# Field evaluation of hazelnut varieties HGA Conference 2002.

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# Hazelnut Variety Research

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Project commenced in 1995.

Hazelnuts were introduced into Australia over 150 years ago. However, they have not been grown as a major crop, although the climate and soils in the southeastern part of the continent appear to be suitable. Many groves comprise Australian selections rather than recognised cultivars.

During the early 1900's, groves of hazelnuts were established in the upper Ovens Valley in Northeast Victoria. Most groves were removed in the 1950's to make way for higher return enterprises such as tobacco (Paskas, 1988). The variety Wanliss Pride appears to be the main variety grown in this area. It is likely this is a selection from Imperial de Trebizonde (Allen, 1987). During the 1960's and 70's, Imre Tokolyi of Melbourne made several selections from imported nuts (Kenez, 1989). His selections known as Tokolyi Cosford, White American and Turkish Cosford, were later planted in groves. Other local seedling selections include North-East Barcelona and Woodnut.

The first recorded variety trial commenced in 1937 at the Glen Innes Research Centre on the Northern Tablelands of NSW. Thirty varieties were planted on a spacing of 3m x 3m, with yields of up to 7.5kg of nuts per tree being reported (Trimmer, 1965). The origin of the cultivars in this trial is unclear, although they were probably seedling types. In 1972, suckers from the Glen Innes site were transferred to an arboretum at the Agricultural Research Centre at Orange, NSW.

# The principal objectives of this research are to:

- determine the most suitable hazelnut varieties that could be used for the establishment of a hazelnut industry in south-eastern Australia.
- assess the effects of geographical region and climate on hazelnut production and varietal performance.
- assess the productive potential of hazelnuts (*Corylus avellana* L.) in Australia.

During the 1980's, the Victorian Department of Agriculture established collections of hazelnut cultivars at Ovens and Toolangi Agricultural Research Centres. Yields of up to 4kg/tree were reported from Atlas, which out-yielded all other cultivars at Ovens (Sample, 1993). At Toolangi, 'good crops' were reported 12 years after planting (Kenez, 1993) from the varieties Atlas, Barcelona, Cosford (Cob), Du Provence, Royal Italian, Wanliss Pride and White American.

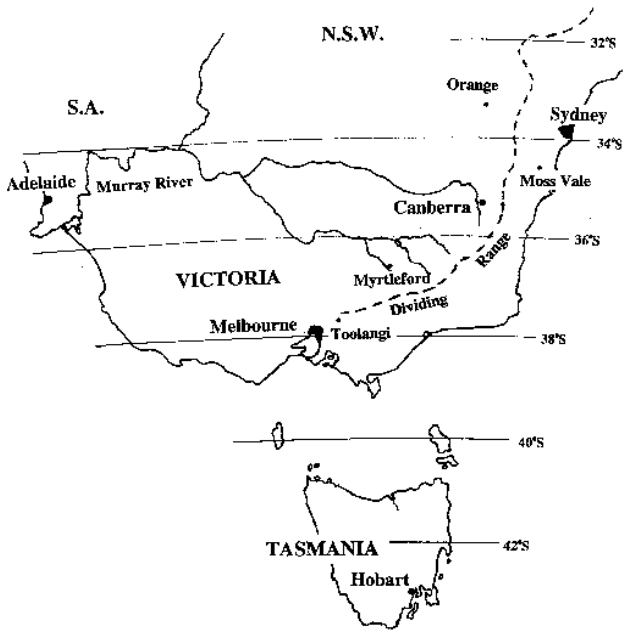
The objective of this research is to study the performance of introduced cultivars and Australian selections grown under a range of climatic and soil conditions.

Twenty-four (24) varieties are being evaluated including those suitable for the in-shell and kernel markets. The varieties are mainly of European and North American origin, with some Australian seedling selections. Most varieties are on their own roots, although a few had been grafted, girdled above the graft and planted with the girdle below ground level, to encourage them to produce their own roots.

# Experimental design

- An evaluation of 24 genotypes, including cultivars from Europe and the USA along with Australian seedling selections
- Five sites; NSW (2), Vic (2), Tas
- Replicated blocks with 2 trees per plot

# Location of Sites



A randomised block design has been used with four replications. At Toolangi and Orange there are four trees of each variety in each replicate, whereas at Myrtleford and Moss Vale there are only two trees per variety per replicate. The Toolangi and Orange sites were planted in July 1995, the Myrtleford and Moss Vale sites in July 1996. The Kettering site was planted in the winter of 2000.
All trees in the treatments are surrounded by a buffer row which includes a wide range of pollinator varieties, to maximise pollen shed throughout the block and minimise any yield limitations from inadequate pollination or genetic incompatibility.
The tree spacing is 5m between rows and 3m within the rows. A 1.5 metre wide strip down each tree row is sprayed with glyphosate for grass and weed control. The strips between the trees are mown regularly. All sites are irrigated in summer to minimise water stress. The irrigation system at Orange has comprised drippers delivering 4l/hr, whereas at Moss Vale and Myrtleford micro sprinklers are used.

## Characteristics of the sites

| | **Kettering** | **Moss Vale** | **Myrtleford** | **Orange** | **Toolangi** |
|---|---|---|---|---|---|
| Coast (km) | 5 | 40 | 200 | 200 | 60 |
| Alt (m) | 50 | 690 | 300 | 920 | 600 |
| Latitude (S) | 43° | 34° 29' | 36° 44' | 33° 19' | 37° 34' |
| Temp pattern | Maritime, cool winter, mild summer | Maritime, mild | Continental warm summers | Continental Cold winters | Maritime, cool summers |
| Rain pattern | All seasons, erratic | Dry spring | Dry summer | Variable summer | Dry autumn |
| Soil | Grey podzol | Red podsol | Alluvial | Krasnozem | Krasnozem |

Site selection includes a wide range of climate types and soils to enable the effects of climate on flowering and nut production to be assessed as well as any genetic x environment interactions.
This research probably covers a greater diversity of environmental conditions than that encountered in any previous variety studies. It should provide some much needed information on the effects of the Australian climate and soils on hazelnut growth and production.

## Climate comparisons, key production areas with locations in Australia.

| | Samsun Turkey | Corvallis Oregon | Reus, Spain | Myrtleford Vic | Kingston Tas |
|---|---|---|---|---|---|
| **Annual rainfall** | **740** | **1084** | **518** | **903** | **680** |
| ***Hottest month*** | | | | | |
| **Mean max °C** | **26** | **27** | **28.5** | **28** | **22** |
| **Mean rainfall** | **38** | **14** | **11** | **45** | **46** |
| ***Coldest month*** | | | | | |
| **Mean min °C** | **3** | **1** | **5.6** | **1** | **2.4** |
| **Rain days** | **10** | **19** | | **14** | **12** |
| **Est Chill hours** | **1200** | **1460** | **966** | **1110** | **1100** |

The main centres of hazelnut production in the Northern Hemisphere have a maritime climate. It appears that hazelnut production is favoured by cool winters and mild summer temperatures. In Australia, the field studies are being conducted over a range of climate types.

The climate at Myrtleford compares favourably with key areas of production such as Oregon and the Black Sea coast of Turkey. The Kettering site has a cooler summer climate than most overseas centres of production.

# Soil analyses before planting

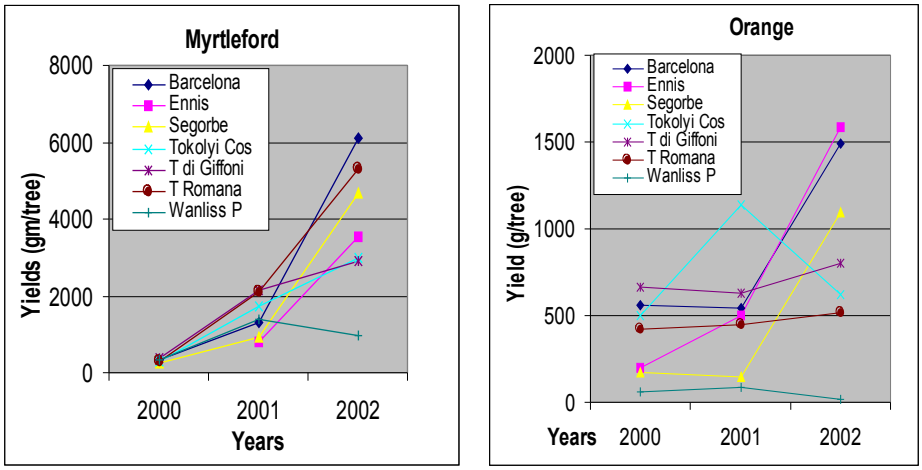
| | Moss Vale | Myrtleford | Orange | Toolangi | Target |
|---|---|---|---|---|---|
| pH $_{Ca}$ | 4.3 | 4.5 | 5.7 | 4.5 | 5.0 |
| P (ppm) | 9 | 7 | 21 | 3 | ? |
| K (meq) | 0.3 | 0.6 | 0.6 | 0.5 | 0.2 |
| Al (meq) | 0.6 | 0.2 | <0.1 | 1.4 | <5 ? |
| Mn (ppm) | 666 | 416 | 897 | 432 | ?? |

The soils at both Orange and Toolangi are volcanic in origin, having been developed from basaltic lava flows, which have weathered to form krasnozem soils with duplex profiles. The clay loam A horizon (200-250mm deep) overlies a heavier textured B-horizon. The soils are deep and well-structured. The soil at Myrtleford is alluvial and is situated on a relatively recent floodplain or terrace. The soil is deep, with varying textures down the profile, due to the changing deposits of material that have, over time, been spread across the floor of the Ovens Valley. Generally, this alluvial soil has a coarser texture than the krasnozems. The Moss Vale site is a red podsol, derived from sedimentary rock. It has a duplex profile, the A horizon is a sandy loam overlying a heavier textured clay loam B horizon. All sites are well drained, but it is possible that the water table in the floor of the Ovens Valley is closer to the surface than at the other sites.

Soil samples were taken from the top 100mm of the profile at all sites before planting and analysed for their available nutrients. All soils were found to be acidic and were limed before planting at the rate of 5t/ha, except Myrtleford, where 7t/ha was applied.

It is often stated that hazelnuts require soils that are slightly acid to neutral in reaction. A pH Ca of 5.0 appears to be the minimum desirable level. Soil pH can affect the availability of many elements, including the potentially toxic elements of Al and Mn. No references on the effects of these elements on hazelnut production have been found in the literature.

# Mean nut in-shell yields (gm)




Some very valuable yield data is now being obtained.

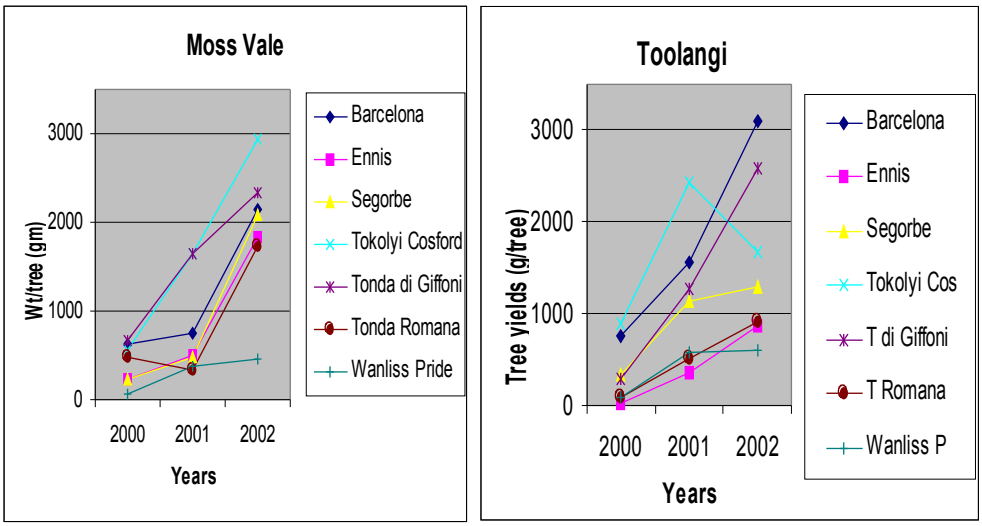
In general, varieties producing the highest yields in the Australian field studies are those of high vigour, with early and mid season female bloom, namely Tonda di Giffoni, Barcelona, Segorbe and the Australian selection known as Tokolyi/Brownfield Cosford.
Willamette, Montebello and Tonda Romana have also produced good yields. Lewis has grown well since planting in 2001, although it is too early to have any yield data for this variety. The in-shell variety Ennis has also performed well despite its late female bloom. Although data on kernel quality has yet to be analysed for this variety, there is some indication that kernels do not always fill well.

The greatest site contrasts are between Myrtleford and Orange, with trees at Myrtleford growing and yielding particularly well. It is important to try and ascertain the reason for this, which maybe be due to climate, soil type, management, or a combination of these factors.

It appears the soils and climate of the Ovens Valley is particularly suitable for hazelnut production.

Bacterial blight was a key factor affecting the growth of trees at Orange in the 2001-02 season. Most varieties were severely affected by this disease. Ennis appeared to be the least affected variety, the cultivar Jemtagaard #5, a late polliniser in the buffer rows appeared to be the most affected.

# Mean tree yields Moss Vale and Toolangi

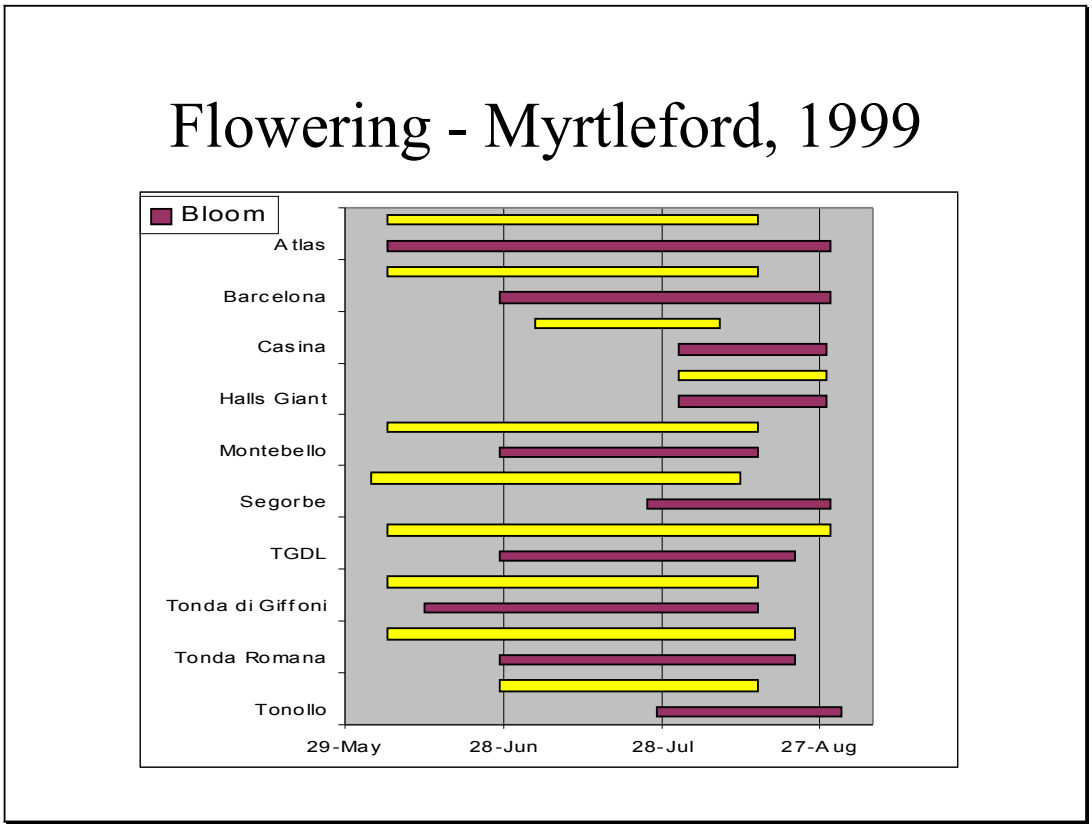



# Catkins and female blooms

The effects of climate are probably best considered from the perspective of stages of plant growth. As *Corylus avellana* is a deciduous species, it has a need for a degree

of chilling to overcome dormancy in floral organs and vegetative buds. Mehlenbacher (1991) studied the effects of period of chilling on catkins, female inflorescences and vegetative buds in Oregon. He found that catkins generally required less chilling than female flowers. In many cases female flowers and leaf buds required similar chill hours, but there were considerable differences in chill requirements between cultivars.

Although the post rest heat unit requirements were not determined by Mehlenbacher's experiments, it was observed that considerable post rest heat units were required for vegetative buds to open, whereas little post rest heat was required for catkin elongation and stigma exertion. This may vary between genotypes.
At the trial sites in Australia, general pattern of flowering by cultivars is similar to that reported by Melenbacher, but estimated chill hours at Orange are considerably higher than those reported by Mehlenbacher in Oregon.




The periods of pollen shed and female bloom have been recorded at all sites over the last 4 years. Some patterns have emerged, with some varieties being consistently earlier than others. For example Tonda di Giffoni, with its low chill requirement, is always early into bloom, whereas Halls Giant, a high chill variety, is always late to shed pollen.

The higher yielding varieties are generally early to mid season in the time of bloom. Presumably this maximises the opportunity for pollination and nut production. A variety like Halls Giant is always low yielding, one reason may be that there is very little pollen being shed at the time that Halls Giant is blooming.

## Variation in date of commencement of pollen shed and female bloom all sites 1998-1999.

| | Pollen shed | | | | Female bloom | | | |
|---|---|---|---|---|---|---|---|---|
| | Julian day to start of pollen shed | | Period of pollen shed | | Julian day to start of female bloom | | Period of female bloom | |
| | Mean | SD/mean | Mean | SD/mean | Mean | SD/mean | Mean | SD/mean |
| Barcelona | 168 | 7.7% | 46 | 46% | 187 | 9.7% | 51 | 30% |
| Ennis | 180 | 7.9% | 46 | 36% | 220 | 5.2% | 28 | 35% |
| Hall's Giant | 218 | 4.6% | 22 | 47% | 224 | 6.1% | 21 | 40% |
| Segorbe | 170 | 6.9% | 48 | 23% | 208 | 7.2% | 38 | 36% |
| Tond di Giffoni | 162 | 7.7% | 40 | 23% | 177 | 7.0% | 40 | 22% |

Comparisons of times of pollen shed and female bloom indicate that at sites with mild autumn and winter temperatures, such as Moss Vale and Kettering, pollen shed commences when the chill hour requirements, as determined by Mehlenbacher (1991) had been received. At Orange, the site with the coldest winter climate, chill hour requirements were achieved at an earlier stage in autumn. However, flowering did not occur until a later date, supporting the hypothesis that a post-chill heat requirement is also needed to stimulate flowering.

Most varieties were protandrous, that is they shed pollen before coming into female bloom. The length of flowering varied far more between seasons and sites than did the date of commencement of flowering. The length of flowering tends to be longer at Moss Vale and Kettering, the sites with milder autumn and winter temperatures. It is anticipated that collection of further data on flowering and a more detailed analysis of temperature records for the sites will lead to a better understanding of the relationships between temperature and flowering. This knowledge is required to provide guidance to growers on varietal selection over a wide range of geographical locations

# Mean chemical composition of leaves 1997-2000

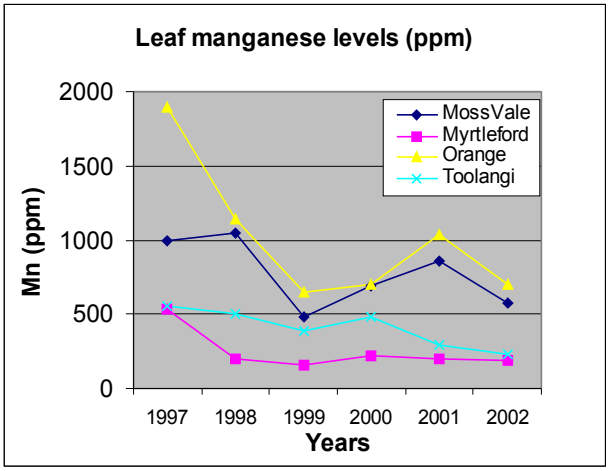
| | Moss Vale | Myrtleford | Orange | Toolangi | Target |
|---|---|---|---|---|---|
| N % | 2.83 | 2.73 | 2.81 | 2.97 | 2.2 -2.5 |
| P % | 0.16 | 0.15 | 0.15 | 0.19 | 0.14-0.45 |
| K% | 0.88 | 0.87 | 0.95 | 1.06 | 0.8-2.0 |
| Al % | 0.02 | 0.02 | 0.03 | 0.03 | ND |
| Mn ppm | 805 | 276 | 1097 | 481 | ND |
| B ppm | 53 | 37 | 50 | 55 | 31-75 |

Over the six years that the trials have been maintained, composite samples of about 100 leaves have been obtained from each site during March.

These samples have been analysed for total element content. The mean values for the six years are presented above. Phosphorus (P) tends to be at the lower end of the desirable range at all sites.

Boron has been adequate, but boron sprays have been applied at some sites. Manganese levels have varied between sites and have been consistently high at Orange, where the poorest growth and yields have occurred.

# Manganese levels in leaves (ppm)

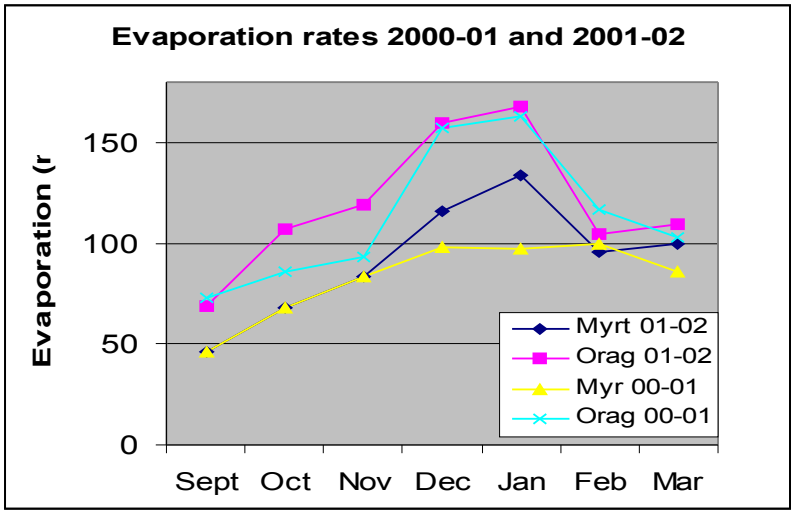



The soils at all sites were found to be acid before planting. Lime was applied at all sites to alleviate this situation. Manganese levels were also noted to be high at all sites, but at the time of planting, the significance of this for hazelnuts was not recognised. Aluminium levels were noted to be relatively high at Toolangi. It was anticipated that liming would reduce the potentially toxic levels of both manganese and aluminium over time. Other elements were considered to be either at or close to desirable levels.

All varieties have grown well at Myrtleford, generally better than at any other site, with growth being poorest at Orange. There appeared to be an interaction between site and varietal growth. At Orange, the varieties TGDL, Negret and Wanliss Pride have made very poor growth, with about 25 % of the trees of these varieties dying in their first season, necessitating the planting of replacement trees. Both the original and replanted Wanliss Pride trees at Orange are still performing very poorly.

It is hypothesised that high levels of manganese are toxic to hazelnut trees but varieties such as Atlas, Barcelona, Tonda di Giffoni, Tokolyi/Brownfield Cosford and Segorbe may have reasonable tolerance to this element. Manganese levels vary with seasonal conditions as well as pH. Wet conditions favour increased availability of manganese due to changes in the oxidation status of the element.

# Growing period evaporation rates at Orange and Myrtleford



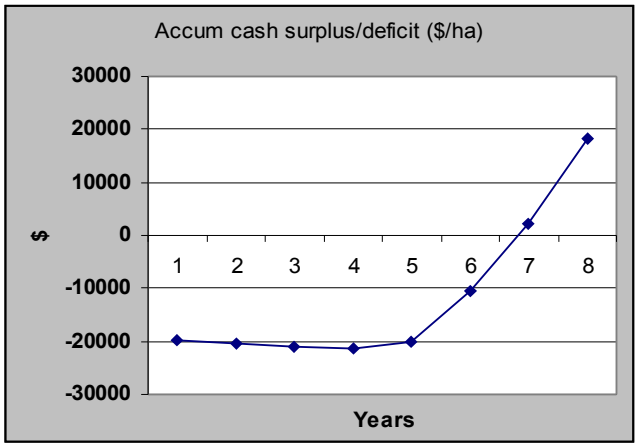

Automatic weather stations have been installed at all sites. Some comparisons of climatic data have been undertaken.

Evaporation data collected from Orange and Myrtleford indicates higher levels of evaporation at Orange during the growing season.

This coupled with the use of only 2 drippers per tree at Orange may have caused moisture stress on trees at that site, thereby restricting growth and productivity.

In 2002, micro-sprinklers have been installed in 2 replicates, to ascertain the effects of irrigation on the growth and yield of the trees.

# Yield data is required for finance and budget estimates




Information on the development of yield over time is essential for investment decisions, when planting.

Assuming a return of $3.50/ kg for nuts in-shell, a planting cost of $12/tree and a cost of $3000/ha for the installation of an irrigation system, a person who already owns land and obtains yields comparable to the Myrtleford site could produce a break-even yield in about the 7th year after planting.

This is but an example, to illustrate the value of having yield data that can be used for financial planning. It also illustrates the need to achieve high yields early in the life of a plantation.

Hopefully the current research can be continued for a further 3 years to provide valuable yield data.

# Key issues and challenges:

- Obtain yield data from all sites for another 3 years
- Target yields of 5 t/ha at Myrtleford
- Determine factors constraining yields at Orange
- Develop a climate model to predict flowering phenology
- Ascertain pollinisers for Tokolyi/Br Cosford (and Tonollo)
- Determine market acceptance of Australian grown nuts