Participation by Dr Andrew Granger at the Fifth International Cherry Symposium, Bursa, Turkey, June 2005

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Purpose of Report: The aim of this report is to provide feedback to the Australian Cherry industry through HAL regarding scientific knowledge gained by attending the 5th International Cherry Symposium held in Turkey, June 2005.

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Media Summary

The 5th International Cherry Symposium held during June 2005 in Turkey attracted around 350 participants from 42 different countries. Oral and poster presentations were provided. Topics included breeding and genetics, physiology, culture, pests and diseases, self-incompatibility and fruit cracking.

Main points were as follows:

- During the period 1991-2004, 230 new cherry varieties were released worldwide.

- 78% of breeding programs were public and 22% private.

- Breeding programs produced a range of seedling numbers with most producing 500 seedlings per year, the smallest program produced 20 seedlings per year and the largest in the world based at Lenswood in South Australia produced 2-3,000 seedlings per year.

- The most important character selected for across all breeding programs was resistance to rain cracking. A program is in place at INRA, Bordeaux France to identify the genes controlling cracking in cherry, using molecular methods.

- Turkish cherry production was 40,000 tonnes in 2004 and will rise to 100,000 tonnes in the next 10 years.

- A virtual cherry tree program has been developed by Professor Greg Lang, Michigan State University, USA. Professor Lang demonstrated the software and showed how pruning cuts can be made and the resultant growth of the tree visualised. The program has great potential as a research and teaching tool.

- Cristobalina, a Spanish sweet cherry cultivar, carries the S_3S_6 self-incompatibility genotype and is self-fertile. This represents another source of self-fertility in cherry and is yet to be quantified.

- Photosynthesis occurs in leaves and produces carbohydrates that are used in the growth of leaves, shoots and fruit. Fruit takes priority in carbohydrate use and are supplied mainly by subtending spur leaves. Trees on Giesla 5 rootstock require 5 leaves per fruit for satisfactory growth according to Dr Matthew Whiting, Washington State University, USA.

- In Oregon, the most profitable cherry grown is the white variety Rainer returning $3.28/kg while the most profitable red fleshed variety is Sweetheart.

- The Firmtech II® machine is becoming the standard for measuring firmness of cherries in grams per millimetre of deflection of the fruit surface. Categories are soft 0-190, caution 191-240, average 241-290 and firm 291 + g/mm.

- The sweet cherry varieties Kordia and Regina have excellent flavour. In a consumer based sensory evaluation conducted in a farmers market in Portland, Oregon, USA Regina was the most preferred variety based on taste.

- Turkish cherry production is spread throughout the country, little or no rainfall occurs during the cherry season. The main variety grown is 0900 Ziraat, thought to be synonomous with Nordwunder.

- Dr Gryzb, Poland stated that there has been a mix up in planting material of the PHL rootstocks and this is the cause of vastly different results from different locations.

- Chile produces 30,000 tonnes of cherries from 1000 hectares. The majority of production is exported.

- Poland produces 250,000 tonnes of sweet and sour cherries.

- Girdling of a shoot at phase I of fruit growth proved beneficial, probably because export of assimilates was prevented.

- Work in Portugal identified leaf mass area (density) as the best marker for water use efficiency.

- There are 58 member countries worldwide administrating Plant Breeder's Rights under the UPOV convention. The EU covers 25 member countries requiring a single application; all other countries require a separate application. USA operates Plant Patents for clonally propagated species. US patents allow 1 year of prior sales inside USA compared to PBR which allows for 6 years of prior sales outside the country for trees and 4 years for vines and other species.

- Only 20-30% of fertilizer applied to the orchard floor is taken up by apples and pears and the same is thought to hold in cherries.

- Dr P.E. Lauri, INRA, Montpellier, France, recognised as the world expert in cherry tree architecture made the following points. Most of a cherry crop is borne on spurs. Bending of shoots increases fruiting efficiency. Opinion is divided on spur performance, some say spurs decline with age, others not. Well developed spurs and buds at the base of shoots produce the largest flowers and in turn fruit. Management of light interception is best achieved by removing whole branches and spur thinning cuts on the underside of branches. Shading has a greater effect on reducing yield than spur age.

- Prototype mechanical harvesters in the USA harvested 50 tonnes of fruit per day in 2004. The variety Skeena was most suited to mechanical harvesting while the Tatura Trellis was the growing system that gave the best results with mechanical harvesting.

- Turkish scientists have revealed that differences in cell size and orientation in the flesh of cherries determines if they are susceptible or resistant to cracking.

Expected outcomes and how they were achieved

Through interaction with 350 colleagues from 42 different countries

- Continued exchange of germplasm with breeding programs throughout the world.
- Scientific exchanges.
- Up to date information on cherry research from around the world.
- Application of molecular markers to the cherry breeding program.
- Opportunities for cherry as a functional food.
- Feedback on the performance of Australian bred varieties in different locations around the world.

Results of Discussions

Notes arising from oral sessions.

- The symposium was attended by 346 participants from 42 countries. There were 69 oral and 139 poster presentations. Of the oral presentations 15 covered breeding, 40 crop production and management, 14 genetics and biotech and 18 post-harvest and disease management.
- Turkey's production of sweet cherry is 2nd in the world and that of sour cherry 3rd.
- Cherry breeding programs have released 230 new varieties during the period 1991-2004. USA based breeding programs released 43 and Canada 28 during that time. Sixty per cent of new varieties were a result of cross breeding while 16% were derived through clonal selection. 78% of breeding programs were public and 22% private. The bulk of varieties released matured mid-season with only 6% and 8% of released varieties being early and late maturing respectively. Breeding programs based in Europe and Asia produced 50 (Czechoslovakia) to 1000 seedlings per year. The main aims across all programs were fruit size, fruit firmness, colour and flavour. Parents used for various characteristics were tabulated and included Sunburst for fruit size, Kordia, Regina, Vilma and Korvic for fruit firmness. In the case of fruit flavour varieties released by the Czech Republic were identified as having the best flavour, for example Halka, Horka, Vilma, Sylvana, Vanda, Kordia and Korvic. The consumers preference for fruit colour varies from country to country and black is preferred in Italy and Germany. Tree traits such as

compact habit are not seen as a big issue because reversion to a normal habit does occur. This indicates that the compact tree habit may be the result of a chimera. For self-fertility the main varieties used are Stella, Sunburst and Lapins. Parents used for early ripening include Burlat, Sweet Earli, Rita, Firprime, Early Lory (syn. Early Bigi). And for late ripening Corriola, Durone Nero II and III, Regina, Sweetheart, Symphony, Summer Charm, Fertard, Namati, Colney, Korvic and the HL series.

The most important characteristic selected for is crack resistance. There is now a molecular program based in France with the aim of determining the genetic control of cracking.

- Cherries are grown all over Turkey, except in the eastern part where the climate only supports a 80 day growing season. Spring frost causes fluctuation in cherry production but in general it is increasing. In 1995 7500 tonnes of cherries were exported from Turkey, in 2004 it had risen to 40,000 tonnes and is projected to reach 100,000 tonnes over the next 10 years. The main export variety is 0900 Ziraat, no rainfall occurs during the cherry season in Turkish Provences and so cracking is not a problem, however it has been established using artificial rainfall that Ziraat is resistant to cracking (2%). Ziraat produces small crops as a result of poor pollination, currently Bigarreau Gaucher, Stella and Stark's Gold are used as pollinators. In Turkey seedling Mazzard is the most widely used rootstock followed by Mahaleb, SL64, Giesla 5 and 6, Maxma, Wieroots 158 and Tabel Edabriz rootstocks are being trialled. Basin, furrow and floor irrigation are used by farmers. Pruning is a more recently introduced practice. At the moment the cherry harvest in Turkey begins on May 15 and continues through to mid-late August. Researchers are searching for low chill varieties to push production into the sub-tropics for early season production. Brooks, Cristobalina and Garnet are thought to be low chill.

- Professor Greg Lang, MSU, USA showed a virtual cherry program for modelling leaf, shoot and fruit growth. Pruning treatments can be applied and the model run to show what the resultant tree would look like. The model is useful for investigating tree physiology and especially for identifying gaps in the knowledge of tree and fruit growth. It is based on the 3 different types of leaves, fruiting spur, non-fruiting spur and new shoot. Year 3 is seen as ideal in terms of the leaf:fruit ratio (2:1) in cherry trees.

- Dr Anna Wunsch, Spain has established that the self-fertile variety, Cristobalina is self-fertile and carries the S_3S_6 genotype. The latter is surprising given that S3 and S6 are common alleles. When Cristobalina is used as a male parent it can pollinate all other S_3S_6 varieties, when used as a female for crosses with S_3S_6 varieties it cannot be pollinated and this indicates that the pollen function has been effected. When Cristobalina was selfed progeny displayed all segregation classes, i.e. S_3S_3, S_3S_6 and S_6S_6. The presence of both homozygotes indicates that self-fertility is linked to both salleles, although a greater number of S_3 haplotypes were recorded 19:13:7. Brooks S_1S_9 x Cristobalina S_3S_6 produced 4 segregation types in equal

numbers, some being self-incompatible and some self-compatible. SFB3 and SFB6 sequences of Cristobalina were compared with those of Satonashiki and Napoleon and were found to be the same that is conserved. DNA blot analysis comparing Cristobalina and Sato Nishiki revealed no duplication of the S-alleles in Cristobalina. An additional band was found for Sato Nishiki but was not related to self incompatibility. RT-PCR with pollen cDNA indicated that transcription of SFB and expression were the same in Cristobalina and Satonishiki. It was concluded that an additional factor not tightly linked to the S-gene is causing a loss of pollen function in Cristobalina.

- Sour cherries have been classified as self-fertile (greater than 10% fruit set), partially self-fertile (1-10% fruit set) and self-incompatible (< 1%). Note that approximately 20% fruit set is required for a satisfactory crop yield. There is a problem of low fertility of the partial self-fertile cultivars. Dr Mirko Schuster is of the opinion that the problem has arisen through interspecific hybridisation of the majority of sour cherry cultivars resulting in disrupted pairing of chromosomes at meiosis. Shattonmorel from middle Europe is probably the only pure *P. cerasus* in Europe. The other species that *P. cerasus* has hybridised with include P. avium and *P. fruticosa.*

- Excised ovules were grown on an M+S media 2% sucrose and pollen placed nearby grew towards the micropyle (chemotropic effect).

- Dr Matthew Whiting, WSU, USA has made many investigations into photosynthesis in cherry and his findings include that the optimal leaf area index is 3.3. Larger canopies are inefficient due to internal shading effects. Net carbon exchange does not rely on crop load, the production of assimilates in cherry is source limited in the pre-harvest interval. This is because flowers emerge first, followed by leaves, which expand during the fruit growth stage, and supply the fruit with assimilates, that is, the fruit is a preferential sink. Dr Whiting is questioning weather or not it is possible to increase source activity. On a canopy scale, this is possible with the use of horticultural techniques such as summer pruning after fruit harvest to reduce shading; problem with this is that productive organs are removed, reducing assimilation. Reflective covers were used and a measured improvement in gas exchange for the interior canopy was recorded, it also extended the vegetative growth period.

  Trunk growth is inhibited when fruit is on the tree. On the rootstock Giesla 5, five leaves per fruit are required for satisfactory fruit growth. Dr Whiting is also evaluating crop load management techniques such as gibberellic acid applications at different times, dormant pruning and flower thinning agents such as ammonium thiosulphate and lime sulphur with oil. More details are available at the WSU website www.fruit.prosser.wsu.edu

- Dr M Ayala, Chile presented work from her PhD supervised by Dr Greg Lang, MSU, USA. Dr Ayala used labelled carbon C^{13} to determine carbon partitioning in cherry. The more distant the source, the less assimilate in the

sink. Fruit is the priority sink during fruit development. The highest activity during fruit development is stage I and III.

- Replant disease is an unsolved problem in Norway. They have found susceptibility varies between cultivars and rootstocks. For example, Van, Ulster, Vista and Sunburst are susceptible, Lapins intermediate and Kristen and Schmidt resistant. With regard to rootstocks Colt is susceptible, Mahaleb intermediate and seedling resistant. The reasons for tree decline are not clear but high numbers of root nematodes are thought to be the main reason. The root rot fungus Armillaria, Pseudmonas sp. and Prune Dwarf Virus were found in minor amounts in surveyed orchards.

- Dr J Vercammen, Belgium reported on cultivar evaluation trials, 3 trees per cultivar are planted and the cherry descriptors produced by IBPGR (FAO) are used for evaluation. The ideal cherry cultivar for Belgium is described as late, weak in vigour, large, firm, with a good taste, productive, resistant to cracking and resistant to spring frost.

- Dr Lynn Long, OSU, USA provided results of cultivar testing from Oregon. Rainier provides the highest returns to cherry growers in Oregon at $3.28/kg. Sweetheart provides the highest return for dark cherries. The Firmtech II machine is used to measure fruit firmness in g/mm fruit surface deflection. The following ratings are used; soft 0-190; Caution 191-240; 241-290 Average; 291+Firm.

  The breeding line 13S-3-13 from Summerland, Canada matures 6-7 days before Bing and has outstanding size and good flavour, its productivity is light to moderate. Sonata has a very tart flavour while Cristalina and Santina lack flavour. Kordia has excellent flavour as does Regina when picked at a high brix, both have excellent resistance to rain cracking. Lapins is the second most important variety in the Pacific North West and Skeena is being planted in large numbers.

  Gibberellic acid is applied as a single application to the trial site probably generating a differential effect between cultivars.

- Turkey experiences little or no rainfall during the cherry season. Sabiki is a very early maturing cultivar, ripening at the beginning of May. *P. mahaleb* is native to Eastern Turkey at 1000m elevation, and it is proposed to survey forest areas and select candidates for rootstocks.

- VSL-2 is a semi-dwarfing rootstock developed in Belarus.

- Early results from rootstock trials in Turkey showed that Summit gave highest yield on Gisela rootstocks. 0900 Ziraat, the most widely planted cherry cultivar in Turkey, was shown in cross section it had red skin with white flesh. It is thought to be Nordwunder.

- Dr K Hrotko, Hungary, pointed out that there are two subspecies of *P. mahaleb*. The Subspecies *mahaleb* is adapted to a more maritime climate,

typical of Western Europe and its growing zone extends into Asia, it also goes into dormancy earlier.

Medium density plantings were considered to be in the range 500-1000 trees/ha and high density 1-3,000 trees/ha.

Prunus fruticosa, the Steppe Cherry evolved to survive the ice-age, it has a different metabolic system that has an influence on graft compatibility.

- PHL rootstocks are difficult to root by standard techniques. In-vitro propagation using MS-media and 1.5 mg/L BAP gave the highest shoot multiplication. Sixty five to 93% rooting was achieved using 2.5 mg/L BAP for root induction.

- Dr T Robinson, USA reported on cherry tree training systems using Gisela rootstocks. Lowest per hectare yield occurred with the traditional central leader system (on seedling rootstock) and vertical axis (Zahn system) gave the highest yield. Spanish Bush produced smaller fruit size and lowest TSS because of thick shaded canopies developed in Eastern USA.

  Every variety evaluated was susceptible to rain cracking including Regina. Systems that employ substantial pruning during the first 3 years of growth, e.g. Spanish Bush had low yield over the first 5 years. Gisela 5 rootstock with varieties trained to a vertical axis yielded 17t/ha in the fifth leaf.

- In Germany Gisela 5, Gisela 6 and PHL-1 have produced the highest average yields across two varieties on sandy soils without irrigation.

- Dr Gryzb, Poland, stated that there has been a mix up in planting material of PHL rootstocks and this is the cause of vastly different results from different areas.

- The Apulia region in Italy has 17,000 hectares of cherry production and *P. mahaleb* is the dominant rootstock. In a rootstock trial with no irrigation Gisela 5 showed very low survival 9 years after planting. Weiroot 158 had the highest yield efficiency and largest fruit.

- In contrast to results in Italy, Weiroot 158 displayed a mortality rate of 50% in trials conducted in Turkey.

- Chile produces 30,000 tonnes of cherries from 1,000 ha, the main cultivars planted are Bing and Lapins. The majority of fruit is exported. Sailing time to China is 45 days, 15 to USA, 20 to Europe and 40 to Asia. Exports to Asia are increasing.

- Poland produces 250,000 tonnes of sweet and sour cherries.

- Girdling and defoliation was carried out in an experiment designed to determine where carbon assimilation was occurring within a cherry shoot. Girdling of a branch at stage 1 of fruit growth proved to be beneficial, probably due to the prevention of carbon export.

  Labelled carbon (C^{13}) was also introduced into cherry trees, 93% of labelled carbon was found in the fruit and 7% in shoots, this showed that fruits are the preferential sink, compared to shoots, fruiting spurs and non-fruiting spurs. Labelling was carried out three times during autumn and C^{13} was found in 2 and 3 year old wood, roots, buds (fruiting and non-fruiting) in the following spring. One year later a significant reduction of C^{13} was measured in wood, an increase in fruiting buds and little change in the roots. This showed that during remobilisation of reserves fruiting buds had the highest sink activity.

- Portuguese research comparing Summit and Burlat cherry cultivars found that Summit had thicker leaves than Burlat. The intrinsic water use efficiency was defined as Net CO_2 Assimilation/stomatal conductance (A/gs). It was thought that the best option for a marker of water use efficiency in a breeding program would be the leaf mass area (density).

- Doubling, or the formation of two fruit from one flower is a negative character in relation to commercial sales. It is a result of the formation of double pistils and subsequent fertilisation. Application of gibberellic acid and nitrogen tended to reduce the number of double pistils. More formed on the south side of the tree than the north due to increased temperature. Genotype susceptibility varies, for example Stella showed the highest amount of doubling of all the cultivars evaluated. Drought stress did not increase doubles. Pistil formation occurs in July (northern hemisphere) and the formation of double pistils occurs in late August.

- In Argentina fruit thinning on Bing trees at 63 degree days (8 days) after full bloom did not change the Leaf Area Index at harvest. Thinned trees did carry fruit with higher sugars. On thinned trees fruit growth plateaued just before harvest on un-thinned trees the fruit was smaller but continued to grow up until harvest. Fruit growth curves were linear rather than double sigmoid. It was concluded that fruit thinning should be carried out before 400 degree days (47 days).

- There are 58 member countries worldwide administering Plant Breeder's Rights under the UPOV Convention.
  The EU covers 25 member countries requiring a single application, all other countries require a separate application. USA is an exception operating plant patents which allows for 1 year of prior sales inside USA compared to PBR which allows for 6 years prior sales outside the country for trees and 4 years for vines and other species.
  In the EU ornamentals are the basis of the largest number of applications and France made the most number of applications followed by Spain in 2004.

- Dr F Laigret, INRA, Bordeaux, France spoke about linkage maps in sweet cherry based on progeny from a cross between Regina and Lapins, compared to a well established Prunus map developed on progeny from an almond (Texas) x peach (Earligold) cross. Good anchor markers (markers that occupy the same position on all the chromosomes compared) were found and in general there is good synteny between Prunus genomes. Dr Laigret also spoke about the use of chloroplast markers to study 211 accessions of wild, sweet, sour, duke and ground cherries, concluding that sour cherry (*P. cerasus*) is a result of hybridisation between *P. fructicosa* (Ground cherry) and *P. avium* (sweet cherry). It was noted that two white cherries from Spain grouped with sour cherry.

- Only 20-30% of applied fertilizer is taken-up by apple and pear and the same is thought to apply to cherry. The efficiency of soil applied nitrogen up-take is highest in Spring, after one growing season.

- Prolepsis is defined as 2 year old wood characterised by bud scale scars at the base. Sylleptic shoots are one year old wood. Syllepsis is a function of weak apical dominance. Differences in the growth of the main axis of central leader trees were due to differences in internode length and not number. Internode length and sylleptic branching are linked. The vigour of a tree regulates its architecture and sylleptic branches modify it.

- Dr P.E. Lauri is recognised as the world expert in cherry tree architecture and as such was an invited speaker. Some points from his address follow. Most of a cherry crop is borne on spurs. There is an increase in the diameter of the spurs and the number of flowers and fruit per spur from the proximal to the distal position on any parent long shoot. Bending of shoots improves fruiting efficacy. Opinion is divided on spur performance, some say spurs decline with age and others not. Carbohydrate reserves are critical for early growth. Spur leaves are fully developed within 3 weeks after bud burst. Flowers at the base of long shoots are larger with longer pistils resulting in better, larger fruit, albeit a small proportion of the total crop. Well developed spurs also carry larger flowers. To manage light interception, optimally, remove whole branches and use spur thinning cuts on the basal part of branches. Shading has a greater effect on reducing yield rather than spur age.

- Hydrogen cyanamide results in the accumulation of peroxidases. Bud break is controlled by chilling accumulation and late spring temperatures are critical to ripening. Hydrogen cyanamide applied Early Burlat planted at Bari, Italy (900 chill hours) were advanced in ripening by 7-8 days.

- Professor I. Kudan, Dean, Adana University, Turkey gave preliminary results from investigations into growing cherries in low chill areas. Stella and Noir de Guben gave good results in low chill areas. The Richardson Chill Unit Model was used to calculate accumulated chill and cuttings of Kordia, Lapins, Larian, Na-1, Stella, Noir de Guben and Ziraat were taken every 2 weeks and placed in a controlled temperature room at 24^{o}C. Chill was considered as

satisfied if 50% of buds reached green tip within 21 days. Na 1 had the lowest chill requirement (500 chill units) and Kordia the highest.

- Workers in Chile also tested a range of varieties for their chill requirement, including: Burlat, Brooks, Garnet, Ruby, Celeste, New Star, Sommerset, Van, Bing and Lapins.

  Brooks, Van and Lapins required 720 hours at $6^{o}C$, Newstar, Sommerset and Early Burlat 960 and the remainder 1200 +.

  In the field Van and Lapins required 435 chill units.

  It was also noted that moderate fluctuating temperatures were required. Reason being that $6^{o}C$ is required for chilling then $12^{o}C$ to break buds.

- In another study in Chile the ponderated chill unit model Linsley, Moakes, Louw and Allen (1995) was used.

- Dr L. Sekse, Norway, the pre-eminent authority in cherry cracking gave an invited paper which highlighted the many reviews on the subject. Some of the main points were: There is different uptake of water at different locations on the fruit surface. Temperature plays a critical role in cracking. Thick cuticles are more susceptible to cracking. Cultivars show differences in the cell size of the exocarp. Work by Dr Yamaguchi has shown that exocarp cells at the fruit apex have a longer period of cell division, and this may explain the occurrence of cracking in green fruit. Stomatal density has been reported as both important and minor in its effect on cracking. A thick cuticular membrane interwoven between the epidermis and cuticle reduces cracking. Cuticular fractures develop 2-3 weeks before harvest and are not an issue before this time, they develop in stage III of fruit growth. The uptake of water through the pedicel drives fruit growth. Strain on the surface of fruit is found to be highest in the cheek and pedicel depression, this is where cracking most often occurs. Cells have been characterised in crack resistant tomatoes. Osmotic potential is higher in the flesh than fruit skin, and there is no difference in resistant cultivars.

  Sweet cherry fruit regulate water mainly by transpiration.

- Dr Vercammen, Belgium commented that 70% of cracks were caused by water uptake through the skin of the fruit and 30% through pedicel uptake. A range of foliar fertilisers were evaluated for their effect on cracking. Calcium chloride had a small effect and had a negative effect on taste, Nutrileader a seaweed based product produced variable results and at best reduced cracking by 10%. Plantina, a mixture of amino acids from vegetable extracts, applied before rainfall reduced cracking by 10-17%.

- Anthracnose is emerging as a serious disease of cherries in Norway, and probably the rest of the world. It is thought that this is due to less spraying and use of genus specific chemicals. Aborted fruits support infections. A green tip spray is usually effective in controlling Anthracnose.

- Cherry fruit fly *Rhagoletis cerasi* is the most serious pest of cherry in Turkey. First flight occurs in May, peaks in June and the last flight occurs in August/September. Adults emerge in association with rainfall events. Females are attracted by yellow fluorescence in immature fruits and are readily caught in yellow traps, mainly on the south side of the tree. Females prefer to lay eggs on yellow or yellow/red fruit. Eggs are laid on the stylar scar and centre of the stem. There is generally only 1 larvae per fruit. Pupae over winter in soil at a depth of 3-5 cm for 11 months.

- Dr Mirko Schuster, Germany, has identified two new S-alleles S19 and S22.

- Cherry pollen was germinated on 0.5% agar, 15% sucrose and 5 ppm Boric acid and incubated at a constant 25^{o}C.

- In Washington State, USA mechanical harvesting is being evaluated. Production has doubled in the last 10 years and harvest labour is becoming scarce and accounts for 40-50% of annual expenses. Prototype machines have been developed and two are driven down either side of a tree row and comprise an impactor, catching frame and bin holder. At this stage fruit is harvested without stems. Skeena and many other cultivars naturally abscise from the stem. Y-trellis, Bush and Central Leader systems were evaluated for harvest efficiency trees harvested per minute were 1.4, 0.8 and 0.7 respectively. Fifty tonnes per day were harvested. Most bruising of fruit occurred with Bush and Central Leader trees. Eighty three per cent of the crop was collected, 8% was left on the tree and 8% fell on the ground. Most of the fruit left on the tree was on weak wood. So the canopy management strategy was to remove weak wood and increase the fruit on upright wood and maintain a tree height of no more than 3 metres.
  Tatura trellis planted as a one sided tree was found to be the most suitable system.
  Chelan and Tieton showed reduced fruit removal force without softer fruit after treatment with Ethrel®.

- New Zealand produces 2,000 tonnes of cherries from 600 hectares and production is expected to double in the next 5 years. Exports are valued at $NZ14M. The main export markets for New Zealand cherries are Taiwan, Korea, USA, Thailand and UK. Voyage time to Taiwan is 19 days and 4 weeks to the UK.
  The conditions required for long term storage of fruit with good out turn are well established, the problem is to implement them. Grower education is required. Basically fruit must be held at below 2^{o}C.
  A workshop was held in New Zealand included growers, exporters and transport operators. Priorities were set and the most important issue identified was inherent fruit factors followed by temperature management. A temperature protocol was agreed to along the entire chain. Crop load was identified as the biggest issue for fruit management, thus the industry is re-focussing R&D into physiology.

- An economic analysis of cherry production conducted in Switzerland revealed that 3 of the key factors influencing grower income are determined by choice of cultivar. They are size, yield and price.
  Extra Class cherries are defined as having a diameter of 24-28mm, 4.41 Euro per kg of Extra Class cherries was the price used in the model. In 2004 the cultivar Sommerset in its 8th leaf gave the highest total yield and the greatest proportion of premium fruit. Note that the food market in Switzerland is protected and Kordia is the standard cultivar. Changes in labour costs had little influence on returns.

- Dr Lynn Long conducted sensory evaluation of cherries by conducting a blind test of 5 cultivars (Bing, Lapins, Skeena, Regina and Sweetheart) at a farmers market in Portland, Oregon. Cherries were served at 7-10^{o}C (all were treated with GA). Responses from 192 participants were entered through touch screens. TSS (Total Soluble Solids), TA (Titratable Acids) and firmness were measured beforehand. Regina had the lowest TA and Sweetheart the highest. Bing was the least firm and Sweetheart the highest. While there didn't appear to be a strong preference for colour the darkest coloured fruit was preferred (Regina). A clear preference for the largest size fruit was found and a blocky fruit shape was preferred. A round fruit shape was least preferred while a cordate (heart shape) had a moderate preference. Fruit with stems on were preferred although consumers said they would pay the same price for stemless cherries. Some said that they would pay more for a stemless product.
  Regina was the most preferred cultivar for taste (lowest TA). People either really liked or disliked the taste of Sweetheart (highest TA).
  For the overall liking rating Regina stood out, 65% of participants say they liked it best because of its sweetness and 14% because it was firm.
  The main reason for disliking a cherry was lack of sweetness or it was described as "too sour" or "too tart".
  The ideal cherry seemed to be large, heart or blocky in shape, with a stem and sweet to taste.

- Dr Demirsoy, Turkey, presented work that represents a break through in understanding cracking in cherries. Microscopic examination of the fruit skin was made and compared between cultivars susceptible, moderate and resistant to cracking. (Resistant Turkish cultivars included Hüsenba, Erastama and Karakirtik 1 and 2). There was no significant effect of cuticle thickness on cracking, there was however a relationship between cracking and the thickness of the epidermis. There was no relationship between crack resistance and sub-epidermal thickness or cell numbers.
  The cultivars having flatter and regularly ordered subepidermal cells had a low cracking index while those with rounder and less ordered cells had a higher cracking index.
  It was recommended that the chemical content of the cherry fruit cuticle needs further investigation.

- Impact between stems and fruit causes pitting, less pitting has been observed on stemless fruit. It seems that drops on grading machines do not cause excessive pitting.

- The anthocyanin vitisin found in grapes in also found in sour cherry. HPLC analysis revealed levels of 550-850 mg/L. Vitisin has a half-life of 45-90 days in juice.
  Fruit wine preparation involves using diluted juice 8 g/L acid, 8-10% absolute volume with sucrose fortification. Anthocyanins are lost through dilution but stable to fermentation. Colourless polyphenols 650-1700 mg/L.
  Anthocyanins, 75% loss during storage, can avoid with cold storage.

- Sour cherry is a functional food, it contains anthocyanins, melatonin and perillyl alcohol. These are health preserving having effects in inflammation and cancer inhibition. Montmorency and Balaton sour cherries are included in 10 US patents. The sour cherry varieties Boshyak 5 and 6 showed the highest amount of anthocyanin, 726-1478 mg/100g (Lyophilized samples).

How the information gathered will be disseminated

An address covering all aspects of the project was given at the 2005 Cherry Growers of Australia AGM, to be held in Hobart, Tasmania. A CD with the contents of each address was provided to each of the 300 conference participants.

This final report will be circulated throughout the cherry industry.

New germplasm and ideas will be integrated into the cherry breeding program and disseminated through new cherry varieties. Further ideas and the expanded network gained through the project will form the basis of new projects and international collaborations.

Itinerary

Day & date	Flight no. Time(s) Location(s).
Saturday 04 June	SQ230/SQ490 Adelaide-Singapore-Istanbul Depart 1305 Arrive 0725.
Saturday 04 June	Transfer to Bursa
Monday 06 June – Friday 10 June	5th International Cherry Symposium
Saturday 11 June – Monday 13 June	Post-Symposium tour
Tuesday 14 June- Thursday 16 June	SQ491/SQ229 Istanbul/Singapore/Adelaide Depart 1330 Arrive 0700

Recommendations

That the philosophy of supporting the attendance of Australian scientists at international science conferences continues. This will maintain networks and allow

Australian scientists to remain at the forefront of horticultural research and as illustrated by the expansion of the Australian wine industry research and development will underpin the profitable expansion of the horticultural industry in Australia.

Acknowledgements

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Contacts

Please visit the symposium website http://www.5ics.org/en/default.asp for a full list of participants.

Additional Reporting Requirements

Approval of this project was subject to outputs above the standard reporting requirements. They are listed below with a comment regarding their achievement.

1. Report back to Annual Conference in August 2005. A verbal address was given to the Cherry Growers of Australia Annual Conference on August 4th, 2005. Points of interest for cherry growers and researchers were synthesized from about 200 papers and presented in a summarised format with slides and text. Approximately 300 participants attended the conference and each received a copy of the talk.
2. Visit at least two State meetings to present information. At the time of writing this report provision of a verbal report at the Cherry Growers of South Australia pre-harvest meeting and the AGM of the New South Wales Cherry Growers in September had been confirmed. The New South Wales association is in the process of seeking travel funds from HAL to facilitate the attendance of Dr Granger.
3. Minimum 3 “Tree Fruit” magazine articles (topics to be specified by IAC). Dr Granger has supplied editors from both “Tree Fruit” magazine and “Good Fruit and Vegetables” with copies of his papers. He has also been interviewed via telephone re an article. Industry representatives from New Zealand have also sought permission to use Dr Granger’s material presented at the Annual Conference for use in industry publications, permission was granted.