A Summary Report for UK Tree Fruit Growers

International Society of Horticultural Science (ISHS) 10th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

Stellenbosch, S Africa
3rd - 6th December 2012

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Disclaimer

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Background

As well as commissioning near market research and development projects, HDC aims to provide growers with information on best practice and new information emanating from sources outside of the HDC. Conferences and symposia are typical such sources and the 10th International Symposium on Orchard Systems organised by the International Society of Horticultural Science in December 2012, offered a significant volume of information that could be useful to UK tree fruit growers.

HDC commissioned Tim Biddlecombe of Farm Advisory Services Team Ltd (who attended the Symposium) to provide this summary report on key information presented.

Introduction

The ISHS, dating from 1864 and formally constituted in 1959, has more than 7,000 members representing some 150 countries. It is the world's leading independent organisation of horticultural scientists.

The aim of the Society is "...to promote and encourage research and education in all branches of horticultural science and to facilitate cooperation and knowledge transfer on a global scale through its symposia and congresses, publications and scientific structure." Membership is open to all interested researchers, educators, students and horticultural industry professionals.

The society has many specialised working groups and the Orchard Systems Symposium brings together three of these approximately every four years. The groups are:

- Rootstock Breeding and Evaluation, chaired by Gennario Fazio (Cornell University)
- Environmental Physiology of Fruit Crops, chaired by John Palmer (The New Zealand Institute for Plant and Food Research Ltd)
- Orchard and Plantation Systems, chaired by Stuart Tustin (The New Zealand Institute for Plant and Food Research Ltd)

The Symposium consisted of scientific papers and posters covering topics in each working group and an orchard tour of either pome fruit or stone fruit farms.

This report focuses on the oral and poster presentations that were most relevant to UK growers.

Attendance

The symposium was attended by 140 delegates from 27 different countries. Most of the delegates were applied scientists, but approximately 10% were extension workers and advisers. All the main fruit growing regions were represented with delegates from North and South America, South Africa, China, New Zealand and Australia, Europe and the Middle East. Papers were presented covering apples and pears, stone fruits and kiwifruit.

Key topics

Key topics covered in the conference sessions were:

1. Orchard planting systems and tree management
2. Rootstocks and varieties
3. Crop physiology
4. Orchard tour

1. Orchard Planting Systems and Tree Management

The keynote address on this topic was given by Stuart Tustin (The New Zealand Institute for Plant & Food Research Ltd) who noted that intensive systems were largely developed 50 years ago while the uptake and adoption of them is still being debated. The three critical components of further developments are:-

- Rootstock breeding to control not only growth but also the amount of flower produced which generally is far in excess of that needed for a full crop
- Better understanding of the canopy in relation to light and energy capture
- Greater manipulation of the tree architecture.

The world's future needs for healthy crops such as fruit will far outstrip supply in the medium term and so orchards must become more efficient and profitable. Currently orchards produce too much grass and the canopy structure is far too complex and 3 dimensional.

Possible solutions:

- Divided canopies as in the Bi Baum system. We should be thinking about fruiting stems per hectare not trees per hectare
- UFO (Upright Fruiting Offshoot) systems
- Breeding for weak branching tree types, high levels of precocity, flowers that are self-thinning and non-biennial
- Tree types that are very simple and easy to prune
- Tree shapes and orchard designs that intercept 90% of the available light rather than the 60% current maximum

Apples

Nicola Dallabetta reported on a study comparing Gala and Pink Lady planted as Slender Spindles or as Bi Baum (Twin-Stem) trees to determine their effect on fruit quality and fruit distribution in the canopy (Figure 1). Bi-axis trees are formed by two leaders which allow a different fruit distribution compared with the Slender Spindle. The study was carried out in Trentino, North Italy.

Tree architecture and fruit position in the canopy were monitored during fruit ripening using the “plant toons” software, developed to draw the tree architecture and mark the fruit position on the tree. Also, fruits were monitored during the growing season for their growth and maturation. At the end of the season, fruits were harvested, graded and analyzed. Fruit texture was also assessed employing a novel texture analyzer equipped with an acoustic envelop device. Gala in the Bi-Baum trees showed a more even distribution of fruit size and colour through the canopy with better red colour and size compared to the Spindle training system. The Spindle system resulted in a heterogeneous distribution of fruit characteristics through the fruit canopy. In Pink Lady the two training systems differed only in fruit distribution while the colour and size were not significantly affected. Fruit quality traits did not show significant differences between the two training systems. Gala on Bi-axis showed significantly higher texture value (specifically with the acoustic parameters) as compared to Slender spindle. The Bibaum system is a more promising training system for enhancing fruit quality in Gala.

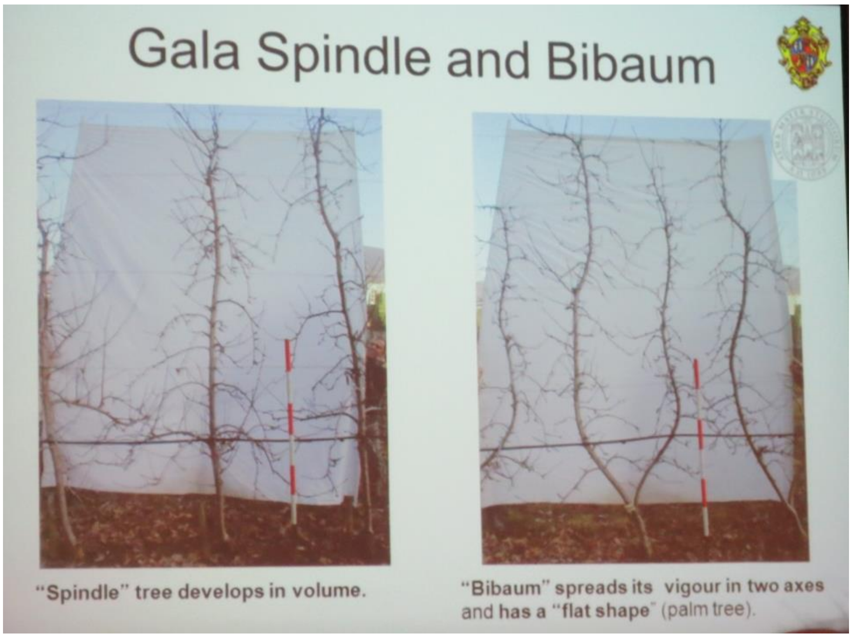


Figure 1 Comparison of Gala on Spindle and Bi Baum trees

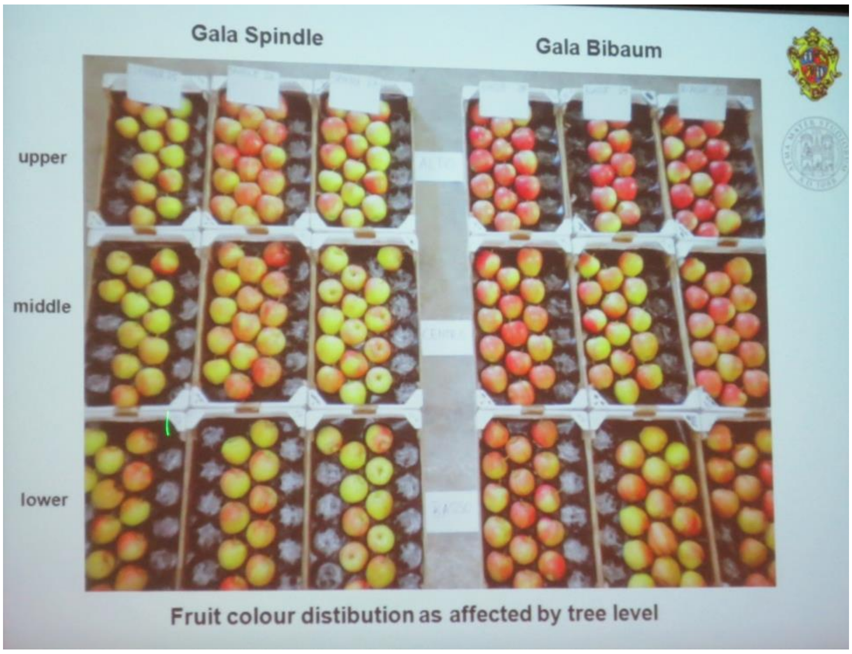


Figure 2 Comparison of fruit colour from differing levels in the crop canopy on Spindle and Bi Baum trees

B.M. van Hooijdonk (New Zealand Institute for Plant & Food Research Ltd) presented a paper which looked at the effect of removing spurs on regularity of cropping and fruit quality in apples.

As young trees of the recently commercialised apple Scilate (Envy™) are precocious, have excessive fruit set and produce large fruit, they can have weak vegetative growth and may become biennial bearing. The trial work presented was aimed at determining the effect of artificial spur extinction (ASE) at spring budbreak on these characteristics. ASE is a method of removing whole spurs in late winter or early spring and is thought to be beneficial in varieties (e.g. Braeburn, SciFresh (Jazz)) which form old complex spurs. It is an early form of crop load adjustment and has been reported to enhance fruit set, fruit quality and return bloom. The balance between fruiting and vegetative growth is also claimed to be better in treated trees. Scientific studies have been carried out to calculate the optimum number of spurs according to the cross sectional area of the branch (BCA) and have found that in New Zealand, five floral buds per cm^2 is about right. This density of flower buds will produce a crop of 100 tonnes/ha for Scilate on M9 planted at 1,666 trees/ha.

In this trial, floral bud numbers of three-year-old trees were reduced from 18 (unmodified) to five floral buds/cm^2 BCA. In the following winter, spur density was halved but the number of short to medium length annual shoots was increased. Gross yields over three years were similar for treated and unmodified trees but the ASE treatment reduced the biennial pattern of bearing. ASE also increased fruit red blush coverage at harvest by 7-8%, enabled a greater proportion of crop to be colour-picked in the first commercial harvest and increased fruit dry matter content. These benefits of ASE were not explained by treatment differences in crop load, but may have resulted from reduced spur density improving the illumination of canopy and fruit.

During the question session, it was noted that to achieve the final density of five fruits per cm^2 BCA, hand thinning was carried out after natural fruit drop so there was a period between blossom and thinning when the fruit numbers were unmodified. Researchers in Switzerland reported that ASE reduced the leaf canopy density which had beneficial effects on disease control, including powdery mildew in organic orchards.

K Breen (New Zealand Institute for Plant & Food Research Ltd) presented a second paper on Artificial Spur Extinction, which looked at ASE in different growing regions in New Zealand and Australia. Commercial Gala trees can naturally carry over 2,000 blooms yet only require 250 fruits for a full crop. Thinning is expensive and the delay between blossom and hand thinning reduces fruit size. At blossom and early fruit development there is strong competition between flowers & fruitlets and also within and among spurs and this induces their natural abscission, which affects fruit set. The study investigated fruit set responses of Gala over five regions and two growing seasons in New Zealand and Australia. The ASE treatments left just spur buds and terminal buds at densities of 2, 3, 4, 5 or 6 buds per cm^2 basal branch cross-sectional area. As the number of spurs removed increased, fruit set increased and the number of buds carrying single fruits also increased, so that only 15% required hand thinning from 3+ fruitlets to singles. Breen concluded that ASE had the following benefits: Allows reduction in flower bud density without loss of commercial crop; directs dry matter resources to only those clusters that will bear fruit; eliminates the need for chemical thinning; simplifies hand thinning as spacing (Figure 3). See later paper on importance of dry matter in fruit.

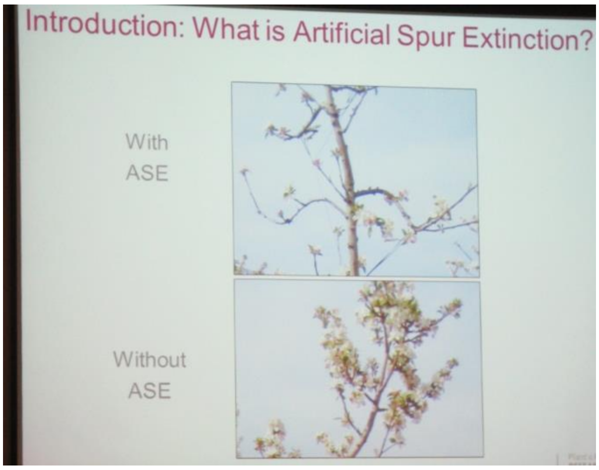


Figure 3 Comparison of trees with or without ASE

Terence Robinson (Cornell University) presented a paper reporting on studies carried out on yield, fruit quality and mechanisation of tall spindle apple orchards. The studies showed that the system with tree densities of between 2,500 and 3,500 trees/ha was only out yielded by the super spindle system but was the most profitable. Cumulative yields of over 150t/ha in the first five years were achieved. Light studies showed good interception of between 70 & 75% when the trees are mature with better distribution in the lower parts of the tree canopy than in systems with less trees per hectare. Using platforms for winter pruning increased efficiency by 25-40%. Mechanical summer pruning to trim only about 30% of the shoots resulted in improved fruit quality in mature tall spindle orchards. The partial mechanisation of harvesting was discussed with reference to picking platforms and also the American DBR and Oxbow machines that use suction tubes to transfer the fruit from the pickers to the bins.

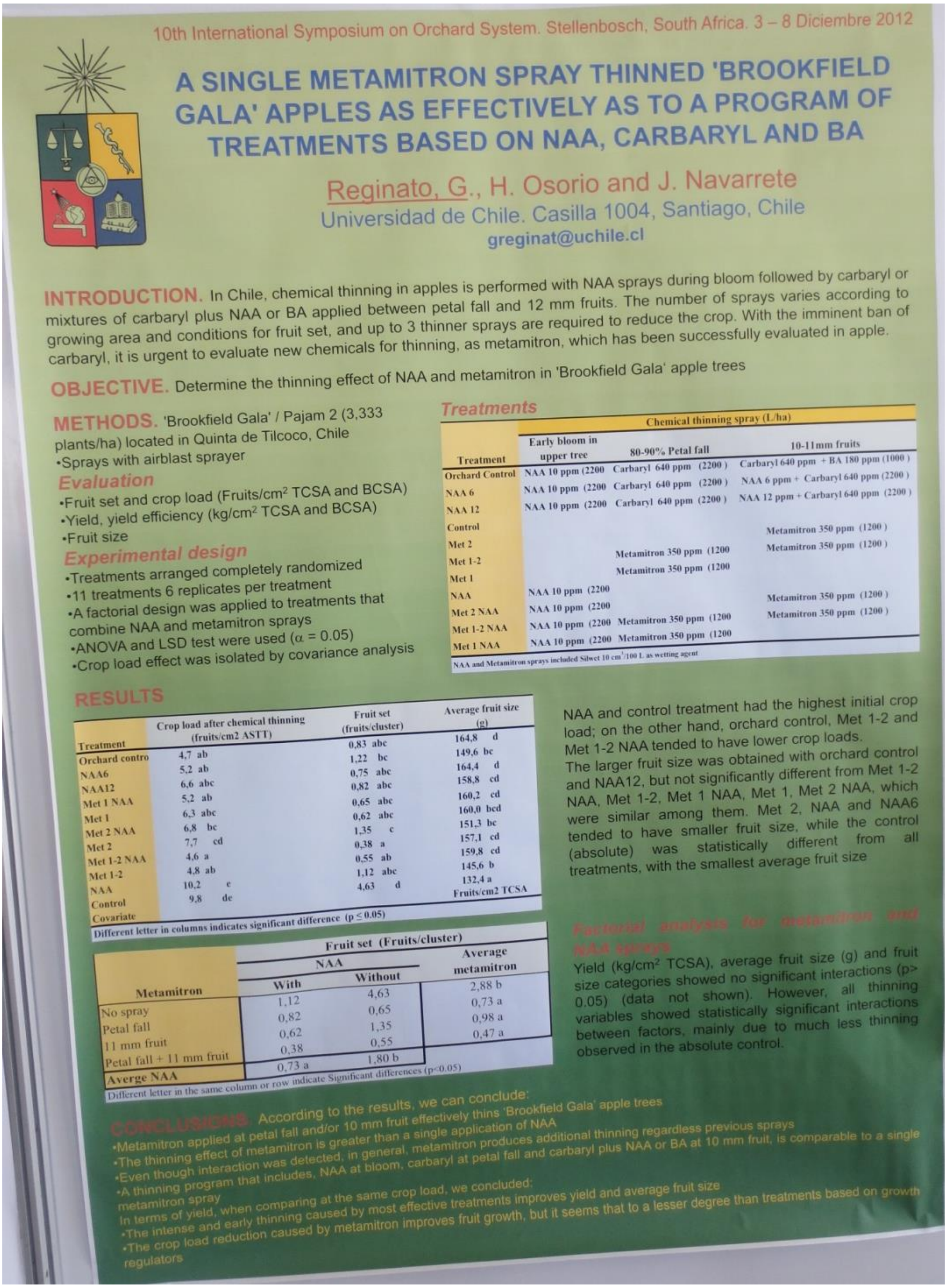
Michael Blanke (University of Bonn) reported that trials using shade cloth over apple trees at the end of bloom or at 23 days after full bloom (DAFB) could induce increased June drop and was a potential alternative to thinning sprays. The best effect was from shading (90%) for 6 days from 23 DAFB. This treatment also led to enhancement of fruit sugar, taste, size and colour.

Rachel Elkins (University of California Cooperative Extension) carried out trials to assess the results of using Extenday in Bartlett and D'Anjou pears. Extenday significantly increased the yield efficiency, photosynthetically active radiation, advanced the maturity and reduced water stress. Yields were 19% higher where Extenday was used.

Tory Schmidt (Washington Tree Fruit Research Commission) presented a further paper on the benefits of using reflective mulches, reporting that the Commission has conducted over 50 replicated trials since 2005 in apple, pear, sweet cherry, peach and nectarine orchards. Treatments included four re-usable woven white polyethylene products manufactured by Extenday Ltd. and a silver mylar material, Brite-N'up. Extenday products consistently improved yields and value of fruit across all crops by promoting fruit set and/or size, while often significantly improving development of red colour. Fruit set, fruit size and fruit colour have never been reduced in Extenday product treatments. In the second and third years of long term apple trials, fruit yields were increased by approximately 25% in plots treated with Extenday products from bloom until harvest. Brite-N'up consistently improved red colour in Gala apples when put down three to four weeks prior to harvest in three years of trials, but by not as much as an Extenday. The use of these materials as harvest management tools was considered as they can sometimes advance fruit maturity and frequently reduce the number of times fruit needs to be picked over to achieve good colour.

Poster session

The following posters were presented at the Symposium, outlining work carried out on orchard planting systems and tree management in apples.



10th International Symposium on Orchard System. Stellenbosch, South Africa. 3 – 8 Diciembre 2012

A SINGLE METAMITRON SPRAY THINNED 'BROOKFIELD GALA' APPLES AS EFFECTIVELY AS TO A PROGRAM OF TREATMENTS BASED ON NAA, CARBARYL AND BA

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INTRODUCTION. In Chile, chemical thinning in apples is performed with NAA sprays during bloom followed by carbaryl or mixtures of carbaryl plus NAA or BA applied between petal fall and 12 mm fruits. The number of sprays varies according to growing area and conditions for fruit set, and up to 3 thinner sprays are required to reduce the crop. With the imminent ban of carbaryl, it is urgent to evaluate new chemicals for thinning, as metamitron, which has been successfully evaluated in apple.

OBJECTIVE. Determine the thinning effect of NAA and metamitron in 'Brookfield Gala' apple trees

METHODS. 'Brookfield Gala' / Pajam 2 (3,333 plants/ha) located in Quinta de Tilcoco, Chile
- Sprays with airblast sprayer

Evaluation
- Fruit set and crop load (Fruits/cm² TCSA and BCSA)
- Yield, yield efficiency (kg/cm² TCSA and BCSA)
- Fruit size

Experimental design
- Treatments arranged completely randomized
- 11 treatments 6 replicates per treatment
- A factorial design was applied to treatments that combine NAA and metamitron sprays
- ANOVA and LSD test were used ($\alpha = 0.05$)
- Crop load effect was isolated by covariance analysis

Treatments

	Chemical thinning spray (L/ha)		
Treatment	Early bloom in upper tree	80-90% Petal fall	10-11mm fruits
Orchard Control	NAA 10 ppm (2200	Carbaryl 640 ppm (2200)	Carbaryl 640 ppm + BA 180 ppm (1000)
NAA 6	NAA 10 ppm (2200	Carbaryl 640 ppm (2200)	NAA 6 ppm + Carbaryl 640 ppm (2200)
NAA 12	NAA 10 ppm (2200	Carbaryl 640 ppm (2200)	NAA 12 ppm + Carbaryl 640 ppm (2200)
Control			
Met 2			Metamitron 350 ppm (1200)
Met 1-2		Metamitron 350 ppm (1200	Metamitron 350 ppm (1200)
Met 1		Metamitron 350 ppm (1200	
NAA	NAA 10 ppm (2200		
Met 2 NAA	NAA 10 ppm (2200		Metamitron 350 ppm (1200)
Met 1-2 NAA	NAA 10 ppm (2200	Metamitron 350 ppm (1200	Metamitron 350 ppm (1200)
Met 1 NAA	NAA 10 ppm (2200	Metamitron 350 ppm (1200	

NAA and Metamitron sprays included Silwet 10 cm³/100 L as wetting agent

RESULTS

Treatment	Crop load after chemical thinning (fruits/cm2 ASTT)	Fruit set (fruits/cluster)	Average fruit size (g)
Orchard contro	4,7 ab	0,83 abc	164,8 d
NAA6	5,2 ab	1,22 bc	149,6 bc
NAA12	6,6 abc	0,75 abc	164,4 d
Met 1 NAA	5,2 ab	0,82 abc	158,8 cd
Met 1	6,3 abc	0,65 abc	160,2 cd
Met 2 NAA	6,8 bc	0,62 abc	160,0 bcd
Met 2	7,7 cd	1,35 c	151,3 bc
Met 1-2 NAA	4,6 a	0,38 a	157,1 cd
Met 1-2	4,8 ab	0,55 ab	159,8 cd
NAA	10,2 e	1,12 abc	145,6 b
Control	9,8 de	4,63 d	132,4 a
Covariate			Fruits/cm2 TCSA

Different letter in columns indicates significant difference ($p \leq 0.05$)

	Fruit set (Fruits/cluster)		
	NAA		Average metamitron
Metamitron	With	Without	
No spray	1,12	4,63	2,88 b
Petal fall	0,82	0,65	0,73 a
11 mm fruit	0,62	1,35	0,98 a
Petal fall + 11 mm fruit	0,38	0,55	0,47 a
Averge NAA	0,73 a	1,80 b	

Different letter in the same column or row indicate Significant differences ($p<0.05$)

NAA and control treatment had the highest initial crop load; on the other hand, orchard control, Met 1-2 and Met 1-2 NAA tended to have lower crop loads.
The larger fruit size was obtained with orchard control and NAA12, but not significantly different from Met 1-2 NAA, Met 1-2, Met 1 NAA, Met 1, Met 2 NAA, which were similar among them. Met 2, NAA and NAA6 tended to have smaller fruit size, while the control (absolute) was statistically different from all treatments, with the smallest average fruit size

Factorial analysis for metamitron and NAA sprays

Yield (kg/cm² TCSA), average fruit size (g) and fruit size categories showed no significant interactions ($p>0.05$) (data not shown). However, all thinning variables showed statistically significant interactions between factors, mainly due to much less thinning observed in the absolute control.

CONCLUSIONS. According to the results, we can conclude:
- Metamitron applied at petal fall and/or 10 mm fruit effectively thins 'Brookfield Gala' apple trees
- The thinning effect of metamitron is greater than a single application of NAA
- Even though interaction was detected, in general, metamitron produces additional thinning regardless previous sprays
- A thinning program that includes, NAA at bloom, carbaryl at petal fall and carbaryl plus NAA or BA at 10 mm fruit, is comparable to a single metamitron spray

In terms of yield, when comparing at the same crop load, we concluded:
- The intense and early thinning caused by most effective treatments improves yield and average fruit size
- The crop load reduction caused by metamitron improves fruit growth, but it seems that to a lesser degree than treatments based on growth regulators

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Healthier Fruits with Extenday® ?

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www.ko-ga.eu

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Introduction

Climate change is associated with an increase in hail storms and losses in fruit quality because of the installation of hail nets.

Reflective mulches in the alleyways may enhance fruit quality and nutritional value (Solomakhin and Blanke, 2007).

Material and Methods

- Ten-year-old cv.'*Gala Mondial*' apple trees at the Campus Klein-Altendorf, University of Bonn, Germany (50.4° N latitude)
- Trees grown under black hailnet
- Reflective mulches were spread in the alleyways five weeks before anticipated harvest
- Standard fruit quality methods
- Small regions of fruit surface were selected for pigment analysis
- Extraction procedure of Solovchenko and Schmitz-Eiberger (2003)

Results and Discussion

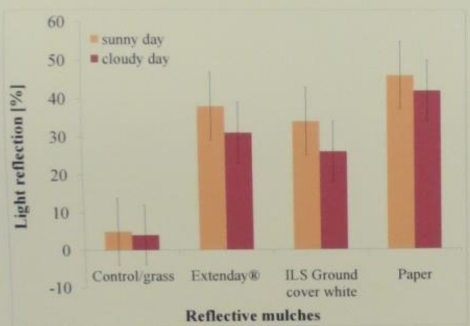

Fig. 1: Relative light reflection of different reflective mulches on a sunny and a cloudy day [%].

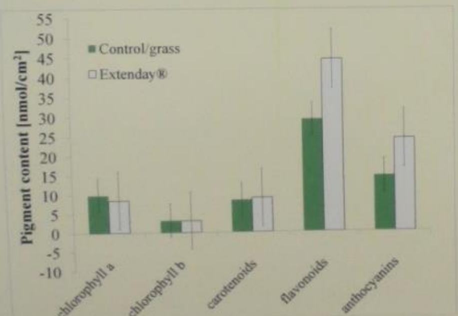

Fig. 2: Pigment contents in nmol/cm² of apple peel of the cultivar 'Gala Mondial' ; mean ± SE, n=16.

Table: Effect of reflective mulch (Extenday®) on fruit quality of apple cv. 'Gala Mondial', mean, $p \leq 0.05$.

	Firmness	Sugar	Starch	Streif-Index
Nominal value	9.0 – 10.0	11.5 – 12.5	4 - 6	0.13
Control/grass	8.7	11.7	3.63	0.24
Extenday® mulch	8.6	11.8	4.51	0.19 *

The reflective mulches increased light reflection by five-fold on cloudy days to nine-fold on sunny days compared to the grass control (Fig.1). The reflective mulches neither enhanced fruit firmness nor sugar, but accelerated ripeness (Table). Anthocyanins and flavonoids were significantly increased by Extenday® mulch (Fig.2). To our knowledge, it is the first time that accumulation of valuable compounds such as flavonoids and anthocyanins in apple fruit has been shown to be enhanced by spreading reflective mulches in the grass alleys five weeks before anticipated harvest.

Conclusion

Reflective mulches have a positive effect on the accumulation of pigments. The high content of anthocyanins and flavonoids can increase the nutritional value of the fruits.

References

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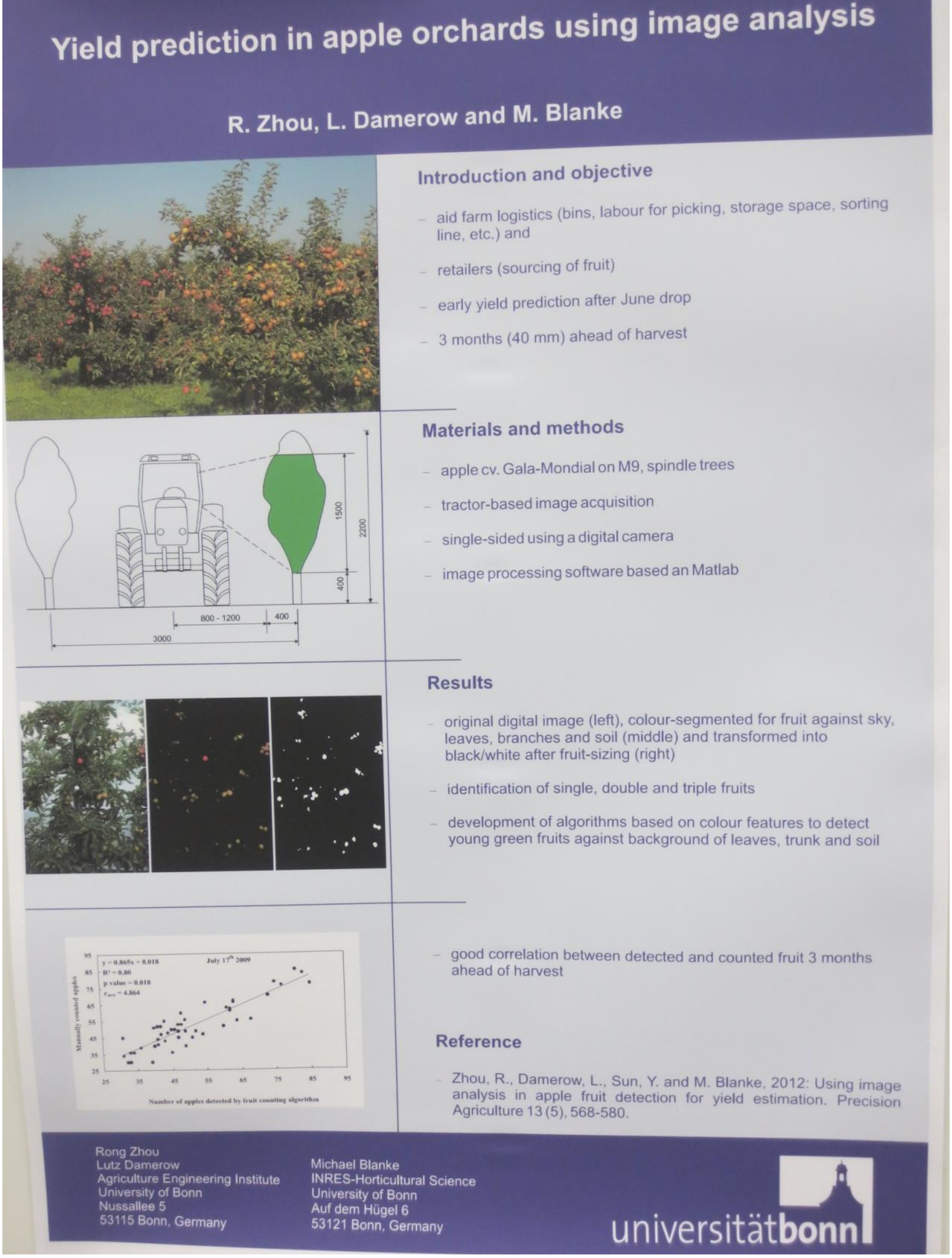
Solovchenko, A., Schmitz-Eiberger, M. (2003). Signifcance of skin flavonoids for UV-B-protection in apple fruits. *Journal of Experimental Botany*, Vol. 54, No. 389, pp. 1977-1984.


Yield prediction in apple orchards using image analysis
R. Zhou, L. Damerow and M. Blanke
Introduction and objective
– aid farm logistics (bins, labour for picking, storage space, sorting line, etc.) and
– retailers (sourcing of fruit)
– early yield prediction after June drop
– 3 months (40 mm) ahead of harvest
1500
2200
400
800 - 1200
400
3000
Materials and methods
– apple cv. Gala-Mondial on M9, spindle trees
– tractor-based image acquisition
– single-sided using a digital camera
– image processing software based an Matlab
Results
– original digital image (left), colour-segmented for fruit against sky, leaves, branches and soil (middle) and transformed into black/white after fruit-sizing (right)
– identification of single, double and triple fruits
– development of algorithms based on colour features to detect young green fruits against background of leaves, trunk and soil
y = 0.865x + 8.018
R² = 0.80
p value = 0.018
July 17th 2009
Manually counted apples
Number of apples detected by fruit counting algorithm
– good correlation between detected and counted fruit 3 months ahead of harvest
Reference
– Zhou, R., Damerow, L., Sun, Y. and M. Blanke, 2012: Using image analysis in apple fruit detection for yield estimation. Precision Agriculture 13 (5), 568-580.
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Millennium Planting Density Trial of 'Bramley's Seedling' Apple on M.9 and M.27 Rootstocks 2000 - 2012

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The northern latitude and maritime climate of Ireland reduces available light for crop growth. The recommended planting density for Bramley in Ireland was 4.9m x 3m and this planting density was known from research at Loughgall to be too low. Thus in 2000 the 'Millenium' experiment was planted (spacings shown below) to determine the optimal density. It was also known that there was a point when increased yield did not repay the initial capital investment, so in addition to yield development, the effect of establishment cost on the commercial returns was also determined. The trees were grown according to best commercial practice.

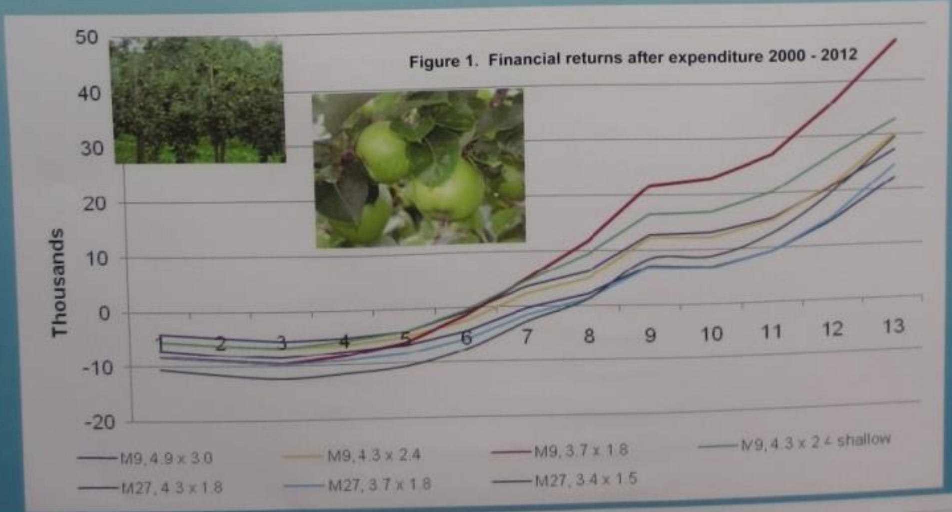
Table 1 Annual yield of Bramley's Seedling Apple (tonnes ha^{-1}) for each planting density

Treatment	Metric	Trees ha-1	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
M27 11 x 5	3.4 x 1.5	1957	0.3	2.6	3.6	10.4	24.6	27.6	39.9	38.2	59.0	18.0	53.8	60.8	42.4
M27 12 x 6	3.7 x 1.8	1492	0.2	2.2	3.3	9.2	20.8	23.6	34.1	29.9	47.3	11.7	43.6	50.7	39.5
M9 12 x 6	3.7 x 1.8	1492	0.2	4.9	4.6	12.7	35.3	38.9	49.1	57.6	77.5	24.4	57.1	74.2	48.3
M27 14 x 6	4.3 x 1.8	1279	0.5	2.2	3.5	10.2	19.2	22.6	30.0	26.5	42.6	11.1	40.4	46.2	33.5
M9 14 x 8 Shallow	4.3 x 2.4	961	0.1	2.9	3.8	10.6	26.8	29.7	39.5	41.9	56.4	16.7	46.7	55.5	29.1
M9 14 x 8	4.3 x 2.4	961	0.3	3.1	3.3	7.3	23.5	24.4	37.7	27.8	57.9	14.4	42.1	53.0	39.7
M9 16 x 10	4.9 x 3.0	672	0.1	2.1	2.5	7.8	20.7	27.8	35.6	28.4	52.5	16.7	38.7	49.7	31.9
Grand Mean			0.2	2.9	3.5	9.8	24.4	27.8	38.3	35.7	56.2	16.1	46.1	55.7	37.8
Sign.			NS	***	NS	NS	*	NS	NS	*	***	*	*	**	NS
e.s.e			0.11	0.24	0.59	2.47	2.86	3.98	4.29	6.01	2.82	2.14	3.43	4.01	4.61
LSD @ 5%			0.35	0.73	1.80	7.62	8.82	12.27	13.21	18.53	8.69	6.59	10.58	12.37	14.20

Table 2: Accumulated yield of Bramley's Seedling Apple ($t.ha^{-1}$) for each planting density

Treatment	Metric	Trees ha-1	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
M27 11 x 5	3.4 x 1.5	1957	0.3	3.0	6.5	16.9	41.5	69.2	109	147	206	224	278	339	381
M27 12 x 6	3.7 x 1.8	1492	0.2	2.4	5.7	14.9	35.8	59.4	93	123	171	182	226	276	310
M9 12 x 6	3.7 x 1.8	1492	0.2	5.1	9.6	22.3	57.7	96.6	146	203	281	305	362	437	485
M27 14 x 6	4.3 x 1.8	1279	0.5	2.6	6.2	16.4	35.6	58.2	90	116	160	171	211	257	295
M9 14 x 8 Shallow	4.3 x 2.4	961	0.1	3.0	6.8	17.4	44.2	73.9	113	155	212	228	275	330	359
M9 14 x 8	4.3 x 2.4	961	0.3	3.4	6.7	14.0	37.5	61.9	100	127	185	200	242	295	335
M9 16 x 10	4.9 x 3.0	672	0.1	2.2	4.7	12.6	33.2	61.0	97	125	178	194	233	283	315
Grand Mean			0.2	3.1	6.6	16.4	40.8	68.6	107	143	199	215	261	317	354
Sign.			NS	***	*	NS	NS	NS	NS	NS	*	*	*	*	*
e.s.e			0.11	0.24	0.76	3.03	5.62	9.41	13.54	17.90	20.51	22.19	25.4	28.43	30.31
LSD @ 5%			0.35	0.74	2.33	9.34	17.33	29.01	41.73	55.16	63.20	68.37	78.27	87.60	93.39

The establishment costs and time taken to break even were a direct reflection of the planting densities. The most profitable planting density to date is the M9 at 3.7 x1.8. But it is obvious from the data that the optimal planting density must be even higher. In terms of the M27 plots, the M27 3.4 x 1.5 treatment was the most expensive to establish but by yr 12 it has become the joint third most profitable and is slowly closing the gap on the best M9 density.



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Agriculture and Rural Development

The effect of ultra high density plantings of 'Bramley's Seedling' Apple on M9 rootstock grown on a trellis system in Ireland

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Trellis systems which are popular in Europe for apple production were never used in Ireland in commercial orchards and Bramley (vigorous triploid) was deemed to be completely unsuitable. However, in recent years a major cider company offered contracts to growers who planted Bramley at 3.5m x 1.5m spacing (~ 1905 per hectare) in a trellis system. In the absence of any supporting scientific/economic data, the apple industry commissioned an experiment to evaluate the feasibility of such a production system. This poster will present the current update on the trellis orchard looking at tree densities ranging from 1905 trees ha^{-1} up to 3077 trees ha^{-1}.

Planting densities : 3.5 x 1.5, 3.5 x 1.25, 3.5 x 1, 3.25 x 1 and 3.25 x 0.8 m were established. Each planting density was replicated five times with 10 trees per treatment, and each set of 10 trees was then subdivided into five pruned back according to local custom (top 30 cm of leader removed) and five growing tall according to the contract. Experimental data was then recorded using the central 3 trees of each treatment. Tree number per hectare was calculated with no allowances made for hedge rows etc. All trees were summer pruned using a conventional hedge cutter (again a significant departure from local practice) with the intention of producing a 'fruit wall'. The agronomy of the orchard, pest and disease control practices were as according to local custom (10 day spray programme for scab control) and no account was taken of tree density.

Table 2. The effect of planting density on yield (tonnes /ha) for Bramley's seedling apple on M9 grown according to contract.

Spacing (m)	Trees per hectare	2009	2010	2011	2012	Total 09-12
3.25 x 0.8	3846	0.5	3.9	30.6	41.6	76.6
3.25 x 1	3077	0.4	3.3	26.2	28.3	58.2
3.5 x 1	2857	0.5	2.6	25.2	29.2	57.6
3.5 x 1.25	2286	0.6	1.4	17.4	24.0	43.4
3.5 x 1.5	1905	0.4	1.2	13.9	19.0	34.6
G.Mean		0.5	2.5	22.7	28.4	54.1
Sign		ns	ns	***	**	**
ese		0.189	0.777	1.895	2.922	4.618
Lsd @ 5%		0.55	2.27	5.53	8.53	13.48

Table 1. The effect of pruning at planting on yield (tonnes / ha) on Bramley over time. No significant differences were recorded.

Row (m)	tree (m)		2009	2010	2011	2012	Total 2009 2012
3.25	0.8	P+	0.6	2.1	28.7	37.2	68.6
3.25	0.8	P-	0.5	3.9	30.6	41.6	76.6
3.25	1	P+	0.5	3.1	24.0	30.6	58.2
3.25	1	P-	0.4	3.3	26.2	28.3	58.2
3.5	1	P+	0.4	2.8	21.8	28.9	53.9
3.5	1	P-	0.5	2.6	25.2	29.2	57.6
3.5	1.25	P+	0.3	1.9	17.7	22.6	42.5
3.5	1.25	P-	0.6	1.4	17.4	24.0	43.4
3.5	1.5	P+	0.2	1.2	11.2	20.5	33.2
3.5	1.5	P-	0.4	1.2	13.9	19.0	34.6

Table 3 . Effect of spacing on the Trunk Cross Sectional Area of Bramley's seedling apple over time.

Spacing (m)	Trees /ha	2010	2011	2012
3.25 x 0.8	3846	4.19	11.98	15.74
3.25 x 1	3077	4.09	12.57	15.84
3.5 x 1	2857	4.21	13.36	17.28
3.5 x 1.25	2286	4.37	15.41	19.74
3.5 x 1.5	1905	4.41	15.86	18.75
G.Mean		4.26	13.84	17.47

Figure 3. Photograph showing style of trellis orchard

Bramley as a triploid is a very difficult tree to manage and produces a considerable amount of blind wood. In a normal growing season about 0.75 m of extension growth is recorded. Increasing tree density (and there by inter tree competition does appear to control growth while still increasing yield. At the two highest densities, the trees resemble standard desert varieties. Summer pruning has stimulated the development of fruit bud, but has not eliminated the need for winter intervention. The question of allowing the trees to grow tall quickly and the potential of generating excessive amounts of blind wood is still an issue. Currently all trees have now reached the same height and are top pruned but there is considerable difference between the two sets of trees. The issue of maximum yield potential of Bramley under Irish conditions is still ongoing.

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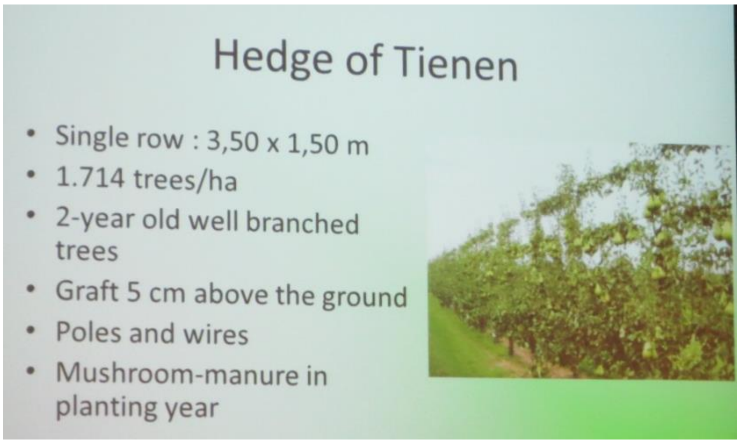
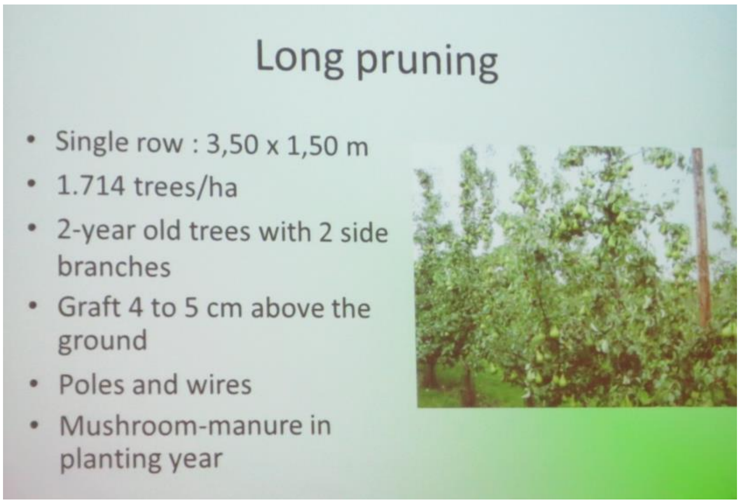
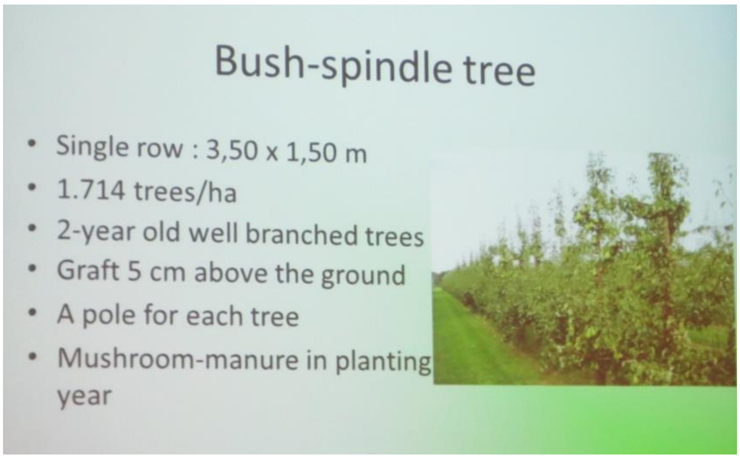
Pears

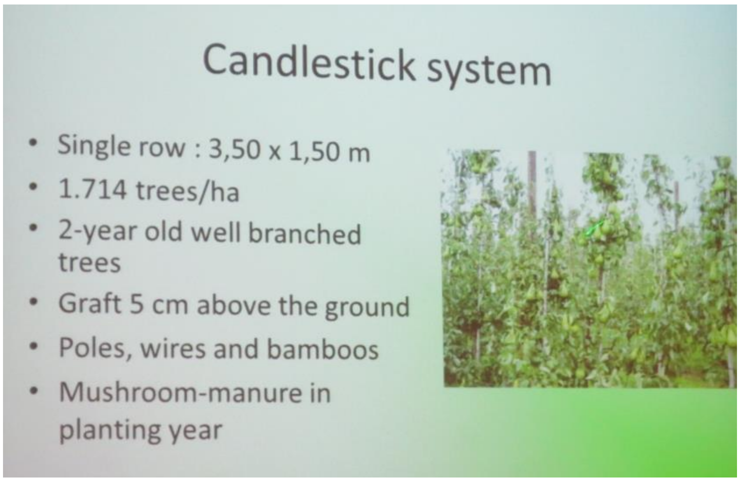
Jef Vercammen (Pcfruit Research Station, Belgium) reported on a trial planted in 2002 to compare seven different systems of Conference grown on Q Adams with Concorde pollinators.

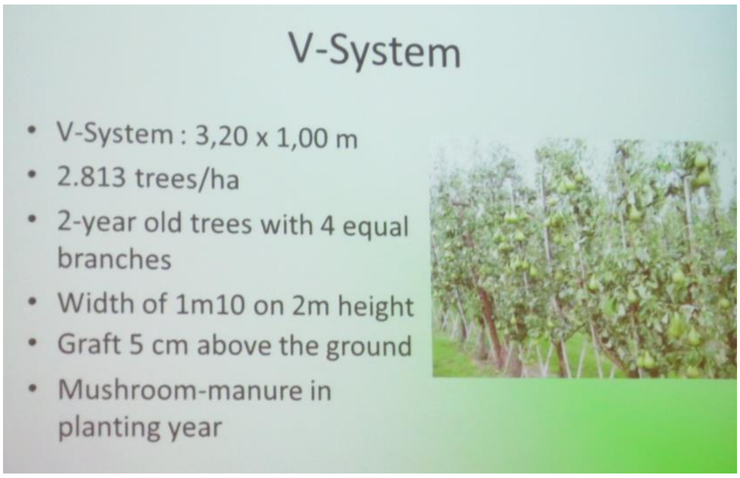
The systems are presented below:

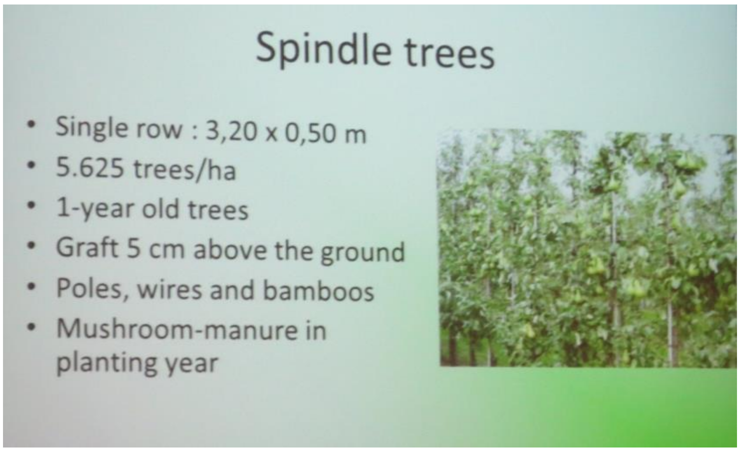


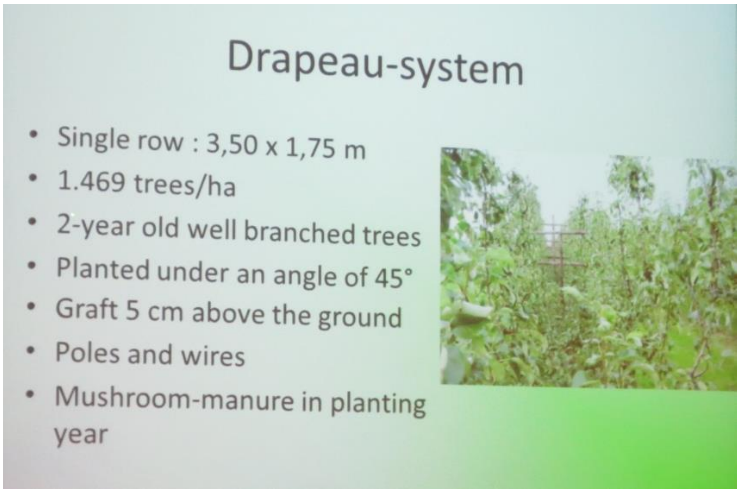



Bush-spindle tree
Single row : 3,50 x 1,50 m
1.714 trees/ha
2-year old well branched trees
Graft 5 cm above the ground
A pole for each tree
Mushroom-manure in planting year


Candlestick system
Single row : 3,50 x 1,50 m
1.714 trees/ha
2-year old well branched trees
Graft 5 cm above the ground
Poles, wires and bamboos
Mushroom-manure in planting year


V-System
V-System : 3,20 x 1,00 m
2.813 trees/ha
2-year old trees with 4 equal branches
Width of 1m10 on 2m height
Graft 5 cm above the ground
Mushroom-manure in planting year





Detailed analysis of the costs during the establishment and production phases were presented along with yields, grade outs and returns. The conclusions were that the Hedge of Tienen and Long pruning systems were cheaper to establish and the Spindle and V systems had high investment costs. Although the Drapeau system is cheap to establish it requires high labour inputs in the first six years to complete the system. The Long pruning system had the highest yields but the smallest fruit. The Drapeau and V-system also had high yields with the V-system having the largest fruit size. The financial results after eleven years showed the best returns from the Drapeau, followed by the Long pruning, with the V-system in 3rd place. The Bush trees were disappointing and the Spindle system was the poorest performing.

The results are summarised in Figure 4 below.

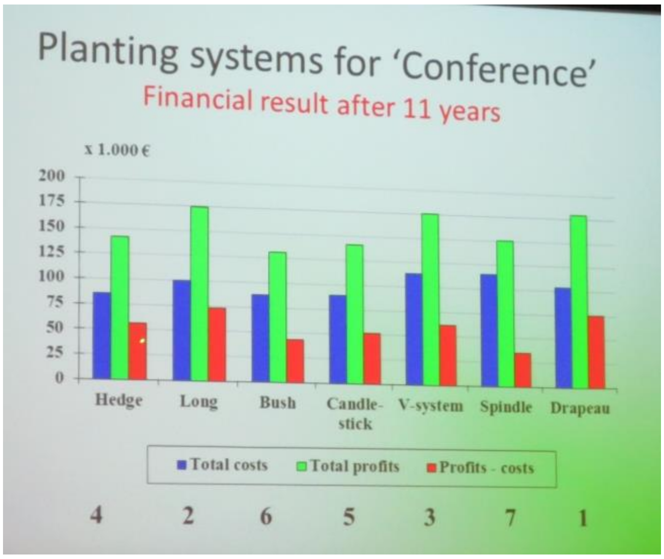


Figure 4 Summary of results from the pear systems trial in Belgium

Stone Fruit

Terence Robinson (Cornell University, New York) described a replicated field trial of four cherry varieties (Rainer, Lapins, Sweetheart and Regina) on G5 or G6 rootstocks, established at Geneva, NY in 2008. Each cultivar was planted at 2 densities (1,389 or 2,778 trees/ha) and trained either as a Modified Spanish Bush or a Tall Spindle (Figure 5). The Modified Spanish Bush tree was developed by repeated heading of the tree to produce a tree with 10 upright shoots for the 1m spacing and 20 shoots for the 2m spacing. At maturity the trees were topped at 2.5m after harvest and the lateral shoots on each of the 10 or 20 vertical fruiting branches were removed, leaving long columns of spurred shoots.

The tall spindle system was developed by heading the leader at 120 cm at planting and removing two out of three buds along the tree trunk at bud swell. The bud removal process was repeated in years two and three on the one year-old portion of the trunk. This resulted in 15-18 lateral shoots along the trunk. At maturity the tree was pruned each spring by removing one to three of the largest limbs (>5cm) along the trunk by cutting them back to a 15 cm long stub or to a sub-lateral branch.

Yield in year three was highest for the Tall Spindle system but in years four and five, the modified Spanish Bush system had similar yield. Yield was a function of cultivar, planting density and training system. Fourth year yield of Lapins at the highest planting density was 8 t/ha. The cumulative yield was highest for the Tall Spindle System planted at 1m spacing, but fruit size was greater in the Modified Spanish Bush. Soluble Solids were not affected by planting system or spacing. G5 rootstock produced higher cumulative yields than G6. High tunnels gave good control of fruit cracking and increased crop value substantially but did not cover the extra investment after three cropping years.

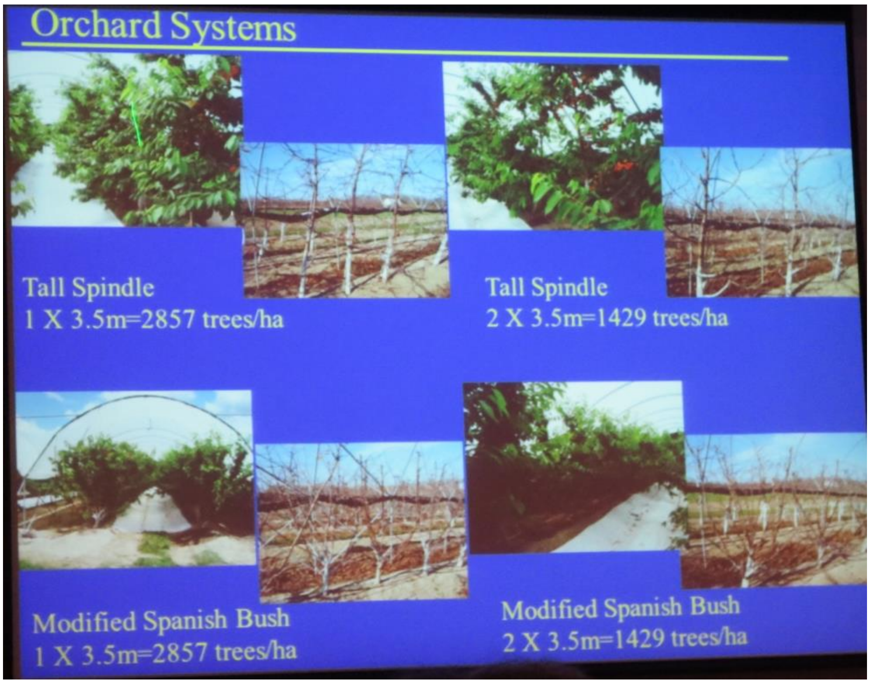


Figure 5 Comparison of Modified Spanish Bush and Tall Spindle sytems

Stefano Musacchi (University of Bologna, Italy) reported on work looking at different pruning times in Apricots. Using two varieties, Carmen & Bora, treatments were applied weekly during the growing season to see if they had any effect on flower bud formation, yield and fruit size. Generally these summer pruning treatments increased fruit numbers per tree but cuts in July resulted in reduced fruit size. In the region of Italy where the trial was conducted, the best timing was determined to be the third week of June.

Greg Lang (Michigan State University) presented a paper describing the first three years of the NC140 project looking at Sweet Cherry growing systems. The trial is being replicated throughout North America with sites spread as far apart as Mexico and Nova Scotia. The four intensive training systems under study have the objectives of a) a maximum tree height that permits most work without ladders, b) a tree structure with minimal permanent trunk or scaffold wood, and c) a canopy structure with simplified fruiting wood that is uniform and renewable. The systems are: 1) KGB, a multiple leader bush with 15 to 20 upright fruiting units; 2) TSA, a narrow single leader, with lateral fruiting units; 3) UFO, a fruiting wall comprised of an oblique, cordon-like leader with about 10 vertically-oriented fruiting units; and 4) SSA, a fruiting wall comprised of closely-planted single leaders with short lateral fruiting units and severe annual pruning (Figure 6 below). Each system is being tested on the three Gisela rootstocks 3, 5 and 6.

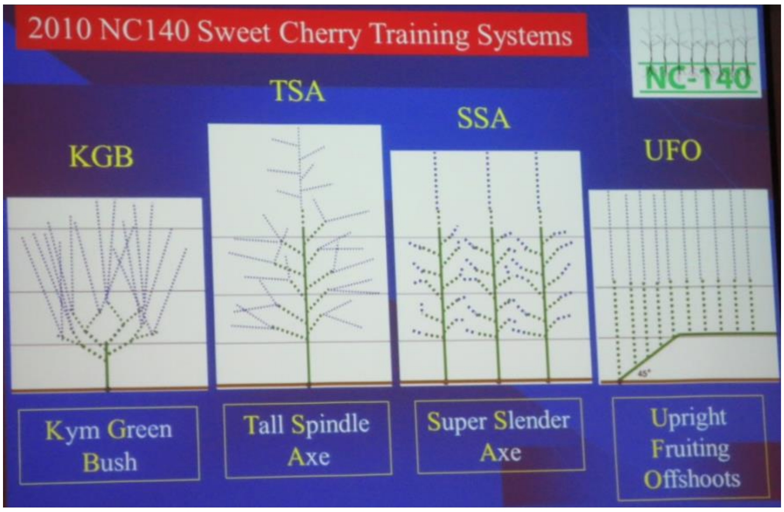


Figure 6 Pictorial display of cherry systems

No actual yield data was presented as the trial is still in the early stages, but consistent effects were noted in the effect of the rootstock on tree vigour, with G3 giving much less growth than either G5 or G6 which were quite similar, with G5 slightly less vigorous than G6. Similar differences were seen with the number of fruiting sites produced by the different rootstocks with G3 having more than the other two. The fruiting wall SSA system produced the most fruiting sites.

M Meland (Norwegian Institute for Agricultural and Environmental Research) reported on two years of trials, testing various blossom thinning sprays, including Sulphur with and without soya oil; ATS with soya oil; ATS and hand thinning on Jubileum plum. They concluded that sulphur sprays had a moderate thinning effect but could not be recommended. However ATS at 1.5% applied at full bloom resulted in adequate thinning.

Poster session

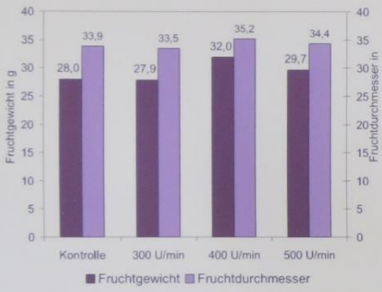
The following poster was presented at the Symposium, outlining work carried out on orchard planting systems and tree management in stone fruit.

Effects of mechanical crop load management (CLM) on source : sink relationship and quality of pome and stone fruit

C. Seehuber, L. Damerow, M. Blanke

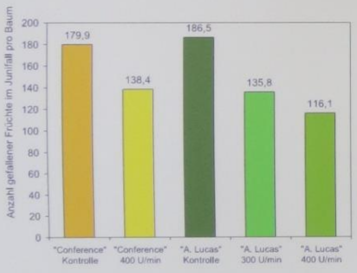
Introduction

- CLM (crop load management) is the prime tool to improve or achieve the required fruit size and colouration for class I marketing of pome and stone fruit
- thinning chemicals can have drawbacks / shortcomings such as their dependency on fruit tree age, cultivar and weather
- No approved – registered thinning chemicals for pear and plum
- Objective was to examine mechanical thinning as a tool for CLM in both pome and stone fruit



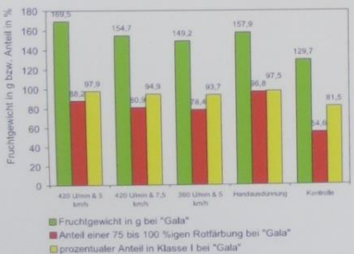
Thinning trial with plum

- Mechanical thinning in European plum with 300 rpm or 400 rpm at 5 km/h on nine-year-old trees of precocious cv. 'Ortenauer' spindle trees on GF 655/2 rootstock.....
- achieved a leaf : fruit -ratio of 5:1 with 130 cm^2 leaf area/fruit
- increased fruit mass by >2 g/fruit (relative to the un-thinned control) and
- increased class I portion > 30 mm diameter



Thinning trial with cv. 'Conference' pear

- Mechanical thinning in pear with 300 or 400 rpm at 5 km/h on 18-year old super spindle trees of cvs 'Conference' and 'Alexander Lucas'....
- increased fruit mass by 23 % in cv. 'Conference' and by 38 % in cv. 'Alexander Lucas' (relative to the un-thinned control), but
- without stimulating shoot growth or vegetative growth



Thinning trial with cv. 'Gala' apple

- Mechanical thinning of cv. 'Gala' slender spindle trees on M 9 with 360 rpm at 5 km/h ....
- increased fruit mass by between 20 g and 40 g, and
- improved the percentage of well-coloured class I fruit by 15 %

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2. Rootstocks & Varieties

Simon Middleton (Department of Agriculture in Australia) described a new apple variety 'Kalei' which has performed well in trials producing yields peaking at 115-140 t/ha and consistent yields over two consecutive years of between 90 and 100 t/ha, depending on the growing system. The variety is scab resistant but can produce very large fruit if trees are undercropped. Further details are included in Figure 7.

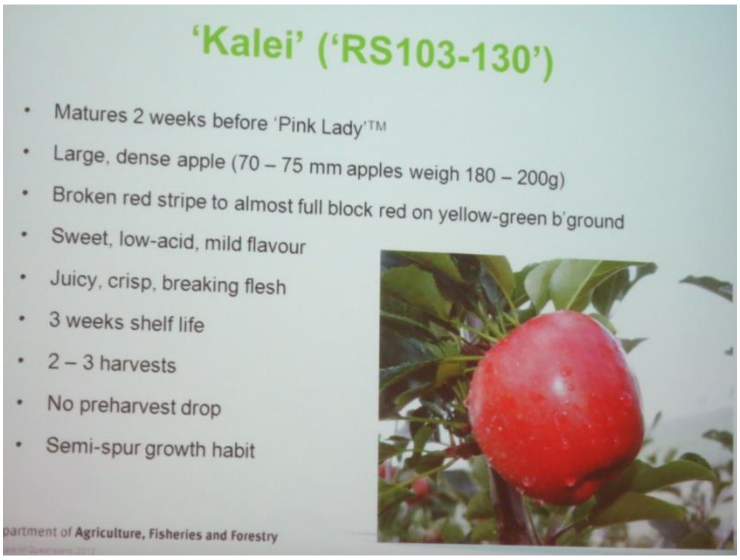

Figure 7 Details of a new apple variety called Kalei

Gennaro Fazio gave the second keynote address on the subject of rootstock breeding and how it could increase productivity in orchards of the future. The paper set out the extent of the influence a rootstock can have on the scion variety in areas such as: water and nutrient uptake, growth and fruiting, branch number and angle, anchorage, hormone transfer, pest and disease interactions, ability to withstand replant disorders and variations in soil pH. With advances in marker assisted breeding, the speaker made the case for careful analysis of traits associated with all the factors listed above so that markers can be identified and exploited in breeding programmes. Advances in these techniques should enable 'designer' rootstocks to be bred for specific soil types and climatic regions suited for particular varieties.

Rolf Stehr (Jork Research Station, Germany) presented data from a seven year study into seven rootstocks for pear. Measurements were made of tree size, annual growth, yields, fruit size and quality. At the end of the trial it was concluded that none of the selections offered any benefit over Quince C or Quince A. The test rootstocks were: Quince S1, PiBu2, PiBu3 and Pyrodwarf and Fox 11.

Jef Vercammen (Pcfruit Research Centre at Sint Truiden, Belgium) described three other pear rootstock trials comparing Pigwa, Quince S1, Pyradwarf, Quince H, C132 and Quince Eline against standards Quince C and Quince Adams. Pigwa, S1 and Pyrodwarf were all more vigorous than QC and Q Adams. Quince H and C132 had similar vigour to the controls, but showed less frost damage in 2009. QH produced less fruit, but C132 had comparable yield to Q Adams and produced larger fruit. Q Eline is slightly more vigorous than QC but yields have been less. It produces fruit with a much smoother skin and had a better mineral composition in both fruits and leaves.

Mariusz Lewandowski (Skierniewice, Poland) presented work on studies of the susceptibility of a range of 14 apple rootstocks to fireblight. CG 16 proved to be resistant; P59 and M7 were moderately susceptible, but all the others were susceptible.

Frank Maas (Wageningen University, Netherlands) described trials to test selections of Prunus Spinosa as a dwarfing rootstock for plum. A thousand seedlings of P spinosa (Blackthorn) were budded and 113 with reduced vigour were taken forward. The number of root suckers and spines were used as further selection criteria, reducing the number for on-going testing to 24, giving a range of vigour and productivity from St Julien A to Krymsk 1(VVA-1) (Figure 8). Some of the most promising selections produced too many root suckers, but the most promising selection in terms of combining dwarfing and lack of suckers and spines, is going forward for wider commercial evaluation. Initial observation shows good tolerance/resistance to Sharka, and tests will be carried out for its compatibility with other stone fruit crops.

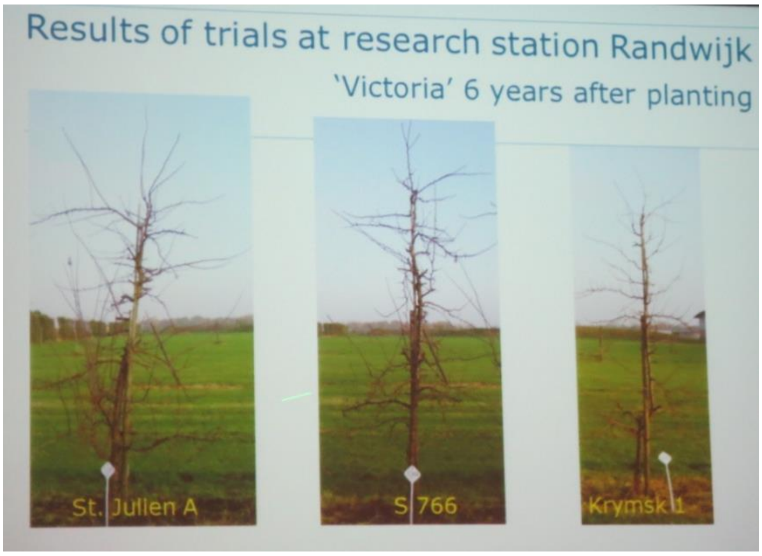

Figure 8 Comparison of rootstocks for plums

Frank Maas (Wageningen University, Netherlands) has also been testing rootstocks for cherry. The trial used Kordia on Krymsk®5 (VSL-2), Krymsk®6 (LC-52) and G5. Shoot growth, increase in trunk diameter and intensity of flowering of 'Kordia' were almost identical. Fruit production per tree was significantly higher for 'Kordia' on Krymks®6 than on G5, while that on Krymsk®5 was similar to that on G5. Both Krymsk rootstocks induced a slightly reduced fruit size and lower sugar and acid content. With Krymks®6 the smaller fruit size was related to the higher fruit load of the trees, so thinning may be needed. With Kymsk®5 the reduction in fruit size could not be attributed to overcropping. Fruit cracking was less in 'Kordia' cherries grafted on Krymsk®6 than on G5 or Krymk®5. Both Krymsk rootstocks produced significantly more root suckers than G5, with Krymsk®5 producing the highest numbers of suckers. Krymsk®5 also developed burrknots. It was concluded that Krymsk®6 could be a good alternative to G5, especially for less well drained soils and because it reduced fruit cracking. Due to its tendency to reduce fruit size and the need to prevent overcropping, Krymsk®6 probably is less suited for self-fertile cultivars than for self-incompatible cultivars.

Poster session

The following posters were presented at the Symposium, outlining work carried out on rootstocks and varieties.

afbi Agri Food and Biosciences Institute

A preliminary evaluation of 'Bramley's Seedling' Apple grafted onto a range of new rootstocks (Geneva, USA and European) and grown in Ireland

Seán Mac an tSaoir1, Dermot Callaghan2, John Mansfield and Frances Ward, AFBI, Loughgall 1 and Kildalton Teagasc Kilkenny 2, Ireland

Irish climate is predicted to change towards wetter winters and drier summers. The Irish apple industry is based mainly on the M9 rootstock which suffers in wet conditions. Alternative disease resistant rootstocks must therefore be trialled for their compatibility with the Bramley in terms of growth, form and function to prepare the industry for ongoing climatic changes. Bramley scions have been grafted onto a selection of rootstocks from the Geneva range in addition to Supporter 4 and M116. These new combinations have been planted with their reference Malling equivalents in a replicated trial across Ireland.

Tree propagator Frank P Mathews (England) obtained the necessary rootstocks and produced the trees in the traditional manner. The novel rootstocks grafted were CG7, CG11, CG13, CG16, CG202, MM116 and Supporter 4. The standard rootstocks used for comparison were M27, M9, M26, M106 and finally M106 with a 9 interstem (M106/9). In April 2010, the trees were planted at a standard 3m x 4m spacing with 7 replicates at Loughgall and one at Kildalton (Co Kilkenny). The central tree of each plot was used for recording purposes. In the winter of 2010, the trees were pruned to remove broken or crossing branches and brought into shape. Subsequently the trees remained unpruned to allow the particular rootstock characteristics to be demonstrated in relation to Bramley.

Bramley formed successful graft unions with all the rootstocks and to date the new rootstocks are matching their Malling equivalents.

Table1 Rootstocks ranked according to Trunk Cross Sectional Area in Nov 2012

Rootstock	Cross sectional Area cm2	Trunk Diam squared cm 2	Bearing Surface per tree	tree volume m3 (pi R2 *h)/3	YA
M9	8.21	10.46	5477	0.76	0.006
M27	9.18	11.69	6122	0.84	0.015
CG 13	12.18	15.50	8122	1.28	0.012
M26	12.97	16.52	8654	2.36	0.025
M116	14.86	18.92	9910	1.85	0.008
Average	16.27	20.72	10854	2.29	0.028
MM106	17.20	21.90	11473	1.84	0.015
CG16	17.42	22.18	11617	3.02	0.022
CG11	17.65	22.48	11774	3.42	0.028
106/9	18.55	23.62	12376	2.78	0.094
SUP4	18.57	23.64	12387	2.24	0.011
CG202	22.06	28.09	14715	3.83	0.038
CG007	26.42	33.64	17622	3.30	0.066

Table 2 Louhgall Rootstocks ranked according to Yield per hectare

Rootstock	2011	2012	Total 2011-12
106/9	0.66	0.94	1.61
CG007	0.68	0.66	1.33
M27	0.70	0.15	0.84
CG16	0.61	0.22	0.83
CG202	0.38	0.38	0.77
Mean	0.34	0.28	0.63
M26	0.19	0.25	0.45
CG11	0.15	0.28	0.44
M106	0.16	0.15	0.32
SUP4	0.20	0.11	0.31
M9	0.21	0.06	0.27
M116	0.12	0.08	0.19
CG13	0.07	0.12	0.19

Table 3 Rootstocks ranked according to mean of Trunk diameter at 40 cm above ground level, with Kildalton (South) and Loughgall (North) shown separately.

	South	North	Mean
M27	5.88	9.18	7.53
M9	8.79	8.21	8.50
CG13	12.92	12.18	12.55
M26	14.51	12.97	13.74
M116	16.41	14.86	15.63
Average	14.86	16.27	15.57
CG11	15.46	17.65	16.56
M106/9	15.52	18.55	17.04
CG16	16.87	17.42	17.14
S4	15.97	18.57	17.27
M106	21.82	17.20	19.51
CG202	19.89	22.06	20.98
CG007	17.59	26.42	22.00

Fig 1 Rootstock site, Loughgall N Ireland Nov 2012

The overall objective of this research is to identify suitable rootstocks for Bramley to future proof the Irish Apple Industry against the predicted effects of global warming. In addition, this research is the first large scale apple experiment which covers both parts of Ireland. In 2010 and 2011 the trees established themselves and 2012 was to be the first year in which reasonable yield levels were expected. However, 2012 has proven to be the most abnormal season since records began in 1856. March ended with very high temperatures which forced the buds to commence growth earlier than normal. April started with frost which caused some flower damage. Subsequently it started to rain. Between 1 April and 11 August at Loughgall, there were three days during which the leaves were dry. Rain resulted in low levels of pollination and photosynthesis. Fruit set and overall yields were significantly reduced, particularly in the South of Ireland where flowering is normally earlier than in the North of Ireland. Large areas of orchards remained waterlogged for the whole summer. A significant degree of root rot will now be expected over the current winter and into next year increasing the urgency of this work.

Teagasc

Agriculture and Rural Development

Effect of Replant Disease on Growth of *Malus x domestica* 'Ligol' Cultivated on P-series Apple Rootstocks

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Experimental treatments: "diseased" versus sterilized soil in two separate years — 2009 and 2010

MATERIALS AND METHODS

The study was conducted in 2009 and 2010. It involved 'Ligol' apple trees growing on different vegetative rootstocks for apple (Figure 1, 2 and 3). Rootstocks came from the same source, had a well-developed root system, a virus-free status and similar size (the diameter of the stem at 10 cm above the root crown was 8-10 mm). They were dug out from stool-beds in late October 2009 and 2010, sorted out and immediately placed in cold storage at a temperature of 0°C. In late March, in both years of the study, the rootstocks were grafted with scions of the cultivar 'Ligol' (winter grafting in hand), derived from virus-free mother trees. The resulting grafts were planted in early April to plastic containers, with a capacity of about 5 dcm^3, filled with a mineral soil. The soil was collected from the orchard rows in which apple trees had been grown for the previous 25 years. The soil was taken separately from two layers: the arable layer (0-20 cm) and sub-arable layer (20-40 cm). From both batches of soil, soil samples were taken for chemical analyses to determine soil pH and the levels of P, K and Mg. Then the soil from the two layers was thoroughly mixed at a ratio of 1:1 by volume and divided into two parts. One part was subjected to pasteurization (disinfection) by steaming with superheated dry steam at a temperature of 95°C for 30 minutes. The other part was not pasteurized and was used as the control. Five days later, the plastic containers were filled with this soil, the grafted rootstocks were planted in them, and the containers were placed in a field covered with white agrotextile. Plants were irrigated and fertilized. The following parameters of the trees were assessed:

1. Rootstock diameter (at a height of 5 cm) before planting and at the end of the growing season, what allowed to calculate the increase of the diameter of the rootstocks at the end of vegetation (Figure 1),
2. The height of the stem of the trees (cm) at the end of vegetation (Figure 2),
3. Fresh weight of the root system of the trees (g) at the end of vegetation (Figure 3).

RESULTS

In both years of the study, the type of the soil had a large effect on the growth vigour of 'Ligol' apple trees. Irrespective of the rootstock, in both years of the study, the trees growing in the non-disinfected soil had on average a much higher increase in the diameter of the stem and its height than those which were grown in the disinfected soil (Figure 1 and 2). Very strong similarity of the results of this experiment in both years of the study and poor growth of the trees in the pasteurized soil indicate that soil pasteurization resulted in a long-term loss of the physico-chemical properties essential for the growth of trees, and, above all, of biological life. Perhaps the response of the trees to being grown in the pasteurized soil (disinfected with steam) would have been different if the trees had not been planted in a freshly pasteurized soil (5 days after pasteurization), but after a period of 2 weeks, or even longer, from the time of the treatment.

The root system of 'Ligol' apple trees responded very differently to the growing conditions of the pasteurized soil than their above-ground part did. Regardless of the rootstock, the trees of this cultivar grown in the pasteurized soil produced a much larger root system, as determined by the fresh weight of the roots produced, than the trees that were grown in the 'tired' soil (Figure 3). On average for all the rootstocks, the trees growing in the pasteurized soil, in both years of the study developed a root system 2.27 times larger than those that were grown in the non-disinfected soil. However, it can be assumed that if the experiment had lasted longer, or if the trees had been planted in the ground, then those with a much larger root system (from the pasteurized soil) would have grown more strongly than those that were grown for a few months in the non-disinfected soil.

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Leinfelder M. and Merwin I.A. 2006. Rootstock selection, preplant soil treatments, and tree planting positions as factors in managing apple replant disease. HortScience 41(2): 394–401.

Figure 1
Increase of the diameter [mm] of the rootstocks in 'diseased' soil and sterilized soil (Skierniewice, average for 2009-2010)

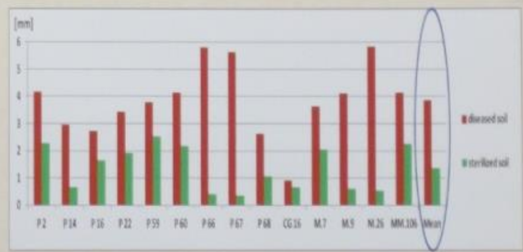
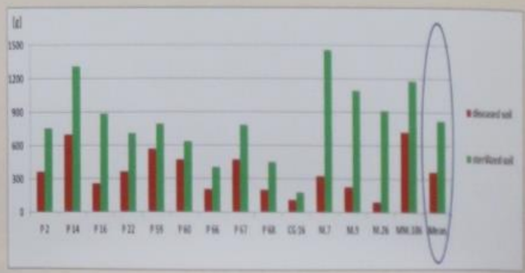


Figure 2
Height of the stem of the trees [cm] in 'diseased' soil and sterilized soil (Skierniewice, average for 2009-2010)

Figure 3
Fresh weight of the root system of the trees [g] in 'diseased' soil and sterilized soil (Skierniewice, average for 2009-2010)



P 67 – A New Semi - Dwarf Rootstock for Apple from the Polish Breeding Program

InHort SKIERNIEWICE

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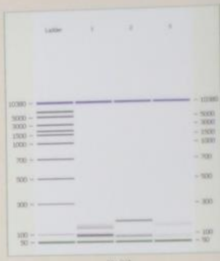
P 67 rootstock in stoolbed

Root system of P 67 rootstock in stoolbed

P 67

DNA fingerprinting generated with ISSR primers: 823 (1), 824 (2), 836 (3), 840 (4)



P 67

DNA fingerprinting generated with SSR primers: CH01g05 (1), CH04a05 (2), CHb12 (3)

INTRODUCTION

Breeding program of vegetatively propagated apple rootstocks started in Poland in 1954. It's basic aim is to obtain rootstocks with the properties of the well known rootstocks M.9 and M.26, but better adapted to the local environment and less susceptible to economically important pests and diseases. P 67 was selected in 1980 from a population of 144 seedlings obtained from a cross made in 1976 between A 2 x P 2. In Poland P 67 is protected by the Plant Breeders Rights and in May 2012 the application was submitted to the Community Plant Variety Office in Angers in order to get the protection in territory of the European Union. P 67 is considered as a semi-dwarf rootstock, however trees on this rootstock are less vigorous than on M.26 and more vigorous than on M.9. P 67 has a good propagation ability in stoolbed (better than M.9 and M.26) and shows very good compatibility with the tested cultivars. The rootstock also shows high yield productivity (not lower than M.9 and M.26) (Table 1). Root system has a good anchorage ability, better than M.9, however trees on P 67 in the orchard require additional support. P 67 has a good winter frost tolerance, better than M.9 and M.26 (Table 2). It is also low susceptible to apple scab, moderately susceptible to apple mildew and collar root of apple but is susceptible to fire blight.

Table 1
Trunk cross-sectional area (TCSA), tree productivity and cropping efficiency coefficient (CEC) of 'Jonagold' cultivar grafted on P 67 rootstock (average 1999-2006)

Rootstock	TCSA [cm^2]	Yield [kg/tree] 1999-2006	Yield [t/ha] 1999-2006	CEC [kg/cm^2]
M.9 EMLA - control	46.9	98.8	141.3	3.5
P 67	40.8	105.8	151.3	3.6

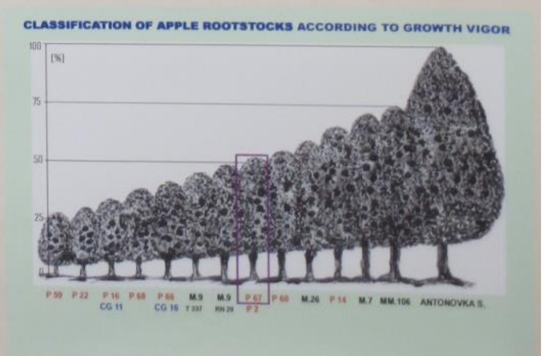
Trees were planted 4.0 x 1.75 meters apart.

It was found, that after ten years of cultivation the trees of 'Jonagold' cv. grafted on P 67 rootstock grew less vigorously than the trees on the standard rootstock M.9 EMLA. For P 67 rootstock was also obtained higher yields and higher cropping efficiency coefficient.

Table 2
Growth vigor of P 67 rootstock in comparison to the control after artificial freezing at -12^oC (average 2009-2010)

Rootstock	Diameter of the stem [%]	Height of the stem [%]	Fresh weight of the roots [%]
M.9 EMLA - control	11.1 a	73.5 a	46.0 a
P 67	26.8 b	88.9 b	61.1 b

'Jonagold' on P 67 rootstock



3. Crop Physiology

G Lopez (Irrigation Technology, Spain) presented data on the effects of severe drought on production and fruit quality and showed that the response of the tree can last over two seasons by reducing the starch in the root system which leads to a reduction in fruit set in the following year.

T Volschenk (ARC Infruitec, Stellenbosch) presented another paper on soil water status. She looked at four different moisture levels determined by the soil matric potential (-20kPa; -70Kpa; -300kPa and no irrigation) at different stages of the growth and fruiting cycle.

E Hamadziripi (Department of Horticultural Science, Stellenbosch University) described work which showed that there are differences in fruit quality attributes including concentration of antioxidants and phenolics, between fruit grown on the outer edge of the tree canopy and those grown within the canopy. These differences could be discerned by consumers. However the trial trees were over 30 years old with a large canopy and tests on smaller canopy trees showed much less variation and growers have no need to segregate fruit in order to satisfy consumer demand.

John Palmer (New Zealand Institute for Plant and Food Research Ltd – ex East Malling Research) presented the third keynote address. John opined that the role of crop physiologists is not adequately recognised by research funders as physiology tends to look at the big picture and is about understanding the many processes that determine plant development and fruitfulness.

Recent advances in orchard design and tree management have resulted in greater yield efficiency, but fruit quality is still largely measured in terms of size and colour. John argued that we need to take precision horticulture to a further stage and produce fruit to a target consumer product that will ensure repeat consumption. To do this, more physiology is required, not less, and also a multi-disciplinary approach is needed that is able draw on the skills and expertise of many branches of science. An example of where crop physiology can give some answers was presented in the work being done in New Zealand to look at the importance of fruit dry matter concentration (DMC) as a measure of eating quality. Studies have found that the correlation between harvest total soluble solids (TSS) and ex store TSS is not good, but there is a very strong correlation between harvest DMC and fruit TSS after 12 weeks of storage. There is also a very strong link between harvest DMC and consumer preference tests, with higher DMC fruit scoring better for eating quality and intention to repeat purchase.

The challenge for crop physiologists is to elucidate the factors that affect harvest DMC, such as crop load, light, water relations etc. and at what stage in the cropping cycle these factors exert the greatest influence so that growers can increase DMC consistently in different growing environments. The challenge is that it is possible, especially in New Zealand, to design orchards with 90% light interception producing 160 tons/ha, but are the apples nice to eat? John urged delegates to at least start looking at DMC in their own regions, and to look at the distribution of fruit in the tree, type of fruiting wood and leaf:fruit ratios and see how they influence DMC.

Alan Lasko (Cornell University, New York) described crop modelling work that he hoped would provide a new tool to advisors and growers to help them in the prediction of a range of parameters such as apple set, yield, optimum cropping and making decisions regarding the need for irrigation and thinning etc. It was found that the weather after bloom affected the natural set, with low light levels enhancing the drop. The interaction of these weather events and the efficacy of thinning sprays is complex as it involves the carbon supply to the fruitlets. Being able to model these interactions would enable growers to make better informed decisions regarding the aggressiveness of their thinning interventions.

Nigel Cook (adviser with Prophyta) explained the difficulties of managing trees subject to inadequate winter chill. The main effect is on the delayed emergence of foliage and blossom which can be spread over many weeks, resulting in fruitlets and blossoms being present on the tree simultaneously (Figure 9).

Figure 9 Typical effect of inadequate winter chilling

The tree habit is also affected creating trees that are basally dominant, rather than apically dominant as we are accustomed to in the UK (Figure 10). This has implications on pruning and tree training especially in the establishment of the orchard. The effects can be partially overcome by storing nursery trees in cold store prior to planting. The lower picture shows the improved tree habit following a period in cold store.

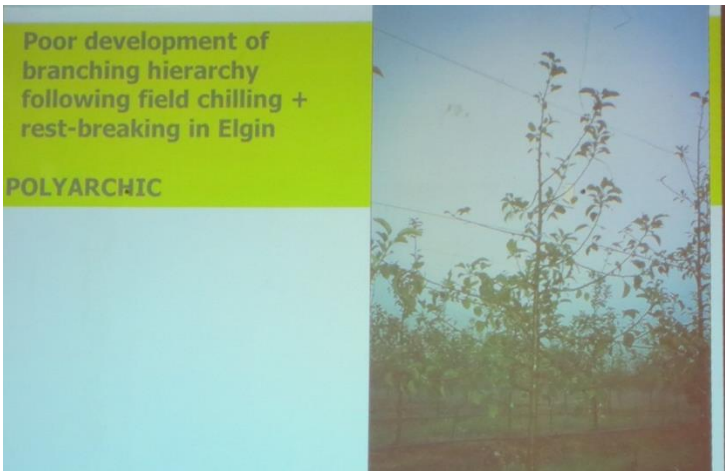


Figure 10 Inadequate winter chilling can result in trees which are basally dominant

Figure 11 Improved tree habit following a period in cold store

Poster session

The following poster was presented at the Symposium, outlining work carried out on crop physiology.


NC STATE UNIVERSITY
EVALUATING APPLE REPLANT STRATEGIES IN THE SOUTHEASTERN UNITED STATES
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Abstract
Apple (Malus domestica) replant disorders, which reduce orchard productivity, have been documented. However, strategies to mitigate these disorders may vary from region to region. Two replicated studies were established in North Carolina to evaluate strategies for managing replant issues. The first trial was established in 2005 in a replant site and is evaluating the effects of a pre-plant soil treatment (1,3-dichloropropene + 35% chloropicrin) and rootstock selection on tree survival, trunk cross-sectional area (TCSA) and cropping. Eight dwarfing rootstocks (B.9, M.9T337, M.9 Pajam 2, M.26, G.41, G.935, G.11 and G.16) and three semi-dwarf rootstocks (M.7, G.30 and G.210) were included in the study. Significant differences in TCSA among both the dwarf and semi-dwarf rootstocks were measured with the fumigation main effect being non-significant at the P≥0.05 level. Significant rootstock differences were detected in the cumulative crop yield for the dwarf rootstocks, which did not occur in the semi-dwarf rootstocks. The second trial was established in 2007 in an 'Adam's Apple' red delicious/M.7 commercial orchard evaluating the effect of three preplant soil treatments (dazomet, chloropicrin and 1,3-dichloropropene + 35% chloropicrin) and an untreated control on tree growth and productivity. The treatments were applied in the fall of 2007 with planting in March 2008. Although early in the life of this study, numerical differences have been detected in tree growth as measured by TCSA and cumulative yield.
Objectives
To identify rootstocks for profitable and sustainable use in NC replant apple orchards while minimizing pesticide inputs.
Evaluate the effectiveness of pre-plant soil treatments to minimize replant issues and increase tree growth and productivity
Materials and Methods
2005 Apple Replant Study
A long-term replant trial to evaluate dwarf and semi-dwarf rootstocks with and without pre-plant soil fumigation.
Site had been in apples that were removed in August, fumigated in October and planted in April 2005 (MHCRS, NC, USA Latitude 35°25'42.69"N, Longitude 82°33'48.48"W)
Split-plot randomized complete block design with fumigation as the main plot and rootstock as the subplot with 8 replications
Fumigation treatment - Telone C-35 applied at a rate of 280.6 l/treated ha with a rig to a depth of 25 cm and a total treated strip width of 2.7-3.0 m.
Eight dwarfing rootstocks - B.9, M.9T337, M.9 Pajam 2, M.26, G.41, G.935, G.11 and G.16
Three semi-dwarf rootstocks - M.7, G.30 and G.210
'Gala' is the scion cultivar
2007 Apple Fumigation Study
apples for many decades and most
Peach trees were removed in
soil cultivated and nutrient and lime
made according to recommendations
'Adams Apple' red delicious'/M.7 trees were planted in March 2008
Randomized complete block design with five - 10 tree replications
Telone C-35 application and soil sealing
Basamid G application and incorporation
Results
Conclusions
2005 Replant Trial:
Among the dwarfing rootstocks trees on G.935 and G.16 had the largest TCSA and trees on B.9 the smallest
Cumulatively, trees on G.935, G.16 and G.11 had the greatest yield and trees on B.9 the smallest
Across the dwarfing rootstocks, there were no significant fumigation effects for all of the parameters measured
For the semi-dwarf rootstocks, trees on M.7 had significantly greater TCSA, and significantly lower yield efficiency, than trees on G.30 or G.210
The main plot effect of fumigation on survival, 2012 yield, or cumulative yield was not significant
2007 Fumigation Study:
Although very early in the life of this study, especially for trees on M.7, there appears to be some trends emerging from the data
There have been no significant differences in TCSA at the P≤0.05 level since planting. However, since 2009 the trees grown in the non-fumigated soil have had the smallest TCSA and cumulative yield.
Rootstock selection appears to be the most reliable, cost-efficient and environmentally sound option at this time
Acknowledgements
•North Carolina Department of Agriculture and Consumer Services Specialty Crop Block Grant program
•Dr. Terence Robinson, Cornell University
•Mountain Horticultural Crops Research Station Staff
•Ms. Joy Smith, NCSU SAS Consultant

4. Orchard Tour

On day three of the Symposium, delegates joined a tour of orchards in the Western Cape and were given talks on the objectives of the South African R&D initiatives and the effects of growing apples in a low winter chill area.

The objectives of the research programmes are to:

- Achieve 300 tons of production by year 6 and full annual yields of 100t/ha
- Increase intensification to 2,000 trees/ha, introduce certified nursery trees and develop more efficient rootstocks
- Improve labour efficiency to < 15 man days/ha each for pruning and thinning and > 6 bins/man day for harvesting
- Improve the soil environment by increasing water efficiency, root function, soil carbon, and soil biological activity and diversity
- Introduce greater precision through monitoring and traceability, mechanisation and gps systems
- Reduce or eliminate synthetic chemical inputs by using IPM, reducing inoculum levels and introducing resistant cultivars.

Figure 11 Trial to investigate the effects of different coloured hail nets

Figure 12 The South African Concept Orchard

Figure 13 The South African Concept Orchard - evaluating more intensiveplanting in a fully enclosed netted orchard to eliminate hail and insect damage.

Figure 14 Traditional orchards still make up a proportion of the production area

Figure 15 Traditional orchards still make up a proportion of the production area

Figure 16 Typical fruit growing valleys in the Western Cape

Figure 17 A new orchard of tall spindles on trellis and planted on a ridge