Overseas study tour report

Travel to Italy, Switzerland and Belgium
8th International Pear Symposium
September 2000

John Magarey
AA Magarey and Sons

Project Number: AP00043
AP00043

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for Apple and Pear industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of AA Magarey and Sons.

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ISBN 0 7341 0329 8

Published and distributed by:

Horticultural Australia Ltd

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50 Carrington Street
Sydney NSW 2000
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Overseas Study Tour Report

Travel to Italy, Switzerland and Belgium
VIII International Pear Symposium
Ferrara-Bologna, Italy. 4-9 September 2000

John Magarey

July 2001

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HRDC Project AP00043

Pear symposium attendance and study tour in Italy, Switzerland and Belgium. This report contains summaries of technical addresses given at the ISHS VIII International Symposium on Pear held in Ferrara and Bologna Italy from September 4th-9th, 2000. There were in attendance researchers and other agricultural workers representing most pear growing regions of the world. Further discussions were held with researchers in Switzerland, Belgium and Holland. The matching funding for my travel and accommodation costs by HRDC is gratefully acknowledged.

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Itinerary

Friday September 1st - depart Adelaide and overnight in Singapore

Saturday September 2nd - travel from Singapore to Frankfurt

Sunday September 3rd - travel by train to Innsbruck

Monday September 4th - travel by train to Bologna then by bus to Ferrara

Tuesday September 5th to Saturday 9th - attend the Pear Symposium

Sunday September 10th to Monday 11th - travel by train to Wadenswil, Switzerland to visit Dr Jacob Ruegg and Dr Thomas Hasler and to visit an apple orchard.

Tuesday September 12th - travel to Belgium

Wednesday September 13th to Sunday 17th - in Belgium and Holland visiting several research stations.

Monday September 18th - depart Brussels flying via Singapore

Wednesday September 20th - arrive Adelaide
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MEDIA SUMMARY

Attending the eighth ISHS Pear Symposium provided opportunities to meet researchers and fellow growers from most of the pear regions around the world. As governments reduce funding for research and extension, and our horticultural products face greater competition on international markets, increasingly growers must seek out for themselves the most up to date and advanced research information. There is therefore a very real need for the Australian pear industry to develop relationships with researchers and growers around the globe to enable an easy information flow to the mutual gain of all parties.

The brief summaries of the reports given at this symposium provide some indication as to the type of work going on and would be a starting point in a search for more information on a particular subject.

The Australian pear industry has many advantages. These include its freedom from most of the diseases currently found in Europe and the Packham pear grown on the Tatura style trellis seems to be a system without significant deficiency. What then are our disadvantages? Our isolation from the majority of research done relating to pear production and from our international markets perhaps is significant. I believe that important gains for our industry will be made as we continue to strengthen linkages with both researchers and growers through out the pear growing regions of the world.

Hopefully we can work together to provide to the consumer a healthy and good tasting piece of fruit that will strongly compete with the convenient, tasty, predictable but not so healthy snack foods of today. I believe that this overseas visit has provided another small opportunity for the Australian pear Industry to build the pear information network.
SUMMARY OF FINDINGS

VIII International Pear Symposium:
Summary of Proceedings
Ferrara-Bologna, Italy. 4th – 9th September 2000

1 General And Economic Overview

1.1. Andrea Segre (Italy)
The worldwide pear industry: current trends and future perspective.

This speaker presented an overview of recent changes in world pear production. It was interesting that the 5.17% increase in production assessed over the period from 1990 to 1999 was primarily due to the increase in area harvested. The yield per hectare had actually decreased by 0.5% over the above-mentioned period.

1.2. George Ing (USA)
Pear production and utilisation in North America.

An overview was given regarding the pear industry in North America. Points of interest were:
- 95% of pears in the US are grown in the West-coast states, main varieties being Williams, Anjou and Bosc. Comice and some red varieties are also grown. Red Anjou is increasing rapidly.
- 50% of western US production are Williams, the remainder being winter pears and principally Anjou.
  - Approximately 50% of Williams are sold fresh and 35% of Anjou are exported.
  - Canadian production is mostly from the western states.
  - Mexico grows Keiffer, Williams and Packham.
  - New US plantings are Red Anjou, Starkrimson, Concorde and Taylors Gold.
  - Principal problems are pear psylla and leaf roller, fireblight, decay and scald in storage.
  - A better size-controlling rootstock is needed; as is the ability to provide a ready-to-eat pear to the customer.

1.3. Enrique E. Sanchez (Argentina)
Pear production in South America.

An outline of the South American industry was presented. The following points were made:
- Production according to FAO is 46,000 ha with Argentina and Chile accounting for 90% of this figure.
- Williams, Packham and Anjou are the major varieties in Argentina and growers have tried red varieties but moved away from them recently.
- Chile has seen a decrease in area of pears. Packham and Bosc being the main varieties grown.
- Total S. American production is about 900,000 tons of which Argentina accounts for 500,000.
• 20% of production is consumed domestically and the rest exported as fresh or concentrated juice. Brazil, Italy and the US are the main importers of Argentine pears while Chile exports half of its production to Europe.
• Ecological and quality issues have become significant and Integrated Fruit Production has been introduced. Organic production is also increasing through excellent market returns.

1.4. Gerhard Buenemann and others (Germany, Netherlands, Norway)
Choice of varieties and cultivation technology in Northern Europe.

An overview of the Northern European situation included the following points:
• Pears are mostly a sideline for growers in this area.
• Pears can grow up to 60 degrees north but have greater climatic risks for growers.
• Belgium and Holland are the leading countries in production, storage and marketing.
• Production in terms of tonnes per hectare is not as good as in Southern Europe
• Quince rootstocks are the most popular but more work needs to be done here.
• For maximum production, the spur leaves need to be well illuminated.
• Williams and Conference are the most popular varieties.

1.5. Valtiero Mazzotti and others (Italy)
Pear industry yield trends in Southern Europe: districts and varieties.

The speaker outlined the major pear producing countries, their production levels and some of the varieties grown there. Some of the key points were:
• Italy is the leading producer with a figure of 800,000 metric tonnes (Southern Europe’s total is about 2.3 MT) followed by Spain (600,000 MT) and France 250,000 Mt).
• Main varieties are Conference (has about 24% of market share), Williams, Abbe Fetel (grown almost exclusively in Italy), Blanquilla (only in Spain), Rocha (grown in Portugal) and Comice which has declined since 1997.
• Variety preferences change from one country to the next.
• Not a lot of change is expected in the near future. Conference will increase in Spain.

1.6. Nicolae Braniste (Romania)
Pear culture in Eastern European Countries.

The Eastern European situation was presented which in summary contained the following:
• Leading producers are Poland, Yugoslavia, Hungary and Romania.
• Total annual yields varied from 468,893 tonnes in 1993 to 287,186 in 1999. This decrease was mainly due to the effects of a severe attack of Erwinia amylovora and Psylla sp., which led to the removal of thousands of hectares of trees.
• Pears are imported by these countries.
• Pears in Eastern Europe are grown under traditional methods and planting systems and it may take 10 to 15 years to catch up with the rest of Europe.
1.7. Hiroshi Gemma (Japan)
The pear industry in Japan and Asia.

The speaker gave an outline of both European and Asian pear production in Japan and Asia and his significant points were as follows:

- Production in Asia, especially in China, Korea, Turkey, India and Iran, has increased in the last 10 years due to greater consumption and technological advances that have improved profitability.
- Japanese pear (Pyrus pyrifolia Nakai) account for 90% of the pears produced in Japan.
- Small areas of the European pear, P. communis are grown and the area and yield is increasing year by year.
- Nijisseiki used to be the leading Asian variety grown but has been replaced by Kosui and Hosui due to Nijisseiki’s susceptibility to black spot.
- There are 13 species of Pyrus grown in China and the leading pear growing province, Hebei, produces the varieties YaLi, Xue hua li and Ya guang li, listed in order of significance.
- Chian’s pear production is increasing and new Asian varieties and Williams are being planted.
- Korean pear plantings have been affected by apple market prices and excess production has resulted in poor prices. New varieties are been planted.

1.8. Allan G. White, and others (New Zealand)
The pear industry in Australia, New Zealand and South Africa: production trade and variety ranges.

The pear industry in Australia, New Zealand and South Africa was outlined and the following points were made:

- Pears are a minor crop representing less than 6% of production in each country.
- Only South Africa has seen an increase in production area (a steady increase from 9000 to 13,000 hectares in the last 10 years).
- Main varieties are Williams (used mostly in processing) and Packham although few Packham are now grown in New Zealand.
- Red varieties have increased in area namely: Corella and Sensation in Australia, Flamingo and Forelle in South Africa while New Zealand has seen increases of Comice and its russetted sport Taylor’s Gold.
- All three countries are net pear exporters (to North America and Europe) with Australia and New Zealand only exporting low volumes.

1.9. Hiroshi Gemma (Japan)
The nashi industry: advances in research and production technology in Japan.

A brief outline of the nashi industry was given which included the following:

- Nashi and in particular Nijisseiki, one of the popular varieties has been exported to the US and European since 1983.
- Production has been slowly declining due to factors such as labour shortages.
- Plastic houses have been used to enhance production along with new varieties.
1.10. Clark F. Seavert (USA)

The economic costs and returns of growing pears in Oregon, Washington and California USA.

The speaker presented production and economic data collected in different growing regions in the US. Figures were detailed only in the verbal presentation and some figures of interest were:

- Average farm size is approx. 30 hectares.
- US farm labour cost ranges from $6 to $8.40/hour. (US $ values)
- Pruning hours per ha range from $89 to $242/ha.
- Land values per hectare varied from $21,000 (Hood River) to $13,000 (California).
- Costs including overheads and labour ranged from $7,500 to $12,500/ha.
- Net income after accounting for packing costs, was around $325/ton for the better orchards.
- The rate of return on investment was around 10 to 15%. Less than 10% was considered a poor investment.
- US per capita consumption is around 1.7 kg of pears.
- Conclusion was that it is hard to make money out of pears.

1.11. M Canavari and others (Italy and China)

An economic analysis of the agricultural side of pear supply-chain in Southern Europe and China.

This speaker commented on the effect that market globalisation is having on pear marketing and consequentially on pear production. The ability of suppliers to provide an assured high quality product at a competitive price on demand, combined with a preparedness to provide funds to promote fruit sales, will be more significant in securing sales in future.

Some other comments of interest were:

- For profitable production, at least 30 tonnes/ha. are needed in Italy, which is less than in France while Spain, having lower labour costs, can produce less than 30 tonnes/ha and still be profitable.
- China has a relatively young industry and production per ha is low but this figure will need to increase as production costs increase.

1.12. Bob Wickson (Australia)

Marketing and development of new varieties.

Time was spent outlining the need for breeders to secure funding for their breeding programs by the use of Plant Variety Rights and other plant patents. Patent issues need to be considered on a national and international basis.

The fact that supermarkets dominate markets combined with an over production means that to achieve good returns growers need to gain more control in the market place. The use of limiting of varietal availability by the use of PVR, trade-marks leasing and franchising was suggested.
2 Biology, Breeding And Biotechnology

2.1 Elisabeth Chevreau (France)
Pear biotechnology: review of recent progresses and future breeding applications.

This speaker discussed recent progress in gene technology in relation to pear varietal improvement. The development of scientific methods to allow genes of specific value to be marked and then inserted into existing varietal material was considered. Points of interest were as follows:

- Work on pear biotechnology started only recently and is a slow process (gene transfer in pear started in 1996).
- Different countries are focusing on different genes.
- We need a better knowledge of the mechanism that results in the traits of interest and the factors that affect the stability and expression of the genes in the pear plant.
- A good array of molecular markers is available for pear.
- Some genes responsible for disease resistance and fruit ripening have had markers developed.
- No genetic map for pears has yet been completed.
- A lot of work needs to be done in the next few years to improve the tools for pear breeders.

2.2 Wim Broothaers and others (Belgium)
Can we develop self-fertile fruit trees on any variety?

This speaker reported on his investigations into using gene technology to identify and remove the gene responsible for self-incompatibility in apple and he then extended the idea to pear. It would seem quite conceivable that, as gene mapping for pear progresses, the production of self-fertile pear trees would be achievable.

2.3 Mehdi Sharifani and J.F.Jackson (Australia)
Gene flow by pollen to Lemon Bergamot pear cultivar using isozyme markers

This researcher reported on work done on gene flow in pears in an Australian orchard although he now has returned to his native country of Iran. The study examined the ability of Packham and Josephine to pollinate Lemon Bergamot and isozyme phenotype markers were used to distinguish the pollen parents. Packham proved to be a better pollinator. Further technical detail was presented in this report.

2.4 S. V. Dolgov and others (Russia)
Plant-defensin genes introduction for improvement of pear phytophagene resistance.

This and other addresses reported on experiences in transferring genes that confer disease resistance or other positive quality characteristics to a given pear variety. Some success was achieved in this study in transferring a gene from radish that gave fungal resisting properties to the pear variety Burakovka.
2.5 A. Manganaris and C. Tsipouridis (Greece).

Isoenzymic polymorphism in pears

This is an interesting account of work done examining the molecular markers for a range of existing commercial pear varieties. The researchers found that the Greek cultivar Krystalli was in fact identical to the Spanish variety Blanquilla. The techniques developed in this work will allow further identification of genes of value to pear breeders.

Poster Presentations and Questions

There were a number of poster presentations of work done on genetic modification looking at nashi or European pears. The proceedings of this symposium would contain this information.

Questions were asked re progress in the field of using gene technology to provide resistance to fireblight. E Chevreau said that we are still quite a way off knowing which gene will provide fireblight resistance. She has tested several and has managed to attain 50% resistance in the susceptible variety Passe Crassane. She is working with other genes and promoters now and believes there is no gene that will provide absolute immunity to the fireblight bacteria.

Richard Bell a researcher from the US said that they have achieved a reduction in the lesion growth of fireblight using genes and promoters. E Chevreau replied that fireblight-testing results in the lab did not always correlate to field results and that shoot and flower susceptibilities differed.

3 Variety Evaluation and Environmental Influences

Keynote speaker

3.1 Elvio Bellini (Italy)

Pear breeding for new traits in pear

This speaker presented an overview of the pear breeding programs. The following points were made regarding the objectives of these endeavours:

- Increased pest and disease resistance has become a stronger focus as growers become under increased pressure to reduce production costs and grow their product under more environmentally friendly conditions.
- Resistance to fireblight, the most devastating disease in Europe, pear psylla, pear scab and powdery mildew has been a high priority.
- USA, Canada, Italy and France have studied the heritability of resistance to fireblight and investigated screening techniques to determine the potential resistance to the disease in both parents and their progeny.
- Other breeding objectives include selection for a more dwarfing habit, increased precocity, early ripening combined with good storage characteristics and enhancement of the red skin colour.
- Traditional breeding methods are being supported by the use of biotechnology.
- A long list of new and perhaps yet to be tested varieties were listed and some may be worthy of our attention for use in Australia.
3.2 Manfred Fisher and others (Germany)
New pear cultivars from Dresden-Pillnitz

This breeding work started in 1961 and three resulting cultivar groups were selected in 1988, 1995 and 1999. The aims of selection were for excellent fruit, good shape, early and heavy cropping resistance to both scab and fireblight, and long storage. A large number of potentially good varieties were listed, the best one suggested as being Uta a high yielding dwarfed tree producing a high quality russeted fruit that has good storage characteristics. Test material for these varieties are available if a non-propagation agreement is signed. This breeding program has now stopped.

3.3 Carlo Rosati and others (Italy)
Thirty years of pear breeding activity at Istituto Sperimentale per la Frutticoltura of Forli, Italy: a review.

A pear-breeding program focused on selecting genotypes suitable for the Po valley. The aims were similar to the previously mentioned work but with the addition of resistance to the pear Psylla. Again a number of selections of potential value were listed and two early varieties highlighted were Tosca and Carmen.

3.4 Allan White and L. Brewer (New Zealand)
The pear breeding project in New Zealand.

An interesting breeding program that is aimed at producing a new range of pear varieties to enhance New Zealand’s export markets to Europe, Asia and North America. The project started with four parts ie. Japanese, Chinese, European and Inter-specific crosses and it is now felt that the largest genetic gains are coming from the inter-specific crosses. Resultant material is providing mixtures of European aroma with Asian pear textures and some are currently under going commercial evaluation. While resistance to fireblight was mentioned it was not a major breeding objective.

3.5 A S Sandhu and others (India)
Selection for superior cultivars of semi soft pear for north-west India

An outline was given of a breeding program started in 1979 but I considered this not relevant to our industry.

Poster Presentations

A number of pear and nashi breeding projects were reported on and they are briefly summarised below.

- The Fruit Tree Breeding Division of the National Horticulture Research Institute in Korea has since 1967 produced an extensive array of interesting nashi varieties.
- A breeding program in Poland focuses on winter hardiness; not an Australian problem.
- The Italian breeding program based in Bologna is crossing nashi and European pear looking for the nashi texture and crispness combined with the conventional pear taste. Some promising
seedlings are under selection at this stage. The nashi characteristic of being table ripe at harvest was also an aim of this work. This project has similar objectives to the New Zealand project.

- Pear breeding in Romania is aimed at producing a scab resistant, fireblight tolerant pear with good taste and able to be stored without cold storage. As in other programs nashi were crossed with European pear. The resulting selections look to be meeting their criteria.
- The breeding work at INRA, d’Angers in France aimed to find a superior replacement for Passe Crassane that, by not having any secondary blossom, would not be so susceptible to fireblight. The variety Angelys is one forthcoming selection with which they are pleased.
- A poster outlining an evaluation of more than 100 European pear varieties in Japan highlighted some that have desirable attributes for their domestic consumption.
- Work is under way in Iran to evaluate nine Asian pear varieties in four different growing regions. They believe that they have a good climate for pear production.
- Various studies are being under taken in India looking at both the Asian and European pear.

4 Rootstock Breeding and Evaluation

Keynote address

4.1 S J Wertheim (Netherlands) Rootstocks for European Pear: A Review

The speaker spoke about the rootstock specifications necessary for successful high-density plantings. They are as follows:

- A series of rootstocks with a variation in vigour to accommodate different soil types.
- Besides having a dwarfing characteristic, early and regular cropping with good fruit size should also be induced.
- Be sufficiently winter hardy, tolerant to pear decline and lime induced chlorosis and not increase the risk of fireblight.

The two most commonly used rootstock species are the common pear (Pyrus communis) and Quince (Cydonia oblonga). Both species have weaknesses and further breeding and selection is needed.

4.2 Filiberto Loreti and others (Italy)

Performance of ‘Conference’ cultivar and several quince and pear rootstock.

This Italian rootstock trial using Conference as the scion involved eleven pear and quince clonal rootstocks. The trees were planted in 1994 and since 1997 trunk diameter and other characteristics have been recorded. The rootstocks have been ranked in order of decreasing vigour ie. Kirchensaller>OHF 282>A 28>OHF 87>OHF40=Sydo=B 21>B 29=EMA>Adams>EMC.

4.3 Anita Azarenko and others (USA – Canada).

Final evaluation of the NC-140 national pear rootstock trial.

An interesting trial that started in 1987 involved nine rootstocks and thirteen locations. No one rootstock was consistently the best throughout all locations or between cultivars within one location. Some rootstocks died because of cold or disease.
4.4 Eugene A. Mielke and L. Smith (USA)  
Evaluation of the Horner rootstocks.

660 seedling rootstocks were created by allowing open pollination of five Old Home by Farmingdale clonal rootstocks in western Oregon. The seedling rootstocks were tested against a standard rootstock and a number of selections showed potential in increasing precocity and reducing vigour.

4.5 Anthony D. Webster, J. Spencer and K. Evans (UK)  
Pear rootstock breeding and selection at Horticulture Research International – East Malling.

The aim of this breeding was to provide the UK industry with a rootstock that:

• was more dwarfing than Quince C
• would be compatible with a wide range of commercial scion varieties
• produced a large size fruit (Conference on Quince C produced too many small fruit).

One new dwarfing quince selection, QR 193/16, shows promise in producing fruits that are slightly larger than those produced on Quince C. A cross between the scion cv. Old Home and a semi-dwarfing Pyrus rootstock BP1, has produced one selection, QR 708-36 which shows promise and is easy to propagate from semi-hardwood cuttings.

Poster Presentations

A large number of posters presented results of work done on rootstock breeding. They are summarised in the following points:

• Hungary uses two wild pear cultivars (Pyrus pyraster).
• Germany started a rootstock-breeding program in 1980 using P. communis, and has selected a dwarfing clone with good all round characteristics. It is called Pyrodwarf. Results from trials around Europe with Pyrodwarf have confirmed the special productivity and dwarfing capability of this rootstock.
• Work has been done in Romania with both P. communis and quince.
• In France breeding work started in 1967 with the aim of creating a rootstock compatible with pear scion varieties which is tolerant to fireblight, and which induces a low vigour in the scion. A selection fulfilling these requirements is a selection called Pyriam and it is said to be of great value under Mediterranean conditions especially where lime induced chlorosis is a problem.
• An Italian rootstock-breeding program with aims similar to the French project started in 1992. They found the South African BP series unsuitable due to their susceptibility to Pear Decline and they are still evaluating their material.
• Spain is looking at graft compatibilities with the rootstock Quince Adams. Other projects compared Conference on a number of Old Home by Farmingdale selections with Quince AEM, Quince BA29, commercial seedling rootstocks and Conference on its own roots. Results varied over time and the OHF rootstocks offered no advantage over quince or seedling stock. Quince BA29 performed well as did Conference on its own roots.
• An Argentine program aimed at finding a stock with low vigour and high precocity and compatible with commercial scions. They compared three quince stocks with the standard P. communis stock and did not use inter stems. Quince BA29 did well for a while until graft incompatibility became a problem; inter-stems are still necessary here.
5 In Vitro Culture and Propagation

This next session of the symposium covered work done on in vitro culture and propagation techniques for pear. The issues discussed were more related to a nursery interest and will not be dealt with in this report. The speakers and their topics are listed below.

5.1 Mostafa M. Qrunfleh and others
   Propagation of *Pyrus syriaca* Boiss. by seeds and stem cuttings.

5.2 Venkat R. Bommineni and others (USA)
   An enhanced in vitro propagation method for rapid clonal multiplication of pear (*Pyrus communis* L. cv Bartlett).

5.3 Carmine Damiano and others (Italy)
   Micro-propagation of temperature fruit trees through temporary immersion technique: the case of the pear.

5.4 Lucia Espen, M. Cocucci and G. A. Sacchi (Italy)
   Vascular tissue regeneration in *in vitro* grafts of pear/quince (*Pyrus communis / Cydonia oblonga*).

Poster Presentations

A number of posters presented information on the above topic. Some covered disease related issues while others dealt with how micro-propagation methods impact commercial pear production.

6 Plant Protection and Biology of Pest and Diseases

6.1 Tom Deckers (Belgium)
   Fungal and bacterial pests in pear growing.

This speaker presented valuable information regarding the following significant pear diseases, namely Pear scab (*Venturia pyrina*), Brown rot (*Stemphylium vesicarium*), Fire blight (*Erwinia amylovora*) and *Pseudomonas syringae* pv. *syringae*. Some of the more significant points were:

- Pear scab remains the crucial fungal problem and infection can come from the over wintering ascospores and from conidia produced on the fungal stroma existing on bark tissue (these conidia can remain viable for up to 3 years or more). Comment-Is this true for Australia?
- Secondary infection is greater for Pear scab than Apple scab. Predictive scab infection models consider ascospore release times and numbers, but the quantitative information is not available for conidiospores on pear.
• The effects of fungicides applied in the growing season on the microbe type and number surviving on the leaf surface was studied at a research institute in Bucharest. Dithane M45 and Captadin(?) were the softest products tested.

• Pear scab The types of resistance shown by different pear varieties to pear scab were studied in France to better understand this reaction and to also develop a notation scale of pear resistance to scab.

• The incidence of Pear decline, a disease associated with phytoplasmas, has been rapidly spreading and causing heavy economic losses. Work was done in Italy to test and certify nursery stock and to further develop laboratory techniques that would more positively detect infected plant material.

• Pear decline is also considered one of the major pear diseases in Spain and work was also done here to improve the detection of and study the survival of this disease in the field. Researchers found that the phytoplasma survived in the tree in the winter and grafting wood taken from the tree was able to propagate the disease.

• Romanian research confirmed the causal agent of Pear decline and identified the vectors of the mycoplasma like organism ie. *Psylla* or *Cacopsylla* species. Hungarian work was also carried out using sprays of summer oil and other products to find new environmentally friendly ways of controlling the *Pear* psylla, the vector for pear decline. The products tried were proved useful tools.

• Pear slug, the larva of the sawfly *Caliroa cerasi* can be a serious pest of pear trees when grown under reduced chemical use. This work looked at breeding trees with resistance to this pest.

• The increasing numbers of thePear rust mite, *E. pyri* in nurseries and commercial orchards in Poland prompted this investigation into the over wintering methods of this pest. It seemed that the mite largely over-wintered on 2-year old twigs.

• An Argentinian poster compared pesticide deposition with different spray volumes applied per hectare in a trellised pear orchard.

• Organic pear production in the Rio Negro valley of Argentina was the subject of this poster. It seemed that one key to their apparent success is the excellent environmental conditions found there. Fireblight is not present, pear psylla is only a minor problem and about 300 hectares are under organic production at this stage. Mating disruption dispensers are used for Codling moth control and Packham and other later maturing varieties need supplementary dispensers put out in December. Mating disruption is supplemented with mineral oils, Rynia, kaolin and diatomaceous earth. Other problems and the solutions they found were discussed. Growers are being rewarded with excellent economic returns for this kind of production.

7 Orchard Design, Training And Pruning Systems

7.1 Silviero Sansavini (Italy)

*Orchard pear design and HDP management: review.*

This speaker discussed the relative merits of modern orchard practice in moving to high density planting systems. An improved level of management expertise is needed to ensure a proper return on the increased investment required for the higher tree density orchards. Research is showing that densities in the 2-4,000 trees/ha range using quince or other dwarfing pear clones with spindle and various hedgerow systems perform the best. The University of Bologna tested several tree densities using Conference on quince MC, and at 2,000 trees/ha had a yield of 7MT/ha by year 3, at 4,000 trees/ha a 12MT yield, and 15 MT at 8,000 trees/ha. The investment needed to establish a high density planting requires a high farm-gate price otherwise the break-even point takes too long to reach and the enterprise is at risk.
7.2 Rachel B. Elkins and T. M. DeJong (USA)
Effect of training system and rootstock on tree growth and productivity of Golden Russet Bosc.

A trial established in 1993 looking at six rootstocks and five tree training systems was undertaken in California. The Golden Russet Bosc trees were grown on various OHxF rootstocks. Trees were planted at 3 x 5m for central leader, three leader and the parallel hedgerow while 1.5 x 5m was used for the free standing perpendicular fan and the Tatura trellis system. The Tatura had the highest cumulative yield/ha but needed the correct rootstock as productivity of training/rootstock combinations varied widely. The main disadvantage of this system is its initial high cost.

7.3 John W. Palmer (New Zealand)
Effect of spacing and rootstock on the production of Comice pear in New Zealand.

A trial using Comice on the rootstocks BA29 or Quince C, and tree spacings of 1.5, 1.9 and 2.4m in rows 3.5m apart, was undertaken in 1993. The aim was to examine the performance of these two rootstocks and to determine their effects on the productivity of this variety. Results showed that Quince C gave higher early yields (year 2) but by year six BA29 yielded more. Quince C showed reduced vegetative growth, a pronounced overgrowth of the scion, and this rootstock produced smaller fruit.

7.4 Josef (Jef) Vercammen (Belgium)
Influence of the plant and pruning system on the financial result of Conference

A grower demonstration plot was planted in 1994 to compare seven different planting systems using Conference and three Quince rootstocks. The training systems compared were as follows: an intensive V-system on Quince C (3.2x0.80 m), trees with a small volume on Quince C (3.2 x 1.25m), a traditional V system on Quince C (3.5 x 1.25m), the hedge of Tienen on Quince Adams (3.5 x 1.75m), the table system on Quince Adams (3.5 x 1.5m) and the long pruning on Quince A (3.75 x 1.74m). The following conclusions were presented:
- The V systems had the highest costs of labour and materials for the first three years and despite higher yields, the intensive V systems were still showing a negative result by year 6. The traditional V system on the other hand performed better.
- After 6-years the bush-spindle trees, followed by the trees with a small volume, gave the best financial result with less production but significantly lower labour costs.

The heavy investment of time and money in the first few years for the V systems resulted in a poorer financial result. However, if favourable market prices continue, then the economics of using this tree training method may change for the better.

7.5 Evelyne Costes and others (France)
European pear architecture and fruiting branch management. An overview of an INRA French research program.

This research program aimed to further study the natural tree growth habit of a number of varieties of pear trees at both the orchard establishment stage and at the mature fruit bearing stage. The objective was to enable the growers to optimise tree training methods for each variety and to give
best information re varietal characteristics to the breeders. Some results were discussed and suggestions made for training several varieties.

7.6 Hannes Halgryn (South Africa)
The bi-coloured pears 'Rosemarie' and 'Flamingo' and the influence of summer pruning on colour development.

Summer pruning and growing the blushed variety Rosmarie on a trellised system helped increase the colouration of this pear in South Africa. These two bicoloured pear varieties are not yet grown on a large scale, and do not develop good colour in the warmer areas. Exposing the fruit to the sun by summer pruning and by careful fruit thinning helped solve the problem.

Poster Presentations

A number of posters dealt with tree training and cultural issues. They are summarised as follows:

- A Canadian project aimed to help solve the problem of inconsistent fruit bearing by investigating various efficiency factors observed in a pear variety by training systems trial. The training systems used were Mini-Tatura, Palmette and Supported Modified Central Leader system. Results showed that highest yields were achieved with the Modified Central leader while Mini-Tatura gave best light interception. The effect of light interception on fruit yield was most significant at fruit set, indicating the importance of light on fruit yield at the early stage of fruit development.

- A Californian study found that trunk girdling of Bartlett about 2 weeks after full bloom did reduce pruning weights in the following year while not significantly reducing fruit yield or size.

- An Italian trial looked at growing several varieties on their own roots and trained to the Tatura trellis system. It took until year 7 for the trees to bear yields over 40 tonnes per hectare but the researchers thought this training system was worthwhile.

8 Nutrition and Soil Management

8.1 Enrique E. Sanchez (Argentina)
Nitrogen nutrition of pear trees.

This speaker reported on work done on examining the processes of nitrogen up-take, storage and use in the mature pear tree. One consideration was the need to optimise the use of nitrogen applications in the field to avoid leaching of this fertiliser to ground water with the resultant pollution of streams. Work was done in Oregon using a stable isotope of N to determine where this fertiliser goes in the different parts of the tree when it is applied at different times of the growing cycle. The following points were made:

- Early shoot and fruit growth uses stored reserves of N, and in the first 3 to 4 to weeks after bloom newly absorbed N goes to the spur leaves. Once spur leaves have reached full size then N is diverted to shoot leaves and fruit.

- Early spring applications of N cause excessive shoot growth while post harvest applied N went into storage organs.

- N applied before harvest goes more into aerial parts while post harvest N goes into the roots.
• Post harvest foliar applications of N are much more effective in supplying N to the flower buds than ground applications.
• Light exposure in the tree canopy affects leaf N content and N mobilisation.
• When strategies are being developed re N fertilisation, then all sources of N available to the tree need to be considered.

8.2 Jordi Marsal and others (Spain)
The water stress limits for pear growing.

A study was undertaken in Spain to determine the maximum water stress allowed before crop survival is threatened. Two-year-old pear trees were planted in 120 litre pots and combinations of spring or summer drought conditions were applied and various fruit and tree parameters were recorded. The conclusion from the work was that vegetative growth was more sensitive to water stress than fruit growth. Various critical water tension figures affecting tree function were listed.

8.3 Amos Naor (Israel)
The interrelations between water potential, fruit size, crop level and stomatal conductance in field-grown ‘Spadona’ (Pyrus communis) pear.

This study set out to better understand how water stress affected crop level and fruit-size under a range of irrigation rates. The work was done in Galilee a semi arid region and five irrigation rates were used ranging from 25% to 100% of the Class A pan evaporation rate. A range of crop loads was also set up for each irrigation treatment. The results showed that crop yield was highly correlated with both midday stem water potential and soil water potential. Stomatal conductance was also highly correlated with leaf water potential but more so, to stem water potential.

8.4 Adamo Domenico Rombola and others (Italy)
Iron chlorosis in pear: causes and remedies.

• In recent years, there has been a significant expansion in area of high-density pear orchards in the Po Valley. As the Po Valley soils are calcareous and of high pH, a significant iron (Fe) deficiency (chlorosis) has become a significant problem of these pear trees grown on quince rootstock. Yield reduction is dramatic and the tree’s life span is shortened. In these soils, iron availability is reduced when iron hydroxides are formed and precipitated. Bicarbonate in high concentration can also cause physiological inactivation of iron within the plant. This project aimed to find solutions to this problem by studying the physiology and biochemistry of tolerant pear rootstocks and by finding ways to modify the root’s environmental conditions to allow efficient Fe uptake. Some findings were as follows:
  • Tolerant rootstocks are able to improve iron acquisition through mechanisms such as rhizosphere acidification, increase of root enzymic Fe reduction and root organic acid synthesis.
  • Fox 11 and Fox 16 rootstocks were recommended for these soil types.
  • Organic matter as compost mixed with iron sulphate and applied to the soil proved effective in preventing this problem.
  • Sowing graminaceous species along the tree line and supplying them with iron sulphate also gave good results. The grass roots are powerful chelators of iron. (?)
8.5 Shmuel Zilkah and others (Israel)
Influence of foliar application of nitrogen on pome fruit productivity.

This work looked at using urea sprays applied at different times during the growing season to achieve an increase in yield. The best time seemed to be at leaf fall and under adverse growing conditions, then also at early bud movement stage (?).

Poster Presentations

There were many posters again on display covering a wide range of issues related to this topic. Some of them are summarised as follows:

- Italian research using labelled Ca (NO₃)₂ fertiliser, applied at different stages during the growing season, indicated that a limited application of N applied before harvest does not affect fruit quality while being effective in augmenting N storage in the roots. This N can then be remobilised in the following spring.
- A study was designed to determine leaf standard indexes for the diagnosis of mineral status of pear orchards. Two important Italian pear varieties were used. Nutrient levels in the leaf varied through the season and for each variety, optimal leaf concentration ranges for sampling in mid July were set for N, P, K, Ca, and Mg. This work was done in the Po Valley in Italy.
- Another Italian project studied the morphophysiological response of in vitro shoots of quince clone MA and Conference to lime induced chlorosis. The interaction of the shoots to various Fe chelates and other compounds was examined.
- Iron chlorosis was also the subject of an American study. This problem is the most serious nutrient deficiency problem of pears grown on clay soils in California. A five-year study compared urea-sulfuric acid and iron chelate (Fe-Eddha) against a control in their effectiveness in relieving this deficiency. Iron chelate gave the best result but urea-sulfuric acid was cheaper and was of some help. Both treatments were best applied through the drip irrigation system.
- An Italian study looked at the effects of salinity on the growth of pear rootstocks.
- The possibilities of using Regulated Deficit Irrigation in the sub-humid Po Valley were studied over a five-year period. The best results were achieved when limited irrigation was used in the 60-day period after full bloom and in the post harvest stage. This also needed to be combined with 100% water use up to full bloom and from the end of the 60 period after flowering to harvest. Another study showed that deficit irrigation reduces shoot growth and increased fruit set in Bartlett pear.

9 Fruit Set Control and Cropping Physiology

9.1 Anthony Webster (UK)
Fruit set control and cropping physiology

To improve profitability of commercial pear production, it is essential to improve the precocity and productivity of cropping in pear orchards. Better control therefore is needed regarding flower induction and development, flower quality, pollination and fruit set, fruitlet growth and fruitlet retention/abscission. Limited research has been carried out for pears compared to apples and often the findings for apple cannot be extrapolated to pear. Another factor causing difficulty is that the effects of various treatments vary in their effect from one variety to another. The speaker discussed research findings relating to work done to improve pear productivity. The issue of growth regulators
is receiving more interest as the market place is now rejecting fruit treated with the growth regulator CCC that was used to increase flowering of pear. The new growth regulator prohexadione-Ca has reduced shoot growth but not significantly increased flowering in preliminary trials. Sprays of gibberellins and BA have improved fruit set and pear retention on young pear trees. An investigation into the reason why terminal flower buds often set fruit concluded that this effect may be associated with a lower potassium content and higher levels of zinc, manganese, copper, magnesium and sodium. Fruit and blossom thinners have only shown inconsistent thinning results so far. The conclusion of the above was that there are many factors involved in pollination, fertilisation, fruit set and fruit development and more work research needs to be done also taking into consideration the varietal and rootstock influences on the above.

9.2 Don C. Elfving and D. Sugar (USA)
Pear tree shoot growth patterns in relation to chemical control of vegetative growth.

This research looked at the effect of the growth regulator prohexadione-Ca (Apogee™) on pear shoot growth. Different pear varieties showed different patterns of shoot growth and growth regulator use needs to take into account these differences to be successful. Apogee™ applications were successful when trees had only a single strong growth flush. Development of effective combinations of Apogee™ concentrations and timings to produce season-long control without violating pre-harvest interval regulations requires further research.

9.3 Claudio Bonghi and others (Italy)
Ethephon, NAA and NAD as chemical thinners of pear fruitlets.

The high cost of hand thinning pears in commercial orchards prompted research into the effects of the thinning agents Ethephon, NAA and NAD. The work was done on the Conference and Rosata pear varieties and carried out in north-eastern Italy. Results indicate that:
- The thinning effect of these agents varies in relation to the time of application, pear variety and chemical concentration.
- Crop load plays a crucial role in influencing the thinning effect of the chemical.
- NAD @ 15-25 ppm seems to be the most suitable chemical thinner for Conference and Rosata pear.

9.4 Stephen M. Southwick and R. Moran (USA)
Reducing secondary flowering in ‘Bartlett’ pear to reduce fireblight

Since fireblight is a serious problem in commercial pear production and because this disease often infects the tree through flowers produced later in the growing season, a study was carried out to understand the dynamics of this secondary flowering. Researchers determined there to be five different types of secondary flowering shoots produced during the growing season and attempted to find ways to reduce this flower production. An integrated approach was recommended involving several growth regulators and summer pruning practices.
9.5 Sally A. Bound and L. Mitchell (USA)
The effect of blossom desiccants on crop load of Packham’s Triumph pear.

This pear thinning trial conducted in a Tasmanian pear orchard used Culminate™ at three different timings during the flowering period applied to the Packham pear variety. At application timings of 20% and 50% bloom, the higher the concentration of Culminate™, the greater the reduction in crop load. The 80% bloom treatments had little effect. The conclusion of this work is that Culminate™ needs to be applied as early as the 20% bloom stage to achieve effective thinning, and that a second application from 50% bloom is likely to enhance the thinning effect. Once full bloom is reached it is too late to apply desiccants to thin pears.

9.6 Tom Deckers and H. Schoofs (Belgium)
Improvement of fruit set on young pear trees cv. Conference with gibberellin treatments: comparison of results with gibberellins GA3 and GA4/7.

A study of the effects of two growth hormones, Gibberellins GA3 and GA4/7, was carried out to see how to increase fruit set on young pear trees. The application of these growth hormones is also helpful in repairing the effects of frost damage. The treatments were applied to two-year-old wood on Conference pear trees at full bloom. The results indicate that a mixture of GA3 and a half dose of GA4/7 gave good results for fruit set improvement. The use of gibberellins did not greatly affect fruit size and shape.

Poster Presentations

A significant number of posters on display related to this topic area, and they are summarised below:

• A report on research done in the USA on the use of the reflective kaolin particle film marketed under the name of Surround concluded by stating that the beneficial temperature reduction by the kaolin cover, the enhancement of photosynthesis and yield, the environmental inert effect and the ease of washing off the particles from the fruit, makes it an interesting tool for alleviating excessive heat stress in apple and pear trees grown in warm and dry locations.

• A South African study looked into ways of ensuring colour development in the red blushed pear variety Rosemarie. Summer pruning exposed fruit to the light and this exposure is known to stimulate the production of anthocyanin the pigment responsible for red colour development in the pear. By keeping the fruit cool with the use of evaporative cooling during the growing season the red colour can be retained. The application of kaolin to the tree canopy reduced losses through sunburn and therefore enabled more red blushed fruit to be harvested.

• A US study looked at the effect of the growth regulator prohexadine-Ca (Apogee™) on blossoming, production and fruit quality in pears. This growth regulator did affect fruit weight colour and return bloom and results varied with the different varieties treated.

• An Argentine study was conducted to observe the effects of a pre-harvest application of ReTain™ on the maturity of Williams pear and to determine the effect of a spring application on the fruit set of Packham pear. ReTain did not significantly control the pre-harvest drop with Williams but Packham trees sprayed with ReTain 2 weeks after full bloom did show increased numbers of fruit after the December drop.

• An Australian project looked at chemical thinning of the nashi variety Nijisseiki. The results showed that benzyladenine was ineffective, Armotherin caused unacceptable russet and that Culminate™ was found to be most effective when applied at 50-80% bloom at rates of 1.5-2.0%
The best thinning results were obtained when applications were made during the middle of the day at temperatures above 18°C. The russetting effect that can occur with Culminate use is less pronounced when spraying is done under warmer conditions.

- Further to the fruit thinning trials already mentioned above, a further study looked into the use of benzyladine (BA) as a post-blossom thinning agent for the Packham pear. BA was applied from 10 to 35 days after full bloom and at rates of 100 to 150 ppm and did have an effect in reducing crop load. The use of BA did also reduce fruit sugar levels and fruit firmness. The recommended time of BA application is 10 to 40 days after full bloom at the rate of 100-150 mg/L.

- An Israeli investigation into the use of the synthetic cytokinin CPPU was applied to the pear varieties Spadona and Coscia to increase fruit size. It was found that this material, when applied at 10 ppm two weeks after full bloom, produced significant size increases in both varieties with an additional 50% yield increase.

10 Fruit Quality

Keynote Speaker

10.1 Paola Zerbini

Pear fruit quality

This address discussed the various pear fruit characteristics that contribute to the eating quality of the pear. Texture is especially difficult to obtain and is affected by many factors including harvest time and pre and post storage conditions as well as storage duration. Texture is related to how cell wall components change during ripening and no chemical or physical analysis until now can substitute for the sensory analysis in defining texture properties of ripe pears. Sugars, acids and other volatiles such as esters impart the typical character to the flavour of the pear. The main impact compounds have been identified as esters of decadienoic acid, but also low boiling point volatiles are important in pear flavour.

10.2 Moshe A. Flaishman and others (Israel)

Mitotic activity in early pear fruit development.

The aim of this project was to study early pear development with regard to the period of cell division. Histological and biochemical techniques were used and a significant increase in cell number was observed in the fruit pericarp between anthesis and 35 days post anthesis. The persistence of the mitotic activity (cell division) during fruit development was determined by fluorescence-activated cell sorter analysis. Mitotic activity reached a peak at 35 days post anthesis followed by a sharp decrease: at 56 days post anthesis, most pulp cells remained at the G1 phase.

10.3 Fraqnesca Rapparini and S. Predieri (Italy)

Volatile components from fruits of different pear cultivars.

This research sought to find sampling methods to analyse the volatile compounds emitted by pear fruit flesh with the aim of finding one that would give results as close as possible to those coming from those perceived by sensory evaluation. The method used was the dynamic headspace, a very gentle, accurate and non-destructive work-up procedure. This method allowed in the very first
minutes after slicing, collection of reliable quantities of the volatiles released in the vapour phase by the fruit slices. This sampling technique allowed a high recovery of very reactive compounds such as aldehydes, while avoiding the possible formation of new products because of altered metabolism. The identification of more than 40 compounds was possible using this method.

10.4 James P. Mattheis and others (USA, Brasil)
Manipulation of ‘Bartlett’ pear fruit ripening with 1-Methylocyclopropene.

The use of 1 methylcyclopropene, known as ReTain, a substance used to inhibit the production of ethylene, was studied in its effect on the ripening of Bartlett pears. This product stops ethylene binding with an important protein and so stops the ripening process for a time. ReTain is applied as a fumigant and several doses are needed to allow the fruit to be successfully stored for up to 6 months. The use of this chemical caused the pears to retain their green colour and reduced the level of decay. Fruit treated and later brought out of storage showed partial inhibition of ethylene production and respiration, fruit softening and the production of aroma compounds when ripening resumed. Protocols need to be developed to allow this product to be successfully used to extend the storage life of the Bartlett pear.

Poster Presentations

Some information presented in the posters on display dealing with fruit quality issues is summarised as follows:

- Non-destructive determination of internal quality in intact pears by Near Infrared Spectroscopy (NIRS) was studied to highlight parameters that could assist in more accurate maturity determinations for fruit. The present study reported on the use of NIRS to estimate soluble solids content, flesh firmness, acidity and dry weight in several pear varieties. The results from the NIRS tests were as good as those from destructive tests. This work was done at the Bologna University in Italy.

- Another Italian investigation looked at using the Vacuum Infusion process that allows air to be removed from vegetable tissue and to then infuse functional solutions eg pectin, alginate gelatine etc into the food by hydrodynamic transfer. This treatment aims to preserve texture by minimising tissue softening due to pasteurisation or freezing processes. In this study, pear pieces used in yoghurt were treated successfully.

11 Post Harvest Physiology and Storage

11.1 David Sugar (USA) Keynote Speaker.
Post-harvest physiology and pathology of pears.

In his address, the speaker outlined the reasons for cold-storing pears and the discussed the controlled-atmosphere oxygen and carbon dioxide gas levels used for optimum storage. Typical CA O₂ levels used are from 1 to 3% with the CO₂ levels being from 0 to 5%. Typical gas levels in the USA are 1.5-2.0% O₂ and <1% CO₂. As the pear is a climacteric fruit, a distinct increase in the rate of respiration occurs immediately prior to ripening. To allow for proper ripening, the so called winter pear needs to be picked before this increase in the rate of respiration begins with the consequential triggering of ethylene production, and then exposed to a post harvest cold treatment.
Superficial scald is the most common physiological disorder of stored pears and it affects the principal storage cultivars of the USA (d’Anjou), Europe (Conference) and the Southern Hemisphere (Packham). Ethoxyquin and diphenylamine (DPA) are widely used to inhibit scald development. Low oxygen atmospheres, (0.5% O₂ used with <0.1% CO₂), have helped reduce scald for short-term storage (3 to 4 months) without the use of anti-oxidants. However these storage atmospheres, when used alone, are not able to control superficial scald on pears stored for longer periods. Research has suggested that plant and mineral oils have some potential to be used to control scald. Brownheart, a storage disorder of Conference, is being studied in Europe at the moment and it seems to be affected by many factors including the CO₂ content of storage atmospheres, fruit maturity, promptness of post harvest cooling and delayed establishment of the CA atmosphere.

Post harvest storage disorders are commonly caused by the fungi Penicillium expansum (blue mould) and Botrytis cinerea (grey mould) and the most common control mechanism is through the use of fungicides. Resistance to the widely used benzimidazole fungicide group has been frequently seen and efforts are being made in the USA to enable the registration of fludioxonil and fenhexamid both highly effective against certain fungal pathogens. Work has also been done developing biological controls which compete with the pathogen at the wound site. These organisms when used with low rates of thiabendazole gave good pathogen damage reduction.

11.2 Paola Eccher Zerbini and others (Italy)
Harvest maturity, mineral content and post-harvest quality of ‘Conference’ pears stored in high or low CO₂.

This Italian research project aimed to find out how harvest maturity, mineral content and storage conditions affected sensory quality and storage disorders of Conference pears. The fruit sampled came from 2 orchards harvested at 3 different times and stored in either a low CO₂ (2%) or a high CO₂ (5%) atmosphere. Fruit quality parameters were also measured at harvest and after storage. The results showed that:
• Fruit from high CO₂ storage atmospheres were firmer out of storage and after a specified shelf life.
• High CO₂ storage gave a greener skin colour.
• Scald levels varied between orchards and were not significantly affected by storage factors.
• Brownheart was increased by harvest delay and by high CO₂ atmospheres and was not affected by the mineral levels of Ca, Mg or K.

11.3 Hiroshi Gemma and others (Japan)
Study on watercore occurrence in ‘Hosui’ Japanese pear.

This project studied the problem of the nashi variety Hosui known as water core which is known to occur in relatively cool summers and in trees grown on certain soil types. Apparently the pulp of the fruit matures ahead of the peel and the reason for this was studied. A certain type of cell was observed to form in the affected fruit and the amounts of cell wall polysaccharides and other cell components were compared in samples taken from fruit grown in different soil types. From a grower perspective, it seemed that cool summers with low solar radiation and low levels of evaporation resulted in a high incidence of water core. The exact reason for this problem in the fruit is still unknown.
11.4 Paolo Bertrolini (Italy)
Influence of calcium and oxygen levels on soft scald of stored ‘Abbe Fetel’ pears.

Abbe Fetel, Italy’s most important winter pear variety, is very susceptible to soft scald which, unlike superficial scald, is not controlled by post harvest applications of the anti-oxidants Ethoxyquin or DPA. This problem is a significant impediment to the success of this variety and so a study was under taken to find ways of controlling this disorder. An investigation looked at how post-harvest calcium dips ranging from 1.0% to 4.5% and various controlled atmosphere storage O₂ and CO₂ levels affected soft scald severity. The results of this study were as follows:
• In untreated fruit, Ca levels were highest in the skin and lowest under the skin at depths between 1-5 mm.
• Soft scald mainly affects the tissues up to 5 to 7 mm deep (where the Ca levels are lowest).
• The fruit dipped in a 4.5% CaCl₂ solution showed the best outcome with only a 4.6% fruit damage level compared to 53% for untreated fruit.
• Increasing levels of O₂ in storage inversely affected soft scald levels.
• Delayed establishment of the CA atmosphere gave a worse result.
• More research work is needed to resolve the issue.

11.5 Haibo Xuan and others (Germany)
Does boron affect the occurrence of physiological disorders of ‘Conference’ pears during CA storage?

Conference pears stored under low O₂ and high CO₂ develop a storage problem called brownheart that significantly reduces the market value of the fruit. A study was under-taken to determine the effect of pre-harvest boron sprays on the incidence of brownheart and on several physiological parameters in pear fruit stored under high CO₂ stress systems. Trees were sprayed with 0.15% Solubor several times before harvest and after harvest stored at −0.5°C and under CA conditions of 5%CO₂ and 2%O₂. Fruit was stored for 4 months and examined each month for various physiological parameters. The results indicated that while the control fruit were highly affected by brownheart by the second month, the fruit treated with boron were not showing any disorders. The boron treatment reduced the fruit membrane permeabilities, increased vitamin C content and increased the antioxidative enzyme activity of the fruit as well as reducing the sensitivity of the fruit to CO₂.

Poster Presentations

As for the other topics, there were a number of posters on display and a brief summary of them is as follows:
• The early and non-destructive detection of the storage disorder known as brownheart was the aim of this German project. The ability to predict the onset of brownheart would allow alternate marketing decisions to be made for fruit before a marketable condition is lost. A rapid non-destructive method of detecting the early stage of development of this disorder was sought. Chlorophyll fluorescence has been studied as an indicator of low O₂ and or high CO₂ levels in CA storage and this research looked to see if chlorophyll fluorescence was linked to the development of brownheart. Results indicated that there existed a positive relationship between brownheart and chlorophyll fluorescence in Conference pear.
• An Italian poster presented results of a study to determine if the biochemical mechanism of scald seen in Conference pear was the same as in other pears. Oxidation of alfa-farnesene in the
cuticle is related to the appearance of scald in pears. The levels of alfa-farnesene in the cuticle were measured in samples taken from Conference fruit held in various storage conditions. The appearance of scald coincided with a decrease in alfa-farnesene as seen in other pear varieties.

- A Japanese project looked at the decrease in starch levels of pear tissue after harvest and held in cold storage or bench ripened.
- Non-chemical control of scald on Beurre d’Anjou pears was the aim of an Argentine study. It was hoped that initial low oxygen stress (0.5% O₂+0.1% CO₂) followed by ultra low oxygen (1.0% O₂+0.1% CO₂) or low oxygen (1.5%O₂+0.1% CO₂) storage levels may inhibit scald production. All fruit were assessed after 196 and 277 days of storage, plus 1 and 7 days at an ambient temperature of 20°C, and results showed that fruit held in conventional air storage with no DPA treatment had 77.5% scald damage and 48% with DPA treatment while the fruit stored under low oxygen atmospheres had the best outcome with no scald damage. More work is needed to confirm the consistency of these results over several seasons.
- A Spanish project looked at biological controls for blue mould on pears and investigated the use of antagonistic bacteria combined with a reduced fungicide dose. This strategy of using 25% of the recommended post-harvest fungicide dose in combination with the bacteria *Pseudomonas fluorescens* gave as good a result as the normal fungicide treatment used alone.
- A Greek investigation looked at the antagonistic relationship between of a variety of fungi naturally occurring on the pear surface and several fungi causing post-harvest spoilage. Some antagonism between the fungi was observed.
- Short-term high carbon dioxide treatments (12 or 20% CO₂+5% O₂) were evaluated for their potential suppression of post-harvest decay of pears. Pears were exposed to these atmospheres for 2 to 6 weeks prior to longer-term storage in air or regular CA storage. Results showed that high initial CO₂ levels reduced decay cause by Botrytis cinerea. Decay caused by *P. expansum* was not controlled by high CO₂ treatments but could be suppressed by bio-control agents. Internal injury caused by high CO₂ levels was studied and the results showed that for pears grown in southern Oregon, injury that related to elevated CO₂ was only observed in pears harvested mid to late in the picking season. This injury increased with an increased exposure to CO₂ and with a delayed initiation of the high CO₂ atmosphere.
- The effect of low ethylene levels in CA storage atmospheres on the outturn of Conference pears was examined in an Italian investigation. The results indicated that reducing ethylene levels to below 3 ppm in storage rooms did not significantly control the ripeness of this pear variety.
- An Italian study examined the best method of ripening Bartlett pears to optimise eating qualities of the pear for the consumer. Fruit was stored in CA using atmospheres of 1.5% O₂ + 1.5% CO₂ and held at -0.5°C for 105 days in one storage regime. Various post CA storage temperatures were trialed to find the best way to handle this pear. The best eating quality was seen when the fruit was conditioned at 20°C immediately after harvest. Different temperature regimes used after cold storage improved the shelf life of the pear.
Visit to Wadenswil, Switzerland, September 10-12 2000

1. Interview with Dr. Thomas Hasler regarding fireblight.

Dr. Hasler is a pathologist at the Wadenswil Agricultural Research Centre and was in charge of the fireblight eradication program in the local area. He spoke of the difficulties experienced in trying to check the local plants for fireblight infections.

History. The fireblight organism was believed to have come into Switzerland in 1996 and since then, outbreaks have been treated very seriously.

Home gardens and farms have been inspected re the presence of fireblight but problems have been encountered that have been very difficult to overcome. The large pear trees now growing on the farmland are not actively managed and are too tall for a person to determine if shoot dieback that may be suspected on high branches is caused by fireblight or perhaps Monilinia sp. These tree are valued as part of the scenic tourist landscape and would not be readily allowed to be removed. Garden plants in the towns have also been surveyed but as there are many potential host plants the job of inspection was very large one.

Funding for this fireblight eradication work has come from the central government and from the cantons but fruit growers are concerned re future funding viabilities. Growers receive compensation for tree removal but they expect that this will not be able to continue indefinitely.

Control. Initially when fireblight was detected, whole orchards were removed if the disease was present and now, with the task of getting rid of this organism seemingly impossible, tree removal is only done in the area immediate to the infected tree(s). Streptomycin at the time of my visit was not allowed to be used but growers would like to be able to use it. The second bloom of fruit trees later in the growing season when environmental conditions are ideal for infection, present problems for the grower and data collected from on site weather stations is used in conjunction with computer models to predict disease outbreaks.

Some work has been done with bees walking them over trays of antagonistic bacteria in the hive before they travel to the fruit trees to try to control fireblight by infecting the flowers with a non-virulent bacteria instead. This only works if flowers are infected in this way before being exposed to the fireblight organism.

Spread. Some infections were believed to have come in through hail damaged shoots and the bacteria has spread over considerable distances (10 km) by wind driven rain. A typical scenario of infection would begin with cankers on the tree branch emitting a bacteria-laden ooze that is attractive to insects and after visiting these sites, the insects may then take the fireblight with them to the flower. Once the flowers are infected bees would then carry the bacteria to other flowers and spread the infection. Aphids can also assist in spreading this disease.
Visit to an apple orchard owned by Mr Puis Jans from Gelfingen, Switzerland.

This progressive apple grower has experienced problems with fireblight and said that he now considers fireblight impossible to eradicate. He believes that the tall farmland cider pear trees on the surrounding hills are infected with fireblight and so he is only in control mode re this disease. They use weather stations to indicate when infection periods have occurred and they cut out and burn infected and adjacent trees when the disease is detected. He also believes that registration and the controlled use of Streptomycin is the best strategy. Ten apple scab sprays are applied each year and the local pathologist thought that this was doing well. Apple prices were poor and this grower was in survival mode hoping that he can survive until less efficient orchards have been removed and supply more closely matches demand. The main varieties grown were Gala, Elstar and Golden Delicious and rootstocks were M9 and M26.

Visit to Belgium and Holland September 14-16 2000

1. Visit to the Royal Research Station of Gorsem, Belgium

Discussions with Mr Tom Deckers regarding problems experienced on our orchard with an excessive drop of Josephine pear fruit in November led to a consideration of the effects of glyphosate use on clay soils. Tom had seen situations where, after glyphosate had been applied to bare clay soils, a negative effect on all growing tips which included the young pear fruitlets. In the nursery situation glyphosate caused growth reduction and distortion for several years after the chemical was applied and this researcher advised against the use of this chemical in the orchard.

The possibility for international collaboration was also discussed briefly, as was the opportunity for growers in Australia to call upon the expertise of Belgium fruit researchers to help with their technical problems. It was evident to me that growers need to seek out the most competent help possible when the need arises and this may require the use of international consultants.

Tom Deckers was involved in the organisation of the pear symposium in Italy and has also been to South Africa and addressed scientific meetings. I believe we need to build the communication network with people such as this researcher and others of similar expertise so that we can keep up with latest knowledge and technical advances in pear growing.

2. Visit to the Research Station for Fruit Growing, Sint-Truiden, Belgium

Mr Jef Vercammen, the Director of Experimental Gardens for Pome and Stone fruits, showed me the packing shed and pear orchard from which their main pear varieties, Conference and Comice were produced. The aim of this research station was for it to be a demonstration orchard where growers could come and see recent varieties, training systems and other up to date practices in action. I was shown the pear variety by rootstock by training system trial that was discussed in Jef’s presentation at the pear symposium in Italy (see presentation 7.4).

The V system consisted of 2 leaders per tree per side with these leaders being supported only top and bottom by a wire and growing up a training pole. The fruit was borne on short shoots which grew out of each leader and the leaders were both leaning out from the main line of the row (to give...
the V down the tree line). They were also leaning away from each other so that the orchard workers could move in and around these fruiting arms. While the V system performed well from a light interception point of view it did not give the best financial result given its higher initial establishment cost and the poor market returns for pears. It is apparent that each grower needs to understand the significant economic and cultural factors that influence the profitability of their fruit growing business before deciding on tree training, varieties and rootstocks.

Jef showed me some Comice packed in 2 layer timber trays ready for the local market. I had expected that transit damage would have been a problem with these containers but apparently it was not. I was given a copy of a booklet detailing recently completed research results but the barrier of a foreign language proves to be significant!

3. Visit to the Fruit Research Station at Lingewal, Randwijk, Holland

Dr Frank Maas, Senior Scientist Pomology, showed me over a large collection of apple and pear varieties on various training systems, that was part of the Wageningen Research Institute. The collection consisted of mature trees mainly on the palmette training system, and it was of interest to see that our premier variety, Packham was of large size and with a poor skin and therefore not of commercial interest in that environment. It was apparent that each country favoured particular varieties and it would be of interest to know what drives this consumer preference to enable the selection of the most appropriated export varieties to be grown in Australian orchards.

The research station also had a trial consisting of Comice on quince C which were growing on several training systems. The block was planted in 1996 and trialed some simple V systems. It seems that the Tatura trellis training system has many preferred characteristics and the main problem under Australian conditions perhaps is the length of time needed for Packham to start bearing consistently heavy crops.

This visit again underlined the fact that quince is the predominate rootstock used in Europe and it is used to grow their partly or fully russetted pears. We need to determine whether Australia needs to move to a more precocious stock than *P. caleriana* and should we breed our own or rely on procuring one from another country that may have different climatic dictates?
RECOMMENDATIONS

1. The pear industry in Australia should actively set out to bring into Australia new pear rootstock and scion material from the various breeding programs around the world and evaluate this material under Australian growing conditions.

2. The relatively disease free status of the Australian environment should be rigorously maintained as there are many pest and diseases in Europe that would have serious consequences in Australia if introduced here.

3. The Australian pear industry needs to recognise the importance of keeping abreast of world's best practice and actively build relationship with the world pear research community to maximise our exposure to new techniques and ideas.

4. The Pear Industry needs to take greater ownership of its research bodies and build a stronger relationship with these agencies to ensure that work done actually is of economic gain to the end user. A vibrant and well-funded research sector is essential if the industry is to remain in a strong position in the global market place. To achieve this, research must be well aimed, properly funded and provide an economic return to the grower. If this does not happen then research investment will diminish and industry's competitive edge will be lost.

ACKNOWLEDGMENTS

I would like to recognise the funding assistance provided by HRDC, now known as HAL Ltd and also the support given by family members and the other partners in our fruit growing business. Dr Ben Robinson from Scholefield Robinson Horticultural Services Pty Ltd is to be thanked for his suggestion regarding my attendance at the Symposium. The great effort of Prof. Silverio Sansavini and his team, who tirelessly worked to organise this excellent symposium, deserves recognition. Thanks also go to Dr Jacob Ruegg, my Swiss host, who gave up valuable time to make my visit there worthwhile.

The writing of this text tested the patience of my brother Peter Magarey and Margaret, my wife, to whom I express my sincere thanks. I should also acknowledge the help of Helena Bak in assisting with the initial text layout.