 2 mm opening is used to standardise the point at which the stone tip emerges from the stone for measurement of stone tip length.

2. Appearance and flavour preference scale from 1 = dislike very much; 4 = neither like nor dislike; 7 = like very much

3. Flesh texture types: sh = stony hard; sh ? = yet to be confirmed as stony hard

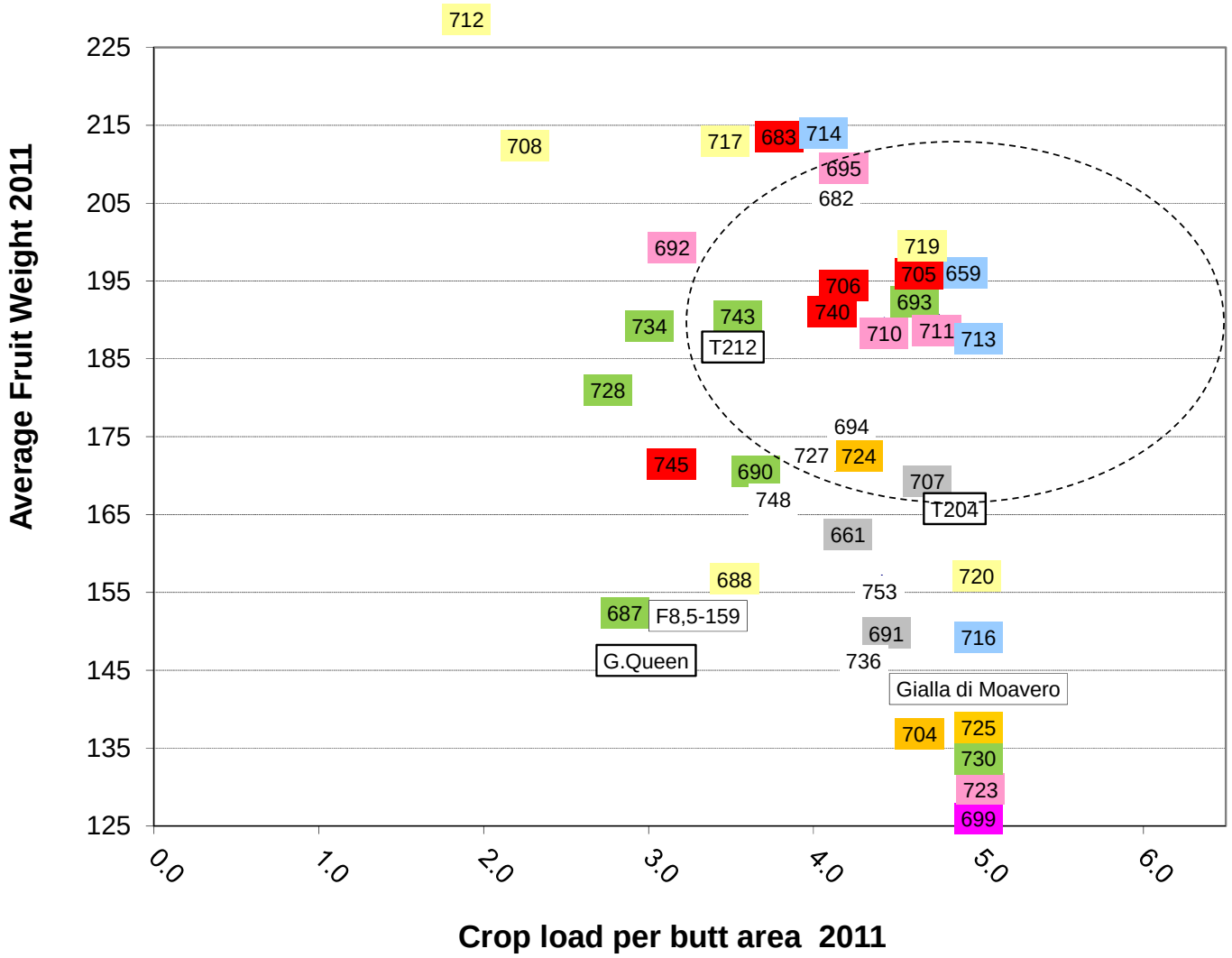
Note: Control results based on replicated trial 2013 data at low crop load.

Fig. 3: Season 2009-10. Average processing yield efficiency (kg/tree/trunk cross sectional area[TCSA]) against crop load efficiency (no. fruit crop loaded/TCSA) of 38 selections, 3 controls (T204, T212 and Golden Queen) and 2 imported cultivars (F8,5-159 and Gialla di Moavero) at low crop load (30 fruit/tree with an average crop load of 0.5 fruit/TCSA). Note: 37 additional selections culled from evaluation in 2012-13 are not shown.



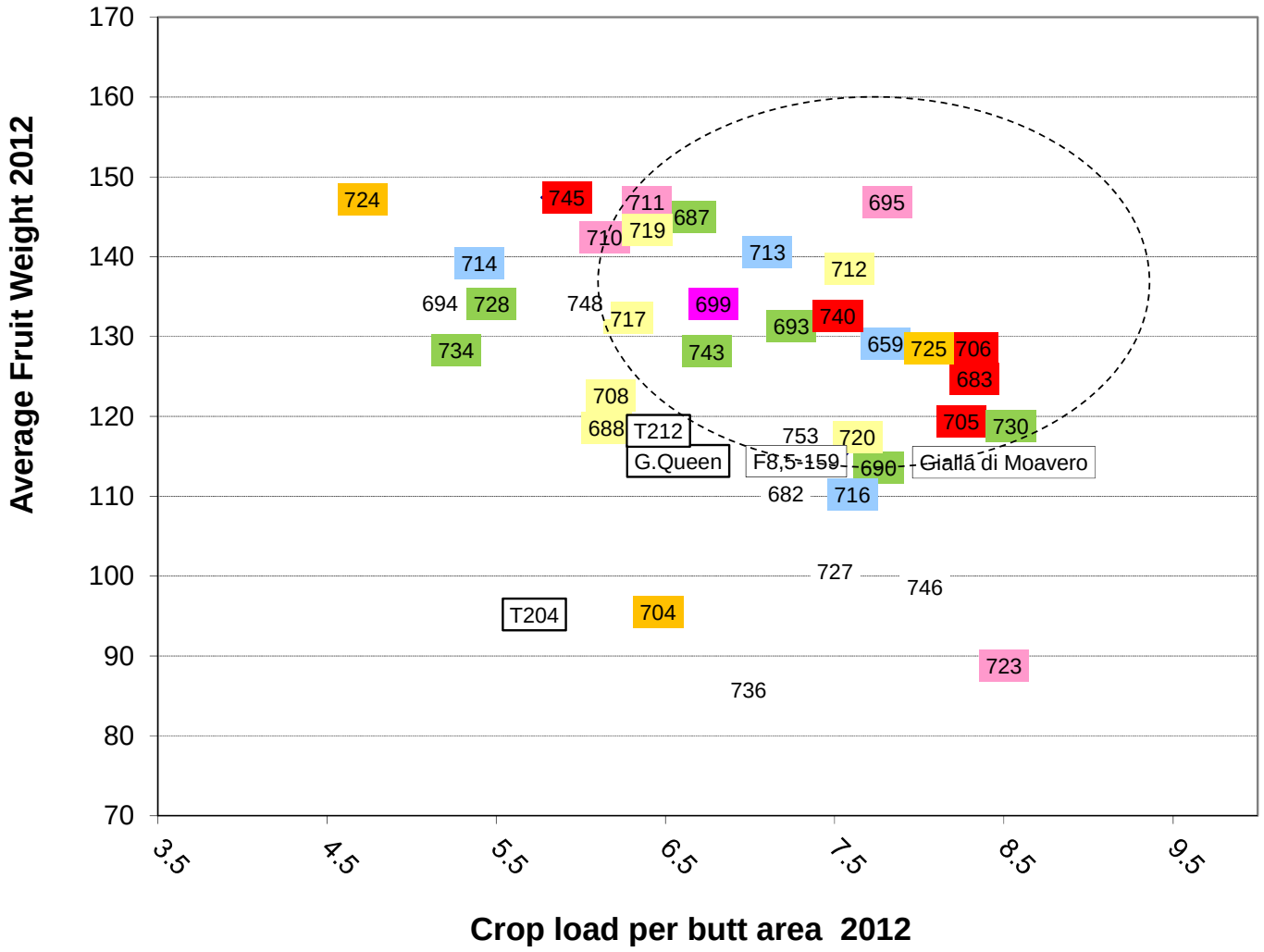
Selection	Cross	Harvest 2010
659	T204 x 7-1-42	09-Mar
682	T212 x B/G 7	10-Feb
683	T212 x B/G 7	12-Feb
687	T212 x Andross	17-Feb
688	T212 x Andross	09-Feb
690	T212 x 3-3-42	06-Mar
692	SAB365 (Yumyeong x Okubo late) x T204	28-Feb
693	SAB365 (Yumyeong x Okubo late) x T204	28-Feb
694	SAB376 (Yumyeong x T215) x OP	18-Feb
695	SAB376 (Yumyeong x T215) x OP	16-Feb
699	SAB151 ((Yumyeong x op) x op	20-Jan
704	SAB379 (Yumyeong x T204) x op	24-Jan
705	T212 x 6-3-8	12-Feb
706	T212 x G/Q	12-Feb
708	T204 x T212	15-Feb
710	SAB365 (Yumyeong x Okubo Late) x T204	19-Feb
711	SAB366 (Yumyeong x Okubo Late) x T204	15-Feb
712	SAB370 (Yumyeong x T215) x op	25-Feb
713	SAB126 x SAB104	22-Feb
714	SAB101 x SAB104	01-Mar
716	SAB388 (Yumyeong x T204) x op	17-Feb
717	T204 x T212	28-Feb
719	T204 x SAB382 (Yumyeong x T215)	27-Feb
720	SAB370 (Yumyeong x T215) x op	04-Mar
723	SAB388 (Yumyeong x T204) x OP	02-Mar
724	SAB388 (Yumyeong x T204) x OP	02-Mar
725	SAB388 (Yumyeong x T204) x OP	07-Mar
727	T204 x T212	18-Jan
728	T204 x T212	07-Mar
730	T204 x T212	27-Jan
734	T204 x Taylor Queen	10-Feb
736	T204 x Taylor Queen	10-Feb
740	T212 x self	17-Feb
743	T204 x T212	12-Feb
745	T212 x self	16-Feb
746	T212 x self	17-Feb
748	T212 x self	14-Feb
753	T212 x Taylor Queen	08-Mar
G. Queen	Unknow n	10-Mar
Tatura 204	B/G 7 x Oom Sarel	31-Jan
Tatura 212	G.Queen x B/G 5	01-Mar
F8,5-159		01-Mar
G. di Moavero		31-Mar

Fig. 4: Season 2010-11. Average processing yield efficiency (kg/tree/trunk cross sectional area[TCSA]) against crop load efficiency (no. fruit crop loaded/TCSA) of 38 selections, 3 controls (T204, T212 and Golden Queen) and 2 imported cultivars (F8,5-159 and Gialla di Moavero) at medium crop load (targeted crop load of 5.0 fruit/TCSA). Note: 37 additional selections culled from evaluation in 2012-13 are not shown.



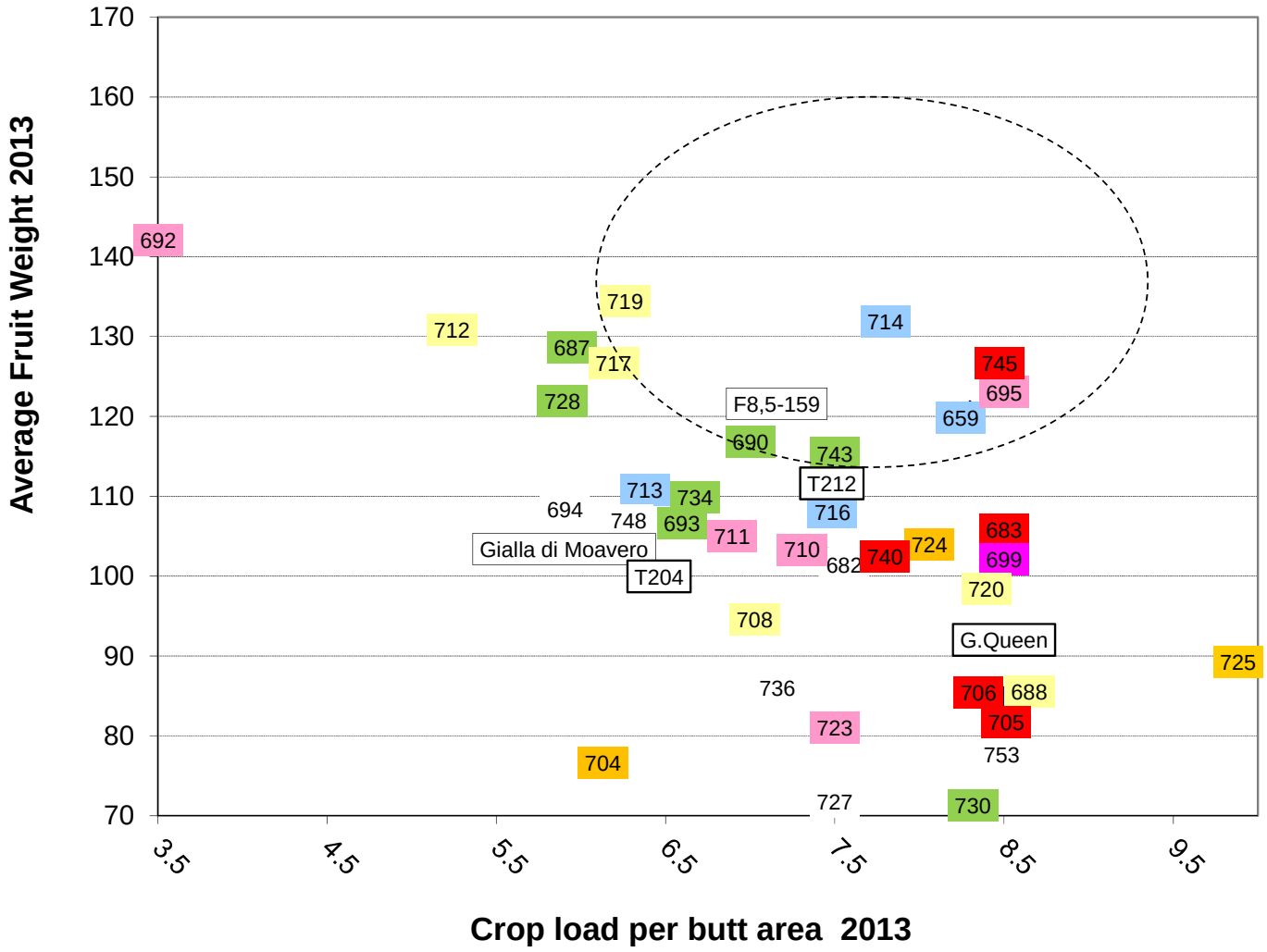
Selection	Cross	Harvest 2011
659	T204 x 7-1-42	01-Mar
682	T212 x B/G 7	09-Feb
683	T212 x B/G 7	12-Feb
687	T212 x Andross	07-Feb
688	T212 x Andross	06-Feb
690	T212 x 3-3-42	09-Mar
692	SAB365 (Yumyeong x Okubo late) x T204	11-Mar
693	SAB365 (Yumyeong x Okubo late) x T204	17-Feb
694	SAB376 (Yumyeong x T215) x OP	08-Feb
695	SAB376 (Yumyeong x T215) x OP	09-Feb
699	SAB151 ((Yumyeong x op) x op	18-Jan
704	SAB379 (Yumyeong x T204) x op	30-Jan
705	T212 x 6-3-8	08-Feb
706	T212 x G/Q	10-Feb
708	T204 x T212	11-Feb
710	SAB365 (Yumyeong x Okubo Late) x T204	08-Feb
711	SAB366 (Yumyeong x Okubo Late) x T204	06-Feb
712	SAB370 (Yumyeong x T215) x op	22-Feb
713	SAB126 x SAB104	15-Feb
714	SAB101 x SAB104	23-Feb
716	SAB388 (Yumyeong x T204) x op	13-Feb
717	T204 x T212	22-Feb
719	T204 x SAB382 (Yumyeong x T215)	26-Feb
720	SAB370 (Yumyeong x T215) x op	28-Feb
723	SAB388 (Yumyeong x T204) x OP	03-Mar
724	SAB388 (Yumyeong x T204) x OP	03-Mar
725	SAB388 (Yumyeong x T204) x OP	05-Mar
727	T204 x T212	18-Jan
728	T204 x T212	05-Mar
730	T204 x T212	29-Jan
734	T204 x Taylor Queen	06-Feb
736	T204 x Taylor Queen	03-Feb
740	T212 x self	09-Feb
743	T204 x T212	07-Feb
745	T212 x self	08-Feb
746	T212 x self	07-Feb
748	T212 x self	06-Feb
753	T212 x Taylor Queen	13-Mar
G. Queen	Unknown	11-Mar
Tatura 204	B/G 7 x Oom Sarel	24-Jan
Tatura 212	G.Queen x B/G 5	25-Feb
F8,5-159		04-Mar
G. di Moavero		29-Mar

Fig. 5: Season 2011-12. Average processing yield efficiency (kg/tree/trunk cross sectional area[TCSA]) against crop load efficiency (no. fruit crop loaded/TCSA) of 38 selections, 3 controls (T204, T212 and Golden Queen) and 2 imported cultivars (F8,5-159 and Gialla di Moavero) at medium crop load (targeted crop load of 8.5 fruit/TCSA). Note: 37 additional selections culled from evaluation in 2012-13 are not shown.



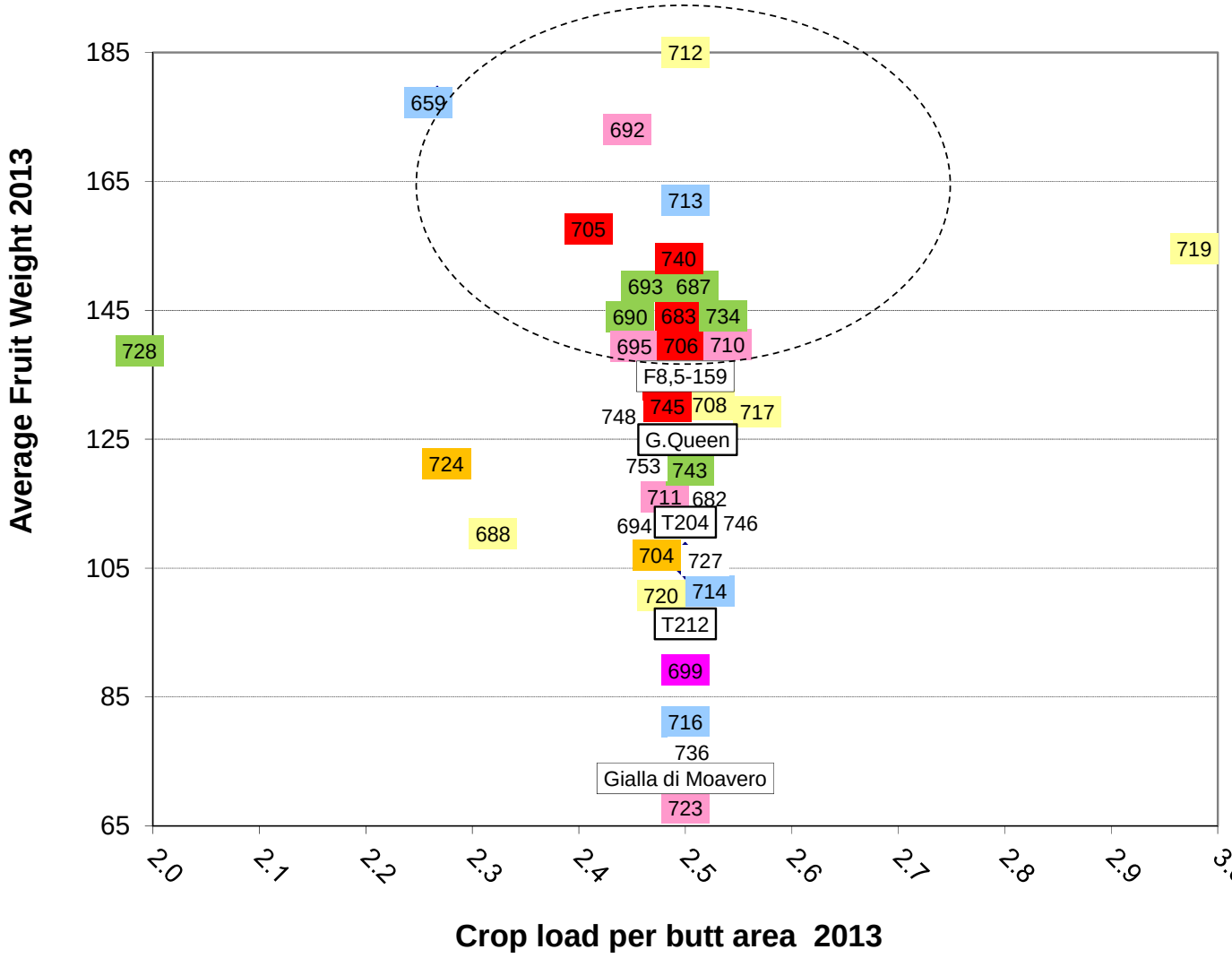
Selection	Cross	Harvest 2012
659	T204 x 7-1-42	24-Feb
682	T212 x B/G 7	01-Feb
683	T212 x B/G 7	04-Feb
687	T212 x Andross	04-Feb
688	T212 x Andross	02-Feb
690	T212 x 3-3-42	01-Mar
692	SAB365 (Yumyeong x Okubo late) x T204	29-Feb
693	SAB365 (Yumyeong x Okubo late) x T204	10-Feb
694	SAB376 (Yumyeong x T215) x OP	30-Jan
695	SAB376 (Yumyeong x T215) x OP	04-Feb
699	SAB151 ((Yumyeong x op) x op	12-Jan
704	SAB379 (Yumyeong x T204) x op	31-Jan
705	T212 x 6-3-8	04-Feb
706	T212 x G/Q	04-Feb
708	T204 x T212	05-Feb
710	SAB365 (Yumyeong x Okubo Late) x T204	07-Feb
711	SAB366 (Yumyeong x Okubo Late) x T204	04-Feb
712	SAB370 (Yumyeong x T215) x op	19-Feb
713	SAB126 x SAB104	14-Feb
714	SAB101 x SAB104	16-Feb
716	SAB388 (Yumyeong x T204) x op	09-Feb
717	T204 x T212	15-Feb
719	T204 x SAB382 (Yumyeong x T215)	16-Feb
720	SAB370 (Yumyeong x T215) x op	21-Feb
723	SAB388 (Yumyeong x T204) x OP	29-Feb
724	SAB388 (Yumyeong x T204) x OP	29-Feb
725	SAB388 (Yumyeong x T204) x OP	26-Feb
727	T204 x T212	07-Jan
728	T204 x T212	25-Feb
730	T204 x T212	26-Jan
734	T204 x Taylor Queen	30-Jan
736	T204 x Taylor Queen	29-Jan
740	T212 x self	07-Feb
743	T204 x T212	03-Feb
745	T212 x self	08-Feb
746	T212 x self	10-Feb
748	T212 x self	11-Feb
753	T212 x Taylor Queen	02-Mar
G. Queen	Unknow n	01-Mar
Tatura 204	B/G 7 x Oom Sarel	15-Jan
Tatura 212	G.Queen x B/G 5	19-Feb
F8,5-159		27-Feb
G. di Moavero		18-Mar

Fig. 6a: Season 2012-13. Average processing yield efficiency (kg/tree/trunk cross sectional area[TCSA]) against crop load efficiency (no. fruit crop loaded/TCSA) of 38 selections, 3 controls (T204, T212 and Golden Queen) and 2 imported cultivars (F8,5-159 and Gialla di Moavero) at high crop load (targeted crop load of 7.5 to 8.5 fruit/TCSA) on 2 to 3 replicate trees. Note: 37 additional selections culled from evaluation in 2012-13 are not shown.



Selection	Cross	Harvest 2013
659	T204 x 7-1-42	01-Mar
682	T212 x B/G 7	08-Feb
683	T212 x B/G 7	13-Feb
687	T212 x Andross	11-Feb
688	T212 x Andross	07-Feb
690	T212 x 3-3-42	04-Mar
692	SAB365 (Yumyeong x Okubo late) x T204	09-Feb
693	SAB365 (Yumyeong x Okubo late) x T204	07-Feb
694	SAB376 (Yumyeong x T215) x OP	07-Feb
695	SAB376 (Yumyeong x T215) x OP	04-Mar
699	SAB151 ((Yumyeong x op) x op	20-Feb
704	SAB379 (Yumyeong x T204) x op	08-Feb
705	T212 x 6-3-8	08-Feb
706	T212 x G/Q	07-Feb
708	T204 x T212	13-Feb
710	SAB365 (Yumyeong x Okubo Late) x T204	09-Feb
711	SAB366 (Yumyeong x Okubo Late) x T204	09-Feb
712	SAB370 (Yumyeong x T215) x op	22-Feb
713	SAB126 x SAB104	19-Feb
714	SAB101 x SAB104	22-Feb
716	SAB388 (Yumyeong x T204) x op	19-Feb
717	T204 x T212	20-Feb
719	T204 x SAB382 (Yumyeong x T215)	19-Feb
720	SAB370 (Yumyeong x T215) x op	25-Feb
723	SAB388 (Yumyeong x T204) x OP	04-Mar
724	(T204 x Yumyeong) x OP	02-Mar
725	SAB388 (Yumyeong x T204) x OP	04-Mar
727	T204 x T212	19-Jan
728	T204 x T212	04-Mar
730	T204 x T212	03-Feb
734	T204 x Taylor Queen	07-Feb
736	T204 x Taylor Queen	09-Feb
740	T212 x self	13-Feb
743	T204 x T212	07-Feb
745	T212 x self	17-Feb
746	T212 x self	19-Feb
748	T212 x self	17-Feb
753	T212 x Taylor Queen	04-Mar
G. Queen	Unknow n	04-Mar
Tatura 204	B/G 7 x Oom Sarel	26-Jan
Tatura 212	G.Queen x B/G 5	20-Feb
F8,5-159		06-Mar
G. di Moavero		29-Mar

Fig. 6b: Season 2012-13. Average processing yield efficiency (kg/tree/trunk cross sectional area[TCSA]) against crop load efficiency (no. fruit crop loaded/TCSA) of 38 selections, 3 controls (T204, T212 and Golden Queen) and 2 imported cultivars (F8,5-159 and Gialla di Moavero) at low crop load (targeted crop load of 2.5 fruit/TCSA) on 2 replicate trees. Note: 37 additional selections culled from evaluation in 2012-13 are not shown.



Selection	Cross	Harvest 2013
659	T204 x 7-1-42	01-Mar
682	T212 x B/G 7	08-Feb
683	T212 x B/G 7	13-Feb
687	T212 x Andross	11-Feb
688	T212 x Andross	07-Feb
690	T212 x 3-3-42	04-Mar
692	SAB365 (Yumyeong x Okubo late) x T204	09-Feb
693	SAB365 (Yumyeong x Okubo late) x T204	07-Feb
694	SAB376 (Yumyeong x T215) x OP	07-Feb
695	SAB376 (Yumyeong x T215) x OP	04-Mar
699	SAB151 ((Yumyeong x op) x op	20-Feb
704	SAB379 (Yumyeong x T204) x op	08-Feb
705	T212 x 6-3-8	08-Feb
706	T212 x G/Q	07-Feb
708	T204 x T212	13-Feb
710	SAB365 (Yumyeong x Okubo Late) x T204	09-Feb
711	SAB366 (Yumyeong x Okubo Late) x T204	09-Feb
712	SAB370 (Yumyeong x T215) x op	22-Feb
713	SAB126 x SAB104	19-Feb
714	SAB101 x SAB104	22-Feb
716	SAB388 (Yumyeong x T204) x op	19-Feb
717	T204 x T212	20-Feb
719	T204 x SAB382 (Yumyeong x T215)	19-Feb
720	SAB370 (Yumyeong x T215) x op	25-Feb
723	SAB388 (Yumyeong x T204) x OP	04-Mar
724	(T204 x Yumyeong) x OP	02-Mar
725	SAB388 (Yumyeong x T204) x OP	04-Mar
727	T204 x T212	19-Jan
728	T204 x T212	04-Mar
730	T204 x T212	03-Feb
734	T204 x Taylor Queen	07-Feb
736	T204 x Taylor Queen	09-Feb
740	T212 x self	13-Feb
743	T204 x T212	07-Feb
745	T212 x self	17-Feb
746	T212 x self	19-Feb
748	T212 x self	17-Feb
753	T212 x Taylor Queen	04-Mar
G. Queen	Unknown	04-Mar
Tatura 204	B/G 7 x Oom Sarel	26-Jan
Tatura 212	G.Queen x B/G 5	20-Feb
F8,5-159		06-Mar
G. di Moavero		29-Mar

Stony hard selections

A large proportion of the high productive selections had Yumyeong in their parental background from which the stony hard gene was derived. This indicates that the source of the stony hard gene has not only provided potential to improve the consistency of fruit quality but has also improved the productive performance of the peach processing germplasm.

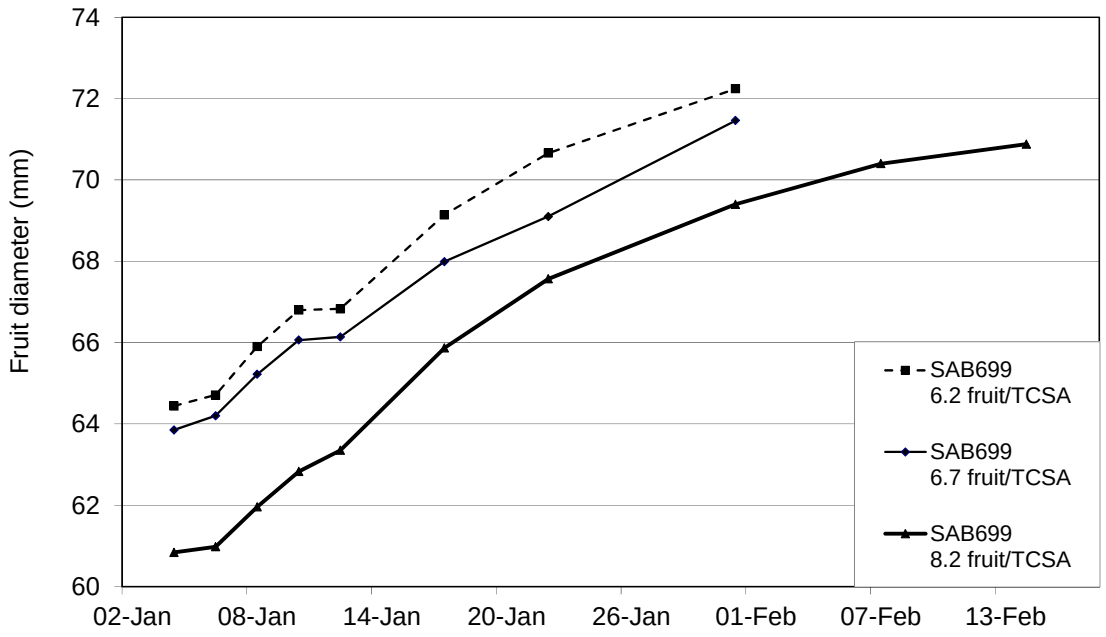
SAB719 and SAB712 derived from a Yumyeong x Tatura 215 cross were retained as breeding germplasm for fruit weight and as a potential heterozygous sources of the stony hard gene. They both showed significantly higher average fruit weights of 174 and 187g respectively compared to 142g on Tatura 204 (Table 3). They also displayed significantly higher sugar levels of 17.7 and 16.6 ^{o}brix respectively compared to 13.6 ^{o}brix on Tatura 204 (Table 4). The percentage fruit set of SAB719 was similar to Tatura 204 but this selection had significantly higher numbers of buds on a standard 40cm lateral due to a greater number of triple buds. SAB712 similarly had a significantly higher number of buds due to the presence of more triple and quad buds than Tatura 204, however it had a much lower percentage fruit set of 13.5% compared to 27.7% on Tatura 204. This tendency for lower fruit set was exemplified by variable crop loads between seasons of 2.7, 2.1, 8.3 and 5.3 fruit/TCSA in 2010, 2011, 2012 and 2013 respectively.

Another stony hard selection SAB725 from an open pollinated cross between Yumyeong and Tatura 204 produced a homozygous stony hard, non-melting yellow-orange fleshed cultivar. SAB725 produced consistent fruit weights each season of 137g, 136g and 134g at increasing crop loads of 1.2, 5.0 and 8.1 fruit/TCSA respectively. In season 2013 it was cross pollinated and not thinned with a crop load of 9.9 fruit/TCSA. At this crop load the fruit failed to achieve processing size with an average fruit weight of 89g. SAB725 had a similar average fruit weight to Tatura 204 and a processing yield/TCSA of 0.33, twice that of Tatura 204 (Table 3). However the processing yield differences were not significant, reflecting the large effect of environment on yields and low heritability. SAB725 had a significantly later full bloom date to Tatura 204 that was more similar to Golden Queen and had a tendency for a greater amount of triple buds. It was recommended for commercial assessment on one orchard and will be included as a control in the next replicated productivity trial of further stony hard, yellow fleshed selections generated from selfed and open pollinated crosses of SAB383 and SAB393 bred in 2009.

SAB724 is from the same cross as SAB725 but has a red stone and some red pigmentation in the flesh which makes it unsuitable for processing. However it has a significantly higher level of sugar at 18.7 ^{o}brix compared to 13.6 ^{o}brix for Tatura 204, and improved eating quality with an average point score rating of 6.4 out of a maximum of 7. It has been retained as breeding germplasm for both improved flavour and a heterozygous source of the stony hard gene in a yellow fleshed background.

SAB695 was the most promising non-melting, white fleshed selection originally derived from a Yumyeong x Tatura 215 cross. It reaches full bloom significantly after Tatura 204 and before Golden Queen, ripens in the same harvest period as Golden Queen and has similar flowering traits to Tatura 204. SAB695 did not fruit in 2010, but in 2011 and 2012 produced significantly higher fruit weights than Tatura 204 of 207 and 144g at increasing fruit set/TCSA of 4.6 and 9.9 fruit respectively. In 2013 it was again able to set a high amount of fruit (10.1 fruit/TCSA) which was significantly higher than Tatura 204 (5.5 fruit/TCSA) to produce high processing yields at a crop load of 8.5 fruit/TCSA two years in succession. SAB965 also had an overall significantly greater sugar level of 16.4 ^{o}brix compared to Tatura 204 (13.6 ^{o}brix). SAB695 had processing yields from 22 to 60t/ha in 2012 based on the planting density of 1000 trees/ha. The flesh tends to brown in the pit following twist pitting and requires further investigation for its suitability for processing.

Fig. 7: Change in fruit diameter of the stony hard selection 699 with an initial harvest on 12 January and final harvest 1 February in 2012.



Selections 699 and 704 highlighted in Fig. 3 to 6 in bright pink and orange respectively have a homozygous stony-hard texture like SAB725. SAB 699 is white fleshed whilst SAB704 is orange fleshed. Fig. 7 shows the growth of selection 699 after an initial harvest on the 12 January 2012 when the fruit had attained processing size. It shows that the fruit continued to grow for a month after the first harvest. Interestingly the growth rate is similar between replicate trees despite the difference in crop loads. SAB699 had a significantly greater processing yield than Tatura 204 of 0.39 kg/TCSA compared to 0.16 kg/TCSA, whilst SAB704 had a processing yield slightly lower than Tatura 204 due to a lower average fruit weight. The average fruit weight of SAB699 at 140g was similar to Tatura 204 at 142g but SAB699 had a slightly higher fruit set of 6.2 compared to 5.2 fruit/TCSA. Its percentage bud set was between that of Tatura 204 and Golden Queen at 35% and a significantly greater number of buds per standard 40cm lateral of 36.7 compared to 23.6 for Tatura 204 due to a greater number of triple buds. SAB699 is likely high chill as it has an average full bloom date of 17 September which is 3 days later than Golden Queen.

A student project was conducted on SAB699 in January 2012 at the University of Western Sydney to determine the quality of the fruit and consumer acceptance in a processed product untreated and treated with ethylene to promote normal ripening (Muhlsimmer et al, 2012a). Flavour of the untreated fruit following processing was deemed unacceptable by an untrained panel and remained firm. Fruit canned after 1 day of ethylene treatment retained their integrity and improved their texture but remained unacceptable for flavour. Following 4 days of ethylene treatment fruit became soft and juicy with acceptable flavour but fruit did not retain their integrity and the syrup became cloudy. It is therefore desirable for processing that stony hard fruit have a non-melting flesh background.

Selections post Tatura 204

The harvest period following Tatura 204 (early Feb) was the highest priority timeslot for the cannery. The most promising selections were SAB705 and SAB706. In addition SAB383, SAB740 and SAB745 showed high productivity but had a more yellow-orange flesh colour than SAB705 and SAB706 and firmer flesh. SAB705 and SAB706 had the same harvest period in

2012 with the first pick on the 4th of February, approximately three weeks after the first pick of Tatura 204 (Table 3). These trees were slightly smaller than the Tatura 204 trees based on their average TCSA, but most trees were able to be cropped loaded to the maximum of 8.5 fruit/TCSA due to their high fruit set.

Overall SAB705 and SAB706 had almost twice the processing yield/TCSA at 0.30 and 0.31 respectively compared to Tatura 204 (0.16 fruit/TCSA; Table 3). Significant differences only occurred in 2012 with processing yields of 0.55 and 0.63 fruit/TCSA for SAB705 and SAB706 respectively compared to 0.16 fruit/TCSA for Tatura 204. It is interesting to compare the differences in harvest yield of replicate trees set at the same crop load at tip change. One tree replicate of SAB705 cropped at 8.5 fruit/TCSA in 2012 produced a yield of 60t/ha (based on 1000 trees/ha) with an average fruit weight of 147g and 8% smalls, whilst another replicate also cropped at 8.5 fruit/TCSA, the tree only achieved 27t/ha with an average fruit weight of 107g and 41% smalls. This demonstrates that large variation can occur between replicates and the need for successive years of evaluation to determine the reliability of a selection for high productivity. Similarly for SAB706, one tree was crop loaded to a potential 95t/ha in spring 2012 based on 8.5 fruit/TCSA. It achieved 55.5t/ha at harvest with an average fruit weight of 148g and 7% smalls. Whilst another 706 tree replicate crop loaded at 8.5 fruit/TCSA in spring only achieved 26t/ha with an average fruit weight of 116g and 23% smalls. As a comparison to the controls, one tree replicate of Tatura 204 was cropped to a maximum of 7.2 fruit/TCSA in 2012 and only achieved a yield of 12t/ha with an average fruit weight of 91g and 64% smalls.

The texture of the selections SAB705 and SAB706 are more similar to Golden Queen than Tatura 204 with firmness at harvest of approximately 3kg (Table 4). Similarly the full bloom period is only one or two days less than that of Golden Queen whilst the flesh colour is orange-yellow similar to Tatura 204. As the parentage of these selections consists largely from Golden Queen their similarity to Golden Queen is not surprising.

Other selections

SAB713 and SAB714 are selections derived from crosses with Tatura Blaze and have a similar harvest period to Tatura Blaze in mid-February. SAB713 had consistently achieved high processing yields based on both high fruit weight and fruit set over the duration of the trial (Fig. 3 to 6). Its processing yield/TCSA was 0.34, slightly higher than that of SAB705 and SAB706 and twice that of Tatura 204 (Table 3). Fruit set was slightly higher in SAB713 (6.7 fruit/TCSA) than Tatura 204 (5.2 fruit/TCSA), possibly due to significantly more triple buds in SAB713 (Table5). It had significantly higher average fruit weight of 163.3g and sugar of 17.1 ^{o}brix compared to 142.2g and 13.6^{o}brix respectively for Tatura 204. However SAB713 had a more yellow-orange flesh colour whilst both Tatura 204 and SAB714 have an orange-yellow flesh colour. SAB714 had higher average fruit weights and higher sugar levels similar to SAB713 which was significantly greater than Tatura 204. However it did not sustain as high processing yield as SAB713 principally due to a lower fruit set of 3.9 fruit/TCSA compared to 5.2 and 6.7 on Tatura 204 and SAB713 respectively.

SAB659 is an orange fleshed selection from a cross between Tatura 204 and 7-1-42 (Taylor Queen x Oom Sarel). It consistently produced good processing yields similar to SAB713 and ripened on the 1st March prior to Golden Queen. It had a full bloom date and flowering traits similar to Tatura 204 but slightly higher fruit set/TCSA of 5.7 fruit compared to 5.2 fruit in Tatura 204.

Table 3: Comparison of productivity traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen recommended for commercial evaluation and/or retention as breeding germplasm against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Parents	Ripe date	5% Lsd[1]	Fruit set			Processing yield			Fruit weight (g)	5% Lsd[1]	Flesh colour
				Fruit/TCSA	(Log)[2]	5% Lsd[1]	kg/TCSA	(sqrt)[3]	5% Lsd[1]			
699	SAB151 x OP	**16-Jan**	**4.9**	6.2	2.0	0.5	**0.39**	**0.62**	**0.20**	140.3	21.4	W
Tatura 204	B/G7 x O/S	23-Jan		5.2	1.8		0.16	0.40		142.2		O-Y
705	T212 x 6-3-8	**08-Feb**	**5.0**	6.3	2.0	0.5	0.30	0.55	0.20	163.3	22.0	O-Y
706	T212 x G/Q	**08-Feb**	**4.7**	5.5	1.9	0.5	0.31	0.55	0.19	159.8	20.6	O-Y
683	T212 x BG7	**09-Feb**	**4.9**	5.1	1.8	0.5	0.34	0.58	0.20	**176.8**	**21.4**	Y-O
745	T212 x self	**09-Feb**	**4.9**	2.4	1.2	0.5	0.20	0.44	0.20	157.3	22.7	Y-O
740	T212 x self	**11-Feb**	**4.7**	3.4	1.5	0.5	0.23	0.48	0.19	151.4	21.1	Y-O
713	SAB126 x Tatura Blaze	**17-Feb**	**4.6**	6.7	2.0	0.5	0.34	0.58	0.19	**163.3**	**20.2**	Y-O
719	T204 x SAB382 (Yumyeong x T215)	**22-Feb**	**4.7**	4.4	1.7	0.5	0.17	0.41	0.19	**174.2**	**21.6**	O-Y
712	SAB370 (Yumyeong x T215) x op	**22-Feb**	**4.7**	3.6	1.5	0.50	0.22	0.47	0.19	**187.1**	**20.6**	W
714	SAB101 x Tatura Blaze	**22-Feb**	**4.6**	3.9	1.6	0.5	0.23	0.48	0.19	**175.7**	**20.2**	O-Y
Tatura 212	G/Q x B/G5	**24-Feb**	**4.6**	3.8	1.6	0.5	0.16	0.40	0.19	154.7	20.2	O
724	(T204 x Yumyeong) x OP	**28-Feb**	**4.7**	4.7	1.7	0.5	0.16	0.39	0.19	162.1	21.1	Y-O
659	T204 x 7-1-42 (T/Q x O/S)	**1-Mar**	**5.0**	5.7	1.9	0.5	0.31	0.56	0.20	163.6	22.0	O
725	SAB388 (Yumyeong x T204) x OP	**1-Mar**	**8.0**	10.4	2.4	0.7	0.33	0.57	0.26	138.4	28.9	Y-O
F8,5-159		**1-Mar**	**4.6**	3.8	1.6	0.5	0.24	0.49	0.19	138.4	20.2	O
695	SAB376 (Yumyeong x T215) x OP	**04-Mar**	**5.4**	4.5	1.7	0.5	**0.56**	**0.75**	**0.22**	**175.6**	**24.8**	W
Golden Queen	Unknown	**06-Mar**	**5.2**	3.3	1.5	0.5	0.26	0.51	0.21	133.3	24.1	O
Gialla di Moavero		**26-Mar**	**5.1**	6.5	2.0	0.5	0.28	0.53	0.21	128.4	23.1	Y

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait.

2. Fruit set/ trunk cross sectional area (TCSA) required a natural log transformation for analysis and was then back-transformed.

3. Processing yield/TCSA required a square root transformation for analysis and was then back-transformed.

B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen; W = white; Y = yellow; O = orange; Y - O = yellow - orange; O - Y = orange - yellow

Table 4: Comparison of fruit quality traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen recommended for commercial evaluation and/or retention as breeding germplasm against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Stone tip length[2]		Stone tip width		Stone width		Firmness		Sugars		Appearance preference		Flavour preference	
	mm	5% Lsd[1]	mm	5% Lsd[1]	mm	5% Lsd[1]	kg	5% Lsd[1]	°Brix	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]
699	1.6	0.6	**2.3**	**0.4**	**22.2**	**2.1**	**6.1**	**1.0**	**16.9**	**2.5**	5.8	0.9	5.8	0.9
Tatura 204	2.1		3.2		25.7		4.1		13.6		5.9		5.8	
705	**2.7**	**0.6**	3.0	0.5	27.0	2.1	**2.7**	**0.9**	13.3	2.2	5.3	0.7	5.4	0.8
706	2.4	0.5	3.2	0.4	27.2	1.9	**2.8**	**0.8**	13.7	2.1	**4.9**	**0.7**	**4.9**	**0.8**
683	2.1	0.6	3.0	0.4	24.9	3.4	3.4	0.8	14.5	2.1	**4.6**	**0.7**	**4.7**	**0.9**
745	2.7	0.6	3.4	0.5	26.8	2.2	4.3	0.9	13.7	2.4	**4.9**	**0.8**	**4.5**	**0.9**
740	**3.5**	**0.6**	3.1	0.4	27.7	2.2	4.2	0.8	13.5	2.1	**4.1**	**0.7**	**4.9**	**0.8**
713	2.5	0.5	3.2	0.4	24.4	1.7	4.3	0.8	**17.1**	**2.0**	**5.1**	**0.7**	**4.9**	**0.7**
712	2.5	0.5	3.0	0.4	25.2	1.8	4.2	0.8	**17.7**	**2.0**	**5.1**	**0.7**	5.5	0.8
719	2.4	0.6	2.8	0.5	25.8	2.2	3.8	0.8	**16.6**	**2.2**	5.7	0.7	5.3	0.8
714	**2.8**	**0.5**	**2.8**	**0.4**	**23.5**	**1.9**	3.8	0.8	**17.2**	**2.0**	**5.1**	**0.7**	6.4	0.7
Tatura 212	2.6	0.5	**3.8**	**0.4**	25.9	1.8	**3.1**	**0.8**	15.4	2.0	**4.5**	**0.7**	**5.0**	**0.8**
724	2.6	0.5	3.5	0.4	**22.9**	**1.8**	3.7	0.8	**18.7**	**2.0**	5.3	0.7	6.4	0.7
659	2.5	0.5	3.6	0.4	26.6	1.7	4.1	0.8	15.4	2.0	**5.1**	**0.6**	**5.0**	**0.7**
725	2.3	0.6	2.8	0.5	**21.2**	**1.8**	3.9	1.0	**17.1**	**2.5**	5.4	0.8	5.0	0.9
F8,5-159	2.3	0.5	**4.0**	**0.4**	**23.3**	**1.6**	4.0	0.7	15.0	1.8	5.9	0.6	5.2	0.7
695	**3.1**	**0.6**	3.2	0.4	**23.8**	**1.6**	**3.0**	**0.8**	**16.4**	**2.1**	5.3	0.7	5.8	0.8
Golden Queen	**3.2**	**0.6**	**3.9**	**0.5**	24.2	1.7	**3.0**	**0.8**	**16.8**	**2.1**	5.5	0.7	5.4	0.8
Gialla di Moavero	2.6	0.5	3.6	0.4	**23.1**	**1.6**	**2.7**	**0.8**	**15.7**	**2.2**	5.4	0.8	5.7	0.8

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait.

2. 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.

3. Appearance and flavour preference scale from 1 = dislike very much; 4 = neither like nor dislike; 7 = like very much

PYE = Processing yield efficiency (kg processing fruit per trunk cross sectional area [TCSA]); B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen

Table 5: Comparison of flowering traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen recommended for commercial evaluation and/or retention as breeding germplasm against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Full bloom		Bloom period		Bud set		Buds per 40cm lateral		Bud positions per 40cm lateral		% Bud types			
	Date	5% Lsd[1]	Days	5% Lsd[1]	%	5% Lsd[1]	No.	5% Lsd[1]	No.	5% Lsd[1]	Single	Double	Triple	Quad
699	**17-Sep**	**1.7**	11.1	2.3	35.0	22.5	**36.7**	**7.5**	**20.8**	**4.1**	20	59	**22**	0
Tatura 204	31-Aug		12.1		27.7		23.6		15.0		32	64	4	0
705	**14-Sep**	**1.7**	12.9	2.3	**57.4**	**22.5**	22.1	7.5	13.5	4.1	25	64	9	0
706	**14-Sep**	**1.7**	13.1	2.2	**53.4**	**21.2**	18.3	7.1	12.9	3.9	44	52	4	0
683	**12-Sep**	**1.8**	13.1	2.4	50.0	22.5	20.9	7.5	14.2	4.1	49	38	14	0
745	**13-Sep**	**1.6**	12.3	2.2	37.3	21.2	19.7	7.1	12.2	3.9	25	75	0	0
740	**12-Sep**	**1.6**	12.3	2.2	44.4	21.2	19.0	7.1	15.1	3.8	**60**	40	0	0
713	**11-Sep**	**1.7**	11.4	2.2	25.7	21.2	28.1	7.1	16.1	3.9	23	50	**27**	0
712	**09-Sep**	**1.6**	**9.9**	**2.2**	13.5	21.2	**37.0**	**7.1**	17.9	3.9	13	45	**38**	**5**
719	**11-Sep**	**1.7**	12.8	2.2	30.0	21.2	**32.5**	**7.1**	17.6	3.9	19	50	**28**	4
714	**14-Sep**	**1.7**	14.0	2.2	31.2	21.2	28.5	7.1	18.3	3.9	39	**37**	**22**	3
Tatura 212	**12-Sep**	**1.6**	12.2	2.2	47.4	21.2	18.3	7.1	11.8	3.9	35	63	1	0
724	**10-Sep**	**1.6**	10.6	2.2	20.0	21.2	**32.7**	**7.1**	18.3	3.9	15	74	11	0
659	31-Aug	1.7	12.1	2.3	32.3	22.5	24.3	7.5	15.1	4.1	26	75	0	0
725	**19-Sep**	**2.9**	10.4	3.8	21.4	36.8	27.7	12.3	15.0	6.7	19	51	29	0
F8,5-159	**04-Sep**	**1.6**	**9.5**	**2.2**	36.8	21.2	21.1	7.1	14.8	3.9	46	46	8	0
695	**09-Sep**	**1.7**	11.0	2.3	34.6	22.5	23.6	7.5	15.3	4.1	32	61	7	0
Golden Queen	**14-Sep**	**1.6**	13.4	2.2	49.6	21.2	17.0	7.1	11.6	3.9	48	47	5	0
Gialla di Moavero	**20-Sep**	**1.6**	13.1	2.2	36.8	21.2	**14.5**	**7.1**	11.6	3.8	**60**	40	0	0

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait. .

PYE = Processing yield efficiency (kg processing fruit per trunk cross sectional area [TCSA]); B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen

Discussion

Breeding strategy

The ongoing breeding program aims to develop new yellow fleshed cultivars with resistance to brown rot, improved productivity and handling through inclusion of the stony hard gene into the existing processing lines and extension of the harvest season.

For season extension

In addition to a significantly later harvest date on 26 March, 3 weeks later than Golden queen, the late season parent Gialla di Moavero also has a very late full bloom date following Golden Queen and a significantly higher fruit set than Tatura 204. Consequently it is preferential to cross Gialla di Moavero with an early flowering, late season selections that do not set fruit heavily to extend the fruit season.

For brown rot resistance

The full bloom and harvest dates for the brown rot resistant cultivar F8,5-159 was 4 Sept (4 days later than Tatura 204) and 1 March (5 days prior to Golden queen) respectively. Hence F8,5-159 has a suitable full bloom period for the Goulburn Valley with a chill requirement of 759 hours, about 100 hours greater then Tatura 204 in 2012. F8,5-159 is to be crossed with processing cultivars with high productivity that have both fruit weight and fruit set at least as high as Tatura 204.

For stony hard gene in combination with brown rot resistance

The stony hard trait prevents the natural production of ethylene that controls many enzymes associated with ripening (Gamberini, 2006), and is controlled by a single recessive gene (hd) [Haji et al, 2005]. Since the stony hard gene was originally derived from the Korean cultivar Yumyeong, with white melting flesh, the first generation of crossing between Yumyeong and the yellow fleshed processing cultivar Tatura 215 generated progeny all recessive for the stony hard gene, as well as the genes for yellow flesh and melting texture.

In 2009 selfed crosses of SAB383 (Yumyeong x Tatura 215) were performed to produce $^{1}/_{16}$ yellow fleshed selections suitable for processing, of which $^{1}/_{64}$ of the population were yellow fleshed, non-melting, homozygous stony hard selections (Fig. 1).

Third generation crosses between F8,5-159 and stony hard selections (i.e. SPCA-16 and SPCA-23; Photo 1) recently identified from self and open pollinated crosses of SAB383 and SAB393 will be undertaken in 2013-14. This cross will again generate the stony hard gene in the recessive, heterozygous state (Fig. 8). In 2012 the yellow fleshed, non-melting, stony hard selection SAB725 was also crossed with F8,5-159 to produce brown rot resistant cultivars in a recessive stony hard background.

A fourth generation of breeding is required for the recessive stony hard gene to be expressed in selections in combination with potential brown rot resistance (Fig. 8). Selfing will generate a typical 3:1 Mendelian segregation for non-stony hard and stony hard progeny such that a quarter of the progeny will be stony hard and three quarters non-stony hard. Those that are recessive for the stony hard gene would not be obvious based on the phenotype but all would be suitable for processing due to the dominant expression of the non-melting genes through the use of two non-melting parents in the cross.

A brown rot resistant stony hard cultivar will bring benefits to both the fruit growers in terms of high productivity, reduced chemical usage for brown rot control and a one-pick harvest, and to

the processor in terms of a “clean and green” product that can be harvested at a set soluble solids level to produce a higher quality, uniform product.

Genomic markers are ideally required to enable populations of segregating seedlings to be screened for the combination of stony hard, non-melting flesh and yellow flesh genes. As all these genes are recessive, the efficiency of breeding would be significantly increased as young seedlings could be tested and the majority discarded that do not have the combination of these genes rather than having to wait for fruit to be available for testing.

In the absence of a suitable molecular marker for stony hard, cross pollination should only be made with non-melting yellow fleshed stony hard selections to produce seedlings populations that only contain progeny heterozygous for stony hard, and non-melting and thus all suitable for use as processing fleshed cultivars. Until a more reliable molecular marker is developed for stony hard, the only other method to detect homozygous stony hard fruit in a processing peach background is to treat the fruit with ethylene and to measure softening of the flesh (Mignani et al, 2006). The ethylene emission of some potential stony hard selections from the SPC-Ardmona breeding program has already been tested by the University of Western Sydney in 2013 to confirm their status.

Productivity evaluation strategy

Narrow sense heritability determines the degree to which traits are transmitted from parents to progeny. Heritability estimates can be used to determine which phenotypic traits or combination of traits will predict the greatest selection response for improved productivity. Processing yield has a relatively low narrow-sense heritability compared to its secondary productivity traits fruit set and mean fruit weight. This is based on a pedigree-based genetic analysis of peach productivity traits using multi-year repeated measures data of Tatura processing peach breeding germplasm and selections from 2006 to 2009 at DEPI. The data indicated that greater genetic gain was achievable by selection from the combination of mean fruit set and fruit weight rather than solely based on processing yield or processing yield /TCSA.

There was also strong correlation between years for some traits indicating that the future response of some traits can be predicted. For the first year to be a reliable indicator of the performance in later years, the narrow sense heritability in the first year and in the later years, and the additive genetic correlations between these years need to be high. The results suggested that first year’s performance was likely to be a good indicator of the performance in later years for mean fruit weight, whilst the second year is a more reliable predictor for processing yield. Although the heritability of processing yield was less than 20% in all years, there was a high correlation between years for its breeding values. Interestingly, the expression of yield based on tree size (i.e. yield /TCSA) did not improve heritability estimates.

Seed extraction and stratification strategy

Fruit set has ranged from 22 to 48% over the four seasons of cross breeding with an average fruit set rate of 33% compared to around 20% achieved in the previous breeding program by DPI Victoria. However for the last two seasons seedling production has been reduced due to seed loss from fungal infection, and in 2012 by a late frost in October shortly after planting.

Seed are initially dry stored following harvest and then stratified in moistened perlite or vermiculite for approximately 3 months to induce emergence of the radicles. Once seed are removed from the stone they appear to become more susceptible to infection, and then once seed become infected removal of the infected area and re-application of a fungicidal treatment do not significantly improve germination rates. Previous research by DPI Victoria has indicated that the source of the fungal infection is from below the testa or within the embryo and was principally due to *pythium* and *penicillium,* whilst *botrytis* was the main cause of seedling rots. The most successful treatments were the fungicides Bogard (100g/kg Difenoconazole) and

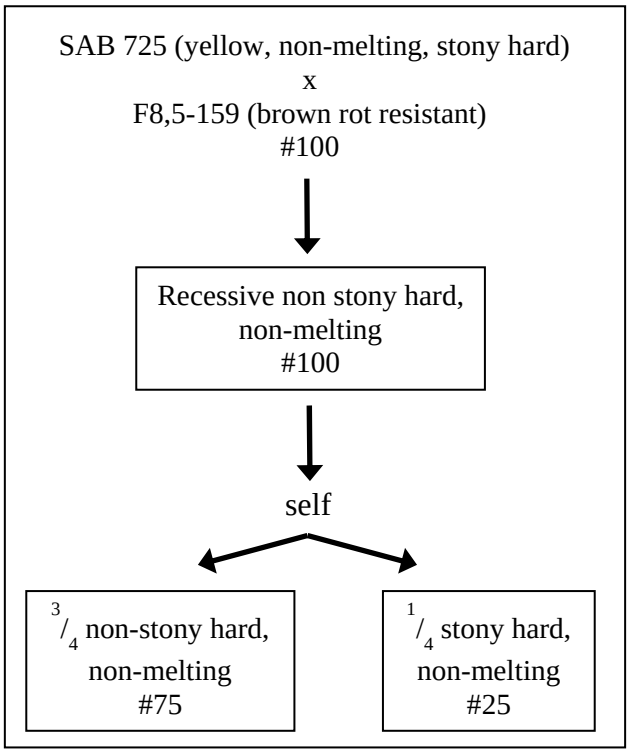
Rovral (500g/L Iprodione) and the biological control agent *Tricoderma harzianum*. Adequate protectant fungicides on the cross pollinated trees during the flowering period also reduce subsequent fungal infections in the seeds.

Protocols associated with seed stratification and seedling production were reviewed in 2012 (Appendix 4). A comparison of seed condition at the end of stratification in 2013 showed that fungal infection of seed previously stored in the stone was significantly lower than seed extracted immediately after harvest. It appears that the intact stone helps protect the seed from fungal infection during storage in addition to the application of fungicides and biological control agents. Hence it is now recommended that seed are dry stored in the stone rather than immediately extracted following harvest. In addition the stones need to be removed from the fruit flesh within a couple of days of harvest and immediately dried to reduce fungal infection.

Commercialisation

Agriculture Victoria Services (AVS), the commercial arm of the Department of Environment and Primary Industries (DEPI), manage the commercialisation of cultivars that where bred prior to the transfer of the canning peach breeding program from DEPI to a private program run by SPC-Ardmona at Toolamba. This arrangement includes SAB104 ("Tatura Blaze) which was protected by Plant Breeders Rights in 2010 (Plant Varieties Journal 23(4) 78-79; 190-194). AVS have developed a Maximum Adoption Plan and a Plant Variety Licence (PVL) for Tatura Blaze. Upon agreement with DEPI, SPC-Ardmona is the licence holder for Tatura Blaze. They are responsible for the commercial release of propagated material to growers in association with non-propagation agreements. Almost 16,000 trees of Tatura Blaze have been established in the Goulburn Valley over the last four years. A Commercialisation / Evaluation Plan and an evaluation & Licence Option Agreement were also developed for the peach breeding germplasm transferred to SPC-Ardmona.

Fig. 8: Proportion of yellow, non-melting, stony hard and non-stony hard types of progeny expected from the third and fourth generation of crosses required to combine yellow, stony hard flesh colour with brown rot resistance. The yellow fleshed progeny suitable for processing are highlighted in the text boxes.



Technology Transfer

Outcomes of the project are evaluated firstly by the number of peach varieties selected for commercial evaluation on fruit growers' orchards over the last 4 years:

SAB572 – planted in 5 blocks	2,100 trees	2012
SAB705 – planted in 5 blocks	1,200 trees	2013
SAB706 – planted in 5 blocks	1,200 trees	2013
SAB725 – planted in 1 block	120 trees	2013

Secondly by the success of these selections under commercial evaluation in terms of the planting rate of new cultivars released from the breeding program:

Tatura Blaze (released 2009) – planted	6,570 trees	2011
	18,880 trees	2012

Recommendations

Two selections SAB705 and SAB706 that ripen after Tatura 204 in early February were recommended for commercial evaluation in 2012. Three other selections (SAB383, SAB740 and SAB745) with high productivity were identified in this same harvest period with a more yellow-orange flesh colour and firmer flesh that will be retained as breeding germplasm. SAB695 is a white fleshed, non-melting selection with high processing yields combined with consistent fruit set and high fruit sizing potential that is recommended for testing in the future if the industry resume processing white fleshed peaches. Several heterozygous and homozygous stony hard selections with high productivity have been identified and retained as future breeding germplasm. The yellow, non-melting, stony hard selection SAB725 was recommended for commercial testing on one orchard in 2012 and for inclusion in the next replicated productivity trial of further stony hard, yellow fleshed selections.

Publications

Tatura Blaze variety application. 2010. Plant Varieties Journal 23(4) 78-79; 190-194.

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Appendix 4: Seed stratification strategy.

Appendix 5: DPI Germplasm

Appendix 1: Comparison of productivity traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Parents	Ripe date	5% Lsd[1]	Fruit set			Processing yield			Fruit weight (g)	5% Lsd[1]	Flesh colour
				Fruit/TCSA	(Log)[2]	5% Lsd[1]	kg/TCSA	(sqrt)[3]	5% Lsd[1]			
657	T204 x T212 (G/Q x B/G5)	**27-Feb**	**4.8**	3.2	1.4	0.50	0.11	0.33	0.20	135.1	21.6	Y
659	T204 x 7-1-42 (T/Q x O/S)	**29-Feb**	**5.0**	5.7	1.9	0.53	0.31	0.56	0.20	163.6	22.0	O
661	T204 x T212	**01-Mar**	**5.0**	5.8	1.9	0.50	0.27	0.52	0.20	136.3	22.3	O-Y
674	T204 x T212	**06-Feb**	**4.6**	3.7	1.6	0.50	0.16	0.40	0.19	**166.0**	**20.2**	O-Y
677	T204 x 7-1-42	**03-Mar**	**5.1**	5.1	1.8	0.50	**0.39**	**0.63**	**0.21**	150.2	23.1	O
680	T204 x 7-1-42	**27-Feb**	**4.7**	**1.9**	**1.1**	**0.50**	0.12	0.34	0.19	135.7	21.1	O
682	T212 x BG7	**06-Feb**	**4.7**	4.5	1.7	0.53	0.23	0.48	0.20	158.6	21.1	O-Y
683	T212 x BG7	**09-Feb**	**4.9**	5.1	1.8	0.53	0.34	0.58	0.20	**176.8**	**21.4**	Y-O
685	T212 x BG7	**12-Jan**	**5.0**	3.3	1.5	0.50	0.29	0.54	0.20	143.2	22.3	Y-O
686	T212 x Andross	**07-Feb**	**4.6**	3.2	1.4	0.50	0.18	0.42	0.19	147.7	20.8	Y-O
687	T212 x Andross	**09-Feb**	**5.1**	3.0	1.4	0.53	0.23	0.48	0.20	145.6	23.2	Y-O
688	T212 x Andross	**06-Feb**	**4.6**	4.2	1.6	0.50	0.18	0.43	0.19	143.4	20.2	O-Y
690	T212 x 3-3-42 (O/S op)	**05-Mar**	**4.7**	4.9	1.8	0.50	0.16	0.40	0.19	134.3	21.1	O-Y
691	T212 x 3-3-42	**05-Mar**	**5.0**	5.5	1.9	0.50	0.22	0.47	0.20	140.9	22.3	Y-O
692	SAB365 (Y x O/L) x T204	**09-Feb**	**4.7**	2.8	1.3	0.50	0.22	0.47	0.19	**177.3**	**21.3**	W
693	SAB365 (Y x O/L) x T204	**16-Feb**	**5.0**	4.3	1.7	0.50	0.22	0.47	0.19	151.7	22.3	W
694	SAB376(Y x T215) x OP	**07-Feb**	**4.8**	3.9	1.6	0.50	0.13	0.36	0.19	161.4	21.9	W
695	SAB376(Y x T215) x OP	**04-Mar**	**5.4**	4.5	1.7	0.53	**0.56**	**0.75**	**0.22**	**175.6**	**24.8**	W
696	SAB336(7-1-42 OP) x OP	**15-Jan**	**5.3**	3.8	1.6	0.53	**0.52**	**0.72**	**0.22**	**177.6**	**23.7**	W
697	T204 x 2-1-39 (G/Q x Coronado)	**14-Jan**	**4.9**	7.1	2.1	0.53	0.08	0.28	0.20	**103.0**	**21.4**	O-Y
698	T204 x Jing Yu	**16-Jan**	**4.9**	4.5	1.7	0.53	0.10	0.31	0.20	**118.5**	**21.4**	Y-O
699	SAB151 x op	**16-Jan**	**4.9**	6.2	2.0	0.53	**0.39**	**0.62**	**0.20**	140.3	21.4	W
702	T212 x 6-3-8 (T/Q x O/S)	**29-Jan**	**5.0**	3.6	1.5	0.53	0.12	0.35	0.20	144.2	22.0	O
703	T212 x 6-3-8	**13-Jan**	**5.3**	4.0	1.6	0.57	0.26	0.51	0.22	131.0	23.3	O-Y

Selections	Parents	Ripe date	5% Lsd[1]	Fruit set			Processing yield			Fruit weight (g)	5% Lsd[1]	Flesh colour
				Fruit/TCSA	(Log)[2]	5% Lsd[1]	kg/TCSA	(sqrt)[3]	5% Lsd[1]			
704	SAB379 (Y x T204) x op	**28-Jan**	**4.9**	4.5	1.7	0.53	0.10	0.32	0.20	121.1	21.4	Y-O
705	T212 x 6-3-8	**08-Feb**	**5.0**	6.3	2.0	0.54	0.30	0.55	0.20	163.3	22.0	O-Y
706	T212 x G/Q	**08-Feb**	**4.7**	5.5	1.9	0.50	0.31	0.55	0.19	159.8	20.6	O-Y
707	T204 x T/Q	**08-Feb**	**4.7**	5.8	1.9	0.50	0.22	0.47	0.19	148.0	20.6	O-Y
708	T204 x T212	**10-Feb**	**4.7**	3.4	1.5	0.50	0.18	0.42	0.19	**164.8**	**21.3**	O-Y
709	T204 x 7-1-42	**13-Feb**	**4.7**	3.8	1.6	0.50	0.15	0.39	0.19	136.3	21.1	O
710	SAB365 (YxO/L) x T204	**11-Feb**	**4.6**	4.0	1.6	0.50	0.30	0.55	0.19	**171.8**	**20.2**	W
711	SAB366 (YxO/L) x T204	**08-Feb**	**4.8**	4.8	1.8	0.50	0.27	0.52	0.19	**165.6**	**22.3**	W
712	SAB370 (Y x T215) x op	**22-Feb**	**4.7**	3.6	1.5	0.50	0.22	0.47	0.19	**187.1**	**20.6**	W
713	SAB126 x T.Blaze	**17-Feb**	**4.6**	6.7	2.0	0.50	0.34	0.58	0.19	**163.3**	**20.2**	Y-O
714	SAB101 x T.Blaze	**22-Feb**	**4.6**	3.9	1.6	0.50	0.23	0.48	0.19	**175.7**	**20.2**	O-Y
715	T204 x SAB369 (Y x T215)	**21-Feb**	**4.7**	**2.1**	**1.1**	**0.50**	0.14	0.37	0.19	**191.4**	**21.3**	W
716	SAB388 (YxT204) x op	**12-Feb**	**5.3**	5.9	1.9	0.57	0.23	0.48	0.22	134.0	23.3	Y-O
717	T204 x T212	**21-Feb**	**5.0**	3.9	1.6	0.53	0.30	0.54	0.20	**181.4**	**22.0**	O-Y
718	SAB126 x T.Blaze	**29-Feb**	**4.8**	3.6	1.5	0.50	0.19	0.44	0.20	154.6	21.6	O-Y
719	T204 x SAB382 (Y x T215)	**22-Feb**	**4.7**	4.4	1.7	0.50	0.17	0.41	0.19	**174.2**	**21.6**	O-Y
720	SAB370 (Y x T215) x op	**26-Feb**	**4.7**	7.0	2.1	0.50	0.15	0.39	0.19	140.3	21.3	O-Y
721	T212 x BG7	**28-Feb**	**5.0**	3.2	1.4	0.53	0.19	0.43	0.20	**178.1**	**22.0**	O-Y
722	T204 x 7-1-42	**29-Feb**	**5.3**	4.2	1.6	0.53	0.27	0.52	0.22	157.7	23.7	O-Y
723	SAB388(Y x T204) x OP	**01-Mar**	**4.9**	8.9	2.3	0.53	0.09	0.30	0.20	**113.9**	**21.4**	W
724	(T204 x Y) x OP	**28-Feb**	**4.7**	4.7	1.7	0.50	0.16	0.39	0.19	162.1	21.1	Y-O
725	SAB388(Y x T204) x OP	**29-Feb**	**8.0**	10.4	2.4	0.71	0.33	0.57	0.26	138.4	28.9	Y-O
726	T212 x self	**12-Jan**	**5.3**	3.5	1.5	0.53	0.29	0.54	0.22	134.9	23.7	Y-O
727	T204 x T212	**13-Jan**	**4.7**	4.3	1.7	0.51	0.24	0.49	0.19	140.8	21.1	O-Y
728	T204 x T212	**02-Mar**	**5.5**	**2.3**	**1.2**	**0.53**	0.15	0.39	0.22	166.4	24.4	Y-O
729	T212 x self	**15-Jan**	**6.5**	3.0	1.4	0.66	0.31	0.56	0.26	123.5	27.5	O-Y
730	T204 x T212	26-Jan	7.0	4.8	1.8	0.71	0.23	0.48	0.29	131.2	32.2	O-Y
731	T204 x T212	27-Jan	5.6	**2.1**	**1.1**	**0.53**	0.07	0.26	0.21	138.5	28.3	O-Y
732	T212 x self	**04-Feb**	**4.9**	2.8	1.3	0.53	0.10	0.31	0.20	138.5	21.4	O
733	T204 x T/Q	**03-Feb**	**5.3**	3.1	1.4	0.57	0.12	0.35	0.22	156.6	23.3	O
734	T204 x T/Q	**04-Feb**	**5.0**	**2.6**	**1.3**	**0.50**	0.15	0.38	0.19	156.7	24.1	O-Y

Selections	Parents	Ripe date	5% Lsd[1]	Fruit set			Processing yield			Fruit weight (g)	5% Lsd[1]	Flesh colour
				Fruit/TCSA	(Log)[2]	5% Lsd[1]	kg/TCSA	(sqrt)[3]	5% Lsd[1]			
735	T204 x T/Q	**02-Feb**	**5.4**	3.3	1.5	0.53	0.15	0.39	0.21	142.3	25.5	Y-O
736	T204 x T/Q	**03-Feb**	**4.7**	3.3	1.5	0.50	0.11	0.33	0.19	121.7	20.6	O
737	T212 x 4-1-5	**02-Feb**	**7.0**	**2.1**	**1.1**	**0.66**	0.31	0.55	0.29	155.2	32.2	O
738	T212 x 4-1-5	**03-Feb**	**7.0**	**2.1**	**1.1**	**0.66**	0.18	0.42	0.29	141.5	32.2	O-Y
739	T204 x T212	**31-Jan**	**5.5**	3.4	1.5	0.53	0.21	0.45	0.22	144.5	24.9	Y-O
740	T212 x self	**11-Feb**	**4.7**	3.4	1.5	0.50	0.23	0.48	0.19	151.4	21.1	Y-O
741	T212 x self	**04-Feb**	**4.7**	3.7	1.6	0.50	0.21	0.45	0.19	142.3	21.1	Y-O
742	T212 x self	**06-Feb**	**4.8**	3.3	1.5	0.50	0.15	0.39	0.19	141.6	21.9	Y-O
743	T204 x T212	**07-Feb**	**4.8**	3.8	1.6	0.50	0.30	0.54	0.19	162.9	21.9	O-Y
744	T212 x self	**11-Feb**	**5.3**	2.8	1.3	0.53	0.16	0.40	0.21	152.2	23.7	Y-O
745	T212 x self	**09-Feb**	**4.9**	2.4	1.2	0.50	0.20	0.44	0.20	157.3	22.7	Y-O
746	T212 x self	**11-Feb**	**5.0**	4.5	1.7	0.53	0.19	0.44	0.20	138.7	22.0	O-Y
747	T212 x self	**12-Feb**	**5.1**	4.6	1.7	0.53	0.14	0.37	0.20	145.8	23.7	O-Y
748	T212 x self	**10-Feb**	**5.5**	3.4	1.5	0.53	0.15	0.39	0.21	157.3	24.9	Y-O
749	T212 x self	**16-Feb**	**5.7**	3.8	1.6	0.57	0.20	0.45	0.23	132.2	25.7	Y-O
750	T212 x self	**01-Mar**	**6.5**	2.6	1.3	0.63	0.19	0.43	0.25	154.6	28.9	O
751	T212 x self	**01-Mar**	**5.7**	2.9	1.4	0.52	0.06	0.25	0.22	120.0	26.4	O-Y
752	T212 x self	**04-Mar**	**5.5**	5.3	1.8	0.53	0.22	0.47	0.22	141.5	24.9	Y-O
753	T212 x T/Q	**07-Mar**	**5.4**	4.7	1.7	0.53	0.29	0.54	0.22	136.4	24.8	O-Y
F8,5-159		**29-Feb**	**4.6**	3.8	1.6	0.50	0.24	0.49	0.19	138.4	20.2	O
Gialla di Moavero		**26-Mar**	**5.1**	6.5	2.0	0.50	0.28	0.53	0.21	128.4	23.1	Y
G. Queen	Unknown	**06-Mar**	**5.2**	3.3	1.5	0.51	0.26	0.51	0.21	133.3	24.1	O
Tatura 204	B/G7 x O/S	23-Jan		5.2	1.8		0.16	0.40		142.2		O-Y
Tatura 212	G/Q x B/G5	**24-Feb**	**4.6**	3.8	1.6	0.50	0.16	0.40	0.19	154.7	20.2	O

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait.

2. Fruit set/ trunk cross sectional area (TCSA) required a natural log transformation for analysis and was then back-transformed.

3. Processing yield/TCSA required a square root transformation for analysis and was then back-transformed.

B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen; G.Queen = Golden Queen; Y = Yumyeong; W = white; Y = yellow; O = orange; Y - O = yellow - orange; O - Y = orange - yellow

Appendix 2: Comparison of fruit quality traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Stone tip length[2]		Stone tip width		Stone width		Firmness		Sugars		Appearance preference		Flavour preference	
	mm	5% Lsd[1]	mm	5% Lsd[1]	mm	5% Lsd[1]	kg	5% Lsd[1]	°Brix	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]
657	2.3	0.6	**3.9**	**0.4**	24.9	1.7	**2.3**	**0.8**	**17.3**	**2.1**	**5.2**	**0.7**	5.7	0.8
659	2.5	0.5	3.6	0.4	26.6	1.7	4.1	0.8	15.4	2.0	**5.1**	**0.6**	**5.0**	**0.7**
661	**3.1**	**0.5**	3.4	0.4	24.7	1.6	4.0	0.8	**17.5**	**2.0**	5.5	0.7	5.6	0.8
674	**3.7**	**0.5**	**4.1**	**0.4**	**29.3**	**1.9**	3.9	0.8	14.0	2.1	**5.2**	**0.7**	**4.9**	**0.8**
677	2.0	0.6	**3.8**	**0.5**	25.2	1.7	3.6	0.8	**16.5**	**2.1**	5.8	0.7	5.1	0.8
680	**0.7**	**0.5**	**2.3**	**0.4**	24.2	1.7	4.6	0.8	**17.7**	**2.0**	**5.1**	**0.7**	5.1	0.8
682	**3.8**	**0.6**	3.2	0.5	**28.4**	**2.6**	4.2	0.9	13.5	2.4	**4.4**	**0.8**	**4.7**	**0.9**
683	2.1	0.6	3.0	0.4	24.9	3.4	3.4	0.8	14.5	2.1	**4.6**	**0.7**	**4.7**	**0.9**
685	**3.3**	**0.7**	3.2	0.6	25.0	2.2	**1.7**	**1.8**	11.3	5.0	**4.0**	**1.8**	4.0	1.8
686	**3.1**	**0.5**	**3.8**	**0.4**	26.3	1.8	3.3	0.8	13.8	2.2	5.3	0.7	5.0	0.8
687	2.2	0.6	3.3	0.5	25.2	2.2	**5.3**	**0.9**	13.4	2.4	**4.1**	**0.8**	**4.5**	**0.9**
688	**2.7**	**0.5**	3.1	0.4	24.3	1.9	4.0	0.8	**16.1**	**2.1**	**4.9**	**0.7**	6.0	0.8
690	**2.7**	**0.5**	**3.9**	**0.4**	25.3	1.6	3.4	0.7	**16.6**	**1.9**	**5.2**	**0.6**	5.4	0.7
691	2.6	0.5	**3.8**	**0.4**	25.2	1.7	3.8	0.8	**15.8**	**2.0**	5.4	0.7	5.6	0.7
692	**1.1**	**0.6**	**2.4**	**0.4**	26.4	2.6	**2.3**	**0.8**	14.9	2.1	**5.0**	**0.7**	**4.7**	**0.8**
693	2.3	0.6	2.8	0.5	24.4	2.1	**1.6**	**0.9**	**17.2**	**2.4**	5.3	0.8	5.5	0.9
694	1.7	0.6	**3.9**	**0.5**			**1.6**	**0.9**	**15.9**	**2.2**	**5.0**	**0.7**	5.6	0.8
695	**3.1**	**0.6**	3.2	0.4	**23.8**	**1.6**	**3.0**	**0.8**	**16.4**	**2.1**	5.3	0.7	5.8	0.8
696	2.5	0.6	3.1	0.5	25.0	2.1	**0.8**	**1.4**	15.5	3.7	5.5	1.3	6.0	1.3
697	1.8	0.6	**2.4**	**0.4**	**23.1**	**2.0**	**5.9**	**1.0**	15.4	2.5	5.7	0.9	6.6	0.9
698	2.1	0.5	2.8	0.4	24.2	1.9	**1.3**	**0.9**	15.6	2.2	**4.8**	**0.7**	**4.9**	**0.8**
699	1.6	0.6	**2.3**	**0.4**	**22.2**	**2.1**	**6.1**	**1.0**	**16.9**	**2.5**	5.8	0.9	5.8	0.9
702	2.4	0.6	3.2	0.5	24.4	2.2	**5.5**	**0.9**	**17.8**	**2.4**	**4.4**	**0.8**	5.3	0.9
703	**3.2**	**0.6**	3.4	0.5	26.9	2.2	5.1	1.0	15.9	2.7	**3.3**	**0.9**	5.7	1.0
704	**0.8**	**0.6**	**1.9**	**0.4**	**22.8**	**2.1**	**5.4**	**0.8**	15.2	2.1	5.9	0.7	5.4	0.8
705	**2.7**	**0.6**	3.0	0.5	27.0	2.1	**2.7**	**0.9**	13.3	2.2	5.3	0.7	5.4	0.8
706	2.4	0.5	3.2	0.4	27.2	1.9	**2.8**	**0.8**	13.7	2.1	**4.9**	**0.7**	**4.9**	**0.8**
707	**2.7**	**0.5**	2.9	0.4	**23.5**	**2.1**	**3.3**	**0.8**	**16.1**	**2.1**	5.5	0.7	6.2	0.8
708	**2.7**	**0.5**	**3.7**	**0.4**	26.9	2.5	4.7	0.8	15.5	2.1	5.3	0.7	5.5	0.8

Selections	Stone tip length[2]		Stone tip width		Stone width		Firmness		Sugars		Appearance preference		Flavour preference	
	mm	5% Lsd[1]	mm	5% Lsd[1]	mm	5% Lsd[1]	kg	5% Lsd[1]	°Brix	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]
709	**1.1**	**0.6**	2.9	0.5	25.2	1.8	4.2	0.8	**17.0**	**2.1**	5.4	0.7	5.1	0.8
710	1.9	0.5	**2.6**	**0.4**	**23.4**	**2.1**	**2.2**	**0.8**	**19.3**	**2.1**	**5.1**	**0.7**	5.5	0.8
711	2.1	0.6	3.2	0.5	**22.7**	**2.2**	**1.7**	**0.9**	**18.0**	**2.3**	**4.6**	**0.8**	5.4	0.8
712	2.5	0.5	3.0	0.4	25.2	1.8	4.2	0.8	**17.7**	**2.0**	**5.1**	**0.7**	5.5	0.8
713	2.5	0.5	3.2	0.4	24.4	1.7	4.3	0.8	**17.1**	**2.0**	**5.1**	**0.7**	**4.9**	**0.7**
714	**2.8**	**0.5**	**2.8**	**0.4**	**23.5**	**1.9**	3.8	0.8	**17.2**	**2.0**	**5.1**	**0.7**	6.4	0.7
715	1.6	0.5	2.9	0.4	**23.5**	**2.2**	3.8	0.8	**16.6**	**2.2**	**4.1**	**0.7**	5.3	0.8
716	1.9	0.6	**2.4**	**0.5**	**21.0**	**2.2**	3.8	0.9	**16.3**	**2.2**	5.6	0.7	5.7	0.8
717	2.0	0.6	3.2	0.5	27.4	2.6	3.9	0.8	14.9	2.1	5.6	0.7	5.4	0.8
718	2.3	0.5	3.1	0.4	24.8	1.6	3.8	0.8	**17.6**	**1.9**	**5.1**	**0.6**	5.4	0.7
719	2.4	0.6	2.8	0.5	25.8	2.2	3.8	0.8	**16.6**	**2.2**	5.7	0.7	5.3	0.8
720	2.4	0.5	2.9	0.4	**23.3**	**1.9**	**2.9**	**0.8**	**16.4**	**2.0**	**4.3**	**0.7**	5.2	0.7
721	**3.2**	**0.5**	**3.8**	**0.4**	24.2	1.7	**3.1**	**0.8**	**17.3**	**2.0**	**4.6**	**0.7**	5.8	0.8
722	1.6	0.6	3.4	0.5	26.0	1.8	**2.7**	**0.8**	**16.3**	**2.1**	5.5	0.7	6.1	0.8
723	**1.5**	**0.5**	**2.6**	**0.4**	**20.4**	**1.7**	**5.3**	**0.8**	**17.0**	**2.0**	**5.2**	**0.6**	5.2	0.7
724	2.6	0.5	3.5	0.4	**22.9**	**1.8**	3.7	0.8	**18.7**	**2.0**	5.3	0.7	6.4	0.7
725	2.3	0.6	2.8	0.5	**21.2**	**1.8**	3.9	1.0	**17.1**	**2.5**	5.4	0.8	5.0	0.9
726	**4.0**	**0.6**	3.2	0.5	27.3	2.1	4.7	1.4	11.5	3.7	**2.5**	**1.3**	5.0	1.3
727	2.6	0.6	3.2	0.5	26.4	1.9	3.9	1.0	15.5	2.5	**5.0**	**0.9**	5.4	0.9
728	2.3	0.6	**4.2**	**0.5**	24.3	1.9	4.7	0.8	**17.4**	**2.1**	**5.0**	**0.7**	5.7	0.8
729	**3.4**	**0.8**	3.0	0.6	26.4	2.6			11.4	5.0	**2.0**	**1.8**	**2.0**	**1.8**
730	2.3	0.8	3.2	0.6	23.7	2.6	4.2	1.3	16.0	3.4	5.5	1.1	6.5	1.3
731	1.7	0.8	3.0	0.6	27.1	3.4	4.4	1.2	16.1	3.1	**4.7**	**1.1**	5.3	1.1
732	2.2	0.6	**2.6**	**0.4**	25.4	2.0	3.7	0.8	15.7	2.1	**4.5**	**0.7**	5.4	0.8
733	**2.8**	**0.6**	3.1	0.5	25.9	2.2	**3.0**	**0.9**	13.5	2.3	5.2	0.8	5.7	0.9
734	2.2	0.7	3.6	0.6	24.3	2.6	4.1	1.0	15.9	2.5	**5.0**	**0.9**	5.4	0.9
735	**3.6**	**0.8**	3.5	0.6			3.1	1.0	**16.3**	**2.7**	5.0	0.9	5.5	1.0
736	2.4	0.5	3.5	0.4	25.4	2.0	3.8	0.8	**17.4**	**2.1**	5.4	0.7	5.2	0.8
737	2.7	1.2	3.3	1.0	27.1	3.4	3.2	1.4	12.2	3.7	6.0	1.3	5.5	1.3
738	1.8	0.9	3.4	0.8			4.4	1.4	15.2	3.7	5.5	1.3	6.0	1.3
739	2.7	0.8	3.3	0.6	26.7	2.6	3.8	1.1	13.5	3.0	5.3	1.0	5.3	1.1

Selections	Stone tip length[2]		Stone tip width		Stone width		Firmness		Sugars		Appearance preference		Flavour preference	
	mm	5% Lsd[1]	mm	5% Lsd[1]	mm	5% Lsd[1]	kg	5% Lsd[1]	°Brix	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]	1 – 7 scale[3]	5% Lsd[1]
740	**3.5**	**0.6**	3.1	0.4	27.7	2.2	4.2	0.8	13.5	2.1	**4.1**	**0.7**	**4.9**	**0.8**
741	2.4	0.6	**2.7**	**0.4**	25.7	2.1	4.4	0.8	**16.1**	**2.2**	**3.6**	**0.7**	5.4	0.8
742	**4.8**	**0.6**	3.7	0.5	26.6	3.4	3.6	0.9	14.1	2.3	**3.6**	**0.7**	**4.3**	**0.8**
743	2.6	0.6	3.2	0.4	27.0	2.6	3.7	0.8	14.8	2.2	**4.8**	**0.7**	5.7	0.8
744	**3.4**	**0.6**	**3.8**	**0.5**	26.1	2.6	3.6	1.0	12.1	2.5	**4.5**	**0.8**	**4.8**	**0.9**
745	2.7	0.6	3.4	0.5	26.8	2.2	4.3	0.9	13.7	2.4	**4.9**	**0.8**	**4.5**	**0.9**
746	**2.9**	**0.6**	3.3	0.5	25.0	2.2	3.3	0.9	14.3	2.2	**5.0**	**0.7**	5.4	0.8
747	**3.3**	**0.6**	3.6	0.5	27.8	3.4	3.5	0.9	15.4	2.3	**4.3**	**0.8**	5.5	0.9
748	**2.9**	**0.7**	3.3	0.5	26.0	2.5	**3.0**	**1.0**	**16.5**	**2.6**	5.3	0.9	5.3	1.0
749	2.5	0.7	3.5	0.6	26.0	2.6	3.1	1.0	13.8	2.7	5.4	0.9	5.5	1.0
750	**3.0**	**0.8**	2.8	0.6	24.4	2.6	**2.5**	**1.0**	15.4	2.5	**4.8**	**0.8**	5.4	0.9
751	2.1	0.6	3.0	0.5	25.1	1.8	3.5	0.9	**19.4**	**2.3**	**4.0**	**0.8**	**4.2**	**0.9**
752	**3.2**	**0.7**	3.2	0.5	25.1	1.9	**2.8**	**0.8**	14.8	2.1	**4.4**	**0.7**	5.6	0.8
753	**3.6**	**0.6**	3.5	0.5	24.9	1.7	**1.8**	**0.8**	**15.9**	**2.1**	**4.9**	**0.7**	5.8	0.8
F8,5-159	2.3	0.5	**4.0**	**0.4**	**23.3**	**1.6**	4.0	0.7	15.0	1.8	5.9	0.6	5.2	0.7
Gialla di Moavero	2.6	0.5	3.6	0.4	**23.1**	**1.6**	**2.7**	**0.8**	**15.7**	**2.2**	5.4	0.8	5.7	0.8
Golden Queen	**3.2**	**0.6**	**3.9**	**0.5**	24.2	1.7	**3.0**	**0.8**	**16.8**	**2.1**	5.5	0.7	5.4	0.8
Tatura 204	2.1		3.2		25.7		4.1		13.6		5.9		5.8	
Tatura 212	2.6	0.5	**3.8**	**0.4**	25.9	1.8	**3.1**	**0.8**	15.4	2.0	**4.5**	**0.7**	**5.0**	**0.8**

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait.

2. 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.

3. Appearance and flavour preference scale from 1 = dislike very much; 4 = neither like nor dislike; 7 = like very much

PYE = Processing yield efficiency (kg processing fruit per trunk cross sectional area [TCSA]); B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen

Appendix 3: Comparison of flowering traits of selections, two imported cultivars F8,5-159 and Gialla di Moavero and two processing cultivars Tatura 212 and Golden Queen against the standard processing cultivar Tatura 204. Data analysis based on multi-year repeated measures in Reml from 2010 to 2012.

Selections	Full bloom		Bloom period		Bud set		Buds per 40cm lateral		Bud positions per 40cm lateral		% Bud types			
	Date	5% Lsd[1]	Days	5% Lsd[1]	%	5% Lsd[1]	No.	5% Lsd[1]	No.	5% Lsd[1]	Single	Double	Triple	Quad
657	01-Sep	1.6	10.8	2.2	34.7	21.2	19.0	7.1	13.0	3.9	37	58	4	0
659	31-Aug	1.7	12.1	2.3	32.3	22.5	24.3	7.5	15.1	4.1	26	75	0	0
661	**13-Sep**	**1.6**	13.1	2.2	32.5	21.2	23.0	7.1	13.8	3.9	28	55	12	**5**
674	**12-Sep**	**1.7**	11.4	2.2	25.4	21.2	25.0	7.1	16.5	3.9	39	56	6	0
677	27-Aug	1.6	11.8	2.2	19.4	21.2	21.5	7.1	13.3	3.9	26	66	7	0
680	**25-Aug**	**1.7**	11.7	2.4	10.7	21.2	19.8	7.1	13.4	3.8	40	52	8	0
682	**14-Sep**	**1.7**	13.0	2.3	**50.3**	**22.5**	24.9	7.5	16.1	4.1	29	71	0	0
683	**12-Sep**	**1.8**	13.1	2.4	50.0	22.5	20.9	7.5	14.2	4.1	49	38	14	0
685	**11-Sep**	**1.6**	11.4	2.2	**49.5**	**21.2**	17.9	7.1	12.7	3.9	44	52	0	4
686	**11-Sep**	**1.7**	11.1	2.2	**50.1**	**21.2**	18.8	7.1	12.3	3.9	34	60	6	0
687	**13-Sep**	**1.7**	12.2	2.3	41.6	22.5	**14.9**	**7.5**	11.2	4.1	51	44	5	0
688	**11-Sep**	**1.7**	12.2	2.2	**59.0**	**21.2**	19.0	7.1	13.3	3.8	45	40	14	0
690	**14-Sep**	**1.6**	13.1	2.2	37.1	21.2	21.9	7.1	13.9	4.1	33	82	6	0
691	**11-Sep**	**1.7**	12.5	2.2	26.9	21.2	25.1	7.1	16.8	3.9	35	60	5	0
692	**04-Sep**	**1.6**	10.3	2.2	18.7	21.2	29.2	7.1	18.3	3.8	26	72	2	0
693	**16-Sep**	**1.7**	10.7	2.2	20.5	21.2	20.2	7.1	14.5	3.9	48	53	0	0
694	**03-Sep**	**1.6**	10.8	2.2	17.4	21.2	28.0	7.1	15.9	3.9	21	60	15	3
695	**09-Sep**	**1.7**	11.0	2.3	34.6	22.5	23.6	7.5	15.3	4.1	32	61	7	0
696	**17-Sep**	**1.7**	12.5	2.3	**54.2**	**22.5**	27.5	7.5	15.7	4.1	23	58	19	0
697	**08-Sep**	**1.8**	11.5	2.4	**62.6**	**22.5**	26.6	7.5	15.9	4.1	32	54	5	0
698	**03-Sep**	**1.7**	11.1	2.3	24.4	22.5	21.9	7.5	14.9	4.1	38	59	5	0
699	**17-Sep**	**1.7**	11.1	2.3	35.0	22.5	**36.7**	**7.5**	**20.8**	**4.1**	20	59	**22**	0
702	**11-Sep**	**1.8**	12.8	2.4	41.2	22.5	21.0	7.5	13.8	4.1	40	60	0	0
703	**14-Sep**	**2.0**	11.4	2.6	**65.1**	**24.5**	**9.8**	**8.2**	**7.7**	**4.5**	**61**	38	1	0
704	31-Aug	1.7	12.3	2.3	26.9	22.5	30.9	7.5	17.5	4.1	20	60	16	4
705	**14-Sep**	**1.7**	12.9	2.3	**57.4**	**22.5**	22.1	7.5	13.5	4.1	25	64	9	0
706	**14-Sep**	**1.7**	13.1	2.2	**53.4**	**21.2**	18.3	7.1	12.9	3.9	44	52	4	0
707	**11-Sep**	**1.7**	11.8	2.2	40.7	21.2	20.9	7.1	14.5	3.9	46	48	5	0
708	**11-Sep**	**1.7**	12.0	2.2	40.8	21.2	20.6	7.1	14.2	3.8	41	53	7	0

Selections	Full bloom		Bloom period		Bud set		Buds per 40cm lateral		Bud positions per 40cm lateral		% Bud types			
	Date	5% Lsd[1]	Days	5% Lsd[1]	%	5% Lsd[1]	No.	5% Lsd[1]	No.	5% Lsd[1]	Single	Double	Triple	Quad
709	30-Aug	1.6	11.5	2.2	25.1	21.2	23.6	7.1	15.7	3.8	38	59	4	0
710	**18-Sep**	**1.7**	11.5	2.2	13.5	21.2	**32.5**	**7.1**	18.3	3.9	17	74	9	0
711	**17-Sep**	**1.6**	11.4	2.2	24.7	21.2	23.2	7.1	12.9	3.9	21	51	**27**	0
712	**09-Sep**	**1.6**	**9.9**	**2.2**	13.5	21.2	**37.0**	**7.1**	17.9	3.9	13	45	**38**	**5**
713	**11-Sep**	**1.7**	11.4	2.2	25.7	21.2	28.1	7.1	16.1	3.9	23	50	**27**	0
714	**14-Sep**	**1.7**	14.0	2.2	31.2	21.2	28.5	7.1	18.3	3.9	39	**37**	**22**	3
715	**26-Aug**	**1.6**	12.8	2.5	11.1	21.2	**30.8**	**7.1**	**19.6**	**3.9**	38	45	18	0
716	**15-Sep**	**1.9**	12.5	2.5	18.6	24.5	**39.7**	**8.1**	18.6	4.4	14	36	**36**	**15**
717	01-Sep	1.7	11.1	2.3	20.9	22.5	26.4	7.5	16.1	4.1	30	54	16	0
718	**12-Sep**	**1.7**	13.2	2.2	26.1	21.2	20.4	7.1	13.0	3.9	35	45	**20**	0
719	**11-Sep**	**1.7**	12.8	2.2	30.0	21.2	**32.5**	**7.1**	17.6	3.9	19	50	**28**	4
720	**15-Sep**	**1.6**	12.4	2.2	34.5	21.2	28.1	7.1	14.9	3.9	18	54	**28**	0
721	**13-Sep**	**1.7**	13.1	2.3	44.3	22.5	17.9	7.5	11.6	4.1	39	43	17	0
722	**28-Aug**	**1.7**	11.3	2.3	17.5	22.5	17.6	7.5	12.7	4.1	50	50	1	0
723	**15-Sep**	**1.8**	12.1	2.4	19.0	22.5	**38.7**	**7.5**	**20.3**	**4.1**	21	**35**	**42**	2
724	**10-Sep**	**1.6**	10.6	2.2	20.0	21.2	**32.7**	**7.1**	18.3	3.9	15	74	11	0
725	**19-Sep**	**2.9**	10.4	3.8	21.4	36.8	27.7	12.3	15.0	6.7	19	51	29	0
726	**14-Sep**	**1.7**	13.4	2.3	39.9	22.5	27.7	7.5	16.8	4.1	27	66	7	0
727	**15-Sep**	**1.6**	**14.3**	**2.2**	27.0	21.2	21.7	7.1	13.6	3.9	32	57	11	0
728	30-Aug	1.7	10.8	2.3	24.6	22.5	**16.0**	**7.5**	11.6	4.1	54	41	4	0
729	**13-Sep**	**2.5**	10.5	3.2	28.9	28.1	**9.1**	**9.4**	**8.0**	**5.1**	**89**	**10**	0	0
730			11.9	3.8	30.9	36.8	21.3	12.3	13.2	6.7	21	78	-1	0
731	30-Aug	1.7	10.8	2.3	29.2	22.5	21.7	7.5	13.4	4.1	29	57	15	0
732	**14-Sep**	**1.7**	11.9	2.3	39.2	22.5	**9.0**	**7.5**	**8.2**	**4.1**	**82**	**19**	0	0
733	31-Aug	1.9	12.3	2.5	19.8	24.5	16.4	8.2	12.8	4.5	**60**	35	5	0
734	31-Aug	1.6	11.2	2.2	27.4	21.2	21.6	7.1	13.3	3.9	32	58	9	0
735	**02-Sep**	**1.7**	12.6	2.3	44.3	22.5	20.4	7.5	15.5	4.1	**59**	41	0	0
736	01-Sep	1.6	12.0	2.2	29.9	21.2	16.8	7.5	12.1	4.1	54	**32**	4	**9**
737	31-Aug	2.2	11.0	2.9	33.3	28.1	18.7	9.4	10.6	5.1	28	66	7	0
738	02-Sep	2.2	9.4	2.9	16.8	28.1	21.0	9.4	15.2	5.1	45	55	0	0
739	31-Aug	1.7	11.0	2.3	39.7	22.5	16.4	7.5	13.0	4.1	**58**	44	0	0
740	**12-Sep**	**1.6**	12.3	2.2	44.4	21.2	19.0	7.1	15.1	3.8	**60**	40	0	0

Selections	Full bloom		Bloom period		Bud set		Buds per 40cm lateral		Bud positions per 40cm lateral		% Bud types			
	Date	5% Lsd[1]	Days	5% Lsd[1]	%	5% Lsd[1]	No.	5% Lsd[1]	No.	5% Lsd[1]	Single	Double	Triple	Quad
741	**13-Sep**	**1.6**	12.7	2.2	26.0	21.2	**13.4**	**7.1**	**10.7**	**3.9**	**55**	45	-1	0
742	**14-Sep**	**1.7**	12.4	2.2	19.2	21.2	**14.5**	**7.1**	**10.6**	**3.9**	55	42	4	0
743	**10-Sep**	**1.7**	10.8	2.2	39.8	21.2	23.3	7.1	15.3	3.9	36	52	12	0
744	**15-Sep**	**1.7**	11.9	2.3	43.5	22.5	**15.9**	**7.5**	12.8	4.1	**64**	36	0	0
745	**13-Sep**	**1.6**	12.3	2.2	37.3	21.2	19.7	7.1	12.2	3.9	25	75	0	0
746	**13-Sep**	**1.7**	12.9	2.3	17.5	22.5	18.9	7.5	13.4	4.1	49	48	2	0
747	**15-Sep**	**1.7**	13.9	2.3	42.9	22.5	26.7	7.5	14.7	4.1	15	69	16	0
748	**11-Sep**	**1.7**	11.6	2.3	43.4	22.5	17.9	7.5	12.6	4.1	42	58	0	0
749	**15-Sep**	**2.0**	12.3	2.6	27.6	24.5	29.4	8.2	18.7	4.5	29	71	1	0
750	**14-Sep**	**2.0**	13.1	2.6	**61.6**	**28.1**	24.4	9.4	13.5	5.1	19	65	17	0
751	**12-Sep**	**1.7**	12.8	2.2	37.8	22.5	**13.0**	**7.5**	12.2	4.1	**85**	**16**	0	0
752	**15-Sep**	**1.7**	12.1	2.3	45.2	22.5	21.8	7.5	12.6	4.1	30	56	10	4
753	14-Sep	1.7	12.4	2.3	37.3	22.5	18.6	7.5	11.1	4.1	27	62	7	0
F8,5-159	**04-Sep**	**1.6**	**9.5**	**2.2**	36.8	21.2	21.1	7.1	14.8	3.9	46	46	8	0
Gialla di Moavero	20-Sep	1.6	13.1	2.2	36.8	21.2	**14.5**	**7.1**	11.6	3.8	**60**	40	0	0
Golden Queen	14-Sep	1.6	13.4	2.2	49.6	21.2	17.0	7.1	11.6	3.9	48	47	5	0
Tatura 204	31-Aug		12.1		27.7		23.6		15.0		32	64	4	0
Tatura 212	**12-Sep**	**1.6**	12.2	2.2	47.4	21.2	18.3	7.1	11.8	3.9	35	63	1	0

1. Significant differences from Tatura 204 at the level of 5% are highlighted in bold text for each trait. .

PYE = Processing yield efficiency (kg processing fruit per trunk cross sectional area [TCSA]); B/G = BabyGold; G/Q = Golden Queen; O/S = Oom Sarel; T/Q = Taylor Queen

Appendix 4: Seed stratification strategy.

It is recommended that seed is kept in dry storage in a clean stone and not extracted at harvest to minimise development of fungal infections.

1. Dry storage protocol:
    - 1.1 Flesh to be removed from stone within two days of harvest by twist pitting the fruit in half and then into a quarter and remnants of the flesh scrapped off.
    - 1.2 Stones immediately air-dried for half a day and the biological control agent *Trichoderma* applied as a powder to the stone.
    - 1.3 Stones to be inspected weekly for any signs of fungal infection and infected stones removed immediately.
    - 1.4 Seed to be extracted from infected stones and if the seed is viable treated with a fungicidal treatment and stored separately in moistened perlite or vermiculite.

2. Seed stratification protocol:
    - 3.1 Seed removed from stone.
    - 3.2 Seed soaked overnight in distilled water to re-hydrate and treated with a fungicidal treatment (i.e. Bogard [100g/kg Difenoconazole]).
    - 3.3 Seed then placed in perlite or vermiculite moistened with distilled water.
    - 3.4 In addition to fungicidal treatment it is recommended that *Tricoderma* powder is applied 2 – 7 days later to establish a beneficial population of *Tricoderma* fungi on the seed.
    - 3.5 Seed to be inspected fortnightly for any signs of fungal infection and infected seed removed immediately and remaining seed placed in clean moistened perlite or vermiculite.
    - 3.6 Once radicles start to emerge from the seed in approximately 3 months the seed is to be immediately planted.

3. Seedling production protocol:
    - 4.1 It is recommended that a Tricoderma drench is applied to the soil in which seed are planted.
    - 4.2 Fungicidal sprays (i.e. Octave [462g/kg Prochloraz]) to be selectively applied to young seedlings if they become infected with fungi such as *botrytis*.
    - 4.3 Seedlings to be raised in a heated igloo until 20 to 40 cm high.
    - 4.4 Seedlings hardened off and transferred outside undercover to continue to grow.
    - 4.5 Seedlings transferred into the field when they are around 40cm in height and stems have started to thicken.
    - 4.6 Plastic trees guards applied immediately upon planting as a preventative measure against rodent and frost damage. Note: Weather forecast should be frost free in the days immediately following seedling establishment in the field.

Appendix 5: Peach Varieties

The Plant Varieties which are the subject of the SPC Ardmona Evaluation and Licence Option Agreement are the following peach selections (DPI Germplasm):

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